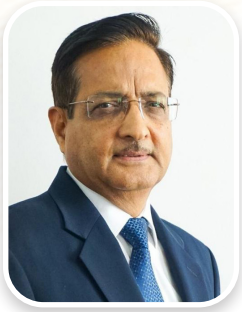
India's Bullet Train Ride

The Journey So Far

NHSRCL
National High Speed Rail Corporation Ltd.

September 2023

Message from Managing Director



*As we bring out the latest version of **'India's Bullet Train Ride. The Journey So Far'**, the construction of India's first state-of-the-art High Speed Rail (HSR) corridor between Mumbai and Ahmedabad is on in full steam. The ambitious project that connects two important financial hubs in west India spans across 508 km, of which 448 km will be elevated, 26 km will run in tunnels, another 10 km on bridges and 7 km on embankment.*

Our very own high-speed train link is being developed with one of the best global technologies in HSR, the Japanese Shinkansen System, which is known for its impeccable safety and punctuality records. As on date, all civil contracts for the project in Gujarat and Maharashtra have already been awarded. These include what became the largest civil contract to be awarded in India so far – the contract for construction of 237 km of viaduct, including four HSR stations at Vapi, Bilimora, Surat and Bharuch and a rolling stock depot at Surat in Gujarat. Recently, we have also started track works and tenders for electrical and signalling are in advanced stages.

As the nation readies itself for its first very own 'bullet train', the gains have already begun. The construction of the corridor has brought in an opportunity for transfer of technology and 'Make in India', for us to bring out the best of Japanese technology and Indian expertise. It has also offered a major fillip to India's steel and cement industry, and created a major avenue for employment for both technical as well as non-technical domains in the country.

There is no doubt that the high-speed rail link is a giant leap for India in terms of development, as we share space with developed nations on the Global HSR map. The journey so far has been very exciting, and it has come with its share of challenges and solutions.

We hope you enjoy reading the latest version!

Shri Rajendra Prasad
Managing Director/NHSRCL

India's Bullet Train Ride

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Chapter 1
INTRODUCTION

As one of the country's most ambitious projects – a High Speed Rail (HSR) corridor connecting India's most populous city of Mumbai with Ahmedabad – gathers steam, the country is all set to make a giant leap in terms of development and enter the league of developed nations on the Global HSR map.

Soon, clogged highways, airport delays and uncomfortable journeys will be a thing of the past. Our very own 'bullet' train, a nickname the train gets from its bullet-like shape and speed, will be seen tearing along west India's landscape, covering the 508 km distance between the two financial hubs in just about two hours. This will be a huge time saving compared to current travel times between the two terminal stations of about nine hours (by bus) or six hours (by conventional railways).

Indian Railways is the fourth largest railways in the world, ferrying a mammoth 8,400 million passengers and over 1,500 million tonnes of freight every year on its massive track network spanning across a distance of about 70,000 km. The HSR project will be a complete game-changer in this landscape and is set to redefine the way we Indians travel.

The state-of-the-art high-speed trains, running on the Japanese Shinkansen technology, will zip at speeds of 320 km/h, which is more than double that of Indian Railways' fastest trains – the Gatiman Express and Vande Bharat Express – that chugs along at 160 km/h. And we as passengers will get to experience one of the best HSR technologies available globally, offering the highest levels of safety, comfort and reliability as we hop aboard this world-class system.

As India takes giant strides on the path to development and positions itself to join the coveted list of global superpower nations, a transformation of our 167-year-old railway system is an integral part of this journey. Towards this end, Indian Railways has envisioned a phased upgradation of its network, both passenger and freight.

The National Rail Plan (NRP) for India envisions enhancing the outreach of the HSR system and increasing connectivity to all the cities of importance. As part of the National Infrastructure Project (NIP), seven HSR corridors have been identified for which the work of preparation of Detailed Project Reports (DPRs) has been entrusted by the Ministry of Railways to National High Speed Rail Corporation Limited (NHSRCL). These include:

1. Delhi – Lucknow – Varanasi (813 km)
2. Varanasi – Patna – Howrah (752 km)
3. Delhi – Jaipur – Udaipur – Ahmedabad (872 km)
4. Delhi – Chandigarh – Ludhiana – Jalandhar – Amritsar (476 km)
5. Nagpur – Nasik – Mumbai (767 km)
6. Mumbai – Pune – Hyderabad (671 km)
7. Chennai – Bengaluru – Mysore (464 km)

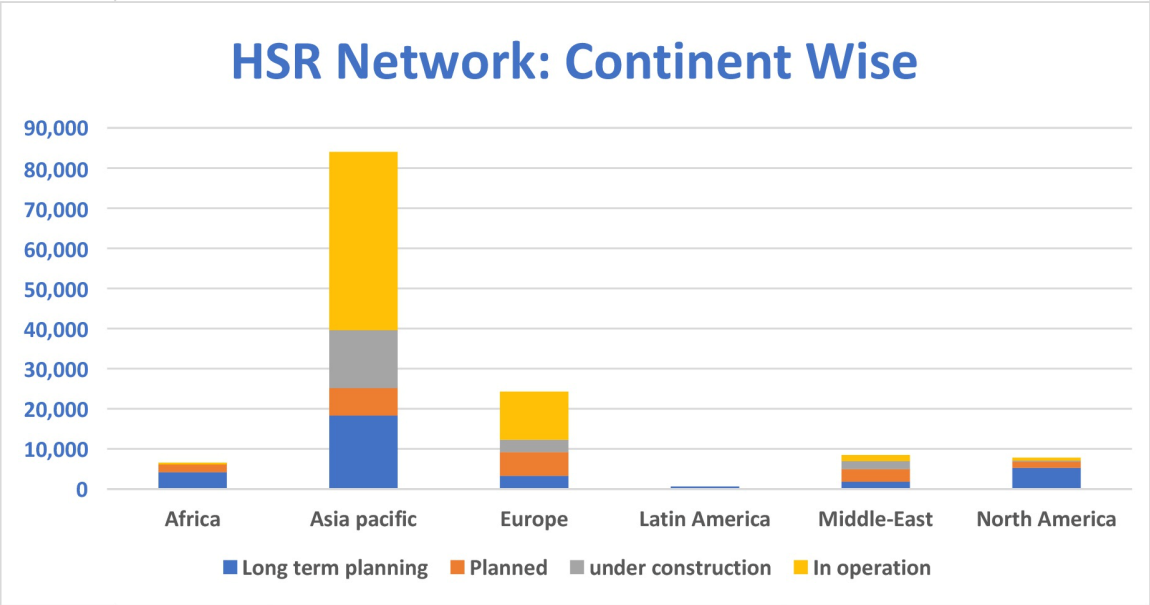
Inauguration ceremony of Tokyo-Osaka Shinkansen in 1964

Vande Bharat Express is the fastest running train in India as on date with a maximum speed of 160 km/h

Global Perspective

According to the Union Internationale des Chemins de fer (UIC), high speed rail combines many different elements which constitute a "whole, integrated system": infrastructure (new lines designed for speeds above 250 km/h and, in some cases, upgraded existing lines for speeds up to 200 or even 220 km/h), rolling stock (specially-designed train sets), telecommunications, operating conditions and equipment, etc.

Globally, high-speed trains cover a total network of over 58,000 km across Asia Pacific, Europe, Middle East, North America, Latin America and Africa (as on September 1, 2022), according to data compiled by UIC's Passenger Department. This figure is expected to double (to 131,799 km) in the near future with several countries planning to expand their networks and new ones entering the fray.



	Africa	Asia pacific	Europe	Latin America	Middle-East	North America
Long term planning	4,195	18,320	3,316	638	1,831	5,307
Planned	2,210	6,844	5,913	0	3,139	1,488
under construction	0	14,416	3,062	0	2,006	274
In operation	186	44,428	11,990	0	1,501	735

Figure: Continent-wise break up of HSR networks

Historically, Japan was the first country to make a foray into the HSR space with the Tokaido Shinkansen, which was started between Tokyo and Osaka in time for the 1964 Olympics. The country now has over 3,000 km of high-speed rail lines connecting all its major cities and the lives of whose populace have completely been transformed by the Shinkansen network.

In Europe, several countries were building new rail lines after the existing ones were destroyed in the aftermath of World War II. As per UIC records, France was the first country to inaugurate

Source: UIC (https://uic.org/IMG/pdf/20220901_high_speed_lines_in_the_world_v3.pdf)

its Trains a Grande Vitesse (TGV) line between Paris and Lyon. Italy followed next with a HSR system between Rome and Florence. Today, Spain, Germany, Belgium, Denmark, Finland, Austria, Britain, Netherlands and Switzerland are all connected via highly efficient HSR systems, which contribute to the European Union's sustainable mobility objectives.

Closer home in Asia, China has taken to HSR in a big way and boasts of a HSR network spanning across 64,000 km, of which over 40,000 km is already operational [2]. It is the longest HSR network in the world, which grew from nothing in 2007-10 to covering two-thirds of the national land area of China from 2011-15. The HSR is being used by 1.7 billion passengers every year, according to a report by the World Bank.

Almost all the countries where HSR systems were introduced have reported big gains, both to the quality of life of their people, economies and the environment.

2 *Source:* https://uic.org/IMG/pdf/20220901_high_speed_lines_in_the_world_v3.pdf

Chapter 2
WHY HSR?

We are a society fascinated by speed. From fast cars to zip us around town and same day "express" deliveries of essentials to high-speed internet and super-fast computing devices, humans are trying to contract time and space in this zealous need for speed.

As concepts of time and distance evolved, the 21st century was marked with innovations by mankind to shrink the coordinates further in a globally connected era. People started moving out of their nuclei in search of a better standard of living and employment opportunities.

In this landscape, high-speed trains have come to symbolise the future of travel the world over especially over distance up to 500 km to 800 km. A 2019 International Energy Agency (IEA) report titled, *'The Future of Rail'* revealed that HSR activity worldwide has expanded five-fold in less than 10 years. Despite its limited geographical spread, HSR activity grew by more than 11 per cent per year between 2000 and 2019, nearly three-times faster than growth in any other non-urban transport mode, attaining nearly 1,029 billion passenger km in 2019.

Introducing a HSR system will fuel India's economic engine, help meet the environmental and energy challenges of this century and also place the nation on the fast track to development. From a people perspective, high-speed trains are a more easily accessible mode of commute compared to air travel, even as the total journey times are similar when seen from door to door.

Social Gains

A HSR is a high-capacity mode of transport – up to 2,00,000 people can use the system each day reducing congestion on roads and on other modes of travel. It offers people a safe, reliable and comfortable mode of travel increasing productivity as the time and energy spent in travelling delays can be saved.

A HSR system plays a pivotal role in achieving regional integration and creating socio-economically balanced societies as it evident from the experience of several countries. It reduces the temporal distance between cities, taking away the need for people to migrate to big Metropolitan towns or financial hubs to earn a living. Cities that fall on a HSR connection to a big hub become satellite towns, bringing down congestion and the plethora of urban challenges that come with it.

This improves the overall quality of life of people in the region as a whole who can travel with much lesser time and costs including. Studies have revealed that with the introduction of HSR, sectors like tourism, healthcare and education get a major boost where the network is introduced.

HSR networks are known for their punctuality and multi-modal connectivity. HSR stations are easy to access as they are mostly located in busy city centres, making them a preferred mode of travel for passengers. However, stations which are located at the outskirts can be converted into transit hubs where the local population can interchange between multiple modes of transport.

The coming up of a HSR line also has an impact on real estate prices and overall development of the cities it touches due to the improved connectivity that it brings to the region.

The introduction of a HSR link between Paris and Lyon led to an increase in real estate prices two years before the line was flagged off and then again two years after the train services commenced. The impact was seen the maximum in areas that were located within a 15 minute perimeter of the line.

Station Area Development, which is on the cards for the Indian HSR corridors too, improves the quality of life of people living there and creates city hotspots for locals and tourists alike to visit.

Economic Gains

The new rail services will connect India's economically vital mega-regions and make them more productive, mobile and internationally competitive. Globally, it has been observed that cities that have HSR networks are more developed and flourish. The connectivity offered by the rail link helps attract businesses, skilled workforce and tourists.

According to a study conducted by London School of Economics and Political Science and the University of Hamburg, cities that are connected to HSR systems witnessed a rise in Gross Domestic Product (GDP) by at least 2.7 per cent compared to their neighbours, that were not on the route.

It also revealed a direct correlation between increased market access through HSR connectivity and a rise in GDP – for every 1 per cent increase in market access, there is a 0.25 per cent rise in GDP. This research was focussed on the HSR line connecting Cologne and Frankfurt opened in 2002, where trains run at 300 km/h.

The coming up of a massive infrastructure project of this magnitude, in turn, creates employment opportunities for the local population, both during the construction phase and after operations begin. During the construction phase itself, the MAHSR project is expected to create about 80,000 (direct and indirect) jobs.

For a country like India known for its technical prowess, getting a new advanced technology for Mumbai – Ahmedabad High Speed Rail corridor is also going to aid the process of Transfer of Technology and skill development of local manpower. Those working on the project will undergo trainings in Japan and use their upgraded skills to reduce unemployment, raise incomes and improve the overall standard of living of people and communities.

A high-speed connectivity also gives a boost to tourism as people from nearby areas can make comfortable day trips to see city hotspots. The opening of the Paris-Lyon HSR link in France, for instance, resulted in an increase of 144 per cent in passengers travelling for business and leisure.

About 14 million tourists use the TGV Mediterranee to travel to the south of France, according to a report titled 'The Economic Footprint of Railway Transport in Europe' published by ECORYS in October 2014.

The report cites a similar impact in Italy with the opening of the Rome – Milan line, where more than 40 million passengers used the HSR system in the first two years and overall demand

witnessed an increase of 39.1 per cent from 2009 to 2011. There was a shift from air to rail travel – air travel decreased by 1.3 million passengers a year between the cities serviced by high-speed trains.

For the economy as a whole, the demand for machines and materials like concrete, steel, etc needed for construction has witnessed a steep increase offering a boost to these industries. The MAHSR project is expected to consume 1.6 crore Cum of cement and 17 lakh MT of steel, which will be made in India and act as a catalyst to give cement and steel industries a boost.

Environmental Gains

Rail accounts for 8 per cent of the world's motorised passenger movements and 7 per cent of freight transport, but uses only 2 per cent of the world's energy demand.

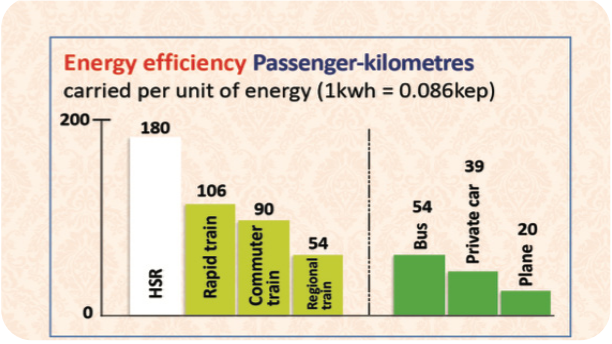
A HSR system generates one-third the carbon emissions compared to car travel and just one-quarter compared to air travel undertaken by the same number of people, taking into account the average loadings typically achieved on each mode. This makes it an eco-friendly mode of travel which will help bring down carbon emissions from the transportation sector as a whole.

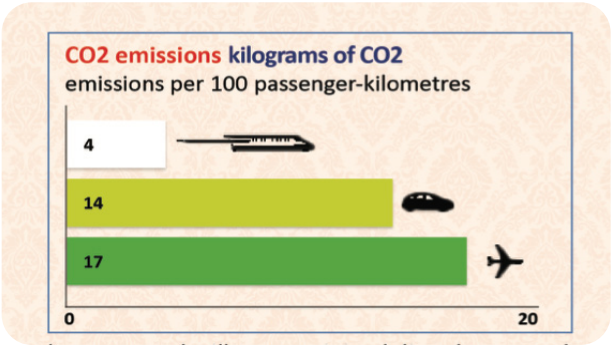
OPTIMAL DISTANCE FOR HSR CORRIDOR

A World Bank analysis of China, the biggest HSR market concludes that HSR is the preferred mode of transport over distances ranging between 150 km to 800 km. In countries like Japan, France and Korea, a distance of about 500 km between two major cities that are connected by corridor with good economic development in the area formed the major attributes for selection.

In addition to the origin and destination stations, the other stations along the route also must be chosen in a manner so that while the 'important' cities are covered. Some of the corridors where HSR projects have been very successful meet these parameters. These include Japan's Tokyo – Osaka line (515 km), France's Paris – Lyon line (425 km) and Spain's Madrid – Barcelona line (503 km).

The world over, a shift has been noticed to HSR from other modes of travel such as air and rail, especially for longer distances (over 500 km for air and 500 to 800 km for rail).





According to statistics of UIC, a high-speed train is the most energy efficient mode of transport in terms of Passenger-kilometres carried per unit of energy. Rail is also the most environmental friendly mode of transport, with CO_2 emissions being less than one fourth of air transport and less than one third of road transport (car).

In case of India, a HSR system will facilitate a shift of passenger traffic from air and road to the high-speed train running between the cities that start to get serviced. This shift will have a positive impact on the environment as a whole, as it will help reduce greenhouse gas emissions and improve air quality.

Mumbai–Ahmedabad High Speed Rail Corridor

The introduction of a high-speed rail corridor in a country marks the start of a transportation revolution and, therefore, what route is selected for the first line becomes very important.

The Mumbai – Ahmedabad corridor fits all of above requirements. The corridor connects India's most populous city, Mumbai, with the seventh most populous one and the area between them has seen significant economic growth over the past few decades.

Imagine traversing the 508 km distance between Mumbai and Ahmedabad in all of two hours, as against about nine hours that you presently take by bus or six hours that a conventional rail chugs along in. Sounds unbelievable, doesn't it?

Chapter 3
The Genesis of NHSRCL

The first mention of a HSR line for India was made back in 2009, soon after which a pre-feasibility study was initiated for the Mumbai – Ahmedabad corridor. This was followed by similar studies for other corridors.

Such was the buzz created by the news of HSR connectivity in India that several foreign countries evinced interest in these potential HSR corridors and helped prepare pre-feasibility studies.

The seed for the MAHSR corridor, as we see it taking shape today, was sown in 2013, when on a trip to Japan, the then Prime Minister of India agreed for a joint feasibility study to bring HSR technology to India in collaboration with the Japanese government.

Interestingly, all the technical aspects of this study were handled by the Japanese, who are the global experts in high-speed rail. But, it was termed as a 'joint' study because the funding was shared. In 2014, the joint feasibility study was constituted and a final report was submitted in July 2015 by the Japan International Cooperation Agency (JICA) consultant. This report is what forms the basis for the Mumbai – Ahmedabad high-speed project.

Inking of the Deal

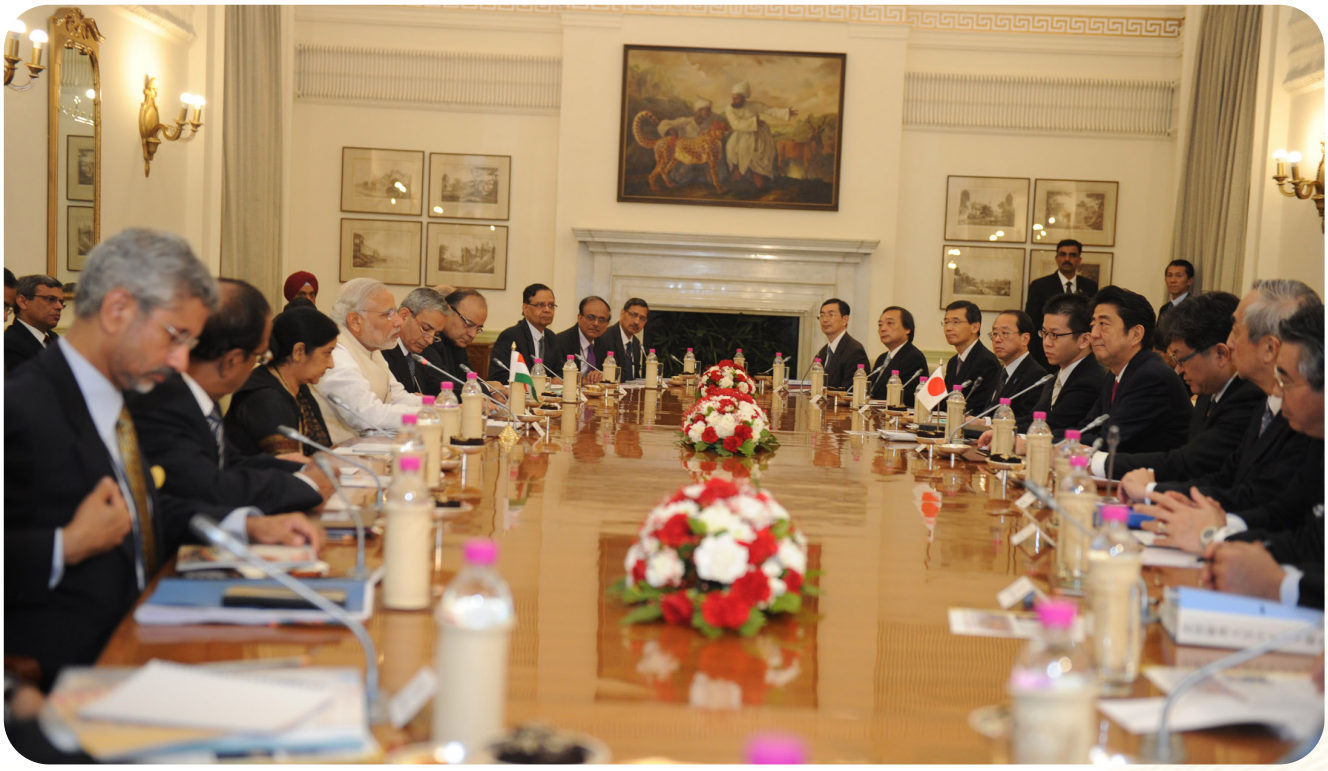
The Government of India took a unique initiative – a detailed review of this joint feasibility report by the Committee on Innovative Collaborations under the aegis of Vice Chairman Niti Aayog and Department for Promotion of Industry and Internal Trade (DIPP). The committee looked into all the fine details of this report, including the reason for selection of the Japanese Shinkansen technology when there are other HSR technologies available the world over.

SHINKANSEN: THE BULLET TRAIN

The Shinkansen System offers one of the highest safety levels in the world – there have been zero casualties in 50 years from when the first Shinkansen train started in Japan in 1964 to 2016. They run at average punctuality levels of 40 seconds, which is also impeccable.

In the meantime, the Japanese government gave their financial proposal on funding at concessional rates, which was also examined by the committee. Based on the recommendations of this committee, the Cabinet approved India's first HSR project in December 2015.

The timing of the approval is a story in itself. The Cabinet nod coincided perfectly with the visit of then Japanese Prime Minister Sh Shinzo Abe to India for the India – Japan Summit meeting. The deal was instantly inked with the signing of a Memorandum of Cooperation between the two Prime Ministers, Sh Shinzo Abe and Sh Narendra Modi, on December 12, 2015. The implementation of the MAHSR project was now on track. This became a turning point for India's HSR journey.



India Japan Summit Meeting between
Sh Shinzo Abe, then Prime Minister of Japan
and Sh Narendra Modi, Prime Minister of India
on December 12, 2015

One of the modalities agreed upon by the two governments was that a separate company will be established to execute the MAHSR project on the lines of Delhi Metro Rail Corporation Limited (DMRC). On February 12, 2016, under the Companies Act, 2013 with an object to finance, construct, maintain and manage the High Speed Rail Corridor in India, **National High Speed Rail Corporation Limited (NHSRCL)** was born as a Special Purpose Vehicle (SPV) with the partnership of Government of India (through the Ministry of Railways), Government of Gujarat and Government of Maharashtra.

THE GROUND BREAKING CEREMONY

By this time, there had been enough talk about the HSR project coming to the country and everyone wanted to see something happening on ground. Soon, NHSRCL was told that there needs to be a 'ground breaking ceremony' for the MAHSR corridor. The demand was for a site where something needs to be physically done for the bullet train project, and not just a symbolic start.

Getting started on the main rail line was not possible yet, as NHSRCL was still working out the modalities of land acquisition. So, a decision was taken to plan a 'ground breaking ceremony' for the High Speed Rail Training Institute. In flat four months, the core team worked day and night to ready itself for the ground breaking ceremony, which was being planned for September 2017.

Time was running out, tenders had to be floated and a site had to be finalised soon. Then, Vadodara was suggested and NHSRCL team rushed to the vibrant city and selected the present option at National Academy of Indian Railways (NAIR) after evaluating many others.

On September 14, 2017, a 'ground breaking ceremony' for MAHSR corridor at Sabarmati and the start of physical construction at Vadodara for training line slab track institute was held with the who's who of India and a 10-employee strong NHSRCL team.

Action Activation

NHSRCL, though born, had no resources of its own and had to rely on Indian railways officials to manage its affairs and come up with schedules and procedures. Amidst all the excitement of bringing a new technology to the country, a lot of work needed to be done before the project could actually take off on ground. A HSR project like this was a first for India and experts in the country had no existing documents or technical specifications to carry out construction and operations of such a system.

The Japanese and Indian sides agreed to not waste any more time and immediately embarked on a follow up study, which would detail the project further. In addition to the follow up study, they also had to start working on the basic designs, detailed designs and Schedule of Dimensions because this is what the project would ultimately be executed with.

Interestingly, everything moved so fast that the Indian government had still not allocated funds for the new project through the budget. So, the follow up study was funded by Japan. Another challenge faced was that the loan from Japan could only get sanctioned after social impact assessment and environment impact assessment was done. But the preparation of designs could not be delayed. The Japanese government agreed to give a grant for the execution of design work through a consultancy in December 2016. This was called General Consultancy excluding supervision.

The very first contract of NHSRCL was awarded to Rail India Technical and Economic Service (RITES) to carry out a detailed survey in October 2016. This marked the transition of the project from a desk study to execution, which entailed surveys, geotechnical investigation and then developing social impact assessment.

While the processes were being streamlined and work on the HSR line was being initiated full-throttle, NHSRCL started working from a tiny make shift office with four employees on deputation from railways. This core team discussed all matters related to the project and were all wearing multiple hats in this new set-up. They were aided by a Japanese team, who helped NHSRCL through the initial designs and processes.
This team was headed by Sh Achal Khare, who took over as the first Managing Director of NHSRCL on April 20, 2017. He was succeeded by Sh Satish Agnihotri, who held the Managing Director's office from July 1, 2021 to July 7, 2022.

The baton of the head was passed on to Sh Rajendra Prasad, who joined NHSRCL in November 2017 as Director Project and was overall in-charge of civil engineering works of the MAHSR project. He assumed additional charge as Managing Director from July 7, 2022 to May 5, 2022 and took over as Managing Director, NHSRCL on May 8, 2023.

The Managing Directors were aided in this journey by an able leadership team, that provided the best possible guidance and vision to achieve various milestones for this ambitious project. The founding team of directors included Sh A K Bijalwan, who held the post of Director Finance from January 2, 2018 to June 30, 2023, Sh Vijay Kumar, who held the post of Director Rolling Stock from August 23, 2018 to August 22, 2023, and Sh Sandeep Kumar, who held the post of Director Electrical & System from August 31, 2018 to August 30, 2023.

On August 29, 2023, the visionary board of NHSRCL has been joined by Sh Anjum Pervez as Director Projects. Prior to this, Sh Anjum Pervez was Principal Executive Director (Planning & Development). Sh Vivek Prakash Tripathi assumed the charge as Director Finance, before taking on this post, he was General Manager Strategic Finance.

On August 31, 2023, Sh Alok Katiyar took over as Director Electrical & System. Prior to this, Sh Katiyar was Principal Executive Director (Signalling & Telecom). Sh Sandeep Srivastava joind the board of NHSRCL as Director Rolling Stock on September 22, 2023. Before taking on this post, he was Principal Executive Director Rolling Stock. With a vision to maintain integrity and efficiency in the organisation, NHSRCL appointed Sh S K Mishra as Chief Vigilance Officer on September 1, 2021.

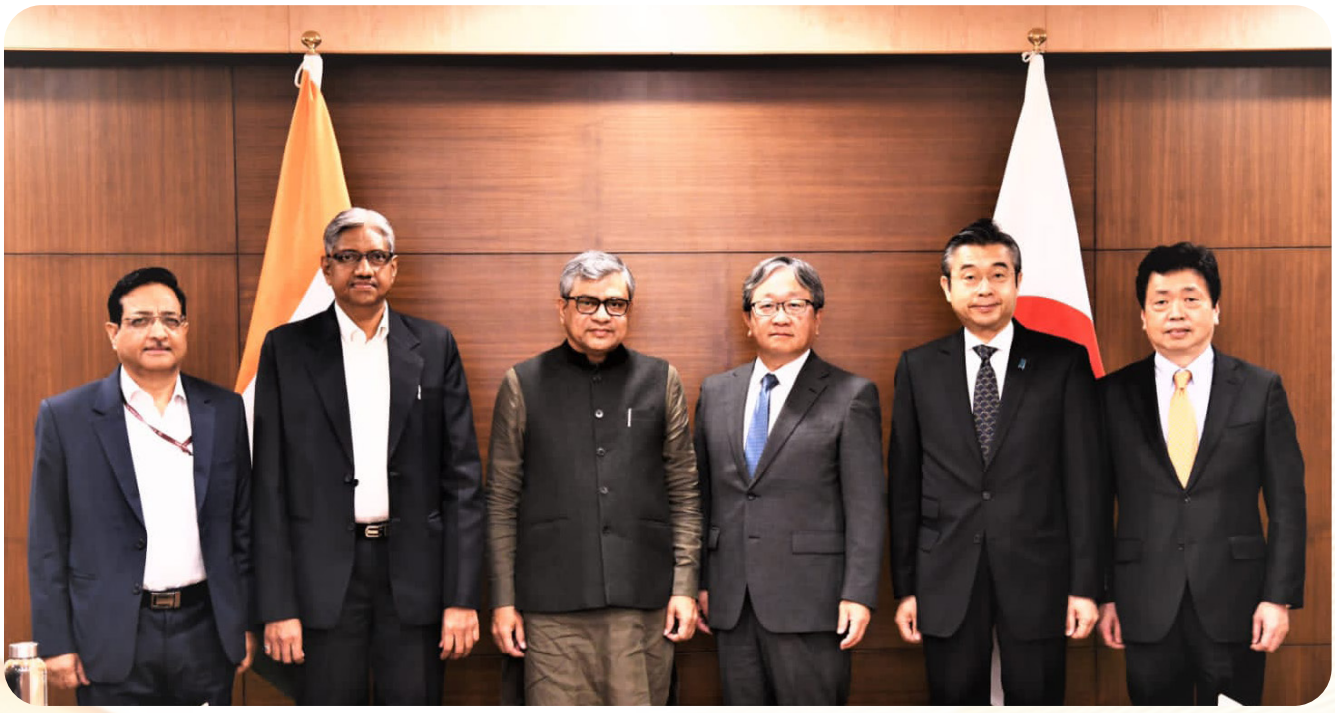
Each of these stalwarts have been handpicked for their jobs and have played an instrumental role in their respective domains in shaping India's first high-speed rail project.

Since its inception in 2016, many more specialists have joined the team at NHSRCL in different capacities. Today, it is a 350-employee strong organisation, comprised of some of the best technical minds of the country.

BOARD OF DIRECTORS

The present strength of Board of Directors of the Company is ten, comprising five functional directors viz. the Managing Director, Director Projects, Director Finance, Director Rolling Stock, and Director Electrical & System; and three part-time official Directors (including Chairman) nominated by Government of India and one official director each nominated by Government of Gujarat and Government of Maharashtra.

Joint Committee Meeting on MAHSR with Hon'ble Minister of Railways Shri Ashwini Vaishnaw and Dr. Masafumi Mori, Special Advisor to the Prime Minister of Japan, January 2023



Mumbai–Ahmedabad High Speed Rail Corridor: Key Facts

Scan to view Corporate Film
or https://youtu.be/WcKfAevLs5E

Chapter 4

MAHSR Corridor – A Leap Forward

Spanning across 508 kilometres, the MAHSR corridor will offer fast connectivity between the two financial hubs located in the states of Maharashtra and Gujarat in western India.

After starting from Mumbai's Bandra Kurla Complex (BKC) area, the high-speed train running at a speed of 320 km/h is all set to revolutionise intercity travel in the region. It will have stops at 10 cities in between namely Thane, Virar, Boisar, Vapi, Bilimora, Surat, Bharuch, Vadodara, Anand, Ahmedabad and will terminate at Sabarmati.

The entire journey will be completed in about 2.07 hours with limited stops (at Surat, Vadodara and Ahmedabad), a fraction of the time taken by conventional trains or road journeys. While most of the corridor will be constructed over ground (465 km is on viaduct), there will be a mixed-bag of tunnels (26 km), bridges (9 km) and embankments (13 km) along the entire journey.

The introduction of this high-speed rail link brings many firsts for the country. India will, for the very first time, see the use of technologies like LiDAR, construction of an undersea tunnel and the use of Static Refraction Topography, aerodynamically designed high-speed trains, improved bogies technologies for noise mitigation for maximum passenger comfort, special lurch control system and air tight car body system, Continuous Automatic Train Control (OS-ATC) system for improving track to train transmission, fall-back system, and disaster management systems among others.

As per current estimates at the start of services, the corridor is expected to be used by 17,900 passengers every day in each direction, who will be ferried in 35 daily train trips made by 10 car configurations. Train services will operate from 6 am to midnight at intervals of 30 minutes. More trains will be made operational during peak traffic hours, when the time between two trains will be reduced to 20 minutes. This will ensure that maximum number of people can use the services.

These estimates are based on a feasibility study prepared for the corridor, keeping in view a 30-year projection of passenger traffic. By 2053, about 92,900 passengers are expected to use the MAHSR system per day and all the systems are being designed to cater to these future levels of traffic.

With trains running at such high speeds, and handling such heavy traffic volumes, one of the best global technologies in HSR the Japanese Shinkansen technology has been selected for the MAHSR corridor after much deliberation.

DESIGNING THE **HIGH-SPEED** VIADUCT

The MAHSR corridor is 508 km long, of which 465 km includes viaducts, steel bridges and river bridges, on which the HSR trains will run. A majority of the corridor has been planned elevated, on a viaduct, as this minimises the need for extensive land acquisition and reduces the overall environmental impact of the project. The alignment of the MAHSR project passes through major cities where blocking off roads was not always feasible. An at grade high-speed railway line would have needed level crossings to make way for the high-speed trains to cross. This would cause delays and congestion. Furthermore, elevated tracks are inherently safer as there is no conflict between the trains, and vehicles, pedestrians or livestock crossing over the tracks, especially in Indian conditions.

Moreover, once the construction phase is over, an elevated track offers a lot more room at grade – a width of just 17.5 m is taken over as against 36 m for conventional railway tracks. This allows for easier movement for the local population as well as for wildlife while the train system functions unobstructed on the viaduct. Another reason for selecting an elevated track was faster time to construction, as building a viaduct is quicker. This minimises disruption to local communities during the construction phase.

Each of these have to be designed for high-speed to reduce vibrations that cause noise as well as passenger discomfort, and also maintain the highest levels of safety. Viaduct structures for high-speed railway lines are heavier than Metro elevated super structures because of lesser permissible deflection of girders for high-speed train operation. The other concern with structure is to control lateral deflections in order to prevent derailments of moving trains in the event of an earthquake, as the train moves 4-5 km even after the automatic brakes are applied when an earthquake is detected by seismometers.

Corridor Design

The MAHSR corridor is the first high-speed railway line to come up in the country. There are no guidelines for construction of HSR lines available for India so far. To maintain the highest standards of quality, almost all the design concepts for structures along the MAHSR on which the trains will run are based on Japanese Railway Standards and Guidelines, which have already stood the test of time for the Shinkansen high-speed railway network in Japan. Towards this, JICA has appointed a Japanese design consultant (JICC) to prepare a comprehensive set of designs and drawings for different stretches of the MAHSR project.

Each of the designs and drawings has been further reviewed by a high level Japanese committee appointed by JICA for the same. Only the recommended drawings are being handed over to NHSRCL for adoption based on which the actual construction is done at sites. Many IITs, such as IIT Chennai, IIT Bombay, IIT Delhi, IIT Kanpur have been engaged for some critical design issues, where adaptation was needed to suit conditions specific to the Indian terrain.

For such a long corridor length, NHSRCL has more than 70,000 drawings, all of which need to be kept in record to aid construction activity. Managing all the designs and drawings is proving to be a herculean task, given that the project is coming up on very tight deadlines. To solve this issue, NHSRCL has created a specialised Drawing Cell, which is tasked with managing the drawings at different stages – from tender to adoption.

To make the system fool-proof and allow for easy referencing for future HSR corridors being planned in the country, all the adopted drawings are linked to design reports and design certificates issued by JICC and recommendation letters issued by the Japanese committee by stamping the corresponding adopted drawings.

To simplify the process of management of such a large number of files, a drawing series system has been set up by JICC to identify the type of drawings related to the type of structure such as superstructure, substructure, foundation, etc. A code system is also being used to label the design type of drawing. For example, Standard Design drawings are marked with SD, Detailed Design drawings are marked with DD, and Basic Design drawings are marked with BD, etc.

Casting and Construction of Viaduct

The construction of a specialised rail corridor of such a massive length requires precision and planning at the back end to ensure the completion of construction in a timely manner. Accordingly, the sub-structure has been designed comprising of an underground foundation (largely pile foundation), pile cap, pier (of varied heights constructed as per pre-approved drawings) and a pier cap (to transfer load from superstructure to pier, and then foundation and soil).

To bring in standardisation, NHSRCL has pre-approved sub-structure types based upon the soil conditions. Seismic stoppers are being provided to act as a connection between super-structure and sub-structure in the event of an earthquake and offer protection from the impact of tremors. Another unique construction technique which will be seen in India for the first time is **'Shinzo Piles'**. These are used in areas where the alignment runs very close to Indian Railways tracks, where the foundations cannot be very wide and where heavy machinery cannot be deployed. In total, more than 100 Shinzo Piles are expected to be constructed along the corridor, with a diameter of 6 - 10 metres.

About 90 per cent of the alignment of the upcoming MAHSR corridor is elevated and the structure on which the high-speeds trains will run will be constructed mainly using the Full Span Launching Method (FSLM). This unique construction method, in which the girders forming the viaduct are cast in a casting yard and then moved to their position on top of a newly constructed superstructure using special carriers, is being used for the first time in the country. India is one of few countries in the world to use and master this technique.

ASIA'S LARGEST GEOTECHNICAL LABORATORY

The Mumbai–Ahmedabad high-speed railway link boasts of housing Asia's largest Geotechnical Laboratory near Surat to cope up with the huge Geotech testing requirement. Spread across a vast 56,000 square feet area, the state-of-the-art facility was set-up in a record time of just five months and has the capacity to carry out 3,500 tests every day. Till date, more than 2,00,000 tests have been carried out using 135 Tri-axial Cells, 339 Cells and 480 sets of Index Property. More than 200 highly-qualified engineers were posted at the lab to enable this testing at its peak.

There will be one casting yard for every 15-16 km stretch of the corridor, which means that the last girder that is lifted onto the viaduct will travel a maximum distance of 16 km on the superstructure and then be fixed in its final position. In all, a total of 23 fully-equipped casting yards have been planned along the length of the under-construction MAHSR corridor, in Gujarat, which cover a route length of 352 km. In these casting yards Box Girders are casted to be used in the FSLM for spans varying between 30 metres and 40 metres, along with SBS girders required for the project. The casting yards are sprawling spaces as they are cumulatively spread across an area of almost 1,000 acres where each yard occupies about 30-97 acres of land area.

An aerial view of a casting yard for casting Full Span Box Girders

> ***"In order to expedite viaduct construction, the full span girder launching method is being used on the MAHSR line. The technology is about 10 times faster than the conventional segment launching technology and has provided a new dimension to the construction industry."***

Shri Rajendra Prasad
MANAGING DIRECTOR

They are equipped with the latest machinery required for creating and transporting the girders, including Jigs for making Rebar Cage, casting beds with hydraulically operated pre-fabricated moulds, batching plants, stacking areas, labour camps for automated and faster production of girders and heavy machinery like straddle carriers, bridge gantries, and transporter and launching gantries.

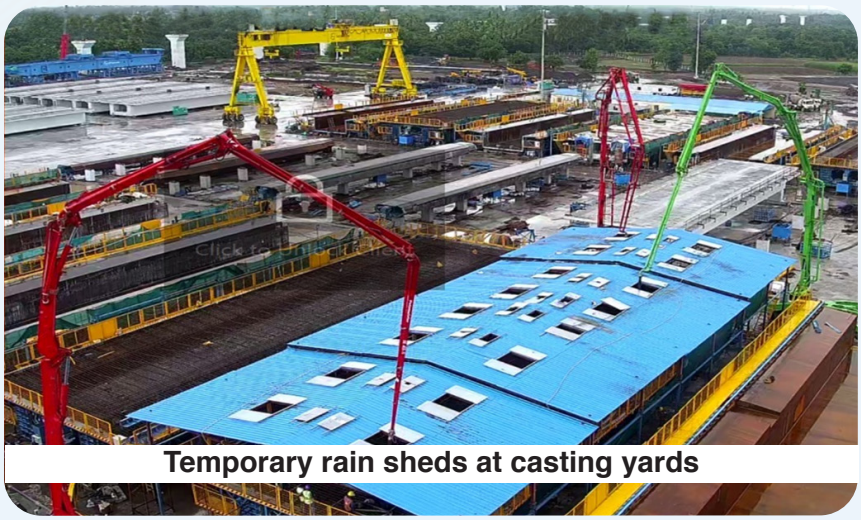
FSLM is around 10 times faster than the conventional Segmental Construction technique used for launching the girders that join together to form the viaduct. Each 40 m girder, with a height of 3 m and weighing 1,100 tonnes, will be lifted by a special launcher and placed on the viaduct. The girder will move along the superstructure till it reaches the location where it will finally be placed. The contractors will have to plan properly to efficiently utilise the available on-ground space. This method also speeds up the construction process.

EQUIPMENT NOW 'MADE IN INDIA'

The first few sets of equipment needed for FSLM for the MAHSR corridor were imported from overseas, after which equipment like straddle carrier, bridge gantry, girder transporter and launching gantry for 1100 MT capacity were all indigenously designed and manufactured at the Larsen and Toubro manufacturing facility at Kanchipuram, Chennai.

To further expedite the construction, NHSRCL standardised the designs for the structures and foundations, even before the process of construction began. The contractors who came in after the tenders were awarded had various options to choose from – such as using 30 m, 35 m, 40 m long girders, and open or pile foundations – to meet the design and quality standards set for the corridor.

THE WORK GOES ON UNABATED



Temporary rain sheds at casting yards

As the project has a tight deadline, the engineers working on the line came up with a unique solution to prevent any weather-related delays during rainy season. All the casting yards where the girders are being cast have been covered with sheds so that the work goes on despite the rains.

ADAPTING THE GIRDERS TO SUIT INDIAN CONDITIONS

A Full Span Box Girder getting ready for launching at a casting yard

In the state of Gujarat alone, NHSRCL needed 7,100 girders to construct a 290 km-long viaduct. Each 40 m girder weighs about 970 MT and needs 390 cum of concrete and 42 MT of steel. To achieve the best quality, many improvments and innovation were done. Prestressing sequence and demoulding process was optimised. In the initial phase, thermocouples were installed in more than 50 girders to measure the temperature of concrete at seven different points in each girder. Further, the covering of aggregates was made mandatory at the batching plants. Chilled water and ice were added to the concrete to bring down the pouring temperature of concrete. The overall casting time for the girders was also reduced from 18 hours to just 8 hours to avoid formation of any kind of cold joints.

A Bridge Gantry and Straddle Carrier in action at one of the casting yards in Gujarat

Girder Transporter Feeding Full Span Box Girder to Launching Gantry for Launching the Girder

Full Span Box Girders are helpful in crossing rail/road with minimum block time

Scan to view video
or https://youtu.be/zcUaKVgGP9Q

MAHSR viaduct construction using Segment by Segment (SBS) method

In certain areas where FSLM cannot be used – like when the width of the span is more than 40 m – the Segmental Launching method is being used for construction. This method allows for incremental construction and launching of pre-cast concrete segments to form the bridge deck or superstructure.

Noise barriers installation on MAHSR viaduct at a location near Surat, Gujarat

The viaduct will have noise barriers up to 1.2 m height all along the corridor. In urban areas, the noise barrier height will be increased by adding 1 m opaque panels. The height of the barrier is such that passengers will get unrestricted view during the journey. The viaduct will have walkways on both sides for maintenance staff, under which all the installations for Signalling and Telecommunications will be accommodated in cable ducts.

Steel Bridges

The MAHSR corridor is largely elevated and will go over National Highways, Dedicated Freight Corridor (DFC) tracks, Indian Railways lines and rivers at several locations along the way. The elevated bridge structure on which the train runs, called a viaduct, will be made with concrete. But, where the span between two pillars is more than 60 metres, steel structures will replace concrete girders to lend greater strength, stability and durability to the structure.

A Steel Bridge getting ready for launching near Surat

In all, about 28 such steel bridges have been planned along the length of the corridor of spans varying between 60 metres and 130 metres. Altogether, the collective length of these steel bridges will be more than 1 km and about 70,000 tonnes of steel will be used in their fabrication. Earlier, the idea was to assign contracts for the steel superstructures to Japan Lead (JV) companies as the standards were stringent and the quality levels expected were very high.

In March 2019, a high-powered committee headed by Director Project on the Indian side and experts from Japan universities and JRTT from Japanese side was formed to evaluate a 'Make in India' possibility. The committee observed that the Shinkansen steel bridges were superior to railway bridges made in India, but with some guidance and skill development from Japanese experts, Indian companies would be able to deliver the same standards.

To ensure full compliance with the Quality Management System and to achieve the highest levels of quality in fabrication of steel truss, NHSRCL has engaged experts from Japan for welding and quality management and technical accuracy. In addition to international welding experts, an Independent Examining Body (IEB), will also be engaged to monitor the quality of fabrication. The painting of steel bridges will be done as per Japanese specifications too, following the C5 paint system, after grit blasting before initiating the painting process.

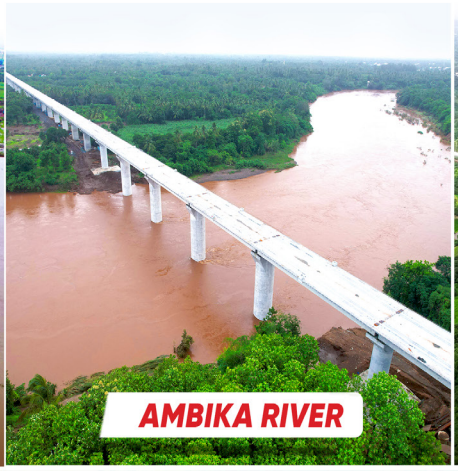
This opening of steel fabrication to Indian players has given a boost to the Indian steel industry and reduced costs. When Indian players upgrade their standards, they can also manufacture for other countries and offer high-quality, cost-effective and reliable products on the global map.

River Bridges

The alignment of the MAHSR corridor has been mapped over several rivers where the high-speed trains will go over specially created bridges to cross over. In all, a total of 24 river bridges will be constructed as part of the alignment, of which 20 bridges are located in the state of Gujarat and 4 bridges in the state of Maharashtra. Out of these, work on 5 bridges has already been completed, namely bridges over Purna river, Ambika river, Mindhola river, Par river and Auranga river.

To make way for the construction, Temporary Access Bridges (TAB) were constructed at some locations like Narmada river to that the progress can be made fast without causing any obstruction to the flow of the river. Other challenges included correcting the tilt in well foundations caused by heavy rains and subsequent flooding. At the Purna river, the height of the pier from the pile cap was 26 metres making it a challenge to carry out construction activity. Engineers from NHSRCL found out prompt solutions to issues that came up in order to keep the work going.


MINDHOLA RIVER


AMBIKA RIVER


AURANGA RIVER


WELL FOUNDATION WORK IN PROGRESS AT NARMADA RIVER, BHARUCH DISTRICT, GUJARAT

Laying the Tracks

For smooth journeys at high speeds, having the right track system is as important as the trains. The MAHSR corridor will work on a ballastless track structure, unlike Indian Railways that runs on the established ballasted track system. The MAHSR line will be built on a frame-type J-slab to economise concrete consumption. The track slab comprises of a pre-cast Reinforced Concrete slab over which fastening devices and rails are fitted. The pre-cast slabs are either 5 metre long or 4 metre long and are fitted with Type 8 fastening systems. At the bottom there is track bed concrete of about 300 mm and circular anchors to hold the precast slabs at regular intervals of 5 metres each.

Casting of first RC Track Bed on MAHSR Viaduct

The track slab is 2,200 mm wide, 4,900 mm long and 190 mm thick, and each slab weighs about 3.9 tonnes. It is laid over the track bed concrete, and a vertical gap of about 50 mm is created between them which is filled by pouring Cement Asphalt Mortar (CAM), a special material which is not being used in India so far. This is used to ensure that there are no gaps left in between and to provide greater elasticity. Special rubber pads will also be placed underneath the rails to provide elasticity and also to absorb vibrations from the high-speed train running.

Further, the cement and sand used to create the CAM needs to be of very high quality. Japanese experts, along with representatives from NHSRCL, took samples from India. After stringent testing, a decision was made to modify these materials and manufacture the CAM locally. While the cement and sand will be procured locally, the special polymer used for the CAM will come from Japan.

The rails will be imported from Japan and JIS Rail 60 kg will be used to match the wheel profile of the train. These rails have an inclination of 1 in 40 as against Indian standards, where an inclination of 1 in 20 is used. The same inclination is there in the rolling stock wheels. Unlike in conventional railways, the crossings used in the HSR line will be movable nose crossings to allow for higher speeds-these will also be procured from Japan. In fact, most of the materials required for track works will be procured from Japan, including expansion joints, insulated joints, welding material for rail welding, moulds for slab casting, polymer emulsion for CAM etc.

Presently, the process of procuring material for track works is in advance stages. More than 14,000 MT of JIS 60 kg and 50 N rails has already been received. 50 number of moulds have been received from Japan for casting of track slabs. Other materials are at various stages of procurement.

This process of track laying will be a first for India, and engineers and supervisors working on this process for the MAHSR line will undergo special training and will be certified by Japan Railway Technical Services (JARTS) before they are allowed to work on the sites. The procedure for laying the tracks is completely mechanised and requires special machinery. This will help achieve economy in the overall cost of the project and the transfer of technology will be beneficial for India in the long run.

While opening track works for Indian companies, training of Indian engineers was made compulsary, to understand the methodology of execution of works in Japan. Training and Certification for the Indian contractor's personnel is being organised with Japan Railway Technical Services (JARTS) as T&C agency.

A separate MOU has been executed between NHSRCL and JARTS to enable this training and a new training facility has accordingly been set up at the MAHSR maintenance depot in Surat. In total, 15 different courses have been identified for training, which started on March 23, 2023.

GATEWAYS TO **THE FUTURE**

To breathe life into the buildings that will form HSR stations, the design of each of the 12 stations on the MAHSR line will reflect the spirit of the city it is coming up in. This will bring about an instant connection with the local populace, and promote a sense of ownership of the high-speed system.

From an architectural point of view, it is simple to make a modern-looking structure. But, to establish a connect with the local environment, the idea was to pick some elements of the city that locals are proud of and then build the concept on those elements. The stations are conceived as a gateway to a modern way of living.

The HSR station buildings will be modern, with use of materials like translucent glass, but with some reflection of the city to make people relate to them. For instance, Surat is known as the diamond city, so the HSR station building has the diamond shape in the elevation and ceilings.

The Sabarmati station is inspired by the river Sabarmati, and the elevation has waves to represent water. The spikes of the Ashoka chakra will also be seen in the design. Ahmedabad architecture is famous for Syed Siddique's iconic jaali, which represents the tree of life. The jaali is being recreated in the facade of the Ahmedabad HSR station building.

The inside of the station area has an intuitive design, where passengers are guided towards the platform and all functions, such as security, ticketing, etc happen during the course of this movement.

A uniform style has been maintained at all the stations to ensure that passengers using the system get exactly the same feel at all stations.

All the stations will meet international standards in functionality and operations and will have soothing colours and all basic amenities like signages, seating arrangements in waiting areas, lounges, kiosks, etc. Effort has been made to keep the location of the stations inside the limits of the cities, and connected to other modes of transport like railways, city buses, Metro lines, and parking facilities, etc.

High-speed trains will see longer travel times so care has been taken to provide good restrooms, next to which will be nurseries for children. The stations will also have lockers to store baggage for those doing day trip to cities, which a high-speed train system will offer. The stations will also have business lounges for first class passengers.

The stations will have an inclusive design for Divyang (differently-abled) passengers. A wheelchair-friendly design, lowered ticketing counters with braille instructions, tiles on the floor for guidance, dedicated washrooms, braille buttons inside elevators are some of the features.

Stations that Enhance Passenger Convenience and Experience

State-of-the-art HSR stations envisaged en route MAHSR

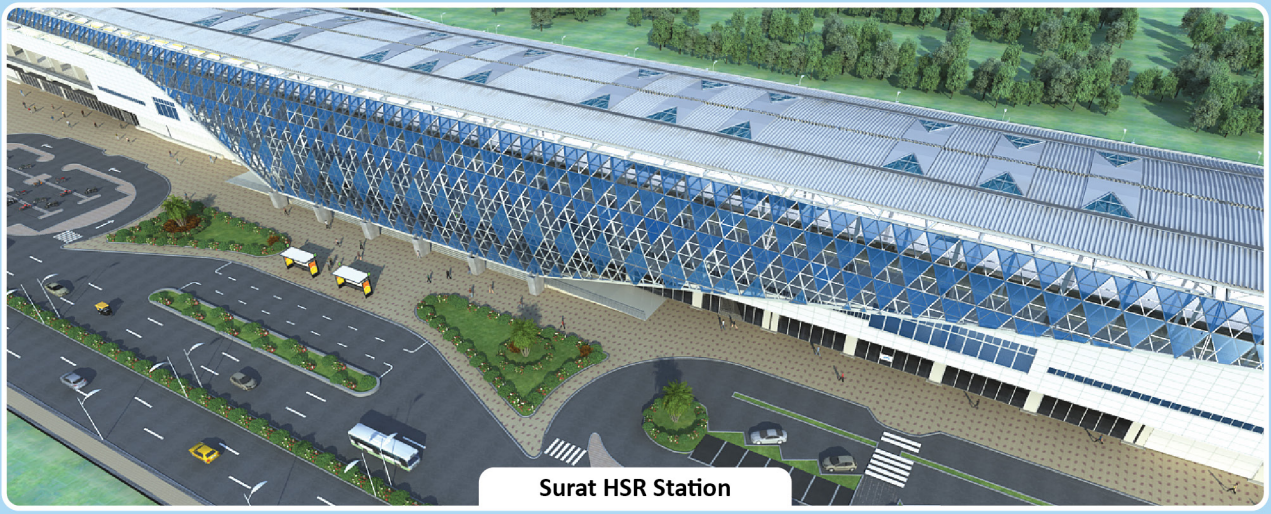

Sabarmati HSR Station


Ahmedabad HSR Station


Anand HSR Station


Vadodara HSR Station


Bharuch HSR Station


Surat HSR Station

Scan to view video
or https://youtube.com/shorts/lSfkS1Gz78Y

Graphical Representation of MAHSR Stations

Station Area Development

Each of the HSR stations are being envisaged to be destinations in themselves. To harness the true potential of improved connectivity with the construction of a high-speed connection, the areas around the stations will be designed as hubs. The idea is to promote existing industries in the city and its surroundings and also build new industrial centres so as to improve the overall standard of living of the local community.

For this, NHSRCL is liaising with various stakeholders including National government, State governments and the local authorities, and two stations each in Gujarat and Maharashtra will be developed by Japanese experts as model stations. These are Virar and Thane stations in Maharashtra and Sabarmati and Surat stations in Gujarat.

To aid this process of economic and social development along the MAHSR corridor through a process of Transit Oriented Development (TOD) around the HSR stations, a Station Area Development Executive Committee (SADEC) has been formed. The committee has representatives from State governments, NITI Aayog, Ministry of Railways, Ministry of Housing and Urban Affairs, NHSRCL along with experts from Japan's JICA, MLIT, JR East and Urban Renaissance.

Green Stations

All the HSR station buildings are coming up as 'green' buildings. This means that they will have elements of sustainability featured right in the design, that includes water efficient fixtures, green-pro products for construction, energy efficient light fittings, and multimodal integration with other transport modes, both existing and proposed.

Passive energy-saving measures and active ecological energy will be incorporated in the designs to help reduce the energy consumption of the buildings. All the HSR stations will be equipped with and oriented to benefit from the ecological sustainability of the station buildings.

Where ever feasible, integrated solar panels are being provided in the roof to minimise energy consumption. Elements such as big windows to allow natural light in addition to a view of the outside and proper ventilation will further bring down energy bills. Rainwater harvesting and water rejuvenation pits will be a vital design element for all buildings constructed as part of the MAHSR corridor.

Under-construction Surat HSR Station

WHEELS OF **CHANGE**

The experience of travelling on the new HSR trains will be nothing like what we are used to. Running at superfast speeds of about 320 km/h, they will reach you to your destination in a fraction of the time taken by conventional Indian Railways trains (the present top speed is 160 km/h), on the way ensuring utmost passenger comfort and the highest levels of safety. It is four times the speed of Metro trains.

The trains for the MAHSR corridor are being brought in from Japan and are known for their comfort and reliability. Suitable changes were made in the technical specifications of the Shinkansen rolling stock to suit them to Indian conditions. High-speed trains on the Mumbai-Ahmedabad line will have three classes defined by the configuration of seats- standard class (3 X 2 seats), business class (2 X 2 seats) and gran class (2 X 1 seats).

> *"The MAHSR corridor will run on the Shinkansen technology where the trains are known for their comfort and reliability. The trains will be modified to suit Indian environmental conditions."*

Shri Sandeep Srivastava
DIRECTOR ROLLING STOCK

At present, the components used in the trains are highly specialised and are currently not available in the country. But, subsequently, six of the first 24 trains will be partially assembled in India. Each train with a 255 m length will comprise of 10 cars.

Passenger Comfort

High-speed trains are going to be used for mid-distance journeys, making comfort a very important factor. The higher the speed of the train, the more the vibrations which ultimately result in riding discomfort. The challenge, therefore, is to increase speeds while maintaining the same levels of comfort as on low speeds.

Shinkansen trains have an evolved suspension and damping system to control vibrations. In addition, these trains have a Vibration Prevention Control System, an advanced feature which continuously monitors the level of lateral vibrations and automatically initiates counter measures when these levels exceed limits

Noise and Air Pressure

The complete train car is designed to contain the levels of noise inside it. The body is made of a hollow double skin structure which does not allow sound to come from outside. Since a majority of noise is generated from the bottom of the train, the floor is fitted with noise absorbent materials to prevent it from reaching the passengers.

When the train enters and exits tunnels, people feel discomfort in the ears because of air pressure fluctuations. For this, the train car is made air tight. Shinkansen trains also have a process of positive air pressurisation inside the train to have better air tightness.

Facilities Onboard Shinkansen Trains in Japan

- *Passenger Information Display System*
- *User-friendly toilets*
- *Modern washrooms*
- *Comfortable seats*

Designed for a Comfortable Ride

To ensure that long-distance rides are not a strain, the trains will have a 3 X 2 seating arrangement with extra legroom (1,040 mm) than what we have in present trains (990 mm) and is also much higher than airplanes. The seats are rotatable ensuring that you always face the direction of travel.

Every car has overhead baggage racks and business class compartments have an additional space for baggage, which can be used exclusively for luggage. There is no worry to go offline as the trains will offer Wi-Fi connectivity to keep you connected and catch up on work while you travel. Every train is fitted with an LCD display showing information such as next station, journey time, the current speed of the train with a corresponding audio announcement system.

THE TALE OF THE FANCY TOILETS

Since the trains running on the MAHSR line are made in Japan, the toilets fitted into them are also going to be completely world-class with button actuated toilet seats that have a washing and drying function. The flush will be air plus water type, as seen in airplanes. The waste generated will not be strewn on the tracks.

Fancy toilets onboard Shinkansen trains in Japan

It will be stored in massive discharge tanks and emptied out when the train reaches the maintenance depot. There are some challenges around this. The discharge tanks have limitations and Indians are known for drinking large amounts of water! So detailed calculations were done to assess the number of trips each train will make before the discharge tanks get full and it needs to be taken to the depot for cleaning. The toilets will have display tutorials on how to use these special toilets.

Utmost Passenger Safety

Zero fatality rate is one of the USPs of the Japanese Shinkansen system. The trains are embedded with Digital Shinkansen - Automatic Train Control (DS-ATC) system with a special braking mechanism to prevent collision and overrunning at stations. The acceleration is all manual, but if the driver fails to apply the brakes in time, the system takes over and stops the train.

In DS-ATC, the signalling comes inside the driver's cab which also shows the speed of the train and the permissible limit. In the event that the driver fails to control it, a Automatic Train Control system takes over to slow the train down.

To ensure passenger safety at all times, the trains are fitted with CCTV cameras and an emergency intercom to facilitate communication between the driver and passengers in case of any untoward situation. The face of the person calling is recognised and saved to prevent misuse of the system.

Long Nose for Improved Aerodynamics

When you run a train at such high speeds, there is air resistance. The long nose limits air drag, an aerodynamic force that opposes the motion of any object against the air. Most of this force comes from the front of the train which clashes against the air with force as the train is running on high speed.

When trains enter tunnels, a lot of micro pressure air pockets are generated. These get released when trains exit the tunnels producing a sonic booming sound. This design helps reduce that.

WHY DO BULLET TRAINS HAVE A LONG NOSE?

The trains which will run on the MAHSR corridor will be based on the ES series rolling stock of Shinkansen. In Japan, a lot of effort went into designing the nose of the train which is shaped like a Duckbill's beak.

The long nose allows for better aerodynamics, which allows the train to operate at very high speeds with minimal resistance or air drag. Japanese experts conducted a series of tests which proved that this shape was most effective in reducing generation of pressure waves when trains running at high speeds entered tunnels.

Figure: The nose of Shinkansen E5 (above) as compared to the beak of a Duckbill Platypus (below)

Safe against Natural Disasters

The train system for the MAHSR corridor is embedded with power failure detection brakes, where in as soon as the primary waves of an earthquake are detected, the power supply to the train is cut off and the train stops on emergency braking.

A severe earthquake brings a high chance of derailment when the train speed is higher than 300 km/h. To safeguard against that, there is an automatic system in place which brings the train to a halt within 80 seconds, a distance of within 4 km using special brakes that are fitted in the train.

High speed rail will be fitted with a network of sensors monitoring rail track temperature, rain monitoring (with special sensors in heavy rainfall prone areas) and anemometers for wind monitoring. Crosswind speeds above 30 m/s will send an alarm signal to operational control center in Sabarmati, so the train will be stopped.

Maintenance

To ensure that a clean train greets you at the station each time to make your journey safe and comfortable, a lot goes on at the backend. Each train running on the network is taken to the depot for cleaning on a daily basis, where the passenger areas are deep cleaned for the next trip.

In addition, all trains running on high-speed lines will be put through primary maintenance every alternate day as part of which all the safety aspects of the train are checked to make sure the running is safe and smooth. In addition, there is a monthly inspection, a bogie inspection every one and a half years, where the bogies are dismantled and checked for safety. A general inspection is also carried out every three years where all equipments including bogies are comprehensively overhauled.

DOCTOR TRAIN

What is common between Dr Yellow of Japan and Dr Avril of Spain? They are not MBBS doctors, but the nicknames of special high-speed inspection trains which have special equipment on board to check the health of train system such as the track, overhead wires and other vital installations.

NHSRCL plans to acquire a General Inspection Train (GIT) for the MAHSR corridor which will run at a speed of 320 km/h and will be equipped with the machinery and equipment to check track systems, overhead power supply systems, signalling and communication infrastructure.

POWERING THE FUTURE

To meet the energy requirements of the trains, as well as various installations/ equipment in several buildings like station buildings, Operation Control Centre, Depots, Training Institute and installations/ equipment along the MAHSR corridor, a network of 12 traction substations, 2 depot traction substations and 16 distribution substations will be built along the 508 km stretch. Electrical power supply will be used to feed energy for traction (running of trains) and non-traction loads such as depot facilities, signalling and telecom systems, station infrastructure facilities, wayside infrastructure and facilities along the viaduct.

The power supply arrangement has three major components, the power sourcing arrangements which are built through and in consultation with the power Utilities and the "railway side", traction power supply network and, Distribution System Network for non-traction loads.

The power sourcing works require assessment of traction and non-traction loads, identification of suitable location for substations and thereafter through joint survey with power utilities and load flow studies the suitable source of power supply – Grid Substations – are identified. In other Railways projects, these activities are carried out after the electrical contractor and rolling stock contractor are in place and basic designs are available. This leads to delays in transmission line and GSS augmentation works.

NHSRCL has been proactive in assessing the traction power supply needs of the MAHSR project through simulation studies and thereafter carrying out the joint surveys promptly by early 2018, approval of connectivity applications from utilities were already received. Works of transmission lines and GSS augmentation have started well in time. As the locations of substations, required along the alignment were finalised, land was acquired accordingly.
Almost the entire Traction Supply System, Distribution System and the power sourcing arrangements would be "Make in India". This was agreed by the Japanese consultants after several discussions and joint visits to India.

Overhead Equipment (OHE) for HSR

Moving trains derive power from an Overhead Electrification (OHE), which transfers 25KV traction power from a stationary traction supply system to the rolling stock through a pantograph installed on the trains. The OHE comprises of a feeding contact line, overhead wires and supporting arrangements such as cantilevers, insulators and tensioning devices.

For the MAHSR corridor, the OHE system will be similar to the one used in Japanese Shinkansen lines, suitable up to maximum speeds of 320 km/h for the main line. An automatic switched neutral section would be provided, so that there is no need for the driver of the train to operate train mounted circuit breakers while the train moves between two different kinds of power supplies, thus eliminating driver fatigue and potential manual errors.

Best Practices in Energy Efficiency

Various energy efficiency and conservation initiatives, best practices have been included in MAHSR specifications which would result in energy savings, better environment quality, financial security and higher savings at stations, depots, OCC and utility buildings.

These include features such as Smart Energy Metering System, Variable Refrigerant Flow System, Heat Recovery Systems, Variable Frequency Drives in various kinds of equipment, Lighting Control System etc. Apart from the above, various guidelines of Energy Conservation Building Code and National Building Code related to comfort, lighting, controls etc will also be followed.

COMMUNICATION IS KEY

The basic difference between a HSR system and conventional railways is speed, and every system installed needs to respond very quickly to ensure overall safety of passengers, employees and installations.

When trains run at the high speeds, the driver sitting in the train needs to be in constant touch with the control room through a fail-safe and reliable system, which in case of HSR is achieved using a state-of-the-art signalling system and radio system.

> *"The MAHSR project will use the Digital Shinkansen - Automatic Train Control technology, which has been proven to be safest technology for the high speed trains in the world."*

Shri Alok Katiyar
DIRECTOR SYSTEM & ELECTRICAL

In Europe, the vital communication on HSR systems happens over the radio. But for MAHSR, very well proven technology – track to train transmission – is used. In this, the train control information is passed to the train through the track. Since the train and trackside are always in contact with one another through track circuit and radio system, the probability of loss of communication gets reduced to a large extent. In the proposed high-speed network for MAHSR corridor, train protection system through DS-ATC is unique in its own way and displays one of the best safety performances in the world.

To make this communication system reliable, a fall back system is provided using a leaky coaxial cable on both sides along the track. The cable is laid by the both sides of the track.

For safety, the system ensures that the trains don't exceed the permissible running speed at any time. If the driver goes over it, a warning is issued and within a few seconds, the equipment takes over to reduce the speed of the train automatically.

This ensures that the chances of collision between two consecutive trains running on the system is almost reduced to nil. Similarly, the speed is also controlled at curves when the train speeds need to be lowered for safety. These locations are automatically stored in the system and warnings are automatically issued to the drivers to lower the speed.

> *"For the first time in India, the MAHSR corridor will use a gas-filled cable for transmission of vital information to reduce downtime caused by damage to cables."*

Shri Alok Katiyar
DIRECTOR SYSTEM & ELECTRICAL

An intricate network of connectivity is established on the entire HSR line. Every station has a Station Equipment Room (SER), which connects it to the tracks and other intermediate SERs for effective communication between the tracks and the trains. All the SERs are connected to the OCC so that the entire working of the system can be monitored and controlled from a centralised location.

Telecommunications

A HSR network has its own internal network of telecommunications, using their own optical fibre network. This includes:

- A dedicated telephone system that connects all the offices on the line
- A wireless communication link between drivers on every train and OCC
- A portable mobile phone for every worker on the field to alert them about an incoming train
- Yard radio systems for communication in depots
- CCTVs, centralised clock system and call recording systems

JAPANESE SIMPLICITY

The Japanese known for their simplicity and clutter-free approach which has found its way into our HSR system. The cab displays is one of the simplest in the world- the driver can see very few elements, such as the permissible speed of the train and the actual speed that the train is running at. This is a different design from the European train screens, which have several other controls and displays in the driver's display.

CATCHING THE **NERVE**

The nerve centre of the main train line is the Operation Control Centre (OCC). It is from here that the train operations and services of the entire MAHSR line will be planned, executed, monitored, evaluated, recorded, analysed and influenced. At the OCC, officials can see the running of the entire system, including the movement and exact location of all the operational trains and all systems associated with the effective running of the HSR system in real time. The OCC for the MAHSR project will be located at Sabarmati.

Any problem on the system – in signalling or track or due to any weather calamity – will be instantly visible on a screen in the OCC enabling quick redressal and correction.

All the trains will be serviced and cleaned following a meticulous maintenance plan comprising of daily, monthly and annual inspections of trains and installations to ensure safe and smooth operations and to enhance the life of the rolling stock. This will be done at Maintenance Depots which will come up at Thane, Surat and Sabarmati.

These state-of-the-art depots will be equipped with all modern facilities and robust Information Technology (IT) systems required for the upkeep of trains and all other installations that make the high-speed system work and have been designed keeping in mind the requirements and train loads right up to 2053 when the system is expected to run at full capacity.

The MAHSR corridor will be serviced by 3 depots, located at Sabarmati and Surat in Gujarat and Thane in Maharashtra. The largest of these is the Sabarmati Depot, which has the capacity to hold all of MAHSR's 1,136 cars for overhaul.

MOBILITY **FOR ALL**

The MAHSR line is an inclusive set-up that is equipped with a host of facilities to make facilitate its use by Passengers with Limited Mobility (PLM) and the elderly. Every train will have special seats and dedicated toilets for PLM and have been designed to allow for entry and exit of self-propelled wheelchairs. Escalators and lifts will be wheelchair-friendly and located in a manner that passengers can board the trains easily.

The entire infrastructure has been designed to meet their needs and requirements. An integrated element are braille signages and tactile flooring for visually impaired passengers, which will help them find their way around the station buildings, platforms and trains.

Special ramps and parking lots will be created for those with limited mobility, who will also have access to special assistance from staff at stations to ensure that their journey is comfortable and hassle-free. Provision is also being made to offer assistance to elderly passengers travelling on the HSR system alone.

CAPITAL MATTERS

The MAHSR project is coming up at an estimated cost of INR 1,08,000 crore (USD 17 billion), which will be executed with Official Development Assistance (ODA) Loan assistance from JICA. For implementation of the project, a government to government cooperation agreement was formed between India and Japan to bring the Shinkansen technology to India and was signed in December 2015. An amount of umbrella funding was allocated in the diplomatic exchanges that followed, with the understanding that loans will be disbursed as and when the amounts are required with the signing of individual loan agreements.

In overall capital structure, 81 per cent will be funded from Government of Japan and remaining will be funded by Government of India (GoI). According to the equity structure of SPV, 50 per cent is held by the GoI through the Ministry of Railways, and 25 per cent each by the Government of Maharashtra and the Government of Gujarat.

The MAHSR project is one of JICA's marquee projects as it accounts for nearly 50 per cent of their portfolio in India, even though they are heavily invested in the country. The loan conditions for the MAHSR are very attractive. It is a 50-year loan at 0.1 per cent, a rate that normally does not appear in JICA's portfolio. This includes 15 years of loan repayment moratorium, and then 35 years of loan repayment with interest. It is a concessional rate offered to India for the HSR project after a special approval from the Japanese Cabinet.

So far, NHSRCL has signed several loan agreements and many contracts have been awarded for the MAHSR corridor including one of south east Asia's biggest infrastructure contracts.

The funding has certain conditions, which are clearly mentioned in the government to government exchange. The loan is only for construction expenditure of the project, and not for land acquisition, rehabilitation or resettlement expenses, taxes, utility diversions, etc. All of these are to be funded from equity or by other means.

Avenues of Revenue

No mass transportation project of this scale can be viable just by fare. This is the first HSR project in India and there is no precedence, but references can be drawn from Japanese railway companies and also from Delhi Metro in India.

The MAHSR line is not just a mass transportation project. It is an urban development project where the stakeholders are many. Countries like Japan have imaginary concentric circles to define prime catchment areas, municipal areas, industrial areas where development emanates around the HSR stations that come up. India will also be looking to introduce something along those lines.

> *"To generate non-fare revenues, NHSRCL plans to develop three stations – Sabarmati Vadodara and Surat – for real estate development. The Sabarmati Transit Hub is nearing completion and efforts are being made to monetise the world class building."*

Shri Vivek Tripathi
DIRECTOR FINANCE

To generate non-fare revenues, NHSRCL plans to develop three stations – Sabarmati, Vadodara and Surat – for real estate development. Secondly, they will engage with municipal authorities and develop the area around the stations. This results in an increase terminal, in land prices and revenues for governments. The world over, it has been seen that revenue increases range from 0.5X to 6X with the development of HSR lines.

The Sabarmati Terminal building, where three modes of transport will integrate, will have 13 floors which will be leased as part of property development. Other avenues being explored include advertising, leasing of space to corporates and individuals, among others.

Finance for Land Acquisition

To make way for construction of the MAHSR corridor, NHSRCL needs to acquire nearly 1,400 hectares of land in state of Gujarat and Maharashtra and Union Territory of Dadra and Nagar Haveli which is classified under four broad heads- private, government, railway and forest land. Land acquisition also includes resettlement and rehabilitation of the Project Affected Families. For the MAHSR project, the complexity of this issue is very high. There are more than 4,000 families that need to be resettled across 2 states, 1 union territory, 12 districts and around 1,400 hectares of land.

If one were to compare this to another project of this scale, say the construction of an international airport at Jewar, the number of villages impacted is just 8 compared to 297 in the MAHSR project. All of the affected families need to be given compensation, or requisite accommodation, which is calculated based on an entitlement matrix to make the process completely transparent.

NHSRCL is following the Competent Authority of Land Acquisition (CALA) system where the State government has been entrusted the power to acquire the land and NHSRCL is only the paying authority.

Land is being acquired through RFCTLARR Act, 2013. Earlier, in Maharashtra land acquisition was done through direct purchase method as per Government Resolution. Later on, the land acquisition was done through regular method i.e. RFCTLARR Act, 2013.

A tripartite arrangement has been created for efficient pay out of compensation amounts to thousands of beneficiaries from whom land will be acquired for the project. Three bank clusters have been selected to disburse payments – ICICI, HDFC and SBI – and for each cluster, an estimate has been prepared based on which funds are transferred to Land Acquisition Officers (LAOs). The LAOs in turn pay the required amounts to beneficiaries. The entire transaction is completed in one day, and NHSRCL gets a statement of all the payments made at the end of each day.

Chapter 5

A RIDE WITH TWISTS AND TURNS

A project of this magnitude that spreads across two Indian states with diverse cultures and governance systems has thrown up a host of challenges for NHSRCL along the way.

Challenge 1: Land Acquisition

Carving out a 508 km-long dedicated high-speed link that traverses through major cities in the states of Maharashtra and Gujarat was not an easy task. To create space for construction and running of the corridor, NHSRCL needed to acquire land that fell on the proposed alignment. In case of high-speed corridors, the path of the track cannot be significantly altered as any sharp curves on the route are undesirable. So, getting the exact patches of land as earmarked in the alignment study was important. A total land requirement of about 1390 hectares was earmarked for the line, of which about 430 hectares was in Maharashtra and another 960 hectares in Gujarat and DNH.

> *"An elevated viaduct minimises the need for extensive land acquisition and reduces the overall environmental impact of the project."*
>
> **Shri Anjum Pervez**
> **DIRECTOR PROJECTS**

The primary challenge with land acquisition is the resistance faced from people. Making the land users understand how they will be benefited from this process of land acquisition is a very important factor. The amount of compensation is also important as is the trust that they are going to get the money promised to them. For land acquired by NHSRCL, the compensation was to be paid in accordance with the land acquisition act, which works out to four times the market rate in rural areas and twice the market rate in urban areas.

NHSRCL followed a process of acquisition through the land act of the State government, which provided for an option of extra incentive over and above what is specified in the land act to encourage land acquisition by consent. Complete transparency was followed for the entire process. When NHSRCL finalised the entitlement matrix, they gave people examples of how the compensation is going to be calculated.

Joint Measurement Survey at Boisar HSR station site

In Gujarat, where land was to be acquired in 8 districts namely Ahmedabad, Kheda, Anand, Vadodara, Bharuch, Surat, Navsari and Valsad, a decision was taken to adopt

the Gujarat Amendment Act, there was a provision of consent where land owners were entitled to 25 per cent extra compensation. On ground, the first step towards this is a census survey to get details about the affected families and their monthly household incomes.

A Social Impact Assessment (SIA) study is mandatory to publish a notification in the newspaper for a field survey. And, for the notification, you have to have details of the land owners, which you cannot do unless you go to the field. Gujarat enacted an amendment wherein they exempted SIA for linear projects, and NHSRCL was able to issue a notification after carrying out preliminary field surveys.

After the notification is issued, a detailed field survey is carried out wherein a central line is marked to get the exact details of land that needs to be acquired. The accuracy level is 70 per cent after the desk study in the notification stage, which increases to 95 per cent correct after the central line is marked and the details are transferred on to a revenue map. A 100 per cent accuracy comes only after a joint measurement survey is carried out.

Once the details of the land owners were ready for the state of Gujarat, consent camps were organised at the district level to disseminate information about the compensation. To build greater trust, they were given 80 per cent of the compensation with 3-4 days of signing the consent agreement. This had a cascading effect on consents, where more and more people started coming forward.

At these camps, district officials also came and updated the revenue records, which also accelerated the process.

Land from Utiyadara and Diva Villages

About 6.2 km of the NHSRCL corridor alignment passes through two villages in Bharuch district, namely Diva and Utiyadara. After the compensation was worked out and shared with the villagers, they were not happy with the amount being offered to them in lieu of their land.

The matter was escalated to the District administration, as the delay in possession was affecting the start of construction of the line. The villagers filed an application with the District Collector for enhancement of rates, who forwarded the case under section 64 of RFCTLARR Act 2013 to the Presiding Officer (Land Acquisition Authority). Finally, the Government of Gujarat intervened and the contractor was granted access to the land to start the civil work in May 2023. The issue pertaining to revision of rates is still under hearing with the Presiding Officer.

Navsari Posed a Unique Challenge

In Navsari district of Gujarat, the land owners wanted parity in compensation as they felt that the compensation amount in the adjacent district was much higher. The Gujarat government stepped in to proactively revise the rates and finally, the land acquisition in this area became the fastest in the entire state. In a span of two and a half months, 80 per cent of the land has been acquired.

In the State of Maharashtra, about 430 acres of land was needed across three districts – Palghar, Thane and Mumbai (sub-urban). In 2018, Maharashtra enacted an amendment to their Land Act, making it similar to Gujarat.

Winning a Legal Battle

A piece of land owned by an industrial house in Vikhroli, Mumbai also fell on the route of the Mumbai – Ahmedabad corridor. This land was needed to create a shaft for a Tunnel Boring Machine to be moved underground, and another ventilation shaft for the same line. Challenging the land acquisition proposal, the industrial house filed a writ petition in the Hon'ble High Court in 2017 and offered alternate land to NHSRCL in lieu of the land notified for acquisition. Since the land was needed to lower a TBM and for a shaft, the location had scope for a little deviation. Therefore, NHCRCL accepted the alternate land, revised the plans for the shaft and had these approved by the teams from Japan to finalise the alignment. Under direct purchase, a compensation amount of INR 572 crore was agreed upon. But, in the meantime, it was learnt that the plot is under an ownership dispute between the State of Maharashtra and industrial house.

As the case was still pending in the High Court, consent was sought from the industrial house for the return of the compensation amount with interest in the event of the title suit being decided against them. But, did not agree to this. After several hearings and arguments, the case finally went to the Hon'ble Supreme Court, which dismissed the petition right on the day of the first hearing on February 24, 2023. The possession of the land pocket was taken by NHSRCL.

Palghar Concerns

In Maharashtra's Palghar district, NHSRCL faced a lot of trouble with acquiring land. There was resistance from local forces, who oppose new projects coming up in the area even though they are not the real land owners who will be affected by the land acquisition process.

Another big issue was Gola land, which is land with multiple owners, the numbers for which can go as high as 90 people for the same piece of land. Palghar district has a sizeable number of such Gola land plots, where finding the correct recipient of the compensation is proving to be a challenge.

NHSRCL also ran into problems with adhivasi land where the owner of the land was not the person using it. There were tillers whose livelihood depended on that piece of land so they also needed to be compensated. But the problem was how to identify the tiller in the absence of proper government records. NHSRCL has reached out to gram panchayats to find out the tillers.

This was not all. There was an issue with forest land. This land belonged to the government but was occupied by tribals. In such cases, consent from the gram panchayats is required as the livelihood of these tribals depends on the forest – be it for the food, wood, etc.

An Underground HSR Station in Congested BKC

The starting station of the HSR line was planned at Mumbai's Bandra Kurla Complex (BKC) where about 4.84 hectares of land was earmarked for the HSR station and another 0.81 hectares of temporary land to facilitate its construction. Since the piece of land which has been identified was situated right in the heart of the city of Mumbai where space comes at a premium, getting possession of the land proved to be a major challenge for NHSRCL. Subsequently, NHSRCL revised the land requirement to 4.84 hectares and MMRDA finally granted possession so that the construction of the line could finally begin. Interestingly, the BKC station has been designed in such a way that a 30 storey building can be constructed over it.

Challenge 2: Mapping of Utilities and their Diversion to Clear Way for Construction of the MAHSR Corridor

Both the states that the MAHSR corridor passes through fare high on the development index and have widespread economic activities. To power this growth and development is a dense network of utilities such as electrical lines, telecom and fibre networks, water pipes, sewerage connections, etc. Many of these utilities can fall on the alignment of the upcoming high-speed corridor, and need to be shifted to make way for construction activities and the smooth running of train operations at a later date.

While some of the utilities are easy to spot, many are not visible on ground or over the ground. Another challenge was put up by the utilities in the railway area which have a direct bearing on the existing train operations of Indian Railways and carry a safety risk with it as well. The only way to map them is by identifying all the utility owners operating in that area and using tools such as ground penetration radars to carry out joint surveys. Once the coordinates for each of the utilities are known, these are marked on the alignment to identify the ones which will infringe the Right of Way (RoW) for construction and need to be relocated for unhindered civil construction works.

In the MAHSR corridor, all the utilities which infringe the RoW either need to be shifted underground or raised to a substantial height so as to ensure that they do not interfere with the construction or running of the high-speed line. The height of the deck itself is planned at 10-12 metres, above which lie the overhead electrical lines. During construction, girder launching machines working also require a minimum height clearance to ensure safety. Due to this, a very special design of tower has been used to cross the Extra High Tension (EHT) lines across the MAHSR corridors. There are about 1,650 electrical utilities needed to be shifted too. This number would have been much lower had the construction and operations of the line not been at such a height. Further, mapping tower footings in an area which is highly developed and has very little space availability posed a real challenge.

> *"The MAHSR corridor is spread across a vast area where a survey of the entire ROW would have taken 12 months. With the use of LiDAR, we were able to bring this down to just 3 months, without compromising on accuracy."*

Shri Anjum Pervez
DIRECTOR PROJECTS

The magnitude of the issue is very unique in this project as compared to other railways projects. Conventional railway lines pass through a combination of greenfield and brownfield areas and therefore the number of utilities to be shifted is not that many. However as the MAHSR corridor passes through industrially and commercially developed States of Maharashtra and Gujarat, this number is very high. As a comparison, in dedicated freight corridors, where there is a requirement of about one utility relocation per kilometre, this number already stands at more than 5 utilities per kilometre for MAHSR corridor, excluding 21 km of tunnels. The overall utilities which have been identified are over 5,000 taking this number to over 11 utilities per km.

The numbers are much higher even compared to Metro lines due to the sheer length of the corridor. The length of an average Metro line is about 25-30 km. The entire network of Delhi Metro is about 300 km, which has been constructed in phases, which is about half the length of the MAHSR corridor. Also, Metro projects come up in city areas where carrying out foot mapping is simpler. Train corridors pass through areas like hills, dense forests where accessibility can be a challenge. Various new techniques such as LIDAR and aerial surveys were employed to overcome such challenges. In order to speed up the process, NHSRCL has deployed several technologies, including Ground Penetrating Radar (GPR) surveys which sense the presence of a metallic object under the ground. The details thus collected are verified with the agencies and the utilities identified.

Linear infrastructure projects or other bigger projects involving substantial land use have always faced big challenges in timely clearances of utilities without any major impact on the civil construction works. With the use of new technologies in mapping of the utilities and timely and pro-active action, NHSRCL has succeeded in relocation of all the utilities in a timely manner without any impact on civil construction works. This is a remarkable feat in the light of the sheer magnitude of the project. It demonstrated that expected progress in the projects can be achieved if the land acquisition and utility relocation activities are meticulously done by the project proponents. MAHSR has been able to demonstrate same.

High-tension power cables and towers were shifted in order to make way for MAHSR corridor

Use of LiDAR

Time is a critical factor for a project of this scale and magnitude. For construction activity to start on the MAHSR corridor, NHSRCL first needed the exact RoW of the entire stretch in order to finalise the actual path of construction on ground. The project is spread across 508 km over mixed terrain, which includes highly populated areas like Mumbai, Ahmedabad and Vadodara, ghaat sections, creeks, where it can be difficult to carry out foot surveys by physically entering the areas. After evaluating several options, the MAHSR project is the first railway project in the country to make use of aerial LiDAR survey to finalise the exact RoW. Here, a helicopter – fitted with special aerial LiDAR sensors, a camera, an Inertial Measurement Unit (IMU), a GPS and a computer – is flown over the route to scan it in detail.

For NHSRCL, the use of LiDAR has resulted in major saving of both time and resources, without compromising on accuracy. LiDAR has reported very high levels of accuracy as there is no manual intervention in the process and also provides data below vegetation and forest cover. Overall, the total survey time was just 3 months, which would have otherwise taken 12 months using other means.

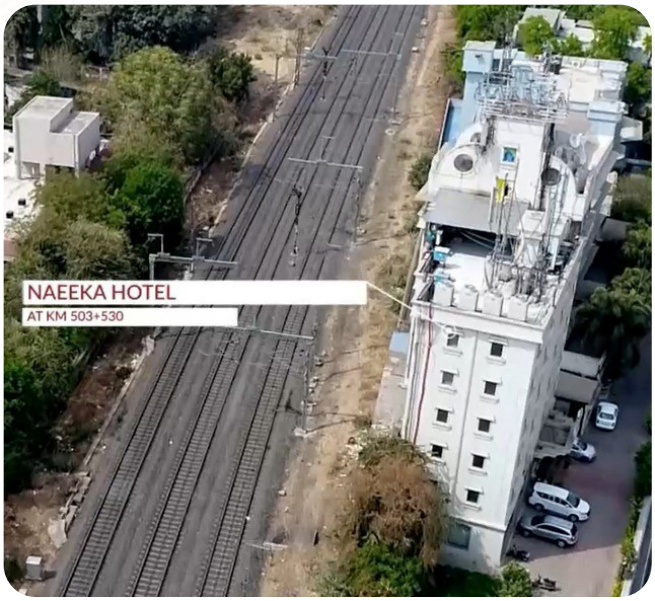
Relocation of Oil Wells

Five ONGC oil wells located in Nandej, about 15 km from Ahmedabad, which are very close to the alignment had to be relocated in compliance with a code of practice as per which a railway line cannot exist within a 50 metre radius of a functional oil well for reasons of safety. NHSRCL went ahead with the capping of these oil wells and coordinated with ONGC to relocate them.

A lot of heavy machinery was used in the process to ensure that the capping is done properly, so that there is no eventuality in the event that the capping comes off. The marathon process from identifying the wells to their capping took about 1.5 years and the work has been successfully completed.

Dismantling a Seven-storey Hotel

It was not just utilities falling on the path of the MAHSR corridor that were posing as obstacles in construction. A seven-storeyed hotel with 32 rooms, located in Shahibaugh area of Ahmedabad was infringing upon the land earmarked for the high-speed rail link to come up. Called Naeeka Hotel, this piece of land was considered to be “prime property” and therefore the owner was hesitant to give the land up to make way for the project. After a detailed assessment of compensation costs carried out by an expert body, which took into account factors such as the cost of the structure, fixtures, employee payments during idle times, interest on loan, transportation costs, etc,



Before Dismantling

After Dismantling

NHSRCL held multiple meetings with the owners of the hotel to make them agree to give up the land. As per the condition of the impact assessment report, the hotel owner was given sufficient time (a period of 8 months) to vacate the hotel premises and hand over the encumbrance-free land to NHSRCL. After getting the land, dismantling the hotel building posed another challenge as it was situated right in the heart of the city, in close proximity to an operational Indian Railways track, a school building, a public road and an under bridge. Under close supervision of NHSRCL, the hotel was dismantled safely within the prescribed time limit without causing disruption to any of the surrounding installations.

Shifting of Graves

A 125-year-old graveyard with more than 1,000 graves was located right in the middle of the proposed alignment of the MAHSR corridor at Tham village of Baruch district. Of these, about 130 graves along with a Mazar needed to be relocated to make way for the upcoming corridor. As per revenue records, this land was notified as Government land, but the Tham Graveyard committee and villagers were not agreeing to surrender it. NHSRCL teams met with them to convince them, but instead, the villagers filed a case against the state government, NHSRCL and

the District Collector with the Waqf Board Tribunal Gandhinagar, Gujarat. The hearings for this case carried on for one year, after which NHSRCL was ordered to change the alignment of the corridor as part of a verdict by the Waqf Board.

NHSRCL challenged the verdict in the Hon'ble High Court of Gujarat, and the court directed that the possession of land should be given to NHSRCL for the project and compensation be given as per prevailing norm to shift the graves. Subsequently, NHSRCL paid compensation and a total 130 graves with adequate provision were shifted outside the RoW.

Challenge 3: Saving the Environment

Large-scale infrastructure projects mark growth and progress for the cities that they touch. But, sometimes, the construction and commissioning can cause damage to the environment. In case of the MAHSR corridor, special efforts have been made to ensure that some of the ecological hotspots for wildlife in north-western Maharashtra – Sanjay Gandhi National Park (SGNP), Tungareshwar Wildlife Sanctuary (TWS) – which the alignment for the high-speed train touches, are not adversely impacted due to this project. The proposed alignment of the MAHSR corridor passes through many Greenfield areas, where a lot of trees needed to be removed/ relocated to make way for the construction of the high-speed line, for which NHSRCL has opted for relocation so that the flora and fauna of the region can be preserved.

Tree Transplantation

Thousands of trees were saved as a voluntary initiative by NHSRCL – a massive tree transplantation drive, wherein NHSRCL extensively explored the option of tree transplantation instead of extensive removal of the trees for MAHSR project alignments. Tree transplantation is the process of unearthing the trees along with root ball and replanting them from their old locations to new locations with the objective of re-growing the trees.

Typically, the process of transplantation is considered to be successful when the tree survives and regains its normal patterns of shoot and root growth, without any significant impact on its future growth potential and life expectancy. In fact, NHSRCL has done a lot of tree plantation work to compensate for the impact of trees removed from the MAHSR alignment, especially in Vadodara, Anand and Kheda districts of Gujarat. Almost 6,000 trees were transplanted of which about 1,400 survived, which is a survival rate of 24 per cent.

A large number of trees were saved using the innovative tree spade technique, in addition to the mandatory plantation which was done for the number of trees being affected by the project. The tree transplantation is done in a ratio of 1:10 in municipal areas, 1:5 in mangroves and 1:2 for other trees. The transplantation is over and above that, for which there is no legal binding on the part of NHSRCL.

Current image of Tree Transplantation carried out in Talavadi Village in Kheda District, Gujarat

Tree transplantation process in Vadodara district, Gujarat

Animal Corridor

Due to its proximity to Mumbai, this area has been selected for three major infrastructure projects coming up in the region – the MAHSR corridor, the Diva-Panvel railway line, a DFCCIL track and a future expressway planned by MMRDA – all on a 100 metre path between SGNP and TWS.

Graphical representation of Wildlife Animal Corridor

Even as the development is good news for those living in cities surrounding this area, the large-scale construction would cause a major dislocation to wildlife. After several rounds of deliberation between the various stakeholders, a decision was taken to create an animal corridor – with an underpass and overpass – which will offer a smooth passage for movement of wildlife in the affected areas.

The overpass, with a width of 30 metres, will come up over the existing Diva-Vasai Line, proposed DFCCIL line and PWD road and will be below the MAHSR line and MMC viaduct. Its design will match the natural vegetation of the surrounding areas, and elements like rocks, logs and water bodies will be added to make the animals feel at home.

Restrictions will be imposed on the use of heavy lighting in the area and high-quality noise barriers will be erected so as to ensure that the levels stay within safe ambient limits for the animals.

Saving the Local Ecology

The alignment of the MAHSR corridor moves underground in the area of a Flamingo Sanctuary. Here, naturalists were of the opinion that the tunnelling process which will be used to construct the tunnel for the high-speed train line will cause vibrations. This process, in turn, would cause the mud flat in the area to settle down.

Flamingos feed on fish that thrive in this mud flat and, therefore, any changes would affect their food flow, forcing the birds to migrate to other areas. In a proactive move, NHSRCL got a study conducted for the same, in which it was concluded that the vibrations would be much below the safe limits. The report was submitted to the Wildlife Board and has been accepted.

NHSRCL, on their part, were earlier considering the New Austrian Tunnel Method (NATM) to construct the tunnel as it saves cost. But, that method requires access to the underground through shafts, which were not possible to create in this area. So, a decision was taken to modify the method of construction to Tunnel Boring Machine (TBM).

NHSRCL also carried out a physical counting of the number of mangroves which will be needed to be cut in the Mumbai area to make way for construction, for which a special permission is required from the High Court which has stayed all cutting of mangroves in the Mumbai area.

For every mangrove that is affected, NHSRCL has deposited money in the ratio of 1:5 towards compensatory afforestation. So, even though the affected mangroves are around 22,000, around 1,60,000 new mangroves will be planted and the expense will be borne by NHSRCL.

Challenge 4: Integration of HSR with Indian Railways

The new high-speed railway link that is coming up needs to be integrated with other existing modes of transportation to make it a success and offer end-to-end connectivity to people living in the area. Of this, one of the most important modes is Indian Railways as it connects the length and breadth of the country through its vast network.

> *"The high-speed railway network is being integrated with Indian Railways to offer end to end connectivity to people using it. The MAHSR corridor will offer this integration at Vadodara, Ahmedabad and Sabarmati HSR stations, even though this was very complex to plan."*

Shri Rajendra Prasad
MANAGING DIRECTOR

Three stops on the MAHSR corridor, namely Vadodara HSR, Ahmedabad HSR and Sabarmati HSR, will integrate this high-speed line to Indian railways and offer a means for easy transfer between the two systems. In the feasibility report of 2015, when the initial survey for alignment of the MAHSR line was carried out, an attempt was made to bring the HSR station as close to the city centre as possible in major cities like Vadodara, Ahmedabad and Sabarmati so that more and more people can use the system.

Vadodara HSR Station

In Vadodara, the HSR station was brought in the vicinity of the Indian Railways station to enable Multi Modal Integration. But, this alignment proved to be a major challenge for NHSRCL for a variety of reasons.

Firstly, the HSR alignment was designed to cross the yard from east to west, over almost 13 lines. The spans of steel bridges proposed to make this crossover were 100 m + 220 m + 120 m, which is higher than what has ever been constructed for a Japanese Shinkansen high-speed network. About 25,000 MT of steel would have been required for the bridge construction.

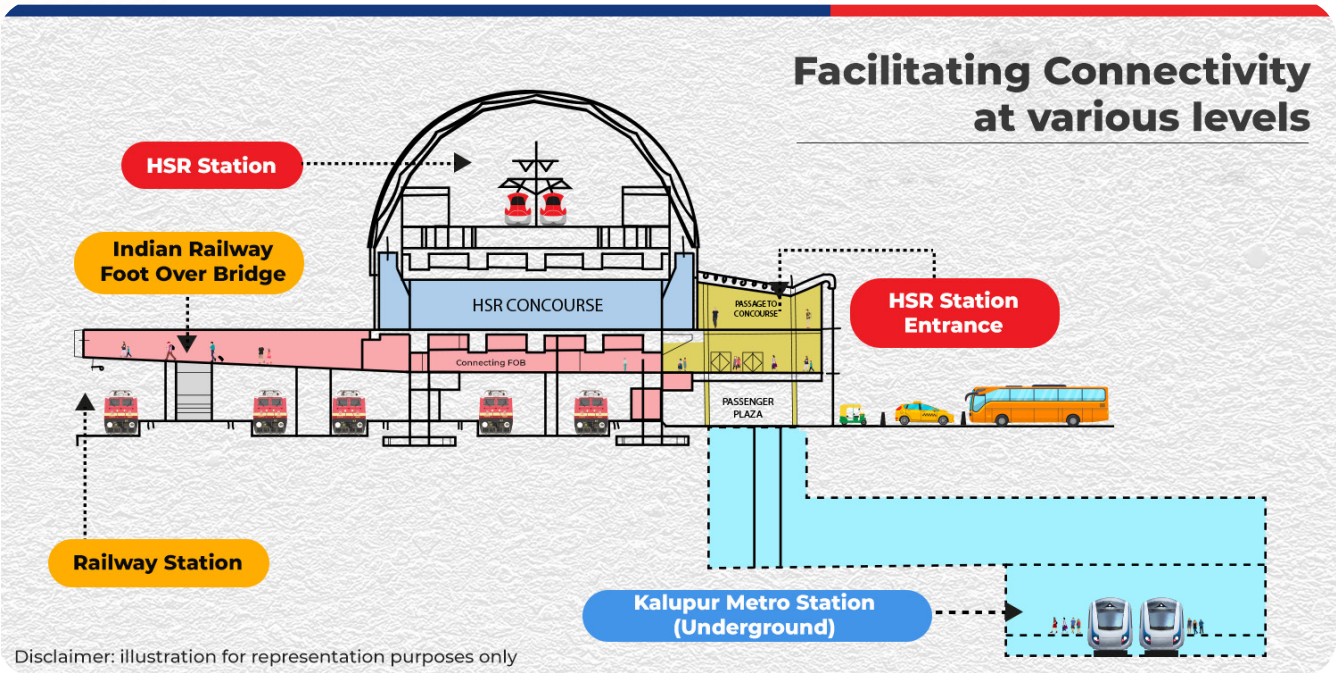
To enable this construction, the process of launching a temporary girder over the main lines and rotating, with trains running underneath, would have been a major challenge. Moreover, the estimated time for fabrication of the steel girder and launching was 66 months, a delay the project timelines didn't allow. The site of construction also fell in the flight paths of aircrafts at the Vadodara airport, due to which an air space clearance was mandatory from Airport Authority of India. The permission was denied as the launching of girders required the airspace to remain closed.

After several rounds of discussion, the alignment of the line for a distance of about 4.3 km in this section was changed to cross the tracks ahead of the railway yard. By doing this, the HSR alignment crossed the Indian Railways tracks with ordinary spans of 40 m on portal piers.

This change resulted in time savings, considerable reduction in designing time and financial savings of about INR 2,000 crore. The new station location thus found also offered better multi-modal integration as it is now closer to a local bus depot with better road connectivity too. Major displacement of home and commercial units was also averted due to the changed alignment, making it a win-win for all.

Ahmedabad HSR Station

At Ahmedabad, the HSR stationis being built over an existing railway line, above platforms 10, 11 and 12 of the Ahmedabad Junction railway station of Western Railways on the Saraspur side. To ensure seamless integration of the HSR station with other modes of transport, the Ahmedabad HSR Station has been designed by NHSRCL with a user-friendly station layout. As per the plan, an integrated building for passenger transit has been planned on the east side of the existing railway station, where passengers can comfortably switch from one mode to another using a network of escalators and elevators.



The integrated building will also be connected to the main foot overbridge of the Western railways station that will offer access to for passengers coming from platforms 1 to 9. On the other side, the building will be connected to the underground metro station coming up on the Saraspur side.

Keeping in view the large number of passengers that will be using this integrated facility, a detailed traffic management plan is being created around the station to ensure smooth movement of traffic and make integration simple with other modes of transport like buses, taxis, three wheelers, private vehicles etc. As part of the plan, the forecourt of the HSR station will have one-way movement of traffic and there will be separate pick up and drop areas for different modes like two-wheelers, three-wheelers, four-wheelers, buses and cycles. Space has also been earmarked for a mechanised multi-level parking lot which will be connected to the main building with a state-of-the-art sky bridge. Care is being taken to earmark dedicated parking spaces for differently-abled passengers. These will be located close to the station entrance.

To make way for this construction and make the integration possible, NHSRCL has shifted 1,200 km of signalling and telecom cables, multiple offices, foot overbridges, electrical substations, etc of Indian Railways, in addition to various other underground utilities such as water and drainage pipelines, diesel fuel lines, electrical cables, pit lines, etc.

Sabarmati HSR Station

The Sabarmati HSR station forms an important link on the Mumbai – Ahmedabad line as it is the terminal station, and the design will be inspired by the Mahatma Gandhi's charkha at Sabarmati Ashram, which is symbolic of India's struggle for independence.

To find a vast piece of land was not possible in the city, so the HSR station is being planned in a railway yard of the existing Sabarmati railway station, between the broad gauge (east) and meter gauge (west) stations. As per the plan, the HSR station and railway stations are being connected by a foot overbridge so that passengers can easily switch between the two different train platforms.

In fact, the location is being converted into an transport hub for the area and will be called Sabarmati Multimodal Transport Hub, as it will also offer connectivity to a Metro station and a BRTS line, in addition to the high-speed railway line and two railway stations (SBT and SBI-BG).

Challenge 5: Modifying Shinkansen to Suit Indian Conditions

The MAHSR corridor is modelled on Japan's well-established Shinkansen network. While the processes and equipment can be replicated in India, the one thing we cannot alter is our weather and dust conditions, which are very different from that in Japan. So far, the only other country where the Shinkansen technology operates outside of Japan is Taiwan, where weather and environmental conditions are very similar to Japan.

Japan is a relatively dust-free environment with moderate summers and snowy winters. In India, on the contrary, the Gujarat – Maharashtra area sees temperatures soaring to near 50 degrees and very high levels of dust. Temperature, dust and humidity are all hazardous for expensive HSR installations. So, can this technology be made suitable for India's extreme weather and dusty environment? NHSRCL commissioned a technical preliminary study to the HKC Consortium, Japan with a special focus on the rolling stock.

> *"NHSRCL commissioned a technical preliminary study to the HKC Consortium, Japan with a special focus on the rolling stock to see what changes are required to suit Indian conditions. The study found that certain modifications needed to be done to meet our requirements."*
>
> **Shri Sandeep Srivastava**
> **DIRECTOR ROLLING STOCK**

The study found that certain modifications needed to be done to meet our requirements. For instance, the Heating, Ventilation, and Air Conditioning (HVAC) capacity is fine for Indian climatic conditions with a slight change in the current layout. There is a need for increased frequency of filter cleaning to cater to Indian dust conditions. To cope with the higher ambient temperatures in India, some propulsion equipment will need to be increased in size. Additionally, improvements will be made in the insulation of Traction motors. The study concluded that it is feasible to install an obstacle detection system in the doors, which is not available in the Shinkansen trains running in Japan.

While redesigning for higher temperatures, the weight for that equipment increases because more cooling arrangements are needed. And, with an increased weight, the power of the train also needs to be increased to achieve the desired high speeds, which brings down its energy efficiency. Another factor affecting the load on trains is the average weight of the Indian passenger, along with the amount of baggage carried, which is also higher than the average Japanese passenger. A weight calculation study revealed that the weight of MAHSR trains can be kept similar to the Japanese Shinkansen trains, but with a reduced seating capacity. Fortunately, this means no need for alterations in the existing propulsion equipment capacity.

Challenge 6: No Water, No Life!

Sabarmati Rolling Stock Depot is the largest of the three Rolling Stock depots which will cater to the MAHSR corridor and has the capacity to service and overhaul the entire fleet of 1,136 cars that will be pressed into service on the line.

Such a massive facility has an estimated water requirement of about 20 lakh litres per day when the line is running at full capacity. Owing to its location in an area where water is a scarce resource, the depot has been designed with the latest water resource management techniques which ensure that 70 per cent of the depot's daily water requirements are met with water recycled inside the premises.

To make this work, the depot is equipped with a state-of-the-art **rooftop rainwater harvesting system**. It will collect rainwater which will be stored in massive tanks created under the depot building, parking lots, traversers, etc. The water will be treated and used for domestic purposes. The sewage from trains will not be dropped on the tracks but brought to the depot and also treated and recycled in a modern **sewage treatment and effluent treatment plants**.

The storm water flowing on ground, or water that overflows from the rooftops, will be utilised towards recharging the groundwater. For this, **a network of percolation wells** is being created across the depot. This will protect the depot from getting flooded and also recharge the ground water aquifers. The remaining water will flow into landscaped water bodies created within the depot through the same network.

This will protect the depot from getting flooded and also recharge the ground water aquifers. The remaining water will flow into landscaped water bodies created within the depot through the same network.

The entire system has been designed using the most modern techniques available and is in compliance with guidelines of the Central Ground Water Board (CGWB). It ensures complete optimisation of rain water in the depot premises, thereby saving gallons of the precious natural resource.

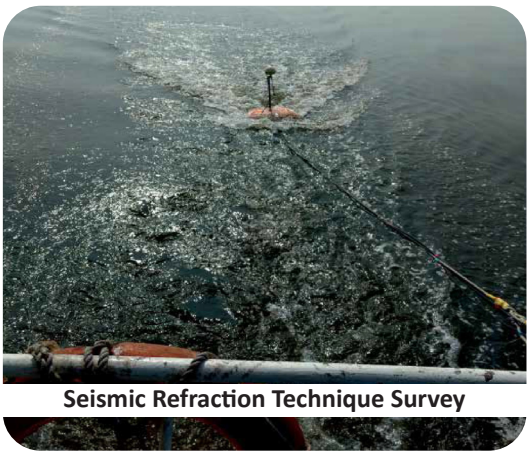
Chapter 6
TECHNOLOGICAL MARVELS

From a tunnel that bores under the Arabian Sea to preserve the ecology in the Thane creek area to a HSR station being constructed over operational Indian Railways tracks which see hundreds of trains pass through every week, the Mumbai – Ahmedabad project has its share of technological marvels which will make us proud. Each of these solutions showcases cutting-edge innovation in engineering design and world-class construction technologies. Though the list is exhaustive, these are some of the highlights.

Undersea Tunnel

The alignment of the MAHSR corridor features a 21 km-long tunnel, a part of which is going to run under the sea bed. This is going to be the first under sea tunnel to come up in the country. The tunnel will start from Mumbai's BKC station and come out at Kalyan Shilphata, of which about 7 km runs under the Thane creek, an ecologically sensitive zone which is home to a wide variety of rare flora and fauna.

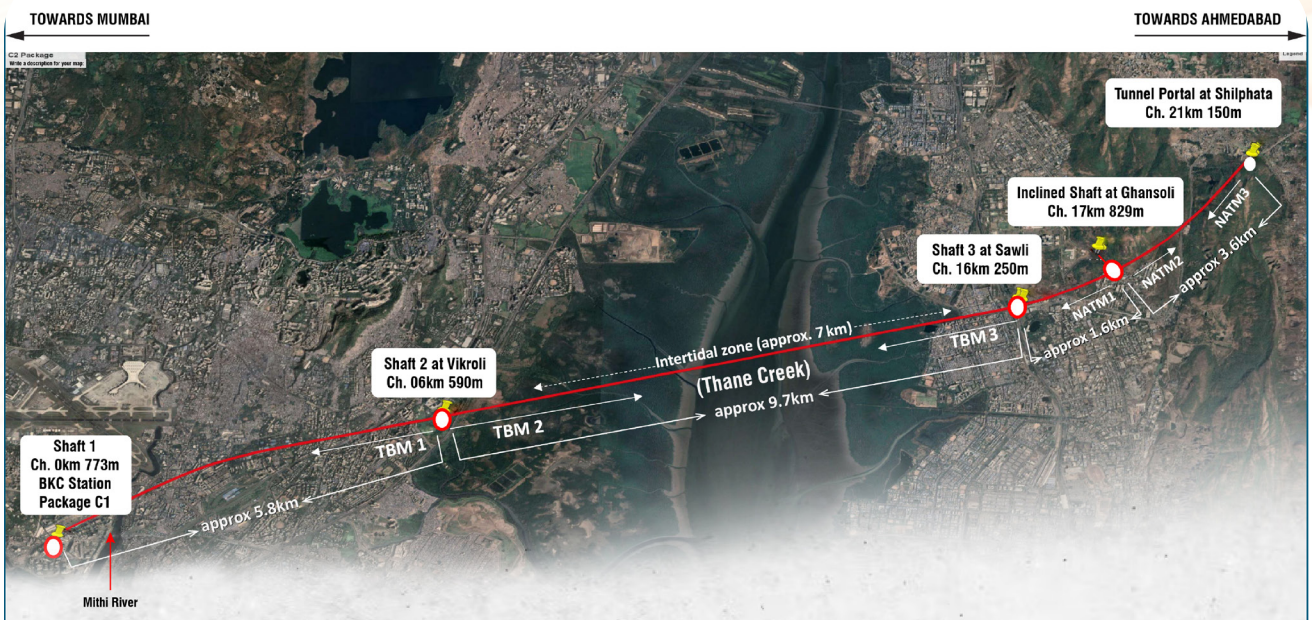
A single tube of 13.1 m diameter will carry both the tracks in the tunnel and the diameter is the largest for any railways project in India, another first. To study the structure of the sea bed, a Static Refraction Technique (SRT) survey was carried out by a team of engineers from NHSRCL, RITES and Japan's Kawasaki Geological Engineering Firm. For this, a high energy sound wave was fired towards the sea bed from below the water surface to help determine the density of rock under the sea bed.

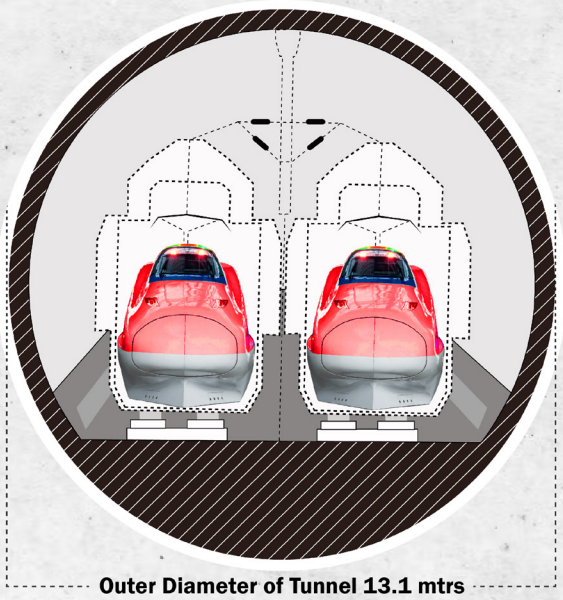


Seismic Refraction Technique Survey

The entire 21-km stretch will be constructed using a combination of two techniques – New Austrian Tunnelling Method (NATM) to carve out 5 km of the tunnel and Tunnel Boring Machine (TBM) for the remaining 16 km.

There was a requirement for creation of equipment rooms at every kilometre inside the tunnels. This is simple to do when the tunnel is being constructed using NATM. But, for the part when TBM will be used, the RC lining of tunnel walls fitted after the tunnel is carved out and will be replaced with a steel lining. This can be later be cut to create space for the equipment rooms. In all, about 39 such equipment rooms will be created along the entire 21 km tunnel.





Outer Diameter of Tunnel 13.1 mtrs

21 km (approx)
Long Tunnel

7 km (approx)
Undersea Tunnel at **Thane Creek**

25 to 65 Meters
Deep from the Ground Level

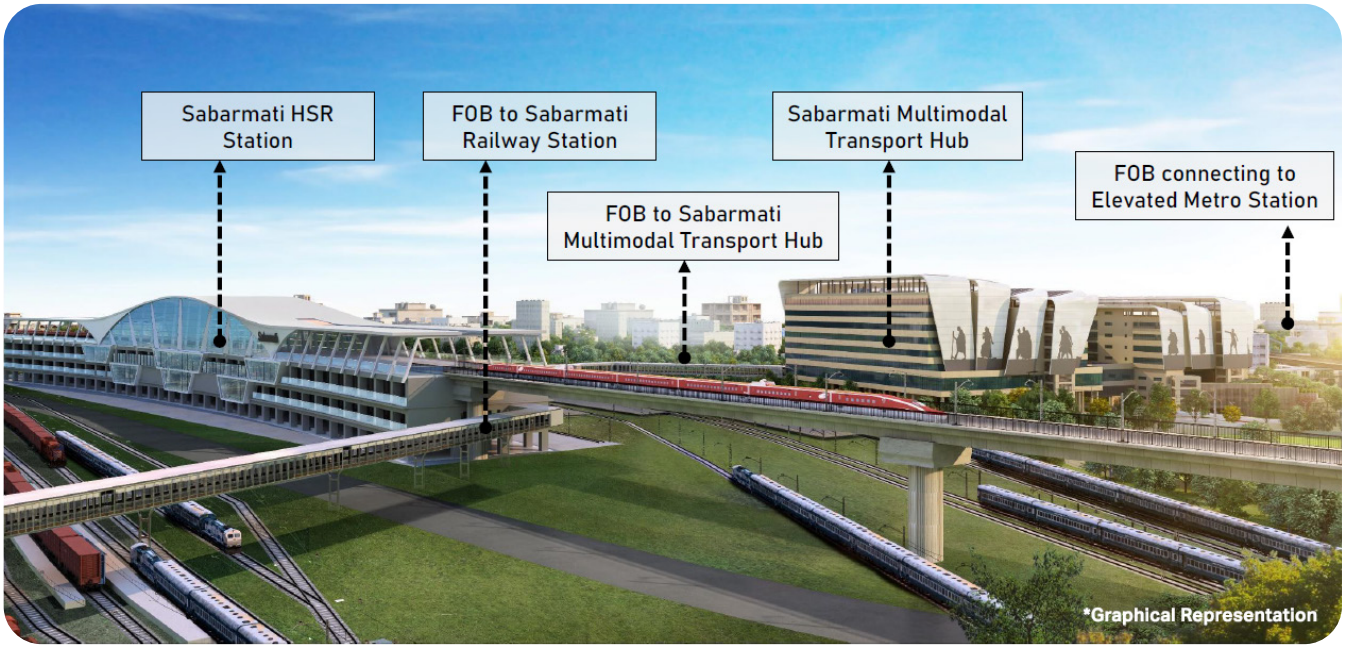
TUNNEL

- Between underground station at Bandra-Kurla Complex and Shilphata in Maharashtra
- 21 km (approx.) long tunnel including 7 km undersea tunnel
- 16 km with 3 Tunnel Boring Machine (TBM) and 5 km with New Austrian Tunneling Method (NATM)
- The tunnel will be a single tube tunnel to accommodate twin track for both-up and down track
- 39 equipment rooms will be constructed at 37 locations
- Tunnel Boring Machine with a cutter head of 13.1 Meter diameter

Sabarmati Transport Hub-An Iconic Structure

In a unique arrangement, the Sabarmati multi-modal transport hub is being developed for the region which will connect the Sabarmati HSR station to two Indian Railway stations (SBI and SBT), a Bus Rapid Transit (BRT) system and two Metro stations, all located within a short walk for easy transfers.

To provide seamless connectivity, three foot overbridges are being constructed in the transport hub. The first one connects the terminal hub building with Sabarmati (Meter Gauge) Railway station on the eastern side, and it will be fitted with travellators for ease of movement. A second foot overbridge will connect the unpaid concourse area of the HSR station to the unpaid concourse of the Metro station and the BRTS station. A third foot overbridge will connect the unpaid concourse of the HSR station with railway platforms of the Sabarmati (Broad Gauge) Railway station.



The facade of this iconic station on the south side displays a large mural made with stainless steel that depicts the iconic Dandi march which lends Sabarmati historical significance in the nation's history. With a total covered area of about 1,33,000 square metres, the hub building is being constructed as a twin structure with space earmarked for offices, commercial development and retail outlets for passengers.

Scan to view Sabarmati Transport Hub walkthrough video
or https://youtu.be/aBwq-KfSnvU

Sabarmati Multimodal Transport Hub

Chapter 7
USHERING A NEW INDIA

A high-speed rail link will act as a catalyst for change for the country and will help redraw the map of India's economic development, thereby creating a strong foundation for future growth.

An infrastructure project of this scale and magnitude will become a magnet of development for the country as a whole. The upcoming HSR systems will offer benefits of connectivity bringing rural and urban economies closer, adding to our technological prowess and creating thousands of employment opportunities.

In this story of development of India, the role of NHSRCL is much more than just facilitating the construction of the high-speed rail line from Mumbai to Ahmedabad.

Make in India

The construction of this iconic railway line will have a strong 'Make in India' component. An integral component of the MAHSR project is Transfer of Technology (ToT) and making India a part of this development story.

As a step towards being atma nirbhar (self-reliant), all the civil construction packages contributing to about 70 per cent of the construction cost are open to Indian contractors. This includes a challenging 21-km tunnel section, of which 7 km lies under the sea.
Furthermore, six train sets to be run on the high-speed line will be partially assembled, commissioned and tested in India itself offering the know-how of the rolling stock. The first 18 high speed train sets will be brought in from Japan.

With Japanese collaboration, and India's quest to place itself on the Global HSR map, one of ToT initiatives entails opening up track construction to Indian contractors. An elaborate facility is being created at Surat for this, wherein the staff from the contractor will undergo training and certification for Shinkansen track technology by experts from Japan.

The idea is to give Indian engineering, technology, construction, manufacturing and other allied industries a much-needed boost, which will place them on the Global map for competence. Indian companies will meet global standards in creation of parts as well as fitting of tracks.

Some of the areas identified for 'Make in India' include:

- Traction & distribution systems (almost the entire set of equipment) which includes various types of transformers, switchgear and protective equipment (circuit breakers, disconnectors, lightning arresters, etc), cables, connectors, ducts
- Battery sets
- Generators
- Overhead equipment poles
- Telecom equipment
- Optical fibre cable
- IP Network
- Wayside protection boxes
- Fasteners for track system
- Depot sleepers
- Track slabs
- Rail turnover prevention device

Innovating for a Brighter Future

Known for its technological prowess, India has all the tools and acumen needed to secure a spot on the Global technology map. To leverage these technical capabilities and offer a one-stop solution to all issues and queries related to HSR systems in the region, NHSRCL set up a HSR Innovation Centre on January 22, 2019.

The centre is tapping the technical capabilities of some of our best minds and develop indigenous capabilities and professional expertise in all aspects of HSR with an aim to provide innovative, indigenous, cost-effective solutions, technical guidance, strategic analysis and advise to the Indian rail transportation industry on significant challenges and opportunities.

It will also contribute towards development of HSR specific standards for India, where the technology is new and we have no precedents or SODs.

The set-up is managed by a Board of Trustees chaired by Managing Director, NHSRCL, supported by the Executive Council and assisted by the Advisory Council, which is entrusted with the task to review the nature of projects that should be undertaken at the Innovation Centre.

This Advisory Council have as members persons of repute from academia and research institutes both from India and overseas, including Indian Institutes of Technology (IITs) at Roorkee, Delhi, Bombay, Gandhinagar, Kharagpur, Advanced Manufacturing Technology Development Centre (AMTDC) of IIT Madras, IISC Bangalore, Ahmedabad Textile Industry's Research Association and University of Tokyo, and Railway Technical Research Institute (RTRI), Japan. The trust will adopt a collaborative approach for funding as well as execution of research projects.

Joining the League of Global HSR Leadership

NHSRCL became affiliate member of UIC on June 30, 2020 and is also de facto member of Asia Pacific region and member of UIC's Intercity and High Speed Committee (ICHSC). This membership is helping NHSRCL gain knowledge about best practices, participation and interaction with several HSR experts in meetings related to finalisation of HSR standards, exposure to available global technologies, construction methodologies, maintenance practices, research and innovation ideas, training opportunities etc.

A Future-ready Workforce

A state-of-the-art centre for advanced training on cutting edge technologies needed for HSR is being constructed at Vadodara, Gujarat. NHSRCL's High Speed Rail Training Institute (HSRTI) will be equipped with the best in class training equipment including simulators, model rooms, slab track, etc to train our HSR staff on use of Shinkansen technologies and processes which will be needed to run the MAHSR corridor.

The training institute will train about 3,500 employees from different specialty areas such as Rolling Stock, Civil and Track Maintenance, Electricals, Signalling and Telecommunications, to equip them with the right skillsets to operate and maintain the upcoming HSR corridor.

The trainings will be based on what is followed at the Shin-Shirakawa Institute in Japan, in order to get the best experience and expertise for the Indian staff.

The institute will have a ballastless slab track and simulators recreated in the campus to offer practical training, which will help bridge the skill gap in the HSR sector and build a pool of resources who are skilled in every aspect of HSR technology. The classrooms will be state-of-the-art too, equipped with internet enabled KYAN interactive projectors, smart boards, LED panels, AV speaker systems and trainee laptops. Training programs will be supplemented with on-the-job training for maximum retention on real HSR projects.

GOING DIGITAL

Keeping up with times, NHSRCL was quick to make the switch to a digital working which also helped during the pandemic, where systems were already in place to make sure that work didn't stop. The execution of the MAHSR project, which is anyway on a tight deadline, continued on full-steam. To enable this, an integrated system was put into place connecting NHSRCL's corporate office with Chief Project Manager (CPM) offices at the project site, Project Management Consultants (PMC), Contractors and also allowing for status reporting via mobile phones. The key areas covered were document and drawing management, scheduling and progress management, contract management, to name a few.

In addition, NHSRCL also executed a MoU with Japan Railway Technical Service (JARTS) in April 2021 under which more than 1,000 engineers and supervisors from NHSRCL were trained in specialised slab track system for track laying in the Japanese Shinkansen system, which is being used on the MAHSR corridor.

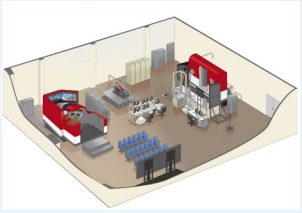
As the civil construction of the Mumbai – Ahmedabad corridor paces up and the line gears up for its Operations and Maintenance (O&M) phase, a need was felt to create a robust O&M infrastructure to ensure the seamless operation of the new line. Towards this, NHSRCL initiated the process of legislating basic manuals and implementation standards for O&M after in-depth discussions with Japanese experts on HSR running.

> *"NHSRCL took a decision to train 360 core staff members about the Shinkansen System in Japan, made possible through a JICA grant. Subsequently, a team of 13 mid-level officials were handpicked to spearhead different O&M initiatives."*

Shri Vivek Tripathi
DIRECTOR FINANCE

NHSRCL has drawn up an extensive On Job Training (OJT) program to enable their staff to understand the complexities of running high-speed rail systems. The KOMLs were sent on a 9 ½-month training program held in Japan in August 2023. Post completion of the training, they will be ready to lead the establishment of O&M organisations, maintenance depots, technology centres, HSR stations, and other important facets for the new line. A dedicated O&M division has also been established to liaison with Japanese experts and develop a comprehensive O&M plan, laying the foundation for the corridor's successful future.

SIMULATOR TRAINING



A crucial cog in the wheel for smooth, efficient and safe operation of the MAHSR line is proper training for drivers, conductors and train staff. For this purpose, NHSRCL will get train set simulators for crew training (Motion driver cabin, motion conductor cabin), and classroom type simulators for driver consoles from Mitsubishi Precision Corporation Ltd (MPC) with the aim of supporting drivers, conductors and other staff to handle real-world scenarios that the trains may encounter more effectively.

The Need for Vigilance

As the organisation grew in size, a full time Chief Vigilance Officer (CVO) was appointed for NHSRCL on September 1, 2021. The main objective of vigilance is to improve system and procedures to eliminate/reduce corruptoin, promote transparency and ease of doing business to enhance efficiency and work culture in NHSRCL. In a bid to bring together all the stakeholders to collectively participate in the fight against corruption, NHSRCL organised various workshops on 'Preventive Vigilance' and 'Ethical Work Culture' to sensitise its employee force. The organisation also celebrates Vigilance Awareness Week (VAW) every year in the week in which the birthday of Sardar Vallabhbhai Patel falls. Various activities relevant to the theme such as workshops, quiz, cyclothons, walkathons, skits, etc. are conducted during Vigilance Awareness Week. A dedicated portal has been created for vigilance complaints tracking and information systems on a real-time basis.

MD/NHSRCL administering integrity pledge to employees on the occasion of Vigilance Awareness Week 2022

"The organisation deals with several high value contracts. Our job is to guide them through all the contact and finalisation processes and introduce industry best practices, wherever possible."

Shri S.K.Mishra
CHIEF VIGILANCE OFFICER

Building a Brand

As NHSRCL is constructing a showcase project for India – its first Bullet Train line, it is important for the organisation to maintain an excellent reputation and brand image towards the successful implementation on a global scale.

The media is considered to be an important source of information about the organisation for its potential customers, stakeholders and employees. Therefore, it is essential that the information shared with the public not only creates awareness about the project but also helps in recognition of the amount of work being done during the execution of the project.

With this objective in mind, NHSRCL always ensures timely dissemination of maximum information through its official website (www.nhsrcl.in) which is available in five languages (English, Hindi, Gujarati, Marathi and Japanese) and through various social media platforms. Such an approach has always helped the organisation to grow at a fast pace and to maintain transparency among the masses. NHSRCL uses all social media platforms like X, Facebook, LinkedIn, Instagram, YouTube, Koo, Blogs etc. to communicate with the target audience. The organisation receives a tremendous response on each and every post that is shared across platforms.

The company also maintains its presence by representing in exhibitions, conferences, trade fairs, organising press tours to our construction sites, conducting various corporate events, producing construction films and videos and many more. As on date, we have more than 2,00,000^{+} active followers on various social media channels who track for regular updates on the project.

A VISUAL IDENTITY FOR NHSRCL

Figure: NHSRCL Logo

A lot of thought went into designing the blue and red logo that NHSRCL is known by today. Its design symbolises the core elements of the high-speed train network that the organisation is known for – speed, technology and connectivity.

The blue element is a graphical representation of a running 'cheetah', which is the fastest animal on the planet. The red element is shaped like an outline of a bullet train, a reflection of the fast speed at which these trains run. The red of the train silhouette is a sneak-peek into the colour of India's bullet train, which will be red too! The 3 grey dots stand for inter-connectivity of this system with other modes of transportation, both existing and upcoming.

When the logo was being conceived, an important facet was youth appeal. A decision was taken to hold an open competition among students of India's top design institutes, including National Institute of Design (NID) and School of Planning and Architecture (SPA). The response was overwhelming.

To select the final design, a three- member committee headed by eminent painter and architect Sh Satish Gujral was formed, which also had members from Niti Aayog and NHSRCL. On October 24, 2017, the design submitted by Sh Chakradhar Aalla, a second-year student of NID was adjudged the winning entry and NHSRCL found its logo.

Empowering our Stakeholders

In an attempt to equip project affected families with a skill-set to create a means for income generation and equip the youth with skills to make them atma nirbhar or self-reliant, NHSRCL has been organising specialised trainings for skill development in areas which the MAHSR corridor will pass through.

The trainings are being conducted under the Income Restoration Program and cover a wide cross-section of disciplines, from hotel management, computer hardware and networking, welding and fabrication, computer accounting, mobile repairing, electrical works, office automation, tailoring among others. Hundreds of people have been trained and a large majority have gained employment using expertise from the programs.

Construction training, Ahmedabad

Tailoring course, Ahmedabad

Electrician training course, Palghar

Motor mechanic training, Gujarat

Consent camp, Gujarat

Looking ahead

The MAHSR corridor marks India's foray into the world of HSR. While planning and executing tasks related to the construction and future operations of the Mumbai – Ahmedabad corridor, NHSRCL has gained knowledge and acquired technical expertise in all aspects of HSR. The organisation is now in a position to offer expert advice in the planning for other HSR corridors in the country.

Even though the MAHSR corridor will be using the Japanese Shinkansen technology, detailed studies undertaken by expert teams at NHSRCL over the past five years have placed them in a position to appreciate and evaluate other technologies which are currently in use in high-speed systems around the world.

NHSRCL can take on the role of a technical expert for all matters related to HSR systems, right from preparation of Detailed Project Reports (DPRs), construction, execution and operations.

With the process of awarding of civil contracts, the construction of the Mumbai – Ahmedabad corridor has begun on ground using international best practices. The path for the new train link has largely been cleared out and one can now see the first signs of this technical marvel rolling out right before our eyes.

The future is bright. India is now taking giant steps in this journey towards building a prosperous future for its people, both socially and economically.

Chapter 8

THE TEAM

This is the able team of leaders who have steered the journey so far at NHSRCL and without who's expertise the progress so far would not have been possible.

Sh Rajendra Prasad
MANAGING DIRECTOR

Sh Anjum Pervez
DIRECTOR PROJECT

Sh Vivek Prakash Tripathi
DIRECTOR FINANCE

Sh Alok Katiyar
DIRECTOR ELECTRICAL & SYSTEM

Sh Sandeep Srivastava
DIRECTOR ROLLING STOCK

Sh S.K. Mishra
CHIEF VIGILANCE OFFICER

Principal Executive Directors

Sh Amiyansu Das
CPM/PROJECT (CIVIL)

Sh H.L. Suthar
PED/TRACK & DESIGN

Sh Pramod Sharma
PED/CONTRACT

Executive Directors

Sh Brijesh Dixit
ED/DEPOT & MACHINERY

Sh Dipak Roy
CPM/PALGHAR

Sh Prashant Mishra
ED/ELECTRICAL

Sh Punit Agrawal
CPM/ELECTRICAL

Sh Rajeev Mishra
CPM/ROLLING STOCK

Sh S.P. Mittal
CPM-2/SURAT

Sh Sunil Kumar
ED/CONTRACT)

Sh Satya Prakash
DEPUTY INSPECTOR GENERAL/SECURITY

Sh U.P. Singh
CPM/MUMBAI

* In alphabetical order
Key-PED: Principal Executive Director
ED: Executive Director/ CPM: Chief Project Manager

Senior Advisor & Advisors

Sh Arun Kumar Bijalwan
SENIOR ADVISOR/
FINANCE

Sh Harjeet Kumar Jaggi
SENIOR CONSULTANT/
CONTRACT MANAGEMENT

Sh P.K. Sanghi
SENIOR CONSULTANT/
CIVIL

Sh Sudarson Nayak
SENIOR CONSULTANT/
OPERATIONS & SAFETY

Sh Sudhanshu Sharma
SENIOR ADVISOR/SURVEY

General Managers & Head of Departments

Sh Abhishek Swami
GM/FINANCE & LAW

Sh Akshay Kumar Marantu
GM/CONTRACT

Sh Akshaya Kumar
CPM-3/SURAT

Sh Amit Asati
GM/SIGNAL &
TELECOMMUNICATIONS

Sh Amol Kr. Pingle
CPM/SIGNAL &
TELECOMMUNICATIONS
SURAT

Sh Arun Kumar Singh
CPM/CIVIL-1/AHMEDABAD

Sh D.P. Singh
GM/DESIGN

Sh Indudhara Sastry
GM/CONTRACT

Smt Jyoti Singhal
GM/TRACK

Smt Kamini Sharma
CHIEF ARCHITECT

Sh Mohit Lila
GM/PLANNING
& DEVELOPMENT

Sh Nishant Singhal
GM/PROCUREMENT

Sh O.P. Gupta
GM/SIGNAL &
TELECOMMUNICATIONS

Sh Onkar Nath Sharma
GM/DESIGN

Sh Pradeep Ahirkar
CPM/ VADODARA

Sh Rajesh Agarwal
CPM/AHMEDABAD

Sh Surinder Pal Singh
GM/QUALITY CONTROL

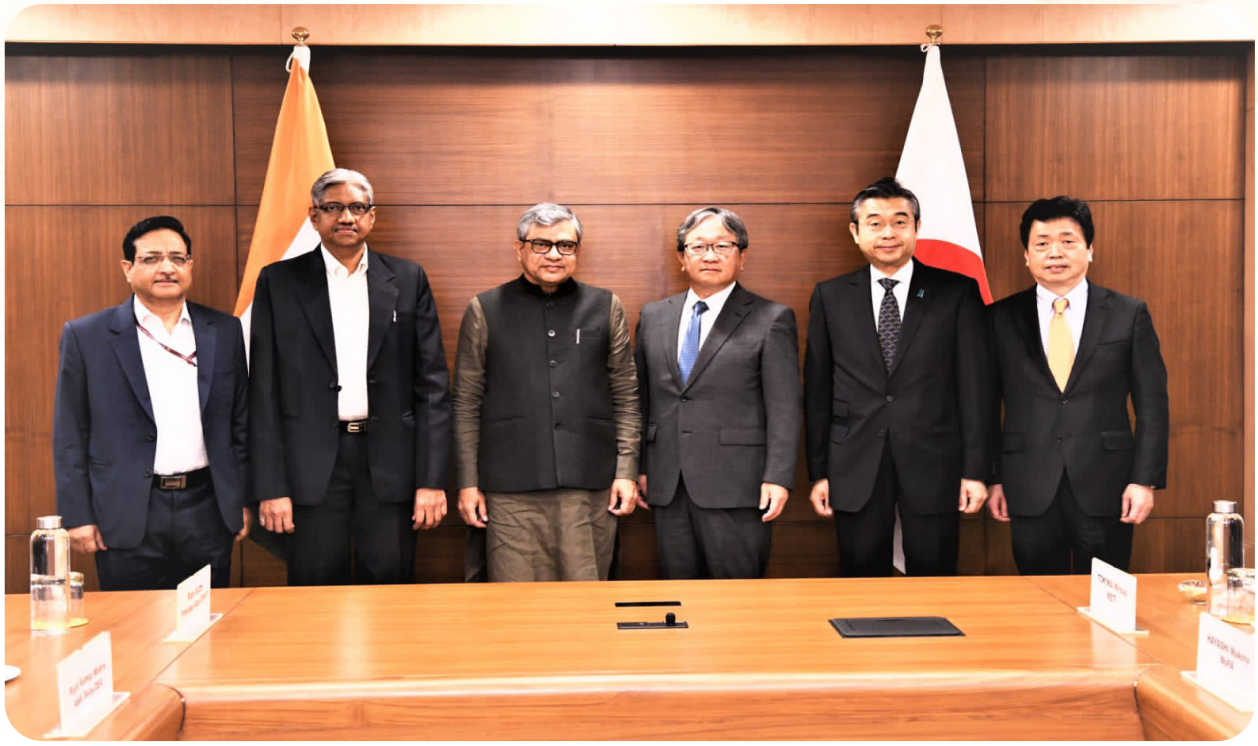
Smt Sumita Sharma
COMPANY SECRETARY

Smt Sushma Gaur
ADDL. GM/PUBLIC RELATIONS

Smt Shivani
JOINT GM/HUMAN RESOURCES

* In alphabetical order
Key-GM: General Manager/ CPM: Chief Project Manager

Let’s take a trip down memory lane and have a look of the moments that team NHSRCL has shared together over the past few years.



Joint Committee Meeting on MAHSR with Hon’ble Minister of Railways Shri Ashwini Vaishnaw and Dr. Masafumi Mori, Special Advisor to the Prime Minister of Japan, January 2023

Joint Committee Meeting on MAHSR, September 2023

Shri Ashwini Vaishnaw, Minister of Railways Visited the Under-construction Sabarmati Multimodal Transport Hub & Ahmedabad HSR Station in Gujarat, September 2022

Smt. Darshana Jardosh, Hon'ble Minister of State for Railways and Textile flagged off the casting of the heaviest Full Span Box Girder of 40 M span weighing 970 MT for MAHSR Corridor at a casting yard in Navsari, Gujarat, November 2021

MAHSR Project riview meeting with Hon'ble CM & Deputy CM, Maharashtra, August 2022

A High-level Japanese Delegation led by Dr. Masafumi Mori, Special Advisor to the Prime Minister of Japan Visited Various MAHSR Construction Sites, January 2023

Chairman & CEO, Railway Board, Shri Anil Kumar Lahoti inspected the ongoing work of MAHSR Project, May 2023

A high-level Japanese delegation led by Mr. Suga Yoshihide, Chairman, The Japan India Association & Former PM of Japan along with Shri Rajendra Prasad, MD/NHSRCL visited Sabarmati Multimodal Transport Hub & SBS launching site in Ahmedabad, July 2023

President of the JICA, Dr. TANAKA Akihiko visited various MAHSR construction sites, March 2023

Felicitation ceremony at NHSRCL Corporate office along with officials from Japanese Embassy, JICC, JICA & other stakeholders on achieving a major milestone of 100% Civil contract award for MAHSR Project, August 2023

Contract Signing ceremonies

NHSRCL Awards Last Civil Package for MAHSR Alignment in Maharashtra, 100% Civil Contracts Awarded for MAHSR Corridor July 2023

NHSRCL Signs Contract for the Construction of 21 km Long Tunnel including India's First 7 Km long Undersea Rail Tunnel June 2023

NHSRCL Signs Agreement for the Construction of Mumbai HSR Station, March 2023

NHSRCL Signs Agreement for the Construction of Sabarmati Rolling Stock Workshop and Depot, December 2022

Contract Agreement Signing Ceremony for 89 Km Viaduct and Anand HSR Station, December 2020

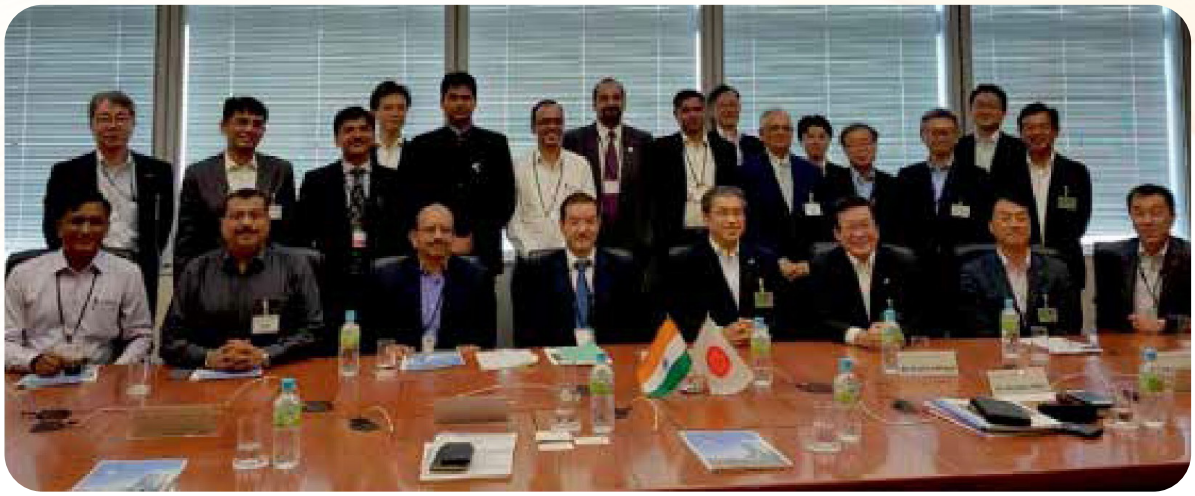
Contract Agreement Signing Ceremony for 237 Km Viaduct and 4 HSR Stations, November 2020

Contract Signing Ceremony for Package T-2, January 2021

Contract Signing ceremony R-1 PS, September 2022

Design Contract, Production & Construction Contracts and PMC Contract for E1 Package, March 2023

Learning/Collaborating with Japanese counterparts



Foundation Day Celebrations

7th Foundation Day Celebrations, February 2023

5th Foundation Day Celebrations, February 2021

4th Foundation Day Celebrations, February 2020

Lamp Lighting Ceremony on 3rd Foundation Day, February 2019

Teambuilding, Sports, Cultural & Other internal events

48 NHSRCL employees participated in the Delhi Half Marathon 2022, October 2022

As India celebrates International Year of Milets 2023, NHSRCL took the initiative to organize 'Millets Mela', April 2023

Team Millets Mela, April 2023

Felicitation ceremony on completion of first 50 km MAHSR viaduct, May 2023

Felicitation ceremony on completion of first 50 km MAHSR viaduct, May 2023

Cricket Tournament in Delhi

Cycle Rally in Ahmedabad

Engaging the young audience at NHSRCL

Women's Day Celebrations

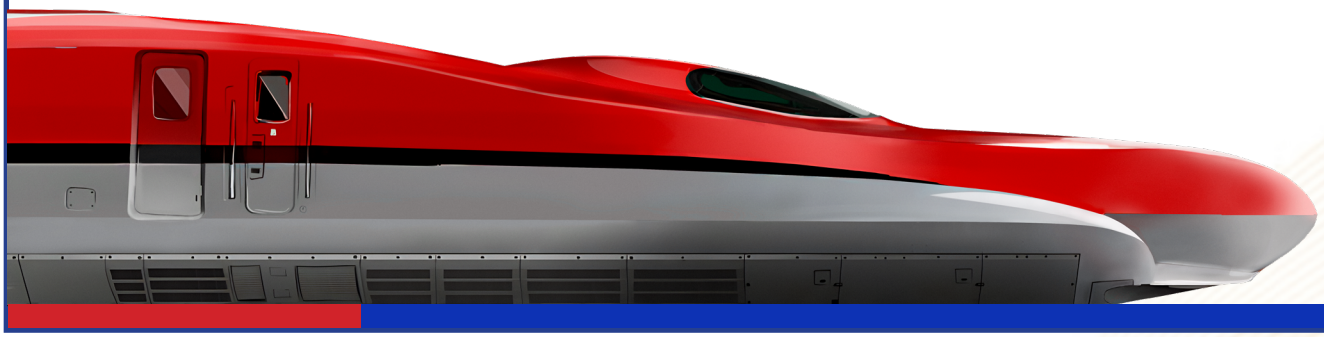
Awards & Honors

NHSRCL conferred with Governance Now 9th PSU Award for the 'Best Communication Outreach' category, February 2023

NHSRCL received 'Organization of the Year - PR Excellence', Best Use of Media Relations' and 'Best Use of Content' by the Public Relations Council of India (PRCI), November 2022

A momentous occasion for NHSRCL upon receiving 'Kalam Innovation in Governance Award'

Aspiring for a Bullet Train ride in 2026!



NHSRCL
National High Speed Rail Corporation Ltd.

Compiled By
Public Relations Department

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