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*Under similar site conditions and work load against hydrostatic wheel loader of similar capacity.*

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Infra Development

U’khand approves ₹2,200-cr extensive mobility network

The extensive Mobility Plan of the Uttarakhand Metro project entailing an investment of ₹2,200 crore has got the approval from the state government. The project includes construction of Personal Rapid Transit (PRT) project in Haridwar city and the construction of Metro Light in Haridwar to Rishikesh and Nepali Farm to Vidhan Sabha Corridor, besides, building the ropeway system in Dehradun, Rishikesh and Haridwar to decongest these cities.

CIL targets ₹15,700-cr transport infrastructure

Speeding up the coal evacuation across its coal blocks, Coal India has decided to invest ₹15,700 crore on transport infrastructure, ensuring first to last mile connectivity (FMC), thereby encompassing 14 additional projects from its earlier target of 35 projects. The company already transports 151 million ton (mt) of coal through a mechanized system and loads through Coal Handling Plants (CHP) and silos from 19 projects, which is being increased to 557 mt by 2023-24 through Phase-1 and 2 projects.

Welspun unveils ₹900-cr warehousing project

One Logistics Parks (WOLP) has decided to invest over ₹900 crore to develop a 110-acre warehousing park in Bhiwandi on the outskirts of Mumbai. The company’s maiden project with a leasable area of 3.2 million sq ft is located on a contiguous land parcel wholly owned by Welspun Group.

L&T secures multiple transport infra contracts

The construction wing of L&T has secured contracts for its various businesses including an EPC contract to construct Packages 11 and 22 of the Delhi-Vadodara Expressway, which will be the country’s longest expressway of NHAI under its flagship Bharat Mala program. The business wing also secured another EPC contract from the Public Works (Roads) Directorate, Government of West Bengal for the reconstruction of 4 lanes Tallah ROB (Hemanta Setu) adjacent to Tallah Railway Station on Barrackpore Trunk Road in Kolkata.

World Tunnel Congress 2020 Malaysia Moves to a Digital platform

ITA and IEM hereby jointly announce that WTC2020 in Kuala Lumpur, Malaysia scheduled from 11th to 17th September 2020 will be moved to a fully digital platform due to the impacts of COVID-19, including border restrictions and health risks associated with international travel and the assembly of large meetings.

IEM commits to refund 70% of monies already paid to WTC2020 by sponsors, exhibitors and registered participants and 100% refund for the charges paid by registered participants for side events such as Gala dinner, site visits etc. This refund includes about 8.5% from ITA by waiving all of its entitlements as agreed by ITA.

The digital WTC2020 is currently in preparation at no extra cost for those already registered and all sponsors, exhibitors and registrants would be notified of the format for the digital event soon by the Organizing Committee of WTC2020. A digital book of proceedings will also be made available to all registrants. The dates for the digital WTC2020 remain unchanged from 11th to 17th September 2020.

WBPDCL launches ₹4,400-cr super critical power plant

West Bengal Power Development Corporation Ltd (WBPDCL) has started work for setting up its ₹4,400 crore Sagardighi super-critical power plant to be completed over the next three-and-half years. The company has considered July 1 as the “zero date” for implementation of the 660-MW thermal power plant in Murshidabad district.

GVMC floating tenders for ₹109-cr infra project

The Greater Visakhapatnam Municipal Corporation (GVMC) is all set to float tenders for the ₹109 crore redevelopment project of RK Beach being financed by the World Bank. As per the schedule, the tenders have been finalized but were delayed due to the pandemic and the subsequent lockdown. Work on the proposed project is now slated to begin in October and the project will be completed within 12 months, said GVMC commissioner G Srijana.

Kerala clears ₹2,000-cr infrastructure projects

The governing and executive body of state government (KIIFB) has approved 55 new projects involving an investment of ₹2,002.72 crore. Most of the new projects pertain to building railway over bridges, roads and other bridges. The body decided to generate funds of ₹1,100 crore from the International Finance Corporation (IFC), a subsidiary of World Bank.
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Roads & Highways

**Dilip Buildcon bags ₹2,782-cr twin road contracts**

Dilip Buildcon has won ₹2,782 crore road contracts in Gujarat, Jharkhand and Bihar from the National Highways Authority of India (NHAI), said an official spokesperson, adding that in Gujarat it secured ₹882-crore project and that it also won ₹1,900 crore EPC projects in Jharkhand and Bihar under joint ventures.

**NHAI invites bids for ₹1,417-cr EPC contract in Gujarat**

NHAI has floated tenders for an 8-lane access-controlled expressway in Gujarat. The scope of work in the ₹1,470.07 crore projects includes construction of an eight lane access-controlled expressway starting from Madhya Pradesh/Gujarat Border near Chhayan village and ending after the Hadaf River bridge near Hathiyavan village in Dahod district, on EPC model.

**MoRTH speeds up ₹20,000-crore Chennai-Bengaluru e-way**

In a bid to hasten the construction works for the ₹20,000 crore Chennai-Bengaluru Expressway, NHAI has resumed the land acquisition process as the project, which is one of the 12 expressway projects being launched, involves the construction of a 262-km-long, six-lane expressway starting from Hoskote in Karnataka and ending at Outer Ring Road near Chennai.

**TN floats tenders for ₹12,000-cr road infra contracts**

The road highway department in Tamil Nadu has floated tenders for road widening, building of bridges, flyovers and other projects involving an investment of ₹12,000 crore. The tenders, which include widening and strengthening of roads as well as flyovers, were floated after getting administrative sanction from the finance department and technical approval from the chief engineer of the highways department.

**NHs network gets ₹574-cr funds in Jammu & Kashmir**

The Central government has approved ₹574.16 crore for national highway works in J&K in the current fiscal. The major works include construction of 3.23 km of three flyovers in Srinagar on NH-44 (Jammu-Srinagar highway) at Bemina, Sanatnagar and Nowgam at a cost of ₹220.68 crore.

**IRB Infra is lowest bidder for ₹2,193.23-cr road project**

IRB Infrastructure Developers (IRB), which is country’s leading highway developer, has emerged as the lowest bidder for a project in West Bengal. The project involves building 6 lanes of the National corridor NH-19 from Dankuni to Palsit stretch at an investment of ₹2,193.23 crore.

**MoRTH announces ₹12,000-cr Surat-Ahmednagar NH project**

Union Transport Minister has announced construction of the first greenfield 421-km national highway project between Surat in Gujarat and Ahmednagar in Maharashtra at an investment ₹12,000 crore. In this connection, plans are ready and the process of land acquisition is being started. The highway would decongest vehicular traffic between Surat and Mumbai thereby streamlining the traffic flow between Mumbai and Pune.

**NHAI kickstarts construction of ₹4,215-cr six-lane highway**

The NHAI has initiated work on the 132-km long six-lane Dankuni-Panagarh super highway stretch at an investment of ₹4,215 crore. The new highway will lead to the complete elimination of black spots and reduce travel time from 2 hours to 1.2 hours.
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MoRTH focuses on EPC model for highway building

According to the Union transport minister, Nitin Gadkari, road projects in the country are likely to be developed entirely on the government funded model EPC to ensure faster execution of projects. The government is opting for EPC and will then monetize, instead of depending on private players to arrange funds, which delays projects.

Arunachal Pradesh gets ₹933-cr highway project

The ministry of road, transport & highways (MoRTH) has given financial, administrative, and technical sanctions for the remaining two packages of the Itanagar to Banderdewa four-lane highway project involving ₹933 crore investments. These are Package B, from the Jully tri-junction (Papu Hapa) to Nirjuli, and Package C, from Nirjuli to Banderdewa involving ₹496 crore and ₹437 crore investment, respectively.

Karnataka plans ₹310-cr highway widening

The Karnataka government plans to widen the Bengaluru-Tumkur highway up to the Kempegowda International Airport (KIA) connecting a score of districts via a 32 km long four-lane signal-free corridor costing ₹310 crore. The road, which branches off the Bengaluru-Tumkur highway from Nelamangala, is connected to KIA via Madhure and Rajanakunte.

Maharashtra goes for 500-km Konkan expressway

The state government in Maharashtra has decided to build a 500-km greenfield Konkan expressway for which the Maharashtra State Road Development Corporation (MSRDC) has issued a RFQ to appoint consultancy services to prepare a feasibility report and detailed project report. Prior to this, the state urban development department had announced that a greenfield expressway will be constructed along the Maharashtra coastline, connecting the three districts of Raigad, Ratnagiri, and Sindhudurg.

U’khand clears three roads in border with China

Amid heightened tensions between India and China, the Uttarakhand government has approved the construction of roads in the protected Gangotri National Park as being strategically important on the China border. The roads will reduce the distance to the border and facilitate movement of the Indo-Tibetan Border Police and army soldiers, who at present have to make a detour of 15-25 km in the tough terrains to reach their posts in the remote border areas.

BRO speeds up work on the Manali-Leh highway

The Border Roads Organisation (BRO) has fast tracked the road construction and bridge building works by deploying the best machinery at all crucial points on the Manali-Leh highway, which is the main link for military supplies to border areas. In addition, it has also expedited work to complete major bridges including in places like Rohtang, Kokasar, Slingri, Zingzingbar, Keling Sarai, Sarchu, Pang or Rumtse, among others.

Ardent Infra wins expressway contract

Ardent Infra Equipments Pvt. Ltd. (AIEPL) has strengthened its presence in India by collaborating with the Haryana based company KCC Buildcon, which has won the prestigious contract for the Delhi Vadodara expressway project. KCC Buildcon has entrusted Ardent for production of 2 million tons of asphalt for the project, which is estimated to be completed in 16 months, said Ashok Tanna, MD-Ardent.

AP floats tenders for ₹3, 736-cr Ramayapatnam Port

AP has decided to float tenders for the construction and allied civil work of Ramayapatnam Port in Andhra Pradesh entailing an investment of ₹3,736 crore. The state cabinet has already cleared the DPR for the first phase of the work. The project will give a big push to development of the backward Prakasam district. The first phase work will be completed within 36 months and the state has already released ₹100 crore for acquisition of about 800 acres of land for phase-I.
Metro & Rail

Railways expedites 498-km Bilaspur-Manali-Leh rail line
Due to heightened tension with China, the government has accelerated the process of building the Bhanupali-Bilaspur-Kullu Manali-Leh railway line and the process of land acquisition and alignment survey is in full swing. The 498-km Bilaspur-Leh rail project had been expedited at a cost of ₹345 crore and the high-elevation all-weather broad-gauge track will connect Bilaspur in HP to Leh in Ladakh.

BMRCL floats tenders for ₹1,906-cr metro contracts
BMRCL has floated a tender for the construction of civil works on the 36-km long KR Puram-Kempegowda International Airport line involving an investment of ₹1,906 crore in three packages — ₹639.9 crore, ₹645.3 crore and ₹620.9 crore, respectively.

Railways unveils 5-star hotel along rail track in Gujarat
The Indian Railways has fast tracked redevelopment of Gandhinagar railway station with facilities matching global aviation standards including housing a 5 start hotel along the rail track. Once complete, the revamped railway station will be at par with international standards and boast world-class passenger facilities.

PPS plans ₹1,200-cr metro coach factory in Noida
After the Jewar airport announcement, there is another investment boost to the Yamuna Authority area with PPS International asking Yamuna Expressway Industrial Development Authority (YEIDA) for 20 acres land involving an investment of ₹1,200 crore. On this score, the company has made a proposal and sent it to YEIDA and it is in the process of getting the green signal from central and state agencies.

GHMRC floats tender for ₹805-cr metro rail contract
Gujarat Metro Rail Corporation (GMRC) has invited bids for carrying out works on the Surat Metro Rail Project Phase-1 involving an investment of ₹805.15 crore. The metro project entails construction of 11.6 km elevated viaduct from Kadarsha Ni Nal to Dream City Dead End, including ramp for depot entry near Dream City and 10 stations (excluding E&M architectural finishing and roofing) for Surat Metro Rail Project Phase-1, Package-CS1.

Railway unveils ₹16,216-cr rail line in Uttarakhand
Indian Railways has decided to build a 125-km long Rishikesh-Karnaprayag new broad gauge rail line in Uttarakhand, which will not just boost tourism, trade and connectivity among five districts of the state, but will also make train journeys comfortable for rail users, including those visiting holy places located across the region. The line will pass through many famous places that will connect Devprayag, Srinagar, Rudraprayag, Gauchar, Karnprayag, Dehradun, Tehri Garhwal, Pauri Garhwal, Rudraprayag and Chamoli. The Rishikesh-Karnaprayag line will have 12 new railway stations, 17 tunnels as well as 16 bridges and will be commissioned by December 2024.

NHSRCL floats tenders for 865-km long high-speed rail line
The National High-Speed Rail Corporation Limited (NHSRCL) has invited bids for preparing a DPR for the 865-km long and second Delhi-Varanasi high-speed rail corridor. The bullet train will reach Delhi from Varanasi in four-and-a-half hours. As per the bid report, this will include drawings of all the bridges over rivers, rail routes, highways and drawings of the proposed stations and maintenance depots - within the next three months.

Railway approves ₹527-cr for Kolkata metro corridor
The Railway Board has approved ₹527 crore for the alignment of its 3.6-km long stretch from City Centre II to Airport as it is the most sustained metro corridor from New Garia to Airport in the city. The elevated Metro corridor will now run along the edge of Airport land parallel to VIP Road before it goes underground to reach the station where it will have an interface with Noapara Airport Metro.

Centre fast tracks ₹2,100-cr Nashik Metro project
The ₹2,100 crore Nashik Metro project proposal has reached an advanced stage of approval as the DPR has been forwarded to the Union ministry of finance and ministry of railways for mandatory approval. The Union ministry of housing & urban affairs (MoHUA) has already forwarded the DPR to the ministries concerned.
**Tunnels & Bridges**

**Indian Railways launches ₹250-cr vertical lift sea-bridge in TN**

The Indian Railways has commenced construction of the first of its kind and country’s first vertical lift railway sea bridge at Pamban in Ramanathapuram district of Tamil Nadu. The overall construction work is likely to be completed in the next two years. The bridge will be 2.05 km long and link Mandapam on the mainland and Rameswaram at the Pamban Island. The vertical lift railway sea bridge project is being developed by Railway Vikas Nigam (RVNL). The foundation stone was laid by the PM in March 2019 at Kanyakumari.

**Bihar kick-starts work on ₹1,710-cr bridge on Ganga River**

The construction work for the Aguwani Ghat (Khagaria)-Sultanganj (Bhagalpur) bridge across the Ganga near Aguwani Ghat under Parbatta block in Khagaria district has been started at an investment of ₹1,710 crore. The foundation of the 3,160 meter-long four-lane cable-stayed bridge along with the approach road was laid by CM Nitish Kumar in February 23, 2014. The bridge will link NH-31 and 107, connecting Sultananjan with Khagaria, Saharsa, Madhepura and Supaul districts.

**Underwater tunnel under Brahmaputra River in NE**

The Central government has granted in-principle approval for the construction of an underwater tunnel in the Brahmaputra river in Assam. It will bring connectivity between the North-Eastern states of Assam and Arunchal Pradesh. The road tunnel will be constructed with the latest techniques which will help the vehicles to operate at a speed of 80-kmph. The tunnel will connect Gohpur (NH-54) with Numaligarh (NH-37) in Assam.

**MoRTH invites bids for ₹633-cr tunnel in J&K**

The transport ministry has invited bids for Sungal Tunnel in Jammu and Kashmir involving an investment of ₹633.06 crore. The scope of work includes designing and construction of 2.79 km Sungal Tunnel including approaches from the existing ch 49.150 km to 64.535 km (design ch 46.450 km to 55.800 km) to two lanes with paved shoulder on EPC model.

**DMRC starts work on ₹510-cr elevated stations in Bihar**

The Delhi Metro Rail Co (DMRC), which is all set to award ₹510 crore for the construction of elevated viaducts and 5 stations, including Malai Pakri, Khemni Chak, Bhoothnath, zero mile and New ISBT for the metro project at Patna in Bihar, has opened technical bids for a 6.107 km long section. This section is part of the 17.95 km long corridor of the Patna Metro project that will connect Patna Railway Station – New ISBT with 14 metro stations.

**Noida unveils ₹467-cr elevated road corridor**

To ensure smooth flow of vehicular traffic in twin satellite cities of Noida and Greater Noida, the Noida authority has started construction work on the 5.5 km elevated stretch over Dadri-Sunajpur-Chhalera (DSC) road at a cost of ₹467 crore. The elevated road will start from Sector 39/43 crossing and end at Sector 82 T-point and once developed it will decongest major traffic in Noida’s Barola, Bhangel, and sectors 49, 45, 47 and 46, among other areas.

**Telangana takes up ₹426-cr elevated corridor**

Telangana has started construction of a four-lane bi-directional elevated corridor from Indira Park to VST (Phase-I) and construction of a second level three-lane bi-directional grade separator from Ram Nagar to Baghlingampally (phase – II) at Indira Park Road, involving an investment of ₹426 crore.

**Equipment News**

**Thyssenkrupp Elevators win two airport contracts**

Thyssenkrupp Elevators has bagged a contract to supply 15 elevators and 8 escalators for the Pune International Airport. In order to cater to the increasing demand for a new airport in the city housing over 7.5 million people, the airport authorities are revamping the existing airport. The Pune airport doubles up as a civilian airport as well as a military airbase. The Airport is being revamped and expanded to handle the growth and improve handling capacity.
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Industry News

Relief to road builders: Heavy earthmoving equipment gets exemption from MV Act

Addressing the longstanding demand of road contractors and equipment makers, the Centre has directed states not to register road building and heavy earthmoving machinery under the Motor Vehicle Act as they have been exempted from Act, MoRTH said in a statement, adding that the heavy road construction machinery is not a motor vehicle, and is not covered under this provision. On this score, the Ministry has requested the States and UTs not to insist upon registration and driving license for these machines.

The ministry informed that it has received a number of representations regarding road building and rehabilitation equipment, wherein concern regarding registration of cold recycling machines and soil stabilization machines (road building and rehabilitation equipment) under Central Motor Vehicle Rules (CMVR), 1989 has been raised.

The representation regarding Heavy Earth Moving Machineries (HEMM) - wherein concern regarding registration of HEMM equipment and their operation has been raised and the move is a step to address such concerns. HEMM such as Dumpers, Payloaders, Shovels, Drill Master, Bulldozers, Motor Grader and Rock Breakers are also categorized as ‘Off the Road’ that are operated and maintained within the mine boundary under sole management, supervision and control of the Mine Manager and are never used outside the mine boundary. On similar lines, HEMMs are not covered under the definition of the Motor Vehicles Act, 1988, and may not be insisted for registration under the Act, the ministry said.

Govt defers BS-IV norms for construction equipment to 2021

The ministry of road transport and highways is contemplating to defer stricter fuel emission norms for construction equipment vehicles, tractors, and harvesters. This comes after requests were made by the agriculture ministry and equipment manufacturers, seeking some time for implementing the next stage of emission norms which were to be applicable October 2020 onwards, said official sources.

Real Estate

Puravankara plans 11 residential realty projects

Puravankara Group has decided to launch 11 residential projects with a total saleable area of around 10.23 million sq.ft. The company has already launched two projects and is ready to start six projects under the Purvanakara luxury brand and five under the Provident affordable housing, according to managing director Ashish Puravankara.

Signature Global invests ₹225-cr in realty projects

Signature Global will invest ₹225 crore over a period of time to develop a new affordable housing project at Gurugram in Haryana. The project, comprising of 852 units, will be developed under the Haryana government’s affordable housing policy, as demand for affordable housing has increased manifold in recent times, informed Group Founder & Chairman Pradeep Aggarwal.

The selling prices of the units range from ₹14.46 lakh to ₹25.80 lakh.

ARHC Scheme Empowers Urban Poor: Dr. Niranjan Hiranandani

The Union Cabinet has approved an Affordable Rental Housing Complexes (ARHC) scheme for the urban poor and migrant laborers. The program will provide a long-term solution to the poorest strata of society, said Dr. Niranjan Hiranandani, President (National) NAREDCO.

He added that this is a significant move as it will create an urban ecosystem providing affordable rental housing to urban migrants and the poor. A proper habitat and living facilities for migrant labourers are needed to restart the urban economy.

Gujarat floats affordable rental housing schemes

The Gujarat government has decided to introduce a new affordable rental housing policy under which the government will incentivize affordable rental housing projects through the public private partnership (PPP) mode. More importantly, the government is considering a proposal to use plots of land reserved for the economically weaker sections (EWS) housing projects to create large scale rental housing facilities under the PPP mode.

Godrej launches big ticket realty project with ASPL

Godrej Properties has entered into an agreement with realty developer Akshaya Shapata (ASPL) to jointly develop a 1.1 million sq ft residential project at Worli, Mumbai. The sea-view project is the first such deal in the country since the Covid-19-led lockdown. The project will be spread over 5 acres and will include rehabilitation of more than 1,500 families living in slum dwellings.
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Power Technique
KONE Elevator India hosts one-of-its-kind webinar for Architects

KONE Elevator India organized an all-exclusive webinar for Architects on the Future of Real Estate Industry and Vertical Transportation in the New Normal on July 21, 2020. It was attended by over 600 architects from India, Nepal, Bhutan, Bangladesh and Sri Lanka. Dr. Niranjan Hiranandani, Co-founder and Managing Director, Hiranandani Group and Amit Gossain, Managing Director, KONE Elevator India and South Asia, discussed the Future of Real Estate Industry and Vertical Transportation in the New Normal, and shared their views on the current state of the Indian economy and the challenges before the real estate industry.

Amit Gossain stated that smart living, the new normal, is being defined by flexibility and convenience. Architects are a key stakeholder in ensuring efficient people flow for urban dwellings and KONE closely collaborates with them around the world to make cities greener and smarter, especially now when the whole landscape of real estate is changing.

“KONE has been studying everyday challenges in urban residential environments and is addressing them with new solutions that are functional, efficient, and adaptive. From elevator call using WhatsApp to elevator air purifiers and escalator handrail sanitizers, there is a suite of solutions that support people transition into a new normal,” he added.

Responding to a question on buyer sentiments, Dr. Niranjan Hiranandani said that the demand for residential housing has gone up tremendously with the idea of Work from Home. “Today, I think the home has become very important and technologies like artificial intelligence, connectivity, digital, and using space optimally will be important. The demand for sizes of the house will also increase.”

“Ideas and changes are taking place and I am pretty excited to see how the post-Covid world will actually cope up with the new situation. But it’s exciting, it’s new and there is a lot of prospect of creating new ideas, new dimensions in architecture and good facilities like KONE does,” said Gossain.

Talking on when he thinks the economy will spring back to normal, he said, “My gut feel is that by Christmas most parts of the economy will get back to normal. In the short term, there is definitely a contraction in demand for commercial space but in the long run, if the economy is managed well and the GDP of India picks up again, the demand for commercial real estate will pick up again. I am bullish about the growth of the GDP in India over a period of time, but we will have to wait and watch the effectiveness of the policies of the government and how the Make in India and Atmanirbhar pan out.”

As part of the webinar, Heikki Rintala, People Flow Intelligence Expert, KONE Asia Pacific, shared his insights on how smart solutions in the vertical transportation industry are going to shape the future of people flow in buildings and how Artificial Intelligence and digitalization are going to play a key role in this transformation.
bauma CONEXPO INDIA Rescheduled for February 2021

North India’s leading trade fair on construction machinery and equipment sector has been postponed due to COVID-19. Earlier scheduled for 3-6 November 2020, the International Trade Fair for Construction Machinery, Building Material Machines, Mining Machines and Construction Vehicles, bauma CONEXPO INDIA will now be hosted from February 23-26, 2021, in Gurugram/New Delhi.

Considering the escalating pandemic as well as domestic and international travel restrictions imposed by the Government of India, rescheduling the trade fair was a strategic decision, which was made after evaluating the market situation in the wake of the coronavirus pandemic.

“It was a unified decision made by the industry,” says Bhupinder Singh, CEO, bC Expo India. “We arrived at the decision after a thorough market assessment and consultation with our key stakeholders. It was felt that the postponement was in the best interest of the exhibitors and the visitors.”

The decision was supported by Arvind K. Garg, Chairman, bauma CONEXPO INDIA - Task Force, who is Executive Vice President and Head, Construction and Mining Machinery Business at Larsen & Toubro. “We are witnessing an unprecedented situation that has affected our industry significantly. This decision to reschedule bauma CONEXPO INDIA, is in accordance with the feedback we received from our important stakeholders – the exhibitors and customers,” he says.

Sandeep Singh, President, iCEMA and Managing Director, Tata Hitachi Construction Machinery Company, also supporting the postponement, comments, “The pandemic has had a deep impact globally and in India, both in human and economic costs. The postponement will give the Indian industry time and resources to enable exhibitors to participate in the 2021 edition.”

Mu. Moahan, President, Builders Association of India (BAI) states: “Rescheduling the event will enable exhibitors and visitors from across the country to participate in the trade fair without any complications. The postponement is even more welcome as BAI National Members Meet can be planned alongside with bauma CONEXPO INDIA 2021 with maximum participation from across India.”

Registration open
Exhibitors and visitors can register online for the 6th edition of bauma CONEXPO INDIA at bcindia.com.
CASE Construction Equipment launches the next generation of its SiteWatch telematics platform with an all-new dashboard, more intuitive navigation and new overview sections that spotlight critical information without requiring the user to search extensively for the data.

CASE SiteWatch is offered as factory options and aftermarket kits for Heavy and Compact equipment in Asia, Middle East, and Africa regions. In both cases, it is possible to use retrofit and aftermarket kits with a subscription plan of 1 to 5 years. SiteWatch complies with the Association of Equipment Management Professionals (AEMP) 2.0 telematics standard, ensuring that the solution is compatible with mixed fleets.

“Telematics data from construction equipment only helps if it’s easy to engage with and easy to understand when it’s presented to you,” says Uday Patial, Product Manager, Construction Equipment Digital and Precision Solutions and Telematics for Asia, Middle East & Africa. “The new CASE SiteWatch telematics platform presents users with a high level of critical data on a very clear and intuitive dashboard, and then puts all critical machine and performance data within just a click or two, whether you’re at your desk or on your tablet in the field.”

The new dashboard features an easy-to-read horizontal menu at the top of the screen above five widgets that focus on core operating information such as an equipment summary, equipment search, fuel level reports and alarm status. An easy dropdown menu makes critical reports on factors such as equipment utilization, fuel consumption and maintenance just a click away, and topline menu buttons take users immediately to fleet and maintenance overviews. Additional reports highlighting specific alerts and fault codes are also available.

For a smooth transition, CASE has made it possible for a short period to switch from the new SiteWatch version to the previous one with a dedicated icon in the top right corner. The switch is meant to simplify the adoption of the new interface and to reassure regular users. SiteWatch telematics help fleets of all sizes work more efficiently in many ways, including:

- **Simplified fleet management:** Always know where each machine is, what its working status is and if maintenance or service is required.

- **Understanding equipment utilization:** Your foreman on one job tells you that he needs to rent a mini excavator, but maybe you have a mini excavator on another job that’s not being used? Knowing when and how equipment is being used can improve profitability/total cost of ownership for the equipment you already own, and help you make smarter equipment buying/renting decisions.

- **Analyzing workload and productivity:** Telematics gives fleet managers and business owners excellent perspective into how equipment is operating, and whether they are getting the most out of their equipment and crew on each project.

- **Real-time alerts/alarms:** Time for an oil change? Engine temps running outside of the preferred operating range? Did a machine move outside of a geofence on a Sunday? Fleet managers and business owners receive alerts in real time to make them aware of machine conditions that require attention.

- **Partner with dealer on preventive maintenance:** As the equipment owner, we believe that you own your data —
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you can, however, grant your local CASE dealer access to your telematics data to more proactively partner with you on preventive maintenance and other service items, such as planned maintenance scheduling, or monitoring machine parameters and identifying issues that may need addressing.

- **Improved billing and estimating:** SiteWatch provides users with an accurate historical view into the amount of time/hours each machine is used on each job, which can proactively help you bid and estimate jobs more accurately, and retroactively assist in billing.

- **Improve record keeping and analysis:** Whether it replaces the old service whiteboard in the shop or simply gives you new perspective into how your equipment is used every day, the reporting menu in SiteWatch presents users with data in a way that is intuitive and brings actionable data to the forefront for more intelligent business decision making and management.

- **Locate equipment:** Not sure which crew has a skid steer, or which jobsite the wheel loader is on? SiteWatch will tell you.

- **Prevent unauthorized use:** The unauthorized use of construction equipment opens its owners up to liability, not to mention the added wear and tear that unauthorized use puts on a machine. Whether geofenced with alerts, or simply identified through retrospective reporting, SiteWatch identifies and alerts equipment owners to the unauthorized use of valuable assets.

- **Equipment security:** Telematics helps locate stolen equipment — which, if recovered and returned by the authorities, is much less expensive than the resulting downtime and replacement costs.

CASE Construction Equipment sells and supports a full line of construction equipment around the world, including backhoe loaders, excavators, motor graders, wheel loaders, vibratory compaction rollers, crawler dozers, skid steers, compact track loaders and rough-terrain forklifts.

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**L&T delivers Komatsu’s first 300-ton Electrical Shovel in India to SECL-Gevra**

L&T Construction & Mining Machinery has achieved a milestone with the erection and commissioning of Komatsu PC3000-6 Electrical Shovel, their first 300-ton electrical shovel supplied at Gevra, India's largest mines under South Eastern Coalfields Limited. At an event held on 20th July 2020 at the site, the mammoth machine was formally handed over to S.P. Singh Bhati, General Manager, SECL, by the L&T team comprising A. Chakraborty and Kiran Tilaganji.

In his message, Arvind K. Garg, Executive Vice-President & Head-CMB, complimented the L&T team on getting the magnificent machine ready for operation, despite many challenges. He said the supply has reaffirmed L&T's commitment to customers and its technical capabilities, and has opened a new chapter in the strategic relationship between L&T and Coal India Limited towards accelerating coal output in the country.

Despite the Covid-19 challenge, L&T team could assemble and deliver the machine within the 30-day deadline. The machine was shipped from Komatsu Ltd, Germany, in segments. The assembly, erection and commissioning at site was carried out by L&T's dedicated team of engineers, welders, machinists, electricians, and others.

L&T is the exclusive distributor of Komatsu Mining Equipment in India. Komatsu and L&T had bagged this order from Coal India Limited for supply, erection, and commissioning of four PC3000-6 (16 CuM) Face Shovels with Electric Drive for delivery to SECL. L&T will take care of the equipment for four years with 85% assured availability.
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With sales of wheel loaders slowing down, manufacturers are beginning to focus on enhancing their product service and support, and engaging with customers more proactively. P. P. Basistha reports.

A midst the bearish business environment due to the fallout of the prevailing Covid-19 scenario, wheel loader manufacturers and owners are looking for ways to sustain their businesses. With cash flow and liquidity not going to improve anytime soon, they are ensuring optimum utilization of their equipment to justify their total lifecycle costs. This preparedness is a way to contend with the current difficult situation as the wheel loaders are lying idle due to negligible activities in the quarry sector, and also to be ready for their future use (post Covid-19), when the loaders will once again begin their digging, hauling and loading, in an even more competitive environment.

Manufacturers are also making their existing and potential customers better acquainted with their product line and their enhanced features and functions once the new emission norms are in place. According to industry estimates, the wheel loader market in India is projected to be 30 percent lower in 2020 as compared to 2019. It is common knowledge now that the business volume of wheel loaders is not going to rise as was estimated before the pandemic set in. Fresh demand will take time to materialize even after the lockdown is lifted, and the market would see stiffer competition.

According to Sandeep Singh, Tata Hitachi India, demand for wheel loaders is expected to be muted due to multiple factors, and delays are expected in new product launches. There is an additional impact of the BSIV compliant machines and the changes coming into effect from October. Proto testing and field trials planned by many manufacturers have been hit by the lockdown and by the disruption in the logistics and supply chain. The start of the monsoon season from June will further stall the launch of new products.

“However, the silver lining is the relaxation announced by the government for construction activities. We have been given to understand that of the 375 national highway projects, work on 260 has started. But these projects will not gain their full momentum due to the shortage of workers. Only 30-40% of the construction laborers are on the sites of major projects (except real estate – which has been hit the hardest). All these factors are expected to depress H1 sales. In such a scenario, equipment manufacturers and owners will have to focus on the reliability of their existing fleet, which would call for greater product support,” observes Singh.

He informs that Tata Hitachi supports its customers with real-time status of their machines. The company’s TL340H, for instance, is equipped with ‘Insite’ telematics that tracks machine utilization and performance data in real time. This remote monitoring facility helps customers keep information on their machines on their fingertips and plan the day ahead, accordingly. “With Insite, customers improve the utilization of their machine and get more productivity as the operators are now better prepared with all the information.”

Tata Hitachi has been serving the Indian market for more than 50 years and has a robust dealer network with over 221 touch points across the country. “We have continued to offer product support for our machines despite Covid-19. All our dealers have trained manpower and workshops to take care of any small or major overhauling work,” informs Singh.
Says Jasmeet Singh, Associate Vice President, Corporate Communications and Corporate Relations, JCB India, “We are offering advanced technology along with reliable and world class product support. Our customers can use the machines with more productivity and lower operating costs, especially during such volatile times. While our Livelink telematics can be used for managing the fleet as it offers the Security, Operations Service parameters for the machine. Our new Intelli Load system gives detailed information to the owners on their functionality, cycle time taken for scooping, hauling and loading etc of the equipment. Our dealerships are are fully equipped to handle the Product Support for the machines which would be returning to work sites after the lock down. Many of our wheel loaders are also engaged in mines and quarries and we are providing parts and service to the owners so that they do not have to face machine downtime.”

JCB wheel loaders come with a range of Bucket Options depending upon the type of work.

Vivek Hajela, General Manager & Head - Construction Equipment Business, Larsen & Toubro, says, “While various measures have been announced by Ministry of Finance and RBI to enhance liquidity and improve lending by financial institutions, we expect banks and financial institutions to remain cautious in releasing funds, post-COVID, which will delay purchase of new equipment. In such a situation, owners will see a higher utilization of their existing fleet of equipment. Hence, we are ramping up product support initiatives through our network of dealers and our in-house service teams. We have a range of L&T Wheel Loaders as well as the Komatsu-manufactured loaders. We had extended the warranty period for sixty days (from 15 March to 15 May 2020), based on the engine hours, and our teams continue to render onsite maintenance for equipment working at mining sites.”

Hajela informs that the company has streamlined its supply chain to deliver parts on-time from its central warehouse in Nagpur, despite concern regarding logistics in the current situation. Showing preparedness for better equipment utilization post-lockdown, they have been giving online training to their customers’ operators and maintenance staff. “RBI announced 3 months moratorium and this is a significant step towards supporting small businesses. Accordingly, we have worked out with our finance channel partner, Tata Capital, so as to hedge the cash flow disruption of our dealers in the prevailing situation.”
Japanese Engine Technology Drives India into the Future

Kubota's Japanese quality and service is giving India a boost.

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L&T Construction Equipment has 30 dealers. We have put in place a robust product support system for undertaking periodic maintenance. L&T EquipCare 24x7 is backed by dedicated call centers for handling queries, complaints and feedback from customers. According to Hajela, their DigiEye telematics for monitoring the Wheel Loaders working at quarries and mining sites has led to their better maintenance and higher utilization.

He informs that the company is imparting online training to its dealers and customers on maintaining the equipment, and on the processes to be followed for restarting the loaders since they have been idle for long during the lockdown. “This is very important as abrupt starting of the machine can cause problems with its functioning. Since, coal mining is continuing and many of our loaders are employed there (although for a lesser duration), we have resumed parts shipment for the equipment. Our dealers are the company’s arteries for giving product support. They are also being trained to deal with the present and upcoming situation (once the lockdown is lifted), and also on the management of financial and non-financial work.” There are close to 800 units of Volvo wheel loaders in operation across India.

Dimitrov Krishnan, Managing Director, Volvo CE India observes that getting finance for buying new equipment continues to be difficult and the problem will not ease soon. “Owing to the prevailing situation, we are seeing customers enhancing the usage of their equipment in order to extend their productivity. This means that manufacturers will have to provide even more product support. Working on these needs, we had extended the warranty period on our machines for sixty days (from 15 March to 30 May 2020). We are engaging with our customers even more proactively in order to drive positive business sentiments, and are making them aware of social distancing guidelines.”

Surat Mehta, Head, SDLG India, informs, “We are ramping up our distribution network, training our dealers to meet the current product support requirements, and imparting online training to our service personnel and owners’ operators and technicians so that they are well prepared to handle the equipment when operations resume.”
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“Since pressure on margins continues to be a major issue, our emphasis has been on leveraging the productivity of our wheel loaders while lowering the cost of operation,” says Sandeep Singh. “Tata Hitachi has always been at the forefront of advancements in the wheel loader segment, especially with notable technologies like power-shift transmission and hydrostatic drive, which increase the ratio of production output to engine power.”

He adds, “We offer a much differentiated product in our 3-ton payload via TL340H with the hydrostatic drive technology. Most of the loaders in the market today are the traditional hydrodynamic wheel loaders, which use transmission to transfer power from engine to axles. Tata Hitachi’s hydrostatic technology transfers power from engine to axle via hydraulic motors, thereby reducing mechanical losses. This increases the efficiency of the wheel loader, which translates to higher fuel efficiency.”

Tata Hitachi’s TL340H is equipped with a variable displacement pump, which adjusts the flow based on the load (bucket and loader arm movement). So, when the loader is on the move, the load on pump reduces fuel consumption. TL340H also features the Level1-Fall Over Safety Protection (FOPS) as standard. A front grill is also provided as standard for operator safety, while the pilot lever gives the operator better control and reduces fatigue. Says Singh, “The full hydraulic brake enables a quicker response and helps the operator maneuver easily in tough site conditions. The hydrostatic drive eliminates the need for clutch and gear shift mechanism, which makes driving as simple as auto-shift. This reduces fatigue and improves productivity.”

Tata Hitachi wheel loaders are offered with a general purpose bucket, rock bucket, coal bucket for various applications. The general-purpose bucket with bolt-on cutting edge is a standard fitment. The bucket design has a spill-guard for preventing spillovers while loading. The strong lift arms and linkage yield high production during digging, loading and hauling. Big bucket breakout force and optimum bucket rollback brings about high production and good load retention. “Buckets are designed and shaped for efficient scooping and loading. Bolt-on cutting edges are easy to replace. The bucket leveler and boom kick-out features further aid in improving the production,” points out Singh.

Says Vivek Hajela, “We will continue to position L&T’s robust, fuel-efficient, 3.5 ton L&T 9020 Wheel Loader for quarrying and mining work. For making the loaders adaptable to mining sites, we have made modifications in the cabin as per DGMS guidelines. However, with the capacities of crusher plants going beyond 200 tph, we will promote our premium model, L&T 9020SX with bigger cabin, higher torque and speeds at lower RPM for enhanced productivity, higher gradeability, increased operating pressure and breakout force.”

Dimitrov Krishnan informs that Volvo’s wheel loaders come with a host of features to deliver total life cycle cost, through lower cost of production and higher productivity. This is supplemented by ‘Torque Parallel Linkage’ - a patented Volvo technology that enables close to 10 percent additional load carrying due to extra rollback of the buckets. For better productivity, visibility and safety, the loaders have a comfortable cabin space. The ‘Opt shift Technology’ provides improved loading and carrying, and their high torque and low RPM give more fuel efficiency.”

“We will continue to bank on the sales of SDLG’s, L 946 wheel loader with advanced 2.5 cum bucket and improved loading, than the earlier 2.3 cum bucket,” says Surat Mehta.

“Sales will also be driven by our L 933, L936, L946 and L958F wheel loaders with customized buckets for different applications, fuel saving technology, modified and redesigned cabin ensuring higher visibility for safer operations. Our wheel loaders also have reverse alarm and auto fire suppression as an option, if working in mining areas like mineral loading. However, we will be driving our future sales on our newer equipment which are fitted with advance engines that meet the BS IV emission norms. Presently, these machines are undergoing tests and we are acquaintance our teams on their features and functions.”

Manufacturers are hopeful that greater product support and interactions with their customers will bring a positive business sentiment in the market. However, with sales diminishing, the challenge will be to make their services economically viable and sustainable over the long term.
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GR Infra is positioned as a strong EPC player in the road construction segment. Please elaborate on the success factors of your company.

GR Infra Projects Ltd has been executing EPC projects for over 20 years. These projects are mainly construction and development of state and national highways, bridges, culverts, flyovers, airport runways, and rail over bridges. We have executed more than 100 projects in the last 12 years.

Since inception, we have focused on the roads EPC sector, which has given us a distinct advantage of mitigating risks associated with the dynamics of the road construction sector, while simultaneously establishing our credentials as an EPC player capable of implementing a variety of road construction projects that involve varying degrees of complexity. We believe that our focused approach will enable us to tap future market opportunities and expand into new markets. Our technical experience and attractive pricing will be the critical factors in enabling us to compete with other players in this industry.

Please name some of your recent/important projects.

We have executed projects across diverse geographic locations in India with varied degrees of complexities like construction in high traffic and high-density areas, construction of tunnels in hilly terrains with slope protection and rock fall protection due to high rainfall. Our projects in Jharkhand and Meghalaya provided us the valuable experience of working in rough terrains.

Our ongoing projects comprise of 23 road EPC projects across the states of Punjab, Rajasthan, Himachal Pradesh, Uttar Pradesh, Maharashtra, Bihar, Gujarat, Andhra Pradesh, Manipur, and Madhya Pradesh.

The 6-laning of Handia-Varanasi section of NH-2 in Uttar Pradesh under NHDP Phase-V on Hybrid Annuity Mode (HAM) is a significant and prestigious project because it is the Highest Single Value Contract with a contract value of ₹2447.00 crores and the first year O&M cost of ₹19.87 crores.

Another important project is the 4-laning of Gundugolanu – Devarapalli – Kovvuru section of NH-16 in Andhra Pradesh under Bharatmala Pariyojana on HAM mode with a contract value of ₹1827.00 crores. This project has opened doors for us into the state of Andhra Pradesh.

To what would you attribute the successful implementation of your two projects in UP and AP?

We would like to attribute the success of these two projects to our supplier partners, and, particularly to AMMANN India. One of the key factors is that we did not lose any productive hours by even a minute. This high productivity, which was instrumental in the success of these two projects, was due to AMMANN India’s excellent teamwork, proactive approach, and customer centricity, which enabled seamless execution of the projects at Andhra Pradesh and Uttar Pradesh.

What support was extended by AMMANN India for the projects?

It will not be out of place to call out the helping attitude of AMMANN India people. As you may know, people make all the difference. To give you more specifics, let me list some of the outstanding work...
The Future is “Microsurfacing”

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BONDS BUILDS BUSINESS
of AMMANN India team that enabled seamless performance of our equipment.

The AMMANN customer support team has been very cordial and co-operative in extending on-site parts support. The company deployed trained operators and technicians at site, which helped us significantly in becoming productive, instantly. AMMANN Engineers have been monitoring the condition of the plants on a regular basis, and since they were maintained pro-actively, there were zero breakdowns. The best part is that the maintenance routines were scheduled by AMMANN India in such a way that our productive hours were not impacted at all. The suggestions given by AMMANN India towards pro-active maintenance were very helpful and gave our team a new perspective on how to achieve more with AMMANN products.

**Which AMMANN India products were used for the projects?**

AMMANN India supplied us two plants ABA 260 and ABA 180 and these plants were deployed in both of our prestigious projects. We wish to place on record that these plants functioned seamlessly as they were backed by the company’s reliable and efficient after-sales support throughout the implementation of the projects.

AMMANN India offers a wide range of products for road construction. Having used their plants for our prestigious projects, we now have full confidence on their product range. In fact, we plan to purchase more plants from AMMANN India for our other projects as well.
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Wirtgen Cold Milling Machines Solve Big Challenge

North of Sacramento, a W 210i and W 2100 precisely milled the spillway chute of the Oroville Dam, the highest dam in the USA. In this process, the milling contractor also benefited from cold milling specialist Wirtgen’s application experience in steep gradient milling.

Temporary Solution Makes Milling in Two Passes Necessary

At an altitude of 235 m, the earthfill embankment dam on Lake Oroville dams the waters of the Feather River. After several weeks of rainfall, the dam reached its maximum water level of around 4.3 billion m³ in the winter after only 50 days. As a result, the owner, the California Department of Water Resources, had to initiate flood control measures at an early stage. The water was discharged in a controlled manner over the top of the dam structure at the level of the dam crown and the adjacent spillway.

Due to the large quantities of water and the extremely high water pressure, however, the 55 m wide, main concrete spillway eroded to such an extent that rehabilitation was unavoidable. The damage was initially minimized provisionally by filling the erosion in the surface with rolled concrete, “so that the owner could open the overflow system during the winter months, if necessary,” explains Chris Anderson, project manager at the subcontractor, milling service provider Anrak. This temporary material had to be removed prior to final concrete paving with Portland cement, however, in order to achieve the desired surface quality. To complete this task, the contractor decided to use two cold milling machines from Wirtgen.

Built-in Wirtgen Leveling System and Milling Drum Design Impress Contractor

Eight days had been scheduled for the removal of the first layer of rolled concrete. The lower section of the spillway was about 300 m long. The milling depth required was approx. 5 cm. This job was performed by the W 2100 equipped with an ECO Cutter milling drum. This milling drum is fitted with up to 50% fewer picks at larger tool spacings (LA) than a standard milling drum. Fewer picks means a lower cutting resistance, making it possible to mill hard surfaces such as concrete. This process was followed by the W 210i with a standard LA15 milling drum to give the milled surface the finer texture required to pave the new concrete layer.

During the job, both machines used the Level Pro leveling system developed by Wirtgen. According to Anrak’s CEO Tom Schmidt, this is a perfect symbiosis: “We’ve used almost every machine under the sun, but none can compete with the Wirtgen milling machine together with the Level Pro system. It is both reliable and extremely precise. The evenness of the surface is perfectly uniform and the machine...
always has excellent traction. The latter is important when milling rolled or Portland cement concrete. And the vibrations that are unavoidable when milling such a hard surface don’t affect the Level Pro system one bit.”

**Logistical Challenges**

After the flat bed trucks had transported the cold milling machines to the upper end of the spillway, the machines were lifted onto the structure with the aid of lattice boom cranes and driven onto the area in need of rehabilitation via specially constructed ramps. Here they faced the next challenge – milling on a 30 degree gradient. This challenge was solved by attaching steel cables with a total length of more than 450 m to the blades of a large wheel loader and to the rear of the large milling machines, thus securing the machines while work was being carried out. In the process, the heavy steel cables were attached to several hundred trolleys that are normally used for transporting heavy furniture in order to prevent them from rubbing against the ground. “We used the trolleys to prevent the texture of the freshly milled concrete surface from being damaged,” explains Tom Chastain, applications specialist at Wirtgen America.

**Application Expertise and Safety Go Hand in Hand**

The machines have a working width of 2.2 m, and it took an average of two hours to remove an entire length. “In order to achieve the desired surface quality, but also for safety reasons, the cold milling machines were operated at a low advance rate of approx. 3 m/minute,” says Chastain. In the end, the W 2100 and the W 210i had each milled 28 full lengths. The cold milling machines loaded the milled material directly onto tracked vehicles with a capacity of 5 m³. These machines are mainly used in open-cast mining, but their excellent maneuverability also made them valuable for steep gradient milling at the Oroville Dam. As soon as the tracked vehicles were filled, they unloaded the milled material at the lower end of the spillway so that it could be transported to a nearby concrete plant. There, the concrete milled material was reprocessed into new concrete for the subsequent construction project.

After the “milling the spillway” subproject had been reliably completed within the scheduled time frame, the entire rehabilitation project costing 1.1 billion US dollars was completed on schedule after around two years.

**For further details, please contact:**

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Atlas Copco: Meeting Demand for Light Construction & Demolition Tools

Growth of the handheld tools market in India is expected to be fueled with the introduction of the ergonomic handheld tools like the TE range of hydraulic, pneumatic and motor driven handheld tools – all of which promise enhanced performance during their application.

Atlas Copco is continuously innovating to meet the ever-changing market needs and keeps upgrading its products to offer the latest technologies. In India’s mini construction market for hand-held tools, the company’s products are seeing high demand due to the following benefits:

- Electric hand tools are easy to use and can be connected via the available power source.
- Ergonomic pneumatic breakers are becoming popular as they ensure operator safety and comfort.
- Where compressed air is available, pneumatic hand tools play an important role. They are mainly used in mining, workshops, and assembly lines, as they offer ease of use, high power, and can do heavy and continuous duty jobs.
- Dust is a major cause of concern at sites, both for the equipment’s optimum performance and operator health. In view of this, the Dust Collector is an upcoming high-tech product that will minimize the risk to man and machine due to excessive dust.

Atlas Copco’s first product - the rock drill model RH 658 5L was developed in the 1960s. It became one of the most popular rock drills in the 1900s and is still available for the mining industry. The company later introduced pneumatic chipping hammers and breakers for brick wall chipping and RCC breaking applications. Its pneumatic breaker range starts from 2.5kg and goes up to 42kg.

The company offers a complete range of hydraulic powerpack driven breakers of 11 kg to 39 kg. Having upgraded its tools over time, the products are now mostly ergonomic, silent, and vibration-free to protect the environment and the operators. In fact, the company is leading the shift towards ergonomically designed handheld tools with vibration-reduction handles that reduce vibration intensity and noise, allowing operators to use the breakers comfortably for more than 8 hours. Its medium weight 25 kg breaker RTEx 25 consumes 50 percent less air, while its powerful heavy breaker 37kg -TEX 33PE has four times less vibration than the non-ergonomic breaker.

Atlas Copco is the only manufacturing company which can also provide hydraulic power pack driven tools and light engine driven tools, along with pneumatic tools. Its petrol engine driven breakers are of great advantage on remote sites where one cannot use pneumatic and electric tools and are popularly used during the Indian army’s rescue operations and for railway applications.

The company’s high-performance Dust Collectors absorb 99.9% harmful dust. This ensures less dust pollution from rock drilling and less discomfort to the operator working in mining sites. The DCP 30 is ideal to work with three rock drills or breakers and the DCP 10 for working with one rock drill or breaker.

Atlas Copco focuses on three segments: mining, construction and post construction repair and maintenance jobs. In the mining application, pneumatic tools are preferred as they are required to complete the job along with drilling and air flushing. For general construction and repair jobs, its pneumatic tools compete with electric tools. Pneumatic tools are application-specific and are mainly used for continuous duty jobs where electric tools are not recommended.

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Unfazed by the Covid-19 crisis, OTR manufacturing behemoth Balkrishna Industries Limited (BKT) is continuing to work on its long-term business plans.

Even while sales of OTRs in India and in global markets remain bearish, BKT continues to burn rubber with its strong grip on road surfaces. It is expanding its business aggressively while keeping operating costs low in order to pass on the benefits to its customers.

Says Mr. Rajiv Poddar, Jt Managing Director, Balkrishna Industries Ltd., “No doubt, the demand of OTRs and other tires are low due to the overall lower demand from many sectors. Plus, companies have curtailed their capital investments due to diminished liquidity. However, we believe that this is a temporary phase as the Indian economy has strong demand fundamentals in many sectors like agriculture and mining, which are performing well, which will generate demand and in turn good revenues. We believe that this is a short-term slump and demand is likely to rise again in the medium and long-term, when the situation is likely to normalize.”

He concedes that though the competition is becoming stiffer as companies are aggressively marketing and branding their products, it helps us being a longstanding brand in this segment of tires. “However, we are geared up to meet competition as BKT enjoys a strong brand recall in both global and domestic markets. Our tires are in great demand as they are of superior composition and have an innovative tread design that helps lower the cost of operation per km with resultant lower fuel cost per hour. We have plans to expand our product line with products like the new Ultra Large OTR tire for rigid dump trucks to complete our bouquet of offerings.”

BKT is on course with its expansion plans and is all set to revamp its first plant in Aurangabad, in addition to further modernizing the Rajasthan facility and adding new products to the Bhuj facility. The company already has a first of its kind testing track in India, at its Bhuj plant. BKT has a production capacity of 1,40,000 tons per annum. As part of its expansion plans and to enhance productivity, the company is revamping its facility in Aurangabad. The Bhuj plant has an advanced rubber testing facility for chemical, physical, and rapid control tests. The tests are conducted to examine the character of the rubber after mixing of the final compound. Its first of its kind testing track in India can test the endurance, performance and driving comfort of its tires on different surfaces - ranging from uniform road conditions to rough terrains such as concrete, bitumen and farm tracks with pebbles.

It has begun the production of highest quality carbon black for internal consumption in full swing, and has also enhanced customer satisfaction, with a special focus on delivering life cycle costs and best support services for the products. As part of its expansion plans and to enhance productivity, the company is revamping its facility in Aurangabad. The Bhuj plant has an advanced rubber testing facility for chemical, physical, and rapid control tests. The tests are conducted to examine the character of the rubber after mixing of the final compound. Its first of its kind testing track in India can test the endurance, performance and driving comfort of its tires on different surfaces - ranging from uniform road conditions to rough terrains such as concrete, bitumen and farm tracks with pebbles.

It has begun the production of highest quality carbon black for internal consumption in full swing, and has also enhanced customer satisfaction, with a special focus on delivering life cycle costs and best support services for the products. Inform Poddar, “We have recently begun production of carbon black as one of the key raw materials for production of OTR tires at our Bhuj facility and have also begun marketing the product which is of the highest quality. Our backward integration will further improve our product quality, while keeping costs down. To scale up business, we will continue to focus on replacement and retail markets with our in-site product support initiatives and are also looking at new segments like mobile cranes. We are looking to work with major crane OEMs and the end-users both in the global and domestic markets. We plan to develop advanced solutions through co-engineering alliances with international OEMs. Accordingly, we will adhere to their quality standards to deliver total life cycle costs and will provide the necessary support services for the products. We are also looking at opportunities in infrastructure construction equipment.”

BKT believes quality and technology of the product is key for future and looks to grow the business sustainably even in the face of challenges from competition, spiraling fuel prices, and the current logistics supply disruptions due to the pandemic. The customer should essentially get the best quality at the most economic cost. Says Poddar, “We are working with our customers very closely and trying to integrate our product supply chain with theirs for timely availability of our products. The Covid-19 crisis, social distancing, and dearth of operating personnel is likely to increase mechanization for higher and faster mobility across sectors, which will also drive demand for OTR tires.”
AJAX: Next-Gen Technological Player in Indigenous Concreting Solutions

AJAX, a leading concreting solutions company, has been providing a wide range of equipment to Indian and global customers for over 28 years. It is the only Indian company to design, engineer, and manufacture next-gen solutions that include concrete mixers, transit mixers, concrete pumps, pavers, and batching plants of various capacities and technologies for varied applications. Ajay Aneja, Chief Marketing Officer, AJAX, informs that the company is committed to technology excellence and product innovation, and has introduced indigenous products such as the Slipform Paver and Self-Propelled Boom Pump for the first time in India. As a customer centric Indian-multi-national, AJAX has a countrywide dealer and an aftermarket support network that ensures high uptime and productivity of its machines.

What are the new technologies developed by AJAX for its concrete pump and the advantages?

Over the last three decades, the need for energy efficiency, higher productivity, easy mobility, and flexibility has been our focus to meet growing customer needs. Increasing urbanization, high-rise residential and commercial buildings, modern industrial infrastructure, and the nationwide rural development programs have resulted in demand for a range of concrete solutions.

Keeping pace with the changing requirements of customers, AJAX developed a first-of-its-kind Self Propelled Boom Pump – a complete solution that is built on AJAX’s own chassis with 4x4 transmission, three-way steering, a lightweight compact design, and a fuel efficient engine. The 25m Boom Pump mounted on this chassis has a revolutionary design to utilize the full boom length to reach unreachable spaces in less accessible areas and deliver concrete effectively. The smaller tight turning radius of 3.5 m is the major differentiator between the conventional boom pumps as it enables better maneuverability at confined site conditions.

Our SPBP 25ZX has the smallest footprint in its class and is designed for efficient maneuvering in crowded and narrow roads. The optimized power to concrete discharge feature of the boom pump delivers the highest volumetric concrete output with low-noise vibration factor. The unique ‘X’ outrigger design requires minimum space and offers outstanding stability in both urban and rural environments. The 4x4 transmission offers a unique advantage to operate in tough and steep incline terrains, which is difficult for conventional truck-chassis mounted boom pumps, especially in remotely located infrastructure projects.

Boom Pump Construction with lightweight and high tensile special steel has made the AJAX SPBP the most fuel-efficient pump, which not only saves fuel but also reduces carbon footprint, and increases profitability for customers.

How are AJAX concrete pumps meeting the demands of the concreting industry?

The SPBP comes with state-of-the-art smart technology. Its Remote Control system delivers safe, reliable and efficient operations in all types of application, with ease. The innovative pump unit and optimized Hydraulic Control System helps in cost-efficient and higher productivity operation.

The AJAX Smart Fleet Telematics is a unique system that gives real-time information of product performance, fuel efficiency, health of the machine and trip data to customers on their mobile phones or computers. This helps them to take timely decisions and improve Fleet Management with the help of Performance Reports generated by the system. The timely updates of service schedules ensure on-time maintenance of the machines, resulting in higher uptime and reduced cost of maintenance.

The superior built quality of components and systems in the machine offers a complete advantage throughout the lifecycle, even in rugged
Please enumerate the technical advantages of your concrete pumps.

- **S-Valve Technology:** The main pumping unit has a special S-Valve with an innovative geometry that guarantees higher output. The special steel hard-faced S-Valve has double active plunger cylinder, ideal for high-pressure site applications and harsh concrete mix.
- **Improved Hopper Design:** It eliminates deposition of concrete and ensures smoother flow.
- **Hard-chromed Material Cylinders:** Designed and built for tough concrete and provides long life.
- **Hydraulic Control System:** The single block design supports S-Valve and main cylinder operations.
- **Twin-layer pipe:** The thick-walled concrete pipes and elbows offer excellent resistance against high velocity and turbulence of abrasive concrete and has 4-4.5 times longer life as compared to conventional ST52 pipes.
- **Radio Remote Control:** Modular Boom Control with intuitive command from any operator position enhances maneuverability and operation across various working sites.
- **Man-machine Interface – Diagnostic Control Systems:** This system ensures safe and reliable operation and positioning of the two-part outrigger system with stable control system.

These superior technology advantages make AJAX a leader in the Boom Pump segment and deliver more value to customers.

Product support: Apart from the intelligent product features, we at AJAX believe that after-sales support is the key to success. With every AJAX equipment comes the guarantee of high performance, hassle-free, safe, and reliable operations. A wide network of dealers and after sales support staff supported by a dedicated 24x7 customer care centre, ensures that there is minimal downtime.

3S Network: AJAX has a nationwide network with over 30 dealers and more than 100 branch offices, ensuring timely service when required and catering to the sales and after-sales support to its customers. The company has a presence in Nepal and Bhutan through its distributors, and is now marking its presence in Bangladesh, Sri Lanka, Myanmar, Kenya, Tunisia, UAE, Cambodia, Oman, Philippines, Uganda, and Egypt.

What factors are making use of concrete pumps popular in infra project sites?

Concrete Boom Pumps have been revolutionizing the construction of large commercial and residential buildings and structures. The placement of concrete in inaccessible areas has necessitated the use of boom pumps in the current construction process. With the growing usage of ready-mix concrete, the need to use boom pumps has increased manifold. While the ease of pumping depends on the type of boom pump available in the market, the distance over which the concrete is to be pumped, nature of the project, site constraints and a number of other aspects can affect the operation.

How would you evaluate AJAX’s competitive advantages in terms of product capability and after-sales support for its concrete pumps?

Product capability: AJAX has always been a pioneer in adopting new technology trends. Our research team seeks to understand the buying behaviour and the pain points of customers while developing prototypes and new product solutions. We address the functioning constraints along with the practical needs and the operating requirements of customers in real-time and the operating site conditions.

Quality planning: AJAX’s strategic product focus begins with the end in mind. AJAX has put in place stringent parts quality planning procedures for its concrete pump vertical, together with material quality inspection, testing standards, field testing and validation with utmost attention to quality.

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Please share a recent case study of deployment of AJAX boom pump.

There is a recent case study of deployment of our boom pump services for a leading Corporate RMC company in India. Boom pumps are generally preferred in large infrastructure and residential projects because of their capability of pumping high volume of concrete in less time and saving substantial labour with their multi-purpose robotic arm. The project site necessitated the use of an optimal boom pump with a small footprint for access to sites with narrow spaces. The competitor could not cater to this requirement of reaching the least accessible areas at the construction site.
AJAX conducted a feasibility study on the scope of the project and the site conditions, and offered the right solutions that met the requirements. The AJAX 25ZX Boom Pump that uses 4X2 chassis was perfect for the project due to its lightweight and flexibility, and it could accurately place the concrete whereas the boom size of the competitor that uses 6X4 chassis, is expensive & unsuitable for the project.

From the operational front, AJAX boom pump had a better reach in narrow spaces with a short turning radius of 9.1m, which a 10-wheel truck cannot reach due to its turning radius of 11m.

In terms of cost-effectiveness, the AJAX product was witnessed to be a low-cost runner owing to low-cost chassis and optimal boom size that greatly reduced the customer’s initial investment vis-à-vis the competitor.

Considering all these factors, AJAX was eventually chosen as an optimal solution provider and resulted in AJAX bagging the prestigious project.

What are the emerging trends in the concrete pump segment?

There is a growing demand in concreting segment with a strong emphasis on indigenization, AJAX has strategically aligned its product portfolio in line with the Indian government’s ‘Make in India, Sell Global’ programme by indigenizing its product portfolio. AJAX offers state-of-the-art machines equipped with top-class technology, manufactured at its Bangalore plant for the complete bandwidth of construction infrastructure segments.

The Boom Pump market is growing, and we are currently witnessing the industry trend shifting towards commercial realty projects. In the Tier I cities, namely, Mumbai, Navi Mumbai, Delhi and the NCR region, high-rise residential buildings of 200m and above are common. Pune, Bangalore, Hyderabad, Kolkata and Chennai are also moving towards construction of >150 m high-rise buildings.

Many Smart City projects are expected to have high-rise buildings. High Pressure Concrete Pumps on Trailer chassis are used in these projects. Customers for large infrastructure projects, require bigger capacity pumps along with big batching plants, as a total solution. The key players in this segment are the European OEMs whose market price is higher. AJAX has emerged as a cost-effective alternative.

What is your projection for the concrete pump segment in the near future?

The global concrete pump market is expected to reach USD 5.9 billion by 2025, at a CAGR of 6% between 2019 and 2025. The increasing focus on infrastructure and development of automation in the construction and manufacturing processes has a significant impact on the concrete pump market growth. The concrete pump segment is getting smarter day-by-day through IOT - digitalization, connectivity; automation is driving the development forward of infrastructure projects.

AJAX is geared to meet the challenges in the infra development sectors with its competitive advantage and differentiation strategy, and establish itself as a high-efficency, quality player in the concrete pump category.

How is AJAX geared up to meet the challenges and demands in the market which is seeing growing competition?

Today, over 19000 AJAX machines are working across the country in varied applications such as CC Roadways – National/State Highways, Driveways, Road/ Rail-over Bridges, Irrigation Canals/ Dams, Tunnels/ Underground passageways, Railways, Airport Infrastructure, Power Transmission Projects, Buildings, Factories, Industrial Foundations, Renewables Energy projects – Wind farm/ Solar Park projects, Urban Infrastructure Development - Skywalks, Metro Rails/Fly-overs etc.

AJAX is committed to embracing digital transformation and is constantly re-inventing itself and evaluating the opportunities and solutions, to emerge as a next-gen player investing in technology to improve its core capabilities and strengths. With the continuing growth and evolution of the concreting industry, AJAX stays at the forefront of technological advancement, benchmarking processes and best practices to deliver customer-centric solutions.

In fact, AJAX has a very strong focus on the capabilities needed to succeed in the new market dynamics and meet the challenges and demands. Strengthening its foothold in the concreting equipment market, AJAX will be introducing new products in the forthcoming customer interface platforms to help customers steer their business with increased speed, greater flexibility and enhanced quality.
Bitumen Storage Tank (Indirect Fired)

- Hot oil is circulated through heating coils of indirect-fired bitumen storage tanks for the melting of bitumen.
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- Tank Capacity- 4kl/6kl.
- Engine- Kirloskar HA 294, 25 HP.
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- Pump- Branded with 4-5 Kg/cm² pressure.
- Standard Width of Bar- 2.4 mtr. (11 nozzles) with extension of 1.8 mtr (8 nozzles).

Cement/Lime Spreader Machine

- Material Compatible- Cement/ Lime.
The Four Dimensions of Industrialized Construction

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

Introduction

Industrialized or manufactured construction is a familiar concept. We have been building with components and even whole wall panels for years. However, with a heightened focus on efficiency due to skilled labor shortages and tighter margins, industrialized construction is accelerating across the globe.

As we noted in our first paper, “Technological advancements disrupting the global construction industry,” modular and prefabricated building accounted for approximately US $237b of construction activity in 2019. This industrialized (“prefabrication”, “prefab” or “modular”) approach shifts many activities away from the construction site and into a factory. Prefabricated building components are then shipped from the factory to the construction site for assembly. While this technique has been around for centuries, recent success stories have compelled developers and contractors to apply prefabrication to their projects. Utilizing this approach can present new opportunities, however, it introduces additional risks to consider as well.

This research explores the opportunities and risks of industrialized construction in relation to the four core dimensions of project management:


The research concludes with a high-level assessment and potential future state of the industry.
**Introduction to industrialized construction**

Industrialization realizes benefits from standardized designs that are repeatedly applied and executed in a controlled environment. Factories are typically set up using these designs to mass produce a product or limited selection of products. Similarly, with industrialized construction, it is more feasible and efficient to build the same product repetitively. As such, industrialized contractors arrange their factory to produce a limited selection of prefabricated building products. According to a survey conducted by Commercial Construction Index (CCI), 62% of general contractors are using prefabricated components, of which nearly half have seen increased use in the last three years.³

Industrialized construction is typically applied by contractors utilizing one of five typologies. Typologies range from individual components to complete modules that are prefabricated in the factory and then shipped to the site location.

Precast concrete is one such prefabricated module, usually identified in Typology 1 or 2. It has been gaining widespread popularity, especially with advancements in geopolymer cement products and prefabricated lightweight aerated concrete (PLAC). Having extensive application, the precast concrete building systems provide an alternative solution to the routine and time-consuming process of forming and pouring reinforced concrete. It can be performed offsite and then later transported to the construction site. In Middle Eastern countries, many houses are built with concrete floors, roofs and walls. General contractors reported using prefabricated and modular exterior walls in 65% of their projects.²

Design repetition of housing presents a significant opportunity for industrialized construction. Countries around the world are struggling to meet the demand. In 2014, McKinsey projected that 1.6 billion people would be in need of affordable housing by 2025.⁶ That number has already been surpassed. In March 2020, the United Nations (UN) reported that 1.8 billion people in the world live in substandard housing conditions or homelessness.⁵ The UN projects this to increase to 3 billion people by 2030.⁷ This problem will continue to escalate with urban expansion and rising prices. Slow income growth and the prospects of a recession further exacerbate this issue. The Organization for Economic Co-operation and Development showed that 2019 quarter three housing prices have grown faster than incomes in over half of countries.⁸ This research suggests that it will take approximately US $1.6t to US $2.1t per year to address the growing affordable housing gap in the next 10 years. Should the demand continue to accelerate at the speed of the last five years, the cost could be substantially more.

**Scope**

**Opportunity**

Given the increasing demand of projects that could be built using prefabricated components, there has never been a better time to adopt industrialized construction. There is no limit to where industrialized methods can be applied, and anything with a repetitive series of components are ideal building types. However, the decision to build using modular construction techniques and adopting the applicable design solution must be made early. Identifying the scope of work early in the planning phase is especially important. This is relevant to small pods and panels, as well as entire buildings designed and constructed this way.

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Modular typology

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**Source:** Modular Construction for Multifamily Affordable Housing, February 2018⁴
New opportunities in the commercial sector are being explored. Asset classes, such as office and retail, are being added to the usual candidates of multifamily, hotels, mixed use and hospitals; all which have building components that can be standardized for replicated application. This doesn’t mean that all of the buildings have to look the same. The structural and foundational components of walls, floors, ceilings and roofs can be constructed using industrialized methods while still allowing for customized finishes. Offices, conference rooms, restrooms, hallways, kitchens and bedrooms can be constructed in modules as well. Case studies, such as Broad Sustainable Building’s modular 57-story Ark Hotel, have paved the way for commercial contractors to pursue this strategy. During adverse times, such as the COVID-19 pandemic, prefabrication has made vital contributions to remediation efforts. Utilizing prefabricated modules, Chinese contractors built a 1,000-bed, 645,000 square foot medical facility in 10 days.9 When commercial design plans incorporate repetition of components and modules, industrialized construction can become highly beneficial and attractive.

Risk
Historically, design standardization has led to declining interest of home buyers and high-end commercial developers. Owners often want a unique product that showcases aesthetics. Commercial developments attract customers with customized features that enhance the user experience.

In many cases, projects require customization. Predefined conditions, such as plot size, structural regulations and design ordinances are unique to a project’s location. When constructing tenant improvements, designers and contractors must work within the confined interior build out. Likewise, inherited projects are typically predesigned or partially built at the time of acquisition. Many developers often require additional customized options and finishes.

These situations can be challenging when applying industrialized methods. Limited design options are often not fully context-or user-specific and can lack the ability for customization. Should customization be required, the contractor may have to modify its standard industrialized scope. Design and factory changes can incur time, cost and quality implications. In some cases, contractors may have to revert back to traditional construction methods.

We have seen some modular construction projects that were functional, aesthetic and financial failures. All of these failures were traced back to a lack of definition during the planning phase, where elements should have benefited from industrialized methods at the outset. Failure to properly design the industrialized components into the plan set led to subsequent issues on-site.

Like most construction projects, risk increases with the size of the building. This risk becomes more prevalent when utilizing industrialization. Single family homes are much easier and repetitive to construct than large commercial projects. As commercial projects scale, customization requirements increase in complexity, thereby decreasing the application of a standardized approach.

Understanding the level of customization is key to determining feasibility. Risk analysis should always be conducted to determine if and to what degree an industrialized approach is the most effective option. The industry is still working to understand these limitations, and how best to scale industrialized strategies.

Time
Opportunity
Industrialized designs can be reapplied to multiple projects, saving time in the planning, procurement, manufacturing and deployment phases. With similar products repetitively being built in one factory, production time is reduced. Nearly 79% of contractors reported schedule reduction using offsite factories.3 As processes become more standardized, workflows and efficiencies become optimized. Workers have predictable schedules because they perform the same activities continuously on a daily basis. Sequential production lines are established that alleviate crowded workspace and allow mobility. Enhanced coordination enables less rework to be performed. All tools and equipment are readily available in a factory, which minimizes down time.

Building inspectors can perform approximately 90% of their inspections within the factory, alleviating the need to schedule multiple site inspections.10 With inspectors coming to factories on a daily basis, consistent relationships and expectations are established that further enhance productivity. It also alleviates inspection delays, which are renowned in booming metropolises. Industrialized construction also offers contractors the advantage of preparing the construction site and prefabricating building components in parallel. Whereas city ordinances often only allow construction during daylight hours; factory work provides the benefit of performing many activities 24 hours per day.

Work performed in the factory reduces labor on the project site by up to 80%.3 With much of the traditional trade work brought in-house to the factory, it eases the burden of on-site management. Multiple contractors are alleviated from “working on top of each other,” as they are often required in a traditional setting. Approximately 89% of contractors have realized increased on-site efficiency when using industrialized construction.2
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Less on-site activity reduces dependencies on the schedule’s critical path. Because the on-site work is limited to constructing the foundation, assembling modules and applying finishes, the schedule is compressed. A simpler, sequential progression can then be established. McKinsey found that industrialized construction leads to schedule compression of up to 50%.\textsuperscript{11}

Schedule compression also minimizes environmental risks, such as weather and seasonality. When the construction site is wet, windy or experiencing extreme temperature, it can slow productivity or delay work until conditions improve. On the other hand, factories provide a controlled, interior environment that is maintained on a daily basis. Moisture is mitigated, wind is removed and temperature remains consistent, thereby allowing work to continue.

Utilizing industrialization, a 2,500 square foot house can take approximately six weeks for site work, three weeks to assemble the modular components and an additional seven weeks for the façade and finishes to be completed.\textsuperscript{10} This is substantially less than traditional construction that can take eight months to build the same house.\textsuperscript{11}

Risk

While there is increasing demand for construction; productivity in the industry has been lagging far behind that of general manufacturing.\textsuperscript{12,13} This is due to many factors, including increasing design complexity, more regulation, demand for eco-friendly materials, and reduced availability of skilled labor and raw materials. Whereas general manufacturing has seen increased automation, industrialized construction is still reliant upon field labor. If the assembly teams are not experienced at panelized construction, time and costs will increase. If the panels are not aligned correctly, the design does not accommodate industrialized manufacturing. In particular, failure to design to industrialized construction can lead to significant rework on-site due to misalignment.

Due to this, accurately estimating productivity in modular projects carries risk. New industrialized methods do not have years of project data to utilize for analysis. Additionally, productivity assumptions are highly sensitive in this industry. As each module is built in the production line through a sequential process, underestimating the time to build one component can impact the entire project. This estimating uncertainty has steered many developers away from industrialized methods.

Conducting a sensitivity analysis on one industrialized project’s housing panels, we found that each panel had a 3.13% impact per hour of production. If a mistake were made in the initial panel, it could affect the construction of other components down the production line. Scaling production to thousands of panels amplifies this risk and could cause a contractor to operate behind schedule from the onset of a project. Change orders during the manufacturing process are therefore particularly damaging. Ultimately, there should be fewer errors in industrialized construction, however the consequences can be much more severe.

As site work (excavating, foundation, etc.) and building components in a factory occur simultaneously, it introduces another risk. Delay of site or factory work may impact the other. If site work is delayed and the material or components are ready, additional staging area could be required. If the site work is completed but the prefabricated components are not ready, the construction site may sit idle. This risk is less of a concern when purchasing materials “off the shelf,” as in traditional construction. Contingency plans for such instances should be established for every project.
Cost

Opportunity

Reducing schedule duration through repetition leads to lower construction costs. McKinsey reports that industrialized construction can cut costs by up to 20%.\textsuperscript{3} With most industrialized designs repeatedly used for multiple projects, design costs can be allocated proportionally. Customized design costs are typically 7% to 12% of a project budget. Depending on repeatability, industrialized design costs can be 10% to that of traditional construction projects.\textsuperscript{10} In addition to cost savings, this presents opportunity for revenue diversification, such as selling in-house architectural designs and prefabricated components.

As industrialization continues to gain efficiency, investors and contractors can realize a quicker payback period due to a compressed schedule, leading to less interest cost. This also allows for the general conditions’ scope to decrease. Monthly costs, such as project and site management, project controls, traffic control, daily cleanup, property protection, security, equipment usage, rentals and utilities therefore become much lower.

Cost savings are found in the factory setting as well. Factories reduce waste by controlling inventory and protecting building materials, whereas construction sites can be disorganized causing tools and material to go missing. According to CCI, 79% of contractors highlighted reduced waste as a key benefit of industrialized construction.\textsuperscript{2} Industrialized standardization also stipulates that work is executed with greater precision. Therefore, fewer measurement errors are made that require materials to be discarded. Additionally, as the modular structure is substantially completed inside the factory, there is less weather, vandalism and theft risk, thereby reducing material damage and replacement. With less exterior exposure, equipment’s useful life is expanded as well. Industrialization also provides cost savings in labor. Site labor often requires specialized trade subcontractors that charge a markup. Much of this trade work, such as mechanical, electrical and plumbing (MEP), is moved in-house to the factory and can be conducted by lower-skilled manufacturing labor. General contractors reported using prefabricated and modular MEP systems in 51% of their projects.\textsuperscript{3}

The site labor is therefore reduced and has lower skill requirements as well, where the primary task is to assemble the premanufactured components. As in any industry, lower-skilled labor demands less payment than skilled expertise. Almost 70% of contractors reported lower construction cost as one of the key benefits of adopting prefab and modular technology.\textsuperscript{3}

Reducing on-site equipment and labor with enhanced coordination in the factory make it easier to implement safety measures. Approximately 71% of contractors highlighted safety as a derived benefit of industrialization.\textsuperscript{3} With factories operating in a controlled setting, industrialized projects have an estimated 80% lower accident rate than site-intensive construction.\textsuperscript{3} Enhanced safety allows work to be performed with confidence and can alleviate costs derived from accidents. Contractors can realize additional cost savings by integrating the supply chain and centralizing procurement to the factory. It can provide greater control and flexibility of logistics and an ability for economies of scale. Ordering greater material quantities in bulk, contractors can purchase directly from manufacturers and remove intermediaries’ markups.

Risk

Industrialized construction faces financing challenges unlike the traditional industry. New methods of industrialized construction have a limited track record, resulting in many lenders hesitant to commit. If a developer is able to secure the initial financing, underbidding could require additional capital. When lenders do approve, a significant upfront payment and higher interest rate are often required. Typically, lenders allocate monthly loan draws based on percentage of on-site work complete. With industrialized construction occurring in the factory, the offsite prefabricated components do not add value to the construction site. The percent complete becomes difficult to assess, therefore impacting loan distributions. Lenders will often limit industrialized loan distributions to site work, component delivery and project completion milestones. This requires contractors to maintain greater amounts of working capital. Should their liquidity dry up, supplier payments can be disrupted, leading to material and service delays.

Industrialized firms may have significant upfront costs. Recently built factories with specialized equipment have cost upwards of US $100m. McKinsey estimates that the allocated factory cost can consist of between 5% and 15% of a project’s total budget.\textsuperscript{11} Architectural designs and manufacturing processes must be developed as well. Semitrucks built for oversized loads are often purchased to transport the prefabricated modules. Whereas cost reduction is expected in the long term, the capital investment is mostly speculative. These capital expenses and any operational costs should be included in return on investment calculations of the supported projects.

Some industrialized firms are experimenting with temporary portable factories at the construction site. This comes with its own set of risks. There is added infrastructure cost for building each portable factory, some of which (i.e. foundations and utilities) cannot be carried to the next site. Additionally, the footprint may not be readily available or incur rental costs. It requires additional transportation, staging, mobilization and demobilization. Assembling and replacing specialized equipment can be complicated, time consuming and require specialized labor.

Whereas prefabrication work is executed in a predictable factory environment, transporting equipment and modules to the construction site can be challenging. Robust project, supply chain and logistical controls are required to ensure timely and effective deliveries. Size, shape and material have to be considered. Small streets, hills, bridge clearances and power lines may have to be avoided with oversized loads. Bumpy streets can cause concrete and other brittle materials to crack. Modules with drywall and windows have increased risk due to compression and movement. When damaged, it may require shipping replacement materials. One way to mitigate this risk is to build the modules stronger.
This often requires additional time and material. Added costs for logistics, transportation, packaging, material and insurance are to be expected.

Some larger industrialized companies have been working toward owning multiple stages of the supply chain. This incurs additional operational risks. Contractors must commit to greater vertical integration of design and construction early in the project lifecycle. Managing both the factory and construction site can be challenging. Mistakes in the factory can affect assembly of the on-site modules. Should assembly errors happen, replacement materials or modules may be required. Often, and especially with young or fast-growth companies, poor coordination incurs additional costs. All processes and departments need to be in complete alignment.

Resource selection and adequate training is essential to operating any specialized equipment and properly manufacturing and assembling prefabricated components. These skillsets may require unique and additional training. Due to the project-based and cyclical nature of the construction industry, contractors often rush selection and training. Ambitious growth or schedule plans may drive a company to hire and mobilize quickly. This increases the chance that performance expectations will be missed.

Quality

Opportunity

Standardizing the factory processes can vastly improve production quality. Repetitively performing distinct tasks enables specified skillsets to be gained. Standard operating procedures help ensure accuracy and consistency. This can also enhance quality by providing a more thorough inspection than traditional construction. Components can be tested in the factory at different build stages for resilience and sustainability. Should modifications be required; they can be completed prior to being shipped to the site. Subsequently, better quality products can be quickly replicated to scale output. Almost 73% of contractors identified increased quality as one of the key benefits derived from prefabrication.9

Increased production quality can have a significant impact on building operations. Less repairs for leaks and building settlement will be required. It can help alleviate the regular maintenance program and prolong the useful life of the asset. This supports whole life costing of a building, of which operations can be up to five times the cost of the capital investment.14

As the industry transitions to the use of robotics, exact specifications will be met on a routine basis. The arrival of 3D printing, machine learning, artificial intelligence, internet of things, and other technologies are expected to provide additional quality enhancements. Completely integrating automation can eventually eliminate errors, enhancing the user experience. Many contractors are applying digitization to the built modules as well. New technologies, such as sensors, energy management systems, solar panels and battery packs can be incorporated with internet of things to create smart buildings. This enhances sustainability and enables carbon neutrality, net zero energy use and predictive maintenance. Founded in 2015, Katerra has developed fully integrated building systems with data feedback loops, providing customers an end-to-end solution that enables better visibility and decision making.

Enhanced construction and building operations mitigate global warming. With construction and buildings estimated to contribute 39% of worldwide carbon emissions, the market for lean and green construction is experiencing rapid growth.15 This has increased the awareness of industrialized sustainability benefits.

As the prefabricated structures are also built much quicker, less energy is expended than traditional construction. Less time on the construction site reduces contamination, such as fumes and runoff. It also produces less noise pollution and public disturbance, which often instigates neighborhood complaints that can subject mandated working hours. By eliminating waste and minimizing its environmental footprint, industrialized construction can be a driving factor to petition communal support.

Modular buildings can also be recycled. Certain components can be disassembled, relocated and refurbished. This reduces the demand for raw materials, further minimizing the amount of energy used to create a building. It also introduces the potential for multiple uses. In the last decade, developers have used shipping containers to build affordable housing and student apartment complexes.

Risk

Industrialized construction products have a poor industry perception as being cheaply constructed with low quality material that leads to substandard performance. Unfortunately, this is based on the mobile and modular home industry of the past, where this
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has been historically accurate. This negative connotation has kept many developers and investors away to avoid exposure. While this perception is a barrier for new entrants, it is improving for most users who have experienced the newer prefab and modular products. With enhanced technology constructing higher quality products, this historical market perception is no longer accurate. Nevertheless, it will require substantial marketing and years of continued success to build industry trust.

**Conclusion**

While industrialized construction is gaining momentum, a “household brand name” has not yet been established. To achieve this accolade, many firms are focusing resources on digitization and employing new strategies in prefabrication and modularization. Technology is a dominant theme and is laying the groundwork for the future. It continues to transform the back office and supply chain of the development process and reshape conventional property uses. Many of these technologies, such as robotics, 3D printing and internet of things, are expected to provide substantial contributions.

As innovation continues to influence industrialized methods, industry demand will rise for expedited schedules, lower costs and greater quality to maximize value creation. This will help meet the rising need of affordable housing and sustainable infrastructure. With market forces aligned to substantiate economic activity, the construction industry will continue to drive industrialization forward.

We expect that a dominant set of players capitalizing on this opportunity will emerge in the next five years. They will focus exclusively on industrialized construction, and will bring design, supply, manufacturing, construction and assembly all under one roof. Their business models will focus on repetitive building types such as multitenant or single-family housing. These industrialized builders will be influential to homebuilding as Tesla has become to automobiles. With anticipation of derived benefit, it is unlikely that any of these dominant players will be traditional construction companies. Instead, they will become vertically integrated, technology-backed manufacturers.

Such industrialized disruption and opportunity have expanded interest of investors and capital markets. As more capital flows into the sector, there will be increasing scope for the lines between traditional and alternative structures to merge. With technology driving market acceptance and growth, new financial models will be developed. Different mathematics will be applied to understand the cost, time and quality factors. As componentization becomes commonplace and transferrable to various asset classes, financiers will be able to evaluate the modules while still in the factory. This will help lift lending restrictions and make capital more accessible. Efficiency levers will further lower the cost of capital. We expect to see lending products transition to manufacturing models in the near future – based on ROI, margin and profitability. Additional profits will be captured and cost savings shared between the contractors and customers. This will enable industrialized growth to begin approaching an exponential upward trend in regard to the global construction industry at large.
Evolution of industrialized construction

Modular buildings have been around for centuries. Below, we highlight a historical timeline of major milestones in the industrialized construction evolution.

Prefab and modular construction evolution

- **1824**: Inspired by construction techniques dating back to Mesopotamian civilization, the first known panelized wood house was shipped from England to Massachusetts.

- **1837**: A portable cottage was exported from London to Australia.

- **1840**: Kit houses were shipped by rail for settlers during the California Gold Rush. Experimenting began with cast iron, concrete, and other materials to explore how the technology could be developed.

- **1869**: The Eiffel Tower was built at a fast pace using industrialized methods because it grouped similar construction tasks together and leveraged assembly-line techniques, significantly cutting down on the cost and labor required to build the iconic structure.

- **1877**: Thomas Edison invented the concept of building homes out of cast-in-place concrete, paving the way for today’s innovations and affordable 3D-printed housing.

- **1925**: Taking inspiration from Henry Ford’s assembly line production style, William Levitt utilized a rapid construction process to develop Levittown in New York. At Levittown’s peak, the 750 square foot cape cod homes were being constructed at 150 homes per week or one every 15 minutes of an 8-hour working day.

- **1960**: By 1960, the post-war prefab-housing boom had created an amplitude of mobile homes that accounted for 15% of US housing.

- **1963**: London’s Broadgate development was constructed modularly, with toilet pods being hoisted into place and installed in a single day.

- **1990s**: Throughout the 1990s, there was a decline in interest of prefab due to the perception of over-standardization and poor quality.

- **2000**: A converted shipping container mobile dwelling unit prototype featuring extendable and retractable modules was released. Further breakthroughs in 3D printing made it possible to scale the fabrication of construction components and modules for housing, bridges, and skyscrapers.

- **2006**: Dr. Behrokh Khoshnevis of the University of Southern California unveiled the Centauri Crafting System, an enormous 3D printer designed to print buildings. It used a crane to do the printing and concrete as the foundation for a building’s structural elements.

- **2014**: Broad Sustainable Building complete a 30-story building in 15 days.

- **2016**: Further technological advancements led to Broad Sustainable Building’s completion of earthquake resistant 57-story Ark Hotel in Changsha, China. This modular development was completed in just 19 days.

- **2017**: Marriott expanded its modular construction initiative and stated that it expected to sign 50 hotel deals that incorporated prefabricated guestrooms or bathrooms, more than 10 percent of Marriott’s signings for the year.

- **2018**: Alphabet purchased 300 modular homes for Silicon Valley employees.

- **2018**: Amazon invested in prefabrication supplier Plant Prefab. Based in Los Angeles, Plant Prefab concentrates on single and multifamily construction.

- **2019**: Katerra wins challenge to build single family home within 48 hours in Riyadh, Saudi Arabia.

- **2019**: Marriott is to build world’s tallest modular hotel in Manhattan, New York.

- **2019**: The Kingdom of Saudi Arabia Ministry of Housing signs a Memorandum of Understanding with Katerra to build 4,101 homes across the Kingdom.

- **2020**: Bouygues Batiment completed construction of the 459 feet Clement Canopy in Singapore. The 40-stories Clement Canopy is a two towers structure made up of 1,996 modules and was 85% finished onsite. It is the world’s tallest modular building in the world.

In response to COVID-19, the city of Wuhan (China) utilized industrialized construction to build a 1,000-bed hospital in 10 days.
References


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Building Better With Concrete

New circulation plant manufactured by Ebawe Anlagentechnik GmbH - a Progress Group company - revolutionizes production process of Huffcutt Concrete Inc.

Massive modular construction on the advance in USA

In addition to septic tanks, American company Huffcutt Concrete Inc. primarily manufactures individually designed sanitary houses made of solid concrete parts especially for motorways, and now supplies them throughout the country. The manufacturer was able to significantly increase its production capacity by investing in a circulation plant made by the renowned manufacturer Ebawe Anlagentechnik GmbH, a Progress Group company. Since then, it has been able to break into new markets and begin manufacturing structural and architectural wall panels. The new equipment will assist in providing the shortest possible delivery time; and also offers impeccable, extremely stable and durable buildings and panels with architectural designs.

American construction company relies on concrete

Huffcutt Concrete Inc. was founded in 1945 in Chippewa Falls, Wisconsin as a small company that mainly supplied septic tanks to nearby municipalities. In the meantime, Huffcutt has extended its product range to several important product sectors. The focus is on wall panel production while sustaining a strong line of modular buildings, sanitary blocks as well as park and leisure facilities that are sold throughout the country. Today, Huffcutt is a leading precast concrete company in the USA, supplying quality products to parks, companies, government organisations and private customers throughout the USA. The company attaches particular importance to innovative processes and durable modular buildings made of precast concrete elements. It
pays special attention to individual customer requests, be it coloured concrete, architectural designs, or sustainable energy options, and supplies custom-made unique products that are 100% tailored to customer requests.

Last year, Huffcutt invested around 26 million euros in the construction of a completely new production hall at the Chippewa Falls site. The solid walls produced on stationary tables were to be produced quickly, efficiently and with high quality on a circulation plant in the future. Huffcutt chose the German company Ebawe Anlagentechnik, one of seven subsidiaries of the Progress Group, as its supplier. Once all the technical and commercial details had been clarified, assembly began in Wisconsin in autumn 2018.

New circulation plant revolutionises production process

The circulation plant consists of 20 production pallets measuring 4.5 x 12.5 m. Each pallet can carry a weight of 22 t and is equipped with fixed edge shuttering and shuttering attachments. The solid wall shuttering supplied directly by Ratec is placed precisely on the shuttering surface using the Form Master shuttering robot. The scope of delivery also includes an M-System BlueMesh mesh welding machine from progress Maschinen & Automation, also a subsidiary of the Progress Group. However, this machine was installed at the related company Stein Bros. Steel in Saint Paul, Minneapolis. Stein Bros. Steel is a manufacturer of steel products for the construction industry and also supplies Huffcutt with reinforcement meshes. The reinforcing steel is unwound from the coil and cut and bent according to the data supplied by the ebos® software. This work step is performed by the MSR 16 machine. The mesh welding machine produces the reinforcement meshes just-in-time and precisely for each solid wall. It is the first of its kind in the USA and enables Huffcutt as well as Stein Bros Steel to efficiently produce tailor-made meshes.

The concrete spreader with screw discharge system discharges the concrete evenly on the pallet surface according to the data provided by ebos®. The vibrating levelling beam attached to the concrete spreader draws off the freshly discharged concrete, brushes it to the desired height and then smoothens it. External vibrators additionally perform compaction according to the concrete layer depth. After a resting phase and curing of the concrete surface, fine smoothing is carried out using a power trowel. These work steps result in a very finely smoothed, paintable surface without subsequent post-processing.

After the curing of the solid walls in the stacking rack, consisting of two towers of eleven levels each, the pallets with the cured concrete elements are moved out via the pallet stacker. On fixed rollers and friction wheels, they are driven to the tilting device and brought into an almost vertical position. This facilitates demoulding and lifting processes considerably and enables the walls to be stored in the subsequent installation position.

After completion of the production cycle, the removed solid wall shuttering is cleaned by means of a set down-cleaning device. The pallet passes through a stationary cleaning unit and is given a clean pallet surface by means of spatulas and brushes and is thus ready for the next production run.

The entire circulation plant is controlled via the ebos® control system, eliminating complicated interface problems. Huffcutt
Figures 8 & 9: Huffcutt manufactures sanitary houses from solid concrete elements and assembles them directly in the plant, already completed with all sanitary facilities. The small buildings are designed in architectural designs with coloured concrete and form liners in tile, stone, and wood optics.

Thanks to the new production plant from the Progress Group, the American precast concrete company was able to make its product range more flexible and thus also land orders for the construction of schools and warehouses with solid and sandwich walls.

**American construction methods on the test bench**

The Huffcutt plant is configured in such a way that it is also suitable for the manufacture of semi-precast elements through expansion with some components. This double-wall plant could revolutionise the construction method there because the construction of properties differs significantly from European construction methods. While in Europe construction is mainly carried out with concrete and stone, the USA relies largely on timber-frame construction with outer walls made of thicker chipboards. The roofs are mostly tacked with roofing felt and walls as well as doors and windows are hardly insulated. For this reason, the houses are mostly equipped with air conditioning systems, which run around the clock in summer. In addition, there are the increasingly frequent hurricanes that uncover entire roofs or completely collapse houses. It is therefore only a matter of time before the European solid construction method is also applied in the USA. Huffcutt could be a pioneer in this respect and, with its solid concrete elements, could also convince other construction companies of the stable and sustainable concept of building with concrete.

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From quality assurance to faster completion, Offsite Construction Technology can be a gamechanger in the post-Covid world, says Nejeeb Khan, Country Head, Katerra, India

India has set an ambitious target of providing housing facilities to all by 2022. With the country’s fast-paced urbanization, 25 million affordable housing units will be required by 2030. Both these facts indicate the mammoth task ahead for all construction industry stakeholders - both government and private. The question no longer is - can traditional methods of construction solve this problem? The answer to that has been an industry-wide resounding, “No.” Demonstration of this is seen across India in numerous delayed, poor quality and high-cost overrun housing projects. If this is a known challenge, what are the constraints the industry is facing to achieve a real technology transformation?

Construction Technology Knowledge and Application

One of the critical challenges facing the industry is an in-depth understanding of construction technology and its application both among end consumers and many practitioners. One such technique is offsite construction.

**What is offsite construction technology?**

Offsite construction technology is when concrete elements are assembly-line factory manufactured and delivered onsite for assembly. The term “Offsite” denotes that the building is being manufactured in a factory instead of onsite as done traditionally.

**Step 1: Value-Engineering Design for DfMA (Design for Manufacturing Assembly)**

The first step in offsite construction is to value engineer and break it down to repeatable components that can be assembly-line produced.

Standard elements in a building include walls, columns, beams, roofs, bathrooms, MEP systems, and staircases. In traditional construction, each staircase is designed and built uniquely, leading to inconsistencies and poor quality.

In offsite construction, once a design is value-engineered, the factory has data on the exact number of walls, beams, and other elements with exact dimensions needed for the building. These computer-generated drawings are fed to machines in the factory, and the machines produce these elements with minimal human intervention.

**Step 2: Industrialized Factory Construction**

A high-end offsite construction factory is fully automated. Machines read the drawings fed to the computer and start the automated production function of building the element.

Factory produced elements are consistent in quality, have minimal chances for errors, and optimally use material and water, ensuring minimal waste.

High-end offsite construction factories like Katerra’s can produce both 2D or 3D concrete elements. 2D elements include roof slabs, wall panels, beams, columns, and even floors. 3D elements include staircases and fully functional rooms like bathrooms, kitchens that come factory-
fitted with MEP and all fixtures, including taps, basins, bathtubs, cabinets, etc.

Step 3: Onsite Assembly

Factory produced elements are transported to the construction site and fitted together using high-end connections that are durable and more earthquake-resistant than traditional monolithic structures.

These connections are vital to ensuring the stability and durability of the structure, and many companies, including Katerra, have an IP (Intellectual Property) on connections. Connections are usually a mix of dry and wet connections, depending on the building codes and requirements.

Advantages of Offsite Construction

Offsite construction has several advantages in comparison to traditional construction methods.

• Factory construction means there is minimal disruption onsite, no dust, no pollution, and no noise. This construction is better for communities and people around the site.
• Factory produced elements have better quality, consistency, and durability, unlike a traditional building, which depends on individual workers skills
• No material waste since machines optimize all the material used and there are minimal errors
• +50% faster than conventional construction, since all elements are machine-made and not labor dependent.
• Offsite construction is safer, it also allows for skill development of unskilled labor and can help create better quality jobs

More sustainable - factory produced elements are steam cured utilizing 70% less water in the process

Fully-controlled all variations and changes, every aspect of the construction process is measured, mapped, and controlled, bringing in transparency to the entire process.

Future Prospects

Let’s now evaluate how these advantages of offsite construction technology fit into the Indian scenario. Firstly, post-implementation of RERA (Real Estate Regulations and Development) Act, real estate firms are penalized heavily for the delay in project delivery apart from facing legal liability. So, offsite construction technology can be a critical element of the timely completion of projects.

Offsite construction also saves realtors from unnecessary cost overruns due to faulty construction at the site by workers. Higher savings in material cost and timely delivery of projects can add both better cash flow and credibility for realty firms, which is beneficial to the bottom line of the realty firms.

Secondly, this is a highly scalable technology that can help deliver the housing numbers we need on time. As the government eyes ‘housing for all’ with millions of homes in affordable housing space, offsite construction technology will be critical to realizing this dream. Even recent government decisions to build affordable rental housing complexes (ARHCs) for migrant workers can make way for the massive adoption of this technology. In the infrastructure sector, offsite construction can be deployed for faster creation of hospitals, bridges, airports, and other critical projects. Offsite construction can also solve the labor shortage challenges faced amid ongoing COVID pandemic.

Moreover, more offsite factories will spur construction activity in the country, boosting the “Atmanirbhar Bharat” mission of India and creating more skilled jobs.

Challenges

Ironically, the adoption of offsite construction technology remains slow despite its advantages. A host of factors is behind this phenomenon, but the lack of knowledge about offsite construction is the first and most critical factor. Apart from this, the upfront investment in technologies and the lack of government intervention is also a significant deterrent. The government has to actively support private players to set up offsite factories with tax breaks and other incentives, which will encourage more companies to adopt this technology at scale.

As India looks to bridge the critical gap in infrastructure, offsite is a must for timely and cost-effective delivery of projects.
As India speeds ahead with development and wants to become a global economy, there are many issues that are hampering the country’s progress. There is a growing demand for high quality building infrastructure - both in the residential and commercial space – and for buildings that are durable and affordable for both the present and next generation of users. Getting capital financing for plants and machinery is still a big problem in India. Builders have to shell out a substantial investment and loans have higher interest rates.

Because of the lack of affordable and sustainable alternatives, the housing shortage has grown to unmanageable proportions. To address this problem, the government has set an ambitious target of constructing 11 million homes by 2022. But achieving this won’t be easy, unless one employs proven technologies like precast, that offers both speed of construction and affordability.

In fact, the construction industry’s challenges can be solved with technologies such as PreCast. Firstly, precast technology uses reinforced concrete, the cheapest raw material on the planet. Secondly, it is compatible with existing building codes and suited to seismic zones as India is prone to earthquakes. Thirdly, it is efficient due to its ability to save raw materials and manpower.

Precast technology can help to build India as a modern nation, but there needs to be greater recognition of the technology so that it becomes an integral part of the country’s infrastructure development efforts, and becomes an acceptable standard. This would enable the precast industry to access subsidies and support.

Elematic’s solutions are available even at low-costs, and as construction activities grow across India, so can a precast plant expand and enhance its capacities to meet the increasing requirements. The precast industry would welcome more architects and designers to come on board as their involvement would advance the cause of precast construction, such that it enters the mainstream as a standard means of construction by the builders and contractors. This move could also be supported by institutions and industry bodies.

Apart from providing housing for India’s growing population, precast can also be the answer to the rising demand for faster building of commercial properties, which, in turn, would bring faster revenues to businesses and help them grow fast. Precast construction takes less time than using traditional methods and since ‘time is money’, on-time project completion is very valuable to builders.

The next phase of the country’s development will be technology-driven. As more people begin to adopt precast construction, we will see the industry becoming more organized, with more efficient use of raw materials, machinery and manpower.

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You can decrease your building project’s carbon footprint by using precast concrete. Compared to cast-in-situ, precast uses less of everything – less cement, less water, and less steel.

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Prefabrication has brought a substantial change in the development of construction industry worldwide over the last few decades. It ensures the strength, economy and environmental performance of the structures and hence is preferred over the onsite construction. Pre-assembly, prefabrication, modularisation, system buildings and industrialised buildings are the various terms used to describe the processes of manufacturing of modular units on-site or off-site. There are various types of modular precast building construction techniques prevalent worldwide. This article discusses the various types of prefabrication technologies along with available standards & codal provisions, its advantages, disadvantages. Prefabrication usage large panel technology was initially developed in the mid 1960s. This is quick construction of huge numbers of building units at a minimal cost[1]. It is referred as off-site construction and fabricating of some or all elements of structure in industrial units, and transporting and assembling them to the construction site where the building is to be made[2]. It is learnt that this construction technique exists from prehistoric times and has not been evolved recently. “The Stonehenge” is a prominent example as it was also completed in different stages as shown in Fig. 1. Concentric rings are made by the arrangement of columns standing in height. To ensure the stability of structure Tenon and Mortise joints were used [3].
Presently, construction materials and techniques have a severe competition: concrete against steel, precast concrete against in situ concrete or steel [4]. It can be produced with excellent quality construction as manufacturing is done under controlled conditions. Thus it’s a large potential of the future in the construction site [5]. Precast concrete building systems are attracting people for wide applicability as they are accessible in numerous shape, sizes, as well as structural elements and un reinforced pieces. In construction industry of every country it is the backbone for the expansion of fresh ideas [6]. Designing with prefab mechanism is not a barrier to creativity; on the contrary these are standardized components and provide group customization at lower costs through economies of high volume work [7].

Global Scenario
The prefabricated construction system has been identified as one of the replacement to altering the speed of conventional construction methods at a rapid rate. These modules are then transported and installed on-site as load-bearing structural blocks of the structure. This type of prefabricated structure also provides environmental benefits, such as the decline of construction waste and CO₂ emissions, and less interruption to the building site’s neighbours by minimizing on-site noise and dust. These advantages are the driving force within the European building industry for the expansion of prefabricated building systems. Moreover, due to increase in population, other countries (i.e. US, Canada, Japan, etc.) also use modular construction technology to construct houses, apartments, offices, etc [8]. Sustainable growth has become globally essential as human race moves through the 21st century. The mainstream construction “work” is, consequently, transferred from the site to the manufacturing units. Assembly lines will carry out most of the work, which means numerous parallel activities can be carried out with no stoppage. The procedure is highly planned, which requires a smaller labour force at higher productivity. Prefabricated construction improves quality, safety, productivity, labour efficiency, construction timeframe, construction waste, noise, dust, and energy use. These advantages can improve the entire industry and benefit all stakeholders in the industry chain, making prefabricated construction more green, environmentally-friendly, and sustainable [9].

Prefabrication Adoption in India
The prefab production was pioneered by Hindustan Housing Factory. The corporation transformed its name due to the diversity of its operations and is now recognized as Hindustan Prefab Limited or HPL. The government-run corporation prefabricates mainly precast concrete for architectural and civil projects and is located in Delhi. When components are manufactured in a stable environment, quality of construction increases. Materials are used more resourcefully, are safer from climatic damage, and can be reused [2]. In the last few decades, Indian Infrastructure and Construction sector has grown exponentially. It is main driving factor for the economic growth. The manufacturing is focusing to take up more versatile and technically intense projects. Consequently, the focal point has moved from cost efficiency to time and capability [10]. On 25th June 2015 The Pradhan Mantri Awas Yojna (PMAY) was launched which involves manufacture of about 20 million houses by 2022 for urban poor while rural housing which envisages 10 million houses in next three years was launched on 1st April, 2016. In order to attain this enormous task, Ministry of Housing and Urban Development, GoI has adopted numerous innovative pre-fab construction systems, developed within the country[11]. So, there is a need to change our gears in the direction of the prefabrication and pre-cast techniques which stress upon the reduced time and the enlarged productivity. It will not end-the product but would only have an effect on the procedure of construction. As it will offer opportunity for dealing with the lack of skilful labour and the deteriorating workmanship standards. The quality of construction is much superior when components are manufactured in a steady environment [12]. They also have the potential to deal with the problem of mass housing crisis in India that we face these days. There is a huge housing crisis in cities which has rendered millions to live in dilapidated conditions. The simple way to clear this build-up is mass housing. The idea of mass housing with a superior density and floor area ratio seems to resolve the setback considerably. This reduces cost on individual owners. Mass housing further economises by standardising resources and structural components, thus ensuing in well-organized management of materials and resources. Even though precast technology is extensively used all over the country but the utilization of this technology is restricted in some parts. At present it is used in business-related towers and a small number of government housing projects. Following are the reasons why precast construction is unpopular in India:

1. Contractors’ prefer for employing low cost labour as against high capital investment
2. Lack of appropriate transportation systems is main obstacle for precast technology as huge precast elements are transported from factory to construction site for erection.
3. Less level of standardization of technology [13-14].

Prefabrication Technologies
There is a recent advancement in design and technology along with increasing importance in the construction area to address the technical, social, and economic and sustainability issues of prefabricated construction techniques. This is a feasible solution compared to the existing conventional techniques. Majority of the advanced nations have by now accepted prefabricated construction technique and is gaining its advantages. Few techniques adopted by India are given in Table 1 [2].

Formwork Systems
Monolithic concrete construction system: In this system, using suitable grade of concrete RCC framed construction of columns and beams; all walls, floors, slabs, columns, beams, stairs, together with door
and window openings are cast-in-place monolithically in one operation. This is made up of Aluminium/Plastic/Aluminium-Plastic Composite especially custom designed modular formwork is simple to handle with minimum labour & without use of any apparatus as shown in Fig. 2. Being modular formwork system, it facilitates in speedy construction of multiple/mass unit scale. Lightweight Aluminium formwork systems are used. In the concrete form a soft alloy weld wire is utilized in the weld process. Fixing of the formwork is finished using tie, pin & wedges system. Skilled labour is not required to do the work [15].

**Modular tunnel form:** Tunnel formwork is used to reduce cycle time and also the slab & the wall are cast monolithically, this system is one type of construction techniques used for multi storied building construction as shown in Fig. 3. Steel components are used. Its effectiveness also stems from the fact that no starter concrete is necessary for walls; it allows easy arrangement and de-shuttering, hot air curing to allow early stripping. It also favours a consistent working sequence to improve labour efficiency. The major element of the system is the half tunnel, it provides the firmness and smooth face needed to produce a consistently high quality finish to the concrete and Manufacturing is entirely done from steel. When two half tunnels are placed together this creates a tunnel. These tunnel sections are in two lengths, 1.25 and 2.5m and are set together to construct a tunnel length that suits the building dimensions. The tunnel is customized to the room width and height by the inclusion of infill sections which are sacrificed at the end of the job. These are not loose fittings but are an integral part of the tunnel [16].

**Kayson’s formwork system:** The Cast-in-situ monolithic reinforced concrete construction system is Kayson’s integrated solution to the problem of large-scale residential housing development as shown in Fig. 4. It is widely recognized as one of the most practical, economically and technically feasible solutions to the problem of building cost-effective, descent, durable and earthquake-proof housing on a mass scale. Indeed, Kayson’s constant efforts over the past thirty years to adapt the system to varied topographical and climatic conditions has resulted in the development of a unique method for building large scale housing faster, better and at a lower cost, in virtually any corner of the globe.

- This utilizes a large steel formwork system.
- These forms are simple to install, durable, more accurate and produce higher quality structures. It gives the opportunity to repeat the entire construction phase within a period of only 48 hours.
- It uses a formwork system that allows the builder to cast foundations, walls, and ceilings in accordance to a pre-defined cycle. It is a combination of
Prefabrication

speed; quality and precision of factory/off site production with the flexibility and economy of in-situ construction.

• Other formwork systems are heavier than these forms.

• The wall forms can be removed within just five to eight hours [17].

Sismo Building Technology: It is an insulating shuttering kit for complete building based on a three-dimensional lattice made of galvanized steel wire. The lattice is filled with different materials to serve as formwork as shown in Fig. 5. Steel wire lattice is the basic structure of the module. At the external sides of the lattice, infill panels are inserted, which convert the lattice into a closed structure that can be filled with concrete. Depending on the function of the wall these infill panels are used: load bearing or not, insulated or otherwise. As during the concrete filling steel wire acts as armature and anchoring for the finished material and it holds reinforcement bars in position.

There are a variety of components made from this technology: 3D lattice (2.2 mm Ø galvanized steel wire), Infill panels (EPS, rock wool, and mineral board), Structural filler (concrete) and Finishing (plastering, natural stone, panelling etc. )[18].

Precast Sandwich Panel Systems

Advanced building system: These are industry made panels, consisting of self extinguishing expanded polystyrene sheet (generally corrugated) with minimum thickness not less than 60 mm and density of 15 kg/m³, sandwiched between two engineered sheet of welded wire fabric mesh. High strength galvanized wire of 2.5 mm to 3 mm dia is used in it. It is pierced entirely through the polystyrene .30 mm thick shotcrete of cement & coarse sand in the ratio of 1:4 applied to make these panels with minimum under pressure. Successfully used in many countries with involvement of different agencies and brand names Morocco, Algeria, South Africa, Kenya, Austria, Malaysia, Ireland, Romania & Australia [19]. The system is shown in Fig. 6.

Panel prefab system: Precast construction system is in general a large panel system, modular system or a grouping of both. Precast large construction panel system consists of a range of precast elements such as walls, beams, slabs, columns, staircase, landing and a few personalized elements that are standardized and planned for stability, durability and structural integrity of the structure as shown in Fig. 7. Designing, strategic yard planning, lifting, handling and transportation of precast elements is involved in precast residential buildings. This technology is appropriate for construction of high-rise buildings resisting seismic and wind induced lateral loads along with gravity loads. Maximum number of repetitions of moulds is obtained in planning of building frame. These elements are cast in a factory which is developed at or near the site which provides a cost-effective solution in terms of storage space and transportation [20].

Ferrocement sandwich panel: In developed countries, ferrocement is a significant laminated unit of building constructions as shown in Fig. 8. It might be used as an independent part of structures like water tanks, walls, infill frames, chemises, silos and marine structures. Cement, sand, wire mesh and water are constituents of Ferrocement and have some attractive properties such as fire-resistance, antirust, seismic resistance, and rot or blow down in hurricanes. It is used in repairing of damaged buildings or retrofitting also. Ferrocement acquire large tensile strength and supreme cracking behaviour if compared to regular reinforced concrete [21].
Structural insulated panels (SIPs): SIP is a sandwich panel utilised as construction member such as wall, roof, and floor for concrete structures as shown in Fig. 9. It vary in altered thicknesses of two layers of rigid material as skin and a thicker layer as core. Based on its appliance, it can be made of a variety of materials. It is usually made of plastic foam such as Polyurethanes (PUR). PUR foam has superior performance against fire, flaming, and smoke rating. Injected PUR foam can be easily adhered to all SIP components such as skin material, top plates, and electrical boxes. Thus, it allows tough bond between mating surface and the foam [22].

Glass fibre reinforced gypsum (GFRG) panel system: Glass Fibre Reinforced Gypsum (GFRG) Panel also identified as Rapid wall is made-up of calcined gypsum plaster, reinforced with glass fibres as shown in Fig. 10. The panel was initially developed in 1990 in Australia for mass scale building construction. In recent times, these panels are being created in India and are being used. The thickness of panel is 124mm to a length of 12m and height of 3m, contains cavities that may be fully filled, partially filled or unfilled with reinforced concrete as per structural requirement. Filling these with plain reinforced concrete possesses substantial strength capable of resisting lateral loads due to earthquake and wind. GFRG panel can also be used favourably as in-fills (non-load bearing) in grouping with RCC framed columns and beams. GFRG Panel is manufactured in semi-automatic plant using water repellent emulsion and glass fibre rovings, cut, spread and imbedded uniformly into the slurry with the help of screen roller. Before shifting to storage area or the cutting table the panels are dried at a temperature of 275°C. These panels can be cut as per dimensions & requirements of the building planned. It is suitable for low rise to medium rise building [19].

Light Gauge Steel Structural Systems

Pods: Small rooms of light steel frame with all fittings and finishing. It is based on factory made galvanized light gauge steel components, designed as per code requirements as shown in Fig. 11. Cold forming method is used to produce the panels and assembled forming structural steel framework of a building of varying sizes of wall and floor. Special types of screws and bolts are used in joining. In residential floors, industrial buildings, commercial buildings, hotels Cold formed sections are broadly used. LGSF is gaining ground in India due to its flexibility, fast construction and durability after being used in North America, Australia and Japan. It is usually ideal for one to three storey high buildings (residential and commercial). Advisable maximum span for these buildings should be 7.5 m. These could be used for short-term or permanent structures such as schools and classroom, military and civil housing needs, post – disaster relief structures and industrial units [19].

Precast Concrete Construction Systems

Industrialized 3-S System using cellular light weight concrete slabs & precast columns: This technology is being used since 1972, and is based on industrial unit mass manufactured structural prefab components meeting the requirements of Indian Standards. The major precast elements are:

- RCC hollow columns with notches
- RCC solid beams (T/L/Square Shape)
- Staircase
- RCC precast slab
- AAC precast slab
- AAC precast block

Appropriate sizes of precast dense concrete hollow column shell are used in mixture with precast dense concrete rectangular / 'T' shape / 'L' Shape beams with light weight reinforced autoclaved cellular concrete/ Precast RCC slabs for floors and roofs. On-site concerting along with secured embedded reinforcement of components and jointing is accomplished for various structures with appropriate size, length and configuration to ensure monolithic continuous resilient, ductile and durable behaviour. The hollow columns are grouted with appropriate grade of in situ concrete. Autoclaved Aerated Concrete slabs could also be used as floor / roof slabs. Joints are filled with reinforced screed concrete (minimum 40 mm thick) of M20 grade minimum. RCC screed is laid over whole area of slab before flooring / water proofing [15]. The system is shown in Fig. 12.

Wafflecrete building system: It consists of huge, structural, ribbed panels of reinforced precast concrete, bolted together and the joints between the panels are caulked to form the walls, floor and pitched or flat roofs of buildings as shown in Fig. 13. The surface
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of each panel consists of 51 mm thick slab with overall panel thickness of 152 mm or 203 mm. In single storey buildings, floors are constructed using precast reinforced concrete floor panels supported on precast concrete grade beams on well-compacted earth is used in single storey buildings. While for buildings of more than one storey, the walls are supported on foundations designed as per the soil condition. Where there is a danger of water or wind erosion of the ground adjacent to the building a concrete apron is laid around the perimeter of building. Internal walls consist of either reinforced precast concrete ribbed panels, conventional masonry walls or concrete walls. Before the walls are lined services like water supply and electricity shall be normally accommodated in preformed slots in the ribs of panels. Trapping the moisture generated from the concrete curing time is reduced. The structure after construction can be shifted from one place to another as the structure is joined using bolt connections [19].

**Steel Structural Systems**

**Speed floor system:** These are suspended concrete flooring system using a roll formed steel joist as an essential part of the final concrete and steel composite floor. an integrated continuous one-way slab and a hybrid concrete/steel tee-beam in other direction as shown in Fig. 15. The joists of altered depths are manufactured from pre-galvanized high tensile steel in a one pass roll former, where it is roll formed, punched, pushed and slotted in a fully mechanized instrument. Depending on the span, the joist depth and the concrete thickness may vary, forced loads and other efficient considerations. It’s suitable for use in all types of construction [19].

**Factory made fast track modular building system:** This comprises of prefabricated steel construction with different walling components. With minimal usage of concrete, about 70 percent of the work is done in the factory, which enables system to deliver the building within a few days of work at site as shown in Fig. 16. The flooring, ceiling tiles, electrical and plumbing fittings are pre-fitted with steel unit. These modules are transported to the site for putting in place which is completed using crane and other required machineries, factory made 3-D Expanded Polystyrene (EPS) wall panels are fixed and shotcreting is done from both sides after all the components are assembled and erected at site. The distinctiveness of system is the well-organized and synchronized activities of site preparation and building construction in factory, rather than two phased traditional process [19].
Prefabrication

Timber-concrete prefabricated composite wall system: Wood has been used as building material mainly attached with brickwork or stone in Europe. In order to develop the seismic resistance of masonry buildings wooden structural elements has been in a practice. It was composed basically of two parts, a slab of reinforced concrete (RC) with a thickness of 50 mm connected with particular connectors. A structure made of CGF panels for load-bearing walls and floors is a modular system in which the panels are prefabricated. The panels are then assembled providing insulation inside the frames and then are easily transported to the site as shown in Fig. 17. After having a foundation curb in the ground, the panels are hooked to it and to each other with nails and screws [24].

Sim[PLY] framing system: In these framing system plywood subcomponents, fastened together with tab and slot joints with hand-fastened steel cable ties are composed together to form structural members in the system as shown in Fig. 18. Due to its renewability, low-carbon footprint, ease-of-use, minimum weight, and affordability Wood is the perfect choice for this sustainable light-frame system. Furthermore, the CNC procedure allows for systems within a given house, including electrical wiring and plumbing. This promotes quick and exact assembly. Mainly are used to maximize material efficiency and lessen plywood waste. The prefabrication allows for disassembly of the house to be rapid and simple, taking only three days. Small, efficient, and mass-produced structures use this Sim [PLY] system [25].

Ultra-thin phase change material technology: To improve the thermal performance of building envelops and to achieve the goal of energy saving, thermal energy storage (TES) is one of the best ways to get better thermal performance. Ultra-thin phase change materials (PCMs) are a series of functional materials that give high-energy storage density in a thin temperature interval. PCM the appliance areas are mostly some cities of Europe [26].

Prefabricated mud wall unit: For faster building construction Low-cost materials are in use. Encouraged to improve and “modernize” natural construction systems, which are environmentally friendly as shown in Fig. 19. Tsuchikabe (in Japanese), also recognized as mud wall, is a combined designed for walls built with clay and mud using customary Japanese craft techniques. It is also identified as wattle-and-daubin Western countries, and has been used globally since the Bronze Age [27].

Futuristic Pathways

Prefabrication is a promising strategy to realize lean construction. Among the diverse degrees of prefabrication, modular buildings make the most of the gain in time savings, because they are prefabricated to a better degree of finish. These are based on local building codes and standards, in the similar way as on-site built construction; thus, of equal quality to an on-site built construction. Although, maintenance during occupancy, deconstruction, and recycle or reuse of modular buildings as they are just not limited to design, manufacturing, and construction stages [28]. Abundant projects incorporating prefab (on various levels) have already been completed successfully, and numerous more are planned. The potential for enlargement in the building economy; embracing higher output, total sustainability, improving place of work and workforce security, was hypothetical some ages ago, but is a practical recognition today and in future, through prefab[7]. The effective factors are shown in Table 2.
Prefabrication

Issues in Prefab Construction
The joints to be provided linking the core structure and the components should be well-built enough to transmit all types of stresses. The strength and stoutness of the entire building depends totally on the strength of the joint. Therefore, it is necessary to have comprehensive studies on entire system rather than component based study. Requirement of skilled labor at site and shortage of onsite automation is one of the major issues in acceptance of prefabrication technologies in construction which requires accuracy and preciseness. Thus, skill development and native automation is mandatory for installation of the prefabricated systems.

During erection or transportation of heavy machinery units are likely to get damaged thus the arrangement of the units has to be done precisely and this procedure becomes clumsy in a congested area. Labor maintenance is one more issue as skilled labor is required in the prefabricated construction as it is different from in-situ construction, which requires machine oriented skills both on-site and in the manufacturing process [29].

Advantages of Prefab Construction
Prefabrication Technology has various advantages like overhauling the view with energy efficiency, minimal wastage and inspection struggle, dependable construction, pace of work, security, sustainability and quality [7].

• The requirement for formwork, shuttering and scaffolding is significantly reduced as Self-supporting ready-made components are used.
• Construction time is reduced thus resulting in lower labour costs.
• Reduced amount of waste materials than in site built construction.
• Reduction in Construction time allowing an earlier return of the principal invested.
• Building ensures accurate conformity to building standards and superior quality assurance.
• High-energy efficiency along with quality control and factory sealing.
• Prefabrication site can be positioned where skilled labour is more readily accessible and the expenses of labour, power, materials, space and overheads are minimized.
• Prefabrication allows construction all over the year irrespective of the weather (related to excessive cold, heat, rain, snow, etc.).
• Construction material wastage is less.
• Independent of climatic condition.
• In off-site construction safety and comfort level of worker are higher [30].

Disadvantages of Prefab Construction
It is known to have the subsequent limitations limited options in design, decreased resell value, high initial investment, non-suitability for foundation and transportation of precast units [7]. There are more disadvantages too. They are as follows:-
• At joints in prefabricated components leakage occurs.
• Transportation costs may be high for huge prefabricated sections.
• Increased production volume is necessary to make sure affordability through prefabrication.
• Initial construction cost is higher.
• The initial design development is time consuming.
• Huge prefabricated sections need heavy-duty cranes and accuracy measurement from handling to place in site.
• Local jobs may be lost, as it requires skilled labour.
• Design and construction of modular buildings, require high levels of collaboration among project parties, especially architect, structural engineer and manufacturer.
• Due to its shorter economic life these buildings typically depreciate more quickly than traditional site-built housing [30].

Conclusion
This mainly focuses on the challenges faced by the construction sector at national, as well as in the international level and its adoption in construction sector. It also discusses the new prefab-technologies developed, along with benefits of this technique in construction industry. Therefore, the paper comes to a conclusion that prefabrication technology with huge advantages is an essential technological up gradation in construction sector to defeat the present challenges world-wide and it has the capacity to make a difference in the sector in terms of financial, social, ecological sustainability in India as well.

References
Prefabrication


In both traditional and modern constructions, natural resources are used directly and indirectly, which leads to their depletion as they are not renewable. The cost to benefit ratio, or the price we pay, or are going to pay, in the future for development, is much skewed and highly dangerous. Cement, steel, tiles, aluminum, paints, and other materials used in the interiors consume a large amount of energy during manufacturing. This high embodied energy has a huge negative impact on these materials, without which, we cannot construct anything.

In such a scenario Ferrocement Technology-based construction comes as a breath of fresh air and gives hope and respite from the onslaught of the rampant depletion of natural resources.

Ferrocement is a very green initiative for constructing sustainable structures. Calculations done on live examples have proven that the technology enables lower carbon footprint and leads to green credit ratings. Firstly, it does not have aggregates and bricks as ingredients. Secondly, it has weld and chicken meshes as the main reinforcement, which requires lesser energy to manufacture. Cements containing high fly ash content, or GGBS, can also be used. The tor steel usage is extremely limited and used as skeletal steel, which offsets the need for formwork and precious timber, and the structural steel used for formwork of modern RCC structures is majorly eliminated. Most importantly, as the thickness of the Ferrocement is very low, consumption of cement, sand, (even manufactured sand can be used) gets reduced.

Today, with the advent of Geopolymers in construction, it is possible to have Ferro Geopolymer-based construction. It has the greatest advantage of replacing cement and sand by 100%.

Fly Ash, which is an environmental burden, and a challenge for safe disposal, can be used and activated using simple chemicals and made to behave like cement. It only requires sunlight (which is abundant in this country for almost 9 months of the year), and a temperature of about 30 to 35°C for curing, and most importantly, it completely eliminates the need for water (the most precious thing on this earth today). In fact, Ferro-geopolymers could be the game changer technology of the future.

The behavior of Ferrocement as a 2-phase, homogenous composite as against concrete (which acts as a heterogeneous composite) makes Ferrocement far more superior than RCC. Its ability to take both tensile and compressive stresses almost equally with very low crack widths, resistance to shrinkage, drying and cracking, makes it a technology of choice for structural designers.

Further, with the reduced self-weight, foundations can be smaller and kept on weaker soils having medium to poor bearing strength. The earthquake loads get considerably reduced, though wind loads could be a matter that needs to be addressed; however, it can be resolved by adding eco-friendly and cost-effective dead weights.

**Eco-friendly & Magical Technology**

Ferrocement is a combination of cement, sand, weld mesh and chicken mesh pressed and filled with mortar. Skeletal steel in the form of 6mm/8mm bars are used for getting the form and shape to eliminate use of formwork.

“A little change in the type and pattern of the reinforcement, the use of fine wire meshes instead of large diameter bars, and press filling mortar either by hand, machines, or pre-casting, makes it a wonder material!”. This is how Dr. (Prof) Divekar explained it after living with it in body, mind, and soul for over 40 years, having designed and constructed a large number of such structures.

**Low-Cost Precast Zatpat Houses**

An engineer in Satara, Maharashtra, has come up with a new research on building Ferrocement precast houses in a day using readymade walls and slabs, and nut bolts. These eco-friendly, economical, and earthquake resistant Zatpat houses are a solution for mass housing and for immediate rehabilitation of displaced people during an emergency. Er. Milind Kulkarni, MD, MKCE, Mumbai, shares details of Ferrocement Technology and its benefits as a low-cost, eco-friendly building technique.

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Normally, while constructing, we use bricks, steel, metal, stone, timber etc, and sheets for roofing. But now we need to reduce the quantity or eliminate these materials. But how do we build a house without them?

Chicken mesh a hexagonal wire woven GI mesh. It is flexible and is stretched while fixing it to the skeletal steel. Weld mesh is a square grid of small diameter bars that are pre-welded in a factory and is more rigid. The skeletal steel is a skeleton of 6/8mm mm diameter steel bar, welded to the required shape and size. The weld mesh is fixed to it and the chicken mesh stretched on both sides of the skeleton steel.

In the second part, a thick cement mortar is prepared. It is a mix of 1 part cement and 2 parts of fine sand and a small quantity of water. This thick mortar is press filled in the chicken-mesh layers, after which the finishing and levelling is done using a plate trowel for aesthetics. Pressing makes it stiff. There is no wastage. After some days it appears like a wooden plank, very slim, and very tough. Curing is required - just like concrete.

The application of this technology in the construction industry is enormous and wide ranging from very small to large structures - both cast in situ and precast. Ferrocement can be used for making security cabins, compound walls, small buildings, domes, pyramids, water tanks, treatment plants, repairs, waterproofing, permanent forms, check dams, silos, roads, pathways, pontoons, blast fences, and a lot more.

Low cost precast ZATPAT house

Jayant Murudkar, a 78-year-old engineer from Satara MIDC manufactured a ZATPAT house in a day by assembling ferrocement components like readymade walls and readymade slabs and joined them with the help of nut bolts. The precast ferrocement wall panels are standardized as 3.5 x 2.5 meter and the thickness is 25 mm. The roofing panels are 4 x 0.6 meter in size with the same thickness. The panels are ribbed so they have greater strength even though light in weight.

Inspected by the Ferrocement Society, the Zatpat house is becoming popular in Maharashtra as it can provide immediate shelters to rehabilitate affected families and can be used for mass housing such as for the Prime Minister’s Awas Yojana. The houses can be dismantled and reused anywhere, which makes them eco-friendly. They are not built by using bricks and timber, yet their walls have tremendous strength since they are made from chicken meshes and are earthquake resistant too.

Er Murudkar has set up a factory to produce the ferrocement components and has installed a machine to manufacture panels of 0.6 x 3 meters, weighing about 100 kg only. A precast wall panel of 3.5 X 2.5 meter size weighs 750 kg only. Thickness of 25 mm is available. A 100 mm thick wall panel is manufactured using thermocol as an insulation filler.

Zatpat house is very affordable. If the plan dimensions of the room are 4.5 m by 3.5 m and height is 2.5 m, the cost of the house is only Rs 1,71,000. This includes excavation, foundation concrete, masonary, door and window, one bathroom and one toilet externally attached to the room. The rate is Rs 1010 per sq foot. A detailed video can be viewed on https://www.youtube.com/watch?v=bIsOE3X4Ros).

Versatile & futuristic material

Ferrocement has been in use for the last 30 years across the country. Everybody is aware of it, but many do not know the details of the technology and the cost. It is a simple, straight, and easy to build technique. It is a futuristic material and is an easy solution for many of the problems which concrete even today cannot resolve.

The typical domes of Shikhar on Ramakrishna temple built in Pune are precast thin petals of ferrocement. They are a classic example of the potential of ferrocement when designed and constructed properly. In America, Mexico, England, France, Germany, and Indonesia, the technology is being used extensively. In India, let us understand and adopt this magical innovation, save our natural resources, and be friendly with our environment.
Relevance of Chemistry in Concrete

Chemistry is truly relevant for concrete because chemistry controls the life/durability of concrete. It explains why cement hardens and the interaction between cement and its environment. Dr. S.B. Hegde at Udaipur Cement Works, highlights the basic inorganic chemistry of cement and concrete under service conditions.

Chemistry and concrete

When cement is exposed to atmosphere it begins to deteriorate is a chemical reaction. When it comes in contact with water it forms calcium silicate hydrate that gives strength to concrete. This is one aspect of chemistry, but chemistry is not only thermodynamics, it is also kinetics. In other words, concrete has the potential to change, but how fast will that happen? Concrete made carefully with the right materials/proportions will develop good optimum microstructure by adequate curing can last for so many years.

Concrete is inherently reactive subject to exposure conditions that reactivity will result in either excellent durability or poor durability. In both the long and short term, it is the chemistry that makes the difference in concrete’s performance. Examples of typical exposure agents that affect durability are:

- Moisture and ground water
- Temperature cycles
- Marine environments
- Pollutants like CO₂, NOx, SOx

Depending upon the composition of concrete and exposure conditions, a variety of possible chemical reactions may deteriorate concrete. Sometimes, however, the enemy is not some outside element, but rather the seeds of destruction must be within the concrete. Portland cement hardens because of a chemical process called hydration. This means, silicate and aluminate minerals in Portland cement react and combine with water to produce cementing property that holds together the aggregate that we call concrete.

Water to cement ratio (w/c) dictates the strength of concrete. Although the size and grades of concrete and the quantity of cement influence the quantity of water in a mixture controls the strength of concrete. Therefore, one has to use smallest quantity of water that will produce plastic or workable concrete. Water may depend on quality, nature of aggregates used and concrete curing history, cause such deleterious effects such as “alkali-silicate-reactivity” (ASR) or “delayed ettringite formation” (DEF). Water may also act as a transport medium for ingress of destructive agents like sulphates to enter into the system.

Temperature affects the rate of chemical reactions and a general rule of thumb is that rate of chemical reaction doubles for every 10°C in temperature. Thus, temperature influences the rate of both concrete setting and hardening. Curing concrete above certain critical temperature may lead to expansion and cracking associated with delayed ettringite formation (DEF). Several external environmental factors may initiate destructive chemical reactions in concrete, particularly, concrete with more open porosity (due to high w/c).

Chlorides can slowly diffuse into concrete in presence of moisture and oxygen will initiate corrosion of reinforcing steel. The oxidation of iron to produce iron oxide is a chemical process that gives large volumes of oxidation products, which makes the structure weak as it creates localized pressure that can cause severe cracking of concrete. Once cracking begins more
surface of concrete surface is exposed to further chemical attack. Most vulnerable part of concrete is the cement paste. Although, concrete is comprised of 10-15 % by mass of cement, it becomes the focus point for aggressive chemical agents like atmosphere, carbon dioxide etc. that dissolve in moisture. Cement paste is highly alkaline with pH of around 12.5-13.5. This high pH is due to the presence of calcium hydroxide and hydration products and the lesser amounts of alkali salts. Under ideal carbonation conditions (50-70 % relative humidity and exposed surface of cement paste) the hydrated lime constituents reacts with carbon dioxide to form calcium carbonate.

As this process slowly progresses perhaps at even rates of only a mm or less per year, the pH is gradually lowered, and finally crystalline calcium carbonate replaces the hydration products.

During designing of a concrete mix, chemistry should be considered. For instance, if the concrete is going to be placed where it has to expose to aggressive environments such as chlorides and sulphates in that situation, only particular type of cement to be used which must be resistant to such aggressive environments.

It is true that not only mix design but also the curing of concrete is very important. Curing of concrete is a process that provides sufficient moisture and thermal energy to promote the hydration phenomena. Curing conditions provide the strength development and thermal cracking: therefore, they have significant impact on durability of concrete. The classic example showing importance of curing and temperature control is concrete deterioration from delayed ettringite formation (DEF). Ettringite formation is normal and useful event as cement begins to set. If its formation is greatly delayed (days or months of concrete hardening) however, it can cause serious durability problems.

Chemical reactions of cement

Portland cement contains calcium silicates and calcium aluminates formed by sequence of thermal and chemical processes including decomposition of limestone: reactions with additives such as clay, iron ore, bauxite etc; fusion of these ingredients and finally the formation of hard, rounded nodules called clinker. This will be formed at a temperature of 1350-1450°C in a rotary kiln. After cooling, clinker is ground together with approximately 5% gypsum.

At this stage we will review some elementary cement chemistry. The present knowledge of chemical composition of Portland cement and what happens to it when it is mixed with water was first disclosed in 1887 by French chemist by name Henry Le chatelier. In his doctoral thesis he correctly identified the major cement minerals. In 1915 scientists at Geo physical laboratory, Washington D.C. was studying the high temperature phase relationships of ternary system CaO-SiO2-Al2O3. Among the mineral phases investigated were-C3S, C2S, C3A, C4AF. The abbreviation used were tricalcium silicate (Ca3SiO5) or 3CaO·SiO2; C=CaO, S=SiO2, A=Al2O3. Accordingly, 3CaO·SiO2 could be written as C, similarly, C2S,C3A and C4AF. The abbreviations for oxides are FeO=Fe, MgO=M, H2O=H, Na2O=N, K2O=K and S=SO3. Tricalcium silicate and dicalcium silicates with impurities are called alite and belite respectively. Other phases like magnesia is called periclase, calcium hydroxide is called Portlandite and ettringite for calcium aluminio silicate hydrate.

Normal hydration reactions

The most rapid reaction that occurs when mixing cement and water is the hydration of C3A. Entirely by itself C3A and water will quickly form Calcium aluminates hydrates such C4AH13 and C4AH6. This can occur so rapidly that the cement/concrete may set within minutes and become entirely unworkable. This condition is called flash set. Chemically the C3A, gypsum and water would form a protective coating of calcium sulpho aluminale hydrate (ettringite) over exposed tricalcium aluminio silicate surfaces that would remain for several hours. C3A hydration reactivates as the initial strength begins consuming sulphates and forming ettringite If C3A contains more than 8% which is much greater percentage than sulphate from some of the ettringite (trisulphate) to form another stable calcium sulphaaluminate compound called monosulphate C3A.CSH12. A fourth major mineral in cement are the ferrite phases or teta calcium aluminio ferrite (C4AF) also hydrates although much more slowly to form chemically similar trisulphates and mono sulphate compounds in which iron replaces a portion of the alumina, cement chemists generally called these Aft (aluminate ferrite trisubstituted) and Afm (aluminate-ferrite-monosubstituted) phase respectively.

C3A + 3CS H2 + 26 H = C4AS3 H12

(Ettringite) - (1)

2 C3A + C4AS1 H2 + 4H = 3C3ASH12

(monomusulphoaluminate) - (2)

The major strength development of concrete however results from the hydration of Ca-silicate phases. Both of these Ca-silicates combine with water to form gel like silicate hydrate or C-S-H

2 C2S + 6 H = C-S-H + 3 H - (3)

2 C2S + 4 H = C-S-H + CH - (4)
The most common type of chemical attack on concrete results from exposure to soils or ground water containing higher $SO_4$ contents. The mechanism of $SO_4$ attack is simple. If cement contains higher $C_3A$, a substantial amount of Ca-monosulphate ($Afm$) phase will form during hydration. This substance is reactive and if additional $SO_4$ from an outside source such as soil or groundwater penetrates the concrete, the monosulphate will readily react with it and convert back to Aft phase or ettringite. The conversion of monosulphate phase into ettringite will result in a significant volumetric increase and be disruptive to the concrete. If this is allowed to continue the concrete will eventually be destroyed.

**Chemistry and cracking**

Cracks in concrete may develop for physical reasons such as drying shrinkage or mechanical loading. Local chemical reactions in the concrete, however, may also result in expansion; buildup of internal pressure and then cracking. Concrete is a brittle material and therefore can only expand to a limited degree before cracking. It is not possible to determine the cause of expansion and cracking from the appearance of the crack pattern on the surface of the concrete. Interior samples should be examined microscopically, chemically or both to determine the root cause of the internal expansion. There are two modes of concrete expansion:

- The aggregate can expand relative to the cement paste
- The cement paste can expand relative to the aggregate.

It follows from physical considerations that in a composite system consisting of expanding particles in a matrix, cracks are formed in matrix radiating away from the particles. Expansion of particles in a hardened paste such as aggregate particles undergoing ASR causes the particles to crack and crack to extend outward into the surrounding paste. A particle cracking, when expanded from surface, is actually fairly common experience. The expansion at the surface causes the inner part of the particle to be under tensile stress, and it cracks from the inside outward.

Shrinkage of cement paste is a common phenomenon related to hydration, and from a cracking point of view, is equivalent to the expansion of aggregate particles.

**Alkali silica reactivity (ASR)**

Chemical reaction called ASR takes place between the highly alkaline (very high pH) pore solution and reactive siliceous portions of some aggregate particles. The large amount of hydroxyl (OH) ions present in the pore solution due to high alkali concentration dissolve the reactive silica in aggregate surface to form an alkali silicate gel. Although any form of silica can react with alkali hydroxides, theoretically. It is the siliceous rocks such as opal, graywacks, chert and glassy volcanic materials that appear to be most reactive. Reactive siliceous aggregates will form alkali-silica gel starting at the surface of the aggregate and moving inwards.

Tensile stresses build up during the reactions causing aggregate particles and surrounding paste to crack; the paste between cracks maintains its composition and strength. Hard, poly crystalline rocks like granite will react with much more slowly. The chemical reactions occur at those heterogeneous areas of grain boundaries. In such cases only minimum degree of reactions may be needed to cause cracking, but only meager amount of gel will form. In ASR distress since in each internal fracture of concrete creates an empty space that the alkali silica reactions cause corresponding increase in volume. The resulting visual evidence of the reaction is observed on the concrete surface.

**Delayed ettringite formation (DEF)**

ASR is an example of chemical reaction in which aggregate portion of the concrete plays a role in deterioration of mechanism. Reactions related to sulphates are a group of reactions that involve only the cement paste. Delayed ettringite formation (DEF) reactions that are associated with concrete exposure to high temperatures during curing.

In DEF affected concrete, the aluminate ferrite tri substituted (Aft) phase or ettringite is usually observed. But ettringite in concrete is not unique to DEF. Ettringite is normal
Figure 4: SEM of calcium sulphoaluminate

hydration product formed by the chemical reaction between aluminates of cement, water and calcium sulphate (gypsum). The formation of ettringite takes place in the paste and is uniformly distributed. Within mature concrete exposed to moist conditions, ettringite is usually found in pores and cracks. This is not indication of damage but rather the result of a normal recrystallization process known as “Oswald ripening”. This means small crystals have higher solubility than large crystals, when concrete becomes water saturated to contain degree the smaller crystals within the paste dissolves in the pore liquid and subsequently recrystallizes as large crystals in any available spaces such as cracks and pores. Oswald ripening is a general chemical principle and calcium hydroxide crystallization behaves in a similar fashion. Regarding DEF, a high concrete temperature at an early age is very important parameter. At certain temperatures generally above 70°C and more frequently above 80°C ettringite becomes unstable because its solubility increases. This temperature is strongly dependant upon the alkali content and other compositional factors of cement that are less understood. Where the components of ettringite go after its decomposition is not clear. Portion of ettringite may be consumed by the C-S-H or may stay in solution. This issue is of great interest for further research. One sign of paste expansion is the presence of voids or cracks around the aggregate particles. Usually, ettringite fills these gaps. Above certain temperatures ettringite is unstable and the primary hydrated aluminates phase is calcium mono sulphoaluminate (Afm).

Therefore, after cooling to room temperature following heat treatment, concrete will contain anhydrous aluminates particles with Afm and Afm phases. During the passage of time and moist curing of such concrete these particles will continue to react with sulphate in pore solution. Both ettringite and Afm phases form depending upon the composition of pore solution. The sulphate liberated from the C-S-H that initially absorbed it during heat treatment maintains the sulphate concentration of pore solution. The hardened paste confines the reacting particles and the volumes of mono sulpho aluminate (Afm) and ettringite formed will result in development of localized pressure. Crystals under pressure will have higher solubility than crystals were not under pressure. When more and more Afm phases are formed on the reacting particles, the pressure will act locally on the particles, the pressure will act locally on the particle and surroundings. In this way reacting particles can act as a local pressure center. This will cause stress to build up in surrounding paste as sort of “sphere influence” around the particle. If pressure created is larger than the tensile strength of the paste, the paste will create or yield. If reacting particles are close to each other mass volumetric expansion will result.

Conclusion

Chemistry is very important because concrete composition and performance are based on variety of chemical reactions that ranges from the original setting and hardening of Portland cement constituent to the ultimately desired engineering properties. The durability of concrete depends on chemical processes developing out of cement and aggregate compositional factor, curing conditions, and exposure to a variety of environmental effects. The chemical reactions that occur during the hydration of chemical minerals determine the concrete microstructure. The hardened concrete is chemically reactive given the right conditions. Therefore, it is essential to design concrete mixes properly and erect structures in a way to control on chemical activity/corrosion.

About the Author

Dr. S. B. Hegde has more than 27 years of experience in Cement Manufacturing, R&D and Product Development with a proven track record in India and abroad. He has published 101 research papers in national and International journals, and there are 6 patents to his credit on cement processes and new cement formulations. He is presently working with Udaipur Cement Works Limited.
When we talk of Primers that are applied before the paint work, what comes to mind are the Acrylic Primers. However, since the last few years, White Cement-based Primers are gaining popularity amongst the construction fraternity due to their technical benefits.

Concrete surfaces whether of RCC or Plastered have micro pores. Applying the white cement-based primer over the surface before painting or before the final coating, brings many advantages as these pores get filled with the white cement’s fine particles present in the primer. As a result, the surface becomes more intact and less absorbent, and enables greater coverage of the paint when it is applied over it.

## Benefits of J.K’s White Cement & Polymer Modified Primers

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J.K. Cement’s White Cement and Polymer Modified Primers named as JK Primaxx are widely accepted by the contractors in the painting segment due to their features and technical advantages.

### Features
- Better adhesion & durability
- Better hiding or opacity
- No VOC (volatile organic compound)
- Eco-friendly
- Has anti-alkali & carbonation

### Benefits
- Better coverage
- Corrosion resistant
- Can be applied on damp/moist surfaces
- Forms a non-continuous film that prevents surfaces from peeling off.
- Easy to apply
- Resists weathering affect
- Gives UV protection.

The above problems are generally observed in Acrylic Primers due to their inability to give safe passage to air vapor to evaporate, whereas the JK Primaxx due to its cement content, allows vapour to pass such that no undue stress is developed on the top coat, making it an ideal prime coat or primer.
Saravanan Panneer Selvam, General Manager, Grundfos India, emphasises the need for energy-efficient products and solutions to address India’s water problems and believes that automation can help streamline the water processes, minimize redundancies, and reduce human intervention.

Over the past decades, we have augmented our R&D to improve our product performance, energy efficiency, and overall sustainability. We were one of the first companies to manufacture IoT integrated pumps, globally. Today, Grundfos India has over 250 distributors and dealers, 8 offices and many home offices across the country, that are addressing the country’s energy and water challenges, and catering to the requirements of the Indian market.

Grundfos India provides energy efficient pumps and smart pumping solutions for various applications – heating and hot water service systems, cooling and air-conditioning systems, industrial applications, pressure boosting and liquid transfer, groundwater supply, domestic water supply, sewage and wastewater in buildings, dosing, chlorination systems, disinfection systems, pumps running on renewable energy and meant for municipal water supply and wastewater.

What were the company’s key growth drivers following its inception in India 22 years ago?

Our journey in India started 22 years ago with a handful of employees, which have now grown to a team of more than 400 employees. The endeavour has been to actively help the country combat its water and energy challenges through innovative, sustainable and highly efficient solutions.

Our facility cum head office in Chennai, which was built in 2005, is India’s first commercial building to be certified by LEED as a gold rated green building; it recently received LEED’s Platinum certification due to its continuous focus on maintaining sustainable features and standards. Our second facility in Dantali, near Ahmedabad, was set up in 2017 to serve the western and northern regions of the country.
Our energy efficient products have been well accepted by every industry in the country, including the construction industry. In fact, a process or application that needs longer running hours for the pump will be an opportunity for such energy efficient solutions. Be it integrated IoT solutions, or the external ones, customers are looking for solutions that can bring down the operational cost and improve the overall efficiency. As a leader in such a technology, Grundfos products are providing the required solutions across various industries.

**What are the challenges?**

A key challenge is changing the mindset of the consumers by helping them understand the concept of ‘life cycle cost’ of the product they buy. For this, they must focus on the energy efficiency and reliability of the product over the duration of its life, rather than just considering its initial cost.

Another challenge is dealing with the influx of ‘copycats’ in the market. This is due to the highly fragmented nature of the Indian pump industry, and a large section of this industry is also unorganized. This is leading to low quality/inefficient pumps flooding the market. While these products are considerably cheaper, they do not match the reliability and operational efficiency of the originals.

It is critical to have energy efficiency ratings in place for pumps in India. For example, IE5 motors are the standard in Europe, while in India we largely use IE2 and IE3 motors. We have been promoting the adoption of energy efficiency pumps, and we urge our customers to understand the overall economics involved in water solutions, so that they make the right purchase decision for their water solutions.

**What recent innovations has the company brought to its products and solutions?**

Grundfos is owned by Poul Due Jensen Foundation; for 75 years, our relentless pursuit of bringing to the market superior quality products has been driven by our R&D. Since our businesses are operated with a sustainable mindset, the endeavour is to consistently innovate and manufacture pumps that give increased energy efficiency and reliability. Our products have helped our customers reduce their impact on the environment by optimally consuming water and energy, while our people-centric policies add value (that go beyond business transactions) to our customers, distributors, and other stakeholders in the value chain.

We had planned a couple of launches this year, but due to the current situation we will take a call towards the end of the year or early next year.

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To what extent has Grundfos localized its global solutions for the Indian market?

To address the Indian market and increase our competitiveness we have localized our global solutions to some extent. This has enabled us to reduce the lead times such that our solutions reach our customers and dealers quickly. On an average, our localization is currently a little less than 30% and we plan to increase it to about 80%. However, our Chennai facility has a higher level of localization than the rest of our operations.

The challenge in achieving this goal is primarily the availability of consistent quality for various components in the country. However, we have developed quite a few suppliers who have the same mindset of setting higher standards of quality for their offerings. We are in the process of developing many more vendors to create a sustainable supply chain in the coming years.

**What do you think should be the water priorities, post Covid-19?**

Covid-19 has had a negative impact on the ongoing water crisis. The extensive focus on hand washing to ‘flatten the curve’ could have serious implications, especially in rural areas with limited access to water. Currently, nearly 163 million people in India lack access to clean water. In the new normal, people who lack access to basic clean water and sanitation are at a higher risk of contracting the virus or associated diseases. It is important to prioritize the demand-supply gap in the post-Covid world and address it with the right solutions.

With the pandemic triggering rapid digital transformation, we are confident that automation and industry 4.0 technologies are going to become the key business drivers. Adoption of automation will streamline water processes, minimize redundancies, and reduce the need for frequent human intervention.

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A sset utilization, productivity, fuel consumption per unit of production, operator skills, and site supervisor efficiency are critical for any mining and construction business. But for any owner or CEO of a company, it is not possible to visit the project site frequently and watch how the operations are going on. For quite a long time it was the responsibility of people involved in the execution of the job at site and the project owner/CEO would depend on the feedback and reports given by the site supervisor on asset utilization, performance, fuel consumption etc. But due to various reasons there would be some gap between the ground reality and the information provided. This would lead to some unintentional errors, which would diminish the equipment’s life, and thereby, productivity.

Remote monitoring of asset operations and fleet management

A competitive business environment and government regulations on emission norms have been playing a critical role in continuous upgradation of technology in construction equipment. Remote monitoring of asset operations and fleet management is one such technology which has been of great help for customers in managing their fleet efficiently. People sitting in their office or even travelling can have access to their machines deployed at sites and see their location, their utilization, their fuel consumption, operator behaviour and performance, and the site supervisor’s execution abilities.

The present generation construction and mining machines are equipped with a device which can capture important data from the machines and transmit it to the owner’s mobile phone or computer through mobile or satellite services. This technology by several manufacturers goes by various names such as Product Link and Vision Link (Cat), Care Track (Volvo), Komtrax (Komatsu) and ConSite (Hitachi). It gives data on fuel consumption, asset utilization, idle running, travelling time of crawler machines, mode of operation (excavators), schedule maintenance adherence, and more. Data can be traced for any specified time and period and the status known at the time of access.

Fuel Consumption: Data on fuel consumption can be viewed for an individual machine, a set of machines, or a fleet of machines. The data provides information details with a clear breakup of working hours, idle run time, and overall performance. With this, machine owners can go through the fuel consumption per unit of production of every machine and know the efficiency of the machine operator. In case of considerable difference in fuel consumption, they can investigate possible causes like leakages, fuel system problem, errors in records, fuel theft etc., and the necessary remedial action can be taken. Expenses incurred in fuel consumption is 50 - 60% of the total operating cost, hence, any saving will have a great impact on the overall operating cost.

Idling time: This data gives the percentage of idle run of engine over the total number of work hours. Excessive idling can cause injector dribbling, fuel mixing with lube oil (loss of viscosity), early wear of bearings, release of harmful emissions, wastage of fuel, and even early repairs of the engine. Every litre of diesel burned will release approximately 2.7 kg of CO₂ into the

Fleet Management Through Remote Monitoring

Equipment users need to utilize remote monitoring facility at project sites and get regular reports on the machine’s operations to find out areas that need improvement in order to minimize operating cost and increase productivity, advises Bhaskarudu Peddakotla.
Remote Monitoring

Remote Monitoring

atmosphere. Long idling of engine leads to inadequate burning of fuel leading to harmful emissions.

Travelling hours: A hydraulic excavator is designed mainly for material excavation and loading jobs. The crawling mechanism in the machine is used for moving it as the work progresses, or to move it for short distances at the site. An excavator cannot be used like a payloader by shifting it frequently since its undercarriage and final drives are designed for limited and slow speed travel. Excessive or high-speed travelling will lead to early wear and tear of the undercarriage parts and of the final drive gears, leading to increase in operating cost and more downtimes of the machines.

Nowadays, some quarry owners are using custom-made heavy-duty axles fitted with tires for shifting excavators within the same quarry to protect the undercarriage components. The recommended travel hours of a hydraulic excavator are <16%, but it has been noticed that in some jobsites, the crawling hours are as high as 35% of the total run hours. Data obtained through reports helps in identifying the time and the operator responsible and based on this information the owner can take corrective action to reduce the travelling time of his machines.

Mode of operation: Excavators are now provided with multiple modes of operation to facilitate the operator to select the most appropriate mode based on the working conditions at the project site. Mode selection is done through a switch in the operator’s cabin to keep the engine’s RPM at a specified range. But many operators operate the machine at a high RPM under a misconception that a higher RPM will give higher production. This is incorrect since the engine’s torque is also critical during excavating and loading. The torque curve of a diesel engine rises to a certain RPM but starts declining after crossing it. This needs to be explained to the operator so that they can select the most appropriate mode of operation, and thereby also save 6 to 8% of fuel without compromising on the machine’s productivity.

Asset utilization: This is information provided about the available hours and actual run hours of individual machine and total fleet plus the time when the machine was off or on. This report helps in finding reasons behind the machine’s poor utilization, frequent breakdowns, long downtime, excess machine (s) at site, etc. Based on the information, the owner can look for solutions like spare parts planning, trimming the fleet size, discussing the issues with the manufacturer, taking decisions on scrapping the machine, and so on.

Scheduled maintenance: Some machines have the option to monitoring whether the project team is doing the maintenance, such as oil and filter change, as per the specified interval or is the team delaying it. Scheduled maintenance is critical for the desired life of the machines, since any delay in maintenance will lead to premature wear of the assemblies, resulting in machine downtime and expensive repairs.

Asset location: Location can be seen live at any point of time and the owner can also opt for geo fencing. This is mainly useful for fleet deployed on rent. One can see if the machine is working in its designated area or is out of the area.

Operation data can be seen with clear time and date in all the incidents and cannot be hidden by the operators or site supervisors. This data helps in identifying gaps in operator and maintenance team such that the owner can initiate training of the team for efficient operating and maintenance practices.

Case studies of improved operating practices due to remote monitoring

Fuel savings in excavators by running in appropriate mode: In a quarry where 15 excavators of 1.6 Cu. Mtr were deployed, the operators used to run the machines in H mode i.e high RPM mode for >60% of the time, keeping the idle run @22%. The actual suggested mode is G which is 200 RPM less than H mode. Operators and supervisors were under the assumption that with G mode they will not get the required productivity. After giving classroom and field training and monitoring the mode of operation versus productivity, they realised that G mode is appropriate, and the H mode is to be used only in exceptional conditions. It was noticed that the machine was operated in G mode to the extent of 65%, H mode 10%, Idle 20% and the resultant reduction in fuel consumption was approx. 2 litres per hour in all the 15 excavators. This amounted to ₹67 lakhs per year (15 machines x 3000 hrs per year x 2 ltr x ₹75/- per ltr). Imagine the saving if the fleet is large and the size of the machine is bigger.

Excessive crawling of excavators: Based on data, when enquired about the reasons behind excess travel (which was 25 to 35%), the operators said that the machines are being used for shifting some material in the quarry, plus there was unplanned blasting, frequent changes of working face etc. This was controlled with some discipline, team coordination, and pre-planning of the work.

Excessive idle run of machines: Operators revealed silly reasons like usage of trucks and excavators for lighting purpose, long waiting at loading machines, starter motor issues, battery issues, etc. – all of which are avoidable. In a quarry, an 8.5 Cu mtr front end loader’s idle run was brought down from 43% to 20% over a period of two months through regular monitoring and counselling. In same sites, the idle run in dump trucks was brought down by 8% over one month.

It is worthwhile for customers to use this remote monitoring facility by paying a nominal subscription fee. At the same time, the service providers must also explain the benefits and train the field team in optimum use of the monitoring technology. In fact, the real value addition that the service provider brings is by making the customer understand all the features in the machine and how to use them for better productivity and reduced cost of operation. The payback will be customer loyalty.
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