

ECC CONCORD

In-house Journal of L&T Construction | Volume - 41, Issue - 1 | Second Special Edition 'Speed & Scale'

It's all about

SPEED & SCALE



From the EDITOR'S DESK

Even as this issue goes to print, India and Australia are squaring up to continue their rivalry in cricket at the iconic Melbourne Cricket Ground that is presently the world's largest cricket ground. The MCG's bragging rights will soon be challenged and superseded as the Gujarat Cricket Association's Motera stadium takes shape at Ahmedabad which, when completed, will be the world's largest stadium with the capacity to hold 110,000 spectators and a perfect example of our continuing theme of *Speed & Scale*. B&F IC was also responsible to help create history on October 31st when Prime Minister Narendra Modi dedicated the world's tallest statue to the nation by inaugurating the 182 m tall Statue of Unity. While its scale can easily be imagined, the fact that this mammoth structure was constructed in just 33 months is a towering example of our technology, engineering and construction skills.

We have been transforming skylines and Mumbai's impressive ever-rising skyline will have two additional tall towers – the ICC Towers – which is perhaps the first residential high-rise with a complete glass façade while in the country's IT Capital, parts of one of WIPRO's largest Offshore Development Centres in Bengaluru has already started functioning, planned and constructed imaginatively to facilitate phase-wise occupation.

Speaking of cities, the Smart World Communication team is fast converting the cities of Hyderabad and Cyberabad into safe, smart cities by creating one of the world's largest smart projects. The impressive bouquet of smart solutions include 10,000 CCTV cameras across 3400 junctions networked to 1 lakh+ community cameras with state-of-the-art Command & Communication Control facility along with 126 viewing centers at police stations, ITMS framework across 372 junctions plus messaging boards, PA systems, emergency call boxes and water-logging detection equipment.

The metro rail system has already revolutionized city commute in several cities across the globe by offering citizens a quicker, greener, more comfortable and economical mode of travel. The team from Heavy Civil IC has converted the vision of the Lucknow Metro Rail Corporation into reality by constructing a 9.59 km long elevated viaduct with 8 elevated stations in 24 months to earn the distinction of having commissioned India's fastest metro rail system.

Our WET IC is constructing the Upper Indrāvati Lift Canal scheme that envisages to irrigate 26, 248 hectares of land across predominately drought prone areas of Odisha's Kalahandi District to bring succour to some 56,000 families and, in the process, convert this region into one of the highest rice production basins.

Finally, overseas, a team from our MMH SBG is in the final stages of commissioning and handing over UAE's first LSAW (Longitudinally Submerged Arc Welded) Pipe Mill; a project won in the face of stiff global competition and, as the Project Director, says, one that is perfectly in sync with the theme of Speed and scale ...

Happy reading!

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"It's game on!"

Project Motera



While for cricket lovers the world over, the Lords cricket ground in London is the Mecca of Cricket, many will swear by the energy, electricity and excitement of playing or watching a match at a packed Melbourne Cricket Ground (MCG) in Australia, that presently has the largest capacity. However, the MCG is set to lose its bragging rights thanks to L&T as the world's largest stadium is in the making at Motera, Ahmedabad. The erstwhile stadium at the same site that could accommodate about 40,000 will be able to seat 110,000 spectators in its new avatar and if the task of building this impressive piece of infrastructure seems daunting, it definitely does not seem so on the face of Project Director, Subrata Dutta (SD).

Sporting a smart, trim goatee, SD exudes quiet confidence. "It's game on!" is how he describes his project that was won



"It's game on! Since the stadium is not a circle but elliptical or oval-shaped, it has thrown up several engineering challenges."

Subrata Dutta
Project Director

on 7th December 2016 when the Gujarat Cricket Association (GCA) awarded the mandate to B&F IC to design and build the world's largest cricket stadium barely 200 km from the site of the world's tallest statue.

"Since the stadium is not a circle but elliptical or oval-shaped, it has thrown up several engineering challenges. There are more number of elements; In fact, we erect at a rate of nearly 500-600 elements every month! We have to be ever careful about the orientation, the alignment, the angle of deflection and other such aspects." Though scale was never in question for this double-deck stadium, speed was critical too, as contractually the facility had to be ready in 24 months that called for some 'out-of-the-oval' thinking, the first of which was to go for a fully casted structure. "Cast insitu columns would have taken us at least 2 months per column and with 43 columns to erect, we would have been killed. Precast columns gain the required strength in only 10-12 days that saved us a lot of time." While precasting is not new for L&T, the scale was, involving casting and



erecting huge 'Y'-shaped columns connected by a Primary Radial (PR) beam.

Even before putting bat to ball, the team faced a bouncer from the Airports Authorities of India. The stadium site is located 3.9 km from the Ahmedabad airport runway as the crow flies and the permissible height for structures within a 4-km radius was only 45 m whereas the stadium rose to 51 m. Design coordinator M Venkatesh Kumar (MVK) had the onerous task of removing this roadblock. "Obviously, we didn't want to change our design so I went all out to get the necessary permissions," he shares earnestly. "My documentation was approved first time itself with no changes and after the Ahmedabad authorities gave their OK, we appealed to the central aviation authorities and finally they cleared our design after site inspections."

Fitting the bowl within a triangle of interference

Lack of space is a normal constraint when constructing urban infrastructure in congested cities but Planning Head, Vishal Pandya, found himself hemmed in from all sides with hardly any elbowroom to fit the stadium. "We had obstructions on three sides," he sighs. "1.3 km of our 2.7 km boundary is in conflict with an abutting residential colony. Every time we start drilling to construct the boundary wall, their houses, which are not all pucca, start shaking!" On another side, was a high-tension 132 kV wire that deprived the team of a vital work front. "The client had promised to have the GETCO (Gujarat Energy Transmission Corporation) line removed by July 2017. It has just been removed last week," says Vishal with a strained smile. Nearly 25% of the construction was stalled due to this 'live' obstruction that also meant under-utilization of costly resources. Completing the triangle of interferences was a temple situated on one side that could not be relocated. "So, we made peace with the Gods," smiles SD, "built a





periphery wall, laid a road and directed the devotees to visit the temple without passing through our site which they once used to posing huge safety issues for us."

The task for SD and team was to fit the bowl within these points, at the same time, allowing for the 8 m periphery road that is mandatory for all stadia. When dealing with 6,500-odd precast elements, with multiple cranes operating in concert that included huge 600, 400 and 300 ton cranes too, lack of space assumes alarming proportions.

The precast story unfolds

"I have been involved with this project for two and a half years right from the tendering stage," says Maulik Shah, the CMPC In-charge, warming up to his precast story that is clearly his passion. "After receiving the drawings from EDRC, we prepared the mould



fabrication drawings and totally, we have done about 800 tonnes of steel mould fabrication. Next, was the critical task of choosing the right fabricators because their delivery can either make or break our project."

A critical decision that changed the tenor of construction was to precast the 'Y' columns in one huge piece rather than breaking them into 2-3 smaller units. The dynamics changed for Maulik and team as size and movement became crucial considerations. The biggest precast beam was 30 m in height and 2.7 m in width weighing cumulatively some 285 tonnes. "Secondly, the column was cast horizontally, loaded and transported to site horizontally but had to be erected vertically. The point when the axis changes is most crucial. Our calculations had to be precise. There was no room for error."

Maulik and team were lucky to have veteran expert 'lift-man' K Kadamban

on hand to handle the process to make a lying giant stand up! With tons of experience of having masterminded and micro-managed heavy lifts across businesses and geographies, Kadamban directed erection after erection, getting quicker with each succeeding lift. Obviously, he is more at ease yelling instructions on site than answering my queries so Maulik explains that the most important aspects in the lifting process are the position of the crane and the coordination between the crane, the operator and the sling that holds one end of the structure. "Once lifted into place, they have to tied to match line and angle and avoid any deflection. We have only a few more lifts remaining," he sums up.

The PR beams that connect the HY and GY columns were initially to be casted in one piece. "But with a length of 48 m, it was too long to be casted in one piece," says Maulik, "and we also were uncomfortable of giving it 4 points

of support." MVK contributes that 3D models were created to arrive at templates that were given to the site team for execution. "The PR beams have strong reinforcements where they are connected to the columns," he adds.

"In such precast operations, sequencing is key as all the activities are interconnected," chips in Vishal. "We had assumed time-frames for certain activities but when we actually saw the drawings we realized that our anticipated timelines were not possible." Casting of columns which was envisaged as a 1 or 1.5-day affair took up to 4 days to start with but with practice, it was reduced to 2 days. "We had planned to complete our precasting activities in 12 months which we will but with 2x resources!" Another example of sequencing and interconnectedness is that the upper bowl of the stadium has to be completed before the lower bowl as space would be an issue to operate the huge cranes.



"The column was cast horizontally, loaded and transported to site horizontally but had to be erected vertically. The point when the axis changes is most crucial. Our calculations had to be precise. There was no room for error."

Maulik Shah
CMPC In-charge



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Vishal Pandya
Planning Head



Seeing is believing

Another clever move was to create detailed mock-ups that made it easier for the client to take decisions, bring everyone on the same page right from the beginning, avoid confusion during construction and, as Quality In-charge, Sudeep Ghosh shares, “helped us gain the client’s confidence. Our aim was to get things right the first time for which it was imperative to have the right designs, material, processes, procedures and perfect coordination between the various partners.” Sudeep is a happy man for he has been scoring 9+ in all his quality audits.

“The mock-ups helped the client to actually ascertain the sightline for spectators viewing a match,” adds SD. Other aspects addressed were setting the high flood level, deciding on the drainage system and even the sound system.



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Sudeep Ghosh
Quality In-charge

Expert opinion on cricket-related issues was welcome. The pitch curator advised on the creation of the outfield, which is in L&T’s scope while players, including a senior Test cricketer, contributed to setting up various players’ facilities in the pavilion. “This was important as we had to calculate the time batsmen would take to reach the pitch within the stipulated period that varies with different formats of cricket matches.”

Design to reality is a long journey

For Vishal, the assumptions made at design stage along with concept architects, Populus from Australia globally renowned designers of sports facilities, proved tough challenges on ground. Apart from having to increase resources to meet his precasting deadline, soil was another of his deterrents. The client had demolished the earlier stadium

TALL SCORES!

Concreting (In Situ) : 66,000 cum	Concreting (Precast) : 34,000 cum	Precast elements : 6,600 nos.	Reinforcement : 14,000 MT
Masonry : 16,000 cum	Plastering : 1,48,000 sq. m.	Flooring : 51,000 sq. m.	Lifts : 19 nos.

before handing over the site but when excavations began, the team encountered flyash in the soil up to 7 – 10 m in certain sections that weakens the foundation. “We have a bearing cap of 20 tons per sq. m and therefore had to replace all the flyash with fresh soil before proceeding with our pile foundations. In many places, the soil was so unstable that we had to lay steel mats to place the cranes.”

As work proceeds, fresh client requests are par for the course and it was no different here. The 5-star finishing in the VIP Gallery and Clubhouse is a fresh request as is the addition of a mezzanine floor, shifting of the media centre, addition of 72 corporate boxes, a unique spiral staircase ... and the list can go on.



To top it all

A standout feature of the Motera stadium will undoubtedly be the roof that, as Vishal explains, has three parts: the steel structural sections that are being locally sourced, the tensile cables from Italy and the PTFE (Poly Tetra Fluro Ethylene) membrane coming from Japan and there is a US partner in the mix as consultants. “A truly international roof!” I exclaim. SD smiles and elaborates: “The roof stands on 2 ‘V’ structures and is not connected to the stadium at all. In fact, the intent was to avoid any extra weight to bear on the stadium. It is actually a cable-stayed support system like in our bridges.” Another critical element of the roof is the Circumferential Beam designed with bolted connections. “There are 64 such connections,” smiles Maulik, “so you can imagine the intricateness of the alignment.”





“Since we were working at heights, we developed a height safety simulation using BIM 360 modelling.”

Santosh Bore
Manager - EHS

10 million, while a LED screen is used for visitor inductions and a housekeeping indicator. “Since we were working at heights, we developed a height safety simulation using BIM 360 modelling,” informs Santosh. “In addition, we have fire load calculations for all facilities with independent risk assessment and installation of firefighting equipment as per fire



Unlike most other modern cricket stadia, Motera will not sport any tall light towers. The LED lights will be in attractive clusters housed at intervals on the PTFE roof.

High on safety with a Sword of Honour to boot

Santosh Bore, Manager – EHS, was away in London to receive the ‘Sword of Honour’, an award that the site richly deserves attributable in large measure to the efforts of Santosh and his team. One is greeted at the site with segregated pathways for both pedestrians and vehicles replete with pictorial, multilingual signage as per Indian Road Congress guidelines along with a well-thought-out traffic plan for safe movement. A digital information board throws up various statistics including the safe man hours clocked by site, which presently is



load. We also have fall protection arrangements at heights of 30 m with a CCTV monitoring system.”

“The CCTV monitoring made a huge impact on the auditors,” adds SD, “because we were able to go to specific locations of their choice, zoom in and highlight our safety measures like safety railings, safety nets, safe staging, the safety measures taken by workmen, the works.” The site is equipped with an ambulance room, an induction room, a safety park and an emergency control room. “We also had a wall on which the senior management signed to demonstrate their commitment towards safety which work very well with all,” sums up Santosh.

Finishing and finishing the project

With the casting and erection almost complete, it is Finishing In-charge,



“Clients are dreamers and it is up to us to convert their dreams into reality.”

V Joseph Peter
Finishing In-charge

V Joseph Peter’s responsibility to achieve 5-star finishing for the VIP gallery and Clubhouse, whose response is a delighted chuckle. “Clients are dreamers and it is up to us to convert their dreams into reality.” Choice of material and decision-making are, according to him, what is slowing down the process but Peter is confident of delivering to the client’s expectations.

Waterproofing and compaction are what normally vexes customers after handover and to address these issues, “we have conducted pre-ponding tests,” informs Sudeep Ghosh, “whereby the mother slab is treated and tested before the application of the waterproofing material.” Of course, as he adds, the section of the right material is just as important.

At least 9-10 months of work remains but as one stands at the top of the VIP gallery, one can almost hear the tumult of a lakh-plus voices cheering an Indian victory! ■

Two significant additions to redefine Mumbai's impressive skyline!

Project ICC Towers



The first thing that hits you at the ICC Towers project site is the sense of hectic yet purposeful activity. It is yet another dreary, wet Mumbai monsoon day that would have tempted many to curl up in bed with a book and a hot cup of chai. However, for the nearly 240 B&F IC employees and some 3,000 workmen at site, it is another day of action as they strain their collective muscle and sinew to complete a huge project in double quick time. "This is the one of biggest projects of this complexity that we have been contracted to complete in a stringent timeline of just 42 months,"



"This is the one of biggest projects of this complexity that we have been contracted to complete in a stringent timeline of just 42 months."

O V Divakaran
Cluster Head – RBF (Mumbai-2), B&F IC

remarks O V Divakaran (OVD), Cluster Head – RBF (Mumbai-2), B&F IC, who was managing the project till his own elevation in March, 2018. "I devote half my day here because we are in that critical last mile to deliver," he explains before quickly excusing himself to take off on a site visit.

To cut a tall story short

Entirely manufactured in house, the Island City Centre (ICC) project features two luxury high-rise towers. A non-tower area is replete with 3 level basements, ground floor, a landscaped

ICC Towers

Tower One: 3 basement levels, ground floor, podium, 51 residential floors, 3 service floors and 2 fire check floors.

Tower Two: 58 residential floors, 3 basement levels, ground floor, podium, 3 service floors and 2 fire check floors.

podium of 13,500 sq. m each level, a club house, a welfare centre and a swimming pool. All of which is spread over a total built-up area of 26 lakh square feet. Totally, the two towers, shortly to be awarded Gold Rating by the Indian Green Building Council, will have 532 three & four BHK apartments with a start rate of around Rs.10 Crore, crowned by the owner's multi-floor penthouse.

"This is one of the first residential projects in India with a glass façade," says Project Manager, Ranjeet Kumar, picking up the story. "We had to build with speed so we planned for success and have consistently achieved a slab cycle time of 6-7 days over a long period of time by using an indigenous automated climbing system for the core combined with indigenous aluminum formwork for the column and slab. Now, we are racing against time to be ready for the CFO approval for the fire-fighting system at the earliest as the client is demanding an OC (Occupation Certificate) by October '18!" One can sense the urgency in Ranjeet's tone for they are fighting tall odds. The weather, for one, has been a big deterrent as rain beats down on the window of his site cabin. "It has been raining almost constantly for the last 15 days (Mumbai has received almost an entire season's rainfall in the month of July itself!) and that has hindered our external panelling work apart from all the other issues of delay in road work, water entering the basements, people commuting and so on."

A delayed start

It is not difficult to identify the reasons as to why the ICC Towers project is racing against time because as per Ranjeet, it is an all-too-familiar story of delays at the early stages of the project. "We had to wait for a good three months for the client to receive the CC (Commencement Certificate) at plinth level. Almost at the same time, Hafeez Contractor, the original architect, walked out with his design team as he



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Ranjeet Kumar
Project Manager

could not match the client, Bombay Dyeing's cost, which was another big disruption. A new architect – Sandeep Shirke & Associates - entered the project!" A new team of lead architects and designers brought with them a new design that has been seeing regular change. "The client has been doing a lot of value engineering and even today, the design is not 100% frozen," Ranjeet smiles ruefully. In any case, a new design necessitated complete re-tendering of the NSC Procurement package. "The vendors who were supposed to have been on board by November 2015 finally came on board only from December 2016 onwards!" However, the contractual period of 42 months for delivery and contract amount of Rs. 1231 Crores remained constant.

Innovating to catch up lost time

Saddled with a contract that does not entertain concurrent delays with all responsibilities resting with the general contractor, OVD, Ranjeet and team had no alternative but to take these delays in their stride, plan and proceed with execution at top speed, innovating along the way. The clever decision to





“We made Baha’i Temple and we are also the people who made Mumbai International Airport so everyone knows we are capable of top class finishing!”

Samrat Datta
Finishing In charge

finishing which is a big reason why our finishing is of a very high order,” says Marnix, who is all praise for the team’s quality of sub-contract management and the skill level available. Finishing In charge, Samrat Datta is more forthright about L&T’s prowess in finishing. “We made Baha’i Temple and we are also the people who made Mumbai International Airport so everyone knows we are capable of top class finishing!”



“Unlike in horizontal projects, in high rises work can only move one way - upwards, so once the external ‘enveloping’ was completed, suddenly a number of work fronts were available to us at the same time.”

Façade In-charge
Ajay Bhosale

To hasten the finishing process, the team split each tower into two zones: podium to the 18th floor and 19th upwards and finishing started simultaneously in both areas that saved Ranjeet and team precious time. “Unlike in horizontal projects, in high rises work can only move one way – upwards,” explains Façade In-charge, Ajay Bhosale, “so once the external ‘enveloping’ was completed, suddenly a number of work fronts were available to us at the same time. We were able to increase our work force and accelerate the rate of work,” reflected in the increase of workmen count from 2,000 to 3,000 over the past couple of months.

involving nearly 15,500 panels over 70,000 sq. meters of facade. Finishing is the most critical activity in this project and a lot rests on the strong shoulders of the Technical Head and expat Marnix Coomans, who brings with him a strong finishing background and rich experience in handling high rises. “My colleagues have an open mind about

No brick in the wall

Another standout feature of the ICC Towers is the introduction of the dry wall concept. All the walls are lightweight and of gypsum that puts less weight on the slab, yet are sturdy, leak proof with an acoustic rating of



“Normally in high rises, you will see the core going up first with the slab following several floors below, but here we opted for the Gallow ACS system with aluminium formwork.”

Ranjeet Kumar
Project Manager

construct the core and slab together gave them a flying start. “Normally in high rises, you will see the core going up first with the slab following several floors below,” explains Ranjeet, “but here we opted for the Gallow ACS system with aluminium formwork.” The system simplified formwork and equipment setup, reduced execution time, simplified logistics complexities, enabled closer supervision and increased safety. “Since the core and slab were moving together minute hourly micro-planning, coordination and control was possible.” The biggest challenge during building the structure was doing high grade of temperature-controlled concrete of up to M80 with the temperature of all vertical elements closely monitored.

After the structure was up, in perhaps the fastest time when compared to other similar projects, came the serious task of installing the unitized glazing system



“My colleagues have an open mind about finishing which is a big reason why our finishing is of a very high order.”

Marnix Coomans
Technical Head





“The kitchen is most vulnerable to fire so we have ensured that in case of any emergency, the fire will not spread to other parts of the apartment from the kitchen.”

Shailesh Lalchandani
Tower Head

44 dB and 1-2 hour fire rating. “The kitchen is most vulnerable to fire so we have ensured that in case of any emergency, the fire will not spread to other parts of the apartment from the kitchen,” informs Tower Head, Shailesh Lalchandani, as he walks me around the site. “Similarly, the vertical risers are also protected and these,” he says, tapping the gypsum wall, “can resist fire for 2 hours.”

A bold move the team took was to have one fixed tower crane. “Yes,” nods Ranjeet, “if things would have gone wrong we did not have room to fix another but the trade-off was that we had more lifting capacity and our cost of capital was less.”



“Our policy of ‘One contractor, One tower’ has yielded rich dividend.”

R Kannan
Site In-charge

“Our policy of ‘One contractor, One tower’ has yielded rich dividend,” contributes Site In-charge, R Kannan. “Right at the outset, we said that we would not pay the sub-contractor on head count. It would only be on measurement. Payment was on completion with incentives, which was our bargaining tool to extract best performance.” Ajay Bhosle mentions another clever move to hire one hoist of 3.4 m x 1.5 m dimensions to move the glass panels to the various floors. “It was OVD sir’s idea to have this hoist which saved us so much of time and effort in manually hoisting the glass panels. This is why we were able to finish one floor in about 4 days!” MEP Head, Milind Pawar too has reason to be happy because he completed the entire MEP works and finishing in 22 months flat.

No challenge, no project

The city of Mumbai presents its own unique brand of challenges. “Initially, we had to stop all noise creating work by 9 pm which was later relaxed to 10 pm as per MCGM revised regulations,” shares Ranjeet. “Our concrete pour takes a minimum of 9-10 hours so we had to time our activities very precisely and set a cut-off time internally of 8.30 pm. After 10 pm, we do noiseless activities like housekeeping, preparing for the next day’s activities till about midnight.” Another issue for the team is that the client’s MD stays in a penthouse in the adjoining tower so he is literally sitting on their head! “OVD used to receive sms text messages from the MD, Mr. Jeh Wadia that we were making too much of noise in the night or that things were not moving fast enough,” laughs Ranjeet.

Space and accommodation are issues typical of Mumbai and therefore the challenge of finding a location for a labour camp to house 3,000 workmen can well be imagined. In fact, a camp less than 10 minutes walking distance

from the site housing some 700 workmen was suddenly demolished by the authorities one day as the permission was held-up by authorities. “That was a full blown crisis because we had to find accommodation for those 700 people overnight! But we managed and overcome the problem.” Ranjeet’s sense of relief is palpable. Presently, the labour camp is located at several locations like Sewri, Worli, Gandhinagar, about 6-7 km away with a fleet of buses ferrying the workmen to and fro.

F&A In charge, S G Sankar presents a calm exterior because although Bombay Dyeing is an extremely demanding client, “they are also a very fair and process-oriented client,” he smiles. “We have to be pucca with our documentation and any small change in systems and processes requires their approval but that is fine if it



“We have to be pucca with our documentation and any small change in systems and processes requires their approval but that is fine if it smoothens the process.”

S G Sankar
F&A In charge

ICC Towers - in terms of numbers

Description	ITEM	Unit	BOQ
RCC	Excavation	CUM	90,180
	Concrete	CUM	1,65,000
	Formwork	Sqm	5,80,000
	Reinforcement	MT	15,800
Finishing	PT	MT	244
	Water Proofing	Sqm	80,781
	Façade	Sqm	71,000
	Masonry	Sqm	75,208
	Dry Wall	Sqm	1,33,700
	Plastering	Sqm	6,25,569
	Flooring + Dado	Sqm	2,63,523
MEP	False Ceiling	Sqm	60,340
	Painting	Sqm	5,69,329
	Elevator high speed 4 mps and 6 mps	Lot	1
	External Development-Road / Drain etc	Nos.	43
	Landscaping	KM	3
	SQM		18,200

smoothens the process." No wonder, the contractor-client relationship is on a good wicket and with a regular invoicing of Rs. 45 Crore per month, "we are actually supporting the cluster," chuckles Sankar.

The site with all its myriad and simultaneous activities is a great proving ground for youngsters like Usha Sridhar Kudtarkar, Rudragowda and Rupam Ghosal. While Usha revels in the freedom she enjoys in her areas of design and MEP coordination and "getting the variation orders approved from the client by hook or by crook," Rudra's wife of just 4 months is struggling to see enough of him. "Every day is a day of pressure," choruses Rudra and Rupam and the 12+ hour workday that they put in day in and day out are vital for the success of this project.

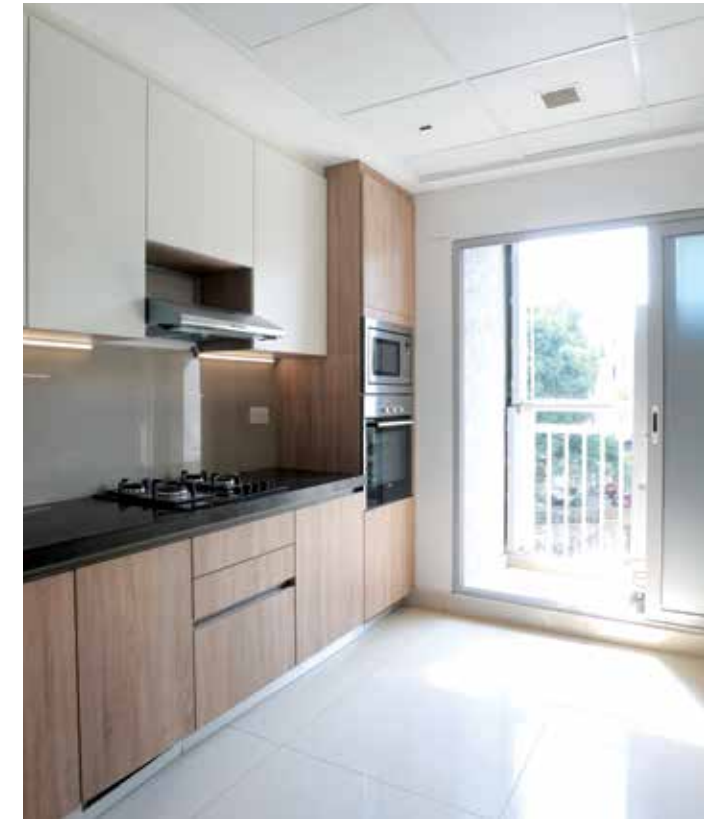
8 million safe man hours and counting

In a high-rise, the safety considerations are huge and therefore Safety In charge, Gopi Krishnan obviously has his hands full. "The hydraulic climbing safety screen with staircase helped as the workmen never realized that they were actually working at huge heights. We ensured that we created a scene as if they were working at ground level." Standing atop one of the towers, the scene of a wet and hazy Mumbai is breathtaking but the strong wind buffeting you is strong enough to drive the wind out of you! Working at height was Gopi's chief concern as was the strong wind as one went higher and the fact that work on every floor was happening on two fronts: façade installation on the outside and finishing inside. "We also created safety

tunnels for the workmen to enter the site," adds Gopi and their efforts have translated into the site clocking 8 safe million safe man hours.

A 'connected' site

The ICC Project won the Digital Award for 2017 not without reason as it is a well 'connected' site. With safety a top priority, the effective use of the safety app and digital harnesses are only to be expected. Procube, the project monitoring app is in vogue, trucks are GPS-enabled and several P&M such as crusher plants, batching plants, boom placers, wheel loaders are already streaming in data for the team to draw inferences, predict trends and take quick, informed decisions. Ranjeet is thrilled with the rewards of digitalization, "we are able to utilize our assets better knowing



"Even the Internal Executive Feedback Reports have consistently rated us 4.5 and more on a rating of 5."

Jayant Prabhune
Quality In-charge

their productivity, total working and idle hours." He can track the status of tools, material and vehicle movement. "We also have a Quality app," chips in Quality In-charge, Jayant Prabhune, "that helps us to raise NCs, observations, record executive feedback and customer complaints and, importantly escalate problems if not timely addressed." Jayant is a happy man as the customer has always

given the project 8+ on a quality rating of 10. "Even the Internal Executive Feedback Reports have consistently rated us 4.5 and more on a rating of 5," his smile reflecting his pride of achievement.

It is a tall order for Ranjeet and his team. What keeps them going was articulated first by Gurinder Singh, another Finishing In-charge, "people here are recognized for their individual contribution and that boosts us all to go that extra mile!" This was echoed by Tower Manager, Shailesh Lalchandani, who says, "it is all about creating a good work culture because if you have a good work culture then people will be enthused to work with their full heart and soul."

They still have miles to go before they can sleep but they are doing their level best to deliver handsomely! ■

A classic example of efficiently managing change

Project WIPRO - IT SEZ





at the beginning of the project, was to reduce the mismatches between the disciplines. “We have already created some 1,500 RFIs (Request for Information) so far,” he grins, seemingly unfazed. Time was always his primary consideration and to hasten the process, he conducted regular design workshops with the client to share his team’s revised drawings and get approvals faster. For TNK, too, quick approvals and continuous progress are crucial to maintain a steady cash flow. “The client is a very good paymaster but we have always shown consistent progress; even if we are to complete one floor and have not been able to do so, we do two half floors (albeit on different levels) to ensure that my cash flow is maintained. We have been able to do an average of Rs. 40 Crore billing per month.” Satisfaction is writ large on TNK’s face.



“We have already created some 1,500 RFIs (Request for Information) so far.”
T Shanmuga Sundaram
Design Head

Clearing the deck to start operations

In November 2015, L&T was awarded the contract to construct an IT facility (initially to accommodate 10,000

Change is inevitable and naturally, project managers factor a certain amount of change into their planning. However, when change assumes alarming proportions and regularity, when change becomes the norm rather than the exception, then a change strategy is required. “Yes, in an ideal situation change is avoidable as it disrupts our calculations,” concedes Project Director, T Nanda Kumar (TNK), “but what is important is that despite change, we have to manage our resources effectively, balance the various disciplines so that work continues unhindered on all work fronts.” Project progress is crucial for every project especially if its scale is as huge and the deadline as crushing, as is the case with the WIPRO IT SEZ project, located on a sprawling 50-acre campus at Kodathi, in the outskirts of Bengaluru.



“Yes, in an ideal situation change is avoidable as it disrupts our calculations, but what is important is that despite change, we have to manage our resources effectively, balance the various disciplines so that work continues unhindered on all work fronts.”
T Nanda Kumar
Project Director

A neat and dapper man in a neat and well-organized cabin, TNK meticulously arranges some papers on his clean, uncluttered desk and continues, “Every change is updated in our Primavera Level 4 package and our variation orders clearly indicate the impact of change on cost and time.” The design team first gets cracking to prepare the revised drawings, which are analysed by the contracts team for cost and time implications. “We share this with the client for a sign off after which our engineering team along with the PMC engineers create a joint measurement to ensure that nothing is missed out post which the execution team gets into action. This way, everyone is on the same page with minimal internal confusion.”

Change has undoubtedly been a source of worry for Design Head, T Shanmuga Sundaram too whose first critical task,



personnel, which has subsequently swelled to 21,000!) for WIPRO featuring 4 blocks and a services building. Work, however, could only kick-start in January 2016 due to a delay in procuring environmental

clearance. "This 3-month delay was actually a blessing in disguise," says Planning Head, V Anand with a boyish smile that suddenly makes him look much younger than he is, "for although the price was signed off, we had our



“This 3-month delay was actually a blessing in disguise, for although the price was signed off, we had our task cut out during pre-planning to match the price. Since payment is milestone based, we had to work out our scheduling very carefully to derive the milestones and get them approved by the client.”

V Anand
Planning Head



task cut out during pre-planning to match the price. Since payment is milestone based, we had to work out our scheduling very carefully to derive the milestones and get them approved by the client. We also had to agree on the payment schedule since as a contractor we wanted it to be front-loaded.”

Anand was perhaps one of the earliest people at site where an overgrown jungle greeted him infested with snakes and other creatures. “There were several sandalwood trees too which we could not cut and thus had to engage the Forest Department,” recalls Anand. “Yes, we had to cut a few trees but undertook to plant some 400 on the periphery.” Soon, the team got started with some serious earthwork that involved excavating down to a depth of up to 20 m. with hard rock “For our deep excavation,



“For our deep excavation, we did not go for the normal shoring methods, instead we opted for a cloth covering for the embankments which worked just as well.”

V. Yegappan
Quality In-charge

we did not go for the normal shoring methods,” informs Quality In-charge, V. Yegappan, “instead we opted for a cloth covering for the embankments which worked just as well.” There were no permissions for blasting at site so the team had to procure special permissions to control-blast through the bottom layer of hard rock. “We found the excavated soil suitable for backfilling so retained 3 lakh cu m of it,” shares Yegappan, “and used another 32,000 cu m as top soil for vegetation.”

Some downs, many ups

The project was rolling smoothly actually ahead of schedule when a fresh National Green Tribunal ruling brought it to a grinding halt. The new stipulation raised the minimum distance between structures and the boundary of a waterbody from 35 m to 75 m! A 1922 map revealed the previous existence

of a lake on the campus and, much to the team's dismay, a sizeable portion of Block 2 fell into the 'no-build' zone. With no recourse in sight, the team had two options: either to keep the drawings intact and shift the entire complex away from the lake or to revise the affected block. "We chose the second option: a rectangular building thus became a smaller, triangular one, all the drawings had to be recalibrated, the services, air-conditioning all had to be changed for all blocks because all are connected resulting in another 3 month delay," Anand's resigned look says it all. "Our targeted date of hand over was not changing and, at that point, we were already 6 months adrift." More trouble erupted as rate issues with the three sub-contractors hired for concreting, shuttering and reinforcement resulted in their termination midstream resulting in more delays.

TNK, for his part, had other headaches of his own. The process of sub-contractor nomination by the client under the General Contracting format was taking too long for his comfort while from a personal perspective, fresh from his role

as Cluster Head in Chennai, TNK had to establish his credentials at the earliest at the project. "A milestone-based project is like a double-edged sword because if you achieve your milestones, there are rewards but you can also suffer penalties if you don't deliver. This project has some very aggressive contractual conditions like milestone-based penalties every 3 months so my first task was to win the customer's confidence which I succeeded by aggressively achieving our early milestones in time. Deep excavation was over in 2 months followed by raft erection in six months that actually set the tone. The client had worked on this project for 2-3 years before us so it was also important for me to gain that knowledge from them in the shortest possible time."

Soon, a huge opportunity to wow the client presented itself to TNK and his team. To get the campus certified as a SEZ, WIPRO had to start operations in at least one facility before March 31st 2017. With their deadline fast approaching, WIPRO turned to TNK and team to help them out. "They came to us only in January. It was only one building worth

about Rs. 8-9 Crores but we saw it as a wonderful opportunity to delight the client. We worked round the clock and 500 of their people started working on the premises from March 30th! Perhaps that is why till today we have not suffered any penalties," he grins triumphantly. Of course, he and his team were stretched but "we utilized common resources to the maximum and even took on some youngsters from other projects on deputation to complete the job without in any way disrupting work on the main project."

Managing multiple stakeholders is a tightrope that TNK has been walking ever since he walked into the project. "On one side there is a very demanding client who is deeply involved in the progress of the project." And, of course, making changes, I quip sharing a laugh. "Then, there are the architects and interior designers, the design consultants, the PMC – Tata Consulting Engineers – and us. It is a tough balancing act! I have an excellent team that has a nice blend of experience and youth and our rapport with the Tata engineers is a big reason for our success."



"LAT of this size (50 sq. m.) and type (with drop beams in the middle) was used for the first time in India."

M Ilyaraja
Site Formwork Head

Reaping benefits of the Large Area Table format

To make up for lost ground, the team had to step on the pedal and achieved a consistent cycle time of 10-12 days for structural works thanks to the Large Area Table (LAT) format they adopted for the main floors above the podium. "LAT of this size (50 sq. m.) and type (with drop beams in the middle) was used for the first time in India so once we hit upon the idea, we had to first sell it to the client." Site Formwork Head, M Ilyaraja's enthusiasm is infectious. "It took some convincing but once the client had bought our idea, it was up to us to implement it well as it forms the backbone of the structure and we had a huge area of 8 lakh sq. m

to cover. My experience in various kinds of formwork came in handy and, as a team, we were able to deliver to the client's satisfaction. For us, it has many advantages," ticking them off on his fingers: LAT involves aluminium formwork panels that are light, easy to handle, requires less labour and overall significantly quickens operations.

Under floor air-conditioning

The WIPRO employees at this Offshore Development Centre will remain cool from an air-conditioning system that sits below the false flooring. As Anand explains, air runs through a sealed gap underfoot throwing up cool air through attractive vents placed on the floor. All the ducting has been dispensed with and since all the pipes are running below, the

height of the work space has increased as there is no false ceiling which has in turn translated into a couple of extra floors.

Creating a pretty façade

"The client was seeking a rustic finish so we have used Fair Faced Concrete on the façade which is not painted," remarks Anand, gesturing to Block B4, which is closest to completion. The façade has two skins: one of aluminium and glass; the other of ceramic tiles on an aluminium steel structure. "This was another factor that worked in our favour because as we had to treat the façade differently, we realized that it was better to do the structure and façade as parallel activities that saved us considerable time and labour."



“We lost time due to delay in the award of packages and once we started, I had to deal with 20 vendors for an area of some 4.3 million sq. feet. We finished the first phase in 12 months.”

Anne Sriram Kumar
MEP & Façade Finishes In Charge

All services atop one tower

The chiller plants, the Cooling Towers, HT/LT installations, fire-fighting systems – are all housed on top of Block 4 and therefore Anne Sriram Kumar, MEP & Façade Finishes In Charge could not start his work till the tower structure was complete. “We lost time due to delay in the award of packages and once we started, I had to deal with 20 vendors for an area of some 4.3 million sq. feet. We finished the first phase in 12 months.” His speed is thanks to the modularization he has introduced in the works. “We have used pre-fabricated ducting, skid pumps with grooved end couplings, there was no welding in the pipelines which required less manpower but has given us more productivity. Now, it is all just plug-and-play!” The diesel rotary UPS system is a new development that do not require batteries and saves the need for maintenance and charging.

Savings in concrete management

For a project that is consuming close to 240,000 cu m of concrete, almost 200,000

of it in 24 months and about 15,000 cu m per month at peak time, any saving on this front is a huge boon. “We replaced 50% of the cement with slag or GGBS (Ground Granulated Blast Furnace Slag) which is actually a residue from our steel plant that has resulted in huge cost savings. It is durable and stronger in the long run,” shares Yegappan. A curing compound used on all vertical surfaces substantially reduced the use of water.

Labour a perennial issue

The good thing is that the requirement of skilled labour has been limited but attrition has been high. “We have 4,000 workmen at present on site but have inducted 21,000.” Anand sounds matter-of-fact. “We pay the workmen their PF and with minimum wages in Karnataka rising by 70%, we have been badly hit.” The site now follows the ‘No Aadhaar, No Entry’ policy and possesses a database of all workmen with their Jaandhan account details.

Embracing digitalization

While the project is digitally connected, the process has been taking time to be fully implemented as Anand points out.



“Not only a recognition of our safety practices but also the depth of detailing we get into.”

R V Sudhakar
Cluster EHS Manager



Project monitoring is through Procube, several P&M are connected, Safety and Quality apps are extensively used, there is face recognition for workmen attendance and, as part of project scope, BIM level 3 is being used too. “While the process of adopting and integrating digitalization has started newly and is in progress, the fruits of implementing digitalization are obvious.”

Sword of Honour

TNK drives ‘safety’ that is evident from the fact that WIPRO project has won the British Safety Council’s Sword of Honour. That according to Cluster EHS Manager, R V Sudhakar is “not only a recognition of our safety practices but also the depth of detailing we get into.” EHS management encapsulates end-to-end processes and requirements to achieve continuous improvement systematically followed to achieve operational excellence.

On the home run

The first five floors of block B4 have been handed over to Wipro and has gone operational from September 2018 and as TNK states confidently, “From next month,



nearly 2,000 people will start working here which is why we have planned our all facilities like steel yard, batching plant, etc. that they do not hinder employees coming to work.” He envisages complete handover of Block 4 by October’18 and completion of Phase 2 that entails all the other blocks by July ’19. “Originally, there was no plan to complete the whole facility but now the client wants to which makes things a little more complicated and our scope bigger,” smiles Anand.

Although the re-sizing of a block reduced the contract amount to the tune of some Rs. 70 Crores, new scope has enhanced contract value by a net of Rs. 250 Crores. Thanks to their good work, the organization has won mandates from WIPRO in Chennai, Pune, Coimbatore and Hyderabad. Here’s hoping that TNK and team continue their sterling work and L&T Construction keep winning more and more projects! ■

Built with speed and precision for smart commute

Lucknow Metro Rail Phase II



The evolution of metro rail systems in India can be broadly classified into two phases: its inception in 1984 in Kolkata post which there was hardly any further development and then, post 2002 when Delhi Metro Rail Corporation implemented a novel urban transit scheme that has now been well adopted and customized across several cities.

Lucknow Metro Rail Corporation (LMRC) has been quick to integrate and innovate urban transit infrastructure with the unique distinction of commissioning India's fastest metro rail system for its Phase

I corridor. Continuing the good work, LMRC, raised its sights for a Phase II line and roped in L&T Construction's Heavy Civil Infrastructure IC, which had played a significant role in its first mission, to do an encore in 24 months! The scope of work this time was more challenging as the alignment ran through the heart of the city involving the construction of 9.59 km of elevated viaduct and 8 elevated stations at K.D. Singh Babu Stadium, Vishwavidyalaya, I.T. College, Badshah Nagar, Lekhraj Market, R.S. Mishra Nagar, Indira Nagar and Munshipulia, including special spans across the North-South Corridor.

Working out a cash centric strategy

"Having done the seemingly impossible across phase I, expectations were high," exclaims Sanjay Singh Gangwar (SSG), Project Director, as he briefs on the strategy, "A balanced cash centric approach was adopted taking into consideration the overall resource requirements across stretches. To begin with, three strategic sections were earmarked that operated as independent sites with internal timelines." Elaborating further, Kallakuri Chakravarthy (KC), the

Planning Manager, says, "The first 2 km was lined up as one segment, while the next 5 km was earmarked as one stretch and the rest of the alignment formed the balance scope. The ploy was to take up fronts that had minimum hindrances and balance the progress of works." As the initial scope largely related to piling, cash flow was maintained towards deployment of the rigs for a period of 6 months and once the ground engineering works were completed, the flow was oriented towards other key requirements. For SSG and team, a positive cash flow gave the advantage to accelerate during the critical phases.



Raising seamless channels of connectivity

For a real feel of the infrastructure, SSG takes us through the alignment with our first point of contact being the K.D. Singh Babu Stadium station where the imposing piers are aligned elegantly across the road. Moving further, we visit the next station. "Space was always a constraint because of the narrow roads so we had to work out a tactic for each station. Though Vishwavidyalaya was the second station, it was the last one built due to ROW issues as it involved availing permissions from three government institutes: Lucknow University, Birbal Sahani and Colvin College located adjacent to the alignment."

"A straight forward solution was not forth coming," adds KC. "Therefore after a lot of deliberation, permission was obtained in early 2018 to move the alignment forward by adding 4 additional piers of 27 m span by successfully erecting 3 precast cross arms over the piers using a cantilever

erection scheme to execute this station in just 8 months making it the fastest constructed station under Phase II."

Gaining ground with curved 'U' girders

Moving over to the next sections – Vishwavidyalaya and IT College stations, SSG instructs the driver to stop over where the alignment takes a well-defined curve. Even finding parking space for the jeep is difficult due to the heavy vehicular and people traffic. "This is one of the busiest junctions beside a railway station and key roads connecting to the other areas of the city," indicates KC. "The original plan was to do in-situ vioded slabs but considering the sensitivity of the location it was not a feasible approach. Design innovation was the only way to move forward," avers SSG. "We convinced the client to go for 7 curved 'U' girder spans, a first-of-its-kind in India, and roped in EDRC to finalize the scheme." The team spent over two months formulating a secure precision frame work as the entire span had to be aligned to a 90 degree curve

along a minimum radius of 120 m as per Indian Railway standards. "It saved a lot of time and earned the good will of the people as not a single public property was disturbed," shares KC, happy with his team's achievement.

Steel 'I' and box girders accelerate the process

"The list of breakthroughs made in this project could become a SOP for such works in the future," acknowledges SSG with a broad smile. "Take for instance, some of the congested areas across the alignment where the conventional 'U' girder format would have been tough to execute. We quickly switched over to steel 'I' or Box girders depending on the requirement. Certainly it came with a slight add cost but considering the overall deliverables it was a win-win situation both for the client and L&T." Urging the editorial team to ascend the IT College station, KC then leads us across a



"The heart of the project was the 177 m cantilever bridge across the Gomti River that is the vital connect between the old and new Lucknow. We had to construct the 85 m central span at a height of 13 meter without any pillar in between so that the span crosses the entire river from one end to the other. After a lot of analysis on the way forward in consultation with client a feasible and innovative scheme was devised."

Sanjay Singh Gangwar
Project Director

section of the elevated stretch. It gave us a weird feeling especially the top-down view with the alignment running close to habitats and establishments. Doesn't it feel like you are entering one of the houses, quips SSG, "I can proudly say that doing such a viaduct alignment in a city where most of the interior roads are medium to narrow calls for world-class engineering."

Doing a 177 m cantilever bridge in 9 months

According to SSG, the heart of the project was the 177 m cantilever bridge across the Gomti River that is the vital connect between the old and new Lucknow. To illustrate the complexities involved, we access a safe portion of the dry river bed. "The 'S' type curvature of the alignment was an extremely challenging," indicates SSG pointing to the completed section. "We had to construct the 85 m central



"Stitching together the span was done with an overhead form traveler mechanism developed in-house at our Kancheepuram Works that was auto launched across the pier ends, not requiring any ground support while integrating the segments."

Kallakuri Chakravarthy
Planning Manager

span at a height of 13 meter without any pillar in between so that the span crosses the entire river from one end to the other."

"After a lot of analysis on the way forward in consultation with client a feasible and innovative scheme was devised," shares SSG. "Keeping the timeline in view, we improvised on the foundation design by going for pile foundation instead of the proposed well foundation with EDRG finalizing the dia sizes that gave a lead of around 3 months. In total, 32 pile foundations were made with a dia of 1500 mm across the river."

"With piers established across both the ends it was time for some hi-tech customization," says KC with a gleam in his eye. "Stitching together the span was done with an overhead form traveler mechanism developed in-house at our Kancheepuram Works that was auto launched across the pier ends, not requiring any ground support while integrating the segments. Within a span of 8 months, the entire segment was



made ready. When the final segment was cast on October 3rd 2018, it was a proud moment for LMRC and L&T for achieving the fastest cantilever bridge construction in India!”

Erecting a 60 m ROB in 5 days

A good view of the Rail Over Bridge (ROB) which sits perfectly at a height of more than 16 m from the ground level is possible only at the top deck of the flyover parallel to it. Upon getting there, we ponder how this 520 t steel truss with a 35 m cantilever span was ‘pushed’ across a railway track that too with a 25000 volt powerline passing beneath the span. “A daunting task that called for the highest safety standards,” highlights SSG. “We did this with precision and that too in just 5 days all because of the micro planning that went into detailing every activity right from fabrication of the steel structures, logistics and preparing the erection plan.” Throwing light on the process, KC mentions. “The entire construction method was devised by our EDRM CMPC team based on an incremental push launching technique with five intermediate trestles using strand jacks, nosing truss and counter weight. As the Railways had imposed a speed limit for the truss operations, the progress of the automatic launcher was slow, though steadily gaining around 500 mm in one go. The job was started in the night of September 24th and finally completed during the early hours of 29th.” For the LMRC officials it was a second such achievement having done a similar one across Phase I while for team L&T it was all about finishing with precision.

Every lift was worth the effort

“When you look at the success of an elevated infrastructure it is all about safe erection,” says SSG indicating at a section of the viaduct that passed over a nalla with a flyover running beneath the alignment. “It was a tricky



location,” adds KC “With a slum habitat right on the banks,” but SSG quickly assures, “We were able to zone in on a secure area to position our temporary platform and innovated on the erection process by taking support from the flyover to achieve the lift.”

“At another location, it was more of a mixed approach that worked,” highlights KC. “With a temple in the vicinity it called for in-situ casting of the portal for the one particular slot while the rest of the span was retained as a simply supported portal.”

“Working close to the main sewer line of the city was another area we could just not take our eyes off!” mentions SSG. “We had to change the position of the crane by doing one side of the girder erection first and then followed it up across the other side which took nearly 3 days but at the end of the day, being cautious was worth all the effort.”

Forging bonds of trust

Having almost delivered the infrastructure scope well in advance and safely, team L&T has reinforced its credentials of being forerunners in metro rail infrastructure with the client having the unique distinction of once again raising the country’s fastest portal of connectivity. ■

Building a first-of-its-kind,
200 million-dollar industrial project in UAE

LSAW Pipe Mill Project



L&T's MMH SBG bagged the mandate to build UAE's first LSAW (Longitudinally Submerged Arc Welded) Pipe Mill in consortium with the SMS Group in October 2015 in KIZAD, Abu Dhabi, UAE for M/s. Al Gharbia Pipe Company LLC, a JV between the Senaat Group U.A.E., JFE Steel Corporation and Marubeni-Itochu Steel Inc. Japan.

Valued at close to a 100 million dollars (being L&T's share), this Greenfield project presented Project Director, Hare Ram, an ideal opportunity to consolidate L&T's credentials in the Middle East. "We won this project in the face of stiff global competition and it was perfectly in sync with the theme

of Speed and Scale," he says with a laugh but quickly sobering mentions the huge scope, tight deadline and a very demanding client. As the consortium leader, L&T was responsible for the entire EPC Project covering all process equipment through the SMS Group, detail engineering & local statutory approvals, supply of equipment/systems such as cranes, process utilities, water systems, plant HVAC, firefighting, complete electrical & instrumentation. "Our responsibilities also covered the entire construction, plant infrastructure works covering civil & structural works, roads, drain, sewerage, boundary walls and the installation and commissioning of all mechanical, electrical &



"We won this project in the face of stiff global competition and it was perfectly in sync with the theme of Speed and Scale. The contractual date of completion was July 21st, 2018 and our scope of work was completed right on schedule! We were able to work faster as all our vendors were specialists in their respective fields."

Hare Ram
Project Director

instrumentation, piping, etc.," adds Hare Ram. The SMS Group was the single technology provider and supplier of key process equipment and commissioning of the same.

Being built on Al Gharbia's 200,000 m² plot of land at Khalifa Industrial Zone Abu Dhabi (KIZAD), once fully operational, the plant's production capacity will touch 240,000 tons annually of large diameter, high quality sour grade steel pipes to cater to the region's construction and energy sectors.

"The contractual date of completion was July 21st, 2018 and our scope of work

was completed right on schedule!" Hare Ram's smile is sufficiently eloquent of how he and his team feels about their achievement. "Only commissioning and testing is underway at present."

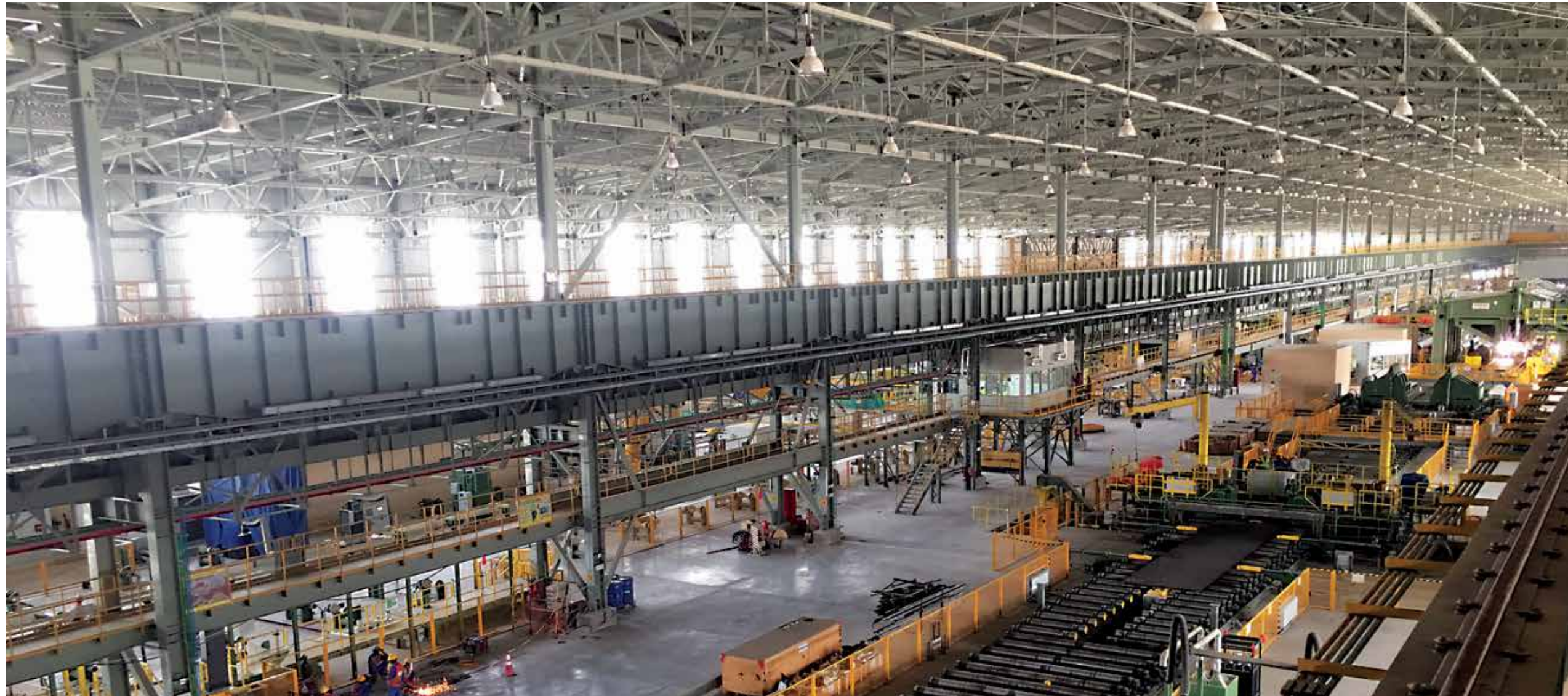
Evolving a winning strategy

To succeed in a project of this magnitude and scale, it was imperative to have a perfect execution strategy. "The bidding team, led by Abhisek Sarkar, prepared a detailed execution plan identifying the key risks involved which became the foundation stone for our execution strategy," shares Hare Ram.



"We actually started construction on the back foot, because despite our best efforts we received the Building Permit only on July 31st, 2016, two months later than our baseline planned dates."

Pramod Kumar Sharma
Project Manager



UAE has some very elaborate and stringent guidelines involving several local authorities therefore the team's next goal was to procure all the relevant multi-stage approvals from each of the concerned authorities. "We knew that this would be a big hurdle to overcome," contributes Project Manager, Pramod Kumar Sharma (PKS), "hence we roped in a local consultant for the liaising though we were assured that this process would take a minimum of six months." Each approval stage had its pre-requisites and requirements related to prior approvals from different agencies that made the approval process even more complex. For effective co-ordination with the technology supplier and local authorities, a 'front engineering office' was set up at Abu Dhabi.

"Our previous experience of having executed projects in the Middle East came in very handy," remarks Hare Ram. "We put an EPC team in place, reduced our dependence on resources from India and adopted a back-to-back sub-contractor strategy." Immediately after winning the contract, the EPC team got cracking to develop an integrated plan, schedule and clear-cut communication protocols with defined roles and responsibilities. Being an EPC project, all the engineering disciplines - architecture, mechanical & utility, electrical,



The project sets new benchmarks

- First to achieve a Pearl 2 rating under Estidama (Code for 'Sustainability' in UAE)
- First in which the majority of engineering was completed within the first 6 months to procure the 'Building Permit' to start site activities
- First to implement pre-engineered structural production bays involving multiple EOT cranes for quicker construction and lesser rework
- First to implement digital transmission and archival of all engineering deliverables & approvals using EDMS

instrumentation & automation, civil and structural – were involved. "This called for an integrated approach involving concurrent engineering of all the departments, together with inputs from the technology supplier to complete the majority of engineering works within an extremely short time period of approximately 6 months." Hare Ram certainly had a mountain to climb, quickly, which he and his team did with some remarkable results.

Starting with a handicap

Once the engineering was completed and signed off, the team started planning the civil works with the construction strategy underpinned by two considerations: greater use of local expertise and increased mechanization. "We actually started construction on the back foot, because despite our best efforts we received

the Building Permit only on July 31st, 2016, two months later than our baseline planned date," says PKS with a long face, "which meant that we had to make up for this delay in the construction phase." Buoyed by the challenge, Hare Ram, PKS and their fighting team adopted a series of smart initiatives to reduce execution time and, at the same time, ensure that the quality of construction remained top class.

Well point system for de-watering: "Since the region has a high water table, we realized that the conventional method of using sump pumps for de-watering would be ineffective," informs PKS, "hence we adopted a well point system which worked extremely well." Installing the dewatering system with the mechanical rigs was proving to be time consuming because of the hard rock strata. "Against an asking rate of 30 drills per day, we were only achieving 4 which was definitely going to impact

our delivery schedule hence we decided to deploy pneumatic drilling rigs to match our asking rate," Sharma's relief is palpable.

Factory manufacture cut and bent rebar and M/s PERI LICO type formwork: The availability of civil work fronts led to the adoption of these two initiatives. "By using factory cut and bent rebar, we eliminated the need for a rebar yard at site." Hare Ram's face wears a winning smile. "Saving us many engineer man hours." Again, due to the hard rock, assembling the rebar cage was taking far too long that the team could ill afford. "Waiting for an excavated foundation was hindering our completion schedule so we decided to assemble the foundation rebar cages away from the foundation location and then shifted the assembled cages to location on cranes which again saved us loads of time," explains Hare Ram. "As all the columns were all of similar type and dimensions,





Mechanical, Electrical, Piping, Balance of plant equipment

Major quantities of work:

- Concrete: 46000 cum including 3800 Cum of Precast
- Steel Structural work: 6000 MT
- Equipment Erection: 6400 MT
- Piping: 55000 IM
- Cable Laying: 510 km
- Transformer: 12 nos

All long lead items of the balance of plant equipment like EOT Cranes, HVAC System, fire-fighting system, air compressors were identified and ordered from local vendors on EPC basis. "We were able to work faster as all our vendors were specialists in their respective fields," reducing PKS's headaches. "That the firefighting vendor was approved by the Abu Dhabi Civil Defense helped to smoothen the transition during the approval phase." Depending on their functional requirements, various types of fire-fighting and protection systems like clean agent, foam, pre-action, water spray, sprinkler, FDA, central battery and voice evacuation were adopted at site. Similarly, various types of

HVAC systems like package ACs, split ACs, chiller systems and ventilation fans were used depending on their functional requirement. Underground water piping work mainly comprised HDPE pipes for which a local piping agency, specialized in laying HDPE pipes, was roped in equipped with all the requisite machines for butt fusion and electro fusion welding. "The task was completed quickly and to our satisfaction," PKS confirms.

The project schedule requirement that dictated the deployment of heavy lift cranes and specialized resources was communicated to all the teams involved to optimize their utilization. As the establishment of power involved several approvals from the local authority, the requirement of the ADDC electrical package was ordered on EPC basis to M/s LTEAFZE, a subsidiary company.

we implemented the PERI LICO type formwork instead of the conventional shuttering material that reduced the lead time in foundation readiness by a whopping 25%!"

Precast to save cost, speed up construction, maintain quality: To combat the huge cost of labour, the project controls team opted to precast the smaller buildings like the switch gear rooms, hydraulic rooms, gate house, weigh bridge control rooms, cable trench and boundary wall. Apart from reducing the dependence on labor, these precast, factory-produced panels speeded up construction, improved quality, safety and productivity too. Hare Ram elaborates, "This relieved the work force whom we could then employ on civil works that required more manpower."

Using Pre Engineered Building (PEB) structures: Faced with a daunting timeline, the team was ever vigilant to seek ways of 'making' time

and one initiative that worked in their favor was to use pre-designed, pre-fabricated PEB structures that were lightweight, economic and easy to construct. "It saved us both cost and time as these were all bolted connections," explains PKS. Strategically ordered on an EPC basis from a local contractor, the total structural requirement for erection came to approximately 3000 MT, a clean 30% less than conventional building tonnage for the same area.

Considering the criticality of the readiness of the process building from a sequencing perspective, the order placed with the PEB vendor for the factory production of the PEB primary and secondary structures was synchronized with the project schedule. PKS adds, "In fact, to meet our quality standards and time commitment, we placed our Quality In-charge, Simanchala Gouda, at the vendor's factory for constant monitoring."





A job well begun and well completed

Since the engineering and placement of major items were completed in time, drawings signed off and construction agencies finalized, Hare Ram's team could immediately take up construction on multiple fronts. "Our back-to-back subcontracting strategy implemented for all ancillary packages mitigated all contractual risks on the fire-fighting and HVAC systems, sewerage treatment plant, cooling tower and EOT cranes." A containerized sewage treatment plant helped to both minimize the site installation work and reduce footprint area while the elimination of the pump house by selecting pumps suitable to operate in outdoor conditions helped, as also did the air-cooled chillers that reduced loss of water.



"They were true partners and as long as we were able to deliver on our milestones, they were ready to clear our invoices as the per the agreed payments terms. Cash flow, therefore, was never a problem."

Hare Ram
Project Director

Just as the team strove to 'make' time, they were also on the lookout for ways and means to enhance the profitability of the project. Value engineering, selection of competitive and competent suppliers/subcontractors, adoption of cost saving construction methodologies and prompt decision-making both at site and BU levels paid rich dividends. Hare Ram is all praise for his client. "They were true partners and as long as we were able to deliver on our milestones, they were ready to clear our invoices as the per the agreed payments terms. Cash flow, therefore, was never a problem."

"In essence," Hare Ram sums up, "our implementation strategies worked in our favor with the deployment of minimum resources, a systemic work activity that resulted in high productivity. All these have enabled us to complete this EPC Greenfield project to speed and scale!" ■

"Key challenges like incorporating the project requirements and design coordination were excellently managed by our engineering team," says Hare Ram. "To facilitate the commissioning activities, temporary power through DG sets was provided for the process machines to proceed with the commissioning activities which saved us a lot of time."

4.48 million safe man hours without LTI – a performance par excellence

For EHS In-charge, Pallab Mondal, the challenges were many, chief amongst which was the stringent EHS code of practices and legal requirements prevalent in the UAE. Procurement of approvals was a tall order so also was synthesizing the working of a



"One legal requirement was that we had to recycle 70% of our total waste. We are about to achieve a Pearl 2 rating under ESTIDAMA and we have clocked 4.48 million safe hours without LTI which is a fair reward for our effort!"

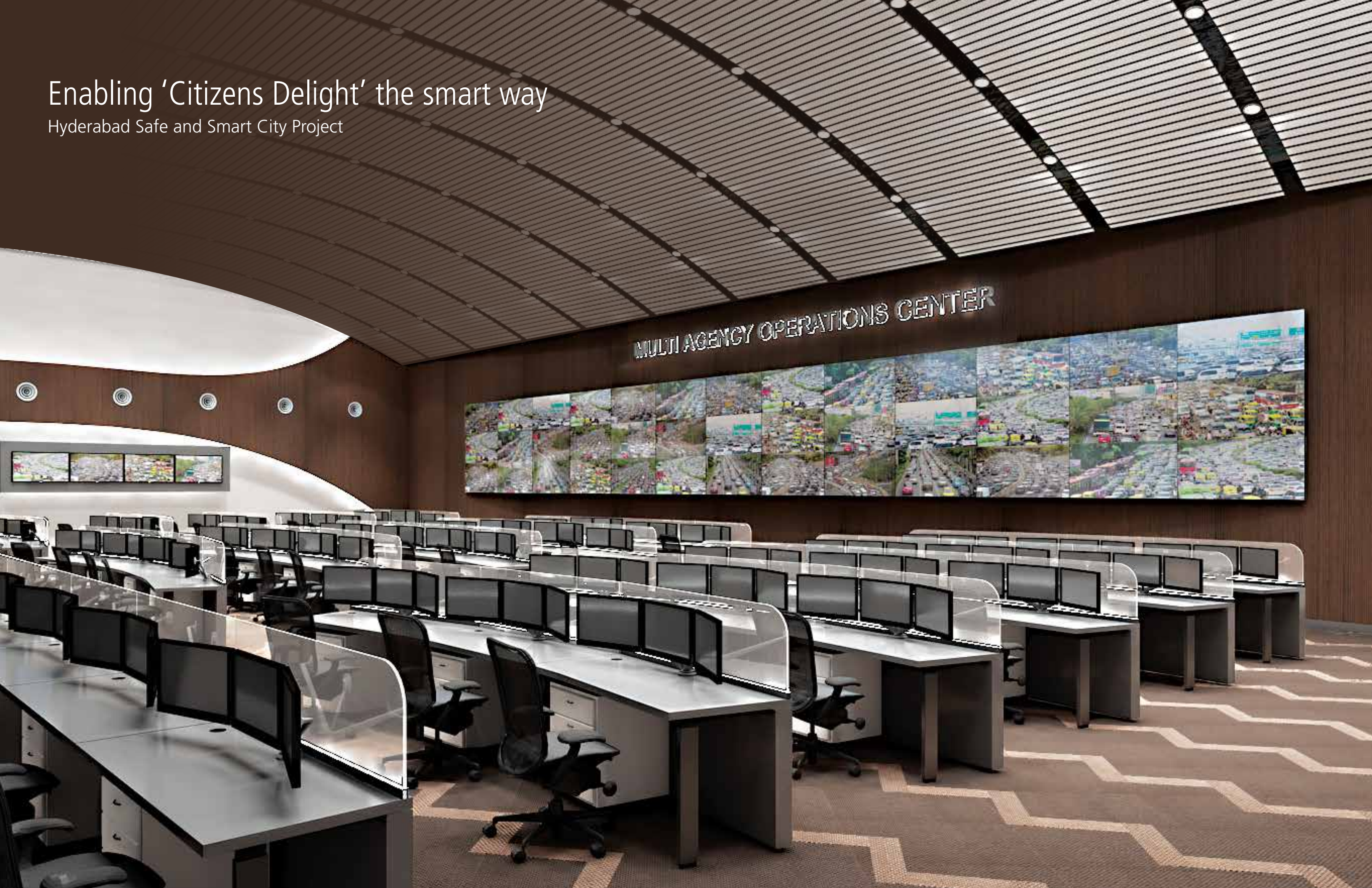
Pallab Mondal
EHS In-charge

cross-cultural workforce drawn from different nationalities, backgrounds and speaking different languages. "One legal requirement was that we had to recycle 70% of our total waste," says Mondal. "Then there were different types of audits and compliances to be fulfilled that had to regularly submitted to the local authorities for approval." Mondal and his team also had to be careful to avoid any comments from agencies like CEMP (Construction Environment Management Plan), ESTIDAMA (a green building concept) and the like "for which we had to be extremely vigilant to identify and minimize hazards." The EHS team monitored all the systems at the project and Mondal is a satisfied man for as he shares happily, "we are about to achieve a Pearl 2 rating under ESTIDAMA and we have clocked 4.48 million safe hours without LTI which is a fair reward for our effort!"



Enabling 'Citizens Delight' the smart way

Hyderabad Safe and Smart City Project



MULTI AGENCY OPERATIONS CENTER

Perhaps one of the most visible gains from the emergence of smart infrastructure across cities is the enhanced quality of urban life. Since the launch of the '100 Smart Cities' mission, India has been quick to integrate intelligent infrastructure across some of the key metros that are on par with global standards. Going forward, the thrust to build next-gen smart cities is shifting from 'citizen-centric' to 'citizen-led infrastructure design' that will characterize the development of tomorrow's world class metropolises. Hyderabad, the City of Pearls, a trailblazer, when it comes to infrastructure and information technology advancement, is all set

to redefine how smart and safe cities are built globally with the state of Telangana leading the way by evolving a comprehensive Multi Agency Operations System for the city that promises 'Citizens Delight'!

Initially conceived as two separate packages involving Intelligent Traffic Management System (ITMS) and City Surveillance, the Request for Proposal was floated in 2016 that aimed to implement the surveillance system over 3 phases across a 5 year period while the ITMS project comprised 9 phases with an installation tenure of 4 years. L&T's Smart World & Communication (SW&C) business which has been at the

forefront in shaping smart metropolises across India bagged both the mandates for Phase 1 works and upon the client's insistence merged these as a single package to be executed within a stringent timeline.

Shaping a futuristic vision

"This is more than a normal surveillance and ITMS project," begins J.V.S Ramakrishna (JVS), Head - Sales, Smart Cities Infrastructure who also doubles up as Solutions Head for the project, as he settles into his chair in his well-established site office at Somajiguda.

"When fully commissioned, multiple agencies will be integrated into one platform thereby empowering every field officer with the right intelligence and, at the same time, the public will experience the benefits of technology. However, the challenge here was very different as there was no crystal ball approach with the client adding several smart dimensions along the course." Sensing my keenness to know more on the dynamics, M. Shanmuganathan (MSN), Project Director, joins in, "It's a unique scheme with a win-win situation for both the city administrators and the public at large. Right from the beginning, the client was keen that we align the infrastructure in line with the overall



SCOPE OF WORK



The scope involved integrating more than 10,000 CCTV cameras across 3400 junctions networked to 1 lakh + community cameras with state-of-the-art Command & Communication Control facility along with 126 viewing centers at police station. In addition, the scope involves setting up and integrating the ITMS framework across 372 junctions, with 177 Adaptive Traffic sensors, 88 variable messaging boards, 80 public address systems, 25 mobile variable messaging boards, 25 emergency call boxes and 10 water logging detection equipment, making this one of the largest projects of its kind across the world.

goals of the project that was specific towards developing proactive measures from the insights gained." Recalling the directives from the then Commissioner of Police, Current DGP of Telangana, who defined the project elements, he highlights, "The focus was on maximizing benefits from a 360 degree smart system ensuring accountable policing and proactive ITMS response in real time situations."

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372 junctions, with 177 Adaptive Traffic sensors, 88 variable messaging boards, 80 public address systems, 25 mobile variable messaging boards, 25 emergency call boxes and 10 water logging detection equipment, making this one of the largest projects of its kind across the world. Probably, New York is the only city excluding China which has such a large scale system with close to 2 lakh+ cameras, shares JVS proudly.

Evolving a 5D execution strategy

An out and right EPC approach would have never worked, hints R. Shankaran (Former Head of Security & Surveillance Business, L&T, who played an instrumental role in bagging



this project). “It was important to have two separate tracks, one for the field infrastructure and an exclusive strategy for the digital solutions.” Certainly, this was no mean task, as the technology applications were largely functional and process centric. However, Team SW&C, had the right man for the right job with JVS leading the charge to bring to the fore his 22+ years of expertise in the IT Industry which includes a significant phase at L&T Infotech.

“We formulated a strategy to roll out technology and business process in Agile Methodology while physical infrastructure implementation followed as per the proven SW&C methods. Basically, the thrust was on framing a range of solutions through daily scrums, user stories, and continuous user testing etc., an approach adopted for the first time for a public infrastructure project in India (LTSCAD – L&T’s Smart Cities Agile Development Methodology).” Both the approaches had one thing in common assures JVS, “A simple but effective formula with each activity put through the frame work of 5 Ds: Discover, Define, Design, Develop and Deploy.”

Solution Architecture

“It took some time to understand the various business processes with regard to the functional applications as the client wanted to evolve solutions that were likely to emerge from the infrastructure set up which called for a business analysis kind of approach,” highlights JVS. “Primarily, we needed to quickly develop an understanding of the dynamics of each complex domain like Law & Order, Traffic, Emergency Management, Disaster Management etc. along with its unique deliverables and base our approach on TOGAF architecture methodology.” To effectively address the business process orchestration requirements and heterogeneous & complex application integration, we have proposed “Event Driven Service Oriented Architecture” with open protocols and messaging based on CAPS extensively used by US Homeland Security for Emergency



Management. This unique solution architecture, has simplified the integration efforts and helped to focus on outcomes and business process.

Ensuring a head start the digital way

Taking us through the Infrastructure & Sensors requirement, MSN relates, “For timely achievement of the physical milestones, the project was phased out across the three police commissionerates with ROW, scope of work and project planning aligned to the Discover phase. Further, to streamline issues, a separate team coordinated with the police station system admins and nodal officers to ensure smooth execution of works at site. In addition, a project governance team oversaw the progress of works and addressed matters of importance with the relevant bureaucrats.” Banking on digital technology, the precise survey

work was completed with minimum field issues as LiDAR with 3D laser scanners ascertained the ground points while through a GPR survey, the optimal path was defined without disrupting the existing utilities. These advanced survey methods ensured a perfect head start by facilitating mapping of the dedicated locations to execute the trenching works. Activities that came under the Define phase included feasibility tests, infrastructure requirements and performance specifications. Considering the humungous scope of material installation and integration, the Design phase was aligned to take care of the construction specifications, schedule of work and the defined Critical Path Method. “We adopted a ‘Just-in-Time’ system that was synchronized across key facets of the project involving safety, stores and quality thereby precisely aligning the procurement in tandem with the execution works.” The Develop

and Deploy charters outlined tasks such as pole erection, sensor deployment, product assembling and phasing out work zones through inspection and evaluation.

Always being ready to accelerate

In such projects, there is never a clear chart to accelerate mentions, MSN, “We have to be ready with a dynamic approach as most of the work was confined to the late hours.” We accelerated and achieved milestones whenever there was a window period, asserts JVS. “With 72 public events scheduled for the year across the city, approvals for facilitating work was always tough to come by. What tilted the scales in our favor was our secure plan for the bigger tasks such as stage wise delivery of materials in line with the work fronts, ensuring design



approvals for OEM equipment through a dedicated team, availing commercial and manufacturing clearance as per the site requirement." Further, excellent support from the client and various stake holders helped us overcome on-field constraints, adds MSN, "We were always informed well in advance about the various service works undertaken across city so that we could fast track installation and integration without any civil disruptions." At one of the zones, highlights JVS, "We raised the bar by doing close to 850 junctions in just a month and half out of the total scope of 3400 junctions that speaks volumes of the kind commitment required in such city centric projects."

Innovating work processes

6000 camera poles and close to 250 km of trenching across the city



"One of the biggest gains from a project of this kind is the setting up of viewing centers, a kind of mini surveillance hub across each of the 104 police stations and integrating the system with 1 lakh+ community cameras assisted by our very own CSTI trained technicians."

M. Shanmuganathan
Project Director

was like doing a hotline stringing work and the team had to be well prepared for unlikely disruptions but state-of-the-art technology ensured safe execution. MSN adds, "We knew exactly where the camera poles had to be placed along with the trenching route and further improvised on the process by going in for precast foundations according to the pole sizes thereby saving time and minimizing risks. For had, bitumen and concrete surfaces, jack hammers with compressors were deployed while horizontal drilling machines used where the ground utilities were minimum. In specifically busy areas, micro trenching machines were deployed along with HDPE ducts with warning tapes and backfilling done immediately after the work to restore the site to its earlier condition ensuring comprehensive public safety."

Taking charge with digitalization

Getting across locations was always a challenge especially during peak traffic for which the project team largely banked on our in-house digital applications that included 'Smart QI' App for submitting inspection reports, ProCube for progress monitoring, SafearmZ for safety, and Quality Management App. "It enabled instant approvals on work permits and facilitated activity checklists with the site engineer accessing the activity specific HIRA, SOPs thereby largely minimizing unsafe acts." For the record, a total of 1455 SEC cards were reviewed through the Safety App while the EHS module enabled reporting of real time observations to site and section engineers for immediate corrective action.



"A lot of research has gone into conceiving the design solutions which makes these centers one-of-its-kind in the world equipped with multiple functions. The Hyderabad center will operate as a State Fusion Center to manage normal day and emergency operations as both operations, technology and data fusion are created for real-time actionable insights."

J.V.S. Ramakrishna
Head – Sales, Smart Cities Infrastructure
who also doubles up as Solution Head for Hyderabad Safe and Smart City

Transforming 104 Police Stations as Command Centers

Having given an elaborate insight about the technology and project, it was time to see some of the significant deliverables. Go to any police station in Hyderabad and you will find that L&T is a trusted and familiar name, acknowledges JVS, as he leads us to one of the adjacent viewing centers. Among the khaki clad service men is a civilian youngster who seamlessly manages the system. "One of the biggest gains from a project of this kind is the setting up of viewing centers, a kind of mini surveillance hub across each of the 104 police stations and integrating the system with 1 lakh+ community cameras. And all this is now assisted by our very own CSTI trained technicians." Spotting us inside the viewing room,





the technician gives me an insight on how this system empowers the police and ensures the safety of the locals citing a few solved cases. While putting up the hardware was not an issue, integrating the existing setup

with our new VMS software was a challenging task as MSN elaborates. "Its functionalities were predefined and had to be customized in line with new service architecture by encompassing additional capabilities." As of now, the

main command and control center can view 5000 community cameras at a time with a provision for recording 2000, while all the police viewing centers have exclusive surveillance access across their respective localities.



Nurturing young software architects

"We have created a talent pool of young engineers who are now capable of developing software in-house for a range of use cases, a fact that all of us are extremely proud of," shares JVS. "This was a hi-tech requirement and there was even a thought of roping in global experts but now we have proved that with the right grooming our in-house talent can match and surpass international standards." What is unique about this is seamlessly integrating 1lakh+ community cameras with advanced ML based analytics, explains MSN, "We have to give credit to JVS for bringing in this architectural flexibility as it enables operational integration based on web services with an open protocol that is typical to the best practices across core IT projects."

In the thick of action

The heart of the matter are the two command and control centers that are coming up at Hyderabad and Cyberabad where L&T has more to do with the integration of the digital infrastructure. "As of now, MSN informs, "Our young brigade holds fort at the temporary setup playing the dual roles of integrators and trainers for the police force. The real system will be in full operation when both the shell structures are done and handed over for empowerment." Giving a gist of the hi-tech offerings in scope, JVS elaborates, "A lot of research has gone into conceiving the design solutions which makes these centers one-of-its-kind in the world equipped with multiple functions. The Hyderabad center will operate as a State Fusion Center to manage normal day and emergency operations as both operations, technology and data fusion is

created for real-time actionable insights. It will have a video wall of 70 inches covering an area of 1560 Sq.ft embedded with IP based controllers backed up by redundant features for achieving 99.9% Service Level Agreement." In addition to the smart elements, what stands out is the proposed sustainable design: A slew of energy saving innovations such as motion based lighting systems to reduce power consumption, precision air conditioning to control humidity, temperature and dust, automated gas suppression systems and water based chiller systems for higher coefficient of heat exchange, passive cabling hybrid architecture and copper CAT 6 A cable for connectivity between IT racks with redundancy, sound absorption carpet flooring, hydrogen sensors and timer based exhaust systems for the battery rooms will make sure these centers are thoroughly green facilities."



Securing Data

With more and more information coming through the digital frame, data security was one of the top priorities lists out JVS. "With the establishment of the command and control centers, there will be two data hubs with one being the primary facility encompassing 100 racks while the back-up center will maintain a failover directory which can also be used for load balancing." The architecture comprises one large system with inherent enterprise-class and redundant options. Video streams will be directed to both the primary and secondary data centers to be recorded simultaneously as backup. RBAC (Role based access Control) is being implemented with proven cyber security solutions.

Realizing the power of big data and AI

Today, Hyderabad, is the first city in the country to benefit from such a large scale smart infrastructure system. "The concept of Multi Agency Operations System has thrown open the potential of developing a robust data lake that is being worked upon by our young engineers," shares JVS. "Going forward, this breakthrough is going to radically shape the future of city administration. Systems such as crime and criminal tracking, jail release management, front line policing, computer aided dispatch, facial recognition, video and geospatial analytics etc., will be entirely driven with IoT, big data analytics and Artificial Intelligence."

Delivering a safe promise is doubly sweet

Having almost finished the Phase I works and awaiting for an opportune moment to go live has earned credibility for the project team with the client. While closing in on the visit, we got an opening with some of the key people who shared their views on the making of this unique project.

Taking us through the nascent days of the concept, Mr. Jitender, IPS, Additional

Commissioner, Hyderabad Traffic Police recalls that giving shape to the broad ideas was perhaps the biggest challenge. "For a large period of time," he says, "We deeply probed the various technologies by visiting different countries, studying their systems and finally proposed a scheme that was unique and comprehensive. With L&T emerging as a single bidder, both the ITMS and Surveillance packages were merged to take this project to the next level of implementation. Evolving as a technology hub for the entire state, this facility, in addition to its routine tasks will also serve as an Emergency Response Center in case of any likely crisis which is a unique mechanism integrated globally for the first time." Acknowledging that raising the bar is a must to meet the deliverables in a project of such scale and complexity, Mr Jitender, IPS (Addl Director General, L&O, Telangana State) lauds team L&T for taking up the mantle and realizing the vision of the Telangana government.

Briefing on the IT dynamics, Mr. Srinath Reddy, DSP, IT Cell, Telangana Police, shares some very innovative applications that could be on par with the internationally acclaimed Scotland Yard or even a step ahead! Beginning with technology driven police services, he presents insights on some significant digital customizations such as the establishment of smart police stations, seamless intelligent traffic management and accountability and transparency. He further mentions a slew of customized mobile Apps, e-Governance, Enterprise e-Cops,

digital crime mapping and many such applications along with a range of analytics that have been instrumental in bringing down the crime rate by 32%.

"The main objective of this initiative is to enhance public safety, build safer communities, partner with citizens to improve trust and confidence on law enforcement agencies, provide situational awareness and actionable intelligence for quick incident resolution, improve road safety and reduce travel time. We were looking for a partner experienced in complex system integration and disruptive technologies with large scale execution ability and are glad to have chosen L&T in this transformational journey." shares Jeevan Reddy, Consultant, Telangana Police.

Garnering a befitting acknowledgement

All the good and hard work was duly acknowledged when the project bagged the 'Best Project Award' at the Smart City Expo for creating an innovative system that empowers citizen engagement, nurtures co-creation processes, sustains inclusivity, ensures feasibility along with multi-stakeholder collaboration. Certainly Phase 1 has set the trend and as Master Systems Integrators, team L&T looks forward to raising another smart milestone! ■



Towards realizing the dreams of 56,000
families in just 60 months!

Upper Indrāvati Lift Canal Project





Choosing the most feasible alignment

The cumbersome task of finalizing the long span alignment was made easy thanks to modern day high tech survey tools as the project team used DGPS technology to line up the preliminary design while a conventional geographical approach was deployed considering the presence of dense plantation and forest cover. “We derived three routes,” highlights SDA, “and finalized the best option to avoid constraints wherever possible such as river crossings, buildings and villages.” “Also this was a feasible alignment,” adds KUK.

Taking a timely detour

Negotiating the issues of ROW was sensitive as it largely involved the local populace. “We had a whole lot of issues involving procedural delays, certain unforeseen policy changes and even having to convince the farmers to accept the price finalized by the government but we took them all in

our stride,” smiles SDA bravely. “But what kept us in good stead was the years of experience gained across such processes and with an experienced team we succeeded in plugging the gaps one by one. Further, a timely relook at the canal alignment that was originally along a forest area made a big difference.” Charting through the forest necessitated meeting a tall list of statutory requirements like furnishing details of the various trees, engaging with the Palli Sabha for the consent of the locals, going through a hierarchical approval process involving the DFO, CCF and many more on ground constraints. Since these could inordinately delay the project, the team took a considered decision to avoid the forest area as far as possible. “The only challenge,” according to KUK was, “Convincing the DFO who was empowered to sanction the diversion of forest land permissible up to 1 Ha. After a lot of brain storming and feasibility studies, alternate routes were proposed which brought down the forest area to 1.323 Ha thereby facilitating execution.”

Every year, India goes through a visible monsoon disparity with some regions experiencing floods while others reel under severe drought conditions. This scenario is even more daunting across the dry lands. However, over the last decade, interlinking and networking of water sources have gradually gathered steam with the advent of technology to partially address the surplus-demand equation. Many of the recent water infrastructure schemes implemented across the country owe its origin and success to this larger vision. Odisha has been at the forefront to build a robust agrarian ecosystem primarily by building multiple lift irrigation schemes to supplement water requirements particularly across its

arid upland areas. The Upper Indravati Lift Canal scheme is one such mega initiative that envisages to irrigate 26, 248 Ha of land across predominately drought prone areas of Odisha’s Kalahandi District promising a radical shift in the livelihood of the people by converting this region into one of the highest rice production basins. Taking forward this grueling mandate is L&T Construction’s Water & Effluent Treatment business, with an onus to deliver the project in just 60 months!

Gearing up for a larger mission

For S. Devanand (SDA), Project Director and team, this is a familiar situation. “Engineering water lifelines across



“What kept us in good stead was the years of experience gained across such processes and with an experienced team we succeeded in plugging the gaps one by one. Further, a timely relook at the canal alignment that was originally along a forest area made a big difference.”

S. Devanand
Project Director

remote locations is something WET IC has always excelled in. However, here, we had a larger mission that impacts the lives of people across 91 villages in the tehsils of Jaipatna, Koksara and Dharmagarh,” SDA elaborates, “Kalahandi is perhaps the driest district in the country with a history of successive droughts making this truly a life changing scheme.” A lot of hope rests on our efforts, acknowledges KU Kugan (KUK), the young planning engineer. The scope of work comprised survey, design, construction of approach channel, pump house, laying of a MS pipeline, rising mains, delivery chambers, formation canal, concrete lining, associated structures, installation of distribution networks including enabling power connectivity.





Spreading the good word

Anticipating ground delays, the project team came up with a people centric approach focusing on sharing the benefits of this mega scheme. “At times this worked though at times it backfired,” shares Udayagiri Srinivas (US), Project Manager, with a rueful smile, “but by and large people started to see the larger vision. Gradually the situation improved, people voluntarily came forward to give up their lands which motivated the rest to follow suit and we were able kick-start our work.” However, there were still some portions of the alignment that needed clearance, reveals KUK. As of now, the ROW has been finalized across 13 villages, 328 Ha for canal works and 237 Ha for other works. Whenever necessary, critical issues were flagged off to bureaucrats to resolve and, in some instances, even the



District Collector had stepped in to clear a 21 km stretch for the canal works and a 500 m stretch that involved 8 rows of pipes along the rising main.

Establishing 5 strategic hubs

A secure logistics plan was evolved especially for the heavy transport vehicles by establishing transit yards at five strategic locations to facilitate material handling without causing much inconvenience to the public. “This is similar to what we implement across most of our long span projects,” though here “It significantly reduced the scope of secondary shifting of materials to the respective locations and catered to the allocation of specific work front related resources.”



“We opted for government lands instead of private properties thereby avoiding delays to construct the pump house. Further, lead items such as MS pipes were fabricated during the early stages of the project and completed in record time.”

Udayagiri Srinivas
Project Manager

Wining the farmers' confidence

Every target was fixed after a great deal of planning and coordination so that the farmers could benefit from them. “With the project spread across three blocks and the canal running to 45 km, there was an opportunity to link the network to some of the areas much ahead of the overall integration and this worked wonders! highlights SDA. On the other hand, land issues were resolved with some smart work, mentions US. “We opted for government lands instead of private properties thereby avoiding delays to construct the pump house and the rising main alignments by getting the local Teshildar’s consent. Further, lead items such as MS pipes were fabricated during the early stages of the project and completed in record time.”



“A comprehensive monitoring plan was deployed to assess the performance across work fronts by incorporating digital initiatives such as GPS for P&M, safety and quality compliance systems and EIP Pragati.”

KU Kugan
Planning Engineer

Defining the structural elements

Building an intake structure is always a challenging task as it is largely located around perennial water sources. “Here, the scope involved diverting the flow of running water through a tail race channel and constructing a 16 m deep coffer dam to construct the fore bay channel,” briefs SDA. “Banking on customized design schemes developed by our EDRC we made cautious headway,” adds KUK. “Necessary silt protection measures were taken to prevent the entry of silt as the structural design encompassed an open fore bay allowing water to be pumped directly to the suction chambers.” Considering the Rabi crop season, the finishing and proactive works were taken up on a war footing and completed within a 30-day period when the barrage was dry. Other significant works included the construction of a 73x25 m pump house, 138 in lined structures along the canal such as village road bridges, cross drainage works where EDRC provided the design edge, super passages, aqueducts and regulators.



Having the right resources

“A comprehensive monitoring plan was deployed to assess the performance across work fronts by incorporating digital initiatives such as GPS for P&M, safety and quality compliance systems and EIP Pragati,” highlights KUK. Plant & Machinery played a vital role in closing the gaps across the civil and mechanical works with almost 1104 km of underground pipeline works ranging from 90 mm to 2000, 8 rows of 1.6 DIA MS and a 132 KVA transmission line and substation in scope. For SDA and team, commissioning will not be the end of the road as there is a commitment of O&M for 5 years from the date of completion.

Being safe and in control

Going by the rulebook is what is required when it comes to EHS and that's precisely how the team ensured safety and control at site. “Beginning with the monthly safety plans, a comprehensive system was put in place that communicated the essence of safety, based on a top-down approach both on and off work.” informs SDA. Quality was another focus area where the team used a Product Development Cycle Analysis along with online assessment systems and regulatory audits to achieve precision.

Engineering a single point control system

The entire flow of water will be monitored through a state-of-the-art

PLC SCADA system which is linked to the Master Control Station for single point management with provision to assess the distribution flow. The pumping station is equipped with 8 vertical turbine pumps operating in auto mode through the Remote Terminal Unit from the Master Control Station.

On the verge of making dreams come true

It's now acceleration phase for the project team with almost 80% of the mission accomplished and soon 56,000 families will reap the benefits of a promising tomorrow while for L&T, it's all about engineering vital infrastructure, touching people and transforming lives! ■

TALLEST FASTEST STRONGEST

On 31st October, 2013, the then Chief Minister of Gujarat, Narendra Modi laid the foundation stone of the Statue of Unity and five years later on 31st October 2018, the present Prime Minister Narendra Modi inaugurated the statue, dedicating to the nation the tallest statue in the world that has been universally recognized as an engineering marvel. Dedicated to the memory of Sardar Vallabhbhai Patel, considered one of India's greatest administrators and statesmen, the 'architect of modern India,' and responsible for keeping the newly created nation of India united, the statue stands tall as a tribute to a man of huge stature.



STATUE OF UNITY SOME VITAL STATS

13 months for designing

33 months for construction

182m (or 597 feet tall)

1,700 tons of bronze cladding

6,500 tons of structural steel

18,500 tonnes of reinforced steel

210,000 cum of concrete

A FEW SALIENT FEATURES

- ▶ Situated on Sadhu Bet, 3.2 km downstream from the Narmada Dam
- ▶ Faces the dam which was the Sardar's vision
- ▶ Made up of two semi joined composite concrete cylindrical cores
- ▶ On the cylindrical cores is a steel superstructure that is bronze clad
- ▶ A viewing gallery at 135 m level
- ▶ It rises out of a star-shaped, geometric base that covers the entire Sadhu Hill
- ▶ The vertical cylindrical cores house high-speed passenger elevators
- ▶ It is conceived as a naturalistic depiction of Sardar Patel in characteristic garb in a walking pose
- ▶ It has a unique, slender width to height ratio, far more exacting than existing technical norms that calls for special engineering considerations



A tribute to India's engineering skills and project management abilities

The Statue of Unity, apart from being a symbol of national pride, and integration is also a tribute to India's engineering skills and project management abilities. We have delivered several projects of national significance and are proud to be associated with building the world's tallest statue, which is a fitting homage to the Iron Man of India - Sardar Vallabhbhai Patel. Our engineering and construction teams along with the architects, the sculptor, and reputed global consultants, have converted our honourable Prime Minister's dream into reality in record time. Our commitment to scale, speed and quality in engineering has yielded this desired outcome, which is not only structurally superior but aesthetically appealing as well."

S.N. Subrahmanyam
Chief Executive Officer and Managing Director
Larsen & Toubro



A triumph of teamwork

It is a tremendous achievement by the Buildings & Factories business vertical. Right from the concept through the entire process of developing the design, the features and characteristics of the statue, the engineering, project planning, logistics, cost controls, were all managed extremely efficiently and reflects a triumph of teamwork. We are proud to have built a monument that makes the country proud and delighted that through this we are honoring a towering Indian personality."



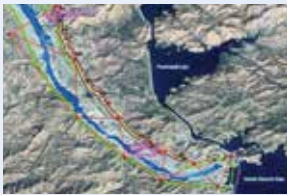
M.V. Satish
Whole Time Director & Sr. Executive Vice President
Buildings, Minerals & Metals

SOU GOES DIGITAL!

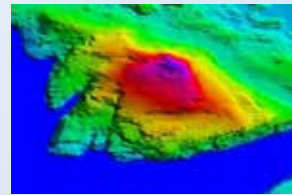
Whether it is understanding the tough terrain or fixing the thousands of micro and macro bronze panels, digitalization has worked wonders in enhancing the efficiency of the construction of the Statue of Unity.

A BOUQUET OF GEOSPATIAL TECHNOLOGIES FOR THE ORIGINAL SURVEY

DGNSS for a control network survey



LiDAR (terrestrial) & Photogrammetry for the topographical survey



Drone-based Photogrammetry for topographical survey & quantity estimation



Sonar for hydrographic survey



Stereo Satellite Image Processing for surveying the river bed



GIS Mapping

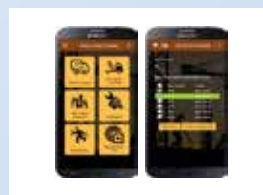


Water flow and spread analysis, hydraulic modelling studies, river morphology analysis, cut/fill quantity & location analyses

TRACKING OF THE BRONZE PANELS



Each panel tagged with a unique RFID



Mobile app to track the status and journey of every panel



All documentation uploaded and maintained related to all tests



Each panel was assessed at site and the RFID tags tested



Then the erection sequence worked out and executed

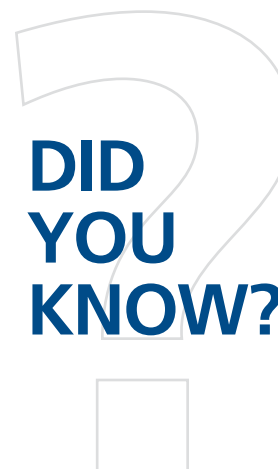
VIRTUAL WALKTHROUGH WITH VR

Using Virtual Reality, designers, architects, engineers, managers and even the client were able to do a virtual walkthrough to fine tune every aspect of construction, analyse and address clashes and get it right the first time!



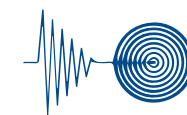
INDIA'S STATUE OF UNITY VISIBLE FROM SPACE

Commercial satellite network 'Planet' has tweeted a picture of the Statue of Unity, the photographed from space.



At **182 m**, it is 100 times bigger than a normal human being

It is twice the height of the **Statue of Liberty**



SoU has been engineered to withstand wind velocities of up to 180 miles / hour and earthquakes of intensity up to 6.5 on the Richter Scale



At 70 feet, the face of the Sardar is taller than the faces of **US Presidents cut out on Mount Rushmore**



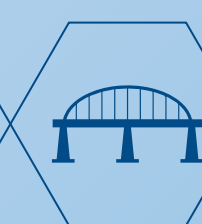
The next tallest statue in the world - the **Spring Temple Buddha - in China** took over a decade to construct; SoU only 33 months

A STATUE AND MORE

An exhibition centre at its base showcases the life and achievements of Sardar Patel

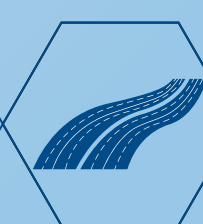


A memorial and visitors' centre



A 320 m long designer bridge connects Sadhu Hill to the mainland

An administrative complex, 3-star hotel and conference centre



4-lane approach road



A 40-m suspended fabric roof structure for the visitors' centre

SOME GLIMPSES OF THE SARDAR VALLABHBHAI PATEL MUSEUM AT THE BASE OF THE STATUE



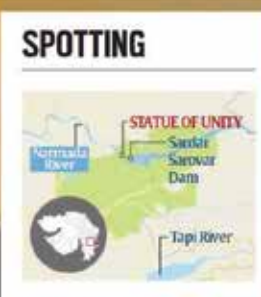
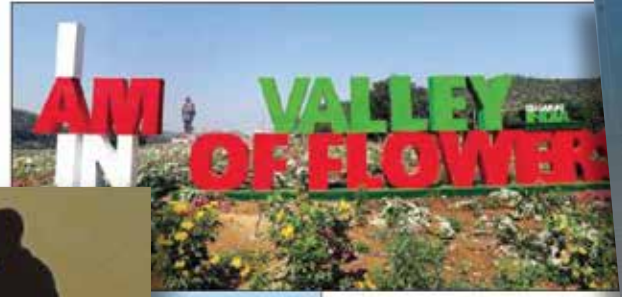
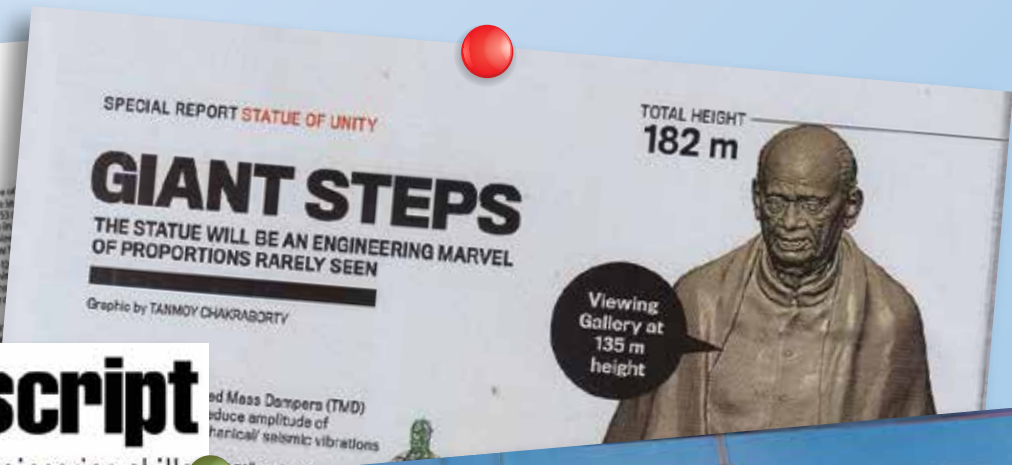
THE WORLD RECOGNIZES AN ENGINEERING MARVEL!



PROJECT COST ₹30 billion

MATERIAL USED

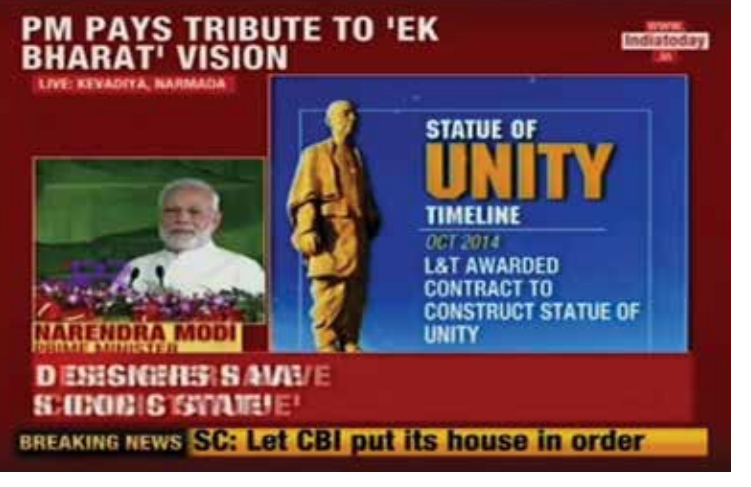
- 210,000 cubic metres of concrete
- 6,500 tonnes of structural steel
- 18,500 tonnes of reinforcement steel
- 1,700 tonnes of bronze for cladding



STANDS ON Sadhu ishar Narmada, 3.2 km down of Sardar Sarovar Dam. According to Statue of U website, 200 km of the reservoir and the Satpura Vindhya ranges can be seen from a viewing platform level of the statue's chest. A ropeway spanning the breadth of the dam is planned.

SELFIE POINTS created 1 km radius around the 1 km-long Valley of Flowe been developed around monument.

A MUSEUM in the statu has artefacts and docum from the life of Sardar P. including from his pers. The museum also has a prototype of the head of Statue of Unity.



Statue of Unity Timeline: L&T awarded contract to construct Statue of Unity



Statue of Unity, S.N. Subrahmanyam, CEO, L&T



PM dedicates Statue of Unity to the nation (SNS with PM)

Construction World recognizes L&T as 'the Largest Construction Company'



Larsen & Toubro was acknowledged as the 'Largest Construction Company' by Construction World magazine at its 16th Annual Awards celebrated in New Delhi on October 24th, 2018. "Selection of a project is key to sustainable revenue growth," said Mr. M V Satish, Whole Time Director & Senior Executive Vice President – Buildings, Minerals & Metals, while receiving the award on behalf of L&T. He added that with many companies climbing the growth ladder it was important for L&T to strategize better and maintain its top position.

To further consolidate the rankings on a global scale, Construction World associated with New York-based Engineering News-Record, popularly known as ENR, the world's oldest and largest circulated engineering magazine, to recognize top international design and contracting firms. L&T is ranked number 28 on the Top International Contractors and number 33 on the Top International Design Firms ranking by ENR.