

THE INDIAN EXPRESS

The Big Picture

SATURDAY, MAY 9, 2026

91%

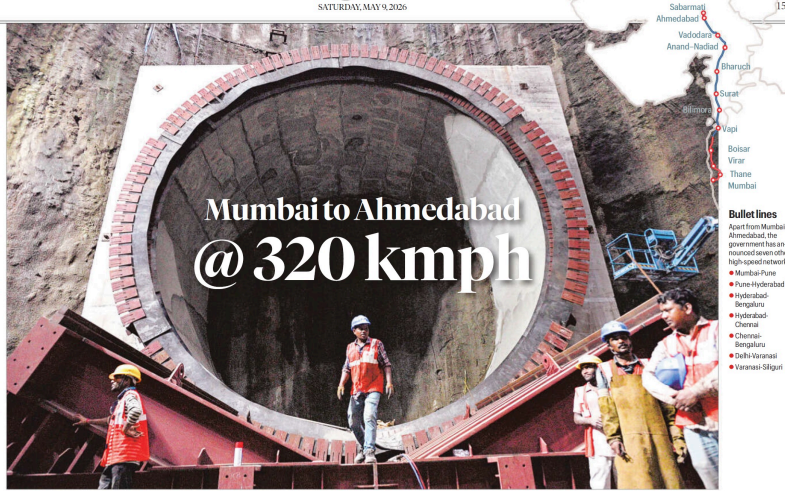
of the 508 km project is elevated. Of that, 21 km is underground tunnel.

21 km (including a 7 km undersea tunnel beneath the Thane creek)

8 Mountain tunnels

28 Steel bridges

25 River bridges



Mumbai to Ahmedabad @ 320 kmp/h

Viaducts that fly over high-rises, 53 steel and river bridges, a 7-km undersea tunnel, and machines that can move mountains. DHEERAJ MISHRA and photographer SANKHADEEP BANERJEE travelled along the 508-km bullet train route, from Ahmedabad to Mumbai, to map the scale of one of India's biggest infrastructure projects

STANDING 23 metres above the ground, Ahmednagar, the site of an under-construction viaduct of the Mumbai-Ahmedabad High-Speed Rail corridor in Maharashtra, is a "mystery" to a group of engineers. The material that lies sandwiched between the track slabs that hold the rails and the track bed has a "secret ingredient" that allows trains to run at blazing speeds of 320 km per hour. Only the Japanese know what it is, they say.

Car workers at the Cement Asphalt Mortar (CAM) injection site, a machine brought from Japan that is being used for the first time in India, say its task is precise. Before the rails can be laid on the track slab, it comes a 400 mm cushioning layer of mortar that absorbs the vibrations generated when a train at such high speeds.

"With this machine, we inject CAM, a mixture of fine ingredients such as cement, asphalt, polymer emulsion, sand, water, and other materials. Three of the ingredients in CAM — cement, sand and water — are missing in India; the rest comes from Japan," Chen explains.

That's the invisible link. "They (Japan) are so sensitive about the asphalt emulsion. They have not told us what it is," says another engineer, adding that researchers at IIT Kharagpur are now studying the material to develop it.

Alone a decade after Prime Minister Narendra Modi laid the foundation stone for the bullet train project in September 2017, the country's high-speed dream are finally taking shape in the form of the 508 km Mumbai-Ahmedabad corridor.

The government hopes to build several other lines, spanning 4,000 km, at a cost of \$6.1 lakh crore.

The 85-lakh-crore Mumbai-Ahmedabad line has Japan as its primary partner. As part of the initial deal signed in 2017, Japan was to supply its famed Shinkansen. However, amid growing "uncertainties", sources said, India has already started building its own bullet trains at a BEM plant in Bengaluru.

After multiple delays, the Mumbai-Ahmedabad High-Speed Rail corridor is expected to be operational by 2026. The first of the stretches, the 48 km from Surat to Bilimora, is scheduled to be completed by August 2027.

Over the Sabarmati
Overlooking the quiet flow of the Sabarmati 600 metres long Sabarmati bridge with elevated railway lines or tracks runs. Over 90% of the 48 km of the high-speed network's 508 km long track will run on viaducts such as these. At heights of over 20 metres from the ground, making a journey in the bullet train ride through the skies.

A senior officer of the National High Speed Rail Corporation Limited (NHSRCL), the government organisation responsible for building and managing the high-speed rail corridors, said that unlike in European countries, the bullet train tracks had to be elevated for safety reasons. "This could not have run the bullet train on the surface. People and animals cross the railway line. Even on the railway's broad gauge lines,

where trains can go up to 160 kmph, barriers are installed on either side of the tracks. Here, in the case of the bullet train, we are talking of speeds of 300 kmph and upwards," he said.

The under-construction viaduct at Sabarmati river, which is one of the terminal points of the railway line, overtook these other bridges. The closest road to the viaduct, its slightly sloped floor (the columns of pillars) support viaducts that are an outlier of rail construction.

Vijay Bhetra, Deputy Chief Project Manager of the site, said that before the seven pieces of the viaduct were built, engineers had laid piles (deep foundations) support heavy bridge loads underneath. "Every engineer has to see to it that under the Sabarmati, this is one of the most difficult projects I have ever worked on. The bullet train itself will be light, but since it will have to travel at such high speeds, other dynamic forces such as resistance, vibrations, and centrifugal force will come into play. So the bridge has to be really strong," he says.

A few kilometres from the Sabarmati viaduct is a steel bridge being built over a road bridge. The structure, 80 metres long, is one of 28 steel bridges planned along the corridor. The bridge has seismic stoppers installed at its piers to help it withstand earthquakes. More than 36,000 tons hold the structure together.

While Japan imposed difficulty from metre gauge to narrow gauge in Japanese standards for high-speed networks, India took the longer route, moving from narrow and metre gauge to broad gauge (maximum speed of 160 kmph) that now form over 90% of the rail network. The next step, high-speed, took

years to take off.

Over 90% of the line will run on viaducts, at heights of over 20 m, making a journey in the bullet train ride through the skies

Inside a Surat slab factory
At a 14-acre factory in Kim, Surat, Arun Yadav, senior worker from that factory, flexes his digital depth collar to one side of a 4.5-metre track slab to measure its thickness. The track slab is the bed on which the high-speed rails will rest. The machine reads 91 mm. Perfect, so he marks "OK" on the surface.

Even a minor variation would have made it "red alert". The factory was set up in September 2023 to manufacture track slabs, one of two such facilities in Gujarat, for the Vapi-Vadodara stretch of the bullet train. At peak capacity, the factory can set 130 track slabs a day. The Vapi-Vadodara stretch will have 6,000 track slabs of which the Kim factory has supplied 36,000 so far.

Sunil Garg, overall technical and joint general manager of BHOON, said its engineers had arrived from Japan to train engineers at the Kim facility.

It's a partnership that is evident at the HSR Depot in Surat. Nearly 80 km away, the depot is where the high-speed coaches will come for routine inspections once the project takes off.

The two engineers from Japan, Hokuro and Nabe-Mura, are at the facility to train Indian engineers to operate a steel slab machine. Hokuro, who has previously worked on Japanese high-speed rail, explains that the bullet train's steel wheels wear out from repeated

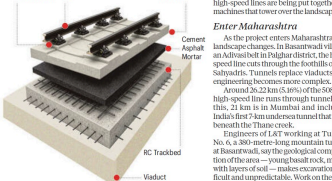


(Top) At Vihari in Mumbai, one of the many tunnels through which the Mumbai-Ahmedabad high-speed line will pass, work on at the Ahmedabad station of the bullet train

Mumbai to Ahmedabad: Traveltimes			
BULLET TRAIN	WAGON	BY FLIGHT	BY ROAD
1 hour 58 minutes	5 hours 40 minutes	1 hour 30 minutes	9 hours

SPECIAL TRACKS
The Mumbai-Ahmedabad High-Speed Rail Corridor adopts the Japanese "J-rail" ballastless track system. It does not use loose stones (ballast) like traditional railway tracks. Instead, the rails are laid on a solid concrete structure (slab), similar to what Japan's Shinkansen uses.

Typical J-slab track has four key layers/components: Rail Fastener, Rail, Track Slab, Cement, Asphalt, Mortar



Length of high-speed networks (in km)	
China	50,000
Spain	3,993
Japan	3,547
France	2,369
Germany	1,631
India*	508*

* SOURCE: INTERNATIONAL UNION OF RAILWAYS



Bullet lines
Apart from Mumbai-Ahmedabad, the government has announced seven other high-speed networks: Mumbai-Pune, Pune-Hyderabad, Hyderabad-Bengaluru, Bengaluru-Chennai, Chennai-Bengaluru, Delhi-Varanasi, Varanasi-Siliguri

shoe-shaped opening will have a hood at the entrance. "At high speeds, a train entering a tunnel creates a powerful pressure wave and generates a loud, explosive sound. The entrance hood helps release this pressure gradually and reduce the noise," he says.

Nearly 20 km from the tunnel, in Gokwana village, Palghar district, a massive launching gantry is at work, picking 800-tonne girders, each 40 metres long, and placing them into position. One after another, these segments come together to form the viaduct or bridge, the spine on which the train will run.

At the centre of this operation is the girder transporter — a 400-tonne, 20-wheeled carrier. It moves slowly, much like the Hunter-Killer mine from the movie 'Tomb Raider' but with far greater intent, as it carries girders from the steel yard, 2 km away, and lifts them to the launching gantry. The launching of a single girder takes about an hour.

From his house in Gokwana, a village of around 6,000, Sachin Pandit can see the blue launching gantry. "Mr. Jayrajwari, I'll tell you, the train must really pass through the gantry. I have to be born again to sit in the train," Sachin Pandit, a jaydar farmer.

Work on the viaduct continues through the night. With it, the hum of machinery and a siren that goes out loud intermittently before every new activity. "There is a lot of noise. It is very difficult for us to sleep," he says.

21-km tunnel in Ahmedabad
At Shilpitha in Ahmedabad, the tunnel passes beneath critical urban infrastructure — two major water pipelines and a 60-millimetre gas pipeline.

The tunnel cuts through the Shilpitha, in some sections, the thickness of the rocks above the tunnel was 80 metres, but elsewhere, it would drop to as little as 20 metres. At one particularly sensitive point, officials said, only a metre separated the tunnel from the pipelines below.

"An error in cutting the tunnel could have damaged these pipelines. Here, the excavation had to be carried out manually," says Kishan Singh, Deputy Chief Project Manager at the site.

For the 21-km tunnel, we mapped over 600 buildings overground to document existing cracks. Before carrying out the blasting, instruments such as crackmeters, fiberoptic, and sensors were installed across nearly 50 buildings. At most, there was a slight increase during the blasting process, like what you feel standing on a bridge," said senior NIPESIL engineer.

The project ends at Bandra Rata Complex (BRC), the only underground station of the project. The website is significant, as a part of the earth has been dug out. Outside, the multi-storied buildings of the business district seem dimmed, resembling a city's ghost.

It was in Mumbai that the country's first passenger train ran between Bandra and present-day Chhatrapati Shivaji Maharaj Terminus and Thane on the Western Railway. The city will host the terminus of India's first high-speed train.

THE INDIAN EXPRESS

The Big Picture

SATURDAY, MAY 9, 2026

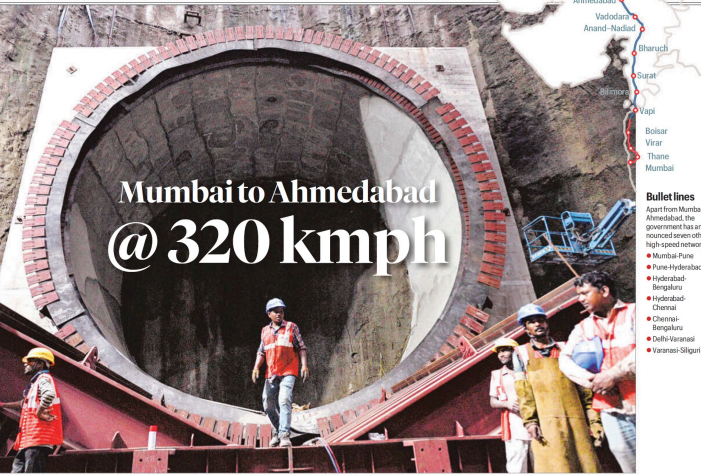
91%
of the 508 km project is elevated. Of the rest, underground tunnel

21 km (including a 7 km undersea tunnel beneath the Thane creek)

8 Month spans

28 Steel bridges

25 River bridges



Mumbai to Ahmedabad @ 320 kmp



- Bullet lines**
- Mumbai-Pune
 - Pune-Hyderabad
 - Hyderabad-Bengaluru
 - Bengaluru-Chennai
 - Chennai-Singapur
 - Delhi-Varanasi
 - Varanasi-Siliguri

Viaducts that fly over high-rises, 53 steel and river bridges, a 7-km undersea tunnel, and machines that can move mountains. DHEERAJ MISHRA and photographer SANKHADEEP BANERJEE travelled along the 508-km bullet train route, from Ahmedabad to Mumbai, to map the scale of one of India's biggest infrastructure projects

STANDING 23 metres above the ground, Anantnaga, the site inspector at an under-construction viaduct of the Mumbai-Ahmedabad High Speed Corridor in Vakhata village near Surat, dresses "mystery" with a group of engineers. The material that lies beneath the track bed has a "secret ingredient" that allows trains to travel at speeds of 320 km per hour. Only the Japanese know what it is, they say.

Guru walks towards the Cement Asphalt Mortar (CAM) injection pit, a machine brought from Japan that shoves liquid into the first time on Indian soil. It is as precise as before the rails can be laid on the track slab. It creates a 40-400 mm cushioning layer of mortar that absorbs the vibrations generated when trains run at such high speeds.

"With this machine, we inject CAM, a mixture of nine ingredients such as cement, asphalt, polymer emulsion, sand, water, and other materials. Three of the ingredients in CAM — cement, sand and water — are available in India; the rest comes from Japan," Guru explains.

That's the missing link. They Japanese know something about the asphalt emulsion. They have not told us what it is, says another engineer, adding that researchers at IIT Chennai are now studying the material to decode it.

Almost a decade after Prime Minister Narendra Modi laid the foundation stone for the bullet train project in September 2017, the country's high-speed dreams are finally taking shape in the form of the 508-km Mumbai-Ahmedabad corridor.

The government hopes to build seven other lines, spanning 4,000 km, at a cost of Rs 16 lakh crore.

The Rs 196-lakh crore Mumbai-Ahmedabad line has Japan as its primary partner. As part of the initial deal signed in 2017, Japan was to supply its famed Shinkansen. However, amid growing "uncertainty", sources said, India has already started building its own bullet trains at a BDM plant in Bengaluru.

After multiple delays, the Mumbai-Ahmedabad High Speed Rail corridor is expected to be operational by 2028. The first of the stretches, the 48 km from Surat to Bilimera, is scheduled to be completed by August 2027.

where trains can go up to 160 kmph, barriers are installed on either side of the tracks. Here, in the case of the bullet train, we are talking of speeds of 300 kmph and upwards," the officer said.

The under-construction viaduct at Sahamrao river, which leads one of the terminal points of the railway line, overlooks three other bridges. The deepest span of rail-way bridge, including spans of precast concrete or piles that support a viaduct, is considered one of the most difficult projects to build under the Sabarmati. This is one of the most difficult projects I have ever worked on," the officer said.

The bullet train itself will be light and since it will have to travel at such high speeds, other dynamic forces such as resistance, vibrations, and centrifugal forces will come into play. So the bridge has to be really strong," he says.

A few kilometers from the Sabarmati viaduct is a steel bridge being built over a road bridge. The structure, 80 metres long, is one of 28 steel bridges planned along the corridor. The bridge has seismic stoppers installed at its ends to help it withstand earthquakes. More than 30,000 bolts hold the structure together.

While Japan moved directly from metre gauge to narrow gauge in Japan, India has to move from metre gauge to broad gauge. The longer route, moving from narrow and metre gauge to broad gauge, is expected to be completed by 2028. The maximum speed of 160 kmph that now form over 70% of the rail network. The next step, high-speed, took years to take off.

Inside a Surat slab factory

At a 14-acre factory in Kinn, Surat, Arjan Yadav, site worker from Uda Prasth, lives his digital life on a tablet to measure its 4.5-tonne track slab to measure its thickness. The track slab is the bed on which the high-speed rails will rest. The machine reads 391 mm. Perfect, so much "OK" on his tablet.

Even a minor variation would have made a difference. The factory was set up in September 2023 to manufacture track slabs, one of two such facilities in Gujarat, for the Vighat-Vadodra stretch of the bullet train. At peak capacity, the facility can cast 120 track slabs a day. The Vighat-Vadodra stretch will need 70,000 track slabs, which the plant factory has supplied.

Surendra Garg, overall in-charge and joint general manager of ICRCL, said from engineers had arrived from Japan to train Indian engineers at the plant facility.

It's a partnership that is evident at the HSR Depot in Surat-Nyol, nearly 20 km away. The depot is where the high-speed coaches will come for routine inspections once the project takes off.

Two engineers from Japan, Hiroaki and Naoki, have arrived to train Indian engineers to operate a wheel lathe machine.

Hakima, who has previously worked on Josefa Shinkansen, explains that the bullet train's wheels wear out fast compared

to the regular train. The wheel lathe machine restores the wheel's shape by shaving off a very thin outer layer of metal, a process called reprofiling. "A new wheel starts with a diameter of 860 mm. Every reprofiling makes it smaller, but once it reaches 790 mm, the wheel can no longer be used," he says.

"The machine was originally designed by the Germans, then the Japanese learned from them. Now we are passing the knowledge on to India," he says.

Interlocking of the bullet train are technological advances of the kind India has rarely witnessed before. Over a century after the British laid railway lines, using hand labour to lay thousands of kilometres of tracks, these high-speed lines are being put together by machines that run over the landscape.

Enter Maharashtra

As the project enters Maharashtra, the landscape changes. In Basantwadi village, an Adambel in Pindri district, the high-speed line cuts through the foothills of the Sahyadris. "Tunnels replace viaducts and engineering becomes more complex."

Anand, 22 km, is 16% of the 508-km high-speed line runs through tunnels. Of this, 21 km is in Mumbai and includes India's first 7-km undersea tunnel that runs beneath the Thane creek.

Engineers of ICRCL working at Tunnel No. 6, a 389-metre-long mountain tunnel at Basantwadi, say the job is a complex proposition of the earth — young basalt rock, mixed with layers of soil — makes excavation difficult and unpredictable. Work on the tunnel started in January 2025 and breakthrough was achieved in 130 days.

"The maximum overburden — the thickness of rock above the tunnel — is just 20 metres. For nearly 250 metres of the stretch, it drops below 14 metres, making excavation very difficult. For the first time, we have an automatic, real-time monitoring system that tells us in advance if there is any possibility of ground collapse," he says.

Devraj Matharu, project director of ICRCL at the site, said the tunnel, with a horse-

shoe-shaped opening, will have a hood at the entrance. "At high speeds, a train entering a tunnel creates a powerful pressure wave and generates a loud, explosive sound. The entrance has to be designed to dissipate energy gradually and reduce the noise," he says.

Nearly 20 km from the tunnel, in Gowans village, Pindri district, a massive launching gantry is at work, parking 180-tonne girders, each 40 metres long, and placing them into position. One after another, these segments come together to form the viaduct or bridge, the spine on which the train will run.

At the centre of this operation is the gantry transporter — a 100-tonne, 26-wheel carrier. It moves slowly, much like the hammer-killer machines in the Terminator, but with a gentler intent, as it carries girders from the casting yard, 2 km away, and shifts them to the launching gantry. The launching of a single girder takes about an hour.

From his house in Gowans, a village of around 4,000, Sachin Paril can see the blue launching gantry. "Main kyaenge, 160 km kaabhi le jata main aabhi health passage (we will die, but may never get to ride this train). I have to be born again to sit in the train," smiles Paril, a ruddy farmer.

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out local intermittently before every new activity. "There is a lot of noise. It is very difficult for us to sleep," he says.

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out intermittently

21-km tunnel in Mumbai

Sahyadris in Mumbai, the tunnel passes through urban infrastructure — two major metro pipelines and 600-mm gas pipeline.

The tunnel cuts through the Parsikhills. In some sections, the thickness of the rocks above the tunnel was 160 metres, but elsewhere, it would drop to as little as 20 metres. At one particularly sensitive point, officials said, only 4 metres separated the tunnel from the pipelines above.

"An error in excavating the tunnel could have damaged these pipelines. Here, the excavation had to be carried out manually," says Kishan Shinde, Deputy Project Manager at the site.

"For the 21-km tunnel, we carried over 600 buildings overground to document existing cracks. Before carrying out the blasting, instruments such as crackmeters, tiltmeters, and seismometers were installed across nearly 50 buildings. At most, there was a slight vibration during the blasting process, like what you feel standing on a bridge," said a senior ICRCL engineer.

The project ends at Baramati Junction Complex (BRC), the only underground station of the project. The work is geologically complex, like a part of the earth has been gapped out. Outside, the multi-storeyed buildings of the business district seem undisturbed, even being built by ICRCL.

At Mumbai, India's railway story comes full circle. It was in Mumbai that the country's first passenger train ran between Borli and present-day Chhatrapati Shivaji Maharaj Terminus and Tannah (now Thane) in 1853. The city will now host the terminus of India's first high-speed train.

Over 90% of the line will run on viaducts, at heights of over 20m, making a journey in the bullet train a ride through the skies

Typical 1-slab track has four key layers/components:

- Rail
- Cement Asphalt Mortar
- Track Slab
- Viaduct

508 km 1,98 lakh cr

Mumbai-Ahmedabad corridor Estimated cost

Mumbai to Ahmedabad, Travel time

Mode	Time
BULLET TRAIN	58 minutes
VANDE BHARAT	40 minutes
BY FLIGHT	1 hour 30 minutes
BY ROAD	9 hours

SPECIAL TRACKS

The Mumbai-Ahmedabad High-Speed Rail Corridor adopts the Japanese 'Y' slab' ballastless track system. It does not use loose stones/ballast like traditional railway tracks. Instead, the rails are fixed on a solid concrete structure (slab), similar to what Japan's Shinkansen uses

Length of high-speed networks (in km)

Country	Length (km)
China	50,000
Spain	3,993
Japan	3,147
France	2,760
Germany	1,631
India	508

Over 90% of the line will run on viaducts, at heights of over 20m, making a journey in the bullet train a ride through the skies

Typical 1-slab track has four key layers/components:

- Rail
- Cement Asphalt Mortar
- Track Slab
- Viaduct

508 km 1,98 lakh cr

Mumbai-Ahmedabad corridor Estimated cost

Mumbai to Ahmedabad, Travel time

Mode	Time
BULLET TRAIN	58 minutes
VANDE BHARAT	40 minutes
BY FLIGHT	1 hour 30 minutes
BY ROAD	9 hours

SPECIAL TRACKS

The Mumbai-Ahmedabad High-Speed Rail Corridor adopts the Japanese 'Y' slab' ballastless track system. It does not use loose stones/ballast like traditional railway tracks. Instead, the rails are fixed on a solid concrete structure (slab), similar to what Japan's Shinkansen uses

Length of high-speed networks (in km)

Country	Length (km)
China	50,000
Spain	3,993
Japan	3,147
France	2,760
Germany	1,631
India	508

THE INDIAN EXPRESS

The Big Picture

SATURDAY, MAY 9, 2026

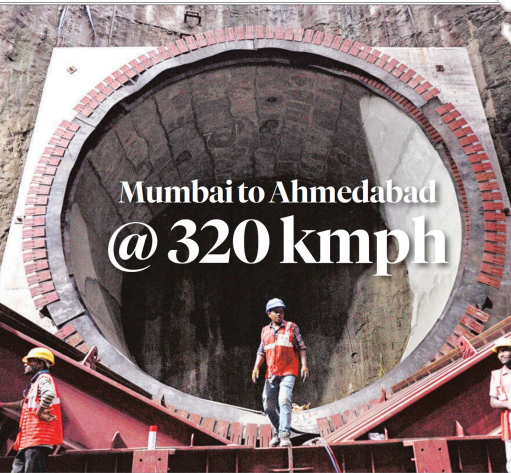
91%
of the 508 km project is elevated. Of the rest, underground tunnel

21 km
(including a 7 km undersea tunnel beneath the Thane creek)

8
Mountaintop viaducts

28
Steel bridges

25
River bridges



Mumbai to Ahmedabad @ 320 kmp



Bullet lines
Apart from Mumbai-Ahmedabad, the government has announced seven other high-speed networks

- Mumbai-Pune
- Pune-Hyderabad
- Hyderabad-Bengaluru
- Hyderabad-Chennai
- Chennai-Bengaluru
- Delhi-Varanasi
- Varanasi-Siliguri

Viaducts that fly over high-rises, 53 steel and river bridges, a 7-km undersea tunnel, and machines that can move mountains. DHEERAJ MISHRA and photographer SANKHADEEP BANERJEE travelled along the 508-km bullet train route, from Ahmedabad to Mumbai, to map the scale of one of India's biggest infrastructure projects

STANDING 2.5 metres above the ground, Anantha can, the site inspector at an under-construction viaduct of the Mumbai-Ahmedabad High Speed Corridor in Vakhata village near Surat, dresses "mystery" with a group of engineers. The material that lies under the viaduct is the track bed that holds the rails and the track bed has a "secret ingredient" that allows trains to travel at speeds of 320 km per hour. Only the Japanese know what it is, they say.

Gain towards the Cement Asphalt Mortar (CAM) injection, a machine brought from Japan that shoves liquid mortar into the joints of the track bed. Before the mortar is laid on the track slab, it creates a 40-400 mm cushioning layer of mortar that absorbs the vibrations generated when trains run at such high speeds.

"With this machine, we inject CAM, a mixture of nine ingredients such as cement, asphalt, polymer emulsion, sand, water, and other materials. Three of the ingredients in CAM — cement, sand and water — are available in India; the rest comes from Japan," Guin explains.

That's the missing link. They Japanese are coming to the asphalt emulsion. They have not told us what it is, says another engineer, adding that researchers at IIT Chennai are now studying the material to decode it.

Almost a decade after Prime Minister Narendra Modi laid the foundation stone for the bullet train project in September 2017, the country's high-speed dreams are finally taking shape in the form of the 508-km Mumbai-Ahmedabad corridor.

The government hopes to build seven other lines, spanning 4,000 km, at a cost of Rs 16 lakh crore.

The Rs 196-lakh crore Mumbai-Ahmedabad line has Japan as its primary partner. As part of the initial deal signed in 2017, Japan was to supply its famed Shinkansen. However, amid growing "uncertainties", sources said, India has already started building its own bullet trains at a BDM plant in Bengaluru.

After multiple delays, the Mumbai-Ahmedabad High Speed Rail corridor is expected to be operational by 2028. The first of the stretches, the 48 km from Surat to Bilimera, is scheduled to be completed by August 2027.

where trains can go up to 360 kmph, barriers are installed on either side of the tracks. Here, in the case of the bullet train, we are talking of speeds of 300 kmph and upwards," the officer said.

The under-construction viaduct at Sahamrao river, which leads one of the terminal points of the railway line, overlooks three other bridges. The deepest span of railway bridge, including spans of precast columns or piles that support a viaduct, is considered one of the most difficult projects to build.

"For every pile, we have to cast 16 piles under the Sabarmati. This is one of the most difficult projects I have ever worked on," the officer said.

The bullet train itself will be light since it will have to travel at such high speeds. The bullet train forces on it resistance, vibrations, and centrifugal forces will come into play. So the bridge has to be really strong," he says.

A few kilometers from the Sabarmati viaduct is a steel bridge being built over a road bridge. The structure, 80 metres long, is one of 28 steel bridges planned along the corridor. The bridge has seismic stoppers installed at its ends to help it withstand earthquakes. More than 30,000 bolts hold the structure together.

While Japan moved directly from metre gauge to narrow gauge in Japan, India has to move from metre gauge to narrow gauge to broad gauge, moving from narrow and metre gauge to broad gauge (maximum speeds of 300 kmph) that now form over 70% of the rail network. The next step, high-speed, took years to take off.

Inside a Surat slab factory
At a 14-acre factory in Kinn, Surat, Arjan Yadav, site worker from Urea Pradesh, lives his digital life on his phone. He is a 4.5-tonne track slab to measure its thickness. The track slab is the bed on which the high-speed rails will rest. The machine reads 91 mm. Perfect, so much "OK" on his phone.

Even a minor variation would have made a difference. The factory was set up in September 2023 to manufacture track slabs, one of two such facilities in Gujarat, for the Vighat-Vadodra stretch of the bullet train. At peak capacity, the facility can cast 120 track slabs a day. The Vighat-Vadodra stretch will need 600,000 track slabs, which the 120-track slab factory has supplied.

Sanchit Garg, overall in-charge and joint general manager of ICRCL, said from engineers had arrived from Japan to train Indian engineers at the plant facility.

It's a partnership that is evident at the HSR Depot in Surat-Nyol, nearly 20 km away. The depot is where the high-speed coaches will come for routine inspections once the project takes off.

Two engineers from Japan, Hiroaki and Naoki, train Indian engineers to operate a wheel lathe machine.

Hakima, who has previously worked on Josefa Shinkansen, explains that the bullet train's wheels wear out fast compared

to where they run on the ground. The wheel lathe machine restores the wheel's shape by shaving off a very thin outer layer of metal, a process called reprofiling. "A new wheel starts with a diameter of 860 mm. Every reprofiling makes it smaller, but once it reaches 790 mm, the wheel can no longer be used," he says.

"The machine was originally designed by the Germans, then the Japanese learned from them. Now we are passing the knowledge on to India," he says.

Interlocking of the bullet train are technological advances of the kind India has rarely witnessed before. Over a century after the British laid railway lines, using hand labour to lay thousands of kilometres of tracks, these high-speed lines are being put together by machines that run over the landscape.

Enter Maharashtra
As the project enters Maharashtra, the landscape changes. In Basarwadi village, an Adeshwari temple in the village, the high-speed line cuts through the foothills of the Sahyadris. "Tunnels replace viaducts and engineering becomes more complex."

Anand, 22 km, is 16% of the 508-km high-speed line runs through tunnels. Of this, 21 km is in Mumbai and includes India's first 7 km undersea tunnel that runs beneath the Thane creek.

Engineers of ICRCL working at Tunnel No. 6, a 389-metre-long mountain tunnel at Basarwadi, say the job is a complex one. The terrain is uneven, and the composition of the rock — a young basalt rock, mixed with layers of soil — makes excavation difficult and unpredictable. Work on the tunnel started in January 2025 and breakthrough was achieved in 150 days.

"The maximum overburden — the thickness of rock above the tunnel — is just 20 metres. For nearly 250 metres of the stretch, it drops below 14 metres, making excavation very difficult. For the first time, we have an automatic road time monitoring system that tells us in advance if there is any possibility of tunnel collapse," he says.

Devraj Mathania, project director of ICRCL at the site, said the tunnel, with a horse-

shoe-shaped opening, will have a hood at the entrance. "At high speeds, a train entering a tunnel creates a powerful pressure wave and generates a loud, explosive sound. The entrance has to be designed to dissipate energy gradually and reduce the noise," he says.

Nearly 20 km from the tunnel, in Gowna village, Pithampur district, a massive launching gantry is at work, parking 180-tonne girders, each 40 metres long, and placing them into position. One after another, these segments come together to form the viaduct or bridge, the spine on which the train will run.

At the centre of this operation is the gantry transporter — a 400-tonne, 26-wheel carrier. It moves slowly, much like the hammer-kicker machines in the Terminator, but with a gentler intent, as it carries girders from the casting yard, 2 km away, and shifts them to the launching gantry. The launching of a single girder takes about an hour.

From his house in Gowna, a village of around 4,000, Sachin Paril can see the blue launching gantry. "Main kyaenge, 10-15 kaubhi le jata main aabhi health passage (we will die, but may never get to ride this train). I have to be born again to sit in the train," smiles Paril, a ruddy farmer.

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out local intermittently before every new activity. "There is a lot of noise. It is very difficult for us to sleep," he says.

Over 90% of the line will run on viaducts, at heights of over 20m, making a journey in the bullet train a ride through the skies

Typical 1-slab track has four key layers/components:
Rail bed, Rail, Cement Asphalt Mortar, Track Slab

SPECIAL TRACKS
The Mumbai-Ahmedabad High-Speed Rail Corridor adopts the Japanese 'Y' slab ballastless track system. It does not use loose stones/ballast like traditional railway tracks. Instead, the rails are fixed on a solid concrete structure (slab), similar to what Japan's Shinkansen uses

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out intermittently

21-km tunnel in Mumbai
The tunnel passes beneath the Thane creek. It is two major water pipelines and 600-mm gas pipeline.

The tunnel cuts through the Parsik hills. In some sections, the thickness of the rocks above the tunnel was 160 metres, but elsewhere, it would drop to as little as 20 metres. At one particularly sensitive point, officials said, only 4 metres separated the tunnel from the pipelines above.

Over the Sabarmati
Overlooking the quiet flow of the Sabarmati, the 489-metre-long Vadhav bridge on which dozens of railway lines or roads run. Over 90% of the high-speed network 508 km long track will run on viaducts such as these, at heights of over 20 metres from the ground, making a journey in the bullet train a ride through the skies.

A senior officer of the National High Speed Rail Corporation Limited (NHSRCL), the government organisation responsible for building and managing the high-speed rail corridors, said that unlike in European countries, the bullet train tracks had to be elevated for safety reasons. "We could not have the bullet train on the surface. People and animals cross the railway line. Even on the railway broad gauge lines,

contact with the tracks at high speeds. The wheel lathe machine restores the wheel's shape by shaving off a very thin outer layer of metal, a process called reprofiling. "A new wheel starts with a diameter of 860 mm. Every reprofiling makes it smaller, but once it reaches 790 mm, the wheel can no longer be used," he says.

"The machine was originally designed by the Germans, then the Japanese learned from them. Now we are passing the knowledge on to India," he says.

Interlocking of the bullet train are technological advances of the kind India has rarely witnessed before. Over a century after the British laid railway lines, using hand labour to lay thousands of kilometres of tracks, these high-speed lines are being put together by machines that run over the landscape.

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out intermittently

21-km tunnel in Mumbai
The tunnel passes beneath the Thane creek. It is two major water pipelines and 600-mm gas pipeline.

The tunnel cuts through the Parsik hills. In some sections, the thickness of the rocks above the tunnel was 160 metres, but elsewhere, it would drop to as little as 20 metres. At one particularly sensitive point, officials said, only 4 metres separated the tunnel from the pipelines above.

An error in excavating the tunnel could have damaged these pipelines. Here, the excavation had to be carried out manually," says a Kinn Shikhar, Deputy Project Manager at the site.

"For the 21-km tunnel, we carried over 600 buildings overground to document existing cracks. Before carrying out the blasting, first, we carried out such as cross-boreholes, and sensors were installed across nearly 50 buildings. At most, there was a slight vibration during the blasting process, like what you feel standing on a bridge," said a senior NHSRCL engineer.

The project end of the Sabarmati Corridor (BDM), the only underground station of the project. The work is being done in a way that a part of the earth has been gapped out. Outside, the multi-storey buildings of the business district seem undisturbed, even being built by LEED 2.0.

At Mumbai, India's railway story comes full circle. It was in Mumbai that the country's first passenger train ran between Borli and present-day Chhatrapati Shivaji Maharaj Terminus and Tannah (now Thane) in 1853. The city will now host the terminus of India's first high-speed train.

Length of high-speed networks (in km)



Enter Maharashtra
As the project enters Maharashtra, the landscape changes. In Basarwadi village, an Adeshwari temple in the village, the high-speed line cuts through the foothills of the Sahyadris. "Tunnels replace viaducts and engineering becomes more complex."

21-km tunnel in Mumbai
The tunnel passes beneath the Thane creek. It is two major water pipelines and 600-mm gas pipeline.

Over the Sabarmati
Overlooking the quiet flow of the Sabarmati, the 489-metre-long Vadhav bridge on which dozens of railway lines or roads run. Over 90% of the high-speed network 508 km long track will run on viaducts such as these, at heights of over 20 metres from the ground, making a journey in the bullet train a ride through the skies.

Typical 1-slab track has four key layers/components:
Rail bed, Rail, Cement Asphalt Mortar, Track Slab

SPECIAL TRACKS
The Mumbai-Ahmedabad High-Speed Rail Corridor adopts the Japanese 'Y' slab ballastless track system. It does not use loose stones/ballast like traditional railway tracks. Instead, the rails are fixed on a solid concrete structure (slab), similar to what Japan's Shinkansen uses

Work on the viaduct continues through the night. With it, the hum of machinery and a stream that flows out intermittently

21-km tunnel in Mumbai
The tunnel passes beneath the Thane creek. It is two major water pipelines and 600-mm gas pipeline.

The tunnel cuts through the Parsik hills. In some sections, the thickness of the rocks above the tunnel was 160 metres, but elsewhere, it would drop to as little as 20 metres. At one particularly sensitive point, officials said, only 4 metres separated the tunnel from the pipelines above.