

On the Fast Track

Technology and innovation transforming the railway sector

India has the fourth largest rail network globally. In the past couple of years, the sector has witnessed many reforms, aimed primarily at modernising the rail infrastructure and improving the safety of operations. Some of the initiatives of note are the high-speed rail (HSR), dedicated freight corridors (DFCs), station redevelopment, Vande Bharat trains and network electrification. Industry leaders express their views on the progress in the railways sector, the key challenges, emerging trends, and the way forward...

How has the railway sector evolved over the past few years?

Manobendra Ghoshal

From the era of steam traction to the launch of Vande Bharat and beyond, the railway sector has been on a transformational journey. With the government's special focus on a modernised, sustainable and efficient railway system, we have seen significant milestones in the sector in terms of HSR, electrification and digitalisation. For the past 50 years (since 1974), RITES Limited, a multidisciplinary consultancy organisation, has remained a catalytic force, undertaking mega and complex infrastructure projects. We continue to envisage our presence in railway projects such as DFCs, HSR and semi-HSR passenger corridors, capacity augmentation works, railway electrification, suburban railways, workshop modernisation, last and first-mile connectivity projects, freight terminals and

logistics parks, station redevelopment, long bridges and tunnels, and energy management and sustainability solutions. The redevelopment of Ayodhya and Varanasi railway stations, doubling works of Gooty-Dharmavaram, setting up of a diesel electric multiple unit (DEMU)/mainline electrical multiple unit (MEMU) shed at Lumding, Assam, and Mavli-Bari Sadri railway electrification are some of our recent notable projects. RITES also provided initial consultancy for DFCs, which will bring about a massive transformation in the logistics industry.

Hari Somalraju

There has been a focus on capacity enhancements through the development of DFCs for faster freight movement, high-speed corridors for long-distance passenger movement and rapid regional rail networks for fast commuting between satellite and adjacent towns and cities.

Express passenger trains are being

designed with the best riding quality and fastest acceleration, and solar-powered passenger coaches have been introduced to enhance passenger comfort. Other innovative improvements include state-of-the-art smart coaches with special diagnostic systems and sensors connected to integrated computer systems for increased passenger comfort; smart locomotives with new features such as asset performance monitor and rail integrity monitor; and smart yards with information and communications technology systems, sensors and data analytics to automatically gather information on rolling stock conditions.

Indian Railways (IR) has also transformed rail mobility into three segments: HSR, regional rapid transit system (RRTS) and Vande Bharat trains. As per the National Rail Plan and the High-Speed Master Plan, the development of the HSR network along 13 corridors in the country would be carried out in phases. The rail budget has earmarked a capital outlay of Rs 2.40 trillion for 2023-24, which is about nine times the outlay in 2013-14. Meanwhile, the development of RRTS to connect satellite towns and adjacent cities is a strategic decision to decongest the mega cities. However, the most meticulous decision taken by IR in recent years has been the development of indigenous Vande Bharat trains, which can run at higher speeds on the existing railway infrastructure, unlike semi-high-speed trains that require major changes in track, rail, power, signalling and other infrastructure.

Sunil Srivastava

I would like to divide the railway sector into two parts. IR and non-IR, that is, metro, HSR, RRTS, etc. Both segments have evolved significantly over the past few years. Some of IR's key milestones have been the introduction of the western and eastern DFCs, large-scale electrification of the railway network, setting up of two locomotive factories on a public-private partnership (PPP) basis, introduction of Vande Bharat trains on various routes, station modernisation and connectivity to remote areas, especially hilly and strategic locations. In the non-IR segment, the HSR between Mumbai and Ahmedabad is a path-breaking project and so is the RRTS in the

Delhi-NCR region. Metro systems have taken off in a big way, with every major city in India having a metro either running or under construction.

What are the biggest challenges that the sector faces today?

Hari Somalraju

The major challenges facing the sector primarily pertain to the upgradation of rolling stock technology, and maintenance of safety, health and hygiene on board trains and around them. The other challenges include improving passenger comfort and connectivity, increasing the capacity of "mass transport", and increasing train availability while lowering costs. In addition, generating revenue and attracting adequate investments in the railway sector are areas of concern. Particularly for HSR projects, there is an urgent need to innovate and optimise designs based on international experiences. There is also a need for technology transfer and local material sourcing.

Sunil Srivastava

The biggest challenge is inadequate resources. There is a shortage of quality construction companies and trained manpower across the sector, in planning, design and construction.

How are technology and digital solutions transforming project design and execution?

Manobendra Ghoshal

We have been using state-of-the-art equipment, technology and software, and advanced simulation and modelling tools to execute our projects. The use of micro-synthetic poly fibres in permanent tunnel linings, advanced topographic technologies such as drone and LiDAR, high-end software such as Bentley Power Rail Track, Global Mapper, Civil 3D and RocScience for alignment works, high resolution satellite imagery, and photogrammetric processing techniques have helped us streamline project management and deliver superior outcomes, thus improving operational efficiency and productivity. Besides, RITES is engaged in structural health monitoring (SHM) of the Bogibeel

Bridge, India's longest rail-cum-road bridge, in Dibrugarh, Assam, and Bridges 39 and 43 of the Udampur-Srinagar-Baramulla rail link project. The SHM system is the latest technology for the inspection, maintenance, rehabilitation and replacement of bridges in a cost-effective manner. It allows the authorities to make informed decisions about the remaining life of structures to plan maintenance or repairs. This helps improve the safety of the structure and provides early warnings of degradations.

Hari Somalraju

Indian Railways has continuously improved its methods by deploying advanced technologies that comply with global benchmarks. It has already achieved the end-to-end digitisation of procurement procedures. Further, the use of building information modelling (BIM) is enabling architects, engineers, real estate developers, contractors, manufacturers and other construction professionals to plan, design, construct and manage a structure or building. The SYSTRA Group provides IR with digital assets and we use BIM as a tool in various projects, ranging from design to maintenance. BIM and 5G technologies can also be used during the maintenance phase to improve efficiency and reduce costs. 5D/7D BIM models can be utilised to create digital twins, providing a complete and accurate representation of the system.

Sunil Srivastava

Not much has changed in terms of digital solutions for design except that in the non-IR projects, BIM platforms and document management systems are being used. IR has been adopting various digital initiatives to enhance operational efficiency and the passenger experience. These include the introduction of digital ticketing, Wi-Fi services at select stations and improved online reservation systems. It has also started a pilot project for online monitoring of rolling stock.

With the growing emphasis on sustainable development, what new techniques and best practices are being adopted?

Manobendra Ghoshal

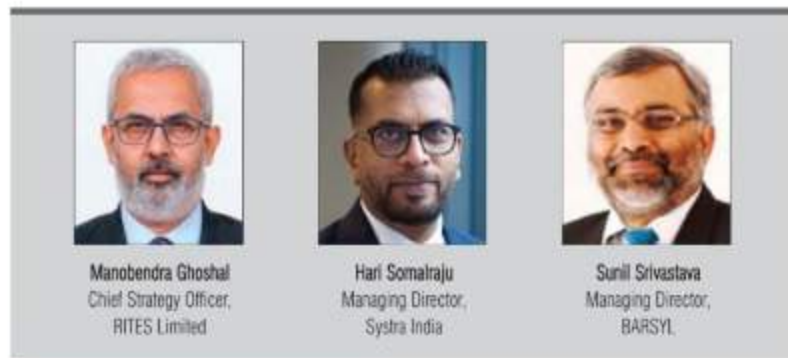
RITES, through its subsidiary REMC Limited, is assisting Indian Railways in meeting the net zero goal, achieving 100 per cent electrification of its broad-gauge network and accelerating the adoption of renewable energy. REMC has already tied up 1,800 MW of standalone renewable power (solar and wind). This includes mega solar parks in Madhya Pradesh and Uttar Pradesh, a solar plant under the CPSE scheme in Karnataka, and wind power capacity in Maharashtra. In the round-the-clock mode, 1,000 MW of renewable power has been tied up for 25 years to provide 24x7 renewable energy to railways.

RITES has recently set up a dedicated sustainability unit that undertakes projects involving advanced sustainable solutions. In a short period, this unit has received orders from the National Clean Air Programme, the Swachh Bharat Mission, etc. Going forward, we will focus on eco-friendly engineering practices with minimal ecological disturbance and endorse solutions that underpin low-carbon, sustainable and smart mobility.

Hari Somalraju

IR has set a target of becoming a net zero entity by 2030 by completing the electrification of all railway tracks. It plans to reduce its carbon footprint primarily by procuring its needs from renewable energy sources. Other strategies towards net zero include shifting from diesel to electric traction, promoting energy efficiency, constructing corridors for freight movement, and obtaining green certification for railway establishments.

Rail is the most environmentally friendly mode of transport, with CO₂ emissions being less than one-fourth of air transport and less than one-third of road transport. According to the International Union of Railways data, a high-speed train is the most energy-efficient mode of transport in terms of passenger km carried per unit of energy. SYSTRA has played a significant role in defining Europe's standards governing high-speed rail. Our expertise in the operation of high-speed lines allows us to factor in operations and maintenance (O&M) con-



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straints as part of the design phase.

Sunil Srivastava

Both IR as well as metro organisations are planning large-scale solar power generation, utilising rooftops of stations or depots. A few metro stations have already done this. Also, all of them are evaluating the possibility of using hydrogen as a fuel for trains.

What are the safety and track modernisation initiatives being undertaken?

Harj Somaraju

Safety is a very pertinent issue. Some of the key initiatives taken by IR in recent years are:

- Introduction of pre-stressed concrete, which has higher tensile strength sleepers with elastic fasteners, and deployment of long rail panels to reduce thermal joints in tracks.
- Adoption of advanced and improved technology for rolling stock monitoring and wheel impact load detectors to improve the rolling stock's O&M.
- Switch from Integral Coach Factory coaches (which were prone to derailment) to Link Hofmann Busch coaches with superior design and higher safety standards.
- Switch to electric locomotives.
- Electronic interlocking on stations to enhance safety.
- Launch of the Rashtriya Rail Sanraksha Kosh in 2017-18 as a dedicated fund for carrying out safety-related work.
- Elimination of manned level crossings. Efforts are being made to replace them with underpasses and overpasses.
- Adoption of automatic train protection (ATP) systems. KAVACH, meaning armour, is an indigenous ATP system developed by the Research Design and Standards Organisation.
- Use of electronic devices and radio frequency identification devices in locomotives, signalling systems and tracks to control train brakes, alert drivers, etc.

Sunil Srivastava

IR is giving priority to safety and has commenced network-wide implementation of traffic col-

lision avoidance systems, also known as KAVACH. Existing lines at various locations are also being modernised to meet the speed requirements of the Vande Bharat trains.

What are the key trends that are likely to shape the future of the sector?

Manobendra Ghoshal

The mobility of people and products is undergoing rapid change. Cleaner, smarter and integrated – this is what tomorrow's mobility will look like. Seamless integration with other modes of transportation and the emphasis on multimodal hubs will create a more interconnected and efficient transportation ecosystem. This paradigm shift in the transport sector, driven by people's mobility needs and requirement of sustainable development, provides an opportunity for players like us to innovate, execute and transform! Going forward, the trinity of infrastructure development – the Gati Shakti National Master Plan, the National Infrastructure Pipeline, and the capex push in the Union Budget – will ensure the timely implementation of projects.

Harj Somaraju

Technology upgradation will be the key to the success of the sector. The main focus areas include achieving 100 per cent electrification, upgrading existing lines with additional facilities and higher speeds, expanding new lines, upgrading railway stations, and developing a large high-speed/semi-high-speed rail network that interconnects major cities. Other trends include the use of drones and smart sensors for inspecting railway tracks, the adoption of digital communication platforms, and the implementation of automatic train control.

Several hi-tech solutions have recently emerged but are not commercially established



at the moment. These include hyperloop, maglev and hydrogen trains. There is also a need to develop mixed lines capable of running high-speed and freight trains.

Sunil Srivastava

Some potential future trends and directions that the railway sector may continue to pursue, based on existing plans and global railway industry trends, are:

- The development of additional HSR corridors, which could significantly reduce travel times between key urban centres.
- Expansion of DFCs for improved freight transportation efficiency and reduced congestion on existing rail routes. The development of dedicated high-speed freight corridors could expedite the movement of goods across the country, benefiting industries and the overall economy.
- Electrification and green initiatives to reduce greenhouse gas emissions and dependence on fossil fuels. The integration of renewable energy sources such as solar and wind power into railway operations is also likely to be explored.
- Modernisation efforts, including the adoption of advanced signalling systems, IoT-based monitoring and predictive maintenance, are likely to continue to enhance safety, efficiency and passenger experience.
- Investment in railway infrastructure, including track doubling, electrification and station upgrades will continue to improve connectivity, safety and passenger comfort.
- India could explore more PPP models for railway projects, including private operation of trains, station redevelopment and investment in railway infrastructure.
- Efforts will be made to improve last-mile connectivity to railway stations through better urban planning and integration with other modes of transportation (for example, metro, buses and ride-sharing) to encourage the use of trains for commuting.
- Railway stations will play a central role in the development of smart cities and transit-oriented development projects, promoting sustainable and integrated urban growth. ■