PUNJ LLOYD update

Delhi Metro
New Heights in Viaduct Construction

Flyover construction has reached new heights with the Delhi Metro. The 6.3 km long viaduct, between Kirtinagar and Tilaknagar was constructed within the stipulated 20 month contract period. With its completion, Punj Lloyd has set high standards for viaduct construction. Piling work in the Delhi-Metro Rail project was challenging. A total pile concrete of 50,000 m^3 was completed in 12 months. 25,000 m long, 1,500 mm dia piling was installed by five hydraulic/mechanical piling rigs, making the Delhi-Metro assignment quite unique. All the piling equipment was moved within a narrow, sanitised 8 m corridor. The space constraints were compounded by the fact that other equipment also had to be moved around in this area. Bentonite recirculation was done through sealed containers to avoid splashing of slurry beyond the barricaded area. Piling locations had to be changed in 20 per cent of the cases to save sewerage

update

we maintained the speed of launching one span per day

Financed by ICICI Bank Ltd.

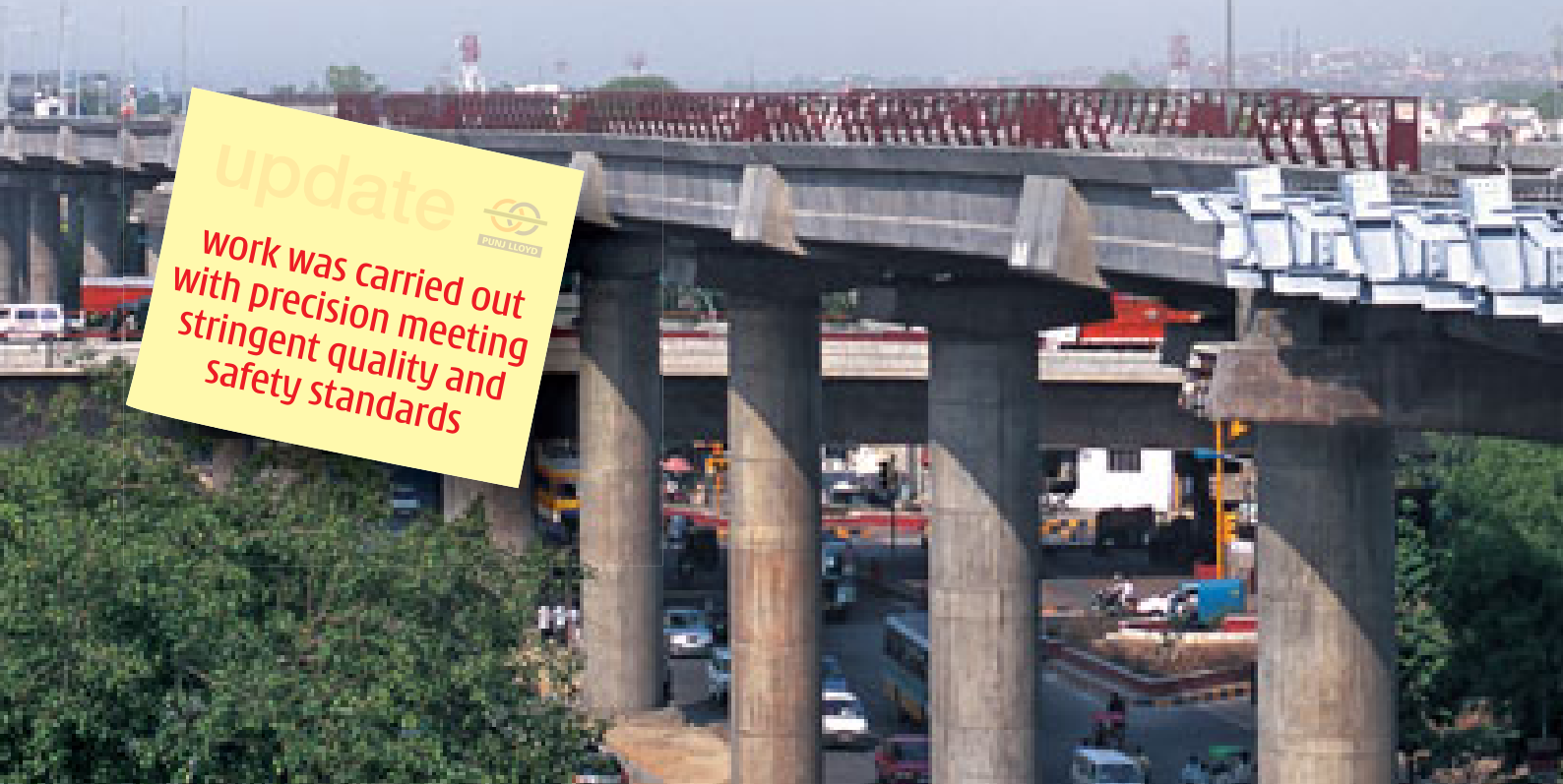
drains. Due to the highly acidic underground water of Delhi, slag cement was used for pile concrete.

The Reaction Pile Method was adopted for the pile load test because of space constraints. The arrangement was capable of creating a load of upto 1,425 MT. This is 25 per cent above the 2.5 times of permissible load on pile. The factor–of-safety against uplift for reaction piles was brought down to 1.2, against the codal requirement of 3.5. This was done with a guarantee of successful completion of the test.

The piers and pier caps for placing segments were constructed within 12 months. This meant constructing one column a day. With a cycle of two weeks for building a pier and 15 to 25 days for different types of pier caps, 14 sets of formwork were mobilised. The station piers were more challenging due to their cantilevers over moving traffic. The supporting arrangement including the placement of formwork for this portion was very critical. The system formwork enabled us to expedite work with minimum number of connections being bolted.

The 12-14 m high elliptical piers were concreted in a single pour. The formwork was designed to sustain the standing concrete pressure equivalent to the hydraulic pressure of that height. The piers were made of M-60/M-45 grade concrete. Tremmie pipe and concrete pumps were deployed to pour concrete into high piers. Cantilever pier caps and portals were cast without any interruption to moving traffic. Temporary steel portals were pinned down at all places to carry out formwork on top of them. The alignment requirement for the viaduct was very stringent as the pier segments of either span had to match perfectly to connect accurately through the shear-key.

Transportation of



The Viaduct Statistics

Length	6 . 3 km
Span	255 nos
Precast Segment	2206 nos
Pile - 1500 Dia	1127 nos
Pile Cap	263 nos
Pier	263 nos
Pier Cap	258 nos
St. Interconnection	6 nos
Temporary Barricading	12.6 km

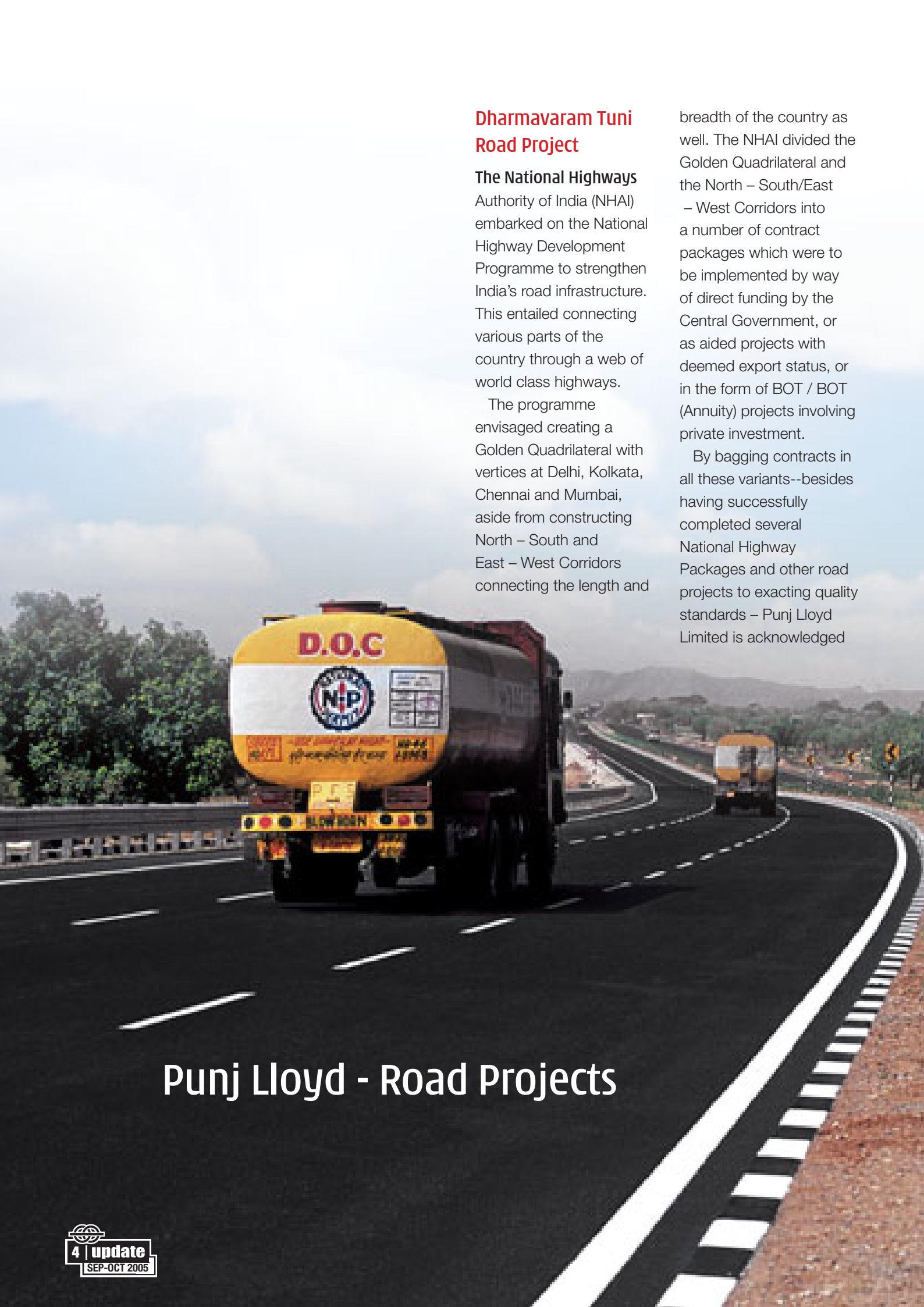
segments 20 km away from the site through dense city traffic made the segmental construction of the superstructure a tough task. Each segment of 60 m was carried by modified trailer to the required location only in the night. Specially designed launching girders were erected at four locations to launch and place the precast segment of the superstructure on spans.

We maintained a pace of launching one span per day. Each span had 8-9 segments including two pier segments on either side. The casting and stacking of segments were planned meticulously to avoid re-handling.

Since the project was executed within city limits, traffic control and diversion of traffic were of prime importance. Traffic marshals were deployed at all junctions to ensure smooth traffic movement during the day and night.

In keeping with our company policy we are committed to maintain the highest level of health and safety standards. Our work was appreciated by DMRC.

◆ S K Panda



Punj Lloyd - Road Projects

Dharmavaram Tuni Road Project

The National Highways Authority of India (NHAI) embarked on the National Highway Development Programme to strengthen India's road infrastructure. This entailed connecting various parts of the country through a web of world class highways.

The programme envisaged creating a Golden Quadrilateral with vertices at Delhi, Kolkata, Chennai and Mumbai, aside from constructing North – South and East – West Corridors connecting the length and breadth of the country as well. The NHAI divided the Golden Quadrilateral and the North – South/East – West Corridors into a number of contract packages which were to be implemented by way of direct funding by the Central Government, or as aided projects with deemed export status, or in the form of BOT / BOT (Annuity) projects involving private investment.

By bagging contracts in all these variants--besides having successfully completed several National Highway Packages and other road projects to exacting quality standards – Punj Lloyd Limited is acknowledged

as a major highway builder today.

The Dharmavaram Tuni Road Project, constructed on a BOT (Annuity) basis, is one such feather in Punj Lloyd's cap. Dharmavaram Tuni Project was a part of the highway connecting Kolkata and Chennai on the Vijayawada – Visakhapatnam section of the Golden Quadrilateral. The importance of this road is the continuous and heavy flow of traffic between these cities.

The project took off in May 2002 and was completed for commercial operation in October 2004. For this purpose, two Special Purpose Vehicles, Rajahmundry Expressway Ltd. (REL) and Andhra Expressway Ltd. (AEL), were formed by Punj Lloyd and Gammon India Ltd. REL was the concessionaire for a 53 km stretch from km 200 to km 253 while AEL was allotted a 49 km stretch from km 253 to km 300, measured along realigned lengths. The EPC contract of Dharmavaram Tuni Project was executed by Punj Lloyd Ltd. for AEL.

The primary challenge for Punj Lloyd's team of engineers was to align and contain the road expansion within an undefined ROW.

SCOPE OF WORK

- 2/3 lane dual carriageways with 49 km of flexible pavement
- 9 km of service roads
- 153 box / pipe culverts
- 3 major and 12 minor bridges
- 5 underpasses
- 4 pedestrian subways
- 16 bus bays with shelters
- a truck lay-bye
- 11 km of road illumination
- 18 km of walkways
- 16 km of guard rails
- 5 major and 80 minor junctions
- maintenance yard of 2000 m^2 area with buildings and facilities

update
NHAI embarked on connecting the various parts of the country through a web of world standard highways

The entire stretch was flanked by fertile paddy fields capable of producing three crops a year against the norm of one. While a basic road existed throughout the length, the stretch passing by the temple town of Annavaram had no scope for expansion. So the existing road and the town had to be bypassed and a new road built. The Annavaram traffic was heavy and land acquisition for the bypass road through paddy fields posed a problem. The farmers were initially reluctant to vacate their agricultural land for road construction, even though they were being compensated by NHAI. Punj Lloyd was eventually able to overcome these issues with local cooperation and progressed on schedule. This became a Greenfield stretch in the project. The old narrow road was dedicated to the temple town and the overall traffic situation improved significantly.

Maintaining unhindered flow of traffic and ensuring high levels of safety while constructing a rail over road bridge (ROB) was a demanding task. Construction of the rail over bridge required the launching and side shifting of Post Tensioned and Pre-cast Girders (each weighing 106 MT) over the electrified track

update

the challenge was overcome by meticulous planning

span through a specially designed trolley.

The existing bridge was 12 m above the ground with steep approaches. The challenge was to construct the new ROB next to the existing one with its deck 9 m over the electrified rail tracks. New structures, a minor bridge, a divided subway to serve as pedestrian–cum–cattle pass and a vehicular underpass, had to be constructed reducing considerably the gradient on approaches to the ROB. Heavy traffic could not be stopped and a total diversion via the existing road through Tuni town was not possible due to complicated procedures and the huge costs involved.

The hurdle was overcome by meticulous planning. Service roads at lower levels on both sides were constructed first and connected to the existing road and ROB. Traffic was guided to the existing ROB and space was created to construct the new structures.

Reinforced earth retaining wall (REW) construction, a relatively new technique was used in this project. REW was chosen because it is cost effective, quick to construct without the use of cranes, and suitable for the locally available granular textured earth. This methodology meant the use of .26 million hydraulically pressed concrete blocks, each weighing 38 kg. A factory 80 km from the site was engaged to produce the blocks. Imported synthetic earth reinforcing mesh was used to make it strong and durable. The friction slab of REW was pre-cast to save time. 24,000 m^2 of reinforced wall construction was carried out.

The REW technique helped conserve space and construct the new ROB along with other structures. The main carriageways were constructed piecemeal as the REW progressed and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several construction giants were involved in the competition from which we emerged victorious

integration was achieved with no disturbance to traffic. The traffic was gradually guided back to the elevated main carriageway.

The ROB superstructure had to be constructed by launching pre-stressed pre-cast RCC girders. The new ROB was a skew bridge constructed on a super-elevation. The approach area to the new ROB was used to pre-cast nine bridge girders, which were launched and side shifted into position.

A section of the road crossed a mountain of hard rock. The gradient of this was too steep for laden vehicles and had to be reduced. This necessitated controlled blasting without detriment to traffic. Traffic was stopped 1 km on either side of the blasting location. Moderate blasts were carried out at intervals of two to three days and the debris was cleared for the traffic to resume. The entire operation took 15 minutes to complete each time and the lowering of the gradient was accomplished within three months. The local administration including the police was notified of blasting in advance.

Gradient correction was carried out for two other hillocks by excavation and realignment of 7.40 km, including 5.30 km of the bypass, was carried out.

A granular sub-base of a specified grading was the first structural layer after sub-grade formation for pavement work. To produce the quantity needed, mining was necessary. Fresh quarries had to be opened with the approval of the Mining and Geological Department of Andhra Pradesh. Agencies were identified to install and

operate eight crushers to produce the GSB material. Traffic management over an 8-10 m high embankment posed a major undertaking. Right of way was not fully available. As a result of this several pockets had to be developed in isolation after a major part of the job was completed.

Two camps were established to complete this project before the scheduled completion date. Each had a separate administrative office, laboratory, mechanical work shop, equipment, 160 and 120 TPH of hot mix plants, 100 TPH wet mix plant, 30 m^3/hr concrete batching plant, weigh bridge, material stock piling yard and other specialty equipment.

◆ S Narasimhan

update
reinforced earth work a relatively new technique was used

update

due to heavy rains construction work is possible only for six months in a year

Thiruvananthapuram City Road Improvement Project

Kerala, the southern state of India with the highest level of literacy is amongst the progressive states of the country and is focussing on infrastructure. The Thiruvananthapuram city road project is a Kerala Government BOT project on an annuity scheme.

Punj Lloyd Limited floated a special purpose vehicle called Thiruvananthapuram Road Development Co. Ltd. with CTNL, an outfit of IL&FS. Despite several other construction giants being in contention, Punj Lloyd emerged victorious. As EPC contractors, work commenced in May 2004 and is scheduled to be completed in Nov 2006.

The salient purpose of this project is improving road travel within the city of Thiruvananthapuram. Throughout its entire length, the ROW passes through crowded and

Scope of work

- 42.06 km of flexible pavement
- 2,3,4 and 6 lanes
- 1 two lane bridge
- 3 four lane bridges
- 2 two lane minor bridges
- 1 three lane underpass
- 2 three lane flyovers
- Painting 84 km of kerb
- 84 km of drain
- 84 transverse ducts
- 23 km of street lighting
- 93 bus bays
- 32 bus stops
- 84 km of footpath
- 75 grade junctions
- 42 km of retro reflective traffic signs
- 42 km of thermoplastic road markings
- Pipe, slab and box culverts
- 10,610 m of retaining wall upto 7 m high

heavily constructed areas of the city. As a result, land acquisition poses a major challenge.

Special measures have been adopted for this project keeping in mind its unique urban nature. Traffic has been managed perfectly by designating experienced traffic marshals and using sign boards and diversions wherever necessary. To minimise interference with vehicular movements, work is also being carried out at a brisk pace during lean traffic periods.

Camp facilities for the project have been located outside the city to save on space and minimise pollution. Total mobilisation of equipment and manpower has taken place at the site. Local workforce has been engaged to facilitate coordination and to generate employment.

Silchar Balachera Road Project

This road is the starting point of the East West corridor which will eventually connect Silchar, Assam in the east to Porbandar, Gujarat on the west coast. This is a vital road across India from the point of view of connectivity.

Eleven construction companies were involved at the bidding stage of this project and Punj Lloyd won the contract even in the face of such stiff competition.

Punj Lloyd's section of this road project starts at Silchar and ends at Balachera, Assam. The construction period is 36 months. Work commenced in Sept 2004 and is scheduled for completion in Sept 2007.

The scope of work includes four-laning of 25.54 km of existing road, constructing 2 major bridges, 8 minor bridges, 1 rail over bridge, 2 box culverts, 31 slab and 84 pipe culverts. The ROW passes through agricultural land and tea estates. A 7 km bypass to skirt a small town will be constructed in the form of a Greenfield project.

Due to the heavy and incessant rains in Assam, construction work is only possible for six months of the year. Land acquisition is a major challenge as the belt includes fertile agricultural fields. Therefore, acquisition is piecemeal.

A total of 66 engineers and 600 workers have been deployed to work on this project. Work will generate employment for the local people. Punj Lloyd's earth moving equipment of crushers, concrete batch plants, excavators and dumpers has already been mobilised at the site. The camp is spread over four blocks with office, lab, worker and staff facilities.

All environmental clearances from concerned authorities have been received and the Punj Lloyd team is on the job to make road travel in this part of India more comfortable.

◆ S C Sachdeva

update

currently working on nine highway projects

Compulsory safety measures for road projects

Sustainable development is a core philosophy at Punj Lloyd. Here, a project is considered a success when all Health, Safety and Environmental (HSE) aspects are as exemplary as the engineering. To minimise mishaps in all road projects, it is mandatory at Punj Lloyd to implement the following safety measures:

Risk Assessment of the activities is used as a tool to terminate and reduce risks. Controls are identified for all risks and addressed in documented procedures.

Personal Protective Equipment is deployed for any residual risks. Usage of PPE such as helmets, safety shoes is compulsory.

Regular Trainings are scheduled to refresh knowledge on various HSE topics related to the site. Daily Tool Box Talks are used as a means to spread awareness among the employees.

Emergency Response Plan Regular Mock Drills are conducted to reduce response times and evaluate their effectiveness. Any shortcomings observed during the exercise are evaluated and corrective action taken.

Occupational Health is monitored by certified health experts. Periodic employee health checks are conducted—both pre-placement as well as during employment. This reflects Punj Lloyd's commitment towards the well being for its employees. The company maintains very high standards of hygiene and house keeping at all its road project sites.

Medical First-Aid - Qualified First Aiders are available at all sites in case of injury. First-aid trainings are conducted at regular intervals.

Cautionary signages of 'Work in Progress' are put up wherever required. Diversion signages are positioned 200 m before a diversion and at the Diversion.

Barricades with retro-reflective paint and danger signboards are put up wherever work is in progress for overpasses or underpasses. ◆

Environmental Initiatives at Civil Construction Sites

Measures for air pollution reduction

Fast loading of material, water sprinkling at haul roads and crushers, covering of chutes and conveyor system of stone crushers, use of breathing husk to control cement emissions from batching plants, locating stone crushers one km away from the nearest dwelling, providing hot mix plants with dust collectors at hot air exhausts and maintaining equipment and vehicles in top condition.

Measures for noise pollution reduction

Silencers and mufflers are fitted on equipment and noise barriers on DG sets to control noise.

Soil conservation and prevention of contamination

Adopting innovative designs of drainage systems to ensure water logging does not occur along the highway. Storing oil, grease and HSD on impermeable floor to prevent contaminating underground water bodies, installing stone crushers one km away from nearest water body to prevent dust particles from dissolving in water. Taking precautions to ensure that construction debris and other material don't fall into the river or water bodies.

For selection of borrow areas only non-productive land or raised land having soil heaps is selected. Borrow and quarry areas are closed, graded and provided with smooth drainage.

Measures for energy conservation

Completing our road projects before time results in saving of non-renewable natural resources like oil, fuel, paper etc. During project execution all efforts are made to reduce the consumption of natural resources. Low NO_x burners are used in hot mix plants resulting in reduction of fuel consumption. All camps and offices are provided with T12 fluorescent lights of high efficiency. All EXIT signs are demarcated in florescent tape instead of lights.

Green Belt Development

At our road projects Green Belt Development forms an integral part of environment conservation initiatives. Over 83,580 trees have been planted and 10 million m^2 of grass turfing along road embankments were carried out at all our road projects. Trees are planted in borrow areas. Neem, Mango, Ashok trees have proved to be good pollution and noise filters.

It is our constant endeavour to provide better and smoother access to all parts of India and improve the quality of road journeys undertaken in accordance with international environment standards.

◆ Praveen Puri

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