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Feature

Roads

Use Technology, Build Roads Quicker

With ambitious plans for road construction, it is necessary to build a robust system to execute construction of durable roads at a quick pace. INFRASTRUCTRE TODAY, in a quest to dig out more information on road building and management, brings its readers the latest technologies on a platter.

A record 16,271 km of National Highways have been awarded and 8,231 km constructed during the year 2016–17; however, the pace of work needs to pick up both to complete the current projects and to take up new ones. Meanwhile, road construction in India has accelerated to an all-time high pace of 20 km per day, as confirmed by the Ministry of Road Transport and Highways.

State-owned National Highways Authority of India (NHAI) plans to add around 50,000 km of road network in the next five to six years. CRISIL research estimates that between the fiscal years 2018 and 2020, construction of highways would require investments of Rs 2.2 lakh crore, or more than twice the Rs 1 lakh crore set for spending between the fiscal years 2015 and 2017, with higher execution of publicly-funded projects.

With such ambitious plans for road construction, it is necessary to build a robust system to execute construction of durable roads at a quick pace. It also becomes crucial to maintain the quality of the built roads in order to avoid extensive maintenance costs.

Meanwhile, it remains a million dollar question as to how the country can construct durable roads that too swiftly and efficiently. Does technology have an answer?

INNOVATIVE TECHNOLOGIES

Accredited by Indian Roads Congress, TruPave by Owens Corning is an engineered paving mat. The pavement interlayer is a non-woven 136 GSM glass fibre and polyester 'hybrid geo-synthetic paving mat' that conforms to ASTM D7239 standards.

The glass fibre in the engineered paving mat,

▼ Between the fiscal years 2018 and 2020, construction of highways would require investments of ₹ 2.2 lakh crore.

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which is ASTM D578 boron and fluorine-free Advantex glass, gives dual advantage of resistance to corrosion and added physical and mechanical properties to the reinforcement.

So far in India over 1 million metre square of TruPave has been laid on bitumen roads and there are several successful case studies. One of the successful projects has been the Jaipur expressway made by GVK.

The expressway, built in 2002–2003, showed extensive wear and tear due to the plying of heavy vehicles exceeding laden weight limits at the approach roads to the toll plaza. GVK-L&T had sought advice from Osnar Chemical for a quick solution. Osnar recommended the use of TruPave as an interlayer between dense bituminous macadam (DBM) and polymer-modified bituminous concrete (BC). This suggestion was accepted and the approach roads to the toll plazas were constructed. The new 50 mm overlay comprised TruPave geo-synthetic as an interlayer laid between DBM and BC.

During the overlay in 2009–2010, there was a requirement of strengthening the pavement with geo-fabric. Glass fibre geo-grid and TruPave were tried, and GVK decided to complete the work with TruPave due to its easier handling characteristics. All cracked or distressed portions were first covered with TruPave and then with polymer-modified BC. Result: The overlay with TruPave as an interlayer has performed well till date.

Similarly, Pune-based Global Road Technology (GRT) has many products to offer. Its Cold In-Place Recycling (CIPR) caught our attention. A recent visit to their factory enabled IT to know how this technology works in a country like India. According to **Nicholas James, Director, GRT**, the technology, which can rehabilitate a road is an established one worldwide and GRT is the first company to introduce it to the Indian road sector.

He says, "Together with NHAI and road developers, the major focus of the government is to speed up the rehabilitation and construction of road pavements with better and long-lasting quality."

Nicholas adds, "CIPR with binders such as foamed bitumen produces flexible and highly durable base layers. The recycled in situ material forms part of the pavement structure – providing a renewed stronger foundation for the final BC overlay. Recycling is proved to produce stronger pavements and can reduce layer thickness saving money and time."

The company has discussed the technology with Madhya Pradesh, Maharashtra and Rajasthan governments, and has offered to provide alternative design proposals for road projects using GRT advanced techniques.

Meanwhile, as a leading road developer, Nashik-based Ashoka Buildcon has some materials to suggest. **Satish Parakh, MD and CEO, Ashoka Buildcon**, was vocal about the four materials that have been deployed in their projects.

According to him, use of cement treated base (CTB) and cement treated sub-base (CTSB) has reduced the thickness of main crust layers and provided improved durability, thus saving time and material cost. In addition, Pulverizer, a specialised machine for soil stabilisation, has been used for mixing CTB and CTSB. In terms of setting good ecological footprints, pond ash, a waste product of thermal power plant that harms the environment, is effectively used. "For filling behind the RE wall, as a substitute to murrum soil. Recently, the Ministry of Environment and Forest has come out with a notification that mandates the use of pond ash in the construction of roads," he adds. Another waste product of steel plants, electric arc furnace (EAF) slag, can be used as a component of GSB.

From his experience, Parakh believes that since pond ash and EAF slag are waste products which are available in abundance, they help in saving cost to the company. This reduces

Advantage TruPave

- Cost-effective: TruPave engineered paving mat works to preserve the pavement surface and protect the pavement structure longer – which means less maintenance and lower costs. It has been recognised by leading contractors in India to be economical and faster than waterproofing mastic.
- Good stability: The product remains stable in high-temperature hot-mix designs and does not shrink or melt. So there is no need to factor up material requirements to allow for shrinkage or loss.
- Low moisture damage: TruPave mat combines with asphalt to form a low permeability moisture barrier.
- Mitigates reflective cracking: Low elongation through high modulus glass fibre supports in maintaining the durability of roads.
- Recyclable: It is millable and recyclable by design. When milled, it is reduced to small pieces and goes to the hot-mix plant. Other paving fabrics typically clog the milling equipment, or are rejected by the hot-mix plant, adding to the cost and causing delays.

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Build roads with sensors, cut fuel consumption by 47%

In 2013, Gayatri was selected by the National Highways Authority of India (NHAI) for widening of the Panikoili to Rimuli section of the NH215 highway in Odisha. This highway is considered an economic lifeline for the mineral-rich area.

In addition to widening the road from two lanes to four, the project required building facilities including flyovers, underpasses, bridges, bus bays, rest areas and service roads. The project also included highway traffic management systems, highway patrolling service and accident vehicle recovery service.

In order to widen the road, the Gayatri team had to lay each layer of material precisely, starting with the sub-base course, base course and finally the surface courses. To prepare the sub-base course, they conditioned the soil and mixed material, and loosened up the hard layer of material, so that the subsequent material can bind properly. There was a 250 mm layer of soil and the next layer was an embankment top layer, 70 mm in thickness. Five full-time surveyors surveyed the NH215 site initially.

Traditionally, road-building projects require the initial survey, plus ongoing subsequent grade checking of the project site. Not only is surveying, running and resetting stakes costly, it is time-consuming and means the motor grader is often running, but not being utilised. This burns fuel and adds wasted time to the project. With the grade control system, only the first pass requires a grade stake and checker.

The rest of the passes look up the first pass using an auto mode. Machine-mounted sensors calculate the necessary blade position to achieve the desired cross slope of the sub-base course and surface layers.

Here, Gayatri, in consultation with its technology partner SITECH India North & East, adopted the Cat AccuGrade 2D Cross Slope system for its motor grader. The system uses sensors on the machine to control the slope of the blade during operation.

The system makes automatic adjustments to the left or right lift cylinder as the operator runs the grader. It delivers all of the information to the in-cab display so the operators can quickly spread material or cut at the correct cross slope, which reduces manpower utilisation. Real-time cut-and-fill data and in-cab guidance give the operator the opportunity to work more confidently and achieve greater accuracy with fewer passes, using lesser material.

To monitor the effectiveness of the technology, Gayatri tested the system-laying material for a 140 m long by 15 m wide bed. The surface course layer material was 250 mm aggregate and had to maintain a tolerance of +/− 25 mm; the slope was approximately 2 per cent.

With the grade control system on the motor grader, the operator made 21 passes in 50 minutes, compared to manual grading, which took 33 passes in 89 minutes. The result was 36 per cent fewer passes required and 44 per cent less machine runtime. In addition to decreasing passes and runtime, accuracy improved by 25 per cent.

With the sensor, Gayatri gets accurate tolerance limits (+/− 10 mm), which has helped them reduce manpower requirements. Once the peg marking is done, it runs automatically by auto sensors of hydraulic systems, so no manpower is required later, which means engineers can spend their time on other tasks.

Overall, Gayatri was able to stay on grade and improve productivity and accuracy by 42 per cent, compared to conventional methods. Further, they were able to increase accuracy and decrease both fuel consumption and grading time, while building a better road that is expected to have a longer life and overall lower long-term maintenance costs.

With less rework, Gayatri saved costs on the final embankment layer material. Fuel consumption for the embankment layer dropped from 19 L to 10 L, showing a 47 per cent increase in efficiency. The team also used the motor grader to cut and maintain the road ditch slope when building the road drainage systems. This was needed to remove material from the bottom of the ditch.

dependency on quarries, where the supplies are becoming increasingly erratic. This also reduces liaison time with the government with regards to royalty.

BUILDING INFORMATION MODEL

Building information model (BIM) helps infrastructure developers to improve their ways of planning, designing, building and managing roads and highway construction projects. BIM enhances road design and highway design projects by providing necessary insights on 'what-if' scenarios earlier in the design and construction process to reduce rework and create a more integrated approach to design.

Dilip Buildcon uses technology, instead of manual interventions, for survey and data collection by extensive use of light detection and ranging (LiDAR) technology, GIS and remote sensing, drone mounted high-resolution digital cameras and advanced software. **Devendra Jain, CEO, Dilip Buildcon**, says, "During construction,

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we use drone surveys of our site to monitor the progress of work and to quantify the work done between two surveys".

As he further explains, use of LiDAR and photogrammetry for surveys has resulted in saving time in places where traditional survey methods were not possible or time-consuming. Flaunting what Dilip Buildcon has, he says, "All of our vehicles or equipment are mounted with high precision, latest GPS because the use of GPS has helped in monitoring delays, pilferages and fuel consumption resulting in overall efficiency."

Electronic toll collection (ETC): Although the ETC system made its first global presence in 1986 in Norway, it took India over two decades to adopt this technology to eliminate the delay on toll roads by collecting tolls electronically. FASTag, the ETC system in India operated by NHAI, is now implemented across the country.

Automatic vehicle category classification (AVCC): This is another pioneering technology that allows automatic classification of the vehicle for the purpose of toll collection as soon as a vehicle enters the toll plaza, thus reducing dependence on the toll collector to classify the

▲ Technology has streamlined toll operation and will revolutionise highway management.

In a way, Jain is correct as LiDAR and sensors are definitely making a huge difference in road surveys. During the project mobilisation phase, LiDAR mounted on vehicles and drones and other similar technologies can effectively be used for carrying out surveys in locations such as bypasses and hilly terrains which are difficult to access.

IT IN HIGHWAY MANAGEMENT

Globally, there has been a paradigm shift towards strengthening IT systems and capabilities to create an environment-friendly sustainable business ecosystem. There are a lot of disruptive innovations taking place in highway operations and management which are aimed towards driving efficiency through environment-friendly transportation solutions that are sustainable both from energy consumption and environment perspectives.

Some of these technology solutions have already streamlined tolling operations in India and many more are on the cards, which are likely to revolutionise highway operation and management.

vehicle manually. Together with the classification of vehicle, the system also automatically detects heavily loaded vehicles to be charged separately through in-built integration between the toll management software and WIM software.

Although AVCC has now gained prominence among the highway concessionaire in India, Bharat Road Network (BRNL) has been one of the pioneers in adopting pre-classification technology and integrating the same with existing AVCC across all its toll plazas.

In addition to technologies which have already made considerable progress in transforming Indian highway tolling operations and management, there are some more progressive technology solutions aimed at advancing mobility and increasing safety along highways in the country.

Some of the future innovations expected to revolutionise the sector are as follows:

Advanced surveillance system: Highway monitoring and real-time incident reporting is all set to leapfrog into the next level of innovation through the use of unmanned aerial vehicles (UAV) technology for acquiring aerial images for

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▲ GRT's Cold In-Place Recycling can rehabilitate a road is an established one worldwide technologsgy.

remote monitoring of highways and thereby substantially improving on the real-time incident response system. With increased use of UAVs or drones, we can expect incident reporting, corridor management, route patrolling and other related activities to become highly efficient and effective.

Highway traffic management: Automated traffic maintenance system (ATMS) is one of the most dynamic systems aimed at facilitating smooth, hassle free, fast and safe drive along the highways. As a part of ATMS and Intelligent Transport System (ITS), a fully automated centralised control centre called Transportation Management Centre (TMC), is set up to collect, analyse and process real-time traffic data from cameras and speed sensors. The data collected through the system are integrated and processed (e.g., for incident detection), and result in necessary actions taken (e.g., traffic routing, dynamic message signs messages) with the goal of improving traffic flow and maintaining safety and security of the road user.

The primary objective of ATMS is to increase efficiency of the transportation system, enhance mobility, improve safety and create an environment for ITS market.

Highway advisory services: Moving a step ahead of the highway transportation management systems (HTMS), the Highway Advisory Services has been making inroads into Indian highway operations and management to deliver real-time information about road conditions and traffic updates to highway commuters through dedicated radio channels. With the launch of a pilot project last year in the Delhi–Jaipur stretch, India entered the elite league of countries providing useful information to drivers on the country's thoroughfares. The technology is modelled along the lines of highway advisory radio stations (HARS) in the US and in select European countries. The system is expected to augment broadcast infrastructure to cover the entire stretch of the highway network, install sensors to gather additional real-time traffic information, broadcast in both analogue and digital radio modes and measure impact through an external agency.

Virtual reality: Use of virtual reality is another groundbreaking event in highway development and maintenance. It can be used to show what the road looks like at the beginning of the construction and how it transforms completely when it is finished.

Bharat Road Network, is among the front-runners in embracing advanced technologies and promoting innovations for e-monitoring and e-maintenance of its highway projects.

Bajrang Kumar Choudhary, Managing Director, Bharat Road Network, says, "We are constantly adopting the existing technology including installation of pre-classification technology for AVCC, inducting ETC tags to make the toll collection procedure more efficient, facilitating cashless transaction and focusing on automation of system and processes."

TECHNOLOGY SUGGESTIONS

- Hot in-place recycling of bituminous pavements.
- Milling and recycling of bitumen.
- Use of latest fleet of machineries: fuel-efficient and latest upgrade techniques such as LiDAR.
- Use of satellite for determination of ground profile and levels.
- Use of latest research in the field of road construction - such as CTB, CTSB, pond ash, EAF slag, etc.
- Use of geo-textile, geo-membrane in various stages of road construction.
- Use of pre-cast, pre-fab and composite girder techniques in major bridges, ROBs, flyovers, etc.

- RAHUL KAMAT