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Infrastructure Development

Tata Projects emerges as Lowest Bidder for ₹889-cr Parliament Building Contract

Tata Projects has emerged as the lowest (L1) bidder for the construction of the new Parliament building in New Delhi involving an estimated investment of ₹889 crore. Out of the seven companies, which placed their bids, only two matched all the requirements. Urban Affairs Ministry informed that Tata Projects submitted a bid for ₹861.90 crore and L&T quoted a bid of ₹865 crores.

Investors to invest over ₹2,300 cr near Jewar Airport

69 firms have been allotted industrial land near the upcoming Jewar airport in the past two months with officials expecting investments of over ₹2,300 crore. There was no industrial land allotment in the first month of the current fiscal. In May, nine firms were allotted 37.50 hectares of land with an investment of ₹1,285.58 crore, and in June, 16 firms were allotted 25.88 hectares of land with ₹315.70 crore investment.

Govt to permit FDI in LLPs in Construction Sector

Government is all set to clear a proposal to permit foreign direct investment (FDI) in limited liability partnership (LLP) firms engaged in construction and infra development. Currently, FDI is permitted under the automatic route in LLPs that are operating in sectors where 100% foreign direct investment is allowed through the automatic route and there are no FDI-linked performance conditions.

Mining sector set for a major revamp

The government is aiming to streamline the working of private mine developers and operators (MDOs) ahead of the first coal mining auctions with private company participation and wider plans for a massive increase in coal production. The PMO has suggested NITI Aayog to consult with industry to create a new legal framework and policy regime for private mine operators.

Odisha unveils twin Barrages worth ₹236-cr

Odisha state government has decided to build two barrages across Baitarani to expand irrigational coverage to 1,500 hectares of land in the district and the neighbouring Bhadrak area. The two projects estimated to cost about ₹236.63 crore and have got administrative approval of the state government.

Ahuwalia Contracts secures ₹323-cr contract in HP

Ahuwalia Contracts (India) has secured a new order involving an investment of ₹323.32 crore. The construction project, which was awarded by the state wing CPWD Hamirpur in HP, involves the construction of 240 Beds Hospital Building of Dr Radha Krishnan Medical College and Hospital at Hamirpur District.

Assam Govt announces ₹12,000-cr Infrastructure Projects

Assam State government has announced projects worth ₹12,000 crore. PWD & Finance Minister Himanta Biswa Sarma informed that the construction work on the projects is being undertaken on a fast-track basis with government funds and external loans. 12 other road projects worth ₹6,000 crore, funded by the Asian Development Bank and Asian Infrastructure Investment Bank, are also all set to commence.
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Gayatri Projects wins ₹196-cr water infra contract
Gayatri Projects has been declared as the lowest (L1) bidder for a project worth ₹196 crore in UP. The scope of work includes the construction of Kachonda Kalan Group of Villages Water Supply Scheme in Lalitpur District and allied works including commissioning, operation and maintenance for 10 years.

NLC India plans ₹43,000-cr for Power & Mining Sector
NLC India has decided to invest ₹43,000 crore in various power and mining projects thereby adding 3,920 mw of power, including 1,000 mw solar and 11.50 mtpa of mining capacity to the company.

Centre approves ₹1,500-cr AP Coastline projects
Ministry of shipping has approved coastline infrastructure projects of ₹1,500 crore in Andhra Pradesh. The ministry is taking up these ventures for the improvement of Kakinada anchorage port under the Sagarmala Programme and the anchorage port capacity would be increased from two million tons to four million tons.

Road & Highway

Govt. settles claims of ₹14,248-cr in road sector
The government has settled highway developers' claims of ₹14,248 crore involving 47 claims this year and discussions are underway to settle another 59 cases on a fast-track basis. Conciliation committees of independent experts have been formed to settle all pending issues. MoRTH has undertaken the settling of contractors' issues, including dues, through arbitration, to ensure ease of doing business and to boost stakeholders' confidence in quality road construction.

MoRTH awards ₹31,000-cr projects from April to August
The NHAI has awarded the highest length of projects during FY 2020-21 as compared to the projects awarded during the same period in the last three years. From April to August 2020, NHAI has awarded 26 projects of 744 km length as compared to 676 km in FY 2019-20, 368 km in FY-2018-19 and 504 km in FY 2017-18. The capital cost of these 26 projects is over ₹31,000 crores, which includes the cost of civil construction, land acquisition, and other pre-construction activities.

NHAI speeds up ₹4,900-cr interstate road project
The work on six-lane 'access-controlled corridor' with service roads on both sides starting from Akshardham Mandir to Loni at Delhi-UP border is all set to start as the NHAI has initiated the tendering process for the project. The corridor is a part of the Union Transport Ministry's project - the 155-km corridor between Akshardham in Delhi and Saharanpur in UP.

PNC Infratech takes up ₹1,547-cr road project
PNC Infratech has signed the concession agreement with the NHAI for the four-laning of Meerut - Nazibabad section of NH-119 (New NH-34) for design chainage km 11+500 (Meerut) to 39.250 (Behsuda) and also from 79.500 km (Bijnor) to 105.700 (Jalalabad), in UP under the Bharatmala Pariyojna on Hybrid Annuity Mode (HAM).

IRB Infra inks pact for ₹1,755-cr Vadodara-Mumbai e-way
IRB Infrastructure Developers has entered into a pact with NHAI for executing a stretch of Vadodara-Mumbai Expressway in Gujarat at ₹1,755 crore for a project under the Bharatmala Pariyojna Phase 1. VM7 Expressway Private Limited has executed Concession Agreement with NHAI for the eight-lane access-controlled expressway from km 190 to km 217.5 of Vadodara-Mumbai Expressway.

MoRTH launches ₹4,300-cr road projects in UP
The Union transport minister has laid foundation stones for 363-km of highway projects costing ₹4,300 crore in UP. These roads will enhance better connectivity, convenience and economic growth.

PM kick starts ₹14,258-cr Road Projects in Bihar
Prime Minister, Narendra Modi, has laid the foundation stones of nine highway projects in Bihar via video conferencing. The total road length of these projects is about 350-km, involving an investment of ₹14,258 crore.
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Bihar unveils extension of ₹15,135-cr ring road project
The Bihar state government has decided that the north side approach road of the Kachchi Dargah-Bidupur six-lane bridge over Ganga river will be extended up to Vaishali in the west and Tajpur (Samastipur) in the eastern direction. The entire ring road project of 135-km involves an investment of ₹15,135 crore. The state CM has directed the road construction wing to build two more six-lane approach roads in its north side to directly link Vaishali and Tajpur districts.

NHAI hastens ₹7,400-cr Mysuru-Bengaluru expressway
NHAI has fast-tracked the 118-km long ten-lane expressway between Mysuru and Bengaluru of ₹7400 crore and the project is likely to be completed by 2022. According to NHAI Superintendent Engineer, Sridhar, the travel time between the two major cities will reduce from 3 hours to 90 minutes.

NHAI plans to lay ₹1,200-cr four-lane Road in Tamil Nadu
NHAI is planning to build a four-lane road from Kurumbapalayam in Coimbatore district to Sathyamangalam in the Erode district, at an investment of ₹1,200 crore. The existing road will also be upgraded up to Barnari and Dhimbam ghat road will be upgraded up to TN-Karnataka interstate border.

Govt expedites work on 290-km long HP-Ladakh road
India has expedited work on a road linking Darcha in HP with Ladakh crisscrossing a number of high-altitude snow-bound passes. The 290-km-long road will be crucial for the movement of the troops and heavy weaponry into the frontier bases of the Ladakh region and will also provide a direct link to the Kargil region. It will be the third road link to Ladakh after the other two roads: the Manali-Leh and Srinagar-Leh highways.

Govt approves ₹3,400-cr for Delhi-Meerut Expressway
The Union transport ministry has approved the first package of a six-lane access-controlled highway, which will be a part of the direct and seamless connectivity from Delhi-Meerut Expressway at Akshardham to Dehradun. The NHAI Board gave the go-ahead to the highways authority to award the work for 31.6 km section from Akshardham to the Eastern Peripheral Expressway (EPE) at Khekra near Baghpat.

UP Govt expedites ₹5,800-cr new expressway in Gorakhpur
The UP government has expedited the land acquisition process for 91-km expressway project in Gorakhpur, involving an investment of ₹5,800 crore. The project will cater to Gorakhpur, Sant Kabir Nagar, Ambedkar Nagar and Azamgarh. The UP Expressway Industrial Development Authority (UPEIDA) has released ₹275 crore to speed up land acquisition for the project.

NHAI unveils ₹1,876-cr Villupuram-Pondicherry Highway
To streamline traffic between Villupuram and Pondicherry, NHAI has proposed to expand the 67-km stretch into a four-way bypass road with 17 bridges and a 45m-60m right of way (RoW) and grade separators at an estimated cost of ₹1,876 crore.

NHAI approves the construction of Delhi-Dehradun elevated e-way
NHAI has given the go-ahead signal for the construction of the Delhi-Dehradun elevated expressway. The project, which will reduce the distance from 258-km to 180-km and travel time from 5 hours to 2.5 hours, entails an investment of ₹10,000 crore. The expressway is expected to complete in the next 3-5 years and will crisscross Ganeshpur, Mohand, and Ashkrodi in Uttarkhand and Saharanpur, Baghpat and Loni in UP.
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Metro & Rail

CCEA approves ₹5,617-cr orbital rail corridor in Haryana

The Cabinet Committee on Economic Affairs, headed by the PM, has approved the 121-km long Haryana Orbital Rail Corridor project connecting Palwal to Sonipat at an investment of ₹5,617 crore. The project, which is to be commissioned in the next five years, aims at improving regional connectivity and decongest the NCR region and will help in developing multi-modal logistics hubs in the area.

EU bank to invest 650-mn euros in Kanpur Metro project

The European Union’s (EU) bank will invest 650 million euros on the construction of Kanpur’s first city metro line. It is the banks’ second-biggest operation outside Europe financing a 32.4-km metro line with stations and rolling stock. The European Investment Bank’s (EIB) investment will help about 3 million masses in Kanpur to benefit from green, faster and affordable public transport.

MP fast-tracks ₹14,442-cr twin metro projects

MP Government has fastened the twin Bhopal and Indore Metro Projects at an investment of ₹14,442 crore and they would be commissioned in the next 3-4 years. The M.P. Metro Rail is forming 50:50 Joint Venture Company between Union and State Governments and the JV will be operated by the Board. The total investment includes the cost of ₹6,941 crore for Bhopal Metro and ₹7,500 crore for Indore Metro.

BMRCL inks ₹140-cr pact for Station Development

Bangalore Metro Rail Corporation Limited (BMRCL) has inked MoU with Embassy Group for the construction of Bettahalasuru Metro Station involving a ₹140 crore investment. The new station will be a landmark station considering its location between Bagalur Cross and Trumpet Junction at Bettahalasuru. It will also be a part of BMRCL’s proposed new line “ORR-Airport Metro” on Outer Ring Road from Central Silk Board to Hebbal via K R Puram and on NH- 44 up to Trumpet Junction.

NHCRL floats tenders for 741-km High-Speed Corridor

Indian Railways has floated tenders for conducting the survey for a 741 km long high-speed rail corridor from Mumbai to Nagpur for running a Bullet Train on the route. The high-speed rail corridor will pass through Nasik in Maharashtra. National High-Speed Rail Corporation (NHSRCL) has been entrusted by the railways to prepare DPR for seven new high-speed rail corridors.

Railway starts Aerial Survey for Bilaspur-Leh Rail Line

Northern Railway has initiated the survey for the Bilaspur-Manali-Leh railway line in Mandi and Kullu districts of HP. A team of the NR officials has arrived in Mandi and is conducting the aerial survey of the new rail line from Bilaspur to Manali. The final survey of the railway line from Leh to Manali has been completed.

NCC emerges as lowest bidder for Patna Metro contract

DMRC opened the financial bids of the civil contract package PC-01 for the construction of 6.107 km stretch between Malahi Pakri- New ISBT section of the corridor-2 of Patna Metro project. NCC Limited has emerged as the lowest bidder (L1) among the other four contenders for this project. The scope of work includes part design and construction of the Elevated Viaduct, Viaduct connection to Depot including an Elevated Ramp for Depot, stabilising & extension of Viaduct for Corridor-1 at Khemni Chak Station, special spans and an elevated ramp at Malai Pakri.

Govt. floats tenders for 7 high-speed rail corridors

The Central government has floated tenders for the new bullet train projects across the country and the Railway Ministry has directed NHSRCL for preparing detailed project reports for all the seven corridors on a fast-track basis. Among others, these include 886-km long Delhi-Jaipur-Udaipur-Ahmedabad high-speed rail corridor connecting the Mumbai-Ahmedabad Bullet train corridor.

Afcons emerges lowest bidder for ₹1,112-cr RRTS rail contract

Afcons Infrastructure has bagged a ₹1,112 crore rail project. It became the lowest bidder for constructing the 4.3 km long Sarai Kale Khan – New Ashok Nagar (Package 6) of the 82.15 km Delhi – Meerut (RRTS) Line after the National Capital Region Transport Corporation (NCRTC) opened the financial bids submitted by infrastructure building players.

Piling work for Delhi Metro’s Magenta Line starts

The joint venture between Sam India Builtwell and Gulermak has kick-started the construction of test piling works at the Majis Park Station for the construction of a 7.473 km elevated extension of Delhi Metro’s Magenta Line (Line-8) between Haiderpur-Badli-Mor and Ashok Vihar stretches. Sam India – Gulermak JV was awarded this section (Package DC-03R) of the Delhi Metro’s Phase 4 project this year at an investment of ₹766.12 crore with a completion period of 30 months.
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**MRIDC fast tracks ₹16,039-cr high-speed rail line**

MRIDC has fast-tracked the Pune-Nashik semi-high-speed rail link, which would bring down travel time between the two cities from 6-7 hours to less than two hours, boosting passenger and freight movement and facilitating the creation of a Mumbai-Pune-Nashik golden triangle and economic hub.

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**Noida Metro to float tenders for Aqua-Line corridor**

The Noida Metro Rail Corporation (NMRC) is all set to float tenders for Aqua Line's Greater Noida corridor, which will branch out from Sector 51 to Knowledge Park 5. Once commissioned, this 15-km extension will link the Greater Noida sectors with Delhi Metro's Blue Line and improve connectivity with the Capital.

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**Railway pushes ₹4,085-cr railway project in Bengal**

The northeastern railway has hastened the Sivok-Rangpo 44.96 km long rail line involving an investment of ₹4,085 crore. Out of the total length, 41.55 km falls in West Bengal and 3.41 km in Sikkim. An investment of ₹682 crore has been incurred up to March 2020 and an outlay of ₹607 crore has been provided for the current financial year.

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**J&K gets ₹3,848-cr Baramulla-Kupwara railroad project**

The railway authorities have conducted a satellite survey for the construction of a railroad from Baramulla to Kupwara in northern Kashmir entailing an investment of ₹3,848 crore. For the project, which was approved by the central government in 2018, the railway has already submitted the report of aerial survey for the 39-km long stretch to the railway board.

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**DMRC invites bids for ₹1,958-cr Patna metro project**

DMRC has invited bids for the construction of the first underground package (PC-03) of Patna Metro’s 14.05 km Line-2 of the Phase 1 project which will connect Patna Junction Railway Station and the new ISBT through 12 stations at a cost of ₹1,958.81 crore. After Package PC-01, about 8-km package PC-03 is the final package of Line-2 and will comprise of 6 underground stations.

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**Survey work for Kozhikode-Wayanad Tunnel Road begins**

The Kerala Government has initiated the survey works for the longest tunnel road in the state, connecting Kozhikode and Wayanad districts at an investment of ₹658 crore and the project is being financed through Kerala Infrastructure Investment Fund Board (KIIFB). The project includes the construction of the tunnel road with a length of around 7-km, which will provide an alternative to the Thamarassery Ghat road and will be a part of the Anakkampoyil-Kalladi-Meppadi road.

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**Navayuga Group bags ₹1,887-cr rail tunnel contract**

The Visakhapatnam-based Navayuga Group has emerged as the lowest bidder for the construction of tunnels and bridges along with formation work in Uttarakhand. The bid comes under package – 3 for building a new rail line between Rishikesh and Karnprayag.

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**Assam Govt announces construction of ₹321-cr flyover in Guwahati**

The Assam state government has announced the construction of a 4-km long new flyover in Guwahati involving an investment of ₹321.41 crore. Minister Himanta Biswa Sarma informed that the flyover will connect the new road, which is currently under construction at the Nilachal hill to the main road.

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**Megha Engineering bags ₹4,509-cr Zojila Tunnel**

Megha Engineering and Infrastructure Limited (MEIL) has bagged the Zojila project in J&K, involving an investment of ₹4,509.50 crore. The company will start the tunnelling work in October this year and NHIDCL will execute infrastructure projects. The project will be constructed in two sections, totaling 33 km. The first section will be 18.5 km long and the second will be constructed in the shape of a horseshoe with a length of 14.15 km.

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Govt approves 12.7-km long tunnel under Shinkun La pass

The defence ministry has given the go-ahead to NHIDCL to prepare the detailed project report (DPR) for a 12.7 km tunnel beneath the Shinkun La pass in the border belt of Ladakh and HP. The tunnel will provide all-weather road connectivity between HP and Leh, which is being developed as an alternate road for strategic reasons. It will link the NH-3 from the HP side with Darcha-Padam-Nimu road to Leh.

KRCL commences work for ₹658-cr tunnel in Kerala

The Konkan Railway Corporation Limited (KRCL) has launched the groundwork for the construction of a 6.8 km long tunnel between Anakkampoyil and Meppadi in Wayanad, connecting Kozhikode and Wayanad in Kerala at an investment of ₹658 crore.

IRCON secures ₹400-cr bridge contracts

IRCON International has secured contracts for the construction of nine road-over-bridges (ROBs) from the Ministry of Railways involving an investment of ₹400 crore. The scope of work is to provide project management consultancy (PMC) services for the construction of ROBs in lieu of existing level crossings.

Real Estate

Lodha Group launches Casa Greenwood realty project

Lodha Group has launched its premium lifestyle project - Casa Greenwood in Amara at Thane in Mumbai. The company has targeted to exploit the changing consumer needs for safe open spaces. It will feature facilities like decks and private gardens, bigger houses, and proximity to the 2-acre forest land developed inside the community.

Prestige Group launches realty projects in Bengaluru and Goa

Prestige group has achieved a key milestone with the virtual launch of three Prestige properties - Prestige Ocean Crest (Goa), Prestige Primrose Hills (Bengaluru) and Prestige Waterford, premium residential property (Bengaluru). In Goa, the group has partnered with the Mathias Construction Pvt Ltd to jointly develop the Prestige Ocean Crest project. It will consist of 106 apartments, seven shops and one sea-view restaurant. Irfan Razack, chairman & MD informed that it is strategically located and provides a well-developed social infrastructure with multiple schools, hospitals, and retail spaces in the vicinity.

L&T Realty forays into Chennai commercial market

Larsen & Toumbro Realty, has planned to build its maiden commercial project in Chennai where 6.85 million sq ft project will be developed in four-five phases. In the first phase, it will develop around 1.2 million sq ft space and that the project is expected to be completed by 2022. It is also building a million sq ft of residential space in the same project.

Hiranandani targets ₹19,000-cr in DC Yotta infrastructure

The Hiranandani Group-owned data centre (DC) company Yotta Infrastructure has planned to invest about ₹19,000 crore in setting up new DCs across four cities including in Delhi and Kolkata. Sunil Gupta, MD and CEO of Yotta Infrastructure informed that in Mumbai, its DC went live a few months ago and its Chennai centre is set to start soon. DCs are capital intensive projects and, between Mumbai, Chennai and Delhi, the company is building 15 structures at ₹15,000 crore.

Rajasthan launches 25 housing projects across state

The Rajasthan CM has laid the foundation stones for 25 real estate projects to be developed by the Rajasthan Housing Board (RHB). The projects include 14 housing schemes, four affordable housing schemes, city park and coaching hub. In Jaipur, two projects like city park and coaching hub will be developed. RHB will develop the city park on around 52 acres in Mansarovar area which is expected to benefit more than 50 colonies.

Port & Airport

AAI speeds up ₹995-cr airport project in Arunachal Pradesh

The Union Ministry of Development of North Eastern Region informed that the Airports Authority of India has fast tracked the construction work on the greenfield airport in Hollongi, Arunachal Pradesh at ₹995 crore and the project is destined to be commissioned by 2022.

Govt approves ₹3,669-cr Srikakulam Port in AP

Andhra Pradesh state government has approved the DPR of the phase-1 works of Bhavanapadu port in Srikakulam costing ₹3,669.95 crore. Special Chief Secretary (Infrastructure and Investment), R Karikal Valaven informed that the Cabinet has given a nod for the development of the port. The DPR by RITES for the development of Bhavanapadu Non-Major Port has also been accorded sanction for starting phase-1 works.
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With the construction market reviving, manufacturers are gearing up to offer more value to the end-users with tech-enabled, robust machines that come with numerous attachments for specific applications. P.P Basistha reports.
The construction sector is seeing some revival as most of the Infra projects that had come to a standstill in April and May due to the pandemic have restarted - leading to green shoots in the industry. The months of June, July, and August saw some recovery, which has certainly improved market sentiment,” observes Deepak Shetty, Deputy CEO & Managing Director, JCB India Limited. According to him, two key sectors are set to emerge in the coming years: Infrastructure development in Rural India and creation of a world-class Healthcare infrastructure across the country. At a national level, impetus to Railways, Irrigation, and large projects like Sagarmala would also drive demand for Construction Equipment. Additionally, the focus on creating 100 new airports, Smart Cities and Metro projects would open up newer opportunities. “As the thrust on infrastructure development continues to be a priority for the Government, we are optimistic about a rapid recovery of the economy. As per the initial reports of September, we are seeing some growth and are hopeful that this momentum will continue till the year end,” says Shetty. JCB today has the widest range of Backhoe Loaders in India that includes 2DX, 3DX ecoXcellence, 3DX Xtra, 3DX Super and the larger 4DX. These versatile machines are used for a variety of applications and in almost every construction project ranging from Roads and Highways, Railways, Irrigation, Rural Roads, and Housing, to general Construction, and Maintenance, in both urban and rural India.

The brand new 3DX Backhoe, powered with JCB ‘IntelliPerformance’, is a smart machine which saves up to 12% fuel and reduces operational cost by 22%. The machine comes with 30 new features like smooth gear shift, new ergonomic seating, LED lights, etc., and is also equipped with ‘IntelliDig’ technology that gives operators real time indication on the depth and reach.

Exhibiting JCB India’s strong focus on Digitisation and Innovation, the backhoe loaders are enabled with JCB’s advanced Telematics Technology – Livelink, for Next Generation Asset Monitoring and Fleet Management. Further, an internal tool, ‘Smart Serve’ has been developed, which digitally supports service engineers and service jobs, to improve machine efficiency and productivity, thereby improving customer profitability.

JCB’s genuine parts application enables the customers to order genuine parts of JCB products, online. All machines by JCB India are backed by the finest after-sales service support through 700 outlets and over 60 dealers. These outlets are spread across India and are equipped with parts and trained manpower, thus ensuring that the customers are never far from professional product support.

Says Shetty, “JCB has always believed in localization. Our flagship product, the JCB backhoe loader is indigenized to almost 97% (by value), and is trusted for its proven productivity, reliability, operator comfort, fuel efficiency and performance.”
Case India is positioning its 770 EX OL, 770 EX PRO, CASE 770 EX Magnum PRO and 851 EX PRO series of backhoe loaders even more strongly in the marketplace. Its PRO series is powered by an FPT Industrial S8000 engine which delivers powerful performance and a fast response time. The series is re-engineered from the ground and provides a high backhoe breakout force, higher loader lift capacity/reach, and best-in-class cab visibility. “The PRO backhoe with its advanced features was ahead of its time when we launched it and it continues to be relevant even today,” avers Puneet Vidyarthi, Brand Leader Case India.

The PRO series has robust machines with a robotically welded two-piece structural frame for greater stability, performance and serviceability, and a heavy-duty structure, tank, fenders and rims to work efficiently in the harsh Indian operating conditions. The backhoes are equipped with Eagle Eye Telematics System for enabling real-time vehicle tracking and communication based on GPS technology, which keeps track of the machine’s performance, while the geofencing feature gives overall security by monitoring the machine’s movement. Vidyarthi informs that the company has given loan and warranty extensions to their customers to ease their financial pressure and has launched a new scheme wherein customers can buy a Case machine and pay for it after 90 days. “Through CNH Capital, our financial arm, we made sure that there is enough capital available for customers who wanted to make new purchases. To provide faster solutions for buyers, we have come up with a 48-hour loan approval policy. For our institutional buyers and customers who own large fleets, we have lucrative finance schemes with some of the lowest interest rates in the market. All these customer-friendly initiatives have enabled us to drive businesses and has earned the Case India brand more recognition and respect.”

He adds, “CASE India has always stood shoulder to shoulder with its customers and dealers. The company has been trying to hedge its production and service costs, while helping our dealers make their business profitable in these trying times, so that we can help retain and build sales when the market improves. We have given them more leeway, support and superior enterprise technology and taken measures for liquidation of old stock lying with them. In fact, when we anticipated such a situation in February 2020, we launched a strong marketing campaign to clear our old inventory. And, even in these challenging times we have been delivering parts and scheduling services for our customers.”
Says Rahul Shorey - Head (Construction), Tata Hitachi Construction Machinery. “The right equipment for the right applications is important for improving productivity and saving the cost of operations. To this end, Tata Hitachi is offering a wide range of attachments for specific applications; they also help in lowering operation and maintenance cost of the customers.”

He informs that Tata Hitachi has been building a strong connectivity between its backhoe loaders and other machines through remote diagnostic tools, IoT and artificial intelligence. For instance, its Shinrai backhoe loaders are InSite enabled. “Digital technologies like Telematics has enabled constant communication with our customers, who get early warning alerts for periodic service, maintenance issues etc, so that they can take timely action to ensure availability of their machines and at the same time reduce the operating cost by saving on costly breakdowns.”

The new Shinrai comes with a range of versatile attachments like backhoe bucket and loader bucket in different sizes to suit various applications, trench buckets for pipe laying and trench applications, ditch cleaning buckets for solid waste handling, and ripper tooth for pulling blocks or concrete. The company offers factory-fitted rock breakers for demolition and breaking of small and medium size stones; augers for special applications like drilling, pole erection, plantation, fencing, and casing applications; and quick couplers for a fast changeover.

Shorey informs that during the lockdown the company was providing services using digital tools to help customers maintain their machines and keep them in good working condition. “Our sales teams were continuously engaged with customers to apprise them of our offerings and how these could aid their business, going forward. We conducted webinars to counsel and instill confidence in them during the lockdown period and discussed upcoming opportunities in infra development in the country as well as in their area of operation. Now, with the pandemic situation easing, most of our dealer outlets have resumed operations.”

He adds, “Tata Hitachi teams have been active on social media to strengthen the company’s brand by sharing the success stories of our customers. We have engaged with contractors, OEMs, and financers so that together we can tide over the slowdown and use this time to explore new methods of conducting and sustaining businesses. We have apprised the financers of how we are supporting customers by lowering their overall cost of owning a machine. In this way, we wanted to instill confidence in the financiers so that they would not desist from funding machines.”
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Abhijit R Shinde, Head Sales & Marketing, Escorts Construction Equipment Limited, informs that ECEL is bringing more value to its backhoe loaders by incorporating advanced and rugged features for multi-application capabilities, backed by reliable service and customer support. “We want that ECEL customers get quick returns on their investments. Our backhoe loaders have a robust, rugged structure; they deliver higher product uptime and require low maintenance, even after prolonged usage.”

He adds, “In accordance with the Indian Government’s mission of Atmanirbhar Bharat, and to cater to the country’s Infrastructure and Road Development, ECEL is offering a complete range of backhoe loaders under models Digmax II and Jungli. Both the variants come with 76-hp to 90-hp engine options. Today, the backhoe loader is seeing newer application areas, and its usage is no longer restricted to digging alone. To meet the new application requirements, we are offering various attachments (as options). These include hydraulic rock breakers, backhoe mounted grader attachment, ripper, range of BH and loader buckets and other tools sourced from specialized vendors. The attachments give our customers more application solutions within a single product.”

Escorts backhoe loaders have a robust, robotically welded structural frame for greater stability, performance, and serviceability. Large box-section structures in high-stress areas such as the boom nose, foot, and cylinder, enhance the machine’s durability. The new heavy-duty front axle ensures that all the wheels remain in contact with the ground even on the roughest terrains, giving exceptional stability and reliability.

The company offers two types of engines: the powerful and fuel-efficient Kirloskar’s water-cooled diesel engine, and Escorts water-cooled diesel engine. Says Shinde, “The company understands that power and performance are critical to the success of a machine. Escorts BHL engine options allow customers to save over 10% of fuel per hour to lower the running cost and have a competitive edge in the highly competitive contracting and hiring business.”

Escorts Intelligent Equipment Monitoring System keeps customers informed about the machine and have control over their business from the comfort of their office, car, or home. The hydraulic system allows the operators to do multiple movements simultaneously with features that are normally found in excavators. With the highest digging force and faster excavation cycle in time, the backhoe loaders work 20% more per liter, giving the best performance in all kinds of strata.

Escorts BHL machine gives the loader dump height of 3 meters and dig depth of 4.8 meters, along with high tear-out force. The backhoes’ high torque engines give
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the best-in-class dozing performance, and ease in loading high body trucks. The new tilting engine hood provides quick access for maintenance. In fact, the machine layout has been designed to ensure that all daily service points are easily accessible at ground level, for quick and efficient servicing.

The cabin has 20% more space with redesigned ergonomics for a more livable cabin for operator comfort. It includes a helper seat, storage compartments and a bottle holder. Large windows provide all-round visibility, improve air ventilation, and enable easy communication to the back of the machine. All the controls have been positioned to offer easy access and faster control.

To enhance customer experience, ECEL is providing 24x7 service and parts support through its dealers, along with add-ons such as extended warranties, etc. The company’s wide distributor network for parts availability has increased the company’s reach across the country. Plus, it is providing phone-based service for end-to-end solutions to customers remotely. Services are given for its own components as well as those provided by the OEMs, including the attachments. “We have a competitive edge in product support, not through standard telematics, but by providing varied solutions based on customer specific requirements. We are also increasing the number of touchpoints for maintenance and are stocking genuine parts with our dealers and distributors. This will ensure timely availability of our machines and reduce their downtime,” informs Shinde.

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“Carraro and hydraulic pumps from reputed brands. The machine is available in both two- and four-wheel drive options.”

“The high-performance AX 124 gives value for money with its best-in-class aggregates and at the right price. To offer more technically advanced machines we are investing in R&D so that our customers get higher productivity out of them, and earn quick ROIs, especially in the current tough times when profit margins are under pressure. We are also digitalizing our internal and external operations to create a more efficient organization,” he adds.

Recent improvisations by ACE in its backhoe loaders include more advanced engines to optimize machine output with minimum fuel consumption, while meeting the emission regulations; advanced hydraulics for higher productivity; a GPS system and telematics to monitor and manage the machines remotely. “The Covid lockdown gave us the opportunity to focus even more on research and development, design of new products, upgradation of existing products and VA/VE (Value Analysis/Value Engineering) activities, wherever possible,” says Handa. He informs that ACE has given financial assistance to its dealers so that they can retain their employees and sustain themselves in the volatile demand scenario due to the fallout of Covid-19.
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Rahul Joshi, Head- Product Planning, Marketing & PMO, Mahindra Construction Equipment informs, “With the advent of BS IV norms, the cost of backhoe loaders is set to increase. To provide customers more cost-effective solutions, we are developing a below 50-hp backhoe loader and it will be within the emission norms. It can be used in 80% of the major applications. Our existing products will also incorporate the new engine technology and they will be further enhanced as regards their operative features, ease of use and comfort value.”

He adds that since there is a pressure on operating margins, the company will be providing telematics in its machines for the benefit of the customers. “We believe that any new feature added to a machine should bring value to the user such that the greater functionality compensates for the additional cost of the machine. We are also enhancing our product support with an all-inclusive approach to meet the changing customer preferences. Our telephonic assistance for dealing with micro problems will increase, and we will work on how to make the per hour maintenance cost more economical such that the value of the parts and of our machines are optimized and the benefit transferred to the end-users.”

Doosan Bobcat – another new entrant in the Indian backhoe loader market launched in 2019 October - is positioning its B900, 76-hp, 4x2 backhoe loader as a competitive product. “The proven design capabilities of Doosan Bobcat will give us a competitive edge in the market for backhoe loaders. The product has been designed to deliver higher productivity, efficiency, lower fuel consumption, and overall lower operating cost.” Says Manjunath S, General Manager, Sales Head, Doosan Bobcat India Pvt Ltd.

Further adding, “The aggregates used in our B900 Backhoe Loader are of the best quality as they are sourced from vendors of repute. Engines from Kirloskar India; cylinders from Wipro India, while the axles are from Carraro to just name some of the key components. Most importantly all the structures like rigid booms, arms, and chassis are all completely made in-house at the company’s new Chennai facility to ensure high levels of quality, reliability and durability.”

Doosan Bobcat for its backhoe loaders is targeting the main construction companies and the equipment rental players. For the rental segment, where the applications would comprise diverse uses across various construction sectors, Doosan Bobcat besides the main product B900 is offering a range of attachments like rippers, hydraulic rock breakers that can further improve the utilization.

“Doosan Bobcat has a pan India dealer network for sales and service of its products. To ensure timely support to our customers, we have dealer partners at every potential state sometimes more than one, each with 5-6 outlets. We want to provide best support to our customers so that they become our brand advocates” says Manjunath clearly laying out the ambitions of Doosan Bobcat for its Backhoe Loaders and other products. With customers’ profit margins under pressure, manufacturers are striving to make owning and operating their machines financially viable during the current lean period. But as demand improves, competition is likely to become more intense - and so will marketing. In fact, an aggressive marketing plan by manufacturers augurs well for the Indian infra sector as it will broaden the range of product offerings and make prices more competitive. It will also strengthen the pre- and post-sales customer support and service packages of the manufacturers to beat competition.
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A whatsapp message looking for a bridge platform got Team CMAC moving briskly on designing of the platform. Within two months of the initial discussions, the company got the purchase order for the platform.

CMAC took up the challenge to provide this suspended platform. The span of the bridge is 28 meters; the cable stay bridge is 234 meters long between two pylons. CMAC equipment is designed to enable work on the underside of the bridge. The client also asked for a floating mechanism to help them work under water.

The design of the platform took shape on a 3-tier basis; the span of platform is 30 meters and the raised height on the ends is almost 5 meters. The tiers (levels) help the technician/artisan to reach the parabolic under the bridge surface. Access onto the platform is given by well-crafted stairs from the bridge deck.

The automation team worked on a 4-motor control panel. Given the importance of the project, the design team at CMAC set the safety systems in place for synchronous tilt and power factor variations, and such like.

When the time finally came to erect and demonstrate it, team CMAC celebrated the first suspended bridge platform on 15 Jan 2020.

Since the client wanted a moving bridge platform, the CMAC team was faced with a huge challenge as the entire system needs to be pulled or pushed while the platform is hanging. Realising the difficulty, the design team went back to the drawing board, and did a lot of structural changes for the top mechanism.

Two counter-weight structures were used instead of one to enable the movement. The wheels of the mechanism were replaced by channels for guiding the movement, instead of rails. After two interactions at the site, Team CMAC proved the effectiveness of the new machine by moving it while the bridge was hanging with the technicians working on it. In a day, the team could work around 15 running meters. Thus the designing gave birth to a new machine – the Moving Bridge Platform.
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As part of Northeast Policy, the Ministry of Railways took up the project of providing rail connectivity to Imphal in Manipur state. As per the detailed survey, the rail alignment takes off from existing Jiribam station in Assam and traverses a length of 111km before connecting to Imphal, running along picturesque lush green scenery marked by hills, valleys, waterfalls and rivers.

At present, people have to travel by road on the existing National Highway (NH-37) which is 230-km long with several steep gradients, hair-pin bends and weak bridges. It takes more than 10 hours by road, whereas it will be less than 2 hours once the rail line is commissioned. The rail link has other advantages of strategic importance as it will usher economic development of Manipur with tremendous tourist potential, and, more importantly, it will form a vital link of the proposed Trans-Asian Rail Network connecting several countries.

As the rail line crosses a series of hill ranges, several tunnels and viaducts are necessary to maintain the gradient required for a railway line. One of these viaducts is spanning across a gorge of width 700m and depth 141m - which is the world’s tallest pier bridge of its category, surpassing the previous record of 139m in a rail line in Europe.

**Challenges**

Challenges encountered and techniques developed in designing and building this world record bridge to make it safe and sustainable.

**Hilly Terrain:** The alignment passes through the hill ranges of Patkai region (eastern trail of Himalaya), comprising a series of tunnels and viaducts. While the high mountains are penetrated by tunnels, the deep gorges need to be spanned by tall viaducts. An alternative to viaducts is high embankments, but this is not a practical solution in the present scenario, considering their susceptibility to failure, requirement of huge earth quarries and need for large spaces, and huge maintenance. Hence, a detailed comparative study was made, and viaducts were found to be the best choice for reasons of aesthetics, environment, sustainability and economy.

The tallest of such bridges (Br.No.164) spans over a gorge of depth 141m and length 703 m. This bridge is slated to become the tallest in the world in its category from the point of view of pillar height, surpassing the existing tallest of Mala-Rijeka viaduct on Belgrade-Bar railway line in Europe where the height is 139m. Digital Terrain Model of the bridge site (not to scale) is illustrated in Fig.1a

Except for a meandering NH-37, there are no other significant roads. The alignment is interior in the hilly forests and far-flung from the NH. All construction materials like cement, steel, aggregate and equipment are to be carted from various places to the work sites along the NH. Hence, new approach
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roads were to be made with heavy-duty excavators from the NH to the sites - often at steep slopes and sharp curves. (Fig.1b). Undulating ground with thick vegetation poses a severe constraint of space required for stacking of the materials.

Contamination of streams by construction waste is to be minimised. The rich local culture and heritage are to be given due respect.

The salubrious environment of the Northeast with fragile flora and fauna is a treasure to be well protected with least damage during construction and operation phases.

Heavy Rainfall: The area receives almost 3500mm of rain annually. Hence, the alignment needs to be designed with adequate drainage to cater to the flash floods and sharp flows causing erosion and instability. Flash floods with landslides are a serious concern, as experienced by the NH presently, which need to be addressed now to ensure that the slopes are well protected and adequate drainage arrangements are made.

Most-severe Seismic Zone: The entire railway line, including the bridge, lies in the most severe seismic zone due to its proximity to the active fault between Indian and Eurasian tectonic plates. Static methods for bridge analysis given in the code are not representative to study the dynamic response of this massive structure. Hence, to ensure overall stability of the bridge and the trains running on it, specific site studies and detailing are essential.

Geological conditions: Being sedimentary formations, the general soil type is classified as shale interspersed with sandstone. Shale when exposed to atmosphere, loses its shear strength drastically, warranting out-of-the-box slope protection measures to stabilize the slope as well as protect the surface from erosion due to the heavy rains in this region.

Security and Law and Order issues: Militancy is a serious concern which needs to be properly addressed not only during construction but also during operation. Threat calls, armed attacks on sites, kidnap and ransom demands of engineers, are a regular phenomenon which are tackled in coordination with the local State Government.

Finalization of Bridge Configuration

Due to the complexity of the conditions and challenges enumerated above, it was decided that the total bridge system needs to be properly dealt right from design to construction to operation stage. Hence, a special team of experts – the Technical Advisory Group (TAG) - was formed. It comprised members from various fields like Bridges, Earthquake, Geotechnology, Hydrology, Environment and Security. The TAG was given full powers to deliberate and decide the best configuration for the bridge from all aspects.

Recommendations of TAG

After detailed investigations, site visits and deliberations, TAG made recommendations considering the constructability, maintainability, durability, and environmental conformity, besides meeting functional requirements of the structure. The provisions are discussed in the subsequent paragraphs.

Reference Codes & Manuals

As this bridge is the first-of-its kind in India, TAG recommended that, apart from IRS codes (Indian Railway Standard), other codes like IS (Indian Standard), IRC (Indian Road Congress), AREMA (American Railway Engineering and Maintenance-of-Way Association), UIC (International Union of Railway) and Euro codes shall also be considered to the relevant extent for ensuring a robust design.

Deciding Span lengths

The total gorge length to be spanned is around 700 metres. Various options were considered: continuous spans, arches, balanced cantilever, cable stayed, and simply-supported-through-type-open-web-girder. Longer the span length, higher are the seismic forces and associated deformations, which are detrimental to the safe running of trains. On the other hand, smaller spans entail a larger number of tall piers, which enhances the cost.

To strike the right balance, it was proposed to adopt a span of 106m, as such spans are already in-vogue. The simply-supported option was most desirable in view of its advantages of simple design and maintainability, besides safety and long-term stability. Other spans of 71.5m and 30m are also adopted on the sloped approaches as per site-suitability.

Design Methodology

As desired by TAG, consultants having sufficient experience in similar designs were engaged. In addition, following IITs (Indian Institute of Technology) were associated:

- IIT/ Kharagpur: For developing the site-specific earthquake spectra, as per Colda requirements
- IIT/ Kanpur: For performing the wind tunnel tests for ensuring safety and stability against vibrations
- IIT/ Guwahati: Validation of structural designs and drawings, and value addition
- IIT/Roorkee: Validation of slope-stability studies and protection works

Foundations

As per exploratory bore-logs, the general trend in soil profile is 5m of thick soft shale, followed by 12m of fractured siltstone with interspersed boulders and overlaid on hard sandstone rock. Open foundations are ruled out as the SBC of shale are extremely poor.
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Well foundations are practically difficult considering boulder strata. Hence, Bored cast-in-situ RCC piles are the preferred option. The pile is 30m long well-anchored into the hard sandstone to safely withstand the huge vertical and horizontal forces under most-adverse conditions. Capacity of the piles needs to be calculated based upon the subsoil characteristics available beneath the perfidious layer prone to destabilization.

As some of the piers are on the slopes, structural design of pile foundation is also influenced deeply by the extent of slope failure. In absence of lateral soil resistance, the unsupported length of pile increases simultaneously and the design moment on pile also rises. In such scenarios, the predominant design factor for pile foundation is the moment capacity of piles instead of axial or lateral capacity (Ref. Figures 2a & 2b).

Skin friction is not considered as per the Codal requirement due to soil liquefaction in high seismic zones, corroborated by cyclic pile load tests. All piles are tested ultrasonically by CHUM method to establish their integrity for full depth.

Substructure

As the piers are high, the design is governed more by the top lateral deflection in view of the stability of the superstructure and safety of running trains. Three different pier types were examined: Steel trestle, Reinforced Cement Concrete (RCC) hollow cylindrical and RCC hollow tapered. As there are no other standards, it was decided to limit the lateral deflection of pier to H/500 as per the Building Code, where H is the pier height. Time-History Analysis are performed to understand maximum pier deflections and associated curvature of the track.

Steel trestle was failing in deflection criteria. Tapered hollow sections though apparently economical, pose problem during construction by slip-form. Hence cylindrical hollow RCC piers are selected which have better aesthetically appeal. Economy is achieved by reducing the thickness along the height. To provide better rigidity, diaphragms are provided at regular intervals. Construction of the pier is by slip-form technique, which does not need any support from the bottom. It is supported on series of jacks that anchor against the set concrete.

Second Order Effects on Tall Piers

Tall piers are considered slender as per the height to base dimension ratio. Hence second order analysis becomes relevant. The second order effects can be considered as supplementary action to the internal forces and corresponding deformation due to the first order effect. Second order effects are additional action or effects caused by the interaction of axial forces and deformation under load [4, 5] (Refer Figure – 3a).

The influencing factors for assessment of second order effects are considered as [5]:
- Slenderness ratio
- Magnitude of Axial Load
- Magnitude of Moment
- Reinforcement ratio
- Flexural rigidity of cracked section
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Limit of slenderness provides the basic criteria to the engineer about the consideration of second order effect [4]. As per the common practice the tall piers are considered as fixed on the pile cap level during the calculation of slenderness ratio. In light of the previous discussion, unsupported piles on a collapsed slope, the slenderness calculation should consider the slenderness of the pile group (Refer Figure – 3b). Effect of unsupported length of pile group will increase the slenderness of the system. This is a crucial design factor as an apparently non slender structure will experience second order moment in reality. The additional moments have been properly factored into the design to avoid stress concentration, cracking and serviceability issues in long term design life. The bridge element computer model duly considering.

**Super Structure**

As mentioned in para 3.3 supra, maximum span length of 106m is proposed with Open-web through (OWT) steel girders which are ideal and economical. Steel elements are fabricated in workshop with controlled conditions ensuring consistent quality. Apart from normal loads, members are designed for special requirements like fatigue, erection loads and serviceability. Central camber of 165mm is provided to counter for the vertical deflection under loads.

The overall height of the OWT girder is decided as per the vertical deflection criterion, whereas height had to be decided from consideration of stability and torsional rigidity. After several alternatives, height of 12.5m and width of 8.5m are found to be satisfying the requirements. The guiding criterion to decide the width of the girder is the confirmation of the torsional requirements of UIC code 774 3R.

Apart from normal loads, members are designed for special requirements like fatigue, erection loads and serviceability. Central camber of 165mm is provided to counter for the vertical deflection under loads.

High Tensile Steel of grade E410-B0 as per BIS:800 is used for main chord members with high demand of tensile strength while E250-B0 grade is adopted for cross-girders and stringers with high demand of fatigue resistance under dynamic train loads. All steel members are fabricated from sheets and rolled sections by modern techniques of automatic CNC driven submerged-arc-welding and fully tested ultrasonically. Surface protection of steel is achieved by grit-blasting and metalizing with aluminium to a thickness of 150 microns followed by 4 layers of finishing coats.

The fabricated members are transported to the site, which is more than 1000km away, in special road trailers fit for traversing on hilly terrain roads. Each girder weights around 850tons. Launching such a heavy girder to a height of 140metres is a herculean task as no central supports from bottom can be provided due to site constraints. Hence improvised site-specific scheme of launching was developed modifying the conventional cantilever erection technique the steel girders. The individual members are erected one-by-one by a special overhead crane and connections between members is performed with high strength friction grip bolts HSFG bolts.

**Bearsings**

Due to the long span configuration, tall piers and high order of wind and seismic forces, the magnitude of loads as well as movements to be borne by the bearings are high. Conventional roller-rocker-bearings are found inadequate, especially to counter the high uplift forces due to earthquake. Even pot bearings are found to be having limitation.

Hence spherical bearings with special arrangements are the most suited alternative to safely cater to these special requirements (Fig.3).

The bearings are equipped with claw-and-clamp arrangement to hold the superstructure down to the pier with anchor bolts. This will prevent the lifting-off of the girder in case of severe seismic event that may cause dislodging of the span and eventual collapse, with severe consequences.

In addition, lateral seismic restraining blocks made of RCC are also provided on both sides at both ends to further contain the girder from toppling down during a severe seismic event.

**Final Span Configuration**

Summing up the studies of various elements of the bridge, the final configuration adopted is 5 spans of 106m with 2 spans of 71.5 and one of 30.0m on the approaches.

As the bridge is situated on a deep ravine, pier heights vary from 20m to a maximum of 141m (which is going to be the World’s Tallest in this category)! The final configuration of the Bridge is shown in Fig.4.

The diameter of the tallest pier is 16m with the ring thickness of 2.0m gradually. The pier is supported on 81 bored-cast-in-situ RCC piles of 1.5m diameter.

**Unique Design Features**

Due to the specific challenges and locational constraints mentioned in above paras, conventional design methodology was not found adequate to make a safe, constructible and sustainable design. Certain unique design and construction features adopted for this world record bridge are explained below:

**Site-specific spectra**

The spectra given in the seismic code (IS:1893) is general in nature and valid for the entire Zone-V uniformly. The effect of
faults in the vicinity of the structure is not reflected. Hence site-specific spectra had been developed by IIT/Kharagpur. All the seismic events within a range of 350km and magnitude exceeding 3.5 Richter in the last 250 years had been considered for the study and an empirical formula developed based on regression analysis. Based on this, responses with various time periods had been developed for the bridge location using computer software and these data are utilized for plotting the site-specific response spectra. The PGA as per this spectra is 1.1 times higher than the code specified value as shown in Fig.5a. Detailed modal analysis is performed on the bridge model considered as a whole (Fig.5b).

**Wind Tunnel studies**

The bridge is situated in a deep gorge. The design wind speed calculated as per IS:875 is around 225kmph, duly factoring for the terrain and the pier heights.

To understand the behavior of the bridge during the high wind, it was considered necessary to perform wind tunnel studies. The services of IIT/Kanpur were utilized for preparation of a 1:325 scaled down model fitted with instruments and studying the performance in a wind tunnel (Fig.6).

A comparison of forces and moments as per theoretical analysis and wind tunnel studies was performed and the higher and more critical values were adopted for final design.

**Slope-stabilization**

As the piers are located on sloping ground, computer analysis is made simulating the ground conditions and soil properties to establish the stability during construction phase as well as on long-term basis.

Necessary soil stabilization and slope protection measures proposed by expert consultants in consultation with IIT/ Roorkee are being provided. The scheme adopted is a combination of grouted soil anchors with wire-mesh support and green facia with coir mats as shown in Fig.7a. While the soil anchors provide stability of slope, the facia ensures surface protection from erosion due to rains.

**Mechanized Construction**

Due to restriction of time and working space, most of the activities right from piling to pier construction are mechanized to improve efficiency and quality. Hydraulic rigs, slip-form shuttering, concrete pumps, self-erecting lifts for carrying men and material are some of the equipment deployed. Typical slip form construction is shown in Fig.8a and 8b.

**Inspection & Maintenance**

During trains operation phase, the bridge needs to be inspected on regular basis and maintained. Due to the magnitude of the bridge, conventional methods are not adequate.

Hence following 3-pronged approach is proposed:

- Providing access by way of spiral ladders, lifts and walk-ways to reach the various elements of the bridge
- Structural health monitoring by instrumentation where different sensors are fixed at critical locations on the bridge which constantly measure various parameters like stresses, deflections, tilt and wind speed. Typical scheme is shown in Fig.9. The sensors are connected to a central data processing system and storage unit. Real-time alerts
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- Waste Oil Collecting System.

- Portable Welding Machine.
- Bottle Jack, Measuring Can & Funnel.
- Analogue Tyre Inflator with long hose pipe.
Soil Cement Blocks

Excess soil from the excavation is converted into blocks in terms of IS:1725-1982 by simple block making machinery. After setting and curing, the blocks are used in the project itself for slope protection. This innovation is not only economical and environment-friendly, but also encouraged local employment and use of local resources.

The concept has been appreciated by the State and Central governments and nominated for the prestigious Golden Peacock award for eco-innovation.

Eco-tourism

The bridge is a world record structure and will be a global attraction by itself. Besides, its location in a picturesque valley with rich scenic beauty makes it more attractive to tourists the world over. The local government is involving the local people to promote home-stay concept, where they will act as hosts cum guide to the visitors. This eco-tourism concept is a win-win situation for all!

Promoting local resources

To the extent feasible, local material, machinery and skilled labour is deployed like aggregate, artisans and vehicles. This benefits the local people who get involved in the project.

Fossil museum

The project is located in sedimentary rocks rich in fossils and special formations. During excavation, several fossils are unearthed. All such fossil rocks are showcased in a museum at the tourist spots.

CSR

The project acceptability of the local people is of utmost importance. Hence, to promote a positive image, certain CSR activities have also been taken up. These include water storage tanks with piped drinking water facility, equipping schools with additional rooms, play grounds and toilet facilities for promoting hygiene, and so on.

Conclusion

Like necessity, challenge is also the mother of innovation! The wide spectrum of challenges in this project - ranging from technical to social, cultural, environmental and security - have given us the opportunity...
to innovate and introduce certain novel concepts in designing and constructing this iconic structure, to serve the nation for decades to come.

It is an honor for India that this world record bridge is entirely designed and constructed indigenously by the team headed by the author. The dedicated efforts of all stakeholders is highly commendable in realizing the vision to build this mega bridge project using state-of-the-art technology to make it sustainable and to provide rail connection to the remote Manipur state and benefitting the entire nation.

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Nathdwara near Udaipur in Rajasthan is famous for the Shrinathji Temple. This holy town now boasts a 351 feet (107m) tall statue of the trident-wielding, stoic, and compassionate Lord Shiva - the largest Shiva statue in the world and amongst the five largest statues in the world. With the recent completion of its construction, devotees now have yet another reason to visit Nathdwara.

**Envisioning the Statue**

The Shiva Statue, also known as the ‘Statue of Belief’, was envisioned by Madan Paliwal, Chairman of Miraj Group, Udaipur. He conceptualised a giant statue of Lord Shiva built on Ganesh Tekri, a hillock in Nathdwara. His vision also included putting Nathdwara on the tourist map of the world. With the recent completion of its construction, devotees now have yet another reason to visit Nathdwara.

**Design Attractions**

The Shiva Statue (seated over a pedestal that resembles a hillock), is designed as a three-layered structure. The innermost layer comprises of four RCC core walls that rise from the base of the hillock and form the structural core of the statue. The second layer is a structural steel framework. The third layer is a concrete shell built using ultra high-performance concrete and moulded to the statue’s profile. All three layers are structurally connected. The statue has been designed to have all the details, expressions, features, and emotions of Shiva cast in shell concrete. The surface of the statue has been coated with zinc and finished with copper to increase its longevity, with a lifespan of 250 years. It can withstand wind speeds up to 250 kmph and earthquakes of Zone IV intensity, even though Nathdwara is in Zone II.

Facilities within the project include a Meditation Room, Visitors’ Room, Administration Office, and a VIP Lounge. The hollow space within the shell skin has slabs at various levels to enable horizontal and vertical access inside the statue. Two viewing galleries have been provided at 270 ft and 280 ft levels.

Based on a Computational Fluid Dynamics (CFD) study of the statue, the required number of ventilators and shafts have been provided for natural ventilation, and LED lighting inside the Statue and in the allied buildings, to reduce power consumption.

A water jet at the apex of the Statue represents the Holy River Ganga, flowing from Shiva’s Jata (matted hair). A 25-ft high Nandi Statue (the celestial bull and vehicle of Lord Shiva) has been built facing Shiva, beholding his divine form with reverence and love.
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The area surrounding the Statue includes facilities for parking, pavements, a water body, bridge, landscaping, an amphitheatre, food court, handicraft shops, and an amusement park for children.

**Construction Methodology**

The SP E&C team that had built many buildings and factories in the past was confounded with the challenge of creating this one-of-a-kind statue. Unlike modern day statues that are generally built using profiled metal claddings or with metal pieces assembled together, the Shiva Statue was built using monolithic concrete moulded to get the required features.

Owing to the organic form and shape of the proposed construction, the engineering skills, and the conventional methods of construction (which are more suitable for geometric designs and structures), were useful - but only to a certain degree. Hence, a customised and flexible approach was adopted for the construction.

Considering the risks in constructing such a tall structure, SP E&C set up the site infrastructure and temporary facilities to enable a safe working environment for the employees and construction workers. In addition, a dedicated team of HSE personnel from SP managed and monitored the company’s HSE programs and initiatives to ensure compliance. SP also encouraged the workers to improve their working environment as a safeguard against accidents.

The four RCC cores that rise from the base of the hillock, together accommodate three stairwells and four elevators to access the floors. Shiva’s trident is built using an RCC core wall from the base of the hillock and is free standing from the top of the hillock. All the RCC cores were built using dedicated slipform moulds. The heights of the four RCC cores inside the statue vary, with the tallest being 340 ft. The trident head is fabricated from structural steel framework covered with a 10-mm thick cover plate to the required profile.

The hillock is built with 300-mm thick RCC peripheral walls, while the skin of the statue is built using 200-mm thick RCC walls. The exterior surface of the hillock was finished to resemble a snow-clad mountain.

Single use FRP moulds were specially designed and made by the sculptor to obtain the required exterior profile and features of the statue. The inner profile was obtained by using custom-made plywood moulds to suit the profile. The construction involved 2,650 MT structural steel fabrication and erection; 2,700 MT of reinforcement steel; and 8,500 Cum of ultra-high-performance self-compacting concrete.

Initially, two tower cranes were provided. Once the hillock was built, only one tower crane was retained for the statue portion. The peak labour strength was 1,000. Post erection, the structural steel was painted with epoxy paint and vermiculite coating was applied for fireproofing.

The most difficult portion to construct was the folded left leg which is 60-ft cantilever from the thigh portion to the knee and resting on the other thigh which is of 60 ft unsupported length. The entire portion was temporarily supported over a sturdy scaffold frame till the concrete attained its strength. The concreting of the right arm resting on the left leg was equally challenging. It was cast from the left leg portion moving in upwards and then joining the shoulder. The structural framing comprising of various elements was carefully assembled by means of the tower crane prior to the final welding. Most of the work was carried out in during the daylight hours owing to the safety risks associated with structural steel erection and working at heights.

After completion of the structural works, the metallizing work was taken up. The surface of the statue was cleaned, sand blasted and then sprayed with liquified 99.9% pure zinc with the help of a metallizing machine to form a protective coating. The entire surface was then finished with a coating of copper. These works were executed by a specialist agency.

The 25 feet high Nandi Statue (Nandi - the celestial bull, the vehicle of Lord Shiva) has been built facing Shiva, beholding his divine form in reverence and love.

The 351 feet tall Statue is built using RCC corewalls, structural steel framework and an outer monolithic shell of ultra-high-performance concrete.
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Focus on Quality Control

Ultra-high-performance self-compacting concrete of M-50 grade was used for the Lord Shiva Statue and Nandi. The concrete mix was designed using locally available good-quality coarse aggregate and fine aggregate with Alccofine-1203 as pozzolanic material and performance enhancer for meeting the durability parameters. Concrete mix-designs were finalized locally with guidance from subject experts of Rajasthan Technical University, Kota. The sources of concrete ingredients were carefully selected to ensure uniform properties throughout the project lifecycle and to ensure high durability throughout the design life of the structure. The concrete mix for the skin of the statue was designed as ultra-high performance self-compacting concrete taking into consideration the durability parameters along with the requirements of SCC viz., low yield stress, high deformability, good segregation resistance and moderate viscosity.

All the lab tests for ingredients and the concrete mix were conducted in a well-equipped quality control laboratory established at the project site. All grades of concrete were produced under controlled conditions from an on-site batching plant. The thickness of skin concrete is 300-mm with double layered corrosion-resistant steel. Concrete in formwork was poured through funnels from four designated locations to enable the concrete to flow in either directions in the formwork. Concreting height was restricted to 1-m in the entire perimeter of the statue per day to ensure formwork safety for lateral concrete pressures. Special precautions were taken for concreting during hot weather conditions to prevent formation of thermal and shrinkage cracks in concrete. Proper curing of skin concrete was carried out for a period of 28 days by frequent sprinkling of water to keep the concrete surface moist. The curing for the core walls was done through sprinklers installed in a slip form set-up.

As important as it was to pay attention to the concrete ingredients and the mix design, the quality control while achieving the dimensional accuracies, proportions, profile, features, and expressions of the statue, deserved equal attention and care. The task was pretty challenging considering the organic form of the construction. The final result is a testimony to the SP E&C team’s ability to manage complexity and attention to detail.

The project has received many awards such as Excellence in Concrete Structures by the American Concrete Institute, Outstanding Structure by the Indian Concrete Institute, and the Golden Peacock National Quality Award from the Institute of Directors (2020).

Safety Measures

The organic form of the statue coupled with the high-rise nature of this construction posed many challenges during construction. The workers had to execute many high-risk activities in hot weather and high wind speeds at scaffold heights of up to 370 feet. Shapoorji Pallonji had prioritised hygiene, health and safety of the construction crew and workmen at the site. In addition, the company’s construction management team had established a robust HSSE monitoring system and the right work processes to ensure that the standards were adhered to on a continual basis. Moreover, the senior management was committed to provide the necessary support for successful completion of this prestigious project.

The safety measures at the construction site added to the smooth progress of the construction work and motivated the construction crew towards successful completion of the project. The hard work of the project team has been recognised by the National Safety Council of India and the Construction Industry Development Council. The project won the NSCI safety awards in 2017, 2018 and in 2019, and the CIDC Vishwakarma Award in 2018.

Achievement

Despite several technical challenges, the Shapoorji Pallonji E&C team successfully delivered the Shiva Statue project along with the amenities in June 2020. It was indeed an enlightening and uplifting experience for the project team, which had developed a strong collaborative relationship with the client’s team to realize the project’s completion.

Says Rajesh Mehta, Managing Director, Miraj Developers, “This Statue of Belief is symbolic of the firm belief our Chairman has in the infinite power of the universe. The monumental scale of the Shiva Statue made it a unique and challenging project. The highly committed Shapoorji Pallonji team has transformed the grand vision of the Miraj Group into a concrete reality.”

The Shiva Statue is an awe-inspiring marvel in the holy town of Nathdwara and a symbol of India’s engineering prowess. The Statue will be unveiled formally to the general public very soon and is expected to draw large crowds of pilgrims.
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Inventaa finds Tekla the Perfect Solution for All Precast Projects

18,810 Precast Elements - One Herculean Project

The Bhubaneswar Development Authority (BDA) awarded Inventaa with the construction of a large-scale residential project comprising of 33 Blocks of 5-storey apartment units in the city of Bhubaneswar in Odisha. All 33 blocks were walk-up units considering the low height of 17.50 metres for the buildings. A typical floor houses 8 residential units with an 8-to-a-core arrangement.

The structural system for the project was the precast wall-frame system which comprised of precast reinforced solid concrete structural walls, room-size slab solution, beams and staircases. Besides precast, reinforced pergolas were provided at the terrace level as a unique architectural feature of the building and the foundation arrangement was of strip footings for all structural precast walls. While the footings were a cast-in-situ system, the walls were made of prefabricated elements for the more controlled, site-based execution requirements. The structural material consumption of a single building/apartment unit, including the foundation, SOG and complete superstructure was, 726 cubic metres of concrete and 75
metric tons of reinforcement. Multiply that with 33 blocks and we begin to realise the sheer size of this massive project that came with many more additional challenges.

**Massive Project, Tiny Worksite Spaces, and Unique Design Challenges**

The super compact land space designated for the construction of this mass housing project was perhaps the biggest challenge. The tight block layouts at various parts, and the narrow approach for elements and crane positioning added to the already restricted site-space challenge.

The size of the project and the vast volume of construction involved, increased the possibility of conflicts or clashes on-site and the resultant rework was ever-present and at its peak. On the other hand, the project schedule hardly had any scope for errors and reworking, which could push the team to miss the pre-decided project delivery deadline and adversely affect the budget and hence the profitability of the project.

Further, the sunken slabs required for all the toilets had added a plethora of challenges for all teams involved in the project. These sunken slabs involved floor diaphragm action and integrity connections of the precast element from the engineering aspect and complex precast elements for intermediate attachments, and 3D slabs requirement from the production aspect.

**Tekla: The Solution Provider for all Challenges from Design to Execution**

For Inventaa, Tekla was the definitive choice to successfully deliver this project that came with a multitude of challenges. Tekla enabled the stakeholders to control the project in a centralized manner right from efficient design to planning, monitoring and improving upon the execution of the project on-site. The efficiency achieved by using Tekla helped the team to deliver 10% extra area per unit as a result of the improved designing right at the beginning.

Recalling the experience, Satyanarayana C, Managing Director, Inventaa Industries said, “At Inventaa, we always look to digitize the entire construction process to the maximum possible extent. The project in discussion here was completely handled in-house including the development of the architectural concept, structural engineering/design, production of the precast elements, installation of precast elements with all the requisite structural work at the site, and finally the installation of services (MEP) and architectural finishing. Tekla held our hand through all of these phases which would have otherwise been very difficult to manage by using a dozen different applications.”

**Why Inventaa recommends Tekla for Precast Projects**

**Multitude of Benefits from the Accurate 3D Design Model Generation**

Tekla enabled the team to generate highly accurate and reliable 3D engineering design models. These constructible 3D models were then used by the team to extract all up-to-date production and execution drawings and details for the plant production and on-site execution activities. The centralized 3D model was also successfully leveraged in production planning by plugging in the execution schedule. The materials required for the project were also accurately extracted and monitored from the same Tekla model, which helped to also tie-in the cost dimension to the 3D models.

**Project Scheduling & Monitoring at One Place**

All production activities and site execution processes were being monitored on the schedule generated on Tekla, and it was actively plugged into the BIM workflow, giving a clear picture of the project to all the teams and the management involved. By enabling the stakeholders to schedule the complete project timeline elaborately, Tekla helped in time-bound project completion and saving a significant number of work hours. The ease of project scheduling and controlling also enhanced the on-site work-efficiency. For example, erection sequencing, which would typically take 4 days for a typical tower, took less than a day to complete.
Seamless and Real-time Cloud-Based Collaboration

Apart from the vast size and volume of the construction, the project also involved a large number of stakeholders and various teams specializing in different aspects of the project. Unobstructed and truly real-time collaboration was the most critical requirement to avoid errors, clashes and ultimately rework. Higher number of errors and reworks could not only derail the on-time project delivery but would have also hampered the profitability of the project. However, Tekla facilitated a smooth, real-time and multimodal collaboration among the different stakeholders, which significantly curtailed the number of RFIs.

Optimization of Design, Rationalization of Manpower & Associated Costs

With Tekla, the entire 3D model was generated by one person, who could further efficiently extract all production and execution drawings out of the same 3D model, which otherwise requires 2-3 people, or at times even more, had they been working on any 2D drafting process. Working with Tekla in 3D helped in controlling and optimizing the entire design process efficiently to ensure that all clashes were identified and rectified in the office itself instead of on-site and the most suitable design options were evaluated and fixed upon easily.

Tekla: Delivering Any Project, Any Challenge

The ease of project specific customizations offered by Tekla software makes it a boon for the construction industry, which is witnessing rapid diversification. Apart from the flexibility, Tekla provides a complete solution for all kinds of projects – simple or complex, small or large-scale – which makes it the best in the business. Tekla software is the most efficient and effective solution for the precast concrete construction industry.

Says Sumedh Gupta, General Manager, Inventaa Industries, “Tekla’s BIM solution was and is the best fit for all our requirements throughout the complete life cycle of the project, from the design to procurement, production, execution and finally monitoring phases of the project. We have also had the flexibility to fine-tune and customize Tekla to fit perfectly within our processes and standards and in fact, improve upon them by leaps and bounds. This flexibility of the software allows organizations to easily adopt Tekla either partially or fully based on their existing processes and workflows. It is an extremely efficient solution for all types of precast projects, and we are happy to strongly recommend Tekla to our precast industry.”

Inventaa: An Innovative, Reliable Producer

Inventaa Industries, which was set up in the year 1979 for bulk manufacturing of drugs, subsequently diversified into ‘building material’ products. They have set up 4 precast plants in India with a vision to be the most innovative, sustainable, reliable producer, manufacturer, service & solution provider in the chosen verticals. Their largest integrated production facility is located in Keesara, Andhra Pradesh; it produces Precast Concrete Elements, AAC Blocks, and Interlocking Pavers.

Besides producing precast elements, Inventaa has been successfully delivering turnkey building construction projects for a wide variety of segments such as residential, commercial, industrial, hospitals, hotels and any other such buildings. The company also supplies precast structural and non-structural elements, AAC Blocks and Interlocking Paver blocks to other large construction projects.
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Integrated software solutions for production of lattice girder floors

Orion Beton is a Dutch precast concrete plant based in Enschede. By replacing and updating all software-based processes, Orion Beton has taken a major step in the automation of its production process.

For the digital modernisation in their software sector, Progress Software Development GmbH, a company of the Progress Group, is the reliable partner. The successful cooperation with various machines and software solutions dates back to the year 2003.

The core business of Orion Beton is the production of lattice girder floors, which has been optimised in the fully automated circulation unit of the precast concrete plant. The ebos® and profi® MES systems developed by Progress Software Development, accompany all aspects of the production process in a consistent manner. These integrated and complete systems replace a variety of partial software solutions, enabling employees to carry out their entire work processes in a single homogeneous and user-friendly system.

“Our production stability was increased immensely by using ebos, and thanks to the optimised pallet assignment, the production process runs much smoother,” says managing director Jan Rook.

Software solutions guarantee smooth processes

The ebos solution, which was specially developed for the precast concrete industry, functions as a higher-level ERP system and is used for planning and controlling all business and production processes. From sales, calculation, project management, production and assembly planning, to logistics and materials management - all the processes are managed by a centralized system.

The big challenge in implementing the modernisation was to install ebos and e®bos together, to replace the existing system and to have everything up and running within a few days. Progress Software Development achieved this through an intensive lead time and qualified specialists on site during the go-live.

“The decision in favour of e®bos and thus in favour of Progress was made, among other things, because of the open structure of the database and the structural updates. The possibility of integrating ebos into e®bos played an important role, as did the fact that we have been familiar with the cooperation with Progress for almost 20 years,” emphasises Jan Rook.

A success story lasting over 40 years

Orion Beton was acquired by AGAR Holding in 1973. Only two years later, the company moved from Delden in the Netherlands to its current location in Enschede, where it also started producing the lattice girder floors. In the beginning, the company produced 50,000 m² per year, but over the years the production volume has increased considerably through various modifications. For example, a new hall including a circulation plant was built in 1986 for the production of floor slabs. This was extended in 2003 by an M-System mesh welding plant. In 2014 the VGA Versa lattice girder welding plant was installed, which is equipped with a fully automatic height adjustment during production. An additional bending machine for reinforcement bars enables the company to produce...
Pallet assignment in ebos. With ebos it is possible to replace a large number of partial software solutions with a single, perfectly integrated system.

Production module in ebos. The difference between ebos and other ERP systems is that the entire Progress know-how, from mechanical engineering to the production of precast concrete elements and software development, has been combined in one solution.

The M-System mesh welding plant was developed for the most flexible production possible and thus fits very well into the overall concept.

The reinforcement itself and to manufacture and weld cages. Recently, another important component was integrated, the fully automatic stirrup bending machine for reinforced steel from the EBA S-line. All these machines come from Progress Maschinen & Automation, also a company of the Progress Group.

Orion Beton has two large production halls. The first one is used to produce the traditional lattice girder floors by means of a highly modernised carousel plant. In the second hall there is a more than 3 m-wide bed for the production of prestressed lattice girder floors and a second bed for the production of other products, such as unit floors or beam floors.

Advantage through a wide range of services

“A prerequisite for high performance with calculable accuracy are machines and software solutions, which on the one hand can be optimally integrated into our existing plant and on the other hand contribute to a targeted increase in efficiency,” says Tonny Bunte, the project manager for erpbos in the company.

Orion Beton found the right partner for these high demands in the Progress Group. Reliability, experience as well as familiarity with the performance have been the decisive factors for this long-standing successful cooperation.

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How can the Precast method meet India’s construction requirements and bring better quality and affordability to the projects?

The construction industry in India, traditionally, has always been site based, which has led to a build-up of inefficiencies, resulting in delays, material and time wastage leading to increase in construction costs, while missing out on the benefits of assured quality and standardisation. Due to the impact of Covid-19 we are seeing a backlog of pent up demand for building infrastructure in the residential and commercial space. At the same time, a shortage of affordable housing for the needy segment has grown to unmanageable proportions. The only way to meet the required scale of construction will be by adopting a construction technology like Precast, which has proved to be the most effective, especially when you have large volumes to achieve, as it offers quality, speed of construction, and is cost-effective.

Precast uses concrete, which is the cheapest raw material on the planet, and reinforced steel. The technology is compatible with the existing building codes, which are in line with RCC buildings, and suited to seismic zone requirements in a seismic active country like India.

By taking a manufacturing approach and implementing technology in construction, we will have the benefits of cost saving, quality construction, and timely completion of projects due to the faster speed of construction enabled by the Precast method, which will also bring standardisation - currently a missing element in India’s construction industry.

What could trigger greater demand for Precast construction?

As with any enterprise, a systematic approach and standardisation can transform the construction industry - making it more organised. The precast method, backed by technology, is a proven construction technique and highly recommended for meeting India’s housing and infra development requirements. In fact, there is already an impressive number of precast reference projects in the country.

We believe that the push for technology and mechanization due to the pandemic is one such trigger event that is fast unfolding. The shortage of skilled labour is another trigger. Market demand for transparency in the construction business and expectations of a quick RoI by customers due to their changing perception of project delays, is also transforming the way the construction industry market will perform in the future.

In fact, we believe that the industry is set to change for the better within the next 5 years as there will be a greater need for mechanization, construction technology, and cost efficiency. Government initiatives in infra development and housing projects will see bigger participation of architects and engineers, because when push comes to shove everybody wants a better quality of houses, and commercial and industrial buildings, which are also affordable. Precast construction technology can meet all of this.

What challenges lie ahead for the Precast Industry?

Success begets success. The Precast industry would need the Government’s support and the big builders to understand what constitutes a good precast structure so that they can build by following the best construction practices. Efficiently designed projects by architects who understand the precast methodology, and a vibrant, supportive ecosystem will help make precast popular in the country. Once the benefits are seen, then the drive to change the traditional way of construction will become unstoppable.

What are your expectations for the Precast industry in 2021?

We are seeing renewed interest in the commercial and residential segment with many projects taking off in 2021. We expect the trend to accelerate as we will see many success stories of the precasters, which will encourage more players to enter the precast segment. It may not be far away when a precast building in the residential, commercial, and industrial segment becomes a commonly seen structure. Elematic has an expert in-house structural design and service team to support the market in the drive towards precast construction.

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ECE is planning to introduce a premium White Line range despite a sluggish market. What are the advanced features of the range and how will it meet the Indian buyers’ demand for value-for-money products and their expectations of a quick RoI?

White Line is our hi-specification range of products with the latest features like additional safety, operator comfort, integrated telematics, and more. The products launched under the White Line series are currently targeted to address the higher performance demands of Fleet Owners and the Corporate Customers.

These machines are designed to offer higher lift capacities, better fuel efficiency, operator comfort and other ergonomic features. In addition, this series will have many industry-first features like anti-toppling system, outrigger sensing, human proximity sensor, integrated telematics, performance monitoring, etc.

White Line is expected to complement our existing range as well, with some of the relevant performance and additional safety features made available in our existing range. Once we switch to BS-4 engines, the entire work-cycle for the machines in terms of relevant parameters can be mapped. This again will help our customers to get enhanced performance. We are also working on a self-diagnostic tool made available on the equipment for onsite trouble shooting and fixing.

White Line brand is premium by appeal, but not by price. The value proposition and RoI offered will match or exceed what is being offered by our competitors.
What other benefits such as after-sales support, spare parts, buyback offer, servicing/maintenance contracts etc will be offered to your White Line buyers?

White Line machines will be sold through a separate dealer (3S) network. The after-sales capabilities have already been worked out with our new partners to ensure quick response time. Also, last year, we switched to a digital format for aftersales. We will continue to improvise on this digital connect (App-based) for improving our response time.

With financing by NBFCs and Banks shrinking, many OEMs are looking at options like leasing or setting up a financial arm for the benefit of their buyers. Is ECE considering any such move?

We currently have no such requirements as our products are getting funded by all NBFCs and Banks. We have running MoUs with financers and the same is reviewed as per the need-base.

What is your analysis of the CE market potential post Covid-19 in view of the Government’s focus on infra development, alongside the negative GDP growth projection for FY21?

For the CE Industry Q-1, FY21 was a complete wash out, however, Q-2 is showing recovery MoM sequentially. We expect the market to continue this growth trend with the expectation of a full recovery in Q-4 of this fiscal. But this will be highly dependent on the impact of the pandemic situation that emerges during the period.

Of the US$100 billion projected for Infrastructure projects, about 40% is under implementation and others are at various stages of award. We feel that the funding gap can be addressed by strengthening the bond market, and through public and private investments.

What kind of demand do you envisage for your products from the prestigious Bharatmala phase 1 project, for which the government is fast tracking the awards?

All our products complement the Bharatmala project and we see good demand, going forward.
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BONDS BUILDS BUSINESS
TEMOWA: Voice of the Construction Equipment Industry

J. Vivek Kathipara, MD, BOSON Infra India & General Secretary of TEMOWA, expresses his solidarity with the Construction and Infra Development industry by aiming to enhance the Association’s reach in representing the community of construction equipment suppliers and creating an environment which is conducive to their business growth and advancement, while facilitating the Tamil Nadu State Government’s infra development plans and implementation.

What is your outlook for infra construction in FY 2020-2021 and how will the ongoing Covid-19 crisis impact contractors, builders, and equipment owners in the short term?

The pandemic threat has had its ramifications across all industries and across almost all sectors as they have all experienced an unprecedented slowdown. The Construction Industry in India was deeply impacted due to the lockdown as the restrictions on movement of man and material brought the Construction and Infrastructure projects to a halt and shutting down the operations of the Earthmoving and Construction equipment. The slow progress of projects that ensued can be attributed to the acute shortage of labourers at the worksites and the restrictions in transportation of materials and workers.

TEMOWA, on the strength of its inventiveness and determination, stood together with its member companies and voiced the concerns of the HEMM owners to the State Governance and the officials concerned.

Now, with the lockdown restrictions being lifted, Infra projects are picking up at a brisk pace, and we are seeing an increase in demand for Construction and HEMM equipment. Both the Central and State Governments are continuing their focus on infra development projects, and there is renewed confidence in the construction industry.

The construction companies/contractors must, however, assure their workers of their safety and protection against the pandemic threat so that they will return to their workplaces with confidence. This will help the stalled projects to resume work at a faster pace and thus compensate for the slowdown during the past months. With the support of the State Government, we expect the Real Estate companies and builders to kickstart their projects with full vigor, which will lead to a fast revival of the Construction Equipment Industry.

Most of the equipment is financed through banks/NBFCs, but the pandemic has created a liquidity crisis, due to which, equipment owners are facing liquidity shortage, unavailability of loans for buying new equipment, supply chain disruption leading to unavailability of spare parts and timely servicing of their equipment. As a premium Association of Equipment Owners, how are you looking at these aspects and are you seeking government support to ensure that the businesses of your members stay afloat?

While RBI had come forward with its recommendation for Banks and NBFCs to offer a moratorium for the lockdown period, we at TEMOWA and the general public would have preferred a clear instruction from RBI (rather than guidelines and recommendations), to refrain the Banks and the NBFCs from employing force or intimidating equipment buyers for payment of their EMIs during the lockdown when construction activities were completely shut down.
TEMOWA acts as a spokesperson for the State Government by creating awareness of its initiatives to the Construction Industry and the benefits, while standing firm as a representative of the Industry by voicing its grievances and concerns to the State Government.

Many projects have either stalled or some work is going on, due to which, many equipment is laying idle at project sites. However, a few projects are working at full strength and looking to deploy more equipment, but due to the liquidity crisis and limited financing options, they are not able to buy the equipment. In such a scenario, is TEMOWA looking for some out-of-the-box solutions to help both the parties, that is, the ones whose equipment is lying idle and the ones who need new equipment?

We need to appreciate the initiatives of the Central and State Governments for taking measures to sustain the economy during the pandemic. Post the nationwide lockdown, we noted that work at the projects did not stop completely; rather, the work continued to progress, though at a slower pace. Now, work in the projects is in full swing and the State Government of Tamil Nadu is continuing with the development of infrastructure projects.

We are seeing an increase in demand for construction equipment, machinery, and parts; in fact, demand seems to be at its peak lately owing to the thrust on completing the delayed projects and restarting work on projects that had stalled.

The Tamil Nadu State Government has been actively providing a conducive environment for investments in industries in various sectors, which is igniting the much-needed positive vibe in the construction industry.

What are the objectives and goals of TEMOWA? How many members are there currently and what benefits do they get from being a part of the Association?

The Tamil Nadu Earthmoving Equipment Owners Welfare Association (TEMOWA) was established in 2002 to work for the support and development of Construction Equipment and HEMM owners in the state of Tamil Nadu. These include owners of Construction and Earth Moving equipment such as Hydraulic Excavators, Wheel Loaders, Backhoe Loaders, Motor Graders, Vibrating Compacters, Tippers, Forklift Trucks, Dozers, Batching Plants, etc.

In fact, since its inception, TEMOWA has been the focal point and platform for the equipment owners to network, communicate and support each other on various issues that impact their business.
As a premier Association, its objective is to promote and safeguard the interests and rights of the equipment owners who are our members.

Today, the Association has grown in strength and credibility as a reliable entity, with over 5000 members operating across many districts of Tamil Nadu. The Association has been at the forefront of policy implementations and changes. By giving a common platform to its members to voice their grievances, TEMOWA has been paving the path for their better business prospect and advancement.

What are the issues and challenges faced by the owners of Construction & Earth Moving equipment? Please give some instances where a favorable solution(s) was found by TEMOWA.

TEMOWA has effectively advocated on behalf of the fraternity and succeeded in gaining the TN State Transport Department’s consent for grant of complete exclusion from payment of late fee charges on Road Tax payments imposed on the equipment owners for the months of the lockdown period.

TEMOWA recently came forward in support of the equipment owners who were facing pressure from private funding institutions for EMI payments for their equipment loans, and who were employing force in seizing their vehicles, in spite of the RBI Recommendation of Loan Moratorium owing to the pandemic lockdown.

TEMOWA recently met the Hon. Deputy Chief Minister of Tamil Nadu, Shri. O. Paneerselvam to seek his direct intervention in safeguarding the business interests of the equipment owners and to support them in their resurgence. The State Government graciously responded to the grief expressed and did the needful by instructing a private funding organization to return the confiscated equipment to the owner for non-payment of his loan EMI during the lockdown months.

How effective has a national body like TEMOWA been for the Construction Industry, and as General Secretary of the Association, what are your long-term plans to take forward its objectives and goals?

The proactive approach of the Association has been commended over the years, which can be attributed to the efforts of former President – (Late) Shri Kathipara Janarthanan, who was a veteran politician and a pioneer in the Construction Equipment Business Sector. He was far ahead of his times in foreseeing opportunities, and he overcame many challenges, which earned him the respect from the corporate sector and the public. In fact, his ambitions always encompassed the needs of the society and his endeavor was to serve the people in the best way possible.

As his son and successor, I am actively involved in the performance of TEMOWA, and in building a strong relation and trust among the members. As a professional in the field of construction, I would like to earn the same amount of credibility as that of my father by following his principles in leading the Association.

I express my solidarity in enhancing the Association’s reach in representing the community and working firmly towards creating a beneficial environment for the Growth and Development of the Construction equipment suppliers segment, facilitating the State’s Infrastructure Development process.
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ECHELON Paving at Delhi-Mumbai Expressway with VÖGELE Super 1800-3 Pavers
Impressively Wide Incredibly Accurate

The Delhi-Mumbai Expressway is one of the most prestigious expressway projects in India, currently. It will start near Gurugram at Sohna and terminate at Mumbai (JNPT). With a total length of 1353 km, the Expressway is divided into 49 packages (31 packages in Delhi-Vadodara section, 13 packages in Vadodara-Mumbai section, and 5 packages in Mumbai-JNPT section).

The eight-lane expressway is being built under the engineering, procurement and construction (EPC) route and will reduce the distance between the two cities by over 150 km and cut travel time to 13 hours from the current 24 hours, and is likely to be ready by 2023-24.

The project was necessitated because of heavy congestion on the Delhi-Mumbai National Corridor along the NH-48 of the Golden Quadrilateral. Passing through Haryana, Rajasthan, Madhya Pradesh, Gujarat and Maharashtra, the Expressway will also provide easier connectivity to the cities of Jaipur, Kota, Chittorgarh, Indore, Ujjain, Bhopal, Ahmedabad and Vadodara.

**Background**

It is required to pave the width of road in multiple lanes because paving the full width of the pavement in a project like the Delhi – Mumbai Expressway is usually impossible. In this project, flexible pavement section has base layers such as WMM width of 19.55 meter and bituminous layers varies in width from 19.25 to 18.75 meter.

Most often, differences in the temperature and mat plasticity cause an improper bonding of the fresh Hot Mix Asphalt with the older Asphalt lane and this subsequently causes the longitudinal joint to possess a significantly lower density than the rest of the pavement. Over time, a longitudinal crack usually occurs between the asphalt mats, permitting the intrusion of water, increasing roughness, and potentially limiting life of the pavement.

While deliberating and adopting the paving methodology in such a project, one of the most important factors comes to mind is the longitudinal joint type and its position. The objective is to have a strongly interlocked joint that provides the same sealing effect as that of other parts in a carriageway to avoid water intrusion into the layer and thus avoid oxidation and raveling of pavement. While there are several conventional methods of joint preparation, making and repair, but, somehow, the hot and hot joint proves to be the best among all because of its paving methodology and way to address the base from where generally the problem and defect arises.

**Hot and Hot Paving (Echelon Paving)**

Paving with two or more pavers in Echelon is ideal for an integral bond between asphalt strips. In this paving method, the distance between the pavers is to be kept as short as possible to have minimum temperature difference between the paved lanes.

The first roller following each paver should be of the same size. The rollers start rolling towards the joint from the outer pavement edge inward. Compaction ends approx. 15 cm beside the longitudinal seam on either side. The joint is then the last strip to be compacted by the rollers. This way, a tight bond between the strips is obtained.
Benefits of Echelon Paving

- Increased production per shift
- Cross-slopes easier to maintain
- Cost saving on account of repairs of failure of faulty joints
- Produces pavements and longitudinal joints of uniform density. In other words, longitudinal hot joints built by the Echelon paving method produce jointless pavements

Technology from world leader VÖGELE

We, at VÖGELE, feel proud to support the nation’s vision of building world-class roads in the country by serving our customers with Super 1400 Asphalt Pavers (Make in India) and state-of-the-art German technology Asphalt Pavers like Super 1800-3 (10 meter) and Super 2100-3 (13 meter).

VÖGELE’s Seamless Product Range

VÖGELE’s seamless product range is considered unique in the industry. Whether a service road or a highway, an airfield or a racetrack, a new construction or a rehabilitation job, thick or thin, hot or cold – customers will find the right machine in our product range for every paving task. Our products range from pavers with state-of-the-art screeds to material feeders which are particularly suitable for large-scale job sites and digital solutions for Road Construction 4.0.

The extensive product range of VÖGELE is divided into two lines: the Classic Line and the Premium Line. The Classic Line is for pavers equipped with the particularly easy-to-use ErgoBasic operating concept. The Premium Line comprises all pavers that feature cutting-edge technology and advanced mechanical engineering. Premium Line products are all equipped with the ErgoPlus 3 operating concept. The varied range of asphalt pavers has paving widths ranging from 3.5 meter to 18 meter in single pass.

A seamless product range for every requirement, anywhere in the world

We secure our customers’ success with innovative machinery and solutions. Being the No. 1 in innovative technologies is consequently, one of the guiding principles of our business activities. Advancements in engineering are all well and good – but for us, the focus is on turning these advancements into solutions that benefit our customers.

The Delhi – Mumbai Expressway is one of the biggest examples of our latest technology and high-quality paving by VÖGELE Asphalt pavers throughout the length. In the past, we had continuously given high-quality results from Wirtgen Group machines in the Indian road construction sector such as the Yamuna Expressway, Agra-Lucknow Expressway, Buddha International circuit, Purvanchal Expressway, Jaipur Ring Road, and in various Airports, etc.

For further details, please contact:
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Website: http://www.wirtgen-group.com/india
Indian contractor Prakash Asphalting & Toll Highways India tested an AMMANN ARX 91 Articulated Tandem Roller on a jobsite and was extremely pleased with the results. “The AMMANN ARX 91 was able to achieve the desired compaction at our jobsite in fewer passes, which resulted in overall savings in fuel/diesel costs,” said Anurag Surana, the company’s General Manager – Mechanical. According to him, the ARX 91 was 5 to 8% more fuel-efficient than other products in the segment.

Surana added that the operators were also pleased with the AMMANN compactor: “Our operator was very comfortable driving the ARX 91, as it has excellent visibility of the front and rear drums till the edge, even while compacting closer to the edges. All the controls are conveniently located on the operator platform, giving operator comfort with zero fatigue, and thereby allowing the operator to work longer hours at a stretch.”

The ease of access to service points and AMMANN’s support drew special praise. Stated Surana, “We would seriously consider procuring the AMMANN Articulated Tandem Roller Model ARX 91 in the future for our fleet.”

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Surat geared up to recycle 100% of its C&D waste

In order to scientifically channel the huge Construction and Demolition Waste generated by the city of Surat, Surat Green Precast Private Limited (SGPPL), in 2019, set up a state-of-the-art C&D Waste Recycling plant from CDE Asia.

ReUrban Compact from CDE is a one-of-a-kind C&D Waste Recycling Plant with a capacity to process 300 TPD - enough to handle the entire city’s C&D waste. It is equipped with a specialized segregation system, debris handling section, crusher, a multiple section screening unit, etc, that ensure that the C&D waste is processed in an efficient manner to produce an impressive line of repurposed products with minimum environmental footprint and water usage.

Kanoj Lakhani, Managing Director, SGPPL, says “Our aim is to build the best products from waste, cause no unnecessary harm to the environment, and apply business acumen to inspire and implement solutions for the environmental crisis due to the waste produced in construction projects. We have achieved all this with the commissioning of the CDE Plant. From a total of 50 points last year, ranking points for C&D waste management for Swachh Survekshan 2021 have been doubled to 100 points – 50 points for recycling and 50 points for reusing the products. All the products have been tested by the National Institute of Technology in Surat (SVNIT) and we have started producing paver blocks from recycled sand and aggregate. We have achieved a compressive strength of 50 n/mm² while using 100% recycled material.”

He informs that Banchhanidhi Pani (I.A.S.), Municipal Commissioner, S.M.C, has given the approval to buy back 10% of products required by SMC. The volume of buyback will be reviewed periodically, and the percentage increased accordingly.

The plant strengthens SGPPL’s vision of a greener Surat by efficient recycling of waste consisting of cement concrete, cement mortar, bricks, rubble, stone, sand and soil to produce high grade washed and dewatered sand and aggregates by removal of oversize and ultra-fines. The state-of-the-art technology recycles and restricts the usage of water to a mere 6-8 m² and limits power usage to 120 KWH, making it extremely eco-friendly.
The C&D Waste Recycling plant promises to:

• Recover aggregates, plaster and sand from Construction & Demolition Waste.
• Provide high yield/production through complete automation and remotely controlled system.
• Consume minimum water through recycling and repurposing the resource.
• Have minimum geographical footprint.
• Produce high grade washed Aggregates, Concrete and Plaster Sand.

Apart from providing a sustainable source of sand and aggregates, the plant will also have the following positive environmental impact:

• Reduce 508 tons of CO₂ emissions, which is the same as burning 250,000kgs of coal every year.
• Save 9100 Giga Joules of Energy, enough to power 3000 Indian homes for an entire year.
• Free 30,000 sq. yards of land from landfills, unlocking 100 crores worth of Real Estate every year.

The National Clean Air Programme (NCAP) aims at reducing particulate pollution by 20-30% by 2024 in about 122 cities which do not meet the National Ambient Air Quality Standards. Clean air action plans in these cities have included C&D Management as part of the clean air strategy. The other big development is the 15th Finance Commission’s direct allocation of Rs 4,400 crore to Urban Local Bodies (ULBs) for air pollution control. C&D Management is the direct responsibility of ULBs, and this funding can catalyse transformation in cities.

Within a year of commissioning, Surat has already jumped to the 2nd position in the Swachh Survekshan rankings, which gives a lot of weightage to how a city handles its waste. In fact, the Surat Green story is one of the many successes that CDE Asia has achieved in their efforts to combat the problem of diminishing resources of natural sand through recycling and reuse of construction and demolition waste and also simultaneously solving the ongoing problem of waste disposal.

“CDE Asia is proud to have partnered with SGPPL for C&D waste management in the most effective way. The development of smarter, greener and sustainable cities will enable them to outgrow their dependence on natural sand, and thus help preserve and restore the ecological balance. It will also enable them to participate in a scientific process of repurposing waste to produce high-grade sand and aggregates made to exacting industry standards,” says Manish Bhartia, MD, CDE Asia.

Surelia Engineers Innovative Vibratory Roller Attachment for Backhoes & Excavators

Surelia Engineers has introduced an innovative Vibratory Roller which can be attached to any Excavator and Backhoe loader. This attachment is used as a compactor for slopes, unreachable or difficult to reach areas where a conventional compactor cannot reach. It helps to achieve the desired compaction which not only eliminates the need for manual compaction but also brings high productivity, better efficiency with quality and economy in project completion.

The compact design of the Vibratory Roller attachment makes it perfect for operating at the construction sites of Railways, Roads, Irrigation Canals, Trenches, Embankments, Water Sewage projects and so on. It is easy to use with its plug-n-play type feature, making this Vibratory Roller an agile job site attachment.

The Vibratory Roller Attachment comes in two variants:

• SINGLE DRUM VIBRATING ROLLER- SDA-300 (Suitable Carrier: Backhoe Loader, Long Boom Excavator)
• SINGLE DRUM VIBRATING ROLLER- SDA-600 (Suitable Carrier: 14-30 Tonne Class Excavator)

For further details, please contact:
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ACE to represent Doosan’s Industrial Vehicle - MHE segment in India

ACE - India’s Leading Material Handling & Construction Equipment manufacturing company and the world’s largest crane manufacturer - has joined hands with Doosan Corporation to represent their Industrial Vehicle - MHE segment in India. This is a strategic move for both the partners to secure a majority market share in India.

Doosan Corporation, a Korean multinational conglomerate and a Fortune 500 company, is one of the first foreign MHE brands to foray into India. Today, the Doosan brand has become popular due to its technologically advanced and innovative products, and their reliable performance. ACE – a home-grown brand of India, has become a leading company with its core philosophy of offering ‘Reliable Products at Reasonable Price supported by prompt Service’.

Chetan Gole, CEO (Forklifts Vertical), ACE

Over the last few years, many MNCs have come to India to partake in the country’s economic growth. These global companies, mainly comprising of European and Japanese brands, along with some major Indian players, have contributed approx. 20-25% of the current MHE business. This can be attributed to their strong affinity to high performance, premium products.

ACE’s co-operation with Doosan will help the latter company to regain and consolidate its market share as it will use ACE’s wide network of 100+ dealers for sales and service across India. ACE, on the other hand, will get a pie of the premium segment, which will increase its market share further.

The new partnership of Doosan in India with ACE is expected to streamline and support existing customers and infuse new energy and confidence in the Doosan brand in India, thereby making them leaders in the Premium Segment. It will be a win-win situation for both the partners.

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India's top shuttering plywood brand ALLIANCE manufactured by Sunrise Panels, is a high value product and especially designed for use in high quality construction work. Due to its superior performance, ALLIANCE is highly recommended by leading builders and architects across the country.

ALLIANCE is a combination of especially selected layers of matured hard wood veneers bonded with high viscos phenolic resin. Both the sides are overlaid with impregnated phenolic high scratch resistant paper film and the edges are sealed with resin to keep moisture away from the plywood.

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**Advantages**

- Strong and rigid panels
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- Favorable weight to strength ratio
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- Can withstand impacts and other forms of bruising
- Environment friendly.

**As a maintenance-free panel, it is used for different concrete formworks such as system shuttering, girder formwork and regeneration panels. It can also be used as a multipurpose, maintenance-free formwork panel for various purposes.**

Its durable overlays ensure smooth concrete cast finishes and multiple uses, depending on the used overlay, site practices, requirements of concrete finish, and the maintenance, handling and storage practices.

**Says Rajiv Gupta (Partner), Sunrise Panels, "Our products are specially designed and manufactured keeping in view the applications, requirements and usage for specific zones and construction activities. Our world-class infrastructure has enabled us to manufacture the products without any limitation on size, thickness, and density. Having established our Alliance brand pan India, we are now working to extend our business in foreign countries."**

He informs that Sunrise Panels employs environment friendly manufacturing processes to provide quality products due to a close understanding of customer requirements and market trends. It follows continual improvement in identified processes and objectives to enhance the organization’s performance and provide reliable customer service.

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Need to Reorient Smart Cities Mission to Tackle COVID Challenge

The National Smart City Mission - aimed at upgrading core infrastructure of 100 selected cities through sustainable smart solutions for providing quality life to citizens - is at a critical juncture in the wake of the COVID-19 pandemic, requiring a relook and a reworking of its strategy to meet newer challenges.

By Vinod Behl

Purpose, Implementation Strategy & Progress of Smart Cities Mission

The Smart Cities Mission (SCM) launched in 2015, was envisaged as a 5-year holistic program, aimed at providing `1000 crore to each of the 100 selected cities (borne equally by the Centre and the States) between 2017-22 to rejuvenate their core infrastructure. Each city, by creating a Special Purpose Vehicle, was expected to raise additional funding from the market. The strategy to implement the Mission revolved around area-based development, housing inclusiveness, creating walkable locations, enhancing citizens’ security, preserving and developing open areas, alongside cost-effective citizen-friendly governance.

Over the last five years, the Mission has made considerable progress, which is evident from the statistics. A total of `2,05,018 crore of investment for 5951 projects in 100 smart cities is proposed. Till now, tenders for 4869 projects costing `1,68,209 have been issued. For 4038 projects, costing `1,31,295 crore, the work is in progress or completed.

Digital Transformation - Key Driver for Smart Cities Mission

Digital transformation of cities holds the key to the success of the Smarts Cities Mission and the future of our cities and its residents. Digital transformation of cities can help meet the major objective of making governance citizen-friendly, cost-effective, transparent, and accountable. Data is the key driver to all policies, programs, projects and measures. Therefore, the focus on Big Data and the city’s behaviour towards its data management is a critical element towards being a truly smart city. Siemens has created a global data-driven index - Atlas of Digitalization - to rate cities based on digitalization readiness and digitalization potential.

Therefore, the current challenge is to make our cities data-driven. Built environment data - the authenticated Digital DNA of all cities - is already captured by cities in various formats and processes through building, engineering and planning departments, besides postal services. The integration of a city’s data in an accurate and authentic manner is key to following the path to becoming a smart city. And for that, we need a proactive approach of identifying and managing the city’s Digital DNA - the building blocks to effectively and efficiently use the city’s ability to repurpose its existing data and documents associated with the built environment.

Covid Challenges for Smart Cities Mission and the Path Ahead

Covid-19 has given us an opportunity to recalibrate the Smart Cities Mission and build sustainable cities, better equipped to handle such pandemics. It has also exposed the absence of strong and resilient health systems in our cities, which act as the first line of defense - not only against disease outbreaks - but also for meeting everyday health challenges. Considering that by 2025, 40% of India’s population will be living in urban areas, there’s a need to upgrade the health infrastructure to address challenges posed by pandemics like Covid-19.

It is an irony that creation of health infrastructure is a very low priority in smart cities. In overall spending under Smart Cities Mission heads, only 2.3% is dedicated to health and education and only about 1% of the smart city projects are for health infrastructure and capacity building. Only two sectors - environment and solid waste management - have got a share of investment equal to health and education. In contrast, area development (23%) accounts for the highest share followed by urban transport (14%), water supply (11%), housing (9.9%) IT connectivity and digitization (8.5%), energy (7.2%), sewerage & septage(7.2%), and economic development (6%).

So far, the major focus of the SCM has been to make cities economically vibrant. But now, in the post-Covid scenario, SCM needs to be re-focused and reoriented with greater priority to health, as our cities can become economic engines only if its citizens are healthy. And we can achieve it successfully by leveraging digital technology like telemedicine.

The writer is Editor, PropTOQ real estate magazine
Technological advancements disrupting the global construction industry

Coauthored by Eric Ottinger, Harshit Minglani and Mark Gibson FRICS, Ernst & Young LLP

Global construction trends and technological advancements

The world’s rapid transformation from manual processes to digital technologies is empowering the construction industry. Construction companies are now provided with unprecedented levels of transparency, choice and convenience. With enhanced capabilities, there is an increased demand for higher quality, greater safety and timely completion of projects. This influx of technological solutions is mitigating risks and streamlining the building production process. Digital innovations and megatrends continue to evolve and shape the future of the construction industry.

This research provides a high-level overview of the technology landscape and potential future state of the construction industry. This paper will focus on three core areas identified herein:

1. Design oriented digital technologies
2. Industrialized and componentized construction advances
3. Construction automation – supporting work through digitization

Realizing the demand

IT and software companies have recognized a demand for digitization in the construction industry and are expanding their software offerings to include solutions tailored for many processes. There have been several innovative construction technologies introduced in the last decade, including building information modeling (BIM), project control and scheduling software. Sensors, cameras and drones are being used to monitor project progress and create smarter buildings. Automation is to be found in almost every repetitive process and the industry is seeing a resurgence in industrial manufacturing in order to compensate for declining on-site construction productivity. These evolving technologies have directly
Numbers above were extrapolated from external sources
Design oriented digital technologies
Building information modeling (BIM)

Utilizing BIM has become the most commonly used technology in the construction industry, from design through project completion and operation. 73% of US contractors surveyed by Dodge Data & Analytics report utilizing BIM, with 79% of those using it on more than 30% of their projects. BIM is the process and digital representation used for modeling and management of the physical and functional characteristics of a construction project or facility. It is a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life-cycle; with the possibility of existing from earliest conception to decommissioning. BIM can be applied to create 3D models, and has evolved to additional dimensions, including schedule (4D), cost estimating (5D), sustainability (6D) and operations maintenance (7D). It affords a number of benefits, such as more effective design, enhanced coordination, a reduction in change orders and a more efficient construction process overall. During design and construction, BIM offers savings in cost and time, gains in accuracy and reduction in errors and rework. The estimated savings of total project cost using BIM is typically between 4% to 6%. Critical information can be input to the digital BIM at the earliest phases of design and planning. BIM allows engineers to easily analyze alternative scenarios and visualize the entire planned sequence of the project. This limits waste and allows products to be delivered closer to a just-in-time model rather than being stock piled onsite. Because of this, BIM can directly compliment prefab design, supply chain management and project installation by allowing owners and contractors to identify impacts to multiple project elements. As the dimensions of BIM have evolved, it has become a critical input to digital twins.

Digital twin

One of the latest trends in the construction industry is creation of a digital twin to enable simulation and predictive analytics. The digital twin enables convergence of the physical and virtual world, where every process, product or service is represented by producing a digital replica of a physical asset or living entity. This allows analysis of data and monitoring of systems to identify and resolve problems before they occur, prevent downtime, develop new opportunities and plan for the future by utilizing simulations. By reconstructing an as-built state of a structure in BIM, we can then compare it to as-planned execution and take corresponding actions to correct any deviations.

Digital twin building simulations can be used to assess the energy demand, indoor environmental quality, carbon emissions and payback periods of energy management systems over the lifetime of an asset. Once the building is operational, a digital twin can notify the user of maintenance malfunctions, such as a light going out in a fire stairwell. The manager can then check the visual representation to locate the exact positioning of the bulb and the best access route. Strategic benefits will also include automated progress monitoring, facilities management, root cause analysis, intelligent recommendations, self-tuning, predictive maintenance, 3D databases of reflective virtual asset information, data collection for AI systems, data storage and historical recall.
bauma CONEXPO INDIA 2020
is postponed to February 23-26, 2021
Gurugram/New Delhi
**Augmented and virtual reality**

Technologies like augmented reality (AR) and virtual reality (VR) have enabled construction companies, investors and customers to visualize elements of the design, build and post-construction phases of their projects. AR is a live, direct or indirect view of a physical, real-world environment whose elements are 'augmented' by computer-generated sensory input, such as sound, video, graphics or GPS data. VR is an artificial environment that is created with software and presented to the user with a virtual model of the real world. VR therefore allows for isolation of the user during prototyping. 2D, CAD and BIM plan sets can be transformed into a fully immersive augmented and virtual reality, providing a virtual 3D overlay view of buildings and interiors. This allows stakeholders to obtain an improved understanding of what is to be built, along with visibility of spatial mapping. Additionally, it can increase customer and investor satisfaction by allowing a greater degree of input in the initial planning and design phase. Providing full emersion allows for stakeholders to increase accuracy in projections, optimize training, identify risks and increase safety before the construction process begins. Subsequently, it can increase reliability while decreasing margin of error. Usability can consequently be improved earlier than the traditional process of utilizing plan sets.

**Geo-enabled technologies**

Geo-enabled technologies have unlocked the potential of location data to drive informed decision-making, process standardization and efficiency. These technologies utilize cameras and sensors to obtain data, measurements and quantities over the lifecycle of a project. Drones, also known as unmanned vehicles or remotely piloted aircraft, are becoming increasingly popular to provide onsite digital asset tracking, continuous spatial inspection and progress monitoring. Having the ability to capture broad-scale aerial photography and send real-time images, video and data to computers or mobile devices is expected to be used for simulating a construction environment to test scenarios and facilitate evidence-based decision making. Such deployment promotes faster planning, construction work and site safety. In the UAE, contractors are extensively using drones for monitoring and inspecting sites. In a labor deficient Japan, Komatsu Ltd. began using drones that create 3D maps, extract blueprints and simulate construction plans. The future of drones on a construction site will help enhance analytics, schedule management, labor efficiency and promote waste reduction.

360-degree cameras can provide monitoring for enclosed rooms and buildings. These cameras are providing assistance with waste reduction and tracking materials, equipment and inventory. This technology is also advancing toward labor productivity tracking and precise real-time spatial measurements. Suffolk Construction has integrated image recognition software with automated monitoring capability to recognize construction risks and hazards. Cameras eventually may be used in optimizing cost management and holding contractors accountable for design, materials, labor and potential change orders. Sensors have also become increasingly popular. Gilbane Construction Company has recently adopted a system of wearable sensors that enables management to analyze construction operations and productivity in real-time. Utilizing these sensors alongside GPS diagnostics, work can be monitored remotely to help enhance productivity.

**Industrialized and componentized construction advances**

Digitally-enhanced manufacturing of componentized buildings

With a heightened focus on efficiency and faster building methods, industrialized construction (prefabrication and modular) is on a growth path and the trend is emerging across the globe. According to a survey conducted by Commercial Construction Index, ‘nearly half (45%) of contractors currently using prefabrication and modularization techniques have seen increased use in the last three years.9 The industrialized approach shifts many construction activities away from the site and allocates these tasks to a factory. Preassembled building components and modules are then shipped to the construction site for assembly. While these are not new concepts, opportunities have compelled developers and contractors to apply prefabrication with technological innovation to their projects. Pursuing this strategy helps overcome construction challenges, including speed of delivery, economic viability, quality and enhancing environmental sustainability.

Many construction companies are applying digitization to prefab and modular. This will drive further momentum and may eventually lead to the emergence of one or two market leaders in this space. Technology is a dominant theme as it continues to reshape conventional property uses, while transforming the back office and construction supply chain. Many of these technologies addressed in this paper, such as drones, 3D printing, robotics, AI and IoT, are expected to provide substantial improvements to industrialization and construction productivity. The continued impact of disruptive forces - from changing customer behavior to technology initiatives, changing demographics and growing competition from non-traditional players like startups and technology-based businesses - is leading to continued and advancing change. It seems likely that, over time, componentized or industrialized construction will become the dominant solution in the industry for certain asset types, such as multifamily and commercial.

**3D printing**

Also referred to as additive manufacturing, 3D printing digitally creates successive layers of materials to produce three dimensional objects from a digital file. 3D printing has evolved to be a natural fit within the industry, usable for a variety of suitable materials (notably polymers, metals, ceramics and concrete) and providing almost limitless freedom of flexible design. Realizing reduced costs associated with fabricating complex shapes provide less constraints on architects and designers. Emerging opportunities include printing piping and fittings, tools and equipment, formwork for concrete, structural insulated panels, walls with embedded MEP systems and roofs with solar tiles.
Robots have been contributing to production lines of manufacturing industries for decades, performing repetitive tasks more efficiently and with greater accuracy than humans. Some prefab construction companies are exploring robotic capabilities and have begun implementing them in their production factories. Present initiatives indicate that fully autonomous factories, logistics, transportation, and eventually the complete supply chain, may be completely automated with robotics.

Construction automation – supporting work through digitization

Robotic process automation (RPA)

RPA is one form of automation, commonly used for boring, repetitive and mundane tasks. Automation takes a current or modified process and enhances this via the use of digital tools, enabling machines (computers) to undertake the work previously executed by humans. It improves speed, accuracy, consistency and cost of executing these routine tasks. RPA can change project controls and tasks related to project finance. For example, financial forecasts may no longer require manual entries in Excel. Instead, the robots (a ‘bot’ or ‘program’) can collect data from multiple systems, while algorithms build forecasts based on past and present data (using predictive analytics). A computer software program that operates repetitively with rule-based processes, RPA replicates and collaborates with the actions of a human being, interacting with the user interface of a computer system. The software is trained to connect multiple fragmented systems with automation and is based on functional specifications that can be adjusted. Given a renewal of the existing IT landscape is not required, a high level of automation that collects and transforms data can be reached with minimal effort. The software then allows the capture and interpretation of a business process in a repetitive, audited and controlled manner. Subsequently, business and administrative processes can be fully automated and programmed by a computer to monitor and reduce costs, save time and enhance reporting.

Briq has developed RPA programs with bots to track and record city council meeting minutes and permitting issuances across municipalities. Users receive weekly ‘intent to build’ scores for the metro area, along with market updates and forecasts. This allows for real-time information to be shared with developers who look to capitalize on investment opportunities from a recent entitlement or rezoning.

EY teams have recently created Payment Application Managed Service (PAMS), a digitally automated back of house support solution. PAMS is a cost-efficient construction and facilities management invoice processing solution for clients with large owned or leased real estate or infrastructure portfolios. Successful digital transformation of a company’s payment application and processing leads to internal procedures being automated and therefore saving costs, improving controls and enhancing transparency. PAMS has had many success cases, including automating 72% of payment processes for a global company and reducing the processing time from 60 to 7 days. This client experienced 40% processing cost savings and 9% lower total costs for all of their payments. RPA and other forms of automation can supplement typical human tasks, reduce error rates, enhance controls and eliminate redundant and repetitive tasks. This may help address some of the skill shortage being experienced by construction in the competitive labor market.
Facial recognition and biometrics
Facial recognition captures graphical information using multiple data points like distance between the eyes and facial curves that are unique to individuals. The information is stored utilizing an algorithm in a database. When accessed, the system scans and matches the facial information by applying it to the algorithm. Current investment by owners, developers and contractors include facial recognition to enhance safety at the construction site, access control and productivity monitoring. Using facial recognition, site access is restricted to workers and authorized personnel. Contractors are also able to use the data from facial recognition as backup for invoicing.

In 2019, the global facial recognition market was projected to grow from $3.2B to $7.0B by 2024, at a CAGR of 16.6%. As the technology progresses, it can potentially change the landscape of physical security, payroll systems, project controls and resource optimization, helping to reduce cost and enhance control. Facial recognition is currently saving Health and Safety International’s building services contracts £140,000 per year.12

Artificial intelligence (AI)
The global AI construction market is also forecasted to grow substantially, from $407.2M in 2018 to $1.8B by 2023, at a CAGR of 35.1%. AI is a label given to computing systems that exhibit the ability to perceive information, retain it as knowledge, and apply it to making decisions. AI may also interact in ways that seem natural to humans, while simultaneously learning from those interactions by utilizing machine learning. Supported by vast amounts of accessible data, advances in AI have allowed for improved learning algorithms that enable the extraction of deeper levels of meaning. AI can drive productivity improvements as the systems augment human skillsets and reduce the need for tedious human effort.

The rising demand for AI- and machine learning-based solutions, the increasing need for greater safety and the ability to reduce production costs are all expected to drive the growth of AI in the construction sector. Current AI efforts include project schedule optimization through historical data, identifying unsafe worker behavior through image recognition and classifying signals and patterns to deploy real-time solutions. This allows AI to prioritize preventative maintenance and prevent unplanned downtime through enhanced analytical platforms. As this technology progresses, it will optimize project supply chains by tracking and analyzing complex data, such as providing the ability to employ artificial neural networks to predict cost overruns.

Blockchain
Blockchain helps provide the construction supply chain increased functionality, efficiency and visibility. Blockchain is an open public database where transactions are stored in virtual blocks. These blocks are connected together in a chain, creating a complete history of all transactions that have occurred within a particular network. Blockchain has the potential to encrypt and protect key elements in construction operations and supply chains. This technology could potentially handle all contractual relationships using concepts like smart contracts and electronic verification. Blockchain-enabled distributed ledgers can enable better transparency and accountability in construction projects by addressing scope creep, contract changes and elimination of waste to reduce costs.

A grouping of smart contracts can be used to create a decentralized autonomous organization (DAO) that is operated by rules encoded as computer programs. Smart contracts executed between the client and the contractor will enhance the design, tender, install, monitoring, certification and handover of the built asset. By integrating blockchain, a construction company or building maintenance system could function by a project or building’s DAO placing an order for products and services. Materials are tracked in an undisputable blockchain ledger and the DAO accepts delivery. Once the DAO calls out a contractor to install the material, smart contracts release payments as materials and services achieve milestones. Should milestones or thresholds be missed indicating reduced fees, the automated system would send alert and recommend course correction. Lastly, the DAO would make final payment to both the supplier and installer from the owner’s bank account. The DAO could enhance rent collection, corporate expenditures and insurance payments with autonomous management.

Internet of things (IoT)
IoT enables the connectivity of assets and big data analytics, providing new insights for project teams by capturing large amounts of reliable data in real-time. IoT is the network of physical devices, such as components, appliances, equipment, buildings and vehicles embedded with electronics, software, sensors, actuators and network connectivity, enabling these objects to collect and exchange data over the internet. Combining the features of telematics, asset management and connected BIM, along with using radio-frequency identification and tracking devices, could lead to highly increased efficiencies.
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The benefits of IoT span across the entire lifecycle of a project and promote sustainable, whole life costing. Throughout the entire life cycle, machine learning will continue to recognize opportunities and provide analytics and recommendations to maximize productivity.

Emerging opportunities include installing meters and monitors at the beginning of construction to analyze output (energy, utilities, labor, etc.) and optimize visibility supply chain interaction and site conditions. IoT enables green buildings to complete tasks, such as shutting down unnecessary systems when the building is unoccupied and opening and closing louvers automatically to provide optimal levels of natural light. Predictive maintenance programs can also be established with IoT. When fitted with sensors, construction equipment can automatically send notice if any abnormal patterns are detected. This alerts workers to intervene early to avoid critical down time or further damage.

**Smart buildings to smart cities**

IoT is the basis and overarching framework for smart buildings, providing a key enabler of new business models for commercial real estate. With building automation and IoT centralizing control and integrating all systems in a building (heating, ventilation, lighting, etc.), it augments the complete project life cycle and establishes the business case for smart buildings.
buildings are constructed to provide autonomous improvement strategies and recommendations (utilizing AI, RPA and machine learning) that enhance the well-being and productivity of users while simultaneously saving operational costs and increasing building efficiencies.

Building managers are looking at smart buildings to analyze space users’ needs and move beyond the traditional lessor/lessee relationships. Smart buildings are planned to transform the business model and create real estate as a customer service platform. The customer service platform leverages data, machine learning and integrated building infrastructure to significantly enhance the user experience. To enable the transformation of a smart building requires a deep understanding of tenants, usage and occupancy patterns, as well as driving more information from building management systems - all of which can be explored through various smart building technologies.

New technologies, such as Tesla’s battery packs and solar roof tiles can be incorporated into smart buildings to enhance energy efficiency and enable the building to be net zero. Net zero establishes that the total amount of energy consumed by a building is roughly equal to the amount of energy created on-site. With a battery pack and solar roof tiles, buildings are now able to become completely net zero, create and store additional energy, which can allow a building to remove itself from the traditional power grid. Surplus energy can then be sent back to the power grid and require the owner to be compensated.

Smart buildings will consistently analyze energy consumption and determine its distribution during operations.

**Conclusion - implementation of ConTech and PropTech**

The globalization of capital, emerging technologies and changing demographics require the real estate and construction sectors to rethink traditional paths to successful management of the built environment. To remain competitive, companies must explore new structuring options, improve the efficiency of operations and balance portfolios to maximize return on investment – all while mastering digital disruption and gaining a deeper understanding of customer preferences.

To create a successful digital strategy that will maximize chances of long-term success, firms should first challenge its strategic direction, and then define the future state of the organization that will create lasting value. Only 25% of real estate and construction firms have a digital strategy and only 9% feel they are prepared for the digital revolution. A key factor in this lack of progress is the minimal profit margins systemic within the industry. Construction firms typically have profit margins of 2-3% compared with an average of 20% in other industries. When profit margins are narrow, spending 1% of revenue on digital upgrades and innovation can seem like a heavy and risky investment; however, failing to invest in solutions that could boost output is counterproductive. The most innovative will invest and gain a critical strategic advantage over the rest. The World Economic Forum estimates that a 1% rise in productivity could result in savings of $100B per year in the construction industry.

Additionally, many studies have recognized that the industry wastes up to 30% of all capital injected, an unsustainable situation in the long term. We expect a few, digitally focused, construction and real estate organizations to take on these challenges and to subsequently dominate the global market in the second half of the century.

New technologies and market competitors continue to emerge. The rapid evolution of construction and real estate technologies emphasizes that those who act fast and decisively, embrace disruption, and focus on achieving long-term flexibility will emerge as the leading organizations in the future. Companies should include digital in every aspect of their operations in order to achieve maximum data-driven insight. This will enable them to identify new opportunities and threats across their value chains. With technological innovation quickly expanding, now is the time to embrace disruption, use change to enhance productivity and efficiencies, and prepare for the progressive digital evolution within the construction industry.

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With India planning to reach the US$5 Trillion economy in next 5 years, infrastructure sector which attracted about 40% of total PE/VC investment in 2019 is expected to play a major role. The Government intends to spend about US$1.4 Trillion in next few years on infrastructure with clear focus on time bound creation of assets of world class standards. With India expected to be the 3rd largest Construction market globally by 2022, there exists a tremendous need & opportunity for trained personnel, mechanisation, technology / knowledge transfer and strengthening of existing supply chains in the tunnelling & underground infrastructure space which is a key component of the infrastructure industry. This conference aims to meet these key objectives by providing a platform for best in the industry to come together to explore knowledge sharing & business networking opportunities. Experts from the industry sub-segments will be sharing their thoughts on the subject. Companies & Industry Professionals are invited to participate in this mega event of the decade. A great opportunity for academicians, practitioners, decision makers, businesses & other stakeholders involved in the Infrastructure sector to meet, connect, interact & showcase their products / services besides providing a rare collaboration & networking platform for everyone.

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The pervasive gloomy situation that has spread in all possible realms of life due to the Corona virus pandemic has only strengthened the great old saying ‘necessity is the mother of invention’ - be it the improved capabilities of IT professionals to work from home, increased usage of online learning/conferences/webinar or a major push to Make in India (a valid example is set up of more than two lakh enterprises to manufacture PPEs!). In fact, many industries have invented ways to not just adapt to the changing times but also proliferate their businesses. Hence, it is only apt to say that for the construction industry in India (in which technology intervention has been comparatively slow and less disruptive), a booming future in a post-Covid era is possible if the status quo is challenged through a paradigm shift.

Technology to the Rescue

In view of the aforesaid, let’s get an overview of one such disruptive idea, primarily focussed on construction of buildings and factories, interior fit-outs, and residential construction, which could be a game changer for the industry.

The entire lifecycle of such projects is largely based on manual methods of correspondence and supervision, including email, WhatsApp, Excel and PowerPoint reporting. Moreover, there is an absolute lack of automated mechanisms to raise a red flag when a milestone deadline is breached, when there is a discrepancy in specifications and quantity of material received at site compared to the Bill of Quantity (BOQ), when there is a dilution in design, when there is discontent between contractor and customer for BOQ reconciliation, or when the labourers are not adhering to PPEs.

Another critical concern at construction sites (which till now has been preferred to be sent to oblivion), is the unsafe and unhygienic work environment for the labour workforce. This will now become of utmost importance when work resumes in full force, in a world scarred by the deadly Corona virus. All these concerns and challenges ultimately result in delays in project completion, sometimes unprecedented, along with cost escalations (the brunt of which has to be borne by the customers and contractors alike), and violation of safety norms. So, for the construction industry to be competitive and to rebound with a bang, use of technology is imperative to not just lower costs and deliver projects on time, but to also pay heed to the plight of the labour workforce. A cloud based IoT enabled platform seems to be the right solution. Let’s explore how it works.

Cloud based IoT enabled platform for Construction Projects

At the onset, the platform, which should be essentially an application, could serve as an end-to-end solution right from the design conceptualisation till the project hand over and snag completion. To go a step further, the app can also extend its features to cover the repairs and maintenance of the infrastructure as well, till the building lifecycle ends.
Once the customer/developer decides to create a new infrastructure – a new office campus, a new residential project or maybe a new commercial building – the app comes into the picture. All the stakeholders (employees of the customer/developer) could download the app and browse through several design themes as well as architects, to not just select what best meets their requirements but also the latest market trend. Of course, the enterprise that owns this app would have to onboard the architects on its platform.

Once the architect is finalised and is ready with the BOQ, approved makes, 3D layouts, etc., all these documents can be uploaded by the architect on the app. The customer can now browse through several contractors, whether turnkey or activity based, on the app and select whichever is best suitable. All the selected contractors could see the BOQ, approved makes, layouts, etc. Point to note here is that this might not be as simple as it sounds, and a fair amount of feature upload will have to be provided by the app owner. The best part of this would be that the contractor would be fully aware of the entire project scope right from when he is awarded the contract, along with the architect and the customer. This does seem like solving half of the project problem – the communication gap between architect, contractor and customer.

When the project starts, the app features could help the customer set milestones and the contractor would be able to feed in the entire project schedule into the app - whether it be Gantt Chart, S curve or any other thing. This would then let the customer as well as the contractor know, automatically, whenever a milestone is breached or whether the daily scheduled tasks are completed or not. All this, literally at the tap on your phone!

For a win-win situation

Apart from this, through the use of simple IoT solutions like Bar Code generators and scanners, the customer and contractor can virtually track the entire manpower and material movement onsite, which eventually would enable the customer to know what material has come to the site and what is yet to come. Moreover, there could be some mandatory checks in the app that would need the Project Manager to click and upload photos on a daily basis and which could be accessed by the customer and the architect, which would help in immediately flagging any design dilution. The project deadline, thus, would fall in place by default. So, the architect is happy that his/her firm’s design is being executed as desired; the customer is happy that he is getting value for money; and the contractor is happy because it would add to his company’s reputation to execute a project as conceived, and on time.

Other approaches can also be integrated to this app-based platform, including a third-party payroll process to ensure that all labourers get paid as per their working hours, along with entitlement to the other benefits of organised labour. There is a plethora of IoT sensors that can be used - like drones, proximity sensors, wearable gadgets and much more, which would land the customer a completely connected site, right on the phone.

Unarguably, this is only a beginning of an era in the construction industry which has a mammoth potential to adopt deep tech methods and make the best use of them for all the stakeholders - customers, contractors, architects or even the labour workforce - resulting in a win-win situation for all, and, to an extent, doing away with the jinx that the construction industry is set to see a downturn in a post-Covid world. That world surely can be surprised!
Revision of Indian Standard Codes of Civil Engineering – Prospects and Necessity

It is not only necessary but rather indispensable for civil engineers and professionals engaged in civil engineering practices to have a practical understanding of the modification and changes in the Indian standard codes of practice taking place time to time by the Bureau of Indian Standards, New Delhi. Major changes such as Limit State Design method, change in seismic zones, new load considerations, mass irregularities, entrant corners, serviceability approach, dynamic loading analysis, etc. are to be followed so that safe structures with long serviceability can be accomplished. The dynamics of change and regular adjustment in IS codes cannot be ignored if at all the structures built have to stand the test of time against ravages created under the force of threats and hazards.

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Standard codes of practice for civil engineering enumerate prospects and necessity of the design and construction practices of the structures. They provide a set of rules and regulations that specify the standards for the design of all types of structures within the ambit of civil engineering. The purpose of codes is to provide minimum guiding standards for safety, health and general civil works (encompassing sanitation, sewerage, water supply, water drainage, rain water harvesting, lighting and ventilation), structural and mechanical integrity, means of egress, fire protection & control and energy conservation. The standard codes for civil structures become laws of having particular jurisdiction when formally enacted by the concerned, appropriate government, semi government or private authority.

Standard codes provide safeguards to the public. Though no code can eliminate all risks but it can reduce risk to an acceptable level. Standard codes for structures have been a primary source for guidance in design and construction of building structures for many decades. Earlier the main focus was curtailing loss of life and property. Currently the codes are focused to address a myriad of new technologies/design concepts. Contemporary provisions, requirements and stipulations have expanded beyond health and safety requirements to include other socio-economic values such as accessibility, energy efficiency, indoor air quality and sustainability.

Hence, codes are developed, reviewed and revised from time to time for incorporating additions, alterations and modification of factors considered important with respect to criterion for design, construction practices and operation of buildings.

Every new code is a response to review of a prior failure. Natural and manmade disasters have revealed our underestimation of safety requirements and compelled us to formulate ways to improve. The addressal of experienced inadequacies, over the years, has led to evolution of codes. This has helped to prevent mass casualties arising out of structural failures, inadequate lighting, inadequate ventilation, fires, and flooding. As society moves forward, standard codes for civil structures shall continue to evolve too, reflecting the lessons learned about the materials used/practices followed and the way it is to be re-implemented. The code, being adopted as Standards by jurisdiction, may or may not be implemented with intent to serve as regulatory requirements.

Rationale of the Study

Energy waste is one of the most expensive consequences of older building codes. As energy conservation becomes more important for economical and environmental reasons, new building codes are being enforced specifically to address this factor. Energy codes are not just designed to protect natural resources; they also make buildings safer, more efficient and also ensure healthier environs.
For example, public health improves when indoor air quality is more strongly regulated whereas sustainability incentives have given homeowners more control over their utility costs.

Standard codes are generally intended to be followed and applied by architects, engineers, interior designers, constructors, facility managers, and regulators but are also used for various purposes by safety regulators, environmental scientists, real estate developers, subcontractors, manufacturers of building products / materials, insurance companies, facility managers, owners and tenants. Codes, when adopted into law, regulate the design, construction, operation and maintenance of structures. The flexibility of the code towards acceptance of advanced materials and improved methods of construction is of utmost importance. Innovative materials and practices are demanding equal treatment as with older materials which have already proven their worth. Lack of clear and explicit requirements with regard to improved specifications and procedural requirements render the codes deficient and are one of the most pressing problems of structural regulations today.

Examination of the properties, features and failures related to current materials, disasters like cyclone, tsunami, earthquakes, flood, landslides, study of requirements for modern buildings / blocks /roads/cities, design methods, encountered and suspected failures, information on latest innovative materials, reports of tests, proceedings of engineering societies, compilations of data of various kinds, quality of materials, methods of test, methods of assembly of materials and performance under conditions of use, improved uses of a particular material etc. should give a good idea of whether a few selected amendments will accomplish all that is needed for standard codes or the same needs to be reviewed and revised.

With the passage of time, rational stipulations in terms of provisions in codes of practice of civil engineering design and construction have gradually come up to the attention all over the world and the current practices across the world are based on either Limit State Method (LSM) or Load Resistance Factor Design (LRFD) method. The design carried out by LSM / LRFD method takes precise care of performance of structural components efficiently and economically in different structural system. Since LSM / LRFD method has been acquired as the design philosophy in most of the countries because of its rational approach, it is being widely perceived that Indian Standard Codes need to be modified in tune with Limit State Method of design while maintaining Working Stress Design (WSD) as a transition alternative. This, in turn, has helped the civil engineers to understand the nuances and spirit of design as well as construction practices.

The switching of design methodologies from WSD to LSM is to ensure flexibility of structure along with strength. As with WSD method, structures are supposed to work upto elastic limit but as per LSM, structures are supposed to perform beyond elastic limit. Importance is given to serviceability requirements in deciding structures stability in addition to the strength requirement. Change of seismic zones, considering dynamic loadings with static loadings, Erection load, mass irregularity, and vertical geometric considerations are some of the factors which cannot be avoided. This, in turn, would help the civil engineers to understand the nuances and spirit of design as well as construction, operation and maintenance practices.

Objective of the Study

The present study seeks to present a close perspective on the evolution of various Indian Standard Codes of civil engineering practices in Indian conditions and subsequent changes in such codes from the point of view of design practices. For the last 70 years, the Bureau of Indian Standards (BIS), New Delhi has published and regularly revised codes such as Code of Practice – Plain and Reinforced Concrete (IS:456), Criteria for Earthquake Resistant Design of Structures (IS: 1893), General Construction in Steel (IS: 800), and also several others, e.g. Code of practice for Design Load (Other than Earthquake Load) for Building and Structures (IS: 875), Ductile Design and Detailing of Reinforced Concrete Structures(IS: 13920), etc.

The Indian Standard codes for civil engineering practices are being revised by the BIS as per basic design and engineering requirements, new inventions, latest design concepts, improved materials and environmental happenings. Hence it is pertinent to spell out the major changes that are reflecting in the revised or latest codes with respect to the previous ones. The modifications, additions, eliminations and revisions in IS codes definitely reflect the modified requirements for existing structures and revisions to be admissible for designing new structures. The design and construction of all the structures must comply with the latest relevant codes. In the fitness of the context, a comparative study has been made between IS: 456 – 1978 and 2000 (Code of Practice – Plain and Reinforced Concrete), IS: 1893 – 1984 and 2002 and also IS: 1893 – 2002 and 2016 (Code of Practice – Criteria for Earthquake Resistant Design of Structures), and IS: 800 – 1984 and 2007 (Code of Practice–General Construction in Steel). This has been presented here:

Comparison of IS 456: 1978 & 2000

1) Type of cement: Types of cement were duly mentioned in IS 456 – 1978 version including OPC, PSC and PPC in clause 4.1. Further types of cements were also included in the 1978 version of the standard through an Amendment No. 2 in August 1994 including all the three grades of OPC. It may be noted that the cement types were given even in 1964 version of the standard. In IS 456 – 2000, recognition of all three grades of OPC cements along with other types of cements has been given vide clause 5.1.

2) Admixtures: In IS 456 – 1978, Fly ash as a pozzolana was covered in clause 4.5 and chemical admixture was covered in clause 4.4 whereas in 2000 version, enumeration of allowable mineral admixtures [clause 5.2] and approval of practice of chemical admixtures [clause 5.5] has been taken care of.

3) Water testing: The provision of testing water was covered in 1978 version through the Amendment No. 2 issued to it. In IS 456 – 2000, method of testing water for concreting has been described [clause 5.4].
4) Characteristic strength of steel: Even though the characteristic strength of steel was not specified in 1978 version under its clause 4.6, the same could be construed. In IS 456 – 2000, characteristic strength of steel has been defined as minimum yield or 0.2% proof stress [clause 5.6.3].

5) Grade of concrete: In IS 456 – 1978, M15 is the minimum strength of concrete for structural purpose whereas in IS 456-2000, M20 is the minimum strength of concrete for structural purpose [clause 6.1.2].

6) Modulus of elasticity of concrete: In IS 456-1978, modulus of elasticity is considered as Ec = √5700 (fck) in N / mm² [clause 5.2.3.1] whereas in 2000 version, whereas modulus of elasticity of concrete is taken as Ec = √5000 (fck) in N/mm² [clause 6.2.3].

7) Quality assurance factor: In IS 456-1978 quality of concrete was proposed to be controlled through the provisions of workability, durability, mix proportioning, and production and control of concrete, etc. and a clause on transporting, placing, compaction, joints, curing and supervision covered therein. In 2000 version, while elaborating the provision Quality Assurance Factor, an additional clause on quality assurance measures was added as clause 10.1.

8) Basis of design: Working stress method (WSM) primarily is the basis of design in IS 456-1978, however it covered structural design by Limit state method (LSM) in Section 5. In IS 456-2000, Limit state method (LSM) of design was further elaborated and the WSM was relegated to as an Annexure. Applications of these methods were clarified in Clauses 18.2.1 and 18.2.2.

9) Bending moment coefficient: In 1978 version, it is I/24. In 2000 version, bending moment coefficient at midpoint of interior spans has been increased from 1/24 to 1/16 and brings its value to ¾ the value at support.

10) Tolerance limit for cover: In IS 456-1978, it was indicated that a tolerance limit of 1/4 inch (6mm) was specified in the last paragraph of clause 11.3. In IS 456-2000, tolerance limit for covers to steel fabrication have been specified [clause 12.3.2]. Of course, the provisions were made quite stringent in the 2000 version as compared to those in 1978 version.

11) Cracking of concrete: Though this was specified in IS 456-1978 vide clause 34.3, but provisions were not detailed. An Annexure F was also included on crack width calculation. In IS 456-1978, limit state of cracking guidance regarding width of cracks allowed to different environment [clause 35.3.2]. As a matter of fact, provisions were detailed in the 2000 version as compared to those in 1978 version.

12) Fire resistance: In 1978 version, it is not mentioned directly; instead fire resistance requirement was mentioned through reference to the Indian Standard, IS 1642. It is glaring to note that in IS 456-2000, minimum requirement of concrete cover, member dimensions for concrete members, to have required fire resistance has been mentioned in clause 21.

13) Workability: In 1978 code, workability is related with the slump and compacting factor [clause 6.1]. However, it also recommends that, in the ‘very low’ category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor should be done. Similarly, in ‘very high’ category of workability, the measurement of workability by determination of flow will be appropriate. In IS 456-2000, workability has been simplified in terms of slump only [clause7.1].


15) Grades of concrete: Specified grades from M10 to M40 are mentioned in clause 5.1 of IS 456-1978 whereas from M10 to M80 are in IS 456-2000 vide clause 6.1. Subsequently grades up to M 100 were included through Amendment No. 4 to the 2000 version of the standard code of practice.

16) Stripping Time: In IS 456-1978, period for the vertical frame removal is 24 to 48 hours [clause 10.3] whereas in IS 456-2000, vertical formwork to columns, walls and beams can be removed after 16 to 24 hours [clause 11.3]. There is a substantial change brought in this clause through Amendment No. 5 to the standard with respect to stripping time specified for concrete based on OPC and those fly ash or slag based, as well as stripping of formwork based on gain of strength.

Comparison of IS 1893: 1984 & 2002

1) Seismic zones: In IS 1893-1984, seismic zones are divided into five zones whereas in IS 1893-2002, there are four seismic zones as Zone I and Zone II are merged together as shown in Figs. 1 and 2.

2) Seismic zone factor: In IS 1893 – 1984, values of seismic zone factor Z are different which do not reflect realistic values of effective peak ground acceleration whereas in IS 1893-2002 (Part 1), values of seismic zone factor Z have been changed to reflect more realistic values of effective peak ground acceleration.

3) Response spectra: In 1984 version, response spectra are same for all types of soil conditions. Though it had BETA factor (A factor to modify the basic seismic coefficient and seismic zone factor, depending upon the soil foundation system) for Types I, II & III of soil for various foundation systems. In the 2002 version, soil conditions for response spectra are specified for three types of soil items named rock-hard, medium and soft soil.

4) Fundamental natural period: In the former version, empirical expression for estimating fundamental natural period is different for all types of structures. It provided T for 2 types of buildings. It also provided Ta for dams (as provisions for Dams still continue to remain part of 1984 version). In the latter version, empirical expression for estimating fundamental natural period is the same for all types of structures. It provided Ta for 3 types of buildings.

5) Load condition: In 1984 version, at the time of designing, only static load condition is considered whereas in 2002 version, at
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the time of designing, static and dynamic load conditions are considered.

6) Soft storey: It is not detailed in IS 1893 – 1984. Its clause 4.2.1.1 mentioned use of MODAL ANALYSIS for buildings having irregular mass/ stiffness distribution; (including in Fig. 3). In IS 1893 – 2002, soft storey clause was EXPLICITLY MENTIONED (after the failures observed in Bhuj earthquake). Soft Storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three-storey above [clause 4.20].

7) Performance of building: It is not mentioned in 1984 edition. It cautioned with respect to irregular shape; and irregular distribution of MASS & STIFFNESS [clause 4.2.1]. In 2002 edition, it is mentioned that buildings do perform well in an earthquake; a building should possess four main attributes, namely simple and regular configuration, and adequate lateral strength, stiffness and ductility [clause 7.1].

8) Response reduction to earthquake: Only Performance factor is considered in 1984 version. Response reduction factor was known as PERFORMANCE FACTOR (K), and its specified values based on structural framing system. (See also Foreword, 0.7 for ductility related requirements). Ductility requirements were available in 1984 version; for which a reference was made to IS 4326 (see notes under 3.3.2). In 2002 version of the code, concept of response reduction due to ductile deformation or frictional energy dissipation in the cracks has been given by Response reduction factor.

9) Load combinations: In IS 1893-1984, load combination is UL = 1.4 (DL+LL+EL) whereas in 2002 version, load combinations for plastic design of structures are as follows: (a) 1.7 (DL+IL), (b) 1.7(DL±IL) and (c) 1.3(DL+IL±EL).
10) Partial safety factors: Partial safety factors for limit states of serviceability and collapse and the procedure as given in relevant Indian Standards (IS : 456 – 1978 and IS : 1343 – 1980) are considered in 1984 code. In IS 1893 -2002 (Part 1), Partial safety factors for limit state design of reinforced concrete and prestressed concrete structures are as follows:
(a) 1.5( DL + IL) (b) 1.2 ( DL+IL ± EL) (c) 1.5 ( DL ± EL) (d) 0.9DL± 1.5EL.
These values in are in line with those given in IS 456:2000.

1) Unreinforced masonry infill (URM): In the case of URM walls modelling, IS 1893-2002 code is silent about modelling of masonry infill walls. Only equation for $Ta= 0.09h'/d$ for Buildings with masonry infill walls is given in its clause 7.6.1. Hence, in analysis, $Ta$ is taken considering masonry infill whereas stiffness of infill is not considered in analysis. In IS 1893-2016, EQ loads when infills exist have been considered for RC framed building with URM. A detail procedure for URM infill by Equivalent Diagonal Strut method has been given in its clause 7.9.2.2.

2) Soft storey: As per 2002 version, soft storey is defined as the storey in which lateral stiffness is less than 70 % of that in the storey above [Clause 4.20] whereas as per 2016 version, soft storey is defined as the storey in which lateral stiffness is less than that in the storey above [clause 4.20.1].

3) Weak storey: As per clause 4.25 of 2002 version, weak storey is the storey in which the lateral strength is less than 80 % of that in the storey above whereas as per clause 4.20.2 of 2016 version, weak storey is the storey in which the lateral strength [cumulative design shear strength of all structural members other than that of unreinforced masonry infill (URM)] less than that in the storey above [clause 4.20.2].

4) Dynamic analysis: In IS 1893-2002 (Part 1), requirement of dynamic analysis is given in clause 7.8.1 for regular buildings (Zone – IV, V,.. height >40m and Zone – II, III ... height > 90m) as well as for irregular buildings (Zone – IV, V,.. height >12m and Zone – II, III ... height >40m). In IS 1893-2016, as per clause 7.6 and 7.7.1, equivalent static analysis shall be applicable for regular buildings with Height < 15m in seismic Zone II as per clause 6.4.3, equivalent static method should be used for regular building structure with approximate natural periods is less than 0.4 second.

5) Re-entrant corners: According to IS 1893-2002 code vide clause 7.1, condition for re-entrant corner is A/L > 0.15 – 0.20. As per IS 1893-2016 for re-entrant corner vide clause 7.1, A/L > 0.15 in buildings with re-entrant corners, three – dimensional dynamic analysis shall be performed.

6) Mass Irregularity: In the former version, mass irregularity is considered to exist when the seismic weight of any floor is more than 200 % of that of the floor below or above vide clause 7.1 whereas in the latter, vide clause 7.1, mass irregularity is considered to exist when the seismic weight of any floor is more than 150% of that of the floor below such that $Wi > 1.5$ W – 1 and $Wi > 1.5 Wi+1$ where $Wi$ as shown in figure in the code. Further it reads that in buildings with mass irregularity and located in seismic zones III, IV and V dynamic analysis shall be performed.

7) Vertical geometric irregularity: As per 2002 version vide its clause 7.1, Vertical Geometric Irregularity exists when the horizontal dimension of the lateral force resisting system in any storey is more than 150 % of the storey below or above such that $A/L>0.15L$ and $L2/L1>1.5$ where A, L, L1 and L2 are as shown in figures in the code. As per 2016 version of the code, vide clause 7.1, Vertical Geometric Irregularity exists when the horizontal dimension of the lateral force resisting system in any storey is more than 125 % of the storey below $A/L>0.125L$ and $L2/L1>1.25$.

8) Increase in soil pressure: As per IS 1893-2002, when earthquake forces are considered, increase in allowable pressure in soils for different types of soils (Type I, II, III) and different types of foundations, namely piles, raft, well foundations, etc., was from 25 %to 50 % as given in clause 6.3.5.2. In percentage increase in net bearing pressure and skin bearing pressure and skin foundations for soil types A, B and C as 50%, 25%, and 0% respectively, as per 2016 version of ISI 1883. For soft soil, no increase in bearing pressure shall be applied because settlements cannot be restricted by increasing bearing pressure.

9) Liquefaction potential: IS 1893-2002 speaks that Specialist literature was to be referred whereas in IS 1983-2016, Annexure F has been introduced.
Comparison of IS 800: 1984 & 2007

1) Basis of design: IS 800-1984 deals with working stress design concept in which, permissible stress value is never let to reach yield stress whereas IS 800-2007 primarily focuses on Limit State Design Concept which means steel is used beyond its yield value. Working stress design concept is still given in separate chapter of IS 800:2007.

2) Material characteristic: In 1984 version, non-linear behaviour of material was not considered while in 2007 version, the same has been taken into account.

3) Load combinations: In 1984 version of the code, the load combinations are given in clause 3.2 which are (1) DL + IL, (2) DL+IL+WL or EL and (3) DL + WL or EL where DL - dead load, IL - imposed load, WL - wind load and EL - Earthquake Load. It had provisions relating to consideration of stresses generated through secondary effects such as Erection, handling, temperatures effects, settlement of foundations, etc. (Clause 3.4.2.7). In 2007 version, besides the above three load combinations, one more load combination, i.e., DL + ERL has been added vide clause 3.5. Here, ERL stands for erection load.

4) Permissible stress: As per clause: 8.9.4.7 of IS: 800–1984, shear stress shall not exceed 110 MPa whereas in IS 800-2007, shear stress shall not exceed 110MPa vide clause 10.5 nor as calculated using clause 10.5.7.

5) Classification based on buckling and rotation before failure: No such classification has been made in IS 800-1984 whereas in IS 800-2007, sections are classified in clause 3.7, based on its local buckling strength and the ability to allow rotation before failing. These are (a) Class 1 (Plastic), (b) Class 2 (Compact), (c) Class 3 (Semi-compact) and (d) Class 4 (Slender).

6) Restoring Moment: In 1984 version, Restoring moment > 1.2 times maximum overturning moment (due to DL) + 1.4 times maximum overturning moment (due to IL and WL/EL). In cases where DL provides the restoring moment, only 0.9 times DL shall be considered vide its clause 3.12. As per the design philosophy of IS 800-2007, structure should satisfy two limit states, viz. Limit state of strength and limit state of serviceability. As per this version, the structure as a whole or any part of it is to be designed to prevent instability due to overturning, uplift or sliding under factored load as given below:

6.1 The actions shall be divided into components aiding instability and components resisting instability.

6.2 The permanent and variable actions and their effects causing instability shall be combined using appropriate load factors as per the Limit State requirements, to obtain maximum destabilizing effect.

6.3 The permanent actions (loads) and effects contributing to resistance shall be multiplied with a partial safety factor 0.9 and added together with design resistance (after multiplying with appropriate partial safety factor). [Clause 5.5.1 of IS 800-2007].

7) Deflection criteria: As per IS 800-1984, max. deflection for all applicable loads (Vertical / Horizontal) = l / 325 where l is the span [clause 3.13], whereas in IS 800-2007, deflection limits have been provided separately for Industrial buildings and other buildings and separate limits have been mentioned for different members in vide clause 5.6.1.

8) More criteria for load combinations: In IS 800-1984, no additional criteria are given. In IS 800-2007, two more combinations of loads have to be considered (clause 12.2) which are 1.2 DL + 0.5 LL ± 2.5 EL and 0.9 DL ± 2.5 EL.

9) Fire resistance criteria: No such criteria are given in IS 800-1984 whereas IS 800-2007, deals with the Fire Resistance Level Period of structural adequacy of the following:

9.1 Variation of mechanical properties of steel with temperature
9.2 Limiting steel temperature
9.3 Thermal increase with time in protected members
9.4 Determination of period of structural adequacy from a single test
9.5 Three-sided fire exposure condition.

Conclusions

Engineering principles and practices undergo constant experiments, innovations and improvements to suit the demands and required needs of the time. Engineering prudence demands Indian standard codes of civil engineering design and practices to be not left in a static state. Therefore, it requires upgradation and revisions with new perspective so as to give thrust in the direction of construction audits. It is to be ensured that constructions taken place shall be reviewed with the point of view of its auditing in terms of quality, strength and sustainability. Thus, it is most imperative that civil engineering design and practices in Indian conditions are given a prime focus in light of the methods and measures as pointed in the preceding paragraphs.

Continual execution and implementation is, therefore, a watchword and the conception and creation of any structure is thus as cardinal as the implementation and practice of the modification introduced at intervals by the Bureau of Indian Standards.
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Many people, particularly operators, have their own myths on idle running of engines of the machines they operate, such as idling is essential to warm up the engine before loading the engine (moving with or without load); idling is good for the engine and there will not be any load on the engine; keeping engine running in idle is better than frequent switch off and switch on. But the facts are entirely opposite as given below:

**Idle running:** Keeping the engine running at low idle without any work by the machine. Low idle RPM will normally be between 650 to 750 RPM

**The allowable idle run:** Normally, 15 to 20% of total run hours is allowable idle run. This provision is given to take care of the safety of the turbocharger and certain unavoidable working conditions like waiting at loading machine, waiting at dumping yard, momentary stoppages on haul roads during crossings, giving passage to loaded vehicles coming in the opposite direction, vehicles climbing gradients etc.

**Excessive idle running:** Any idle running beyond 20% of total run hours or >5 minutes in a single stretch is considered as excessive idle running. There are incidences of 60% idle running of machines in some worksites.

**Effects of excessive idling of engine:**

In a compression ignition engine, the cylinders are designed to be hot and maintain adequate temperature to burn the injected fuel completely. But during idle running, due to low reciprocating speed of piston, the compression inside the cylinder will not be as effective as during high piston speeds. Due to this, the temperature generated inside the combustion chamber will not be at the desired level, which will lead to the following issues:

- Piston rings do not expand adequately, causing insufficient sealing between piston ring and liners which again leads to leakage of compressed gases
- Incomplete burning of injected fuel and leaving unburnt fuel in the combustion chamber, and passing the unburnt fuel to engine sump through the gap between piston ring and liners
- When fuel starts passing through the gap between the piston ring and the cylinder walls, the fuel washes the piston rings and cylinder liners and dilutes the lubricating oil. This action gradually develops a glazing/shining surface on the liners, eroding the crosshatch marks provided for lubricating oil retention
- Glazing not only loses oil retention in liners but also slowly erodes the oil film which leads to accelerated wear of piston rings and loss of compression. This further increases the gap between the liner and the rings causing severe leakage of compressed gases into the crank case, leading to excess blow-by
- Excess blow-by means loss of compression pressure, loss of power and time to overhaul the engine. Further continuation of running with same status leads to throwing lube oil through exhaust gases (lube oil passing into the combustion chamber through the increased gap between liner and rings)
- Improper burning or poor compression leads to excess carbon formation in piston rings grooves, piston crown, ring band, cylinder head, valves, injector tips etc
- Excess carbon formation leading to sticking of piston rings in grooves, leakage of gases between valve and valve seats, improper fuel spray due to blocked injector spray holes and ultimately aggravating all issues mentioned above and loss of power

Excessive Idle Running of Diesel Engine and the Effects

While idle running is unavoidable and even essential to a certain extent, excess idle running is always dangerous for the engine and the environment.

By Bhaskarudu Peddakotla
• Diesel dilution in engine causing drop in lube oil viscosity and washing out bearing surfaces, dropping lube oil pressure, killing oil film and making metal to metal contact of moving parts and ultimately faster wear of bearings and journals and premature overhaul of engine
• Diesel mixing with lube oil also leads to faster wear of lube oil pump components and reducing pump efficiency
• Improper combustion of gases emits lot of harmful substances like carbon monoxide, nitrous oxide, carbon dioxide, sulphur dioxide, particulate matters etc., through exhaust gases causing health issues to public
• Wear rate of diesel engine during idle running will be 60% more compared to normal operation
• Further idle running of engine means burning the fuel for no work and increasing operating cost unnecessarily
• For every litre of burning of diesel 2.65 kgs of carbon dioxide is released in the atmosphere
• An engine which may give life of 20000 hours may come for overhauling even at 8000 hours due to excess idling of engine
So, excess Idling of engine leads to many issues like premature overhauling of engines i.e increasing operating cost and downtime, unnecessary burning of diesel again leading to increase in operating cost and polluting the atmosphere with harmful exhaust emissions.

However, certain amount of idling is necessary for the engines. For example a turbo-charged engine has to be kept idle for 60 to 180 seconds before shutting down and after starting, i.e before accelerating. Also, while waiting at loading areas and other miscellaneous jobs.

How to control or minimize idle running
• Utilize the data from machine, downloaded through electronic tool and remote monitoring devices, as all present generation machines are equipped with electronic devices to monitor the operating practices
• Analyse the reports and identify areas of improvements which can be done machine- wise or even operator-wise
• Gaps may be in synchronization of loading machines with hauling machines, waiting machines at refuelling area, unloading area, communication between supervisor and operator, electrical problems like self-starter, alternator, batteries etc., and sleeping of operator inside the cabin- all of which are avoidable
• Follow good maintenance practices of all the auto electrical components by keeping a ready stock of all the consumable parts
• Allocate the right number of dumpers to loading machines with proper work planning
• Educate and guide operators and other staff associated with the operation and maintenance in plugging the gaps and keep monitoring performance with periodical reviews
• Create ownership among all the stakeholders at site and recognize and reward best performers

Case Study
At a site where 10 dumpers and 3 loaders were deployed, the idle running of dumpers was 56% and the loaders was 45%. Fuel consumption during idle running of dumpers is 5 LPH and loaders 7 LPH and average utilization of each machine is 3000 hours per year. Imagine the savings from the fuel if this site can bring down the idle running to 20% maximum on all the machines. The savings will be 66,000 ltr of diesel per year, which amounts to Rs. 48 lakhs. Imagine the savings if the fleet size is large and has higher capacity machines. It is not only saving money through the diesel but a lot by protecting the engine from premature wear and protecting the environment from pollutants.

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