

ECC COLCORD

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**CREATING
INFRASTRUCTURE
FOR A BETTER
TOMORROW**

From the EDITOR'S DESK

The recent news that even Kerala, erstwhile one of India's greenest and wettest states, has been drought affected throws into sharp relief the seriousness of what the country is facing this summer. With an estimated 25% of our population reeling under severe drought conditions, the writing is very much on the wall that the climate is changing, unfortunately not for the better and that the powers that be have to start, if they haven't started as yet, thinking of quick and long-lasting solutions to turn things around.

Interestingly, two of the projects that are featured in this issue of 'ECC Concord' are the kind of steps that need to be taken in multifold to address India's heat woes. As the country bakes under a blazing sun, it makes eminent sense to capture, store and use Solar power for the good of all. The hitherto unknown village of Panaiyur, Tamil Nadu, suddenly has its time under the sun because of the 60 MWp solar tracker plant, the largest in the country, constructed by our Solar team. In fact, they are all set for an encore by closing in on completing another 60 MWp project.

Rajasthan is another state that bears the brunt of the summer heat year after year and right in the heart of this sandy, arid expanse, our Water IC is building a part of the Pokaran-Falsoond-Balotra water supply project that will bring succor in the form of potable water to as many as 234 villages in the Jaisalmer and Barmer districts. Though, for our colleagues, it has been one very hot and sweaty desert safari, for the people of the region, they bring sweet relief.

The 3 million plus citizens of the city of Nawabs, Lucknow, will soon have reason to cheer as the Lucknow Metro takes shape and eases city commuting. Amidst densely populated areas of the city and contending with a number of ground level challenges, our Heavy Civil IC is reinforcing our credentials as the India's leading metro developer. Still in the western part of the country, the TI IC is building a 6-lane carriageway cutting across the salt bowl of India to connect the landlocked regions of North India to the ports of Kandla, Mundra and Adani and give trade and commerce in the region a huge fillip.

Lastly, in one of the fastest growing IT hubs of the country, Gurgaon, our B&F IC has created a new age, state-of-the-art IT facility for HCL Technologies that will accommodate 12,000 employees situated on the banks of the Yamuna.

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Giving
IT INFRASTRUCTURE
a Qualitative Difference



Even as the world slowly moves to the cloud, India continues to play the crucial role of being the world's 'back office' for IT and ITES (IT Enabled Services) thanks to the ready availability of world-class infrastructure, cutting-edge technology, technical manpower and, of course, the India cost advantage.

Noida is one place where all these are readily available in good measure and hence has attracted industrial giants and infotech companies to set up base there. HCL Technologies, one of India's original IT garage start-ups, has established its permanent base at the IT hub - Sector 126 to support its operations across 26 countries including 500 points within the country.

L&T, amongst the first to greet India's digital dawn, is building a unique 'plug and play' infrastructure for HCL on a turnkey basis. The HCL Phase 3 - a state-

of-the-art facility with a unique design of expanding floor plates is spread over 2.2 million sq.ft built-up-area that can accommodate 12,000 employees.

L&T's scope of work involved

- Design and build of two software towers - S4 and S5 each with 3 basements + GF + 13 floors and the Cafeteria superstructure building with 3 floors of 5.1m height each. The scope encompassed complete Civil and MEP warm shell including structural works, external finishing, service room finishes and MEP works (HVAC, PHE, FPS, ELV systems, Lifts and Electrical systems).
- Construction of Service Buildings - Water Treatment Plant, Sewage Treatment Plant and Electrical Substation.

- External Development Works consisting of sewer and storm water pipe connections along with the road works for about 1km around the S4 and S5 Towers and Cafeteria superstructure.

Smart design

As India's foremost construction organization, L&T recognizes its responsibility in positively contributing to sustainable design awareness, proficiency and innovation. Team L&T adopted a Green design to deliver durable and long-term benefits to HCL by incorporating efficient energy, environment, water management and safety systems through combined expertise of different engineering disciplines aided by the right technology mix.

The structure of two towers is planned as a dual system with more than

75% of the lateral force taken by the shear walls. It is designed for seismic consideration of Zone-IV. The slab panel size is 13.5 m x 13.5 m and the load on an internal column is around 3500 t. The ground and 7th floors are planned for state-of-the-art data centres with each floor featuring 2 ODCs (Outsource Development Centres), service rooms including 4 AHU rooms, 2 electrical rooms, server rooms, a cafeteria and toilets. An atrium of 30m X 14m rises from the ground up to the top floor while the basement can accommodate up to 1,400 cars.

13.5m x 13.5m panels make up the office area, designed as PT slabs of 275mm thickness with a drop thickness of 475mm that satisfy all service ability considerations including vibration analysis as per BS Code 8110: 1997 and ACI Code 318: 2011.

A diaphragm wall of 800mm / 1000mm width and 21m depth will encircle the entire campus (700 running metre) to facilitate 3 basement excavations of nearly 15m depth, as the soil is silty with a very high water table.

The podium slab outside the tower serves as a roof for the first level basement and is designed for 900mm soil fill with localized fire vehicle movement (45 t fire tender loads).

7 underground tunnels (10m width & 3.5m depth with 3 bays) were dug outside the towers to ventilate the basements.

The 4800 sq.m roof is designed using Kalzip of radial profile and is supported structurally on the Cafeteria terrace using 400 t of structural steel.

Connecting at the pinnacle

A 22m long walk bridge connects the S4 and S5 towers at a height of 45m on the 9th and 11th floors respectively. The erection of this double height walkable space involved 80 t of structural steel covering an area of 224 sq.m and it was erected with the help of a 150 t capacity mobile crane positioned on the podium slab with re-propping of slab till foundation. The bridge rests on Neoprene bearings placed along the edges of the S5 and S4 blocks.

The bridge offers a splendid view of the beautiful sprawling landscape of HCL on one side and the oft placid Yamuna River across the dam road on the other.

A skylight roof with glazing supported by steel beams and a composite deck has been designed for the atrium portion at terrace levels for the two blocks at a height of 60m from ground level running through the 22m length.

An 8m high wall supported by steel frames and laterally supported on the shear walls has been mounted to the terraces of the S5 and S4 blocks

at a height of 52m. Made with 42 t of structural steel, it is positioned on a vertical plane at the terrace and ACP cladding to hold HCL's logo.

At the heart of the building – The MEP System

HVAC System

The centralized air-conditioning system is designed for a total tonnage of 4800 TR with 6 Primary Chilled Water Pumps, 12 Secondary Chilled Water Pumps, 6 Condenser Water Pumps, 302 Air Handling Units, 9 Heat recovery units, 16 Winter Cooling Fans, 65 Jet Fans and 128 Axial Fans. A Life Safety System linked to the fire alarm can be operated during emergencies.

Green features to optimize energy

In pursuit of developing sustainable and carbon neutral built spaces, the HVAC system has been designed using CFC based refrigerants, high performance chillers and high efficiency motors with variable speed drives.

While the Chiller Plant helps conserve energy, the variable speed secondary pumping system in the service building supports conservation during part load operations. Pressure independent control valves at every AHU outlet control room temperatures and floor mounted work station AHUs with variable frequency drives regulate air quality as per load fluctuations. When the ambient temperature is less, fresh air is supplied to minimize the load on the chillers and thereby reduce operating power consumption. Chemical filters (activated carbon filters only) are used for the HRUs and winter cooling system.

Fire safe

The entire facility is provided with an automatic analogue addressable fire detection and alarm system with 100% power back-up.



Public Health Engineering

The project scores high on water efficiency with a slew of water saving devices like sensor-type flushing systems and low flow fixtures. A 620 KLD eco-friendly Sewage Treatment Plant and a 420 KLD Water Treatment Plant have also been installed.

Energy saving practices

- Building Automation system to monitor water and energy performance
- Building system monitoring by means of temperature, humidity and CO2 sensors
- Double glazing
- Over deck insulation
- High performance CFC free chillers
- Energy efficient light fixtures
- Recycled water for irrigation

- Energy conservation panels for energy saving in lighting loads
- LED lights for basement and stair cases.

Integrated Building Management

An Integrated Building Management system with redundant architecture capable of controlling and monitoring from both main and redundant control rooms is located at the ground floor of the S4 and S5 blocks. It is integrated with the PA system for zone monitoring, amplifier monitoring and controller monitoring and also helps in energy consumption monitoring.

Public Address System

A Public Address system, capable of making announcement through call stations from both control rooms, are

located on the ground floor of the S4 and S5 Blocks It features 39 amplifiers and 1500 speakers with an auto dialing feature to predefined numbers in case of an emergency.

Electrical System

A reliable and flexible Tier-3 configuration electrical system has been installed with a 16.5 MVA Transformer designed with forcer cooling for additional 10% capacity enhancement to take up future loads. The substation has also been planned with a spare pedestal for the 15.25 MVA DG set to handle future load expansions. There are three 33 KV panels connected by ring mains for redundancy. A 120 km cable runs through the system with a 30 km earthing conductor, 65 km of circuit wiring and conduits and 4900 light fixtures. The 5000 KVA UPS serves as a back-up for the entire network.

There are 16 high speed passenger and 2 service lifts in each tower.

The winning edge

Being a brown field development in a Special Economic Zone, resource planning and execution were challenges. Since HCL Phase-III Project was an extension of the existing operational campus which is spread over a total area of 50 acres, the task was to execute the project without disrupting the already functioning office environment. Efficient team work along with effective project and logistics planning ensured that the excavation process was carried out without disturbing the existing service lines, material movement was managed and despite space constraints all temporary infrastructure like site office, formwork yard, reinforcement yard for the construction activities were erected.

Situated on the Yamuna river bank, the silty sand and high water table of 9m LVL called for extensive dewatering to bring down the water table to 24m. A 20m deep diaphragm wall was constructed along the 700 m long periphery within a period of 3 months to avert monsoonal disturbances.

The erection of both the Kalzip Roofing of 4800 sq.m that was lifted 20m above the ground and the Connecting Bridge on the 9th floor posed challenges because of space constraints. A material builder hoist of 2T capacity was installed in both towers for movement of material across the 60m tall buildings.

Innovation & Technology

Large Area Table Formwork System

To meet the demand for speedy construction and project delivery, a Large Area Table Formwork System was adopted which is suitable for most slab & beam configurations with lesser requirement of skilled man-power. It is 30% lighter than the other conventional systems and a single table covers up to



60 sqm of shuttering area. The project used 6000 sqm large area table system covering 55000 sqm shuttering area.

Post Tensioning Works

A Post Tensioning system was used for a Typical Flat Slab to achieve faster cycle time that helped in Deshuttering of the slab right after 3 days of concreting thereby helping achieve a cycle time of 12 days for the whole slab.

Extended Slab Casting

The 5m cantilever slabs on the 9th, 10th and 11th floors were erected with the help of channel sections of two floors height instead of the conventional 40 m high staging that resulted in enormous saving of material, labour and time.

Twin Mast Climbers

Twin Mast Climbers were used for the external façade works to enhance the speed of works safely.

Scissor Lift

For external finishing works like the installation of ACP sheet and stone cladding, a Scissor Lift of 18m height

was used that provided a safe working platform and aided faster execution.

An IT Complex par excellence

Being an SEZ development, project management and micro planning were crucial. precise planning of the procurement schedule, optimum utilization of resources to achieve maximum productivity, adopting innovative techniques for speedier completion, maintaining Safety and Quality standards, maintaining Gross Margin under ACE and timely invoicing were some of the attributes for success of the project.

A measure of the safety standards was that the project clocked 12 million safe man hours.

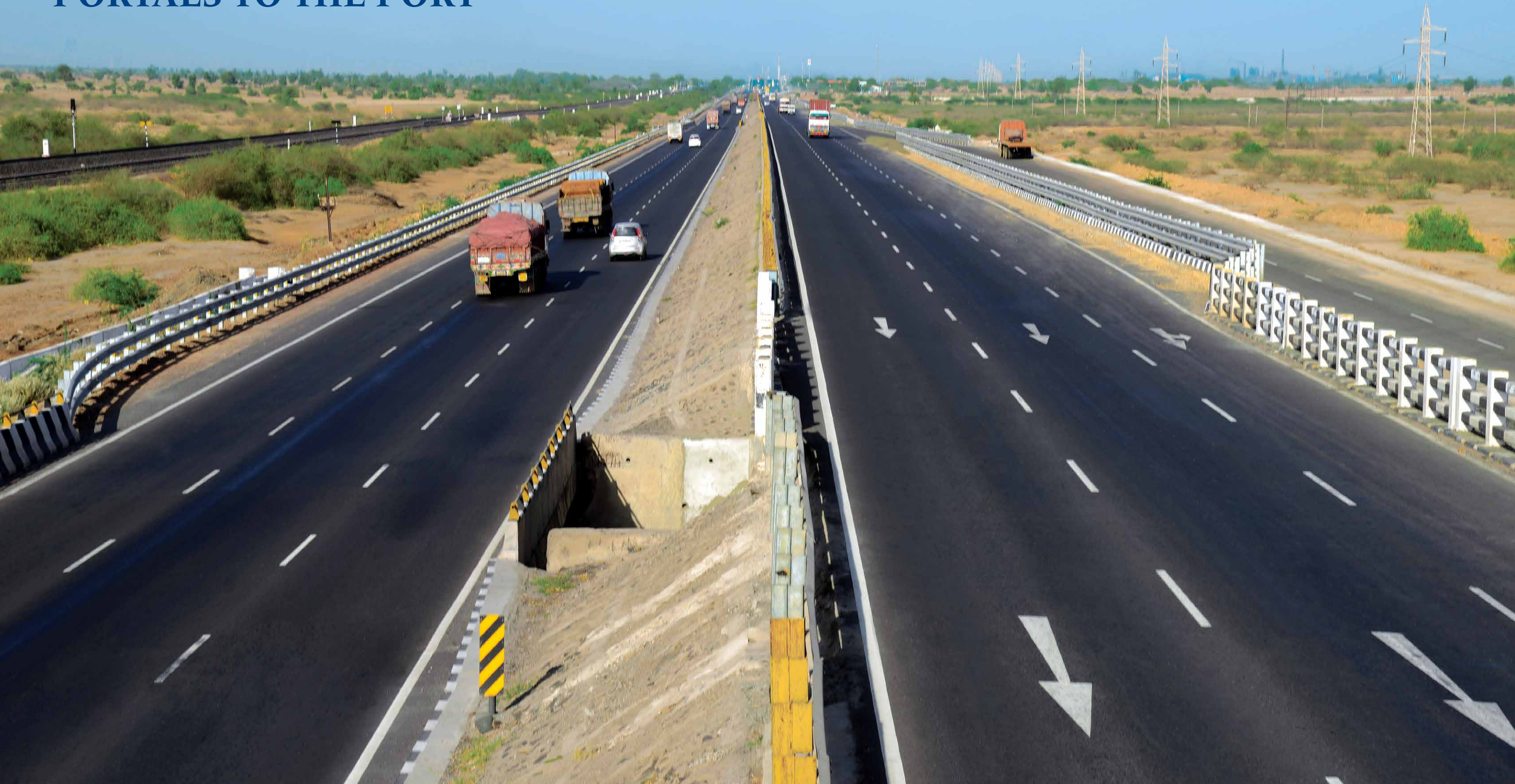
“The customer’s perception is your reality” and the sterling work of Team L&T not only won accolades from HCL Technologies but, more importantly, additional scope within the zone as well as new jobs in Lucknow. Just shows that it’s not only about completing projects but building relationships!



Samakhiali - Gandhidham Road Project

Opening up

PORTALS TO THE PORT





The cool interior of the MUV at a pleasant 20°C is in stark contrast to the 45* mercilessly dry and scorching heat outside. As we cut across what was originally called Gujarat's 'Little Rann of Kutch', a sharp glitter in the distance catches our eye. "It is the Agariyas" clarifies the driver who seems to be knowledgeable of the terrain and finds it amusing that in this world of real-time digital communication, this de-notified scheduled tribe still communicates with broken pieces of glass. Their original home in the salt pans have now been converted into a Wild Ass Sanctuary to protect the hardy but endemic and endangered Asiatic Wild Asses. Skirting this strange expanse, which is predominantly arid round

the year but submerged in rain water during monsoon, is a world-class six lane highway that L&T is constructing.

The route between Samakhiali and Gandhidham, a section of National Highway-8A, is one of the busiest in the country. Primarily because it is an evacuation route for the ports of Kandla, Mundra and Adani on the west coast and it connects to the India - Pakistan border in the Kutch district of Gujarat. Since most parts of Northern India are land locked, these ports are the closest gateways for Exim trade making the access routes virtually a game changer in the economic performance of the region. Since the existing carriageway could no longer handle the heavy commercial vehicle

movement, NHAI (National Highways Authority of India), as part of Phase V, proposed to six-lane the route to give trade the long awaited but much needed shot in the arm.

Making inroads

L&T's Transportation Infrastructure vertical won the mandate to construct six lanes of carriageway from km 306.000 to 362.160 (56.16 km) between Samakhiali and Gandhidham in Gujarat on a Design, Build, Finance, Operate and Transfer pattern. A SPV - L&T Samakhiali Gandhidham Tollway Private Limited - was incorporated to execute the project with a concession period of 24 years. Scheduled to be completed within a period of 30

months, L&T is entitled to collect toll from the users of the project highway during the concession and the construction periods.

The 56 km project stretch includes six flyovers, a rail over bridge, a couple of viaducts and close to a dozen vehicular underpasses apart from several minor bridges, culverts, drains and ducts. The project scope for metal beam crash barrier alone accounts for a whopping 78 km and RCC utility ducts for another 112 km. The team has put up a lakh and a half sq.m of retaining earth wall along the alignment which warranted a 75 km length of concrete covers for the drains.

"We started on the back foot without a work front owing to land acquisition

The salt bowl of India

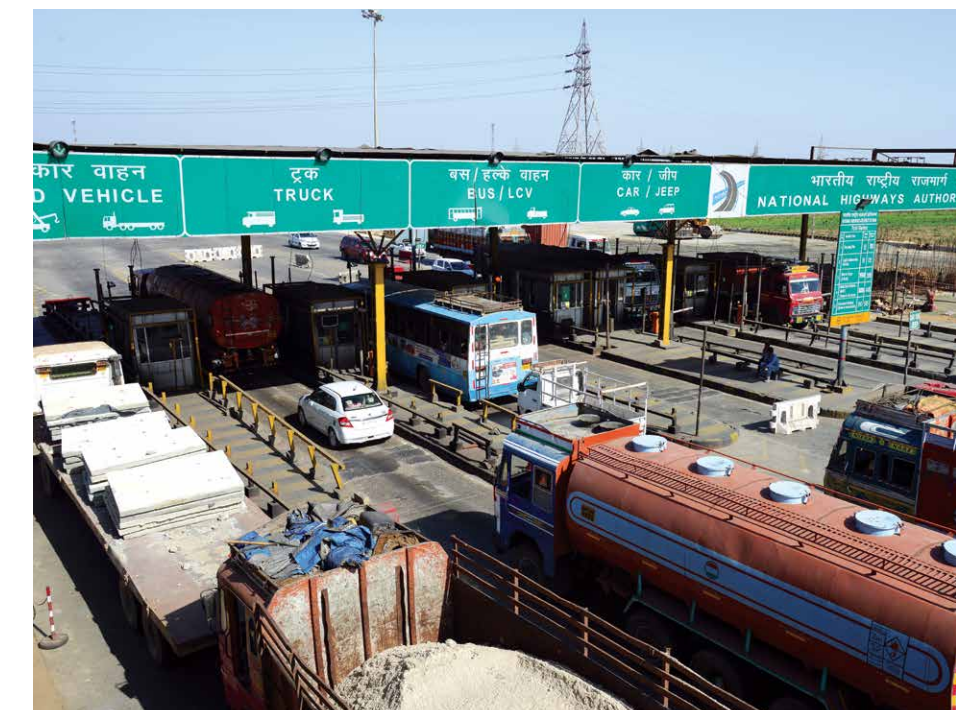
While the Asiatic Wild Ass could easily survive the unforgiving heat of the Kutch region, it could not survive the guns of the erstwhile colonists and the royals which is why the 5000 left on this sanctuary are an endangered and protected species today. Usually found in small groups, these elegant animals paint a colorful streak to this otherwise barren landscape with their shiny blackish-brown coat. Measuring close to the size of a donkey, these animals are agile with speeds matching that of a horse.

According to the Salt Department of India, over 75 % of the country's total salt supply comes from Gujarat with Kutch playing a major role. The *Agariyas* or the salt workers (*Agar means salt*), come to the central salt pans from the periphery of the sanctuary during the summer to peacefully co-exist with the wild ass population, producing and selling salt to eke out a living. Hardly ever in the lime light, this region also gains the moniker of 'survey number zero' because no survey has ever taken place here. Sadly, the Agariyas too are facing extinction by being driven out of the region that has been their home for generations by the forest department.

issues. It took a lot of rapport building and negotiations with the local community apart from liaising with Governmental officials to begin work," shares the project manager who recalls that what started as a meager team swelled to 150 employees who

managed 1200 workmen during peak project periods.

"In a land where all that one could see was soil, L&T's project team faced an acute shortage of this very resource that is in abundance around us," quips the planning manager





One of the flyovers

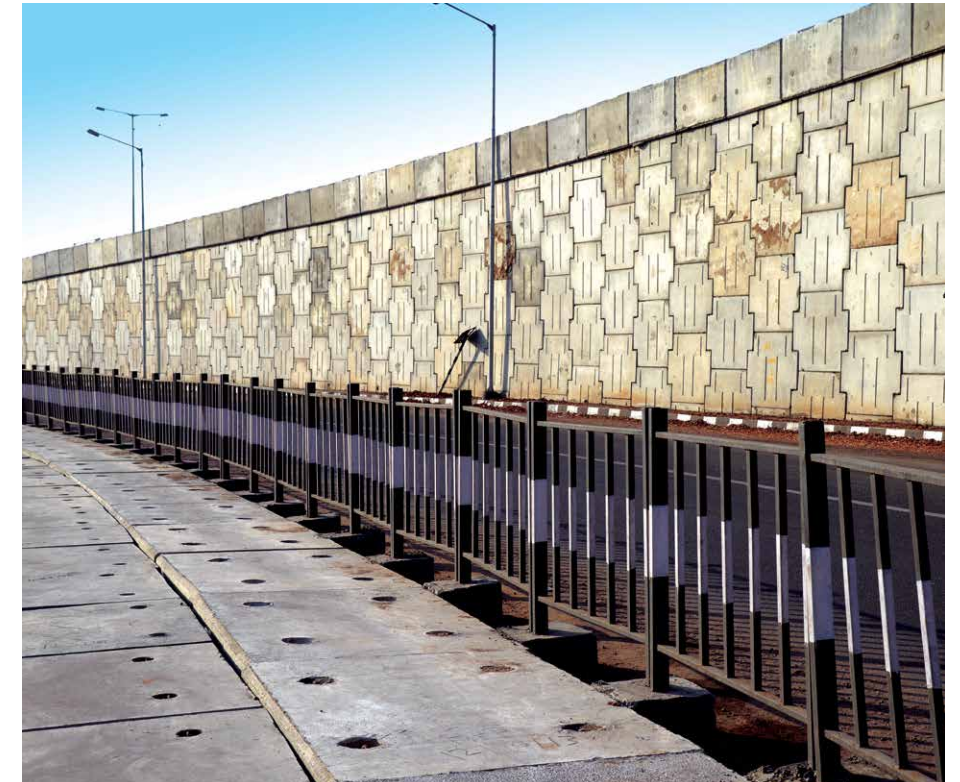
adding that mining activities were prohibited five kilometers from the boundary of the Wild Ass Sanctuary. Since soil requirement was very high for the embankment and backfilling activities, a special team was formed to solve this issue through proper resource identification and logistic planning which included bringing soil from the closest possible approved areas. He also recalls the team's arduous efforts in casting and erecting over 385 precast girders which weighed anywhere between 55 to 73 tons. Recalling another innovation, a planning engineer explains the team's strategic decision of completing 112 km of utility ducts using precast methodology in the place of cast in-situ saving enormously on time and resource. The causeway in the service road too was converted into a box type structure for enhanced quality and economy in construction.

"Workmen welfare was always a priority as the migrant workmen's health was crucial for the seamless progress of the project. Midday rests were prescribed apart from keeping them adequately hydrated with buttermilk and lemonades. Their camps were conveniently located and were adequately airy to offer comfortable boarding after a hard day's work. To this effect, the project team rented out permanent residences in the nearby villages for the workmen," shares the IR person from the time office. However, it was the execution team that bore the brunt of the scorching heat covering meter upon meter with world-class six lane highway that could cater to the heaviest of loads from the adjoining ports. The team burned the midnight oil on several occasions to make up for lost time and to expedite progress as and when work fronts were made available on a staggered basis.

A drive for safe work culture

"Construction and road workmen had to contend with the threat of oncoming traffic and, at times, enraged and abusive motorists. In addition, there was heat stress, hearing problems, and occasional respiratory distress while working alongside loud equipment. It is not just PPEs such as reflective jackets, steel toed safety shoes and hard hats that ensure safety. Proper induction and sensitization on safe working methods have to be drilled deep down at a behavioral level to make safety a second nature," asserts the safety in-charge adding that the team diligently positioned safety stewards at all worksites who made it their only job to constantly remind workmen to remain vigilant.

For all excavations beyond 500 mm depth, the safety team installed New Jersey crash barriers apart from including PVC delineators and reflective stickers for better visibility at diversions. The worksite was cordoned off to clearly demarcate it and prevent unauthorized entry. Working tirelessly to keep construction activities safe for both road users and the crew, the safety team devised warning zones as per international standards and under no circumstances was the four lane configuration compromised even during the peak of execution. All the signage were prominently displayed to provide legible and advance alerts to the drivers both during the day and night. Through such coordinated initiatives, the site successfully crossed 14 million safe man hours till January 2016 apart from bagging prestigious international safety awards such as RoSPA, British Safety Council and National Safety Council.



View of the drainage and railing work

Our MUV continues smoothly over the newly laid carriageway without the slightest hint of jerk or body-roll and the road furniture at every necessary

position is all that the driver needs to occasionally follow to drive us safely across to the end of the project command

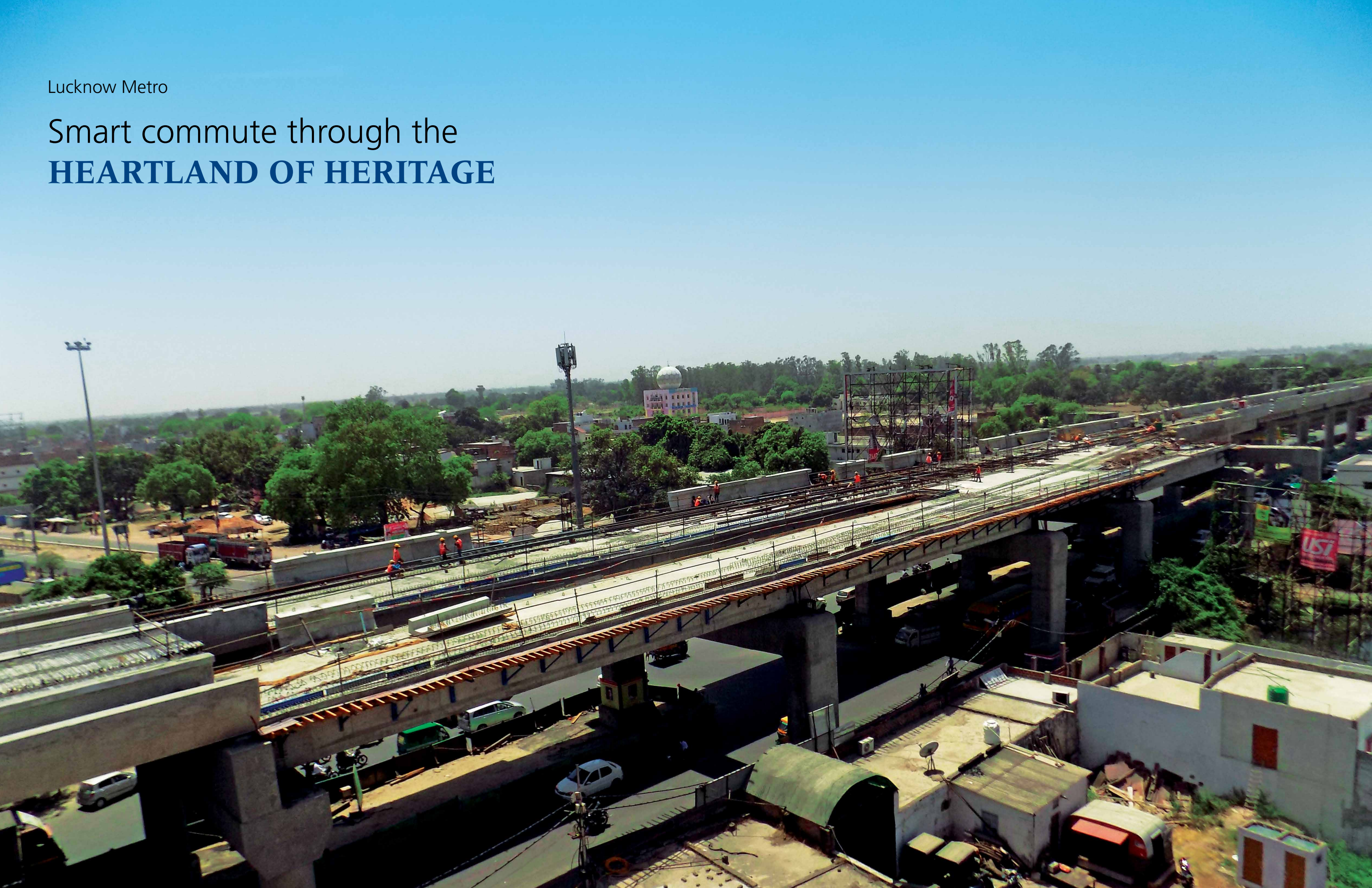
area. The vehicular underpasses and flyovers at the busy intersections ensure a non-stop journey as we approach a major flyover with a board indicating that we need to take a right turn to proceed towards Mundra. The flyover looks impressive and complete in all respects in terms of lighting, and road furniture such as catenies, traffic signage and statutory boards to give any road user the pleasure of taking the right turns without having to rely on the sweet virtual voice of the 'GPS' lady. The site engineer who accompanies us indicates that the flyover allows 8 lane traffic at the deck and two more at-grade service roads apart from a couple of underpasses. A major Rail Over Bridge too adjoins this flyover which would have made matters more complicated during its construction. Zooming down the elevated portion, we marvel at the crimson dusk that descends quickly as we drive towards our abode silently thanking the minds and hands that have created this marvelous road infrastructure to connect people and places.



One of the rail over bridges

Lucknow Metro

Smart commute through the **HEARTLAND OF HERITAGE**



The city of *Nawabs*, Lucknow is a confluence of the 'then' and 'now'! The city still retains its old world charm and it's not just the heritage structures or the lip-smacking *Awadh* cuisine or even the wafting soulful music that occasionally fills the city streets that is Lucknow's uniqueness but its 3 million citizens who make this city one of the most courteous places in the country with their ubiquitous '*Pehle Aap*' (You First) culture. The city's fast-paced horizontal growth has attracted people from far and wide forcing rapid development of suburban areas. Although the majority of vehicles hitting the city roads are privately owned, the worrisome fact is that the public transport system is woefully inadequate. While some cities have 70 to 80 buses per lakh residents, in Lucknow it is as low as

6 buses per lakh. To introduce a more robust, reliable, environment and commuter friendly public transport system, The Lucknow Development Authority commissioned DMRC (Delhi Metro Rail Corporation) to prepare a Detailed Project Report (DPR) for a Mass Rapid Transit System (MRTS) to forecast travel objectives with a horizon year of 2030.

The preliminary DPR proposed setting-up two corridors of Metro Rail viz. North-South and East-West measuring 23 km and 11 km each for a cost outlay of Rs. 6,880 crore and Rs. 5,494 crore respectively. While, the North-South corridor would have 19 elevated and 3 underground stations, the East-West corridor would feature 5 elevated and 7 underground stations. A special purpose vehicle - Lucknow Metro

Rail Corporation (LMRC) - was set up for the seamless implementation of this integrated multi-modal transport system.

Making a name for itself

Lucknow Metro has won the sobriquet of being India's fastest and most economical metro project which is not just because it is one of the flagship projects of the incumbent government in Uttar Pradesh but thanks to the efficiency and coordination among various partners involved. With trial runs planned from December 2016 and commercial operations slated to begin from March 2017, Lucknow Metro competes aggressively with Kochi Metro (*where L&T is once again one of the primary contractors*) in fueling progress at a rapid pace.

L&T won the mandate to construct 8.3 km of the metro priority corridor in 24 months flat that runs from Transport Nagar to Charbagh in the North-South corridor connecting the airport with the railway station and cutting across some densely populated urban areas.

Armed with strategic project planning and optimal resources including state-of-the-art plant and machinery, timelines were drawn up from the very onset of the project which were held sacrosanct by the team. Each milestone was achieved in full appreciation of its bearing on the next and its cascading impact on the final goal. The team got granular and charted all the utilities before hand apart from rerouting them with diversions to avoid unpleasant surprises during execution. A case in



point was the presence of multiple loops of electrical and signaling utilities which were properly charted, identified and shifted with the concurrence of the maintaining agency with least hindrance to services.

Armed with technology

Apart from the stringent timelines, a large quantum of construction activities including foundation and heavy segmental erection had to be carried out along the center median of arterial roads in a small time window in the middle of the night without causing any inconvenience to commuters. Relying heavily on technology that was already a proven success at the Delhi Metro, the team envisaged deploying 'U' girders to complete the spans. Appearing like a tub, two such heavy girders made up for a single span. The "U" girder conveniently replaced the conventional segmental erection method and all the other nitty-gritties involved along with it. 551 of these heavy girders were cast at a dedicated precast yard and transported to the actual site, lifted and placed in position. What used to

take days through the conventional method was now fast tracked to only a few hours. Using a combination of 400 and 350 ton cranes, the team was able to complete one span per day thereby gaining immense speed in completing the superstructure.

A steely resolve to beat conventions

Another critical crossover was at a four-road junction which also included the statue of a prominent leader of yesteryears making it impossible to locate the piers. After much deliberation and brainstorming, the team arrived at the option of constructing a 60 m steel bridge to cover this section which totally eliminated the need for piers. Once fabricated, the gigantic bridge was lifted by heavy duty cranes, placed on temporary trestles and pulled to position using strand jacks and Hillman rollers.

Shuttering and de-shuttering have forever been a cumbersome process that blocks out access to much of the areas below any super structure that



is under construction. If it happens to be a metro viaduct with a busy road below, the challenge only gets multifarious. The Lucknow Metro team defied conventions and replaced the shuttering system with profiled metal decking sheets using it as sacrificial shutters. These sheets were placed

over the I-girders and concreted in-situ thereby totally eliminating the necessity for supports leaving the road completely clutter-free for commuter use at all times. Saving 30 % on time, the team could complete one span in just about 3 days as against the one month cycle period of the conventional system.

Making the right connections

While firing on all cylinders to complete the priority section, the team achieved yet another milestone by bridging the connection over the Utraita railway track near Transport Nagar overcoming the unnerving task of erecting four, 30 m long I-girders weighing 75 tons each. What made the task unique was that the erection had to be done over an existing railway track below which was a busy road, making the inflexion point a complex three tier transportation infrastructure. With limited space to even place cranes, the team meticulously planned the sequence to minimize traffic blocks and drew up a schedule to fit the erection scheme into just two blocks of three hours each on the 19th and 20th of February 2016. Using a smart combination of heavy duty cranes, the girders were dexterously placed in position within the planned timeframe drawing immense appreciation from the public and widespread media attention.



Stationed as numero uno

In what comes as a first in the history of Metro rail construction, much of the station building areas at Lucknow Metro were also adapted for precast construction. Right from the concourse, the station building used large precast elements that were stitched together into place to magically create structures in just a few days. Apart from the speed of construction, this technology totally eliminated the need for in-situ staging and shuttering that would have otherwise disrupted the busy traffic. The team had to contend with barricades of just 8 m width within which all movement of the heavy duty equipment had to be managed so that traffic in the two lanes were left undisturbed.

Numbers that made the difference

1200 mm dia pile	: 2203 nos.
Pilecap	: 484 nos.
Pier	: 484 nos.
Precast piercap	: 247 nos.
Precast U - girder	: 551 nos.
Precast I - girder	: 226 nos.
Stations	: 19700 sq.m
Concreting	: 215000 cu.m
Reinforcement steel	: 28000 t

Getting resourceful

A dedicated team worked tirelessly to deploy the most optimum resources to make the project not just speedier, but also viable. The foundation drive was powered by eleven rigs while the erection activities were efficiently handled by about twenty cranes of various types and configurations. Girders were transported

on specialized multi-axle trailers and tractors and seventeen transit mixers made endless trips to the two batching plants to keep the flow of concrete on for the in-situ operations. As always, hiring and retaining skilled workmen was an imperative despite the high level of mechanization involved and by striking a rapport with trustworthy labour contractors, the team ensured that this invaluable resource peaked at 3500 during busy project schedules.

On the fast track

L&T has already established its credentials as a leader in creating new age metro systems and the Lucknow Metro is one for affirmation of that fact. By always putting the residents of Lucknow first in terms and safety and convenience, team L&T has reciprocated the 'Pehle Aap' culture in the land of the Nawabs and is all set to create smart commute infrastructure in other tier 2 cities of UP including Kanpur.

60 MWp Solar Tracker Plant, Panaiyur

Fast tracking the **SUN BEAMS**



The solar buzz in India began with the launch of the Jawarharlal Nehru National Solar Mission which envisions the production of 100 GW of power by 2022 on the back of which there have been several solar power installations across the country especially in Rajasthan and Gujarat. Though the southern region was a trifle late to join the solar energy bandwagon, significant inroads have been made in recent years by wooing technology developers with state-of-the-art prowess to enhance its energy retention capacities.

Developing a watts up zone

Tamil Nadu, one of the top 3 southern states engaged in building large scale solar power infrastructure, is on a

mission to produce 3000 MW to achieve grid parity in the near future. In the fiscal year 2015-16 alone, the state has added 420 MW which is the highest capacity addition across the country. The arid zones in and around the Madurai belt with large tracts of wasteland are being transformed into lucrative energy generation hubs. Tiruchuli, an isolated, nondescript village in Virudhunagar District is one such region that is being hailed as the emerging powerhouse where a slew of mid-range to large scale plants are being set up.

Bringing technology to the fore

The tracker system is a proven technology that controls the movement of the solar photovoltaic panels through an axis that is either single or double tilt

oriented. Through a range of options one can precisely reduce the angle of incidence between the incoming sunlight and a photovoltaic panel by aligning with the Sun's positional shift thereby ensuring that the proportion of energy derived from direct radiation is higher. It is expected that the technology cost will come down in the near future enabling solar photovoltaic systems evolve towards multi-dimensional tracking systems.

Raising the solar bar

The 60 MWp solar tracker plant in Panaiyur village is India's largest tracker plant that was executed by L&T within a span of 8 months and commissioned recently. Now, the stage is set for an encore as the team is on the verge of completing another 60 MWp

project in just about three months thereby setting an unprecedented benchmark in the solar industry. Right from the initial stages, the stakes were demanding as this was a high-tech job that called for a clear understanding of the technology and execution methodology. The client stepped in to make things easy by conducting debriefing sessions to L&T's project team on the way forward. The editorial team got a glimpse of things in the making by visiting the commissioned plant and also the work in progress site and shares insights on how these two benchmark projects were put together at very short notice.

Transforming lives

Its boom time for the locals, relates the driver while on our way to the plant as most of the people are engaged in jobs



Solar team checking the alignment of the modules



India's largest (60 MWp) tracker based solar plant near Tiruchuli

at the various solar power projects. Revealing his local knowledge, he shares that this place is renowned for spinning mills which is very evident from the topography where agriculture takes a backset. A sharp detour leads us to a mud track that seems never ending that finally leads us to rows of shiny blue panels which seem to merge with the horizon spread across the 340-acre plant. Alighting from the vehicle, we find that the porta cabin is the only shelter from the sweltering heat. Two members of the only crew who remain apart from a few operators stationed to oversee the commissioned plant meet us and take us inside the makeshift office. The rest of the team is working round the clock at the adjacent project site states one of the lead engineers.

Making over of the bush land

To start with, the vast bush land had to be cleared to facilitate access and earmark

locations for work. "It was important to quickly mark the foundations and enable excavation as the scope involved installing a whopping 192192 modules and 158 trackers which called for a range of civil, mechanical and electrical works," informs the planning in-charge. While setting foot on the Greenfield zone, the team found that the soil was black cotton in nature but as it was peak summer the preliminary ground works were easily completed and a level field was established.

Lining up the stub placements

The loose soil had to be doubly checked before taking up the piling works for the nearly 27000 stub foundations apart from the other major civil works for structures. The planning engineer draws our attention to the steel frame that holds the module. "It was vital to get the markings done precisely for the stub works as the alignment



Close-up view of the auto control panel

determined the overall spacing and layout of the plant. Though the depth of piling was around 0.9m to 1.5m, a lot of customization was done especially during the auguring work." To further illustrate, we are taken to a row of solar PV modules, "A tracker system comprised 30 rows at 4m spacing and required 6 piles per row at 9m spacing and such a vast stretch was covered using tractors fitted with piling grooves. Close to 500 stub foundations were cast at one go and closed to secure against any likelihood of rain water hampering the works."

Laying the tracker system

For a layman, it takes a bit of explaining to understand the workings of the

tracker technology for by looks of it, it merely seems to be long steel rods that are connected to rows of modules. Needless to say, there is much more to this trend setting technology. Weighing close to 3000t, the materials were sourced from Chennai as well as overseas and moved to the respective locations across the site and integrated with four combinations of torque tubes weighing between 80 to 155 kg. The process of integrating the trackers was hard work as it was done manually and auto tools were deployed for precision tightening and torquing. Guiding us amidst a tracker, the planning engineer opens up an auto-control panel kit and expounds, "These new generation AP 90 single-axis systems control the east-west movement of 30 rows of modules

per single motor block through the feed received from the mini weather stations installed across the plant via the SCADA system."

Unloading the modules

As we looked out for a vantage position for photographing a line of modules, the crew briefed us on the dynamics of putting the panels together. Technically, the process is known as 'shaking' and formed the bulk of the works. Sourced from China, each module weighed around 23 kg and the complete consignment was docked at the Tuticorin port and moved to the project site through 398 containers in a phased manner. At site, the modules were unloaded using specially

designed forklift attachments made compatible with JCB backhoe loaders that facilitated navigation through natural soil and undulations. The lead engineer elaborates, "The first quality check was done as per SOP while opening each pallet and the client was informed of damage, if any. A crew of 8 workmen was engaged to mount the modules that came in two categories - 310W and 315W, which were aligned to the earmarked tracker and row orientations. A typical row comprised 42 modules and the team planned an empty row in between the working stations to facilitate installation."

Stores houses for the power centre

A few prefabricated structures are spread out across the plant and strikingly different among them is the orange colored building which is the main control unit that monitors the entire plant. The HT panels working in full swing give off a deafening sound as we are taken through the unit which is amazingly cool thanks to the roofing that is specially coated which limits heat radiation and maintains a pleasant temperature which is good for the equipment, explains the operator. Upon the insistence of the crew, we visit a few inverter rooms which are spread out at 16 locations across the plant. These units are prefabricated structures built to sustain the heavy equipment, highlights one of the engineers. The major civil scope comprised construction of the inverter rooms and a main control unit that was customized to accommodate HP and LT panels, inverter and switchyard equipment and a battery bank. The team had the onus of ensuring complete waterproof coverage for the equipment as most of them were unloaded in open areas adjacent to the respective buildings during construction.



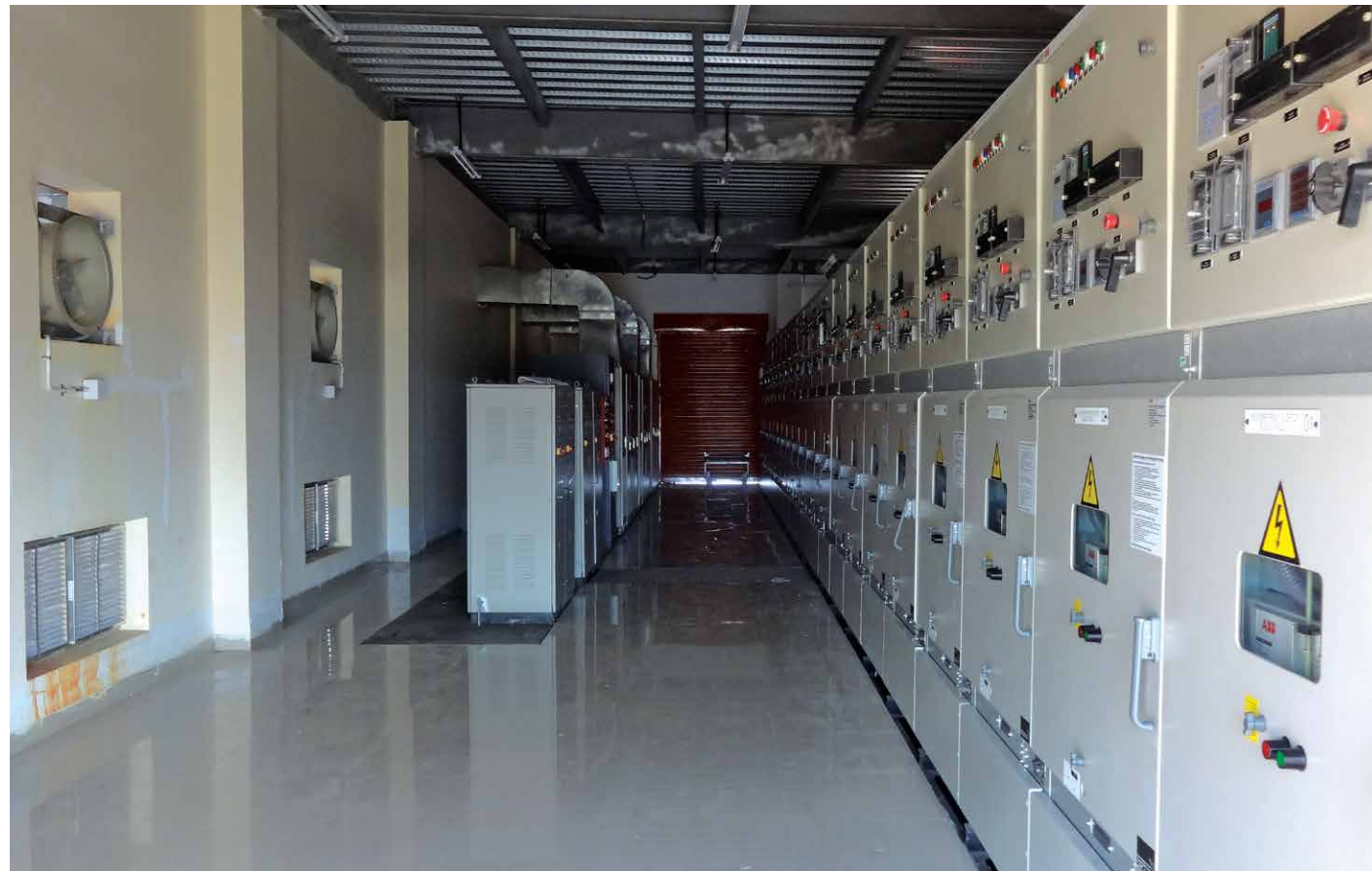
One of the mini weather stations installed across the plant



MCR Slab casting

Learnings from the monsoon effect

A much anticipated lunch break provided relief from the scorching heat and gave us some time to review the work in progress and photographs that revealed a flipside to this arid zone during the monsoon. “Even walking was difficult during rains,” exclaims the planning engineer. “Loading and unloading materials was a nightmare as the trailers got stuck in the slush and we had to patiently wait for the weather and ground conditions to improve.” For the team it was a great learning under these conditions as much of the excavated pits were completely flooded and this insight was taken forward at Phase II works where the cable trenches were completed and closed before the onset of monsoon.



Electrical panels at the main control room



Inverter room

Good practices that reaped rewards

A range of improvisations and value engineering concepts were implemented for streamlining the work process that included high-tech gauging tools for fixing the stub alignment, customized templates for executing complex civil and mechanical foundation works and high quality bonding additives for grouting works. By adhering to the SOP and Quality standards, team L&T was able to achieve the milestones within the schedule. The final outcome of the project depended on pre-commissioning and testing of a range of equipment covering UPS, battery bank string monitoring boxes, HT and LT panels, auxiliary and inverter duty transformers and switchyard

equipment. The team used PV analyzers to conduct the open circuit testing before back charging the power transformers as per the recommended guidelines and energized the AC and DC supply of inverters by synchronizing with power generation that commenced with the rotation of the trackers initially in manual mode and subsequently in auto mode.

Signing off on a safe note

Getting to meet the safety in-charge was a tough task as we are told that he was in the thick of action at Phase II works. Making some time we visit the plant and get an insight into the safe practices. “A large fleet of 1500 workmen across a vast land space that was prone to lightning strikes

called for installation of adequate lightening arrestors, updating daily weather forecasts to the gangs and routing the shortest safety assembly points in case of any emergency. The team also prepared a risk assessment plan by identifying job related hazards and further reiterated the safe practices during the daily pep and tool box talks. A safety walk down was organized once a fortnight for scrutinizing in-depth issues such as near miss cases, frequency of lapses and severity in project EHS statistics.” And as we close in, he gets a message and beams sharing, “The site has just bagged the prestigious RoSPA award” which affirms team L&T’s credentials of setting safe benchmarks.

Pokaran-Falsoond-Balotra Siwana
Lift Water Supply Project

Charting a water lifeline in **THE LAND OF DUNES**



Rajasthan, one of the most water-deprived states in the country faces a perennial challenge of effectively managing water distribution across its urban and rural areas, a task that becomes extremely arduous during the harsh summer months with the rapid diminishing of its meager water resources. For sustenance, the state largely depends on ground water and a few inter-state distribution channels among which is the Indira Gandhi Canal, one of India's largest water distribution networks that reaches out across its seven districts: Barmer, Bikaner, Churu, Hanumangarh, Jaisalmer, Jodhpur, and Sriganganagar.

563 villages get access to potable water

It is common to sight villagers around the innumerable hamlets that dot the arid zones make long treks to fetch water from the sparse distribution centers.

However, this grim scenario is beginning to change, thanks to the government's initiative of building a slew of water infrastructure developmental schemes and extending the distribution network across the interior regions. One such mega scheme is the Pokaran-Falsoond-Balotra Siwana lift water supply project which is envisioned to supply drinking water to 563 villages. When commissioned, the facility will benefit most of the villages around the Jaisalmer and Barmer Districts.

Fulfilling a vital human need

L&T was entrusted with the task of executing a major portion of this scheme covering 234 villages which involved survey, geo-technical investigation, design, supply and construction of all related works of transmission main system involving pumping and gravity mains, clear water storage tanks, cluster

distribution system, village transfer chambers, PLC with SCADA automation, approach roads and ancillary civil works with campus development. The major quantum of works covered construction of 34 elevated service reservoirs, 6 ground storage reservoirs, DI pipe laying and jointing works across 173.85 km, BWSC pipe laying and jointing across 135.37 km, HDPE pipe laying and jointing across 777.93 km, UPVC pipe laying and jointing across 315 km. With the alignment passing through the heart of the desert land, the team had a task at hand to evolve a secure strategy to install the pipeline network within a stringent time frame of close to 24 months.

Routing the 1500 km alignment

The project team had to hit the road running as temperatures soared beyond 50 degrees centigrade when the survey works commenced and quickly lined

up the alignment of transmission mains within 3 months using state-of-the-art Differential Global Positioning System. Having fixed the contour, four reliable vendors were roped in to manufacture and deliver a range of pipes in stages as and when the work fronts were taken up. A detailed quality assurance plan was also drawn up in consultation with the client which facilitated inspection and ensured timely delivery.

Making the most of a desert safari

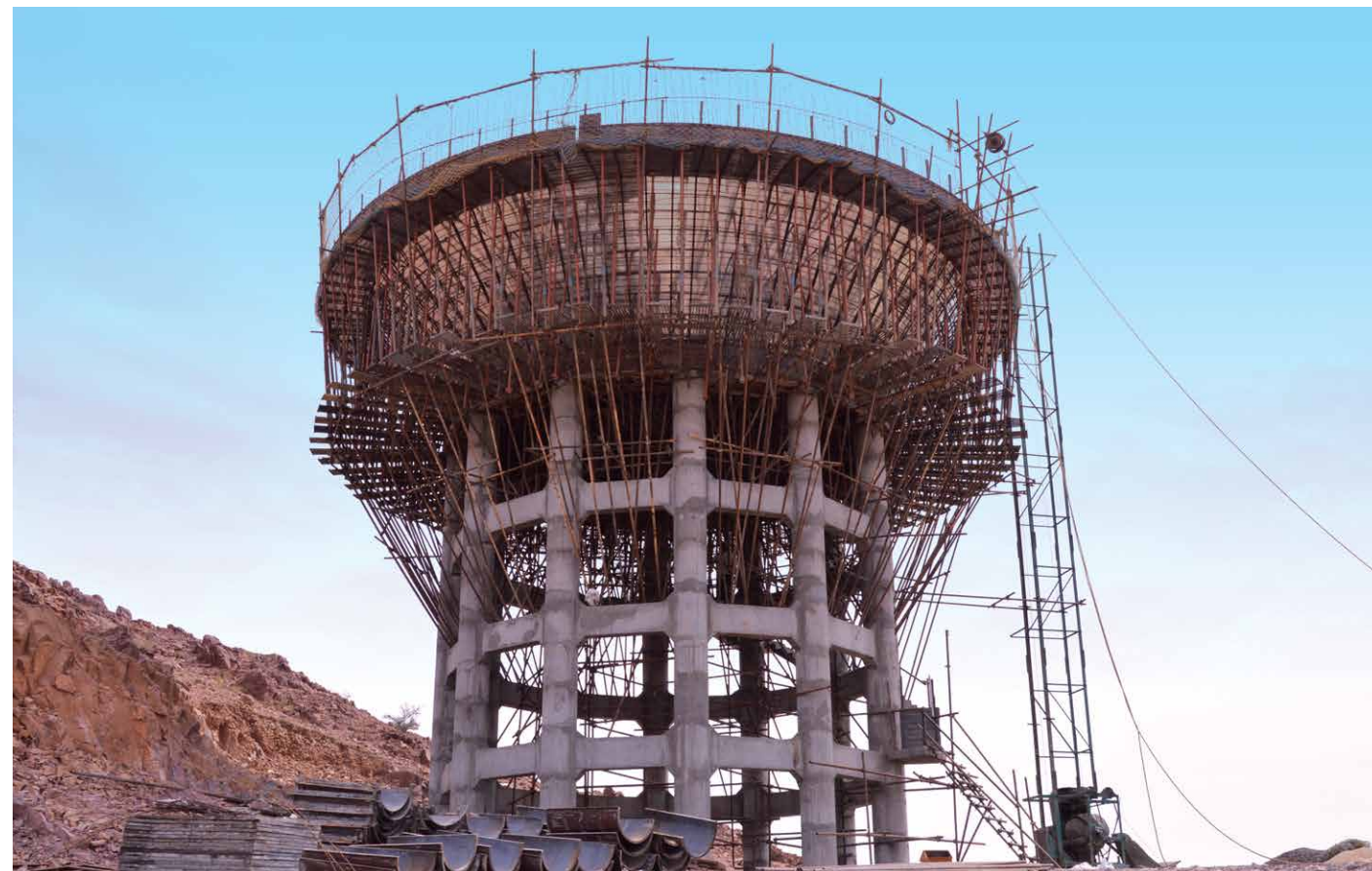
The desert terrain was highly unpredictable and while going forward the project team encountered sandy regions as well as rocky strata that called for deft handling of the pipe laying channels. Only after a thorough study of the soil pattern, the process of excavation was determined. In areas where there the soil was loose, extreme caution was taken to maintain proper clearance during dumping and in rigid regions, breakers were deployed. The average depth of the village distribution pipe channel spanning 1131 km was between 4m to 5m while the laying of the rising mains was done at a further depth due to the hydraulic calculations in the BWSC pipeline. The going was certainly tough for the team as it had to bear the sweltering heat and gusty winds but what kept the unit together was the acknowledgment from the locals who were delighted to know that access to potable water would soon be realized.

Raising robust retaining structures

A major portion of the scope comprised construction of civil structures that included 34 elevated service reservoirs ranging from 20m to 25m in height having 100 KL to 1250 KL of storage capacities across remote locations on the top of sand dunes that rose to 40m. The team accessed the work spot by making approach ramps that facilitated safe movement of materials. Further, during the geo-technical investigation it



Storage reservoir



Elevated storage reservoir



Pipe laying



existing pipelines and cables. The task was a composite one involving laying of a range of pipes with varying diameters which were transported directly from the vendor's factory to the respective locations along the alignment. Adhering to stringent norms, the pipes were laid across stretches using new generation hydra cranes. The welding of the pipes was done as per IS 816:1969 standards through the shield metal arc welding process and later inspected and tested for hydro and non-destructive qualities. Some of the major milestones achieved included laying and successfully testing of 280 km of transmission and distribution mains within one and a half months, commissioning of pipelines across 14 km covering 3 clusters in Hire Ki Dhani offtake for an existing water point and achieving sectional testing for 1100 km of pipe laying with client certification.

Empowering the transmission system

L&T executed the complete automation of the pumping system with the PLC SCADA which monitors and controls the flow in the plant. The pumping station is equipped with two single-stage/multi-stage horizontal split casing centrifugal pumps with one unit being a standby and has the provision of being operated in auto or manual mode through the Remote Terminal Unit from the Master Control Station. The treated water discharged from the plant at Biliya is once again put through a treatment process at the various offtake points that together account for 28586 KLD of potable water.

Delivering a promise

Having done the good work, the onus is now on L&T's desert warriors in keeping the system running efficiently for the next 10 years there by adding one more milestone to its innumerable list of water infrastructure projects that has quenched the thirst of millions across India.

was found that soil had chloride content and was treated before taking up the civil works. The team implemented a secure staging process with fall arrestors and the task was monitored by an EHS official and also subjected to timely inspections during phases of construction. An exclusive crew took up the construction of ESR in batches which enabled the team to achieve the milestones. At the ground level, the team also executed 6 storage reservoirs out of which a few were underground. The civil works also constituted construction of a pump house which called for a range of customization in the RCC framing to accommodate and precisely groove in equipment such as pumps, motors

along with its accessories, switch gear panels and delivery pipes with valves. The floor area of the pump house was designed to facilitate pumping of water under gravity for maintaining positive and vortex free suction.

Integrating the maze of channels

The crux of the project was in integrating the transmission mains with the numerous offtake points and routing it across the villages. To speed up the process, the project team worked on laying the village distribution mains after a thorough inspection and routed the alignment without damaging the

Ending the year on a high note

The Power Transmission & Distribution IC witnessed strong order inflows from both the international and domestic markets during the final quarter of the fiscal. While several EPC orders have been booked in the Middle East including in Oman, the IC has made a strong foray into the South East Asian markets with a breakthrough order from the Electricity Generating Authority of Thailand (EGAT) for the engineering, procurement and construction of a 500 kV transmission line for Thai/Laos border crossing. Another breakthrough EPC order was bagged in Ethiopia from the Ethiopian Electric Power for the construction of a 400/230/15 kV substation and three 230/15 kV substations which will be critical in improving the energy infrastructure of the country.

In a largest ever substation order win in Malaysia, PT&D IC is set to commission the largest GIS in South East Asia (43 bays) with the fastest ever commissioning schedules (15 months). L&T was shortlisted and awarded the project after a stringent capability evaluation and on the strength of its commendable past record for fast track project execution. Further EPC orders were bagged in Malaysia from Sarawak Energy in East Malaysia for a 275/132/33kV substation establishment.

On the domestic front, PT&D won significant orders from the Power Grid Corporation of India for the Bhuj Banaskanta transmission line and the construction of +/- 100MVAR STATCOM installation at 400/220 kV NP Kunta substation under Transmission System for Ultra Mega Solar Park (Part A) in the Anantapur district of Andhra Pradesh. Another order was bagged under the RAPDRP scheme for engineering, supply, erection and commissioning of new 33/11kV UG cables and lines with augmentation and network up-gradation of existing power lines in Bhubaneswar.

The Buildings & Factories business bagged orders from several existing customers for the development of commercial and residential spaces apart from a major turnkey order from a leading developer to construct a world-class Mixed Used Development in New Delhi. The project includes construction of a convention centre, business centre tower and two hotel towers as part of the overall development. Other orders included a high rise residential project in Mumbai featuring six towers with 55 to 60 floors and a multi-storied residential building involving 16 towers in Lucknow. In the IT and ITES sector, the business has secured a prestigious turnkey order from a global Information Technology major for a world-class IT Park in Bengaluru that is scheduled to be completed in 30 months.

In the international arena, B&F has won the mandate to construct a regional airport in the Sultanate of Oman. Scheduled to be completed in 24 months, the scope of works includes construction of passenger terminal building,

ATC complex, cargo and other service buildings including mechanical, electrical and plumbing (MEP) works, special systems and external works. This will be the third airport project to be executed by L&T in the country.

Transportation Infrastructure IC has won orders from the National Highways Authority of India (NHAI) for four-laning the Addahole (Gundya) to Bantwal cross of NH-75 in Karnataka apart from the Villikuri - Kanyakumari sections of NH-47 in Tamil Nadu. Another order was also won for the construction of 42.45 km of the Simga - Saragaon section of NH-200 in Chhattisgarh.

From the Railways business, the IC has won a major order from the Dedicated Freight Corridor Corporation of India Ltd, involving electrification works for a 422 km section of the western dedicated freight corridor from Vadodara in Gujarat to JNPT (near Mumbai) in Maharashtra. L&T is already executing the electrification of the remaining Rewari - Vadodara stretch (915 km). Both these projects put together make it one of the largest railway electrification projects in the world, covering 1337 route km with over 3000 track km of high-rise railway electrification.

The Smart World & Communication Business bagged an order from the Lucknow Metro Rail Corporation Limited for the design, procurement, installation and commissioning of telecommunication systems at various stations under Phase-1A of the Lucknow Metro Rail Project. The scope of work includes design, supply, installation, testing and commissioning of fiber optic transmission systems, telephone systems, train radio TETRA systems, public address systems, passenger information display systems, master clock and CCTV systems.

Orders poured in for the Water & Effluent Treatment business from the Hyderabad Metropolitan Water Supply & Sewerage Board for the construction of approximately 650 km of pipeline network, twenty water storage reservoirs and other associated works.

The Metallurgical & Material Handling business secured its first direct order to execute an Ash Handling Plant (AHP) covering high concentration slurry disposal systems on an EPC basis from NTPC Limited for the Tanda Thermal Power Project in Uttar Pradesh apart from another order for the construction of a coal handling plant for the same facility.

L&T Geostructure secured a major order from the Indian Oil Corporation Limited for the engineering, procurement and construction of marine facilities such as berth structure supported on steel piles, approach trestle and other associated structures at Ennore Port near Chennai in Tamil Nadu.

L&T Wins Golden Peacock Award for Risk Management



L&T was conferred the prestigious 'Golden Peacock Award for Risk Management' for 2015 by the Institute of Directors (IoD) in the 'Diversified' category. The award was presented at a ceremony on December 18, 2015 in Bengaluru, attended by a distinguished gathering of business leaders. Mr. R. Govindan, Vice President - Corporate Finance & Risk Management, L&T, accepted the award from Mr. R.V. Deshpande, Minister of Industries, Govt. of Karnataka.

The Golden Peacock Awards, instituted by the IoD in 1991, are regarded as a benchmark of corporate excellence worldwide. IoD is an independent, non-profit apex association of professional corporate directors. Over the years, it has grown to associate with around 35,000 senior executives, representing prominent organisations from the private, public and government sectors India-wide, and now, increasingly, world-wide.