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**Ahluwalia bags ₹1,193-cr construction contracts**
Adding to its project portfolio, Ahluwalia Contracts (India) has bagged contracts worth ₹1,193 crore in the construction and allied sectors, including an electrical segment on EPC basis at K G Marg and Africa Avenue in Sarojini Nagar area.

**Bengaluru wins ₹9,771-cr infrastructure booster**
The Karnataka government has announced allocation of ₹9,771 crore for multiple infrastructure projects in and around the Bengaluru city. Out of the total allocation, ₹8,772 crore has been earmarked for overall development and ₹999 crore for solid waste management.

**UP kicks starts ₹2,821-cr infra projects in NCR**
In a major boost to infrastructure building on the outskirts of the national capital, the UP CM has launched 23 development projects involving an investment of ₹2,821 crore. The projects include 13 projects such as a flyover hospital and a parking lot in Gautam Buddh Nagar entailing an investment of ₹1,300 crore.

**World Bank infusing $70-mn in waterways**
The World Bank is set to provide a grant of $70 million to develop India’s under-utilized network of rivers and canals as an alternative mode of transport in response to the shipping ministry's proposal for technical assistance grant from the Bank to build a transport connectivity and grid linking waterways in eastern region with its South Asian neighbors.

**TN takes up ₹413-cr urban infra projects**
The Tamil Nadu government has announced underground drainage projects worth ₹413 crore for Coimbatore and Trichy municipal corporations, said municipal administration minister, S P Velumani. He informed that ₹175 crore has been allotted for Coimbatore to complete 153 km of underground drainage system and also ₹238 crore for Trichy city under the smart city funds.

**Meghalaya gets $300-mn foreign funded MITP**
The state cabinet has decided to build Meghalaya Integrated Transport Project (MITP) under the externally aided project of the Central government to improve connectivity in the state. Union finance ministry has already approved the project worth $300 million sought in two phases of 150 million USD each.

**Konkan & Pune secure ₹24,157-cr infra infusion**
The Maharashtra government has allocated ₹24,157 crore for projects like marine highway in Raigad, Ratnagiri and Sindhudurg districts of Konkan region and outlays for expansion of the Pune Metro network and has proposed an economic corridor in Satara district.

**Aurangabad roads get ₹152-cr booster**
The state government has cleared ₹152-cr for development of roads within the municipal limit. State Urban Development Minister Eknath Shinde said that the government has sanctioned ₹152 crore of the total amount worth ₹263 crore sought for the purpose, and that the Aurangabad Municipal Corporation, Maharashtra Industrial Development Corporation and Maharashtra State Road Transport Corporation will jointly carry out the construction work.
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CCEA clears ₹7,662-cr cross-country highways
The CCEA, chaired by PM has given approval for rehabilitation and upgrading of two-lane roads into four lanes with a length of over 780 km in states like Rajasthan, Uttar Pradesh, Andhra Pradesh and Himachal Pradesh. The projects involve an investment of ₹7,662.47 crore which includes a loan component of ₹3,500 crore.

Adani Group bags ₹1,546-cr road & highway projects
The Adani Enterprises-led consortium has received a letter of award (LOA) for road contracts from NHAI involving an investment of ₹1,546.31 crore. With the newest cache the Group has a total of four road projects under Hybrid Annuity Model (HAM) spanning across states like Chhattisgarh, Telangana and Andhra Pradesh.

UP pushes ₹36,000-cr Ganga Expressways
The Uttar Pradesh government has fast tracked 628 km long Ganga Expressway project involving an investment of ₹36,000 crore. It will link 12 districts in Prayagraj (Allahabad) and Meerut districts crisscrossing Amroha, Bulandshahar, Badaun, Shahjahanpur, Farrukhabad, Hardoi, Kannauj, Unnao, Rae Bareli and Pratagarh.

Maharashtra steers 150-km A’gabad-Jalgaon road project
Travelers will soon have a smooth ride to the world famous Ajanta Caves in Maharashtra as the work of four-laning of the 150-km Aurangabad-Jalgaon highway has been fast tracked. One side carriageway will be completed shortly and the entire work is slated to be completed by the end of this year, said Public Works Department executive engineer Jayant Chivane.

PM kicks starts ₹15,000-cr Bundelkhand expressway in UP
The Prime Minister has laid the foundation stone of 296-km Bundelkhand Expressway in Chitrakoot district of Uttar Pradesh. With the commissioning of this ₹15000 crore project together with a UP Defence Corridor also in Bundelkhand area, the socio-economic landscape of the entire region is set to be transformed.

Govt. commits 37,571-km road network in North East
The central government has targeted to build a 37,571-km road network connecting all the capitals of the north eastern states. Under the northeast rapid road scheme, a total of 711 km will be constructed in Arunachal Pradesh; a 1,560-km trans-Arunachal Pradesh road would reach Tawang in the west near the Bhutan border, besides building the 2,000 km Arunachal Frontier Highway.

Karnataka cracks road infra projects worth ₹13,600-cr
The Karnataka government will build four cloverleaf interchanges, six flyovers and five underpasses on a 65-km stretch of Peripheral Ring Road proposed between Tumkur and Hosur Road. As per the pre-feasibility report, the ₹13,600-crore project comprising eight-lane right of way (RoW) is being designed to complete the NICE Road on the outskirts of the city.

NHAI unveils ₹10,520-cr highway in Bengaluru
NHAI has speeded up the second phase of the Bengaluru-Mysuru expressway, which will be widened from the current four-lanes to a six-lane access controlled stretch along with two-lane service roads on either side. The ₹7,400 crore project is being built along with the proposed 10-lane Bengaluru-Mysuru Highway at an investment of ₹3,120 crore.

MSRDC pushes ₹1,222-cr Sion-Panvel highway widening
In a bid to decongest the Sion-Panvel Highway, the Maharashtra State Road Development Corporation has chalked out a plan to develop a six-lane elevated road between Kharghar and Turbhe in Navi Mumbai at an investment of ₹1,222 crore. MSRDC is sending the project to the state government for final approval.
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Himachal gets two greenfield highways worth ₹2,700-cr

The Union Government has approved upgradation of two roads at a cost of ₹2,700 crore under the Green National Highway corridor projects, which will restrict carbon emissions and contain ecological disasters using Japanese technology. The roads are Hamirpur-Mandi via Sarkaghat-Kotli (105 km) and Paonta Sahib-Shillai-Gumma (109 km). The two stretches measuring almost 214 km will enhance the length of double-lane roads to 2,600 km, said department Officer, Vipnesh Sharma.

Karnataka shortens ₹2,061-cr Salem-Bengaluru highway

The Karnataka government has decided to shorten the route of Salem-Bengaluru highway to facilitate travelers to reach Bengaluru faster while commuting on NH 844. According to sources, the project will cost ₹2,061 crore and will involve construction of a new route via Rajakottai and Palacode, thereby shortening the distance to Bengaluru by 25 km.

AP floating tenders for ₹1,550-cr highway project

The Andhra Pradesh government is floating tenders for the first phase of the Rajahmundry-Vizianagaram highway covering a stretch of 410 km and is being built through Visakhapatnam and East Godavari’s Agency areas at an investment of ₹1,550 crore.

MoRTH approves six-lane Nashik-Pune Highway project

The Union Transport Minister has recently approved construction of the six-lane Nashik-Pune national highway. Once completed, commuters to Chakan, Maharashtra Industrial Development Corporation (MIDC) via Chandani chowk and Nashik road will be benefitted to a great extent.

Plans afoot to connect KMP and Delhi-Mumbai e-ways

NHAI has decided to build an interchange to connect the Kundli-Manesar-Palwal (KMP) Expressway with the Delhi-Vadodara-Mumbai Expressway at a cross-section of Sohna, Palwal, Manesar and Nuh. This will be a loop interchange that will connect both expressways and will be build after a new toll plaza comes up in Palwal.

NEC takes up ₹189-cr Tuensang-Longleng road project

North Eastern Council (NEC) has launched the much-awaited construction and rehabilitation work on the Tuensang-Longleng road under the North East Road Sector Development Scheme (NERSDS) at Nagalampong Zero Point Longleng at an investment of ₹189 crore, informed state minister S. PangnyuPhom. The 51-km road is considered to be the oldest PWD road in Nagaland constructed in the year 1950.

Puducherry gets ₹2,185-cr contract on HAM model

In a major boost to road infrastructure in the Union Territory, Centre has approved road and highways development projects worth ₹2,185 crore for Puducherry. The state’s CM V Narayanasamy informed that Transport Minister Nitin Gadkari during his recent visit to the area had approved these developmental projects.

Sekura Roads highest bidder for ₹1,428-cr IL&FS projects

Edelweiss-backed Sekura Roads has been declared the highest bidder for two IL&FS road projects with a combined bid value of ₹1,428 crore and a haircut of 22 percent to the lenders. Both the projects, Jharkhand Infrastructure Implementation Company with bid value ₹512 crore and Jorabat Shillong Expressway with a value of ₹916 crore have a total debt of ₹1,834 crore.

NHA offers sops for builders in BOT road projects

In a bid to attract private investors and builders to take up road projects under Build-Operate-Transfer (BOT) model, NHAI has announced steps including a policy of one-time fund infusion to complete the projects, policy of deferment of premium for financial stressed projects, and provision of harmonious substitution for Special Purpose Vehicle (SPV) in consultation with lenders and concessionaire, with certain riders.

Maharashtra plans 500-km long greenfield e-way

The state government has proposed to construct a 500-km greenfield expressway along the Konkan coastline connecting Nhava Sheva in Raigad district with the border of Maharashtra and Goa, informed urban development minister, Eknath Shinde. MSRDC is conducting a technical and financial feasibility study of the project.

PNC Infratech wins ₹1,602-cr contract on HAM model

PNC Infratech has stated that it has received Letter of Award (LoA) from National Highways Authority of India (NHAI) for a Hybrid Annuity Model (HAM) project worth ₹1,602 crore. The project involves rehabilitation and up-gradation from 2 lanes to 4 lanes of the National Highway (NH) stretch under NHDP-IVB (BharatmalaPariyojana) for Unnao-Lalganj section of new NH-31 (old NH-232A), on HAM model in UP. The project is to be completed in 30 months.

Arunachal launches Trans Arunachal Highway project

The Arunachal Pradesh government has launched construction work on the Trans Arunachal Highway (TAH). State Home Minister Bamang Felix informed that the Potin-Pangin stretch of the highway will become operational after nearly 12 years of wait.
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NFR steer clears ₹5,021-cr rail line in Mizoram
The Northeast Frontier Railway (NFR) has speeded up construction work on the 51-km long Bairabi-Sairang new rail line. The ₹5,021.45 crore project will inject a massive booster to rail connectivity as it will connect Mizoram to the Indian Railways network up to Bairabi railway station, a gateway to the state, said Railway Board Chairman, Vinod Kumar Yadav.

Decks cleared for 72-km Bangalore Metro extension
Decks have been cleared for the 72-km extension of the Bangalore Metro Rail project with the BMRCL’s acquisition of 33 religious places for construction of the planned Phase-II project on six stretches across the city, said Special Land Acquisition Officer at BMRCL, Channappa Gowdar, who informed that a majority of the land housed temples which will be demolished and rebuilt.

Railway launches ₹13,809-cr Jiribam-Imphal rail line
The North-East region is set for a major infrastructure boost with the Jiribam-Imphal railway line being fast tracked. The ₹13,809 crore line declared as a national project was taken up in the year 2008 but has remained in limbo. Recently, the Railway Minister had declared that the last Open Web Girder of Bridge Number 44, first-ever over 100 metres tall Pier Bridge of the new line was launched successfully.

HMRPL unveils Tirupati-Tirumala monorail project
The Hyderabad Metro Rail Project has decided to build monorail line connecting the two religious placed. The project is based on a proposal sent by TTD Board Chairman YV Subba Reddy to the managing director of Hyderabad Metro Rail Project NVS Reddy, and his team is currently studying the scope of setting up a monorail or light metro rail option; the report is expected to be submitted soon.

IRSDC to start upgradation of ₹270-cr Bijwasan rail station
IRSDC is set to start redevelopment of the Bijwasan railway station in Delhi into a global-standard transport hub at an investment of ₹270 crore on engineering, procurement and construction (EPC) model.

AAI takes ECB route to fund ₹25,000-cr airport infra
In a bid to ensure smooth funding flow for capacity expansion of airport infrastructure across the country, the Airports Authority of India (AAI) has decided to raise $300 million through External Commercial Borrowing (ECB) for the proposed five-year outlay worth ₹25,000 crore starting this year, said chairman Arvind Singh, adding that the AAI board has already given the green signal for the move. The airport authority aims to spend a minimum of ₹5,000 crore each year on the infrastructure in line with the government’s announcement of building 100 new airports in five years in addition to the 48 airports newly made operational in the past four years.

NCLAT approves ₹650-cr Adani’s bid for Dighi Port
In an attempt to bail out the debt-ridden Dighi Port located south of Mumbai, the National Company Law Appellate Tribunal (NCLAT) has approved ₹650-crore resolution plan submitted by Adani Ports & Special Economic Zone (APSEZ). The resolution came with a huge 79.2 percent haircut to the lenders.

BIAL inviting bids for KIA airport project in Bengaluru
Upgradation of the first runway at the Kempegowda International Airport (KIA) is set to start shortly as Bengaluru International Airport Limited (BIAL) is inviting bids to execute the project. Runway RWY 09L/27R or the North Runway of KIA is being upgraded from CAT I to CAT III and BIAL has issued a Request for Proposal to appoint a contractor for the installation, testing and commissioning of Cat-III AGL system for North Runway (09L-27R) and associated taxiways at KIA.
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The Centre has given approval for an elevated expressway connecting Delhi with Dehradun, which will shrink distance from 250-km to 180 km, at an investment of ₹8,080 crore. The NHAI chairman S S Sandhu said that the elevated road will reduce travel time to two and a half hours from the current six hours.

MahaMetro has begun construction of one of the most ambitious segments of its projects, which includes the development of flyover and Metro route over the existing road and railway line at Kamptee Road. The first of its kind structure will create a 4 layer transportation mechanism at Gaddigodam, Kamptee Roor which the Central Railway has recently approved.

MahaMetro has initiated construction work on another underground metro corridor connecting CSIA Airport with Line 7A line between Western Express Highway (WEH), Andheri, and Dahisar east. The 3.1-km corridor 7A will have an underground stretch of 2.1 km as there will be a twin tunnel. The contractor will be using the cut-and-cover method whereby the stretch of road will be dug up and then reinstated after work is completed.

The Centre has agreed to the construction of an elevated expressway connecting Delhi with Dehradun, which will cut the distance from 250 km to 180 km, at an investment of ₹8,080 crore. The NHAI chairman S S Sandhu said that the elevated road would reduce travel time to two and a half hours from the current six hours.

The MSRDC has planned an elevated sea-link project along the upcoming Bandra-Versova sea link up to Virar, via Charkop and Vasai from a km into the sea, instead of building it along the coast. The construction cost of the project is pegged at ₹21,000 crore. The eight-lane 57.8-km link will reduce travel time by one-and-a-half hours during peak hours, besides being eco-friendly, said MD, MRSDC, RadhyeshamMopalwar.

The state PWD is building a ₹1,800 crore elevated rail corridor from Sarda Circle to Datta Mandir Chowk in Nashik region of Maharashtra. The Nashik unit of NHAI, which was to prepare the DRP and implement the project, has directed the state PWD (NH) to take over the project as the department is under the state government, but has to get the nod from MoRTH as funding for all projects comes from the ministry.

The MSRTC has approved the much-awaited Kharagpur-Turbe connectivity project comprising an elevated road and tunnel entailing an investment of ₹1,222 crore, said official sources, adding that a detailed project report (DPR) will be prepared and tenders will be floated shortly. Out of the total cost, ₹300 crore will be contributed by CIDCO, ₹150 crore by MIDC and MSRTC each, and the remaining ₹622 crore will be borrowed.

The MSRDC is currently building Mumbai-Nagpur SamruddhiMahamarg aimed at reducing travel time between the two cities to eight hours from the current 16-hours. As many as 1,699 structures including bridges, flyovers, rail-over bridges, tunnels and interchanges are being constructed along the corridor.

The Delhi Metro Rail Corporation (DMRC) is set to launch construction work on a bridge on the Yamuna under Phase IV, connecting the existing two bridges on Yamuna — Wazirabad Bridge and the Signature Bridge. Delhi Metro will construct a 560m-long bridge on River Yamuna on the Majlis Park – Maujpur corridor of Phase IV, informed spokesperson of DMRC, Anuj Dayal.

The Karnataka government has announced the construction of a new bridge between Indiranagar and Medahalli in the KR Puram constituency area in Bangalore at an investment of ₹200 crore. The distance between the two points is 12 km and the bridge will go a long way in solving and streamlining the traffic related problems.
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**Real Estate**

**MSRDC floats tenders for ₹2,940-cr Sea-Bridge**

The Maharashtra State Road Development Corporation (MSRDC) has floated tenders for construction of the Rajiv Gandhi Sea Link Bridge in Mumbai involving an investment of ₹2,940 crore, said an official spokesperson of the road building agency. The scope of work envisages developing, maintaining and operating (along with tolling rights and obligations) the bridge on design, build, finance, operate and transfer (DBFOT) model for a period commencing from 24 March 2010 and expiring on 31 March 2052.

**GMDA to connect NH-8 with MG Road via underpass**

Shortly after concerns were raised by environmentalists over a proposed road through the Aravali Biodiversity Park, DLF together with the Gurgaon metro development authority has proposed to connect the NH-8 with MG Road by building an underpass beneath the park. Vice-Chairman, DLF, Rajiv Singh, suggested that the possibility of connecting NH-8 and MG Road beneath the biodiversity park is being explored.

**NBCC set to start ₹32,000-cr project in Delhi**

NBCC is set to start construction work on the 8 million sq ft commercial space in South Delhi’s Nauroji Nagar and Sarojini Nagar entailing an investment of ₹32,000 crore with the Delhi High Court vacating the stay on construction of a commercial hub in the heart of the national capital. The company has started the process of sale of commercial space and is expected to complete the work within three years. The government had announced redevelopment of seven housing colonies in Delhi, of which three — Nauroji Nagar, Netaji Nagar and Sarojini Nagar — were assigned to NBCC.

**NABARD delivers ₹400-cr infra booster in J&K**

National Bank for Agriculture and Rural Development (NABARD) has sanctioned ₹400.64 crore for the current fiscal for J&K. The funding is a part of the NABARD’s Rural Infrastructure Development Fund (RIDF) - Trench XXV; which aims at augmenting rural infrastructure. Prior to this, the Bank had sanctioned ₹209.87 crore for construction of 82 rural roads and 03 bridges. A road of 291 km will be constructed, benefiting 9.15 lakh people in 19 districts in J&K.

**Telangana targets ₹11,917-cr low-cost housing units**

In a big boost to the housing sector, the Telanaga government has allocated ₹11,917 crore to build low-cost housing units across the state during the new fiscal, said state CM in an official statement, adding that with this six-year long wait, the dream to own a housing unit will be materialized.

**L&T & DB Realty in JV plan 1.4-mn sq ft residential projec:**

Larson & Toubro’s real estate development arm, L&T Realty, is forming an alliance with DB Realty to jointly develop over 1.4 million sq ft residential project in Mumbai’s western suburb Malad, said sources, adding that the project will be developed on DB Realty’s 8-acre land parcel in Dindoshi locality of Malad wherein L&T Realty and its partner will share space developed in 60:40 ratio.

**MMRDA unveils skyscrapers at BKC complex**

The Mumbai Metropolitan Region Development Authority (MMRDA) has unveiled a long term plan for the integrated redevelopment of Bandra Kurla Complex (BKC) starting with E Block; the entire region will have buildings with heights up to 80 metres and housing about 25-30 storeys each. The plan includes redevelopment of buildings into skyscrapers and connecting them with elevated walkways; gardens at podium levels, sky gardens, improved recreational facilities, a pedestrian plaza and a pedestrian bridge across the Mithi River.

**MSRDC floats tenders for ₹2,940-cr Sea-Bridge**

**TCS & DLF plan ₹3,954-cr SEZ projects in NCR**

Software major TCS and realty building giant DLF are set to set up SEZ projects for IT sector in Haryana and Uttar Pradesh and have sought governments’ nod to go ahead with the projects. TCS has proposed to set up an IT/ITeS SEZ at Noida in Uttar Pradesh on an area of 19.9 hectares at an investment of ₹2,433.72 crore.

**Telangana targets ₹11,917-cr low-cost housing units**

**MMRDA unveils skyscrapers at BKC complex**
AMMANN ABC ECOTEC ASPHALT-MIXING PLANT

How does Ammann help asphalt-mixing plant owners turn a profit?

It starts by offering plants at a low acquisition price – and continues by incorporating technology that minimises costs after the purchase.

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• A state-of-the-art, intuitive control system shrinks fuel and aggregate usage. It also boosts quality by reducing operating error and ensuring strict adherence to recipes.

Asphalt-mixing plant owners get all this and more with ABC EcoTec – and at an amazingly affordable acquisition price.
Equipment News

The Machine Finishing Facility of WIRTGEN INDIA Pune plant was inaugurated on 20th Feb. 2020, by Domenic Ruccolo, Chairman & CEO-WIRTGEN GROUP, and Ramesh Palagiri – MD & CEO-Wirtgen India, in the presence of its customers, vendors and business partners. The state of the art facility consists of high pressure washing space for machines as big as a screen, 1000 lux level lighting and Downdraft type booth design with very specific air velocity, to provide best machine finish and a safe working environment for painters. The event also included seminars on new technologies in road building and road rehabilitation, exhibits of Wirtgen machines, and a live demonstration of CTSB paving.

Wienerberger announces ₹30 crore investment in its Kunigal factory

Wienerberger AG, the €3.3 bn global player in the construction sector, will invest ₹30 crore in its Kunigal factory, located in the Tumkur district of Karnataka. The investment is aimed at proactively reduce carbon emission by switching to natural gas as a fuel, enhancing production capacity by 25% & launch of new product solutions. In fact, 95% of the existing factory electricity requirement is already being met through renewable energy.

The announcement was made by Christof Domenig, CEO, Wienerberger Building Solutions, Wienerberger AG, on the company 200th anniversary and the 10th anniversary of operating in India, at Wienerberger’s factory in Kunigal. The new investment will enable the company to support its expansion plans including an upgrade and an implementation of new equipment in the factory, converting to natural gas as a fuel and launch of new building solutions that will enable construction practises to be simplified and faster with less resource consumption. Globally, the 200 years old company boasts of building over 180,000 houses, covering 290,000 roofs, laying 745,000 km pipes, and paving 17,000,000 m² surfaces in 2018 alone.

Managing Director, Wienerberger India, Monnanda Appaiah, said, “Among others, the company is also constantly looking at new growth opportunities in the Indian market including the launch of new sustainable and future-ready solutions for construction. In the last 10 years, despite volatility in real estate market, our plant has always run full capacity and this is itself a proof of the value that our solutions bring to our customers. With the ₹30 crore investments we will also be upgrading our machinery and will install new equipment with the latest technology to enable us to scale up production by up to 25%. The products manufactured in Kunigal offer significant technical advantages over conventional walling materials, apart from being environmentally friendly and cost effective.”
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JCB achieves yet another milestone by rolling out 750,000th Backhoe loader

JCB celebrated a unique milestone as its 750,000th backhoe loader rolled out of its production line. The landmark machine was driven off the line at the company’s factory in Rocester, Staffordshire – the very location where the first JCB backhoe was manufactured about 70 years ago. It was in 1953 that company founder, the late Joseph Cyril Bamford CBE, conceived the idea of the JCB backhoe loader, which created, for the first time, a single machine which combined a front shovel and rear excavator arm. In its first full year of production in 1954, just 35 of the machines were produced and it took more than 20 years for the first 50,000 to be made. JCB now manufactures backhoe loaders in UK, India, Brazil and USA.

Commenting on the milestone achievement, JCB Chairman Lord Bamford said, “Some of my earliest childhood memories are of watching our first backhoe loaders being produced at Rocester and it’s incredible to think we have now manufactured 750,000. What’s even more incredible is that the backhoe remains one of the world’s most popular construction equipment, almost seven decades after the first machine was produced. It really is testament to the versatility of the machine that its popularity continues to endure and will see it continue to prosper in the future.”

The 750,000th model is a special edition of JCB’s latest 3CX backhoe loader, bearing a unique livery and comprehensive specification. Despite its maturity, the backhoe loader remains hugely popular in terms of global construction equipment sales – even though new and competitive products have evolved over the past 67 years. JCB’s iconic backhoe is the biggest selling in the world – and has been for 19 consecutive years. Speaking on the occasion Subir Kumar Chowdhury, Managing Director and CEO of JCB India said “JCB introduced the Backhoe Loader in India four decades ago. Today, it is visible at almost every worksite in metros, towns, and villages, working tirelessly towards building a new India. JCB Backhoe Loaders have made a significant impact in the country, with the machine becoming almost synonymous with infrastructure development.” The latest backhoe production milestone comes after JCB celebrated the manufacture of its 500,000th backhoe in December 2012 – a 5CX, the most powerful commercially available backhoe JCB has ever made.

Ingersoll Rand launches energy efficient MSG® Turbo-Air® 2000 Centrifugal Compressor

Ingersoll Rand, a world leader in creating comfortable, sustainable and efficient environments announced the launch of its new generation of MSG® Turbo-Air® 2000 Centrifugal Compressor for the Indian market. MSG® TURBO-AIR® 2000 has the capability to cater flow capacity from 505 CFM to 1700 CFM with pressure range from 3.5 Barg to 10 Barg. A three-stage compression makes it the best-in-class and the most efficient compressor of its range. The compressor will be packaged locally from the company’s Naroda manufacturing facility in Gujarat and will allow companies across sectors such as manufacturing, pharmaceuticals, food & beverages, textiles, automotive, agriculture, power, etc to achieve improved operating efficiencies with up to 20% energy savings and reduced operating life-cycle costs.

Chairman & Managing Director, Ingersoll Rand India, Amar Kaul, said “Currently, Indian businesses are increasingly looking at improved output while keeping the cost and environmental impact in control. Turbo-Air 2000 has been designed to cater to all these concerns while ensuring ease of operations and high reliability attached with Ingersoll Rand products. With the packaging done locally from our Naroda plant, we are hopeful that we will be able to further enhance our customers’ experience.”

Getac launches tablet for logistic & field professionals

Getac has launched ZX70 G2, a fully rugged, highly portable tablet to boost productivity and decrease downtime for mobile field professionals in the utilities, manufacturing and transport & logistics (T&L) sectors. The ZX70 G2 builds on the proven track record of Getac’s popular ZX70 tablet, bringing design, next generation connectivity and powerful computing performance in a lightweight and compact design.

Rajiv Chaturvedi joins Hyundai CE India

Hyundai Construction Equipment India has appointed Rajiv Chaturvedi as Vice President Sales, Marketing, After-Service and Parts. His scope of work in India also includes Nepal, Bhutan and Sri Lanka. Prior to this, he was working with Tata Hitachi Construction Machinery. He brings with him over 26 years of experience in sales, marketing and allied functions, beside which his career spans various areas such as channel management and dealer development. He has worked as national vertical head in a mining business; even winning a prestigious award, along with his team, from Hitachi Construction Machinery (HCM), for improving the mining business in India.
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CLOSE TO OUR CUSTOMERS
Kubota Corporation to invest in Escorts Limited

Kubota Corporation, a leading global tractor and machinery manufacturer of Japan, will acquire 10% equity stake on a post capital reduction basis, in Escorts Ltd - a leading engineering conglomerate in India. This move will further integrate and deepen their relationship towards achieving their mutual ambition of global leadership. On completion of the transaction, Escorts and Kubota will partner to become a leading player in the Indian market and a hub of product development, manufacturing and sourcing for global markets.

Key Transaction Highlights

- Escorts will issue and allot 12,257,688 equity shares through a preferential issue to Kubota at an issue price of Rs. 850 per equity share, subject to shareholders’ and necessary regulatory approvals. Kubota’s investment will constitute 9.1% of the equity stake on a pre capital reduction or 10% on a post capital reduction basis for a total investment of Rs 10,419,034,800. This price represents a premium of approx. 48.21% over the last traded price on March 19, 2020.

- The Board of Directors of Escorts has given in-principle approval to consider a reduction of 12,257,688 equity shares held by the Escorts Benefit and Welfare Trust, subject to receipt of necessary approvals and upon completion of the preferential allotment to Kubota. This shall ensure that the total equity share capital of Escorts remains unchanged.

- Simultaneously with the Preferential Issue, Escorts will acquire 40% stake in Kubota Agricultural Machinery India Pvt. Ltd (KAI), the marketing and sales company of Kubota in India.

- The existing 60:40 Joint Venture between Kubota and Escorts, namely Escorts Kubota India Private Limited (EKI), will continue to operate.

Strategic Rationale

- This will be a win-win collaboration and benefit Escorts with product innovation through indigenization of global R&D, production systems excellence, global supply chain, sales and distribution, and act as a global sourcing hub for Kubota.

- Kubota will have assured supply of cost-effective products in and for India, joint product development for emerging and global markets, and expansion of product range through respective distribution networks.

- New avenues of growth in construction equipment and agriculture implements, leveraging strengths of both the parties, with focus on products including earth moving equipment and smart agriculture implements.

- Create one of the largest Indo-Japan agriculture collaboration aligned to Indian government’s “make-in-India” vision, by integrating technological excellence and frugal innovation to provide latest farm mechanization solutions across the globe.

Nikhil Nanda, Chairman and Managing Director, Escorts Ltd., said, “At Escorts, we believe in strategic global partnership with an objective to address global farm mechanization needs. We are pleased to partner with Kubota to offer farmers with innovative solutions and thereby maximize productivity for profitable growth in domestic and export geographies. This collaboration aims at leveraging R&D strengths of Kubota to offer cutting-edge products for domestic and export markets, serving customers in new markets and new product lines. With our manufacturing expertise and strong domestic distribution combined with collaboration with Kubota, we aim to reach our objective of becoming the market leader in farm mechanization, and address the food security challenge.”

Yuichi Kitao, President and Representative Director, Kubota, Japan, said, “We are excited to make strategic investment in Escorts. It is a validation of our mutual commitment to offer best in class technology products for global markets and thereby enhance customer experience. Escorts has a strong technology legacy and diversified portfolio in agriculture equipment solutions market and Kubota has proven global technology capabilities. Through this collaboration, we believe that we will cater to India and other growing economies which require high-end technology and new-age tractors to address growing demands of highly mechanized farming. Kubota and Escorts, together, with their leadership in respective geographies, will consolidate strengths and technology innovation excellence to emerge as a global leader.”
Atlas Copco India Appoints New Managing Director

Atlas Copco India has appointed Frans Van Neierk as the new Managing Director and Vice President India Holding, effective January 2020. He will be responsible for the company's operations in India and Bangladesh.

Frans van Niekerk, a South African citizen, has more than 20 years of experience within the Atlas Copco Group, most recently as Vice President of Southern Africa Holding. Before that he has held a variety of Business Control functions for the Mining and Rock Excavation Technique business area in South Africa, as well as in Southeast Asia, Chile and Sweden.

"With his long and international experience he is very suitable to contribute to our presence and development in the important Indian market," said Hans Ola Meyer, Senior Vice President Controlling and Finance and CFO. Frans’ education includes studies in accounting and economics from Lyceum correspondence college in South Africa. He succeeds Giovanni Valent who is retiring after 25 years in the Atlas Group.

Commenting on his new role, Frans said, "I am delighted to be appointed as Managing Director for Atlas Copco India and look forward to working with the team to grow the India market even further. We will continue serving our impressive portfolio of clients with the robust approach that Atlas Copco is known for, assuring a seamless delivery of our services."

Bosch Power Tools, India, a market leader in the power tools segment offering a complete range of power tools for construction, woodworking, and the metalworking industry, has appointed Nishant Sinha as the Regional Business Director for India & SAARC. He brings his rich business experience to lead the growth of the power tools products, accessories, measuring tools, lawn & garden tools, and after-service businesses across multiple channels at Bosch Power Tools.

Nishant is an engineer from I T Banaras Hindu University and has a post-graduate degree from IIM Calcutta. His vision for the company is to curate compelling value propositions and customized solutions satisfying customers while adding value to the organization and its customers across relevant markets. The new Director aims to develop a stronger customer-connect and focus on effective channel expansion for deeper market penetration of the power tools division. Along with his team he will work to broaden the reach of power tools, accessories, and measuring tools through alternate channels, while also strengthening the digital and services network of the brand.

Commented Nishant Sinha said, "I am happy to lead the Bosch Power Tools division in India and SAARC and look forward to fostering a collaborative work culture delivering high-performance standards to provide superior value to the customers and stakeholders. Bosch Power Tools in India and SAARC have exceptional people and an innovation-oriented work culture that has ensured its past successes as a market leader. I endeavor to channelize its full potential to propel growth and a wider outreach with customer-focused quality-driven initiatives."

Decorative paint company Kamdhenu Paints newly launched Kamo Star water-proof putty for interior and exterior walls is a white cement polymer based premium quality putty that keeps walls safe and beautiful. Its water repellent, anti-efflorescent, and gives an aesthetic finish to walls. It is available in pack sizes of 20 and 40 kg.

The wall putty market is growing in India owing to growth in construction infrastructure. It is anticipated that this demand is likely to sustain in the coming years due to increase in construction activities in rural India and increasing awareness of the benefits of applying putty over walls before painting.

Commented Saurabh Agarwal, Director, Kamdhenu Paints, “Kamo Star water-proof putty is an outcome of quality research and conforms to international standards. It is a testament to our commitment to offer world class yet affordable products to customers. We are hopeful that this quality product will witness an overwhelming response from industry contractors, real estate developers and individual home builders.”

Kamdhenu Group, founded in 1994, is led by Satish Kumar Agarwal. The company is a market leader in branded TMT Bars and Kamdhenu TMT Bar with sales turnover of around ₹12000 crores. Kamdhenu follows the franchisee model for its steel business to bring more transparency and dynamism to the operations of the company, which has over 11,500 dealers and distributors in India out of which 7,500 are exclusive for its steel business and 4,000 dealers for its paints business. Kamdhenu was conferred with India Power Brand 2016, Asia’s Most Promising Brand - 2016 and World’s Best Brand 2015, and it bagged the World Best Brand award for steel as well as paints in 2017-18.

For further information, please visit www.kamdhenupaints.com
Japanese Engine Technology Drives India into the Future

Kubota’s Japanese quality and service is giving India a boost

Specifically designed for a wide variety of applications, Kubota is the world’s leading brand in compact diesel engines for industrial and construction machinery. With wide product range, great versatility and high power density, Kubota caters Indian clients' needs, continuously expanding support network in India.
Trimble has introduced the latest versions of its Tekla software solutions for advanced Building Information Modeling (BIM), structural engineering and steel fabrication management—Tekla Structures 2020, Tekla Structural Designer 2020, Tekla Tedds 2020 and Tekla PowerFab 2020. Tekla software is at the heart of design and construction workflows building on the free flow of information, constructible models and improved collaboration. Tekla Structures supports the constructible process to transform the entire design, build and operate lifecycle.

**Tekla Structures 2020:** It delivers enhancements, improvements and new features that enable efficient workflows for better productivity, increased mobility and collaboration across project teams, including:

- Easier modeling of complex shapes with geometry improvements
- Better usability, control and productivity with concrete rebar detailing enhancements

**Trimble Connect** collaboration platform, a cloud-based solution that allows stakeholders to share, review, coordinate and comment on data-rich building models, drawings, schedules and other project information in real-time across the project lifecycle, from a laptop, desktop or mobile device. With Trimble Connect, constructible BIM data is extended to the field, Liberating data and breaking down silos to improve coordination and project management across touchpoints. New functionalities and usability improvements now better support workflows and make it easier to get started with Trimble Connect.

**Tekla Structural Designer 2020 structural analysis and design software:** It introduces data-driven design with a new direct link between Tekla Structural Designer and algorithmic modeling plugin Grasshopper, enabling quick and easy exploration of different early-stage design alternatives.

- Quick and easy formworks modeling and improved hollowcore concrete detailing
- Enhanced drawing tools that provide speed with confidence
Innomac Drives Technology

to bring New Generation Bar Cutting, Bar Bending Machines, Suspended Platforms, BMU’s & Hydraulic Home Lifts

- Complete range of Bar Cutting & Bar Bending Machines available to process from 8mm Dia TMT rods to 40mm Dia Rods of all grades of steel available in the market.

- Heavy and Robust machines design enhance the highest reliability and availability of the equipment for construction sites.

- The Bench marking features are innovatively designed for adding safety standards, increasing productively and also reducing the maintenance in all INNOMAC range of equipment.

- The International Advanced Technology, Building Maintenance Unit (BMU) are designed and manufactured with a close Monitoring by Global industries experts to cater Indian (BMU’s) requirements.

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Tekla Tedds 2020 structural analysis and design calculation software: It offers further integration with Tekla Structures and Tekla Structural Designer for convenient design management across both solutions. With enhanced integration, Tekla Tedds calculation can be automatically associated with a variety of Tekla Structures and Tekla Structural Designer objects.

Tekla Structural Design Suite: A new bundled product including Tedds and Tekla Structural Designer and accessed using cloud licensing, providing better value choices to customers and allowing them to take advantage of new product integrations.

Tekla PowerFab 2020 steel fabrication management software: Delivers improved production tracking, enhanced visualization and streamlined project management on the go. Tekla PowerFab now includes more flexibility in parts tracking through stations and routes on the shop floor and the ability to track external processes, such as erection, which can be shared and visualized from the field with Trimble Connect.

To learn more and to download Tekla 2020 versions, visit: www.tekla.com/2020.
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AMZONE INTERNATIONAL PVT LTD.
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Tel. +22-2520-0194/195 E-mail info@amzoneinternational.com
Buildings have an unavoidable impact on everything we do in our lives. Today, the buildings are evolving to be more efficient, reliable and safe. The architects are trying to create a bright, functional, and well-planned building design that would stimulate creativity, improve the flow of energy, increase performance, and create a well-balanced personal space. Many residential complexes and business hubs display how luxury and comfort once relegated to either home, office, retail, or hospitality categories have merged. Two of the most important of these amenities remain the vertical mobility solutions and the air-conditioning that make these buildings more than just homes or office, and transcend them into offering an experience.

With global expertise and local understanding, Toshiba is helping design smart building solutions that are at the heart of buildings and that can adapt over time. More than 140 years of experience give Toshiba a solid foundation to know how to bring automation to buildings to make them more efficient, responsive and adaptable.
Toshiba’s Vertical Mobility Solutions

Toshiba’s elevator excels on performance, comfortable ride, safety, environment sustainability, aesthetics, and after sales support, which form the cornerstones of elevator industry. Through its subsidiary Toshiba Johnson Elevators India (TJEI), Toshiba is well placed to cater to all segments of Indian elevator market, from high-end premium segment, to upper-mid segment. In last 6 years, TJEI has registered a Y-o-Y CAGR of 10-15%. Continuing the growth trajectory, TJEI aims to achieve top market share in its targeted segment by achieving a sales target of 2,000 units per year by FY2022.

In 2019, TJEI announced the capturing of its largest order till date in India for 128 elevators in Surat Diamond Bourse (SDB). The scope of work entails supply, installation and maintenance of the 128 elevator units. Toshiba will install high-tech world class premium elevators for Surat Diamond Bourse with 12-car group control system. All the elevators come with ‘Destination Control Systems’ for seamless traffic handling.

As for Toshiba Destination Control System (DCS), Toshiba has recently been awarded with the top distinction in this year’s iF DESIGN AWARD, the iF Gold Award. From 7,298 submissions, only 75 were awarded the gold by the independent expert iF jury. The winning FLOORNAVI, won in the discipline Product, in the Public Sector / Government category. The jury stated regarding its decision: “Toshiba has designed an efficient elevator DCS in line with universal design to cater to the needs of able and disabled people. Artificial intelligence allows for floor destinations to be bundled effectively, reducing waiting time. The simple and easy interface is readily adaptable to various architecture contexts.” Espousing its global reputation for ultra-high-speed elevators, TJEI has brought high-speed elevators with maximum speed of 6m/sec to India. With an augmented focus on keeping elevators’ quality and ‘Made-for-India’ products, TJEI has set up a Training Centre and Distribution Centre (TCDC) to focus on quality improvement activities and provide highly reliable products to the market, with safety and security as its top priority. TCDC will allow TJEI to further improve the efficiency of on-site work by advanced stocking and assembling parts facilities.

Toshiba’s Temperature Control Solutions

For over 30 years, Toshiba has reinforced its position as a leader in the air-conditioning market by investing heavily to develop and maintain the quality of products that differentiate it from other manufacturers. Toshiba is one of the first brands to bring the inverter revolution in India and has long been respected for its technologically advanced, energy-efficient air-conditioning solutions. With continuous product innovation and channel partners, Toshiba has been growing rapidly in the air-conditioning business in India.

Demand for the energy-efficient systems is on the rise for use in luxury condominiums. In recent years user expectations of air conditioning systems have changed. The Toshiba VRF systems can optimize room comfort and reduces energy and maintenance costs, combined with maximized simplicity and operating flexibility. VRF benefits from the advantages of direct expansion linked to inverter control and the most sophisticated electronic control. This technology has many advantages, from the system design to the installation and operation phase. The wide range of indoor units makes VRF the most flexible choice to satisfy any building requirement.

As buildings turn smarter, they are becoming physical manifestation of saying ‘we want you to feel comfortable and relax’. They should be able to adapt to the needs of the people and the businesses within them. With advantages like dedicated manufacturing set-up, R&D to design India-specific products, highly motivated sales and after-sales team, backed by the lineage of 140 years of experience, Toshiba is the only global company that can offer building solutions to complete the vision envisaged by the developers.
KONE India continues to expand in Eastern Market

KONE Elevator India is further strengthening its position as a leader in innovation and safety in elevating systems, with a focus on the eastern market of India, where it is setting up more customer service centres.

The company has made large investments in the Indian market over the years. In an effort to bring its innovations and services faster to its customers, it has introduced the world’s most intelligent elevator and escalator services, KONE 24/7 Connected Services. With IBM’s advanced analytics engine, the information will be used to enable new services and new experiences to KONE customers and result in fewer faults and faster repairs.

Amit Gossain, Managing Director, KONE Elevator India, said, “We are excited to be part of the government’s plan for growth in Eastern India’s infrastructure sector and look forward to providing premium experiences with our advanced products. In the coming years, the country will see an even bigger focus on smart cities and urban development, and our workforce is well equipped to lead this technological advancement and infrastructure development.”

KONE develops and manufactures elevators and escalators with maximized passenger safety and easy inspection, to ensure safe operations at all times. The company’s safety policies are clearly communicated to the employees and subcontractors to preclude any deviation in any process. Risk assessment and regular safety audits are done at every stage and reinforcing its focus on safety, KONE does not provide collapsible gates.

The company is expanding in the neighbouring countries with its world-class products manufactured at its facility in Tamil Nadu. “We have entered the Bhutan market, which is a tough market from the strata perspective, and we are certain that our higher connectivity and customer-centricity will deliver customer satisfaction. We are expanding in Bangladesh and Nepal. They are very similar to the Indian market in terms of customer base and outlook,” informed Gossain.

High-rise buildings have a unique set of requirements when it comes to vertical transportation. KONE takes its technology to new heights with innovative solutions. KONE India has installed elevators at ‘The 42’, the tallest residential skyscraper in Kolkata (currently the tallest completed residential building in India). The project is located in Chowringee, the central business district of the city, standing at 252 metres (827 ft) and comprising 61 residential floors. This installation is testimony to the company’s strength in R&D and leadership in elevator innovation. The elevators provided by KONE have various speeds of 5 m/s (4 nos. passenger elevators), 4 m/s (1 no. service elevator), 3 m/s (1 no. goods elevator).
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thyssenkrupp Elevator sets up central spare parts warehouse in Pune

thyssenkrupp Elevator has launched its first central spare parts warehouse in Pune. The new-state-of-the-art warehouse will further improve services for customers operating in domestic and neighboring markets of Bangladesh, Nepal and Sri Lanka.

“As a single management and storage point, Indian Technological Warehouse in Chakan, Pune aims at maintaining total availability of all spare parts for their operators, optimizing their logistics through analysis and processing of data collected in real time. The warehouse operations will later be integrated with ERP Warehouse Management model for optimized inventory management and logistics processes,” said Manish Mehan, CEO, thyssenkrupp Elevator (India).

With a total surface area of 10,000 sq. ft., the new warehouse in Pune holds up to over 5000 different parts and components for maintenance service. In addition, it has the capacity to handle more than 10,000 orders per year. As part of the group’s global spare parts business initiative, additional central storage points worldwide will be launched across different continents. “With this new project thyssenkrupp aims to reduce the environmental impact and promote a more sustainable supply chain. thyssenkrupp Elevator promotes interoperability and efficiency by eliminating unnecessary journeys for shipment of components,” added Mehan.

By ensuring round-the-clock availability of spare parts and distributing them in time to its service technicians, thyssenkrupp provides an effective solution to minimize downtimes of defunct elevators. As a result, there is a 10% saving per year in the number of trips made by technicians to pick up components at their local office between jobs. In addition, there will be a 20% optimization in waiting time for the customer until the elevator is put back into service – simply because technicians will have the spare part at their disposal immediately.

Photo credit thyssenkrupp Elevator
# ASSURING YOUR ASSET’S LIFE & PERFORMANCE

## PROTECTIVE COATINGS FOR ALL APPLICATIONS

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<tr>
<td>• DTM Epoxy Monocoat</td>
<td>• Zinc Silicate &amp; Zinc Rich Primers</td>
<td>• Thermosetting Acrylic Paint</td>
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<td>• DTM PU Monocoat</td>
<td>• Epoxy Primers &amp; Finishes</td>
<td>• Hi Gloss PU Top Coat</td>
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<td>• DTM Synthetic Primer &amp; Paint</td>
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<td>• Quick Drying Primers &amp; Top Coats</td>
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<td>• Solvent Less Epoxy Coating</td>
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## OTHER INDUSTRIAL PRODUCTS

- Epoxy MIO Coatings
- Synthetic Alkyd Paint
- NC Paint, Oil Primers
- HR Paint (up to 900°C)
- Paint Remover
- Floor Coating
- FD Auto Paints
- Chlorinated Rubber Paint
- Fast Drying Stoving Paint
- PU Stoving Paint
- Epoxy Laquer

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For Further Information
Please contact Customer Care Cell:
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Email: info@kromapaints.com
INNOMAC: On a Roll

In 2019, Bangalore-based INNOMAC Engineering Industries launched a range of construction equipment such as Bar Cutting Machines, Bar Bending Machines, Suspended platforms, Hydraulic Home lifts and Building Maintenance Systems (BMUs) across the country.

The company targeted the southern India market for the first 3 months after launching the products during Excon-2019. The response was overwhelming from the visitors at Excon and we even got some confirmed orders. We have already dispatched a couple of machines that were booked during Excon. In fact, we have supplied many more machines in Bangalore and in other southern states. We have taken direct feedback from the end-users for more than 50 machines in the first two months of their utilization, and the remarkably positive feedback on our Bar benders, bar cutters etc. has been extremely encouraging. This confidence in our customers has led to repeat orders of our equipment. So, we can say that our entry in the construction equipment segment has been smooth, fruitful, and is going to meet our growth expectations in the future too.

The company has now strengthened its presence in Mumbai, Pune, and Delhi by recruiting a dedicated sales and service team of qualified and experienced engineers and managers. They have completed their product and factory training before being placed at their respective regions. INNOMAC will now be strengthening its presence in the East and in Central India by May 2020.

Post Excon, we have added another new product – Building Maintenance Units (BMUs), which were developed by our team of professionals; they have designed and erected more than 300 units of BMUs for permanent building maintenance in the Middle East and in European countries for building bridges up to 600mtrs.

What’s driving INNOMAC’s innovativeness in product development is the company’s state-of-the-art R&D division, its Innovation Centre and world-class manufacturing facility in Bangalore.

Mr. RajaMurthy M R
Managing Director
INNOMAC Engineering Industries Pvt. Ltd.

The complete ranges of Davit, Monorail systems, telescopic crane type and others ranges of BMUs are being offered to Indian customers as per their requirements. The world-class design of the BMUs are made to suit malls, shopping complexes, business houses, high-rise apartments and skyscrapers.

INNOMAC has implemented ISO 9001 - 2015 processes across all its operations to ensure high quality systems. Our stringent quality control systems are ensured to get first time right products. Customer feedback is taken in our Monthly Innovation Meeting which is held across our cross-functional teams for new product developments.

The key strength of our company is our team of professionals who work on meeting the specific needs of the customers and strong technological support, implementation of quality control and uncompromising on our services. With 12 branches across the country, we will be adding more dealers in tier-2 cities during the next 6 months, and also in Colombo, Nepal, Dhaka, Dubai and Saudi Arabia during Q1 and Q2 of 2020-21. We will be developing two more new products which we plan to launch by April / May - 2020.
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Crushing & Screening
Manufacturers confident of market rebound; developing new products

Undeterred by the slowdown in demand, crushing and screening manufacturers continue to introduce new products while upgrading their existing solutions and strengthening their product support initiatives. P.P Basistha reports

Given the strong demand fundamentals in view of the new road stretches under the Bharatmala project and other state highways being planned, the crushing and screening manufacturers remain unfazed by the current slowdown and are introducing new products and upgrading their existing products and service packages. As per industry estimates, demand for crushing and screening units was down by close to 30 percent in 2019 as compared to 2018. However, manufacturers are of the view that when the market improves, availability of new products and advanced solutions in the market will preemt a strong brand recall.

Avers Rajen Khoda, Group Business Development Advisor, Puzzolana Machinery Fabricators, “There has been a sharp slowdown in demand for all construction equipment, including Crushing & Screening machines, which has affected businesses especially during April to November 2019, as compared to the same period in 2018. However, market seems to have bottomed out now and indications since Dec 2019 are very positive for the industry, so 2020-21 should see healthy growth.”

He adds, “The slowdown has been primarily due to lack of finance availability and due to issues in land acquisitions for road projects. The government is putting in lot of efforts to address both. In the meantime, Puzzolana continues to invest in developing more cost-effective mobile, semi-mobile and static Crushing & Screening products by improving the metallurgy of the components to reduce their wear and tear and the operating costs.”

Khoda informs that most of the countries are favouring Tracked Crushing & Screening machines, and since India too is following the trend, the industry can expect exponential growth in mobile machines. Puzzolana provides mobile and static crushing & screening machines for the Construction and Mining industries; and as part of its ongoing product development program, it launched the PTI 1313 Track Impactor during Excon 2019. “This is yet another first in India; it can meet demand for recycling application and for softer rocks like limestone etc.”

He adds, “Our design philosophy is to develop products that are simple, easy to use, and high on performance as end-users are looking for cost-effective solutions and reliable equipment. For instance, our dual-powered Mobile Crushers & Screens can save energy up to 70% by using grid power. The choice of an alternative energy source provides a way to reduce high diesel costs and reduce the carbon footprint of our machines.”

“India continues to be one of the most rapidly emerging economy and we expect Puzzolana Equipment to play a major role in developing the country’s infrastructure. We have grown with the country during the last several decades and currently enjoy the largest market share in the Crushing & Screening business in India. We will continue to develop, design and manufacture new products,” says Khoda.
South India-based crushing and screening behemoth Propel Industries has made some recent launches, many of which, according to the company, are unique. Says Senthil Kumar, MD, Propel Industries, “Our new AVCG-600, 550 - 750 TPH Gyratory Cone crusher has a 360-400 mm feed opening, delivering output of 100-250 mm, and has an increased capacity with reduced maintenance and downtime. We have optimized the cavity design for providing maximum yields of high-quality products. AVCG 600 guarantees trouble-free operation in varying feed conditions with high reduction ratio. The crusher delivers high crushing performance as it is built to crush the hardest feed due to an increased bottom shell product discharge area, and there is lesser wear and tear, leading to increased capacity.” According to him, the product places the company in league with premium European product manufacturers.

Propel’s new AV HI250 horizontal shaft impactor, designed for both domestic and international markets, is designed for crushing of limestone, dolomite, gravel, glass, sandstone etc. Based on the company’s R&D, it has premium features like a high efficiency belt drive, hydraulic gap management and other innovations to give the lowest cost of operations and ease of usage.

TMV 200, 180-320 tph and TMV 300, 250-470 TPH, track mounted vertical shaft impactors from Propel’s stable are highly energy-efficient and productive. The e-track screen is built with the flexibility to power the plants either through an electric grid or through an on-board genset power pack. The heavy track units have quick set up hydraulic systems and promise availability and high performance.

Propel’s new-gen AVRC1300 roll crusher in the 50-150 TPH capacity range is designed to deliver the best quality sand with minimal fines. It can be used with high level of versatility, on one end it can take feed size below 20mm and crush it to less than 5mm and on the other side it is suitable for giving reduction of 3-4 times on larger feed sizes of up to 75 mm. Designed for both domestic and international markets, it has premium features like a high-efficiency gear drive, hydraulic gap arrangement and other innovations to enable the lowest cost of operation.

To further strengthen its position, Propel has introduced four deck track mounted screens under the TMS series. The product is available in two models: TMS 1561, 400 TPH and TMS 1861, 500 TPH. “This four-deck high screen is the world’s first. It is designed and developed with our manufacturing expertise to give trouble-free operations even under heavy and continuous applications. Its well-engineered buck bolt fastening system makes it very safe and reliable. It is made rugged with heavy-duty track units and a heavy-duty double deck vibrating grid (available as an option), and it has a dual power mode (electric connection or by onboard genset power pack optional unit) making it eco friendly. Our TMS track mounted screens come with an option of dust suppression,” informs Kumar.

The PW 100, 80-100 tph, PW150, 120-150 tph, PW 200, 160-200 tph, PW 250 100-280 tph under the company’s Prowashseries are designed to ensure maximum efficiency to the washing plant. They have been developed to deliver high quality washed sand (manufactured and plaster sand) and their modular design facilitates extremely accurate separation of silt and clay from the final wash sand. Says Kumar, “With the new line-up of products, we will be re-orienting our marketing strategy for both domestic sales and for export markets like Middle East, Nepal and South Africa, and will strategize our product support accordingly.” Presently, Propel’s export sales comprise 8 percent of its business. Propel is gearing up to expand in the International market in a big way in the coming years.
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Gopi Krishna More, Managing Director, Torsa, informs that the company has completely revamped its stationary and mobile crushing plants with the introduction of Torsa’s fourth generation crushers. “These plants are more compact and have a modular design such that they can be transported on standard containers and installed with ease on areas where there is paucity of space, as in hilly sites. Their bolted design enables ease of maintenance as they can be quickly opened up for repairs.”

He adds, “We have developed our crushers for various applications and customers. Our fourth generation 50-250 tph plants are available as skid and wheel mounted. The product line has been reconfigured to meet the target requirements and categorized for the business segments which we are looking to target. We are also targeting our 50-250 tph units for road contractors as well as quarry owners. The skid-mounted plants can be used by contractors involved in road projects with long gestation periods. Our C7 Nomad series of 50-80 tph wheel-mounted plant is also available as a skid-mounted crusher for aggregates and iron ore. The crushers in this category can work with feeder-jaw-cone and screen. For the big contractors, we will be offering our SC 20, 200 tph and SC 25, 250 tph crushers, which are available with hopper, feeder, screen, cone and VSI. Our fourth generation crushers have higher flexibility and can generate throughputs of 0-6-10-20-40 mm, and as per project requirements.”

Torsa crushers are sturdy and strong with Hardox Steel for the grizzly feeders. Manganese alloyed graded steel (MS 206-A) has also been used in special cases. “To ensure higher productivity, flexibility and ease of transportation and set-up, we have optimized the design of the plants based on the R&D of our various International associates. The advanced design enables the plant to deliver close to 80 percent of rated throughput, and even more,” says More.

In a tie-up with Minyu, Torsa is offering standard, hydro pneumatic and super cone crushers, which include a unique, high speed cone in the 100-250 tph range for customers looking for super premium solutions. The cone crushers imported from Minyu come with an automatic gap setting. Torsa is also offering dry screening plants for pre-screening and wet washing plants. Says More, “The trains have been standardised so that they can be combined easily with our main crushing and screening units. Our inclined screens also enable ease of operation and maintenance as their fitment of nuts and bolts enable a quick change of screens.”

Torsa is now keen to expand to other parts of India. Says More, “As an eastern India company, we have remained focused in the east and north eastern markets. However, with our new, expanded range of products, we are now working on a marketing strategy to expand to the north and south, where we have a fragmented presence, so far. To support our population of almost 3000 units, many of which are working in crushing clusters, we have set up a dedicated ‘Torsa Spares and Services Centre’, which will take care of both pre- and post sales with special utility vehicles.”

The company is setting up a second facility at Kolkata (after its first Aminga facility in Assam), for manufacturing medium capacity jaws, screens and feeders.
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Says R.S. Raghavan, Managing Director, PROMAN Infrastructure Services, “For longer stretches of road contracts, which are the norm these days, it makes sense to have medium size, multi-location crushing plants strategically placed to cover the projects. These plants are quickly relocatable as they are mobile and have the flexibility to produce various mixes of crushed products right from the GSB stage (initial stage of the road projects) to the final products for finish and wear course.”

The company is supplying two -and three-stage modular plants which are easy to relocate and quick to install, while the conveyors are foldable with an option for medium to high stockpile capacity. It has recently launched a unique portable tertiary crushing system which can be attached to any two-stage track, mobile and fixed plant. As an option, PROMAN is offering PLC logical intelligence in its crushing plants; the smart box monitors operations and safe performance of the cone crushers and vertical shaft impactors.

The company’s after sales and service team is well-trained to support its customers across the country. Its warehouses, located in western, northern and southern India, ensure quick supply of spare parts to customers’ project sites.
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Trenchless solution is used in constructing infrastructure for various segments and projects of different dimensions, ranging from roads and bridges to power and energy, telecom to oil and gas, water and sewerage etc. Different infrastructure projects require different methods such as horizontal directional drilling, tunnel boring, moling, auger boring, etc – Vermeer is providing all these solutions globally, with its wide range of equipment. In India, Vermeer offers the entire range of products but limited to size depending on the project’s requirement. In fact, trenchless technology is gaining traction in Indian projects across sectors. From its use in telecom, oil and gas sectors, it is now being considered for almost every sector. This change is due to greater awareness on its benefits and government regulations on trenching.

Trenchless technology is used for creating infrastructure a few metres below the ground, so the most important preliminary step in a project is to analyse the strata. This is generally done by the contracting companies who test and obtain the geological report of the jobsite. Based on the analysis, we suggest the most suitable combination of equipment for the job, as we have the requisite equipment and tools to handle both soft soil and hard rock.

Today, digitalisation/IoT-based features are changing the way how the market perceives construction equipment. From a basic tool, construction equipment has become extremely high-tech, and is greatly improving the project owner’s productivity and profitability with speed and efficiency of construction. Continuous advancements and technical upgradations in the construction equipment has optimized their utilisation, while bringing down construction time and cost.

The electronic features in Vermeer equipment are their backbone as they not only make it easy for the operator to understand the job’s complexities, but also enable safe and trouble-free operations through the equipment’s control modules and software updates. These help in tracking the machine’s performance parameters and in identifying faults, such that preventive maintenance can be initiated at the earliest, thus reducing the machine’s downtime. By following the operation guidelines provided through the digital media, the operator’s efficiency and productivity increases significantly.

At Vermeer, we feel that the need of the hour is enabling a good customer experience with timely support by our service team. We are focusing on improving our support system, increasing our business network, and our range of solutions. The Government has outlined huge plans for infra development across the country. Many projects are in the pipeline and many are on the verge of implementation. So, we envisage a lot of opportunities in the not too distant future.
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In an atmosphere of increased competition, operational challenges and tighter margins, engineering and construction (E&C) companies are adopting new construction technologies in order to differentiate their services from their competitors, informs P V Prasanth, Director, Operations and Technology, Shapoorji Pallonji Engineering & Construction.

The evolving landscape of new technologies in the E&C sector are transforming all stages of the project delivery process. These technologies are changing how companies design, plan, and execute projects. By adopting advanced software, construction-focused hardware, analytics capabilities and advanced construction technologies, companies are eliminating many of the problems that have dogged the E&C sector for decades. Such improvements could not have come at a better time, as construction projects are becoming increasingly complex and expensive, putting managers under greater pressure to improve costs, timelines, and efficiency.

Many E&C companies have begun incorporating new construction technologies into their projects, across all project phases (design, pre-construction, construction, operations and management). While some of their efforts have focused on software tools for digital collaboration, companies are also looking at new ways to monitor and manage performance. Many new materials, building systems and innovative methods of construction are also being explored.

The major E&C companies use enterprise-resource-planning systems. In addition, new digital tools and solutions are being used for the design, preconstruction, or operations and management phases. In the construction phase, on-site execution, digital collaboration, and back-office integration are being reimagined with the use of such digital solutions.

**Digital Tools that Support On-site Execution**

During the execution phase, E&C companies typically encounter many difficulties, ranging from low productivity to delays in material shipments. The digital tools available currently allow the companies to mitigate some of the most
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BONDS BUILDS BUSINESS
Some field-productivity applications help companies to manage project staffing across skilled trades or to monitor on-site productivity at the trade or worker level.

Many applications facilitate the tracking and reporting of safety incidents across job sites. In addition, they allow managers to distribute safety alerts and tips to the entire workforce.

Some new applications help managers inspect remote sites by providing pictures and image tags, while others allow them to update and track their punch lists in real time. This, in turn, increases efficiency and accuracy during on-site execution.

While most tools in the on-site execution cluster fall into these areas, a few companies have also developed products to assist with many other onsite activities, including supply-chain logistics.

**Digital Tools that Support Collaboration**

E&C stakeholders—including architects, designers, and site engineers—are more numerous and widely dispersed than those in most other industries. They need to communicate and align frequently, since certain changes, such as a seemingly minor modification to a materials order, could significantly increase timelines or costs if made too late in the game. That explains why many E&C companies focused on tools that promote digital collaboration—the online exchange of information—throughout all E&C project phases. Some of the most compelling tools relate to the following use cases:

- **Design management:** E&C staff often need to update drawings and other project documents while on site. Rather than returning to the office to complete such tasks (as these engineers would have done previously), they can now make changes in the field.

- **Contract management:** These tools help staff with many critical tasks. For instance, workers can use them to update contract-compliance checklists or collect information about client and contractor communications that occur as the execution proceeds.

- **Performance management:** With these tools, managers can update and immediately share information (including workforce data) in the field, particularly during the crucial preconstruction and construction phases. Some performance dashboards can automatically import field data, simplifying the process of collecting information.

- **Document management:** Many companies are adopting tools that let them upload documents, track changes, and record all decisions made about their content. In some cases, document-management tools can also serve as a permanent repository, giving E&C firms easy access to past records.

**Digital Tools that Support Back Office Integration**

Back-office integration, involving functions such as accounting, finance, and human resources, can help companies to access and exploit valuable project data on finances, costs, and schedules. All too often, however, analysts fail to mine this information because it is not easily accessible. E&C companies have developed solutions—mostly designed from an accounting perspective—that give managers immediate access to real-time back-office data. Many back-office-use cases focus on scheduling, managing equipment, and enterprise resource planning.

E&C companies are applying new hardware and software solutions to many use cases, sometimes by forming partnerships with large equipment manufacturers. A few examples:

- **Predictive analytics:** Every construction firm is a giant repository of data. E&C companies are now taking advantage of this information by creating new applications that can collect thousands to billions of records from all source systems. These solutions apply advanced analytics and machine learning to data—both structured and unstructured—to optimize decision making for multiple topics, including workloads, staffing levels, and strategies for minimizing inefficiencies.

- **Project monitoring enabled by drones and IoT:** Some companies are using these technologies to improve 5-D BIM—the process companies use to create digital representations of physical structures and then consider this information in combination with cost and scheduling data. Companies most frequently use drones to capture site images and aerial survey data, while the IoT primarily helps with monitoring equipment and preventive maintenance. Many E&C companies are also beginning to deploy these technologies to increase safety.

As the operation dynamics of the real estate business in India are evolving and innovating at a pace much faster than envisioned, it is almost imperative that innovations be applied to the most basic as well as most important step in the value chain—construction techniques. It is expected that there will be wider use of technology in construction and construction management in the future as companies realise the long-term efficiency and cost savings of such techniques. Technology in construction space has coincided with growing demand for faster construction and world-class quality. Therefore, construction organisations would have to increasingly adopt newer construction techniques (and devise ways to mitigate/share the high costs associated with these new technologies) to meet the client’s changing demands.
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While clients are expecting more for less, the E&C companies are facing a few challenges in managing their construction operations:

- Reducing Availability of Skilled Workmen
- Higher expectations of Construction Safety Standards
- Higher expectations of Construction Quality Standards
- Increased regulatory, statutory and environmental compliances

Considering the current challenges in the operating environment and the need for growth and faster execution, different approaches to construction are being explored. The ideas and technologies that are becoming imperative for smooth project execution include:

- Modular Construction; Standardization
- Pre-engineered and site-assembled construction
- Mechanized Construction
- Faster construction methodologies
- Homogeneous Quality of Materials & Workmanship
- Cost-effective construction
- High-rise Construction

**Monolithic Concrete Construction**

Adoption of advanced technologies such as monolithic concrete construction (shear wall technology) using aluminium formwork or precast construction is slowly becoming the norm. These technologies reduce cycle times and the requirement of construction labour, reduce project duration vis-à-vis conventional construction, reduce material wastage, and improve construction quality and safety. These technologies also eliminate labour-intensive activities such as masonry and plastering, thus leading to time and cost savings.

A high degree of modularity of designs that ensures a higher repetition of formwork and higher productivity of mobilised resources is an added advantage.

The high-rise nature of residential structures for affordable housing naturally leads us to technologies such as monolithic concrete construction (shear wall technology) using aluminium formwork or precast construction, as mentioned above. Both these technologies are suitable for the Indian environment and to meet the unique challenges of urban housing development we face. Alternatively, the usage of dry wall panel along with an RCC structural frame also leads to quicker and energy-efficient homes. Although there are many examples of successful group housing projects being delivered using these technologies in India, there is tremendous scope to use these technologies to meet the demands of affordable housing in India. Therefore, affordable housing projects need to be designed to suit the adoption of these technologies. This will lead to faster deliveries and project success.

The design-and-build project delivery system lends itself very well to the demands of the current-day construction projects. This system ensures that E&C companies adopt the latest construction technologies that improve cycle times, reduce manpower dependence, reduce material wastage, and eliminate wasteful activities. This automatically brings in time and cost advantages, which are then passed on by the E&C companies to their clients. The adoption of such technologies leads to many additional benefits to clients, such as improved safety and quality and greater chances of project success.

A lot of research and development efforts today are directed towards emerging technologies in precast construction that enable the manufacture of the whole dwelling unit as a monolithic module (with no joints) and complete with interior finishes. Similarly, 3D printing is set to revolutionize housing construction. It won’t be long before these technologies become affordable especially for large volume constructions and become commonplace in India. And these technologies can then emerge as credible solutions to address India’s affordable housing challenges.

The Indian E&C companies are now able to access these advanced technologies through global technology providers who are only too...
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Calibrated Shuttering Plywood

Alliance calibrated Film Face Shuttering Plywood is slightly different from traditional shuttering plywood. As it is manufactured with hardwood veneers suitability bonded with a phenolic resin and calibrated to achieve thickness difference of 0.20mm and laminated with high abrasion resistance impregnated film.

Fabric Shuttering Plywood

Alliance Fabric – Plymouth for Concrete shuttering works is overlaid with industrial interwoven fabric (having 260 GSM before impregnation and 700 GSM after impregnation) which have high abrasion quality.
keen to support this demand. Similarly, the plant and machinery associated with these technologies can be easily imported into India at competitive prices.

**Pre-engineered Structural Steel Construction**

The office buildings construction in India is also witnessing adoption of pre-engineered structural steel building systems in a big way to overcome the challenges posed by the RCC way of design and construction.

Pre-engineered Structural Steel provides many construction benefits of its own. The use of Steel results in an accelerated schedule. Construction Quality is enhanced because of off-site fabrication, and that the productivity opportunities that exist in construction can be best addressed in off-site fabrication with a reduction of actual on-site time and on-site construction. 3-D interoperability and Building Information Modeling allows the close cooperation between designers and contractors in the design, fabrication and erection of steel structures.

Steel buildings enable a shorter construction period as compared to RCC buildings. Steel buildings enable (i) Earlier possession of the building for use; (ii) Lower financing costs; (iii) Better site utilization; (iv) Earlier access for following trades (viz. MEP, Facade & Finishes)

The construction preparatory phase enables the steel structure to be planned and connections to be selected for speed of erection. Pre-engineered steel buildings can take advantage of Just-in-Time manufacturing techniques. The steel frame of the building is designed and manufactured from computer models directly linked to the CNC machines thus ensuring high dimensional accuracy and speed of erection. Quick drying fire-proof coatings technologies are available.

**Conclusion**

India has a huge economic opportunity in the coming years. With increasing per capita income and a population of about 1.25 billion, the Indian economy will continue to prosper aided by digitization, globalization, favorable demographics, and reforms. In addition, increased government spending on infrastructure and increasing urbanisation will provide plenty of opportunities for the construction sector.

E&C companies have adopted numerous tools for use across the project life cycle, ranging from design management to scheduling to safety monitoring. In the future, we will see even more tools emerge, particularly for use related to field management and performance management. With the role of construction technology growing so rapidly, and new use cases emerging constantly, E&C companies that do not invest in the right tools risk being left behind. The new materials, building systems and methods of construction along with emerging project management trends will change the way large projects will be delivered.

The companies that place the right bets now will probably be the industry leaders in the next ten to 15 years if they match their greater investment in technology with a company-wide commitment to change. Above all, they will need to alter fundamental aspects of their organizational structure, corporate culture, and IT systems, with the goal of seamlessly integrating new tools into daily work. With this support, their new tools will give them an edge that no amount of human effort can replicate.
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Concrete Block Making Solutions
Increased automation in production of prestressed hollow core slabs

With a multi-angle saw (MAS) from Echo Precast Engineering, Belgium, the Franconian building materials manufacturer Dennert is focusing on higher automation in the production of prestressed hollow core slabs.

At the Schlüsselfeld location, the company has been producing prestressed hollow core slabs on five production lines for many years. The 1.20-metre-wide prefabricated elements with formwork-smooth underside are used wherever free room design is required, as they allow XXL spans to be bridged without disturbing columns or load-bearing walls. In addition, they have very good fire protection and sound insulation properties and are therefore particularly suitable for multi-storey buildings. They are mounted quickly and can bear loads immediately, which leads to shorter construction times and corresponding cost savings.

For the investment in a new multi-angle saw, Dennert opted for a MAS model from Echo Precast Engineering, Houthalen, one of the seven companies in the Progress Group, a leading full-range supplier in the precast concrete industry. The two companies are linked by a long-standing business partnership. Dennert has been using an Echo S-Liner® slipformer for many years. “When the required reinvestment in a saw was due, we wanted to look to the future and opted for a high-quality machine,” explains Bernd Schwarz, Operations Manager at Dennert. “Since Echo Precast has been our supplier and partner for many years, we took advice from them and quickly found what we were looking for.”

The higher degree of automation compared to earlier production processes played a large part in the decision for the MAS-1100. The machine has both an Internet connection and a touchpad on the side for...
The MAS 1100 from Echo Precast provides Dennert with a higher degree of automation and a more efficient production of prestressed hollow-core slabs (Photo: Dennert).

The multi-angle sawing machine has both an Internet connection and an external operator touchpad (Photo: Dennert).

In addition to the saw for cured prestressed hollow-core slabs, Dennert uses the S-Liner slipformer from Echo Precast Engineering on its five production lines (Photo: Dennert).

operation. It cuts hardened concrete elements up to a thickness of 40 cm. In addition, 0-degree or 180-degree cuts as well as diagonal cuts between 0 and 90 degrees or 90 and 180 degrees are possible. The sawing speed is automatically regulated by the electronic power control of the motor. It has also been extended with an advanced automation module that enables the semi-automatic sawing process. In addition to high-quality software, this module also contains a positioning system with an encoder for the wheels. The MAS 1100 works completely electronically, without any hydraulics. It has both collision protection and a high-end laser for accurate cutting at the required angles.

"With this sawing machine from Echo, we will make our production of prestressed hollow core slabs even more efficient in the future," sums up Bernd Schwarz, "and all in the style of the Dennert company: with the highest demands on the quality of our precast elements and perfected prefabrication in order to offer clients long-term support at a high level."

For further details, please contact:

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The challenge with high rise construction is time, quality and cost. The uncertainty of availability of labour force makes it even more difficult to complete projects in time. In such a scenario, the construction industry is deemed to automate and modernise to cope with the demand and fulfil the growing market aspirations. Precast technology is one of the best possible solutions because with its adaptability and quality control it provides a speedy, cost-efficient and sustainable solution. Engineers and Architects also have an advantage with Precast in terms of accuracy, optimization, durability and quality control. This article discusses the design parameters of precast concrete structures for construction of multi-storied buildings.

1. Design Considerations

High rise structures are prone to lateral loads due to wind and earthquakes, so, while designing a precast concrete high-rise structure, attention should be given to the project in totality, starting from conceptual design to erection.

The seismic performance of a structure is mainly related to its lateral strength, stiffness and ductility. The lateral deflection of high-rise buildings should be controlled not only with the permissible limits by design, but also to a limit that ensures architectural finishes and partitions are not damaged.

The success of a precast system depends on connections. So, understanding of the behaviour of different connections and structure is vital in the computational models for analysis and design. As the behaviour of the structure depends on the behaviour of connections, good knowledge and understanding on connections are vital to achieve economical and practical method to connect the members with adequate strength and ductility for the structure under lateral loading.

The provisions of tie reinforcements, reinforced shear keys and dowel bars provide the required structural integrity for the precast system to avoid progressive collapse. Apart from wind loads and seismic loads, deflections that may arise due to imperfections in elements during construction should be considered. In precast construction technology, the errors in construction can be avoided with the help of proper technology and planning.

2. Design Parameters

The following are the main checkpoints:

- Overall design of the structure for strength and serviceability requirements
- Precast element design
- Connections between precast elements

*With Precast, we can envision a cost-effective, fast-track, safe and sustainable future for the construction of high-rise structures.*

Nidhi Gupta & Ahilan R. Design and Engineering team, Starworth Infrastructure & Construction Ltd., Bengaluru

Design Intricacies of Precast Concrete Structures for Multi-Storied Residential Towers

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2.1 Overall Design of the structure

Deciding the structural system for the building is foremost. The system selected depends on factors such as layout, span length, stability system etc. These systems can be broadly distinguished as portal frame systems, skeletal frame systems, wall-frame systems and cell structures. In India, for the residential towers, we mostly use the wall-frame systems. The walls are designed as load-bearing walls and thickness is decided based on the strength, serviceability and fire rating requirements. Enough RC walls are provided in both the directions to resist the lateral loads and to carry the gravity loads. Slabs are directly supported on the walls in such a case. The architectural layout is converted into the framing plan whereby the configuration of the precast elements is decided. The size of the elements depends on the layouts, preferable location of joints and the crane capacity. An analytical model is developed based on the structural framing plans. The lateral and gravity loads are defined based on relevant IS codes.

2.2 Precast Element design

Once the analytical model is completed and ensured for stability, precast elements are designed. In addition to the loads obtained from the analytical model, these elements are checked for handling stresses as well at different stages, namely demoulding, stacking, transportation and erection. The elements mainly are precast walls and slabs.

2.2.1 Precast Walls

Concrete walls have a large in-plane stiffness that provides stability against lateral loads and resists the gravity loads. The design of the precast walls should be in accordance with IS-1893 and IS-13920, depending on the seismic zone of the project. The load-bearing walls are provided with two layers of reinforcement and the detailing for every element is carried out in accordance with Codal requirements.

2.2.2 Precast slabs

In precast buildings, horizontal loads from wind or other actions are usually transmitted to the vertical elements by floors acting as plates. Floor diaphragm action means the transfer of horizontal loading across a building. The principal functions of the floor system are firstly to transfer lateral loads to the vertical walls at each floor and secondly to join individual load resisting elements into a single lateral load resisting system. There are different types of systems that can be used for precast slabs.

2.2.2.1 Semi Precast slabs

In this system, room size slabs are designed as a single unit. The slab is divided into two parts. One is the precast part that is casted at the production facility and then transported to site for erection and the other part is the cast-in-situ topping. Enough reinforcement is provided in the topping portion to ensure the diaphragm action. The precast slab also acts like the formwork for the cast-in-situ concrete and needs to be propped at fewer locations. It is also easier to route the MEP services in this case.
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2.2.2.2 Hollow core slabs
These are Precast pre-tensioned slabs and the thickness can be decided as per the span. There is an overall topping of minimum 60mm provided to ensure the diaphragm action. In case topping is not provided, the joints between the hollow core slab units should be properly reinforced to take care of the forces generated due to diaphragm action of the slab. For residential construction in India, this system is not very popular as the spans are small, and the overall thickness of these slabs is more, which reduces the clear height of the floor.

2.2.2.3 Full Precast slabs
The slabs are designed as full depth room-sized precast panels with a recess provided throughout the periphery. The recesses are given to facilitate overlapping of reinforcements from the precast panels (as per the requirements of progressive collapse) in order to ensure structural integrity. For these slabs, mostly, the service lines are routed in the recesses and a very high level of accuracy is required for placing tie reinforcements which sometimes leads to issues like congestion in the site.

2.3 Connections between Precast elements
The most important aspect of precast design is the design and detailing of the precast connections. Their role is to provide a coherent and robust structure out of individual elements that are able to take up all acting forces, including indirect actions resulting from creep, shrinkage, thermal movements, fire, and so forth. Connections between precast elements is segregated in two types: Horizontal connections (at floor level) and Vertical connections (along the height of the floor).

2.3.1 Horizontal connections
In the Indian scenario, horizontal connections are mostly designed as dowel connections. These are the connections at floor level ensuring continuity between the verticals of two consecutive floors and the slab elements. As per IS codes, the Precast must emulate the behaviour of monolithic construction. This type of joint is the most widely used detail for emulative design.

2.3.2 Vertical connections
These are the connections between two/three adjacent wall panels along the height. The vertical connectors between two different wall-panels can be various types, for example Rebars, Loop boxes etc. These connections are intended to transfer the shear forces and are designed based on the concept of shear-friction. If the shear demand for the connection is very high, shear keys can be provided to enhance the shear capacity of the connection. Different types of locations where vertical connections will be required are:
- Wall to wall connections
- Column to column connection
- Wall to frame connection

Figure 3: Full Precast Slabs (image source: www.bca.org)

Figure 4: Horizontal connection

Figure 5: A type of vertical connection
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2.4 Connections design for water-tightness
The location and the number of joints provided at the floor level plays a very important role. The crane capacity is a major determining factor in deciding the precast element configuration. Special care shall be taken while detailing every joint so that water tightness of the structure can be achieved by ensuring continuity at all critical locations. The location of the proposed cold joints is a conscious decision taken by the structural designer (simultaneously taking care of the architectural intent) and it helps to address the issue of water leakages to a large extent. A detailed method statement to treat these joints should be developed before executing the project.

2.5 Diaphragm action
The stability of the precast concrete building is provided in two ways. First, the horizontal loads due to lateral loads are transmitted to shear walls by the floor acting as a deep horizontal beam. Second, the horizontal reaction forces resulting from the floor at each floor level are transmitted to the foundations by walls. The way in which the diaphragm behaves depends on the plan geometry of the floor.

2.6 Progressive collapse
Another biggest challenge in precast construction is the design of the structure to ensure stability of the building against progressive collapse in case of accidental loadings (e.g. blasts, fire, etc). Progressive collapse means a chain reaction in which a major part or the entire structure collapses due to a localized failure. In order to prevent this, proper analysis should be carried out and the key elements identified. The structure should be designed so that in case of failure of the key elements, an alternate load path is available. Enough tie reinforcements (as per codes) ensuring the continuity of the load path should be provided throughout the structure. The types of ties to be provided are detailed in IS 15916:2000 and are shown in figure 7.

2.7 Design of non-structural components
A detailed study of all the architectural features and the non-structural components must be carried out. Proper connectivity of these elements to the load-bearing frame should be ensured. For the features where accessibility is an issue, special attention should be given in terms of safety and stability. A detailed erection sequence (along with details of the temporary supports required) should be generated. The design of the elevation elements should be checked for the varying support conditions at every stage of erection.

3. Case Study – Provident Park Square
Located in Bangalore, the project is executed by Starworth Infrastructure and Construction Ltd. as a Design and Build project. The project details are tabulated in table 1.

<table>
<thead>
<tr>
<th>Table 1: Project Details</th>
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<td>Number of elements per floor plate</td>
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<td>Seismic zone</td>
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Few key points about the project are:

1. A special profile is used for all the peripheral walls to ensure water tightness (Fig. 9)

2. Both rebars and loop boxes are used for the vertical connections. The concept of structural and non-structural connections is used to optimize design (Fig. 10)

3. The staircases are designed without corbel supports which look aesthetically appealing.

4. Lot of architectural features such as curved columns, curved elevation bands, pergolas, and punch windows have been incorporated using Precast.

5. Basement drains and compound walls are also planned with Precast.
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Conclusion
As a way forward for the Indian construction, Industrialization is the only way to achieve the quality construction in the next few decades. Precast technology will be key to this advancement and the success of any precast project depends mainly on quality of design. There must be a planned approach to the project as a whole, where structural engineers should play a vital role. In addition to parameters of building design with respect to the Codal provisions, constructability analysis is also an intrinsic part of the design stage. Constructability of every precast element should be understood in terms of crane capacity, type of production facility, type of moulds and shutters available, type and number of accessories, costing of the project, handling of elements, MEP requirements, ease of execution, etc. The aspect of water tightness, which is a major apprehension attached to Precast, should be addressed in the initial stage through proper detailing by the structural engineers.
In other words, the success or failure of residential projects depends on an understanding of the project (as a whole) by the structural engineer who should be willing to take on different roles.

Acknowledgements
1. Puravankara Ltd. and Provident Housing Ltd.
2. Mr. Raj Pillai (Managing Director – Starworth Infrastructure & Construction Ltd.)

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- IS 1893 - Code of practice for Earthquake resistant design and construction of buildings
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Putzmeister Delivers 1,000th Truck Mounted Concrete Boom Pump

Putzmeister delivered its 1,000th Truck Mounted Boom Pump from its factory in Goa, this month. Putzmeister offers truck mounted pumps in 3 configurations: 36 meters (4 arm, Z fold), 42 meters (5 arm, RZ fold), and 47 meters (5 arm, RZ fold) to customers in India, Nepal, Bangladesh, Bhutan, Sri Lanka and Maldives.

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Putzmeister Truck Mounted Boom Pumps have worked on most major metro, bridge, refinery and thermal power plant projects in India. Globally, these pumps are renowned for their ability to work across a range of application conditions and extremely harsh environments, including radioactive environments. In 1986, Putzmeister Truck Mounted Boom Pumps were put into action to help seal the Chernobyl Nuclear Reactor in a concrete sarcophagus. The machines pumped 400,000 cubic meters of concrete to seal the reactor. In 2011, Putzmeister Boom Pumps were adapted to pump water (160,000 litres per hour at a pressure of 85 bar) instead of concrete to help cool down the Fukushima Nuclear Reactor.

The company is currently in the process of rolling out Putzmeister Machine Cockpit on its fleet of Boom Pumps in India. This will allow fleet owners to optimize their machine uptime and fuel consumption. Remote fault monitoring will enable quicker fixes. Automated maintenance alerts will improve equipment management. And, of course, fleet owners will know where their machine is at all times, thereby ensuring no unauthorised movement or use.


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It is a myth that waterproofing treatments can be carried out by application of single material on new concrete or existing treatments. There cannot be a single material that is right for every structure. Most of the failures in waterproofing are on account of this misconception. The only way to ensure reliable treatment is by considering the waterproofing treatment as a system. A System for Waterproofing can be defined as a combination of materials, preparation of specifications, application techniques designed by taking into considerations the requirement of the client or homeowner, which would provide efficient, reliable and long-term protection to concrete structures with minimum maintenance costs.

Waterproofing should never begin with a specific material in mind. The properties of material needed, are to be stated and then the material is to be selected as per the merit. To combat the different entry modes of water into concrete, a combined system of treatments is therefore necessary. To waterproof a structure completely, one has to address the 3 primary routes of entry into the structure, viz.

- Pores, Capillaries and Voids in the concrete
- Joints and Transitions
- Cracks in the concrete cover

These can be achieved by use of:

- Admixtures and additives to reduce the porosity and capillarity in the concrete
- Treatment of joints, transitions and cracks using suitable coatings with reinforcement, flashing tapes and expansion joint tapes
- The cover concrete is to be protected by appropriate surface barrier coatings

Many a times, due to age and deterioration, the effect of these treatments begin to fade, and water enters the living / usable space. It is at this time remedial waterproofing comes into play. The aim of this remedial waterproofing is to minimize the voids in the structural element (walls (basement or rooms), slab (ceiling or basement) or other structural elements. Normally a combination of this re-densification of the structural elements and joint treatment will solve most water ingress problems.

**Waterproofing using Injections**

**Types and its Applications**

Injection Technologies have long been used to treat waterproofing issues. In Brief, Table 1 below gives an idea of the type of Injection materials available and the conditions these materials can be used under. The areas of application of the suitable filling materials and filling methods depend mainly on the intended application goal, the crack width, crack movement, and dampness of the cracks/crack edges/crack flanks and voids. Usually three different injection systems/methodologies are specialized to solve critical waterproofing problems:

- Grid Injection [Crack treatment or creation of a waterproof layer from the negative side]
- Water Bar Injection/Expansion Joint Treatments/Transitions
- Injection Hoses

Selection of materials based on crack width is shown in table 1 and figure 1. Figure 2 gives a brief flowchart for Injection Strategies.
Positive Waterproofing from Negative Side, Grid Injections Low Viscosity Pus or Low Viscosity Acrylic/Methacrylate Gels

Water penetration is often caused by bad concrete compaction, honeycombing or defective seals. Sometimes an interconnected void system also allows water to pass through the element and causes leakages. Grid injection is an application technique, developed from the standard crack injection process. This method is more useful where a true source of leakage is not easily traceable and a complete water stopping solution is required.

Normally if the injection is to be performed into the element, (around a cracks) a combination of polyurethanes is generally used. For very low water ingress or dampness a low foaming polyurethane (PU) can be used in isolation. In case of heavy ingress or water under pressure, a high foaming PU is used as a primary injection to stop the heavy flow, followed by a non-foaming low viscosity structural PU. Low viscosity Acrylic/Methacrylate gels are used specifically for curtain grouting beyond the structure into the soil, when a waterproofing injection into the element is not possible or successful, due to technical, or economic reasons. The gelling of the substrate adjacent to the structure or the injection of gels into gaps in the structure creates a sealing layer, which provides a secondary waterproofing for structural components. These materials can also be used to increase the bearing capacity of soils for foundations or abutment walls. The schematic for the injection is shown in figure 3 and the practical process is shown in figure 4. The advantages of using these materials include:

- Sealing without digging
- Long-term tested, Systems
- Waterproof up to 12 bars
- High chemical resistance
- Adjustable to soil conditions
Thus, no water can reach the leakage affected elements anymore and they have a chance to dry out fully. For a curtain injection first of all a grid of packers has to be set up. The grid should cover the highest assumed level of ground water. The distance of 30cm in-between the packers is just an average.

**Treating Failed Expansion Joints/Water-bar Injection**

This is a special injection application used when joint treatments in an RCC Structure fail. Water-bars are used to seal joints in moving structures against pressurized water. However, the concrete often proves to be defective in the area of the water-bar because of inadequate compaction. Water-stop injections effectively address this defect. The materials used here are flexible methacrylate/Acrylic Gel Injections. This schematic is shown in figure 5.

**Re-injectable hoses**

Other critical areas with regard to the water tightness of a building or structure are expansion joints that are not sealed with water bars. Inserting injection pipes provides the possibility of sealing expansion joints effectively at a later date. The material used for such cases must display excellent flow properties. Figure 6 shows the Injection Hose System.

Injection is a proven method of sealing against pressurized water in structural renovations. The grouting of injection hoses also provides the benefit of using the advantages of injection technology in new construction specifically for the sealing of construction joints. New generation injection hoses can be injected several times, have been used successfully for construction joint sealing for many years. They can be injected with microfine cements, acrylate gels or urethane resins. In contrast to passive sealing systems such as conventional water stops, which only seal by so-called circumference extension, active systems such as injection hoses and injection grouts can be used to strengthen possible weak points in the concrete caused by cracks or badly compacted concrete.

**Conclusions**

The technologies highlighted in the article are a first step to stopping water leakages completely. The injection treatment is usually followed by treating the transition with flashing or expansion joint tapes. This is finally protected by a coating system to enhance the durability of the waterproofing system as a whole.

In conclusion, it is important to know and identify the water ingress avenues expected in the building structure. This will help us in identifying the system that can withstand these loads over time and provide a reliable seal against water ingress into living spaces. The consequences of water/dampness entering the living space is multifold and can impact health, safety, fire-worthiness, structural durability, aesthetics as well as can destroy property. These issues need to be addressed by the waterproofing system, to improve living conditions and safety. Of course, the combination of materials, detailing and application will finally determine the success of the waterproofing system. For more details, contact at ssbuildchem@yahoo.in.
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There has been an exceptional change in the realm of industrialization. The quantity of industries is expanding step by step which has emotional impact on nature. Because of the expansion in number of industries, the degree of carbon dioxide outflows is expanding at a pinnacle rate. Carbon dioxide has become a significant method of reasoning for the yielding of greenhouse impact which is mainly due to the cement production as depicted by the green technology research. The expenses of cement are likewise expanding day by day. The manufacturing of concrete needs colossal vitality, therefore, release same measure of carbon dioxide which is exceptionally perilous for the human well being. Because of this vulnerability, it has gotten compulsory to alleviate the creation of cement by replacing it with alternative materials, for instance, fly ash, bottom ash, ground granulated blast furnace slag, rice husk ash, corn cob ash etc which has the similar properties as that of cement. As it is well known fact that Ordinary cement and concrete composites offer much flexibility and cost effectiveness in their utilization but they are exposed to physical and chemical attacks which affects their performance; therefore, these requires costly repair and maintenance works. Under different loads and situations, ordinary concrete is not much advantageous for effective service life. Therefore, it is pertinent to produce the modified concrete with outstanding properties so that minimum amount of cement is highly desired with the intention that economical and sustainable construction may be achieved along with the reduction in CO₂ emissions in the atmosphere.

The journey of nanotechnology begins from the talk of well known Nobel Laureate Richard Feyman in 1959 at the California Institute of Technology. Nano technology brought a great revolution in the construction world during the past few decades. Nanotechnology is commonly considered to deal with particles in the size range less than 100 nm and with the nano materials manufactured using nano particles. It is a revolutionary step in the field of construction which deals with the synthesis, characterization, utilization and analysis of materials at the nano scale. These can be utilized to improve the mechanical properties and furthermore, to examine the microstructure of concrete. Nano materials have the incredible potential to act as filler which lessens the likelihood of permeability. There are various sorts of nano materials, for example, Nano-silica (NS), colloidal Nano Silica (CNS), Nano-Al₂O₃, Nano-TiO₂, Nano-ZnO, Nano-Fe₂O₃, Carbon Nano tubes (CNT), Nano Fly ash (NFA), Nano concrete, Nano silica fume (NSF) which will brings about the decrease of carbon dioxide discharges.
Commonly used Nano materials and their properties:

**Nano-silica (nano-SiO\textsubscript{2}):** Nano Silica particle can be produced by the different methods such as: Sol-gel method, Electric-Arc-method, biological methodology, precipitation methodology.

Applications of silica nano particles:

i. These are used as an additive for the manufacture of rubber and plastics.

ii. It is acting as strengthening filler for concrete and other construction composites.

iii. It also acts as a stable, non-toxic platform for biomedical applications such as drug delivery.

**Nano-alumina (nano-Al\textsubscript{2}O\textsubscript{3}):** Nano size alumina particles are in the spherical form and have high specific surface area. Methods for obtaining alumina in nano form:

i. By grinding the particles of alumina powder to a nanometer level (for instance, 10-50 nm).

ii. By the decomposition of Al(OH)\textsubscript{3} to aluminium oxide in the rapid achievement of the temperature of decomposition 175 °C and use for it the pressure of 5 bars within thirty minutes. When the decomposition temperature is achieved, aluminium oxide particles in nano size can be obtained.

**Nano titania (nano-TiO\textsubscript{2}):** These are the particles of titanium oxide having diameters less than 100 nm. Ultra fine titanium oxide has the capability to block the ultra violet radiations thereby these acting as sunscreens. These are considered as safer than the other substances for UV protection. Ultrafine TiO\textsubscript{2} is used in housing and construction as an additive to paints, plastics, cements, windows, tiles.

**Carbon nano tubes (CNTs):** Carbon nanotubes (CNTs) are cylindrical molecules which are rolled-into the sheets of single-layer carbon atoms (graphene). These can be categorized into types such as single-walled carbon nano tubes (SWCNT) having diameter of less than 1 nanometer (nm) and multi-walled carbon nano tubes (MWCNT) having several concentrically interlinked nanotubes with diameters more than 100 nm. CNTs have outstanding thermal, electrical and mechanical properties substantially relying on their dimensions. The diameters for multi walled carbon nano tubes and single walled carbon nano tubes are in the range of 1.4–100 and 0.4–3 nm, respectively.

CNTs are produced by the three different methods such as:

- Arc Discharge
- Laser ablation of graphite
- Chemical vapor deposition (CVD)

Graphite is combusted electrically or by means of laser in the first two methods and CNTs developing in the gaseous phase are separated.

**CVD process**

CVD method produce large amount of CNTs under controllable conditions and also these produces at a very low cost. In this process, a metal catalyst can be combined with the carbon-containing reaction gases (such as hydrogen or carbon monoxide) to form carbon nanotubes on the catalyst inside a high-temperature furnace.

**Applications of Nano Technology in various fields:**

A. *Nano Technology in Construction:*

Nanotechnology has been used in various disciplines of civil engineering including better design and construction processes. Nanotechnology is helpful for the development of different structural materials with their different properties, lighter weight and stronger composites, self-disinfecting surfaces. A lot of analysis has been done on the concrete at the nano level to be aware of its structure.

- **Nano Silica:** Silica fumes in micro form are added to the concrete for the purpose of filling the voids, decrease alkalinity and also increasing the resistance against chemical attack. Thus it is well established that silica fumes increase the strength of concrete and produce a denser and more homogeneous matrix. It was believed that the nano silica particles will be more effective than the micro silica fumes. Nano silica can be added to the concrete due to many reasons such as:
  - Increasing the density
  - Reducing porosity leading to a decreased water penetration.
  - Improving the bond between cement matrix and aggregates
  - Results into enhancing the mechanical properties of concrete.

- **Nano Alumina:** It performs similarly as nano silica performs as it leads to a more compacted microstructure of cementitious composites by decreasing the porosity and enhances the compressive strength. It is worth noting that nano-alumina was proved to improve concrete performance at both elevated and low temperatures.
Nanotechnology

- **Nano Titania**: Nano titanium dioxide is another material that has gained popularity for its usage in concrete. These nano particles accelerate the rate of hydration and increase the degree of hydration. Further, the incorporation of nano-titania (nano-TiO₂) may lead to enhancements in strength in addition to the improvement in resistance against chloride penetration. The impact of nano-titania addition on the performance of cementitious composites at an elevated temperature turned out to be comparable to composites incorporating nano-alumina.

- **Carbon nano tubes (CNTs)**: The addition of CNTs in cementitious composites is a challenging task due to the difficulty of obtaining uniform dispersion of CNTs in the cement matrix. If the CNTs are not properly dispersed in the cement matrix, then these results into the poor microstructure which greatly affects the mechanical properties. The compressive and flexural strength of composites containing CNTs greatly enhances up to 50 and 87%, respectively. It also improves both the fracture energy and flexural toughness. CNTs increase the crack bridging capacity of cementitious composites acting as networks between the crack and the pores. CNTs act as the nano filler of voids and thus reduce porosity. The incorporation of CNTs in the cement composites decreases the drying shrinkage. It is worth noting that the influence of CNTs on the microstructure, porosity and thereby mechanical properties of cementitious composites is highly dependent on the quality of their dispersion within cement matrix as well as on the type of surfactant to be used. The benefits of CNTs in concrete are as follows:
  - Durability
  - Crack Prevention
  - Helps in the enhancement of mechanical and thermal properties

Presently, the utilization of nano materials in construction is reduced, due to the following reasons:
  - The lack of information regarding the suitable nano materials
  - The lack of detailed information regarding the nano products content
  - Cost of nano materials are extremely high
  - The risks of health associated with nano materials

**B. Nano Technology in medicine**: The medical application of nanotechnology is nano technology where it ranges from the medical applications of nano materials and biological devices to nano electronic biosensors and even possible future applications of molecular nanotechnology such as biological machines. Presently, the problem arises due to the toxicity and environmental impact of nano scale materials used for the nano medicine.

**C. Nano Technology in electronics and IT**: Nano technology made a great revolution in computing and electronics leading to faster, smaller and more portable systems which can manage and store larger amount of information. These includes:
  - Transistors: These are the switches which enable all the modern computing, its size can be reduced with the help of nano technology. As nano technology helps in achieving the smaller, better and faster transistors which only means that the entire computers memory can be stored into a single tiny chip.
  - Ultra-high definition displays and televisions are now being sold that use quantum dots to produce more vibrant colors while being more energy efficient.
  - Using magnetic random access memory (MRAM), computers will be able to “boot” almost instantly. MRAM is enabled by nanometer-scale magnetic tunnel junctions and can save data quickly and effectively during a system shutdown or enable resume-play features.
  - Nano particle copper suspensions have been developed as a safer, cheaper and more reliable alternative to lead-based solder and other hazardous materials commonly used to fuse electronics in the assembly process.

**D. Energy Applications of nano technology**: Nanotechnology also plays a vital role in traditional energy sources and is greatly enhancing alternative energy approaches to meet the increasing demand of energy in the world. Numerous researchers are investigating approaches to develop perfect, reasonable and sustainable power sources alongside intend to reduce energy utilization and lessen toxicity burdens on the environment:
  - Nanotechnology is improving the productivity of fuel production from crude oil materials through better catalysis. It is additionally empowering reduced fuel utilization in vehicles and power plants through higher-efficiency combustion and decreased friction.
  - Nanotechnology is additionally being applied to oil and gas extraction through, for instance, the utilization of nanotechnology-empowered gas lift valves in offshore activities or the utilization of nano particles to identify microscopic down-well oil pipeline fractures.
  - Scientists are exploring carbon nano tube “scrubbers” and films to isolate carbon dioxide from power plant exhaust.
  - Scientists are creating wires containing carbon nanotubes that will have a lot of lower resistance than the high-strain
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wires as of now utilized in the electric grid, therefore reducing transmission power loss.  
• Nanotechnology can be joined into solar based panels to change over daylight to power all the more proficiently, encouraging cheap solar power in the future. Nano structured solar cells could be less expensive to fabricate and simpler to introduce, since they can utilize print-like assembling forms and can be made in adaptable rolls as opposed to discrete boards. More current research recommends that future solar converters may even be "paintable."
• Nanotechnology is as of now being utilized to create numerous new sorts of batteries that are faster charging, progressively productive, lighter weight, have a higher power density and hold electrical charge longer.  
• An epoxy containing carbon nanotubes is being utilized to make windmill cutting edges that are longer, more grounded and lighter-weight than different sharp edges to build the measure of power that windmills can create.  
• In the area of energy harvesting, researchers are developing thin-film solar electric panels that can be fitted onto computer cases and flexible piezoelectric nano wires woven into clothing to generate usable energy on the go from light, friction and/or body heat to power mobile electronic devices. Similarly, various nano science-based options are being pursued to convert waste heat in computers, automobiles, homes, power plants, etc., to usable electrical power.  
• Energy efficiency and energy saving products are increasing in number and types of application. In addition to those noted above, nanotechnology is enabling more efficient lighting systems; lighter and stronger materials for the transportation sector; lower energy consumption in advanced electronics and light-responsive smart coatings for glass.

Limitations of Nanotechnology  
• Perhaps the greatest detriment that the world is confronting a direct result of nanotechnology is the lack of employment in the fields of conventional farming, fabricating and industrial sector and that is due to the huge advancement of the nanotechnology. Nanotech gadgets and machines have taken place of people to work quicker and proficiently, which has reduced the significance of man power in the field of practical work.  
• Another huge threat, which is brought into the world with the coming of nanotechnology, is the easy availability of nuclear weapons. Nanotechnology has made these weapons more powerful and more destructive. Unauthorized, criminal bodies can reach nuclear weapons easily, and its formulation could be stolen. Unapproved, criminal bodies can reach atomic weapons effectively and its plan could be stolen.  
• Nanotechnology has increased the chance of the health issues. Because of minute size of nano particles, it increases the danger of inhalation that can seriously harm lungs and could likewise prompt deadly medical problems. It enhances the risk of harming the lungs if nano particles are breathed in for 60 seconds.  
• At present nanotechnology is on the most expensive technologies and its cost is increasing day by day. The main reason for not being cost efficient is the molecular structure and processing of the product. It is difficult for the manufacturers to randomly produce dynamic products using nano technology. Huge pricing of nanotech machines makes it unaffordable currently.  
• There are some ethical issues which include the poisoning of mass material which has been processed at a nano scale. It may leave negative impacts on the health and industry. Mass poisoning could happen only if the coatings on the products that nanotechnology has to produce include poisonous micro particles that can penetrate into the brain when it comes in contact with humans.  
• While nanotechnology can help to produce a wide range of goods and improved products, however the particles that are made are so tiny to such an extent that they may cause inevitable medical issues in the bodies of purchasers.  
• Nanotechnology has raised the standard of living but at the same time, it also enhanced the risk pollution in water and air. The pollution caused by nanotechnology is known as Nano Pollution. Such kind of pollution is very dangerous for living organisms under water & on earth.

Conclusions  
Due to the potential benefits of nano particles, nano materials and nano technologies have gained considerable scientific interest in various fields. Nanotechnology makes the structure lighter and more efficient than the other materials. Although construction materials may constitute only a small part of this overall effort, it could pay enormous rewards in the areas of technological breakthroughs and economic benefits. Although today the total market share of nano products for construction is small and deemed to be applied in niche markets, this share is expected to grow in the near future. Nano particles play a significant role as a basis for the design, development and production of materials in the construction industry. Nano materials assist in enhancing the properties of concrete.

Until today, concrete has primarily been seen as a structural material but nanotechnology can help to make it as multipurpose "smart" functional material. They can improve the overall performance of concrete since they have high surface area to volume ratio providing the potential for tremendous chemical reactivity. Due to the negative impact of nano technology, its use may be reduced. The people working with the nanotechnology or nano materials have to be more careful as these helps in creating health issues and these also put a greater effort in creating pollution called as nano pollution.
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WIRTGEN GROUP Machines Construct Yogyakarta International Airport

The first plane to land at the new Yogyakarta International Airport (YIA) on the Indonesian island of Java was an A320 from Jakarta. Eleven slipform pavers from Wirtgen played a key role in the airport’s construction. Once completed, up to 20 million passengers will be able to take off and land there every year. With a current terminal area of 130,000 m², the new airport is set to replace Adisutjipto Airport, which is struggling with capacity issues.

The tight schedule was a particular challenge in the large-scale project in Yogyakarta. Reliable solutions from a single source were required if the concrete slabs were to be completed on time. And this is precisely what the Wirtgen Group sales and service company in Singapore promptly delivered, working in collaboration with the Indonesian Wirtgen Group dealer PT Gaya Makmur Tractors. This included the large fleet of machines required, but also technical support and on-site application consulting.

Exceptional Quality Makes Concrete Surfaces Stand Out

A team of four SP 64 machines, six SP 500 machines, and one SP 84i machine formed the final line-up for the high-precision, cost-effective paving of the 3,250 m-long, 45 m-wide runway, taxiways, and the apron. The 50 cm-thick concrete layer was paved across a width of 2 m, 5 m, or 6 m, depending on the area involved. During the process, dowels, which were prepositioned on reinforcement cages spaced at transverse intervals of 30 cm, and a wire grid were integrated in the concrete as additional reinforcements.

“The quality of the concrete surfaces is excellent,” says Andek Prabowo, CEO of PT PP Presisi Tbk Group of PT PP (Persero) Tbk. The machines also excelled in performance. “The airport is set to grow by another 65,000 m² during the second phase of construction. The landing runway will also be extended by another 350 m,” he says. When the time comes, the fleet of Wirtgen slipform pavers will be ready for action.

Four concrete pavers from Wirtgen were responsible for the high-precision, cost-effective paving of the concrete surfaces at YIA.
Wirtgen slipform pavers are perfectly suited to a wide range of requirements, and are perfect for producing concrete surfaces with a high degree of precision without using the fixed steel molds so often utilized at airports.

Wirtgen – The Airport Construction Specialist

Wirtgen is the ideal technology and quality partner for airport construction, whatever the specifications or location involved. A seamless product range, experienced application experts, and reliable service are key in this respect. Boasting a wide variety of applications, Wirtgen slipform pavers can tackle highly diverse requirements on job sites in any part of the world. For instance, they can easily produce concrete surfaces with a high degree of precision without using the fixed steel molds, so often utilized at airports.

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Multiple construction and construction materials industry segments converged at CONEXPO -CON/AGG & IFPE 2020

Multiple construction and construction materials industry segments unveiled new technologies and products, shared knowledge, networked with industry peers and bought equipment at the CONEXPO-CON/AGG & IFPE 2020, held at the Las Vegas Convention Center and Festival Grounds during 10-14 March 2020.

Registrations for the show totaled over 130,000. At the conclusion of the show, cancellations from international attendees totaled less than 1 percent, indicating that the construction equipment industry in the U.S. remains optimistic, despite concerns about COVID-19.

“We refer to CONEXPO-CON/AGG as the ‘heavy metal’ show, but it’s more than that. It’s also small equipment, education and technology. And that was reflected in every way,” said Mary Erholtz, Vice President of Marketing at Superior Industries and CONEXPO-CON/AGG 2020 Show Chairperson. “Giant machines, incredible exhibits, fantastic education and huge expectations. Organizers of CONEXPO-CON/AGG have a legacy of building and innovating on previous shows, and the 2020 gathering extended the record of success.”

Exhibitors across the show, from the Festival Grounds to North Hall to Bronze Lot to South Hall, expressed enthusiasm for the tremendous engagement they received from contractors and producers looking to purchase equipment. According to IFPE Show Chairperson David Price, Global Marketing Manager of HydraForce Inc., “The crowd was much better than expected under the circumstances and most importantly, the right buyers were on the show floor. We were very pleased with the strong showing from the 300-plus exhibitors at IFPE 2020, and we are now looking forward to the 2023 show.”

Mike Ballweber, President, Doosan Bobcat echoed similar sentiments, “We had a record breaking response in terms of sales leads and attendance at our booth, and our dealers and customers were really excited to be here.”

With growing concerns about COVID-19, the show management worked closely with the Las Vegas Convention and Visitors Authority and the Southern Nevada Health District to make sure exhibitors, vendors and attendees were provided with heightened cleaning services and hand sanitizers to help reduce the spread of germs and enable show participation to stay healthy onsite.

“We were pleased with the success of the overall show and attendance in our booth,” said Ingo Schiller, President and CEO of Tadano America Corporation. “The management team at CONEXPO-CON/AGG has been monitoring the situation and they
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made a very difficult decision to close the show a day early. We appreciate their leadership and we look forward to CONEXPO-CON/AGG 2023."

**Key metrics reflect overall quality of attendees:**
- U.S. buyer attendance increased 8 percent from the 2017 show, and total buyer attendance improved by almost 5 percent.
- Overall contractor and producer attendance grew by 14 percent.
- 6-in-7 attendees serve in a decision-making role.
- Total registered attendance reached over 130,000 for the week.
- Attendees purchased a record-breaking 75,622 tickets for education sessions at the show, a 46-percent increase from the 2017 show.

At the same time, the technological change revolutionizing these industries was pervasive across the shows’ record 2.7 million-plus net square feet of exhibits featuring 2300-plus exhibitors from the leading U.S. and global manufacturers, from multinational giants to small firms with specialized products.

**CONEXPO-CON/AGG’s Tech Experience**

Whether it is artificial intelligence, autonomous equipment, big data, small gadgets, new energy technologies, sustainable highways or the future of cities themselves, CONEXPO-CON/AGG’s Tech Experience focuses on what contractors and manufacturers need to know to keep ahead of the technology curve.

“I was amazed at what some of the minds we had at the Tech Experience think up,” said Helen Horner, Director of Education Programs at the Association of Equipment Manufacturers (AEM), the organization that co-owns and operates CONEXPO-CON/AGG. “What we’re seeing in bringing all these ideas to one place is how some of them connect to form new ideas. Hopefully, those ideas germinate after the show to give us even more amazing technology to explore at the next CONEXPO-CON/AGG.”

One example was a Tech Talk on wireless energy transfer built into roadways to continuously charge electric vehicles while they drive, followed by a talk on turning concrete into a battery.

“New ideas and new connections are the core of what we want people to experience at CONEXPO-CON/AGG,” said Show Director Dana Wuesthoff. “The big iron and big deals are definitely fun, but the technology, information and education are what secure the future of this industry, and the continuing viability of the businesses that attend and exhibit here.”

**Some of the Tech Talk highlights included:**
- **Driving Decisions with AI:** The insights that Artificial Intelligence can now gather for organizations are unparalleled. A presentation showed how construction data can be used to identify the right projects, people and problems before it is too late.
- **Smart Cities:** The technology to build Smart Cities of the future is now available. Digital solutions are providing data to better manage job sites. New generations of construction employees will leverage the big data, advanced automation and virtual site mapping to build the smart cities of tomorrow.
- **3D Printing Buildings – Current Possibilities & Future Implications:** Branch Technology presents their first demonstration structure as a house created entirely by 3D printing! Using the world’s largest freeform 3D printers, the shape of the next generation of housing appears in several weeks instead of several months.
- **Wireless Energy Transfer:** Imagine an electric vehicle like a Tesla or BMW driving down the road and maintaining a 60-80 percent charge the entire way! Wireless power transfer on roadways means that electric vehicles can charge as they drive.
- **Prevention & Protection of Traumatic Brain Injuries:** Prevention of work-related traumatic brain injuries (wTBI) is of utmost importance. One study showed that 45% of patients had not returned to work five years after the accident. This presentation provides an overview of wTBI in the construction industry in North America and Europe, with a focus on the events causing wTBI.

**Other highlights included:**
- Partnership with women in construction groups to highlight the growing role women play in the industry, including the unveiling of the world’s largest 3-D printed statue of a human to honor the growing role women play in the construction industry.
- Workforce solutions area in the Festival Lot that showcased industry recruitment best practices.
- The Tech Experience returned for a second year and focused on modern mobility, sustainability and smart cities.
- The first-ever Fluid Power Hour for the co-located IFPE show, which featured an opportunity for engineers to network with their peers on the show floor.
Onexpo 2020 was held as scheduled on March 10, 2020 in Las Vegas, USA. Established Chinese construction equipment enterprises like XCMG, Zoomlion, Sany, LiuGong, Shantui, Sunward, and many more once again demonstrated the strength, responsibility and self-confidence of Chinese construction equipment industry. With entry restrictions to USA due to the Coronavirus, the Chinese construction equipment booths were represented by the companies’ local dealers and office representatives.

At a press conference of Chinese construction equipment brands jointly sponsored by China Chamber of Commerce for Import and Export of Mechanical and Electrical Products (CCCME) and China Construction Machinery Association (CCMA), Yang Yihang from Chinese Consulate General in San Francisco and Albert Cervero, Vice President of AEM and the Show Organizer, gave speeches, while representatives of leading Chinese construction equipment enterprises XCMG, Zoomlion, Sany, LiuGong, Shantui, Sunward, Dingli and Sinoboom gave presentations. The conference was attended by prominent Chinese and foreign media.
China has become the largest country for construction equipment with total sales of US$ 100 billion in 2019. Sales of hydraulic excavators exceeded 230,000 units, and sales of truck cranes reached 42,000 units, both of which were a historic high. In 2019, the Chinese construction equipment enterprises not only achieved excellent performance in the market but also made outstanding achievements in new product development and technical progress. With Chinese leading 5G technology, many products of Chinese construction equipment such as hydraulic excavators, wheel loaders, bulldozers and rollers have reached a higher level in smart technology. With 5G technology, operators can operate and control machines thousand miles away. Zoomlion, LiuGong and other Chinese enterprises displayed those products with this high technology at Conexpo 2020.

To increase the medical care and treatment capacity against the coronavirus in Wuhan and control epidemics timely, two new infectious disease hospitals in Wuhan, namely Huo Shen Shan Hospital with 1,000 beds, and Lei Shen Shan Hospital with 1,600 beds, were built in a very short span of 9 and 12 days, respectively – an unparalleled feat in the construction sector, in which the Chinese enterprises played important role. As soon as the news of constructing the emergency hospitals was announced, Zoomlion, Sany, XCMG and LiuGong as well as other enterprises dispatched hundreds of construction equipment and operators to Wuhan and equipment operators worked day and night without fearing the risk of contagion or arguing for remunerations, for a miraculous completion of the hospital.

Chinese construction equipment enterprises have always stepped forward in every natural disaster to actively fulfill their social responsibilities, for instance, in combating the sleet and snowstorm in Southern China and during the Wenchuan earthquake in 2008. On August 5, 2010, when a Copper Mine collapsed in northern Chile, in which 33 miners were trapped underground 700m deep, Chinese manufacturer Sany provided a crawler crane for site rescue free of charge. On March 11, 2011, when a tsunami struck the Fukushima nuclear plant and resulted in nuclear leak, Sany donated a 62m concrete pump truck to Tokyo Electric Ltd for water cooling operation. These fully showed the social responsibilities, undertakings and spirit of internationalism of enterprises from China. To date, many Chinese construction equipment enterprises have returned to work, and their output of machines can meet the sharply increasing demand of the market after the Covid-19 epidemic.
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Liebherr has unveiled its new LTM 1120-4.1 at the CONEXPO in Las Vegas using the slogan “There’s nothing more on 4!” It is the most powerful 4-axle all-terrain crane ever built. The new 135 US ton (120 t) machine breaks into a performance class which has previously been the sole preserve of 5-axle cranes. As far as boom length is concerned, it is on a par with 240 US-ton (200 t) class cranes as its 217 ft (66 m) telescopic boom is the longest ever to be installed on a 4-axle mobile crane. Liebherr will start deliveries of the new LTM 1120-4.1 in autumn 2020.

Maximum lifting capacity and boom length

Delivering maximum performance on a 4-axle mobile crane is a concept which has been traditional at Liebherr for decades. For example, when the current LTM 1100-4.2 was launched in 2009, it set new standards in the 4-axle class with a lifting capacity of 22,490 lb (10.2 t) on its 197 ft (60 m) telescopic boom. The new 135 US ton (120 t) crane has added 18 percent to this value at the same length. What is more, the LTM 1120-4.1 can extend its telescopic boom to up to 217 ft (66 m), an additional 10 percent. This means it reaches the same level of many 240 US ton (200 t) mobile cranes on the market.

The new LTM 1120-4.1 delivers outstanding lifting capacity values, particularly with the boom fully raised. Its lifting capacity of 19,800 lb (9 t) on the 217 ft (66 m) telescopic boom makes it ideal for erecting tower cranes and radio masts. Lattice extensions enable the new 135 US ton (120 t) crane to achieve hook heights of up to 308 ft (94 m) and radii of up to 210 ft (64 m). For this a 23 ft (7 m) lattice boom extension is installed as well as a 35 to 62 ft (10.8 to 19 m) double folding jib, which, as an option, can also be hydraulically adjusted between 0° and 40°. A 6.6 ft (2 m) erection jib and a runner, which can be swung to the side, round off the equipment list.

Great economy and flexibility

The new LTM 1120-4.1 can tackle jobs which normally would require a 5-axle crane, eliminating all the logistics work needed for the larger model. Because a 4-axle crane delivers benefits in terms of licensing and route permits, it can tackle jobs faster and with greater flexibility. The design of a 4-axle crane also enables it to work where there is insufficient space for larger cranes. On constricted sites, in particular, Liebherr’s VarioBallast® and VarioBase® innovations deliver enhanced performance, flexibility and safety for this new crane model.

VarioBallast® on the LTM 1120-4.1 enables the crane to operate with a ballast radius of 12.6 or 15.6 ft (3.83 or 4.77 m). The ballast radius can be reduced by 3 ft (940 mm) quickly and easily using standard, mechanically adjustable ballasting cylinders when site conditions get tight. The large ballast radius delivers higher performance and often also cost benefits by reducing ballast transport as many crane jobs can be completed using the system with fewer counterweights.

The maximum of 68,300 lb (31 t) of ballast is distributed so variably that in addition to the 26,400 lb (12 t) axle load version, uniform axle loads of 29,800, 33,000 or 36,400 lb (13.5, 14.5 and 16.5 t) can also be achieved. That means benefits driving on construction site and in countries where higher axle loads are permitted.

ECOdrive and ECOmode reduce fuel consumption and noise emissions

A six-cylinder Liebherr diesel engine in the undercarriage, which develops 330 kW / 449 bhp and torque of 2,335 Nm provides the LTM 1120-4.1 with all the power it needs. The engine satisfies the new stage V emissions directive and can also be built to comply with the regulations which apply in countries outside of Europe, for example Tier 4 for the USA or stage III for low regulated countries.

The ZF-TraXon gearbox is used to transmit the power to the crane’s axles. The ECOdrive has proven its value over several years – it delivers enhanced drive properties which both save fuel and reduce noise. Hillstart Aid makes starting on gradients easier.

ECOmode for crane the operations is now standard on Liebherr mobile cranes with a load-sensing control system – the crane controller calculates the perfect engine speed for the working speed selected using the control lever to avoid unnecessarily high engine speeds. That also saves fuel and makes the engine quieter.
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In this fast-developing world, it has become important for civil engineers to focus both on global developments and the impact on the environment. This approach leads to innovations and research on conserving the environment without compromising on the developments. One such innovative technology is the geopolymer concrete - an eco-friendly technology that makes use of waste byproducts like fly ash, ground granulated blast furnace slag, etc., from various industries, in the preparation of concrete, instead of the Ordinary Portland Cement (OPC). The evidences from various researches show that using OPC in the preparation of concrete leads to almost 5-8% of the man-made global carbon-dioxide emissions, while using materials like fly ash and GGBS reduces carbon-dioxide emissions by 90%.

The seminar started with a keynote address by N.P Rajamane, who also shared comparisons between concretes made using Geopolymer and Portland cement as binders. This was followed by lectures on the following topics by eminent speakers:

- Geopolymer: An Alternative Binder, by Dr. R V Ranganath
- Geopolymer composites to cater to the needs of costal areas producing the same by using marine water, by Dr. T. Venu Madhav
- Development and application of Geopolymer masonry, by Dr. Radhakrishna
- Applications of Geopolymer Concrete, by Prof. SK Singh.

Dr. RL Ramesh, Secretary ICI-BC, thanked the members, dignitaries, speakers, sponsors and coordinators of ICI-BC and delivered the vote of thanks. The Seminar was attended by 250 participants who held interactive Q&A sessions and were very appreciative of the information shared and other tangible benefits that they derived.
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The Indian Concrete Institute, Goa Centre, in association with Ultratech Cement Limited organized the 9th ICI-Ultratech Awards Nite on 19th February 2020 at Hotel Fidalgo, Panjim Goa. The annual event was attended by nearly 250 invitees comprising of Engineers, Architects, Academicians, Builders, Developers, Contractors, Government officials, students and family members of the award winners.

The awards ceremony started with the traditional lighting of the lamp by the Chief Guest and Keynote Speaker for the evening, Er. V. Ramachandra, Functional Head (Ultratech Cement Limited) in the presence of Special Guests Er. K. Jayashankar, Zonal Technical Head (Ultratech Cement and Er. R.M. Dessai, Regional Head Marketing (Ultratech Cement), Er. Joseph Silveira, Chairman, Er. Vikrant Dessai, Secretary and Shivkumar Patil, Treasurer ICI Goa Centre. The Keynote Speaker presented his lecture on “Special Concretes for Challenging Constructions” through a very lucid power-point presentation while the Welcome Address was given by the Chairman and the Vote of Thanks was proposed by the Secretary, ICI Goa Centre.

The awards were given to outstanding concrete structures in 3 categories, namely, Infrastructure, Building and Residential Villa, and were assessed by a jury selected by the centre. An award was also given to the most Eminent Engineer in Goa.

In the Infrastructure category, the winner was the Atal Setu bridge constructed over the River Mandovi by L&T for GSIDC. A special jury award was also given to the Multipurpose Indoor Stadium constructed at Navelim by RBS Candiaparkar for SAI, Goa. In the Building category, the winner was Nanu Resorts, constructed by Nanu Estates at Arambol, Pernem. As the competition was fierce, the jury appreciation awards were also given to Elements, a multi-storey residential project constructed by Jayashree Associates, India for Shantilal Real Estates in Chicalim, Mormugao and the Government College constructed by Harsh Construction for GSIDC at Pernem. The winner in the well-built Residential Villa category was Vista do Rio, a high-end villa located at Aldona, Bardez constructed by NAC Buildcon for Rain Developers. The jury appreciation award in this category was given to Ajinkya Tara, a large residential house constructed for Pandurang G. Patil by Guruvendra Gauns Desai at Sirvoi, Quepem.

The award for the most eminent engineer was given to Er. Raghunath Mangesh Dhume who has worked in the civil engineering field for over 50 years. His achievements in the design and construction of concrete structures over the years within and outside the state have been exemplary. He has also authored a book in Konkani on the life of civil engineers in different projects.

The Jury Members and Executive Committee members of ICI, Goa Centre, were later felicitated by the Chief Guest for the appreciative work done by them.
A lot of writings, research articles, and discussions have taken place on the new construction of structures and on retrofitting of structures. Amid this, scant attention has been paid on how to maintain and monitor the health of the structures built either by the Government or private sectors.

The gap between these two aspects, i.e. between new construction & their upkeep, maintenance, repair, rehabilitation and retrofitting, requires an in-depth study. It is imperative to understand and put in practice the measures to be applied with regards to the design of the structure keeping in mind the physical and chemical properties of construction materials. All the many factors required to sustain the durability of the construction will have to be brought into serious focus if the construction and its maintenance are studied in close coordination.

As part of this study, the structural health assessment on the basis of visual inspection only performed of more than a thousand old dilapidated structures, including residential, non-residential, over-head water tanks, transmission line towers, etc., across India were analysed and assessed. Most of the structures had crumbled within 25-30 years of their date of construction and were found to be structurally unsafe. Preventive measures have been recommended after analysing and assessing the structural health of these structures.

**Scope of Study**

All the structures are designed to be functional and durable for a specific period of time. However, there are occasions when the useful life period of a structure gets shortened on account of some unavoidable circumstances. A structure is designed taking into consideration cultural, sociological, geographical and economical factors, and, thereafter, its designed life is calculated. The designed life of any structure is also dependent on the construction methodologies employed, construction materials used, and environmental factors like moist soil, sea shore, earthquake prone area, windy area, soil conditions, etc. Maintenance factors like timely annual repair, periodical repair, even structural repairs, enhance the durability of a structure. The factors depicting the design life and useful life of a structure is illustrated in the schematic diagram as shown in Fig. 1.

Where the design life has been determined / calculated in accordance with the specifications prescribed in BS EN 1990 Euro Code, the useful life of these assets, as per the Ministry of Corporate Affairs, Government of India, are shown in Table 1 which is as follows:

**Factors Responsible for Ageing, Dilapidation or Derelict Condition of Structures.**

Factors which cause ageing and dilapidation of the load bearing and RCC framed structures, over-head water tanks, transmission line towers and other structures are as follows:

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**Sangeeta Pandey**, Chief Manager (Civil), Power Grid Corporation of India Ltd., Patna, **PVS Sudhakar**, Sr. General Manager (Civil), NOFN Works, Power Grid Corporation of India Ltd., Vishakhapatnam & **Dr. Achintya**, Professor of Civil Engineering and Principal, Darbhanga College of Engineering, Darbhanga.
I. Corrosion and cracking causes ageing of structural components. There is a decrease in the tensile strength with the increase in corrosion level. Corrosion levels less than 3% cause minor reduction in tensile strength of approximately 3%, whereas when corrosion level is more than 10% the tensile strength may decrease by 75 to 90%. Further, the critical bond strength and ultimate bond strength in a reinforcing steel bar decreases with the percentage of corroded surface for various corrosion levels when the corroded area increases by 40 to 100%.

II. Buildings or other structures may be damaged when subjected to extreme loading conditions resultant to natural disasters such as severe earthquakes, landslides, cyclonic storms, floods, heavy rainfall or snowfall, etc.

III. Exposure to aggressive environments such as marine environment, freezing and thawing environment, acidic environment, and climatic conditions like sea shores (where the humidity is high), dry and arid areas, etc., is one of the significant factors which lead to damage and deterioration of the structure.

IV. Liquefaction, differential settlement of soil, extreme conditions of soil existing in hilly, dry and arid areas, and many other factors may lead to soil failure, and, therefore, cause damage to the foundation of the structures.

V. Biological factors like termite attacks, etc., affect the durability of a structure.

VI. Aggressive chemicals accelerate the deterioration of structural elements particularly in industrial buildings.

VII. Deleterious building materials used at the time of construction and improper construction methodologies employed may result in premature damage to the structure. Many times, fast construction and not giving proper time for curing, leads to cracks and other harmful effects on structures.

VIII. A slight change in composition of concrete mix by increasing or decreasing the quantity of cement, sand (fine aggregate), stone chips (coarse aggregates), water and admixtures (if any), at the time of construction, may greatly affect the workability, strength and durability of the concrete structures.

IX. Design faults such as cover to reinforcement, correct choice of type of foundation, etc. may lead to fast ageing of heavy structures.

X. Changes in occupancy, neglect in maintenance, penetration of water and/or chemicals in the structure may give rise to unforeseen stresses in structures.

XI. The basic causes, which lead to ageing of structures despite maintenance, are the difference in codal provisions.

XII. Site activities can also contribute to the deterioration of the structure. Vibrations caused by heavy vehicles (trains, trucks, or highway traffic) passing nearby may cause stresses in the structure because they were not taken into consideration at the time of designing. Around busy vehicular movement areas (i.e., loading docks, warehouse storage bays, etc.), the possibility for impact damage is significant. Columns and walls are highly susceptible to collisions, which can cause structural cracks or deterioration of the surface of the member by exposing reinforcement to the weather.

XIII. India has experienced several major earthquakes in the past few decades and according to IS 1893 (Part I: 2002), around 56% (12% in Zone V, 18% in Zone IV, 26% in Zone III) and 44% in Zone II of its landmass is prone to moderate to severe earthquake shaking intensity. So, not considering the Seismic factor for any part of India also caused many non structural and structural damages to all types of structures.

Choosing cost effective designs with less of building materials and not providing proper time to curing and other factors leads to fast dereliction of structures.

Health Monitoring of Structures

Structural monitoring plays a very important role and is essential for every structure. The main objective of structural health assessment is to place the structure into three categories:

A: The building has not shown any signs of distress and it satisfies all the safety and serviceability requirements according to relevant Codes of practice, hence, no action is needed towards repair, retrofitting or rehabilitation.

B: The building is seen to be deficient (or distressed) but it can be repaired and strengthened to satisfy the codal safety requirements or performance criteria set by the user.

C: The building is badly damaged. It is to be demolished and a new and a better building may be built.
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The main steps of structural health assessment will be to record the damage, if any, and find out the causes for distress in order to assess the extent of distress and to estimate the residual strengths of structural components and the system, including the foundation. After the structural health monitoring, the decision is to be taken whether retrofitting could be carried out or a new structure should be built to replace the dilapidated one, considering the stability, durability and cost-effective aspects. The buildings very commonly spoiled and inflicted with physical harm on its different parts so as to impair its normal function, usefulness and value, can be viewed in the following photographs (from Fig. 2 to Fig. 10). As for most of the cases, drawings were not available for the structures, the method adopted for analyzing and assessment of the structures was visual inspection. Tools used were measuring tape, rule, inspection mirror with swivel head calipers, plumb bob, straight edge feeler gauges, binoculars, camera and film, screwdriver, heavy duty pliers, flashlight, pocket knife, wire brush, magnifying glass, crack comparator level, clipboard and chalk or marker. After assessment a checklist was prepared.

**Rapid (Visual) Investigation**

There are three components and steps for visual investigation which are as follows:

1. Collection of information regarding details about the structure such as design of building, water tower, transmission tower, etc. and its utilization and maintenance in the past.
2. Visual inspection of condition of the structure at site and recording of the details of its distress.
3. Evaluation of the safety of the structure in the light of the specified performance criteria as laid down in the relevant building codes.

Details looked into in the course of visual investigation:

1. Verification of accuracy of original drawings. In the cases where the original drawings are missing or not available, a determination of basic building information was done. Major alterations made in the structure later, and which are not shown in the original documents (drawings) on the basis of which the structure was constructed, were identified.
2. The drawings – architectural, structural, mechanical and foundation plan – and other documents such as the construction specifications (with necessary changes, if any) of the structure, if available, was inspected and studied.

3. Soil and material test reports which are necessary for determination of the question as to whether the structure is durable and functional.

**Exterior Envelope Inspection**

The exterior envelope includes all building materials that are exposed to the outside environment. Walls, windows, doors, and roofs are the most commonly accepted components of the exterior envelope. In the overall inspection of the exterior envelope of the building, the probable causes of deterioration as a result of exposure to a change in the seasonal environmental conditions were kept in mind and findings of Exterior Envelope Inspections are described below:

**Walls:** Problems identified on the exterior walls can be translated to the interior. The exterior walls can be load-bearing or have a non-structural veneer. In a veneer system, a deficiency on the exterior can indicate a structural deficiency in the supporting members of the frame (as for e.g., if a beam in a concrete frame deflects, it can crush the veneer surface below it). As most of the structures were load bearing, so a deficiency on the exterior is transmitted onto an interior surface and can be observed directly. A deformation, crack, or angular displacements from the vertical orientation, of the exterior walls, because of some deflections or expansion on account of the structural frame exerting pressure on the walls, were noticed. The bowing of the crack patterns of the cracks on, some walls mostly indicate structural damages.

**Openings:** A separation of the surface of the walls from the window and door frames has been noticed in buildings with large window and door openings. Loads that would normally pass downward through this part of the wall must be diverted around the openings and back towards the ground. At lintels, sills, and thresholds, a distortion [sagging and bowing] of the window and door frames caused by the loads / forces in the walls that should have normally passed to the ground have been noticed. An assessment of the size and distortion of the window and door frames of structures for were done. A diagonal crack at the corner, which is evidence of percolation of water into the reinforcement steel in the structure, has been noticed. Windows and doors are also subject to abrasion and impact from whatever passes through them. Damaged edges and signs of impact in the windows and doors have been observed.
Health Monitoring

Roof: Cracks, major depressions, evidence of ponding, and other defects, on the surface of the roof in buildings were noticed. Ponding water increases the concentrated load in the area where it occurs, causing stresses on the structure for which it was not specifically designed. Depressions in the roof may indicate an impact blow that may have occurred during construction or during the service life of the building.

Foundation: Many cracks in the foundations, especially in areas near downspouts, corners of buildings, or where major structural supports such as columns meet the foundation walls or piers, have been noticed. These cracks may be the evidence and result of the uneven settlement of the soil.

Component Inspection
The Component Inspection is helpful in determination of the general condition of the structure. A critical evaluation of the structural elements was made with particular attention being given to those components identified in the previous section as potentially dangerous. The length, width, depth, and pattern of cracks, and the places of their occurrence, were observed, measured and recorded. Spalls arising out of the corrosion of the rebars and connectors, the loosening of defective connectors of precast concrete elements, and other defects were observed. The extent of corrosion of the rebars, the percentage (%) loss in cross-sectional area of the rebars, the deformations and other misalignments under loads (temporary or permanent movements), out-of-vertically (i.e. angular displacement from the vertical) of the columns were observed, and, where possible, measured.

Conclusions
Structural Health Assessment of structures is very essential factor. The following conclusions have been drawn to ensure safety and operational viability of the structures:

1. Based on our professional analysis, it has been observed that maintenance continues for comparatively very large period during useful life of structures. In post construction stage the day to day maintenance or upkeep of the building shall certainly delay the decay of the structures.

2. The structures always comply the relevant IS codes with major changes considerations for safety purpose as well as life of structure time to time.

3. All the works like repair, rehabilitation and retrofitting of structures must be performed during useful life of structures. Once the useful service life is over, or other reasons such as redevelopment and proposed change in use of the land and built facility, it may be required to deconstruct structures. Such deconstruction must be preceded by an organized deconstructioning. The decommissioning and deconstruction need to be well planned.

4. The purpose of repair is to bring the building to its original architectural shape and its intended purpose. Repairs are non structural in nature.

5. Rehabilitation is intended to regain the original strength of structures. Such intervention cannot provide more than original strength of the structures, and is appropriate if original strength provides an adequate level of safety and are as per relevant IS Codes.

6. Retrofit aims to enhance structural capacities of any structures in terms of any climatic factors like flood, fire, earthquake etc. To what extent the retrofit has to be carried out is an important decision that also has cost implications.

7. For both retrofitting and rehabilitation work original or existing structure should be in useable condition.

8. The priorities for retrofitting work for structural units may be decided as per National Disaster Management Authority Guidelines.

9. All unsafe buildings shall be constituting danger to public safety and shall be restored by repairs or demolished. Legal notice must be given to the owner or occupier of such structures written notices stating the defect thereof.

10. If the building or structure is not heritage type, then the decision of seismic retrofitting of the building can be based on Cost of Retrofitting as a percentage of Cost of Reconstruction at current rates and depending on whether it is or it is not part of a critical and lifeline facility.

11. Cost-based decision of technical options is presented in Table 3.

12. It is not cost effective to undertake repairs in excess of 50-60% of the replacement cost of the structure. As an alternative, it may make a lot of monetary sense to improve the operational lives of the existing structures through regular maintenance and perform minimal upgrades to ensure that the structures do not deteriorate any further and wherever feasible confirm to today’s operational and regulatory requirements.

References
4. Condition assessment as per National Disaster Management.
5. Retrofitting Guidelines by National Disaster Management Authority (NDMA).

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Table 3: Cost-based decision making of three levels of technical options

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Decision</th>
<th>Cost of Seismic Retrofitting as a percentage of Cost of Reconstruction (including demolition, removal of debris and construction) at Current Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Buildings part of Critical &amp; Lifeline Facilities</td>
</tr>
<tr>
<td>1</td>
<td>Retrofit, if cost of retrofitting is &lt; 50%</td>
<td>&lt; 30%</td>
</tr>
<tr>
<td>2</td>
<td>Detailed technical assessment to determine vulnerability of the building or structure (including analysis of the implications on cost; age; heritage value; importance; proximity to archaeological structure; criticality of building; current and projected Floor Area Ratios; residual life; disruption, expansion, and upgradation of services; and improved function). if cost of retrofitting is in the range 50% – 70%</td>
<td>30% – 50%</td>
</tr>
<tr>
<td>3</td>
<td>Reconstruct, if cost of retrofitting is &gt; 70%</td>
<td>&gt; 50%</td>
</tr>
</tbody>
</table>
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