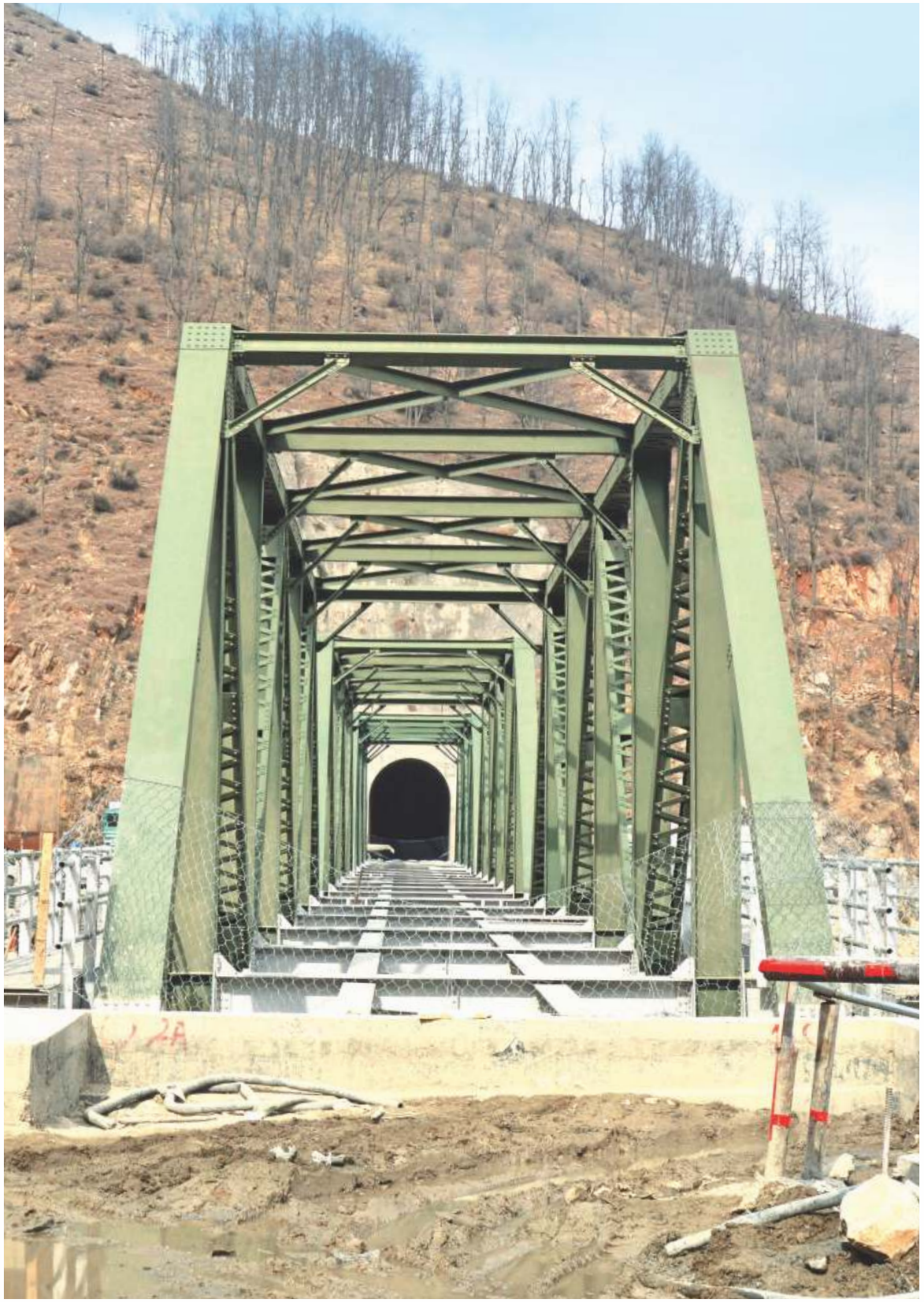

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the rail enthusiast

Vol. 3 No. 2 May 2018

The Rail Enthusiasts' Society Quarterly

THE RAIL ENTHUSIAST

RAIL TUNNELS

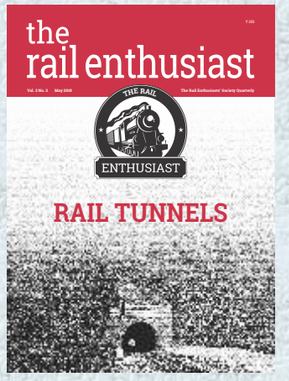
Boro Ghori

Big Ben of Howrah Station

Perhaps the most celebrated landmark of the Howrah Station complex is the "Boro Ghori" (meaning "Big Clock" in Bengali). Daily commuters fondly refer to it as the "Big Ben" of Howrah. This iconic clock is situated on the Eastern wall of the century-old Howrah station building, overlooking the Martyrs' Memorial, which is dedicated to the railway men who sacrificed their life during World War I. While commuters come and go, trains arrive and depart, Boro Ghori continues to mark time without a break since it was installed in 1926.

Manufactured by the Gent's of UK 92 years back, this legendry clock runs so accurately even today that almost a million passengers and about 600 trains using Howrah station on a daily basis run to its time. The twin-faced clock has dials measuring 45 inches in diameter and has an 18-inch long hour hand. The minute hand is 24 inches long. Its visibility across the old station complex is ensured as one of the dials faces platforms 1-8, while the other overlooks platforms 9-14.

- Sanjoy Mookerjee



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by the Rail Enthusiast &
for the Rail Enthusiast

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Musings of the Editor...

It was some time in 1955. With my parents and kid brother, we were travelling by train from Nasik Road (now Nashik Road) to Bombay (now Mumbai). I do not recall which train it was but it was daytime and the weather was the type when birds twitter and all's well with the world. While I had definitely travelled by train before, this is the first journey that I recall quite vividly. I was all of nine years old.

What is now AC 2-tier was then the First Class with no air-conditioning. The coaches did not have a corridor and each compartment opened directly onto the platform and each had its own toilet. There were coupes with two berths and compartments with 6 berths. We were in one of these 6-berthers and fortunately for us, no other passenger travelled that day; the entire compartment was the domain of us boys and our parents. Our mother kept admonishing us to stay away from the windows to prevent coal dust (those were steam days) to get into our eyes. Coal or no coal, there was no way we would remain away from the window to watch the scenery zoom past.

In no time, we were at Igatpuri. We had a long halt as the steam loco was being replaced by an electric one. Easing out of Igatpuri, the train meandered and wove its way over the 15-kilometer Thal ghat that separates Igatpuri from Kasara at the foot of the ghat. The Thal ghat is the passage that was cut through the Western Ghats by the Great Indian Peninsula Railway to extend the rail line from Bombay onto the Deccan plateau. From an altitude of 279 meters above sea level at Kasara, it climbs to 600 meters at Igatpuri, the ruling gradient being 1 in 37. Of course, we were travelling down the ghat but it was equally picturesque and exciting. What we looked forward to and where we imagined all kinds of demons to exist was inside the 13 tunnels on this section. The gentle clickety-clack of the train turned to a loud growl as we entered the tunnel and reverted to the same gentle sound on coming out. Darkness in the middle of the day added to the mystery of the tunnels.

Southern portal of Tunnel No. 49 of Kashmir Rail Link

After Kasara, the train picked up speed and sped quickly towards Mumbai. Just after the last major halt before Bombay, Kalyan, we had our climax – the over one and a half kilometer long Parsik tunnel. It took a little over a minute to cross. This tunnel, we learnt, was the first rail tunnel to be built in the country and was in use as early as 1854. The Thal ghat tunnels opened for traffic only about a decade later as did the tunnels of the Bhore ghat that take you from Bombay to Pune.

This line we were travelling on was one of the first lines built in the country. I feel that its most characteristic feature is the large number of tunnels that it has. However, while bridges that were built in this period, along with their history, are prominently written about and are the subject of many articles and stories, tunnels, though more difficult to build, remain relatively unsung and unheard of. The history of tunnels, or any other area for that matter, can gain salience and standing if characterized by presence, persistence and prominence. It is for this reason that we have dedicated this issue of ***The Rail Enthusiast*** *to "Rail Tunnels", the first time that we have a theme.*

Since the longest and most difficult tunnels are on the new line being built to link Kashmir to the rest of the country's rail network, we bring you a write-up on these tunnels and the difficulties faced in building them. We also bring you a similar article on the tunnels of the Konkan Railway, which boasted of the longest tunnels before the Kashmir link was taken up. We tell you of the tunnels of the Bhore Ghat that cut through the Western Ghats between Mumbai and Pune. We also cover a small insignificant tunnel near the town of Jamalpur in Eastern India. This tunnel happens to be the second oldest tunnel in the country to be opened, second only to the Parsik tunnel near Kalyan. Last but not the least, we talk of tunnelling required for metros. Although longer than normal rail tunnels, these are in a different category and are bored with the help of Tunnel Boring Machines.

A view of the viaduct of the Chenab bridge

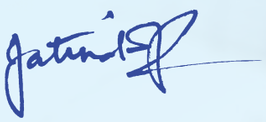
Ballast-less track in Karbude tunnel of Konkan Railway

Of course, although the theme of the magazine is tunnels, we have covered some other areas as well. Our photo-feature gives you glimpses through stunning photographs of a remarkable steel arch bridge being built across the Chenab River as part of the Kashmir Rail Link. At the same time, we also tell you of a very commendable work of restoration of a bridge that had been severely damaged and crippled in the Araku Valley on the Kothavalasa-Kirandul rail line.

The Indian Railways have international trains that run over Pakistan, Nepal and Bangladesh. We bring you a journey made by one of our members on the Maitree Express, the train that links India with Bangladesh.

We would like your opinion on the idea of having a theme for a particular issue. This is the first time we have attempted this. If you, the readers, like the idea, we can have every alternate magazine concentrating on one area of rail enthusiasm.

Happy reading and even happier rail fanning,



(J L Singh)
Editor

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USBRL
Tunnelling Saga – A Himalayan Wonder
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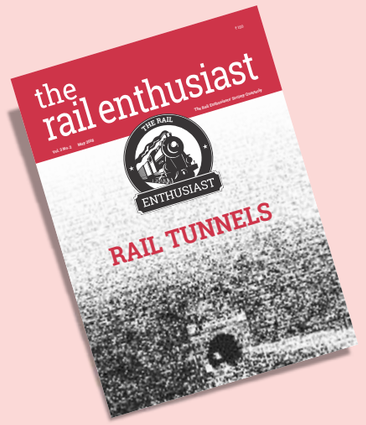
See news of the Jubilee Bridge North of Kolkata and try your knowledge of the railways through the Quiz complied by **Ashad Siddiqui**



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Sudakshina Kundu Mookerjee travelled to Dhaka by the Maitree Express that links India and Bangladesh. Her report on the trip makes you feel that you were part of it

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Feedback

Dear Editor

Thank You for the January 2018 issue of "the rail enthusiast" which has been read with relish from cover to cover, starting with the editorial which conveyed the content in a crisp all encompassing fashion.

To begin with, it was humbling to know about Iqbal Ahmed and his dedication to miniature models. A self-taught person of excellence to be so self-effacing is an example to us all. India has a great future. The other modellers are both impressive and indicate their love for Indian Railways cutting across age and culture. The nostalgia features by V Narayanan and Ranjit Mathur are impressive. The write up on Charni Road station's name is very interesting for its background to provide land for cattle grazing.

The excellent photo feature of railway travel with the night sky as a backdrop, evokes the feeling we all had long back in life, travelling and watching the sky from the window while others slept. Great photographs – just poetry. The back cover too is beautifully composed. If only one could imagine a train's whistle, you could think of "Pakeezah", "Dr. Zivago", "Bhowani Junction" or any old western movie of the Rail Road.

Lucknow Junction in the "Then &Now" feature is again a nostalgic look at history. A little more on Indo-Saracenic architecture would have been welcome. May we have more stories of railways from other countries like US, Canada, African and European countries, including Russia. In "News and Events", the photograph of the Dalali Lama and others riding a 1/8th model of a steam locomotive was very thoughtful and dramatic.

Overall, the entire magazine is improving from issue to issue and all concerned need

A semaphore signal against the night sky

to be congratulated. Only, for a non-rail person and layman like me, the abbreviations need to be expanded and where necessary, a foot note would be welcome. I could not understand abbreviations like EMU, WP, WD, DEMU, WG, etc. without the help of the Internet.

Yours Sincerely,
M M Mehta (through email)
09.03.2018

A train through Tiger country

Dear Editor,

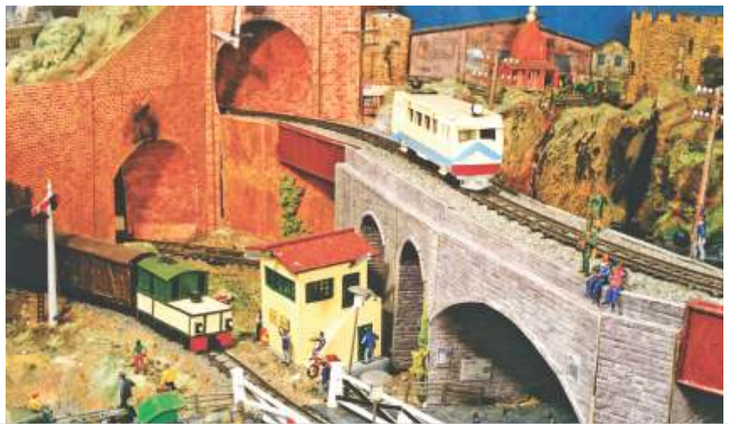
Hats off to Vikas Chander for the pictures that he has clicked for the Photo-feature. The only words I can find to describe them are out-of-this-world. Photographing the night sky is difficult enough. To do so in a rail setting adds to the difficulty.

I worked in the Dudhwa-Palia Kalan area for about a decade in the late 1980s and early 1990s. I always knew that the area was picturesque but the pictures in the photo-feature and in the article "Chasing Trains in Tiger Country" showed me that it takes more than living in a place to appreciate its true beauty. I feel tempted to visit the area again.

Changing the subject, I liked the write-up by Ranjit Mathur on train numbers. Although the current numbering was inevitable following computerisation, the kind of poetry the old numbering of the important trains had is missing now. The same goes for train names: a generic name like Chandigarh Shatabdi just cannot be compared to a powerful name like Frontier Mail or Toofan Express.

Looking forward to the next issue of the magazine,

Yours sincerely
S L Singh (through email)
03.03.2018



Dear Editor,

Ranjeev Dubey had stated in his article on rail modelling in Vol. 2, No. 3 that if the editor let him, he would tell us the story of using standard HO track and upgrading it to O scale for his Kalka-Shimla model. My humble request that you let him so that we can read about this.

Sincerely,
Prem Agarwal (through email)
29.03.2018

USBRL

The Kashmir Rail Link

The British built the railway in India to suit their financial, economic and military perceptions and interests. The lines built were both government as well as private. Local maharajas constructed and added their own railways to the network. When 42 of these diverse systems were brought together and amalgamated under the Indian Railways' umbrella following independence from Britain, about 53,000 kms. of track criss-crossed the nation. Be that as it may, there were still large expanses of the country which the railways did not touch. One of these was the Northernmost Indian state of Jammu and Kashmir (J&K).

At the time of Indian independence, the rail route nearest to J&K went as far as Mukerian in Punjab, to the North of Jalandhar city. The line was extended to Pathankot in 1952. The railway entered the state of J&K for the first time in 1971, when a new line from Pathankot to Jammu was opened. However, to move beyond Jammu into the Kashmir valley, the only mode of surface transportation then was and is even today, National Highway No. 1A, a road that is highly prone to landslides and traffic jams and is snow-bound in winter.

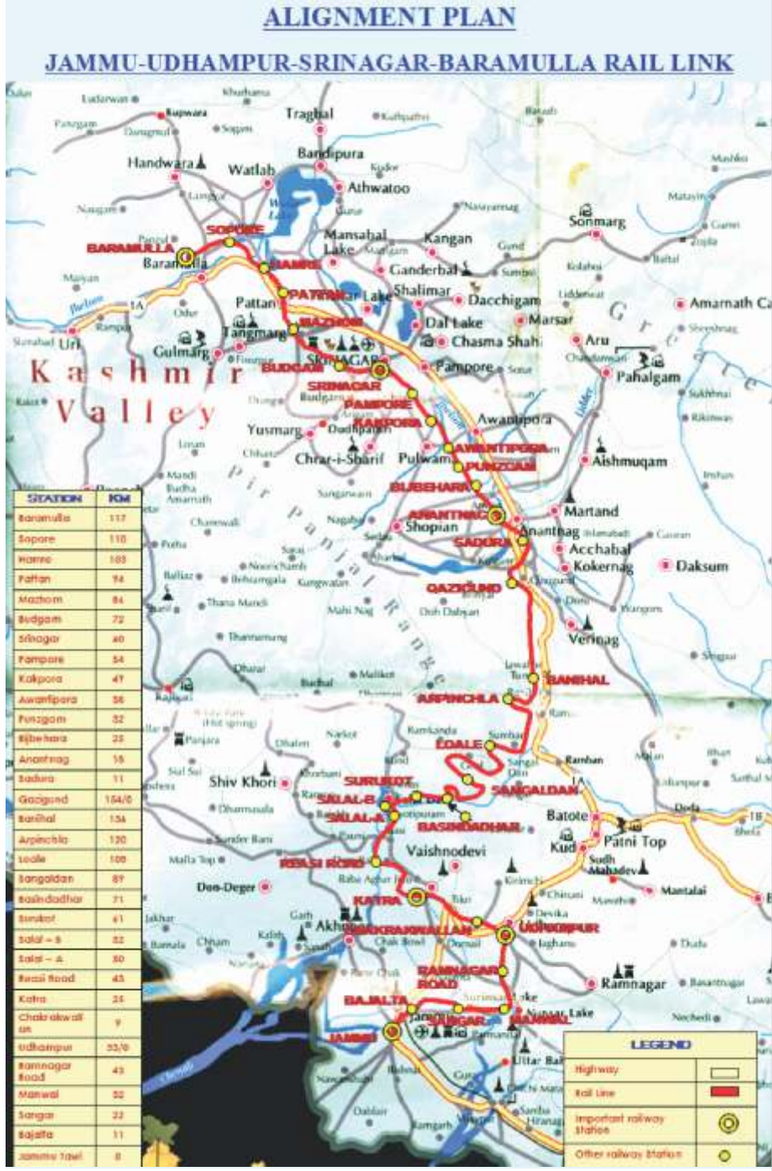
It was always accepted that the railway would provide a good alternative to the road but such a railway would need to pass through the Himalayas, comprising of young fold mountains with tectonic thrusts and faults. It was the difficulty of the terrain that had deterred the British earlier and independent India thereafter to either not consider or postpone the construction of such a rail link. It was only at the end of the 20th century that the idea of a line right into Kashmir took shape. Though the project for a rail link from Udhampur via Srinagar to Baramulla was included in the Railway Budget of 1994-95, it was only in 2002 that it was declared a "Project of National Importance". The actual idea, however, germinated much before that in the form of another project linking the 54 kms. from Jammu to Udhampur termed as the Jammu-Udhampur Rail Link project (JURL). This project was successfully commissioned in 2005. Following this, there was no looking back.

Entry to Pir Panjal tunnel

Panoramic view of Chenab viaduct

Constructing the link from Udhampur to Baramulla has been entrusted to the Indian Railways' Northern Railway zone, who have set up an organisation named the Udhampur-Srinagar-Baramulla-Rail-Link (USBRL) project to undertake the actual work. The project has been divided into 3 parts: Udhampur-Katra (25 kms.), Katra-Quazigund (129 kms.) and Quazigund-Baramulla (119 kms).

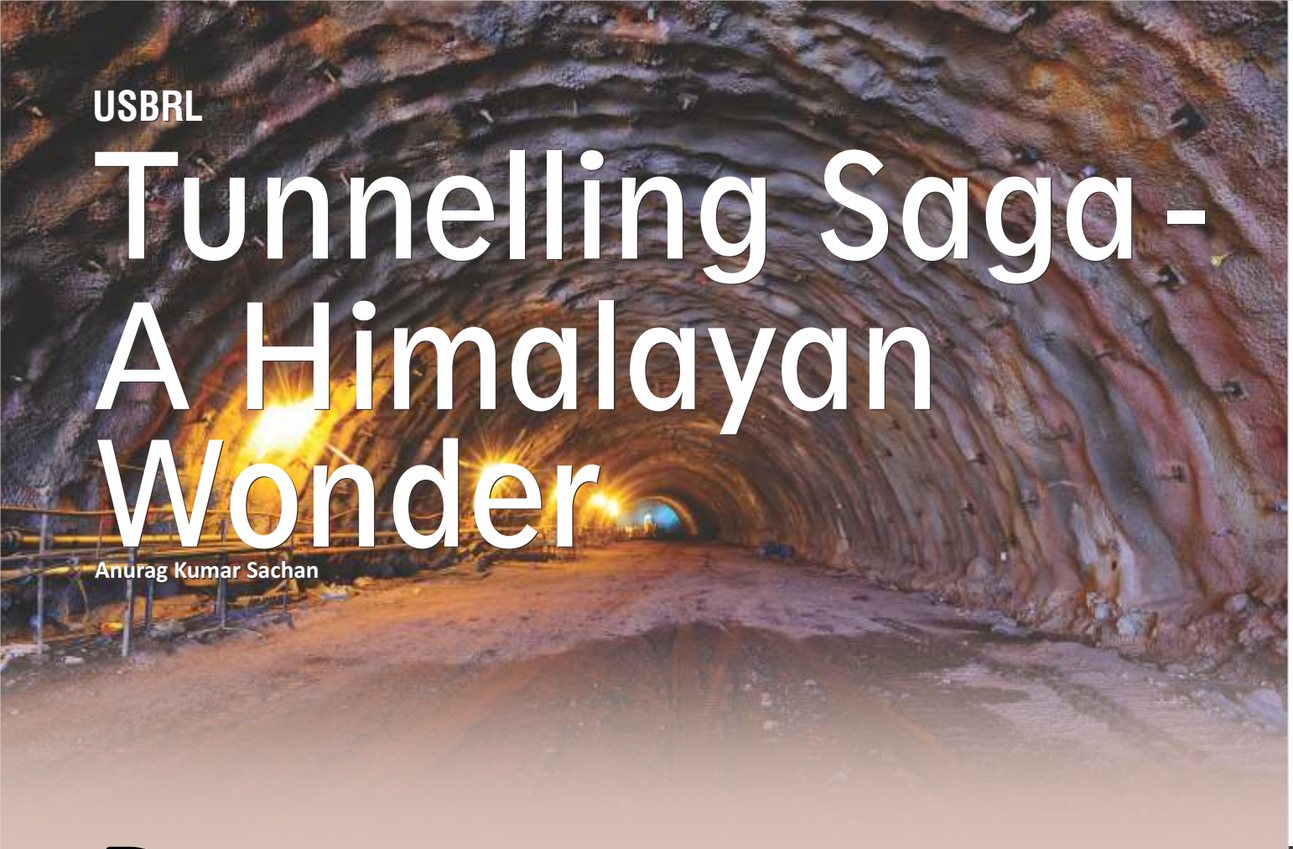
The last of these sections from Quazigund all the way to Baramulla via Srinagar was opened to the public in three stages by October 2009 (Please see map). Thus, trains are already running in Kashmir from Quazigund to Baramulla as a standalone system. In the meantime, the Udhampur-Katra section has also been completed so that to link the Kashmir Valley to the rest of the Indian Railways, it is only the Katra-Quazigund section that remains. The USBRL project team is now working on this section. It goes without saying that this is by far the most challenging part of the project. For instance, of its 129 kms. an astounding 103 kms. or 79.8% is tunnels. This means that 4 kilometers out of every five is a tunnel. The 103 kilometers comprises of 29 tunnels, including two of the longest in the country, the Pir Panjal (11.98 kms.) and the Sangaldan (7.1 kms.) tunnels.



Interspersed between the tunnels, the Katra-Quazigund section also requires bridges. Of these, the bridge over the Chenab River, being built near Salal village, is not only the most challenging but also spectacular, striking and splendid. This bridge will have a steel main arch to cross the river's gorge and a viaduct with steel girders on concrete peers. The rail height from the river bed of the steel arch will be 359 meters making this the highest such bridge in the world. Its single span of 465 meters across the river gives this bridge another significance: this is the longest single span railway arch bridge in the country.

Photos: Courtesy USBRL

Editor: *Please see the photo-feature on the Chenab bridge in this issue. While the Konkan Railway line was in itself a feather in the cap of Indian engineers, the USBRL project represents an even bigger and brighter feather. Both these projects are a culmination of a great tradition in the building of tunnels in the country, beginning with the single tunnel through the Parsik Hills near Kalyan and the tunnels of the Bhore Ghat that plunge up and through the Western Ghats between Mumbai and Pune. This issue of "The Rail Enthusiast" is dedicated to the men and women who designed and conceived these tunnels and to those who actually built them.*



USBRL

Tunnelling Saga - A Himalayan Wonder

Anurag Kumar Sachan

Down the millennia, the Northernmost Indian state, Jammu and Kashmir (J&K), has been the land of legends: a place where not only mystics and emperors but also traders and warriors were astounded by its sheer beauty. The entire state continues to fascinate scholars and laymen, travelers and poets, not to mention tourists and artists. Various twists and turns in its history and its geographical location have endowed it with a composite culture that is as unique, varied and mesmerizing as its topography. Though the Himalayan ranges shelter it from the bitter winter winds and temperatures of Central Asia, snow does regularly coat its hills and dales in the winter months.

Little wonder then that the country is rejoicing that this paradise of beauty is finally being linked to the rest of the nation by twin bands of steel, courtesy the Indian Railways. It will be some time before Jammu and Srinagar are connected directly, but for now the tracks of progress have already been laid within the Kashmir Valley, linking its North and South like never before, although they are still not connected to the rest of the Indian Railways network and work in isolation.

Bringing the railway to J&K has been one of the most challenging projects that the Indian Railways has ever contemplated and executed. When complete, it will link Jammu to Srinagar and beyond to Baramulla, but even the km. section from Katra to Quazigund, the second leg of the project. The 35 tunnels in this segment cover 80% of the route. Thus, with tunnelling and boring through various ranges being one of the prime concerns of the project, working methodology for tunnelling adopted is the New Austrian Tunnelling Method or NATM. It has often been referred to as a "design as you go" approach, by providing an optimised support based on observed ground conditions. More correctly, it can be described as a "design as you monitor" approach, based on observed convergence and divergence in the lining and mapping of prevailing rock conditions.

The first and third legs of Udampur to Katra (25 kms.) and Qazigund to Baramulla (119 kms.) respectively have been completed and commissioned. It is the middle leg that has almost all the tunnels. It also has a challenging bridge that is being built across the River Chenab.

Even before the Katra-Quazigund section was reached, the 25-km. Udhampur-Katra rail line was also an engineering feat. The ten tunnels of this section, covering 10.94 kms. were an engineering challenge owing to adverse weather conditions, rain-induced seepage, learning from segments within the Jammu region and Kashmir valley that have been completed are path-breaking tasks and certainly a big pat on the back of the Udhampur-Srinagar-Baramulla-Rail-Link (USBRL) project team of the Northern Railway zone of the Indian Railways.

The mighty Himalayas are a range of young fold mountains created as a result of collision of the Indo-Australian tectonic plate with the Eurasian plate as recently as 20 million years or so back and rock formation is a matrix, still in the process of stabilisation and metamorphism. Tectonic movements are regular features in the area. Folds and faults due to tectonic movements within the Himalayas have resulted in the region having igneous, metamorphic and sedimentary rock formations. The dominant rocks around the Kashmir Valley are volcanic and are known as 'Panjal traps', while in the Jammu region, limestone and dolomite of sedimentary genesis predominate in the initial reaches, which change to other varieties of metamorphic rocks towards Pir Panjal ranges. There are also three major thrusts and faults along the alignment which makes the whole region prone to seismicity. In fact, most of the alignment lies in Seismic Zone IV with a portion near Srinagar in Zone V. It is this topography that the Kashmir link has had to face and overcome.

The biggest challenge confronted by the 345-km. rail line is the construction of 103 kms. of tunnels in the middle 129-

Portal development

on-site trial and error and sinking in girders in a remote and tough terrain. There were various constraints such as allowable maximum speed, high gradients and sharp curves. In 2008, tunnels on this section faced seepage problems. The 3-km long tunnel near Udhampur was redesigned by an Austrian expert team after an intensive

Lining work in Tunnel T50

Tunnel T48. Loading and charging

geo-technical investigation and use of imported machinery. The problem lay in the swelling soil or layers of clay that acquire volume while absorbing water and contract when they dry out. The Udhampur-Katra section comprises of soft strata. So the tunnel roof was first strengthened and then the central rock mass was taken out. This is the heading and benching method, boring a small opening at the top, allowing a stand-in time with supports and then excavating further. For the extreme case of very soft strata, workmen used the multiple-drift method of advance, in which the individual drifts are reduced to a small size that are safe for excavation. Portions of the support are placed in each drift and progressively connected as the drifts are expanded. The central core is left unexcavated until sides and crown are safely supported, thus providing a convenient central buttress for bracing the temporary support in each individual drift. While obviously slow, the

Support fixing in Tunnel T49

Portal development work on Tunnel T49

Himalayan conditions still forced the adoption of the multi-drift method as a last resort. Due to tectonic movements and thrusting along major fault lines, engineers routinely encountered loose rocks with water gushing through them. The problems were successfully tackled and the section is now operational with trains running up to Katra.

The railway alignment passes through unstable geological formations and undulating terrain of the Shivalik and Trikuta ranges. Mounting the tracks was a mammoth task for engineers as they had to jump over rivers, *nullahs*, canals, channels, gorges and clefts. Design engineers faced the daunting and tricky task of erecting earthquake-proof piers and embankments. USBRL engaged external agencies for geo-technical investigations on seismic profiles, field and laboratory testing of soils and rocks. At many places, experts resorted to core drilling. They found varying strata. Based on known geological conditions, materials, properties and construction procedure, engineers divided the tunnel support system into five classes — good, fair, poor, very poor, over-burdened. They decided to provide permanent steel support along the length of each tunnel with a 300-mm thick concrete lining. 40% of the Udhampur-Katra route is covered by tunnels. There is ballast-less track running inside tunnels on this section.

On Katra-Quazigund section of 129 kms. length, 103 kms. kms. is tunnels. In spite of the best technology from around the world, human endurance and zeal is tested with this level of tunnelling. Tunnels apart, this stretch will have a 1.3-km. long bridge across the Chenab River at a height of 359 m above the river level and with a 467 m steel arch — undoubtedly an engineering marvel and connoted as the world highest Railway Arch Bridge.

On this section, wearing safety helmets, gum boots and bright orange jackets lined with fluorescent strips, a battery of young men work tirelessly 24×7 to see the light at the end of the 5.96-km. “horse shoe” shaped tunnel T5, the toughest in Reasi area. Tunnel T5 takes off from the proposed Reasi railway station, pierces the hilly terrain in the Gran village and is set to emerge at Bakkal village. It is

Tunnel T48. Wire mesh fixing

sunk 700 m from the hill top, despite challenges of the early days, when equipment had to be airlifted to the site. The 3-km. Dharam Khand tunnel No. 3 has been completed. In the case of this tunnel, fragile dolomite rocks intercepted with calcite intrusions were encountered. The biggest challenge in these rock layers is that they contain 70-80% of the water of Himalayan aquifers which ooze out through natural blowholes as cascading streams. When you blast through these pervious layers, the water just gushes out. Which is why the tunnel construction has been a hazardous and daunting proposition testing the knowledge and skill sets of the best engineers.

Tunnelling in Sangaldan area offered its own challenges. These included variegated geology, aquifers, inaccessibility and remoteness of sites. Sangaldan sits on the Muree fault line and the entire rock mass in the project area is, therefore, deformed. The presence of *nullahs* and fresh water springs led to water ingress inside tunnels, sometimes at a force of 1,500 litres per second! Transporting heavy machinery to the site was a challenge as the old Dharamkund Bridge could only withstand payloads of 10 tonnes. So a new steel road bridge with a higher loading capacity was built in record time to cross the Chenab and facilitate the work at Sangaldan. At the Dharamkund site in Sangaldan the construction of Tunnel T48 is in progress. Owing to different rock formations, each tunnel in the area needed a different strategy for its construction.

The longest tunnel in India today is the Pir Panjal tunnel, No. T80, in the Katra-Quazigund section. This 11 kms. long tunnel has several firsts to its credit. Apart from being the longest tunnel, its 640 m deep drill holes for geo-technical investigations were the deepest drilled. This tunnel also saw the first large scale use of NATM and the first use of 'road header' for 'tunnel excavation' in railway tunnelling. Above all, this tunnel has the highest 'over-burden' of 1140 m. The 'overburden' is the mountain strata above a tunnel. Watching the engineers managing the affairs of the tunnel, from the lighting system to the movement of 25 jet fans installed for air circulation, it is worthwhile to recollect the days when this tunnel was under construction and cynics often questioned the possibility of a train ever reaching the Kashmir Valley through the stubborn mountains. It is beyond imagination that the tunnel, which has a dry tarmac now, was at one point of time a rivulet of gushing water. During the excavations, the water-soaked bottom of the mountain seeped from every gap, releasing water jets at 150 to 180 litres per second. It took as much as three months to drain the water physically. Maybe facts and figures will enable a better understanding: the tunnel uses 7,500 metric tonnes of steel and 3,28,000 cubic metres of concrete. More than a million cubic metres of soil have been displaced, enough to build a flyover in a city. For years, an army of 2,000 workers, each 20 supervised by a trained engineer, worked round the clock to drill the mountain. The straight and flawless tunnel runs in the North-South direction and perhaps is the first to have automatic ventilation and lighting.

Wire mesh fixing and drilling activity in Tunnel T49

Adit area

During the eventful seven years of excavation required for building of this tunnel, the rugged, rocky and mostly uninhabited terrain posed extraordinary challenges to the engineers and the workers. It was a huge task to carry the men and machinery to the places where angels feared to tread. Even the machines encountered diverse kinds of challenges. At one place the drill bits pierced through the rocks of one texture only to encounter even tougher rocks encircling it. Sometimes a blast extended its limit and forced the crew to work on what had not been anticipated. At times, road headers equipped with cutting blades failed to raze through, forcing engineers to employ the drill-and-blast method. The tunnel is today illuminated like a shrine and travelling through it is great fun. Visitors may not believe that during the construction phase, water flooded the chambers to such an extent that the workers had to ferry men and material inside on a boat.

Building of approach road to Sumber

Work in Tunnel T48

It would appear that the Sumber leg of tunnel T49 is going to surpass the Pir Panjal tunnel as the longest transportation tunnel at 12.76 kms. However, it is actually supposed to be 5.1 kms. only. Remaining 7.66 kms., commencing from Arpinchalla area, has two offshoots technically called Adits at Hingni and Kundan areas to

A boomer in escape Tunnel T48

View of Tunnel T49 after lining

provide additional working fronts for both, the main tunnel and escape tunnels, and subsequently to serve as a rescue and restoration arm in disaster management. Ventilation ducts have been put up to get in fresh air for the workers at the construction stage as per international standards. The main tunnel is 8 m wide while the escape chute spans 5 m. According to international standards, any tunnel longer than 3 kms. requires an escape tunnel for emergency and rescue and restoration operations. After every 375 m, there is a cross passage connecting the two tunnels. This is generally considered a nominal distance for rescue acts. The terrain here is mountainous with V-shaped valleys, deeply incised since the last glaciations. The work on the tunnel is under way at five separate sites. It is quite a spectacle to watch the engineers and geologists working in tandem to earmark the portion to be excavated for another face opening of this tunnel at Arpinchalla station yard. The portion around the arch, which will in time become the mouth of the tunnel, has been reinforced to avoid crumbling of rocks. A continued effort of 24 hours results in carving just a meter due to geological imponderables and surprises associated with young fold mountains of the Himalayas. Before cutting into the rock face, the pipe-roofing is quite a challenge. The engineers earmark a semi-circle and drill 114 mm steel pipes deep inside the rocks, each 40 cms. apart. These pipes hold up the arch, absorb the stresses and equalise the massive overburden when the earth is gouged out from the tunnel. The pipe-roofing process is a tedious task consuming valuable time period to the extent of 3 days. Despite extreme caution to hold the overburden, the rocks sometimes crumble and even smash the pipes.

The 129-km. stretch of the Katra-Quazigund section, where work is in progress, is the toughest part of the entire project. Unbelievable as it may sound, but 103 kms. of the track will pass through 29 tunnels and the balance length jump over 37 bridges and station yards. Thus, the building of the rail line to link the Kashmir Valley to the rest of the country is not only a tunnelling saga through the Himalayas but also one of Himalayan proportions.

Loading and charging of explosives in Tunnel T13

Tunnel T80

Train emerging from Pir Panjal Tunnel

Pir Panjal Tunnel in winter

Photos: Courtesy USBRL project

About the author:
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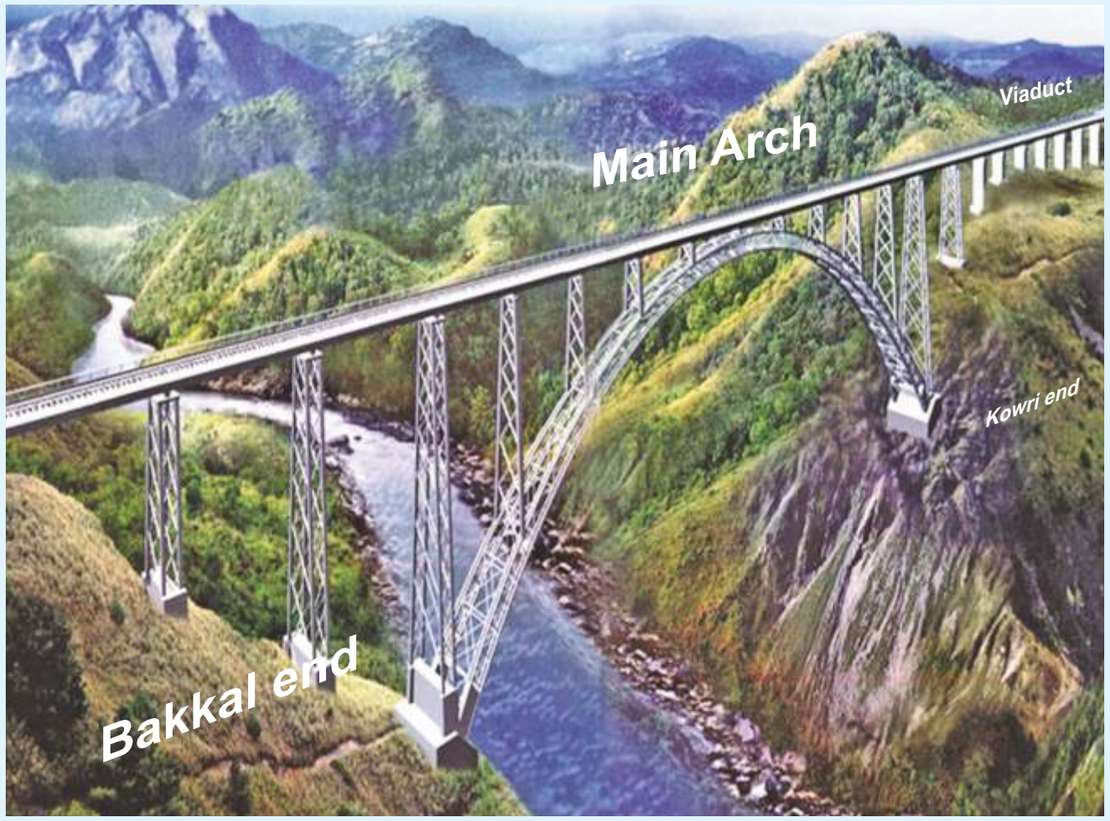
Inauguration of Pir Panjal Tunnel

Bridging the Chenab

Relaxing in the comfort of a train as it crosses a bridge does not a give a complete view of the bridge and the effort that went into building it. The Udhampur-Srinagar-Baramulla-Rail-Link (USBRL) has corrected this by presenting us with a set of remarkable and breathtaking pictures of the 1,315-meter bridge across the Chenab River while it is being constructed. While the tunnels of the rail link are breaking all records of tunnels on the Indian Railways, this bridge is set to become the highest steel arch bridge in the world when complete. Apart from its 359 meters arch height, the 465-meter length of the single span arch is also a record for the Indian Railways. Once the bridge is complete, it will be possible to travel by train directly into Srinagar from any station in the country.

An artist's impression of the bridge on this page gives an idea of the terrain and topography of the land where the bridge is being erected. The unstable geology of the Himalayan mountain range, the altitude at which the work is being done and the remoteness of the site add to the challenges that the construction team is facing.

All photos are courtesy USBRL.



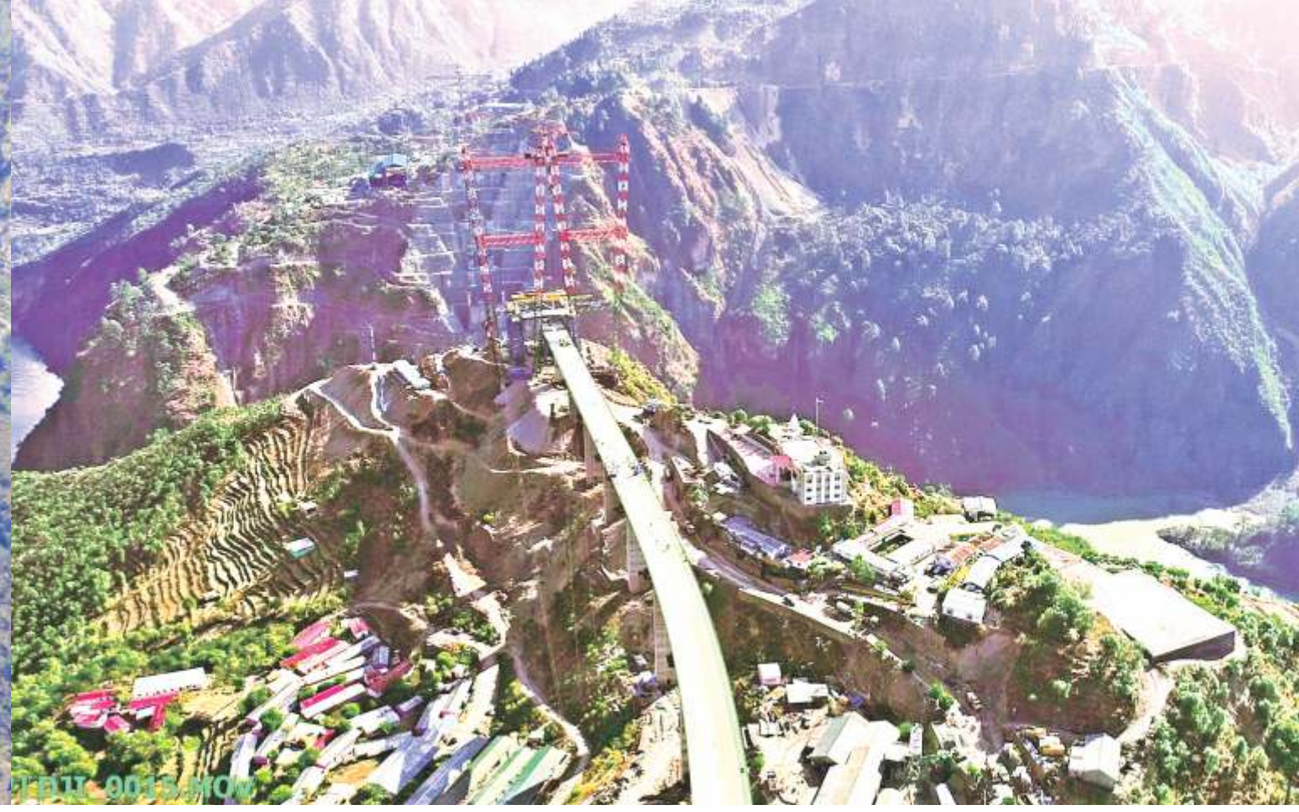


Photo Captions

Page 16 *Artist's view of the Chenab Bridge when complete*

Page 17 *Birds-eye view of the viaduct*

Pages 18-19 *The viaduct at the Kowri end of the bridge*

Pages 20-21 *Valley of the Chenab as seen in the direction of water flow*

Pages 22-23 *The same valley as seen downstream from the location of the bridge*

Page 24 *(Top) Turning of a viaduct segment during its construction*

Page 24 *(Bottom) Placing of the base segment of the arch of the Chenab bridge*

Page 25 *(Top) A view of the Kowri end of the bridge. The start of the viaduct can be seen at the right of the picture*

Page 25 *(Bottom) The foundation pier*

Page 26 *(Top) The under-construction bridge as seen from the Bakkal side end*

Page 27 *(Top) A panoramic spectacle of the bridge. The viaduct can be seen in the foreground*

Pages 26-27 *(Bottom) Another view of the viaduct, it's concrete piers clearly visible*

Back cover *Bridge No. 142 on the Katra-Banihal section*

Konkan Railway

Tunnelling along the West Coast

Joseph George

When the sun finally set upon the British Indian Empire and rose anew over the vast expanse of the newly independent Indian nation, it shone brightly on 53,596 kilometers of railway lines that crisscrossed the length and breadth of the fledgling sovereign state, fashioning a network that reached its every nook and corner. Or did it…?

A cursory glance of a 1947 map of the railways in India would indeed appear to cover the entire country with a rail network, but further scrutiny would indicate large expanses which the iron rails had not reached. One of the more prominent of these areas was the West coast of India South of Bombay (now Mumbai). While the belt along the Bay of Bengal on the Eastern coast had a rail line all the way from Calcutta (now Kolkata) to Madras (now Chennai), there was a big gap when you travelled South from Bombay along the Konkan coast towards Goa and beyond through what is now Karnataka. There was no direct rail link between Bombay and Mangalore (now Mangaluru) in the South.

It was only in the 1980s that such a rail link, aptly named Konkan Railway, was planned. The construction and subsequent operation was entrusted to the Konkan Railway Corporation Ltd. (KRCL) but the term Konkan Railway is commonly used. The building of the railway was taken up thereafter and the first passenger train ran between Mangalore and Udupi on the 20th of March 1993.

Thiruvananthapuram Rajdhani Express emerging from the Ukshi tunnel

Construction was completed on the 739-kilometer line with the flagging off of the first passenger train to cover the whole route on 26th January 1998.

The reasons why this stretch was overlooked by the British and it took four decades after Indian independence for it to be finally linked by rail are not far to seek. The line was not built as it posed enormous challenges, the most prominent being the number, extent and complexity of tunnels it would require. Of its 739 kilometers, almost 85 kilometers or 11.5% of the total route is tunnels. These 85 kilometers comprise of 91 tunnels, 7 of which are more than 2 kilometers long. Till the commissioning of tunnels on the

Profile marking for initial blast

Work in progress in a hard rock tunnel

rail link to Kashmir, the Karbude tunnel of Konkan Railway, at 6.501 kilometers, was the longest on the Indian sub-continent. Other long tunnels include the Nathuwadi (4.389 kms.), Tile (4.077 kms.) and Berdewadi (3.976 kms.). Thus, the saga of the construction of Konkan Railway is one of boring, drilling, cutting and dynamiting your way through arms and tentacles of the Western Ghats that came in the path of the rail line. The 179 major and 1701 minor bridges on the route were also a challenge but the cumulative length of all these bridges is only around 25 kilometers; not a patch on the 85 kilometers the tunnels are covering.

In the Foreword to Christian Wolmar's recently published *Railways of the Raj*, Monisha Rajesh refers to the Konkan Railways as “the missing link that the British were too frightened to attempt building”. The importance of tunnelling to Konkan Railway is reflected in its logo: the shape is the cross-section of a tunnel.

Even when the project was being conceived, it was envisaged that tunnelling would be a critical activity. The many uncertainties and unforeseen problems encountered delayed these works much beyond the deadlines set. This was in spite of the fact that most of the long tunnels were through hard rock and did not give rise to too many unforeseen problems that tunnels through soft soil presented. A clear strategy was required to be in place before execution including decisions on the section of the tunnel, methodology of execution, machinery to be deployed, etc. It was decided at the planning stage itself that the tunnel sections would be suitable for future electrification. Standard sections were prepared for unlined tunnels on straight and curves. Similarly, standard

Ballast-less track in Karbude tunnel

Ventilation fan for Karbude tunnel

sections were developed for lined sections on straight and curves. All tunnels longer than 2 kms. were mostly on a straight alignment. These tunnels were provided with ballastless track.

Given the experience of fumes in long tunnels on Indian Railways, it was decided to provide artificial forced ventilation for tunnels that were longer than 2 kms. on Konkan Railway. All tunnels have been provided with lighting; to conserve electricity, all light fittings have recently been replaced with LED.

To expedite excavation for tunnelling in hard rock, Konkan Railway, after scrutiny of tunnelling machinery in the international market, chose the Atlas Copco jumbo drills and Hagglund loaders that were manufactured in Sweden. For movement, these machines use diesel power while for drilling and removal of excavated debris, they use electrical energy. The latter avoided building up of fumes inside the tunnels while working.

Even before construction began, soil investigation was carried out for all tunnels. Soil investigation was necessary to determine the type of section, execution method and supports required. Strata were determined by boring and actual collection of samples. While in most cases the nature of strata was correct, in a few cases like the Pernem tunnel, there was variation in the cross section plotted after collecting samples. This was because the boring was stopped after rock was encountered and was not continued till the formation level. In locations where it was indicated as rock, soil was encountered. The frequent changes in strata required changes in methodology of execution, supports required, etc. This was further complicated by considerable amount of seepage water. These factors delayed completion of this tunnel.

Tunnelling method that was adopted for hard rock, jointed/fragmented rock and in soft homogenous rock was the full face method. In this method of advance, the entire diameter of the tunnel is excavated at one time. Advance was achieved by the drill and blast technique. Using conventional equipment, progress of around 100 to 120 meters per month was achieved. This was only possible because of availability of suitable customized machines

LED tunnel lighting

An excavator at work inside a tunnel

that could work in tunnels with our dimensions. Hydraulic excavator manufacturers in India like L&T and Tata Hitachi built smaller excavators with modified arms that could turn within the width of the tunnel. These equipments facilitated faster mucking or removal of debris of blasted material.

To tackle longer tunnels, Atlas Copco jumbo drills and Hagglund electro hydraulic digging arms and loaders that were imported from Sweden were used. These were

procured by Konkan Railway and were used in 10 of our tunnels. The Atlas Copco jumbo drill worked very satisfactorily. It was equipped with two drills of 45 mm diameter which could complete a 4 m hole in two minutes. Standard explosives available initially were of 32 mm diameter and subsequently 40 mm diameter slurry explosives were introduced to suit the holes made by the Atlas Copco jumbo drill. Usage of these explosives reduced their requirement per blast and also less fumes were generated. This reduced the cycle time of each operation, as the time required for clearing of fumes was lower when compared with conventional 32 mm diameter explosives and therefore mucking time also reduced.

A typical drill blast and mucking method consists of preparation of face, drilling, charging of explosives, blasting and scaling of fractured rock after blast. This whole process constitutes a cycle. Cycle time in the conventional method varied from 25 hrs. to 30 hrs. and with a monthly progress of around 45 to 70 m being achieved. Using the Atlas Copco jumbo drill and Hagglund loader, the cycle time could be brought down to less than 12 hours. The least cycle time recorded was 4 hours 25 minutes in Nathuwadi tunnel with progress of 180 m being achieved in 1995.

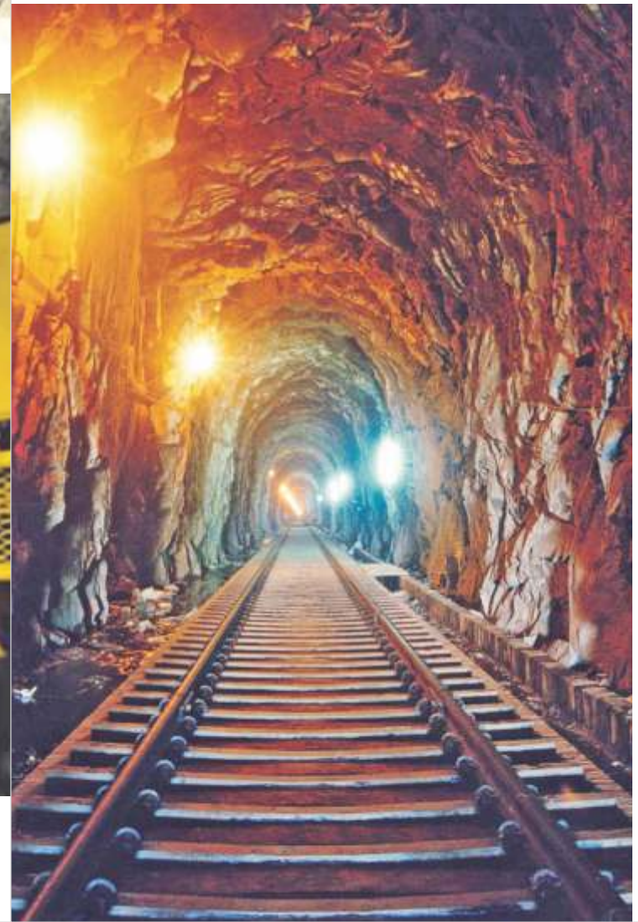
Hagglund loader moving into a tunnel

Atlas Copco jumbo drill

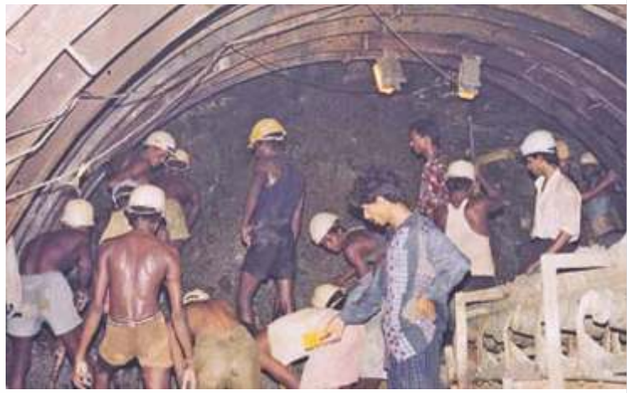
In spite of the advantages of the imported equipment, there was reluctance on the part of contractors to use it; they preferred to drill/blast in hard rock with conventional equipment. This was owing to the cost of operation of these imported machines being comparatively more when compared to conventional drill blast techniques due to the cost of spares, consumables, water and electricity required for operation of these machines. Thus, only 19.06 kms. of hard rock tunnelling was completed using Atlas Copco drill jumbos. This was around 25.5% of the total hard rock tunnelling, the balance being completed using conventional equipment.

Areas where loose fragmental rock, soft rock and highly jointed rock was encountered were provided with steel supports and lining of rock bolting & shotcreting. Rock bolting is a means of rock reinforcement used to stabilize excavated rock in tunnelling. Rock bolts are arranged so as to transfer the load from the unstable part of the rock to the stronger interior part. Shotcreting is spraying of concrete or mortar pneumatically through a hose at high velocity onto a surface, as a strengthening and construction method. After completion of the project, unlined portion of rock tunnels were rock bolted and shortcreted in a phased manner to avoid any loose fall during train operations.

Nathuvade tunnel



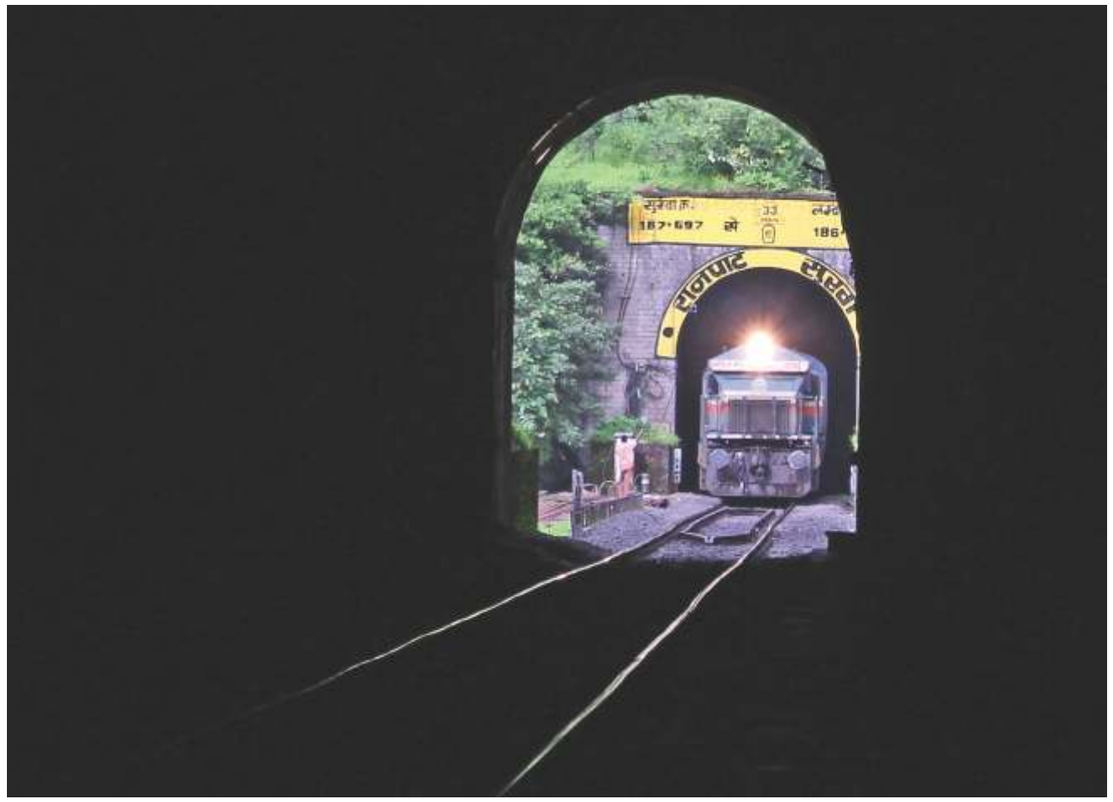
Of the 84.80 kms. of tunnelling, only 6.98 kms. was through soft soil, which was around 8% of the total tunnelling done on Konkan Railway. But even with this short length, it was the completion of these soft soil tunnels that delayed & determined the date of completion of the line. There were seven tunnels where considerable length of soft soil was encountered. Four of these tunnels were in Goa (Pernem, Old Goa, Verna and Padi) and three in Karanataka (Byndoor, Honnavar & Bhatkal tunnels).



Heading work in progress

Benching work being undertaken

The problem with soft soil is the stand up time, which is the amount of time a newly excavated cavity can support itself without any added structures. Stand up time in soft soil, which is obviously lower than hard rock, reduces when it mixes with seepage water and reduces even further during the monsoon when seepage increases considerably. With the experience of tunnels constructed in soft soil on Indian



Ranpat tunnel between Ukshi and Bhoke stations

Railways, a two stage process was adopted in its execution on Konkan Railway, i.e. heading & benching. In large tunnels with soft soil, the heading and benching method is appropriate. This method involves the driving of the top portion of the tunnel in advance of the bottom portion. Heading was done in the top semicircular portion of the tunnel where height is about 3.4 m and width around 6.4 m. It is difficult to get in a hydraulic excavator in this area; hence only man power and other digging tools could be deployed for excavation. Tippers were used for moving out the excavated earth. The excavation was progressed in stages of 0.5 m or even less depending on standup time after which appropriate arch sections were placed and connected to the previous arch section through tie rods. At the spring level of the arch rib, they were connected through suitable wall plates. Between the steel arch ribs, concrete laggings were placed. The gap behind the lagging and the excavated earth was filled with rubble. After proceeding for about 50 m in heading, benching was started. Benching was taken up meter by meter using small excavators. During benching again, depending on the strata and stand up time, the length of bench cut had to be reduced. Each column was connected by tie rods. The gap between the laggings and excavated earth was filled with boulders. This was then followed by concrete lining along the sides of the arch. This was the standard method for soft soil tunnels that was initially adopted.

However, even with this method, owing to water ingress and poor soil conditions being encountered, the stand up time was inadequate to place supports. We were required to go in for a number of modifications to the standard methodology and steel supporting in soft soil. The arch roof collapsed even before it could be supported. To address this, we went in for forepoling and when this also did not work, to drift tunnelling. Forepoling is a method of advancing a tunnel in loose, caving or soft watery soil, by driving sharp-pointed poles, timbers, sections of steel or slabs into the ground ahead of or simultaneously with the excavating. Drift method of tunnelling is such that tunnelling is carried out first in a smaller section of the proposed tunnel and then widened. With these methods too, progress was only a few centimeters at a time. When drift tunnelling also failed, extensive grouting was done and then the drift was again attempted. Owing to repeated failures and slow progress, Konkan Railway even needed major changes in the original design of the tunnels. Even after all these changes, we had collapses, particularly in the Pernem & Old Goa tunnels. This was because after heavy ingress of water, the soil mass separated from the hill and resulted in transfer of loads on to the steel support leading to collapses. The entire work had to be redone, sometimes many times over. Even benching was required to be done in stages when water ingress was high. Because of repeated failures in these tunnels and the cost involved in restoration, the contractors who took up the work gave up and the work had to be finally taken up directly by Konkan Railway. Ultimately, owing to the perseverance and dedication of the workmen, contractors and engineers progress was achieved slowly but surely. Completion of soft soil tunnels is a story of grit and determination in spite of repeated failures.

It is this extensive experience on Konkan Railway in tunnelling that played a role in choosing the right methodology and machinery for tunnelling for the Delhi Metro Rail Corporation Ltd. (DMRC), other metros across the country, Maharashtra State Road Development Corporation Ltd. (MSRDC) road tunnels and for tunnelling for the rail line to the Kashmir valley. A number of Konkan Railway Engineers who worked on tunnels had moved over to DMRC and other metro tunnelling works. Their experience has played a role in completion of tunnelling works in these projects expeditiously. Because of Konkan Railway's experience, tunnelling works in the Mumbai-Pune Express Way were given by nomination and they were successfully completed. Today, Konkan Railway personnel are working in Jammu and Kashmir for the rail link to Kashmir, where again a number of challenges with regard to tunnels are being addressed.

Shield tunnelling blades being assembled

The 84.80 kms. of tunnelling over Konkan Railway through some of the most challenging strata has given necessary and appropriate experience to the engineers and contractors in the country. This bodes well for the future as more projects are taken up in areas where tunnelling will be a necessary part of the road or rail link to be built. In other words, Konkan Railway is the pioneer who has upgraded and uplifted the nation's tunnelling technology and the ability to build any tunnel anywhere.

Photos: Courtesy Konkan Rail Corporation Ltd.

About the author:

Joseph George is currently the Chief Manager of Konkan Railway looking after strategic planning and business development. He was fully involved in the construction of some of the Konkan Railway tunnels

Completed South face portal of shield tunnel at Honnavar

Mumbai to Pune

The Bhore Ghat

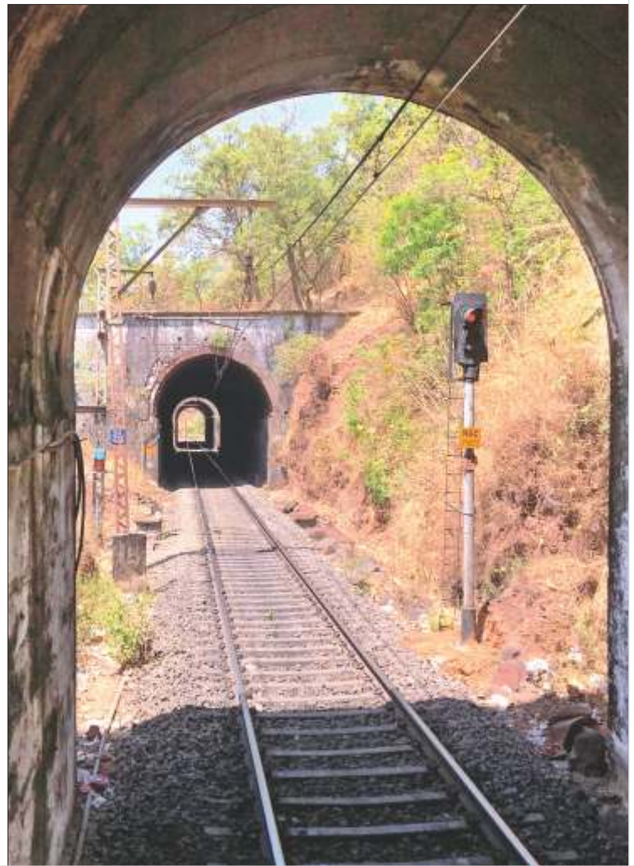
Ashish P. Kuvelkar

To the uninitiated, the word “Ghat” can be very bewildering. Literally, the word refers to steps that lead to a sacred river bank for the devout to take a dip and wash away their sins. The range of hills that runs along the West coast of India is a series of successively higher ridges as you move from the narrow coastal plains to the inland Deccan plateau. The ridges are like successively higher steps climbing to the crest of the range, leading to the latter being named the Western Ghats. There is a similar range along the East coast of the country which is aptly dubbed the Eastern Ghats.

Be that as it may, in Indian rail lexicon, the word “ghat” refers to any rail section where there is a steep incline. Such heavily graded sections are called “Ghat sections” and many have individual names. Among the best known ghat sections are the lines that move inland from the West coast through and up the Western Ghats. Thus, the rail line from Goa that ascends towards Hubbali through the Western Ghats is named the Braganza Ghat, the one from Mumbai to Nashik is referred to as the Thal Ghat, while the line from Mumbai to Pune is the Bhore Ghat. Obviously, since you bore through the hills on ghat sections, all have their share of tunnels.

Ashish P. Kuvelkar sheds light on the building of the Bhore Ghat and its tunnels...

Tunnels No. 30, 31, 32 of the Bhore Ghat



April 16, 1853 was a momentous epoch-making day and one to remember for the railways in India. This was the day when the Great Indian Peninsula Railway (GIPR) ran the first train in the country from Bombay's Bori Bandar near the present day Chhatrapati Shivaji Terminus (earlier Victoria Terminus or VT) to Thane. A small beginning of a mere 32 kilometres but which today extends to all corners of the sub-continent.

For extending this line to Pune, it was necessary to scale the Western Ghats, a range of hills that runs parallel to the West coast of the Indian peninsula. By the year 1856, the line from Bombay VT was extended via Kalyan up to Khopoli, which is at the foot of the Western Ghats. In 1858, the railway line from Khandala to Pune was opened to traffic. Khandala lies at the summit of the ghat section. The Khapoli to Khandala section was the Bhore Ghat.

The line through the Bhore Ghat was the missing link that would have connected Bombay to Pune and then onwards to cities in the Southern states of India. In 1853, the then Governor General, Lord Dalhousie, asked GIPR to work out the possible routes through the Western Ghats. The Chief Engineer of GIPR, James John Berkley, along with his assistants, conducted a detailed survey under difficult conditions. They collected evidence to the effect that the best routes would be two lines through the Bhore Ghat and the Thal Ghat, a little to the North. Subsequently, the Bhore Ghat was selected and over three thousand maps, drawings and cross sections were made that laid out the precise route to be followed through it. To limit the gradient to 1 in 37 and thus within the tractive power of the mid-nineteenth-century steam locomotives, a reversing station was proposed.

The construction of the line through the Bhore Ghat began in January of 1856 and took almost eight years to complete. The building of the line between Palasdhari and Khandala resulted in boring 25 tunnels, building eight arched masonry viaducts, cutting 54 million cubic feet of hard rock and embanking 67.5 million cubic feet of material, with some of the embankments being more than 60 feet high. The line was officially opened by the then Governor of Bombay, Mr. Bartle Frere, at a grand ceremony held at Khandala on April 21, 1863.

From the perspective of laying the line and boring tunnels along it, the Bhore Ghat section can be divided into four distinct phases as seen over the timeline from 1856 till date.

Phase 1: Laying the line

When the line was laid for the first time, 25 tunnels were bored and the alignment included a reversing station in order to keep the gradient limited to 1 in 37, which was necessitated owing to the limited hauling power of the steam locomotives of those days. As the name suggests, a train passing through the reversing station reverses its direction of travel to proceed towards its destination at a higher elevation. This means of gaining height is commonly used on the Darjeeling Himalayan Railway, where double reversals are done on what are called 'Z' crossings. The Bhore Ghat did not have scissors crossings but only one reversal.

It will not be out of place to mention that among the mountain railways in India, the Darjeeling Himalayan Railway (DHR) is unique as it has no tunnels. This is owing to the alignment of the railway following the old Hill Cart Road. To take care of the steep gradients of the Hill Cart Road, the DHR resorted to introducing Z-crossings where the train backed onto higher altitudes. The Z-crossings are also referred to as Scissors crossings.

Phase 2: Elimination of Reversing Station

As electric traction became available, the line in Bhore Ghat too was electrified. Since electric locomotives were more powerful, the reversing station was no longer required. Consequently, the alignment was changed, resulting in closure of one tunnel (which was later used for laying a road) and boring of three new tunnels. This work along with electrification of the line was inaugurated in 1929. An inauguration ceremony at the Khandala end of the last tunnel marked the occasion.

A plaque was put on the said tunnel. It reads:

TUNNEL Nos. 26 & 25
WITH ADJOINING FORMATIONS ETC.
FOR THE BHORE GHAT ALIGNMENT
ELEMINATING THE REVERSING STATION
CARRIED OUT IN 1926-28
AT A COST OF ABOUT Rs. 44.6 LACS BY
THE TATA CONSTRUCTION CO. LTD.

Phase 3: Realignment for widening track centres

Sometime in the mid-1940s, IR started using coaches with wider bodies, which meant that the moving dimensions became wider. The track centres of adjoining tracks were 12 feet apart, which had to be increased to 15 feet 6 inches. The work relating to removal of infringements in the Bhore Ghat was sanctioned in January 1946 at a cost of Rs. 13,10,30,014. The project consisted of widening track centres with additional allowance on curves and included widening of six tunnels between Palasdhari and Jambrung, i.e. in the lower ghat section.

Bakhle Plaque

A plaque commemorating this project is present on the portal of Tunnel No. 6. It reads, “Opened on 23-1-1951 by Shrimati K. C. Bakhle, Wife of the Chief Commissioner for Railways”. The Chief Commissioner for Railways of those days was equivalent to the present-day Chairman of the Indian Railway Board.

Phase 4: Laying of the Third line

As traffic in the Bhore Ghat increased, a need was felt in the mid-1970s to lay a third line between Karjat and Lonavla. With constraints in the ghats, it was not possible to find a straight alignment to lay the line. Thus, between Palasdhari

Tunnel No 49 (25C) with year of construction

and Jambrung, the 3rd line was laid, at places, between the existing two lines. Between Palasdhari and Monkey Hill, the line was laid on a diversion to the right hand side of the existing double line, bypassing Thakurwadi. A new cabin was created at Nagnath on this line. Between Monkey Hill and Khandala, the 3rd line was laid to the left hand side of the existing double line. The third line was completed in the year 1986. With the newer tunnels bored for the third line, the total number of tunnels in the Bhore Ghat increased to 52.

While most of these 52 tunnels carry a single line, 10 of them are wider and carry double lines. While the shortest tunnel is 21.61 meters long, the longest, Tunnel No. 49, is

Portal of service tunnel

Wall built around ventilation shaft of Tunnel No. 49

2156 meters in length. This tunnel was the longest tunnel on the Indian Railways till longer tunnels were bored on Konkan Railway. Tunnel No. 49 has two ventilation shafts to let out smoke accumulated in it. The picture at the bottom of the previous page shows the protecting well built around the opening of the shaft on top of the hill. Tunnel 49 also has a service tunnel to move men and material into it. The portal of the service tunnel can also be seen in the picture on the previous page.

The earliest tunnels in the Bhore Ghat were constructed using primitive construction equipment and techniques. The terrain was inhospitable, but that did not dampen the spirits of the Indian labourers working under the guidance of British engineers. One of the toughest railway lines in the world of that era was thus laid. While more difficult lines have been laid subsequently, it has to be remembered that this was a pioneering line, there was no previous experience and the kind of machinery and equipment available today was not there. Even what little equipment that did exist came from England.

Apart from this, roads were in very poor condition so that transporting material to the work sites was a herculean task. Most of the transportation by road in India at that time was done by bullock carts. Along with this, lack of skills, shortage of water, disease and snakes only compounded the problem. Estimates of deaths during the construction of this line have been as high as 25,000 and could be higher. It is felt that this may well be the deadliest line ever built if an accurate estimate of the deaths of the workforce during construction can be made.

Photos: Courtesy Apurva Bahadur & IRFCA

About the author:

Ashish P. Kuvelkar is an IT proffesional whose hobby is hiking along rail tracks. He can be reached at ashish_kuvelkar@yahoo.com

Scenic but difficult terrain of the Bhore Ghat

Heritage tag for railway bridge

SUBHAJOY ROY

Calcutta: The 130-year-old Jubilee Bridge near Bandel, through which trains ran till 2016, will be declared a heritage structure, railway board chairman Ashwani Lohani said on Sunday.

The railways will put up boards explaining the history and engineering of the bridge, Lohani said. A pathway will be built so that tourists can go till the bridge which stands over the Hooghly river, connecting Naihati (North 24-Parganas) and Bandel (Hooghly district).

Trains now ply through the new bridge — called Sampreeti — which has been built beside the old one. The new bridge has been modelled on Sydney Harbour Bridge.

The Jubilee Bridge that will be declared a heritage structure; (right) **the new bridge** (picture courtesy Eastern Railway) **with the Jubilee Bridge in the background**

The construction of Jubilee Bridge was started in 1882 and the structure was opened in 1887, on the occasion of the golden jubilee of the reign of Queen Victoria.

"It is a heritage bridge. We will turn it into a tourist centre...we will put up interpretation boards explaining the historical and technical significance of the structure," said Lohani. The project will be completed in three-four months.

"A lot of people are attracted to things related to the railways. We will also create a pathway to reach the bridge," said Lohani, who inspected the new and the old bridges with other railway officials.

The new bridge has been constructed at a cost of Rs 290 crore. "The bridge has open web steel bow-string-type structure, resembling the famous Sydney Harbour Bridge. This is the only such structure in India," an Eastern Railway official said.

From "The Telegraph" of 5th March 2018

"Test your Rail Knowledge"

We will be asking you 10 questions in each issue for you to be able to test your knowledge of the history and other aspects of the railways.

1. Which is the Highest Broad Gauge Railway Station in India?
2. The world's oldest working steam locomotive is said to be Fairy Queen. There is a sister locomotive, now restored, which may also claim the title as the Oldest Working Steam Locomotive. Just name it?
3. The first indigenously built steam loco No. F-734 was built in 1895? Which Railway Workshop built it and for which Railway?
4. Coach numbers 9000 and 9001 were built in 1956 at the Matunga Workshop of Central Railway. What were these Twin Saloons mainly used for?
5. The Western Railway started this "Train" Service on May 5, 1992 which was a "First" of its kind in the World. What kind of Train?
6. Which was the First Train with Air-Conditioned coaches to be run in India?
7. Which entity, synonymous with railway travel in India, was co-founded by French author, Emile Moreau, and since the 1950s has been run by the Banerjee family, with its headquarters at Allahabad?
8. Where would you find India's deepest underground Metro station?
9. Apart from Darjeeling Himalayan Rly. and Kalka-Shimla Rly., which is the other "mountain" railway to get World Heritage status in India?
10. What unique feature connects the the following railway stations: Matunga in Mumbai, Gandhinagar in Jaipur, Chandragiri in Andhra Pradesh, Ajni in Nagpur and Netaji Bhavan Metro station (Kolkata)?

Answers

1. *Qazigund Railway Station, on the railway line in the Kashmir valley at an elevation of 1723 m.*
2. *Express. In fact, Indian Railways is planning to approach the Guinness Book and UNESCO to grant Express the same status as the Fairy Queen.*
3. *The Ajmer workshop for the Rajputana Malwa Railway.*
4. *For carrying the President of India. It has carried the first President, Dr. Rajendra Prasad, and even his successors, Dr. S Radhakrishnan, Dr. Zakir Hussain, V V Giri and Dr. N Sanjeeva Reddy. The brick-red saloon did not find any patrons after Dr. Reddy and was lying unused in the yard till Dr. Kalam travelled on it from Harnkot to Patna.*
5. *The world's first "ladies special" suburban train completed 25 years on 5th May 2017. It started between Churchgate and Borivali.*
6. *The first air-conditioned train was the Frontier Mail which was introduced in 1934 by BB&CI (Bombay, Baroda and Central India) which is now part of the Western Railway.*
7. *A. H. Wheeler (Bookseller)*
8. *Delhi Metro's Hauz Khas station. It is 29 metres deep.*
9. *Nilgiri Mountain Railway*
10. *The Railway Stations are run/operated entirely by Women Staff.*

Questions researched and presented by Ashad Siddiqui

Delhi Metro

The Tunnelling Story

Anuj Dayal

A Tunnel Boring Machine (TBM)

As Ram Khilawan stepped out nervously from the bustling New Delhi railway station, he wondered how he would reach his cousin's residence at the other end of the city. After all, his cousin had only instructed him to take the Metro but he couldn't readily spot the Metro anywhere outside the railway station.

Fortunately, within minutes, well-placed and precisely designed signage took him to the New Delhi Metro station and before Ram Khilawan appeared a new world of underground stations, trains and tunnels; something that the youngster from eastern Uttar Pradesh had never imagined.

Indeed, the Delhi Metro has today created a parallel universe beneath the busy streets and alleys of the city of New Delhi and its suburban towns: an underground web of tunnels, through which hundreds of Metro trains traverse everyday carrying lakhs of people to their chosen destinations.

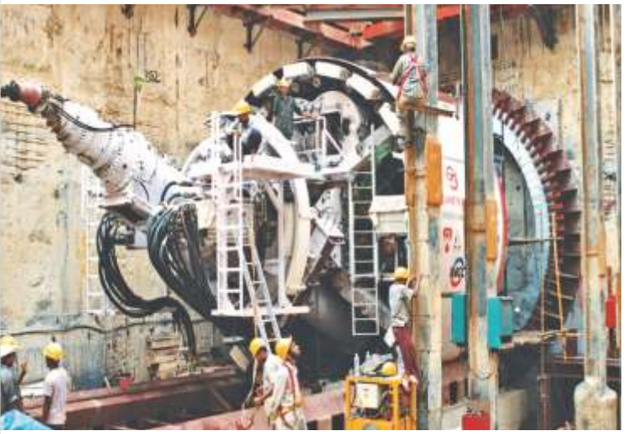
The story of Delhi Metro's tunnelling is both fascinating and exciting. Boring tunnels below such a crowded city was never going to be easy, but to the credit of the Delhi Metro Rail Corporation (DMRC), it has been boring tunnels for over a decade now without causing any hindrance or disturbance to the flow of life above.

In Delhi Metro's Phase 1, the construction for which began in 1998, a total of 13.17 kilometers of underground lines were laid. The quantum of underground work may not seem very long, but this underground section passed through areas of Delhi that are both old and historic. This proved to be a major engineering challenge. In areas such as Chandni Chowk, Chawri Bazar and Kashmere Gate, there were buildings which were hundreds of years old. Many of them were dilapidated and standing in a precarious condition. In addition, innumerable utilities dotted the surface. However, Delhi Metro's engineers believed that the 'show must go on' and many innovative strategies were conceived to take the work forward.

The TBM's cutter

At Chawri Bazar, the engineers decided against constructing a cut and cover Metro station, since such large scale excavation would have posed positive danger to the innumerable old buildings around. Therefore, even the station area was constructed with the help of a Tunnel Boring Machine (TBM), a whopping 25 meters below the surface. The national capital's major railway stations at New Delhi and Delhi were also connected by the Metro as a result of which thousands like Ram Khilawan can today easily reach different parts of the city after disembarking at the Indian Railways' stations.

The experience gained in the first phase gave DMRC's engineers the necessary confidence of taking up larger underground assignments in the phases ahead. In Phase 2 of Delhi Metro's expansion, the quanta of underground work increased substantially and close to 35 kilometers (34.89) of underground lines were laid. A record 14 Tunnel Boring Machines (TBMs) were pressed into service to execute the assignment. This was the first time that so many TBMs had been used for any project in India. As Delhi prepared to host the Commonwealth Games of 2010, these tunnels were made ready in record time to welcome the visitors.



Working on the TBM

Apart from TBMs, the New Austrian Tunnelling Method (NATM) was also used at Saket and Ridge area for tunnelling work. NATM is a technology in which controlled blasting is done to make tunnels. At the ridge, which is considered to be the green lung of the city, NATM was used since creating shafts for entering and retrieving TBMs would have led to the cutting and felling of a large number of trees.

In the first phase of Delhi Metro, underground work comprised of 20.23% of the total work. In Phase 2, the underground component increased to 27.92%, whereas, in the third phase of expansion, the quantum of underground work increased even further to over 33%.

The third phase of Delhi Metro, as part of which about 160 kilometers of new lines are being laid, has undoubtedly been Delhi Metro's toughest stage of construction. About 54 kilometers of underground lines have been laid in this phase. The sheer enormity of the task can be gauged from the fact that the total length of the underground corridors in Delhi Metro's Phase 3 was more than the total underground sections built by DMRC in both Phases 1 and 2. Combining the first two phases, Delhi Metro had a total of 31 underground stations, while Phase 3 alone has 35 stations below ground level. The total length of the underground corridors in the first two phases was 48.06 kilometers while Phase 3 by itself has such corridors of 54 kilometers.

The decision to construct more underground corridors was taken this time to ensure that the construction work caused minimum inconvenience to the population of the city. By constructing so many underground stretches, DMRC also avoided causing any damage to the existing infrastructure such as flyovers and roads. For the first time in the history of

Retrieval of the TBM at the Rameshwar Nagar Gurudwara shaft

Delhi Metro's construction, four different tunnel stretches in Phase 3 have passed below existing underground Metro sections.

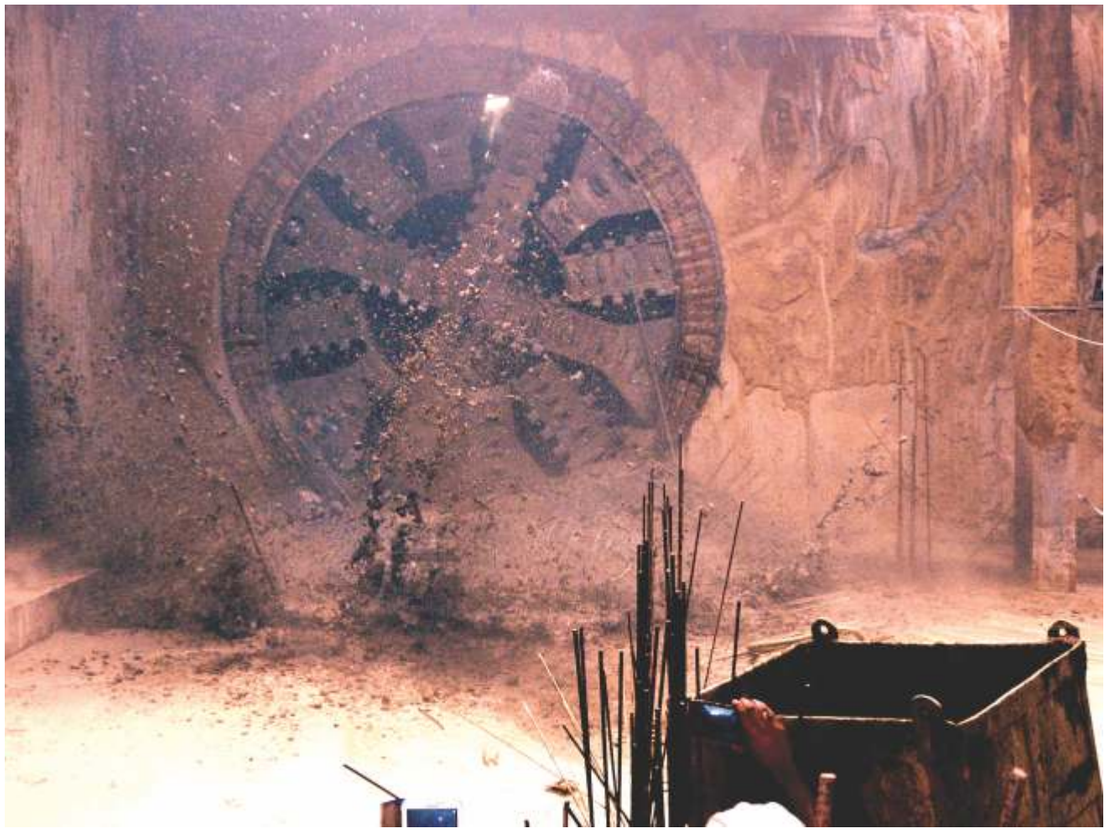
Undertaking such massive tunnelling projects within the confines of a busy city cannot be possible unless the best possible technology is adopted. TBMs are nothing short of modern day wonders which quietly drill and bore tunnels below the surface. They can be equipped with different kinds of cutter heads to cater to different soil or rock strata. The TBMs have actually brought about a revolutionary change in the sphere of tunnelling all over the world.

TBMs have a life of their own. In Germany, names are sometimes given to these machines and every breakthrough is celebrated at times in the whole city with beer and the entire team is in a festive spirit. Tunnellers who operate these machines are a special breed, who receive special training as they need to inculcate the necessary skills and endurance capacity to work constantly 10 to 50 meters below the surface. The person who guides and controls the movement of the machine is a pilot and an engineer rolled into one as even a variation by a millimeter in the movement of the TBM may have adverse consequences.

These machines are equipped with a circular cutter head at the front which in turn has a number of teeth. The cutter head moves forward in a circular manner boring through the earth's surface. The movement of the cutter head is monitored by trained operators who track and supervise its movement through computers. The route for its activity is pre-set.

What sets these mega machines apart is the fact that they can bore through any kind of surface. Today, different types of TBMs are available in the market and the cutter head and its teeth can be modified according to the soil or rock strata that are expected to be encountered. Broadly, two main type of TBMs – for hard rock and for soft ground – are used for boring tunnels. In Delhi, largely soft soil has been encountered. However, in some stretches, hard rock was also found. For example, hard rock was found while tunnelling below the Aravalli ranges for the construction of the Janakpuri West-Botanical Garden Magenta line of Delhi Metro's third phase of expansion.

Breaking through the end of the tunnel at the Red Fort



As the TBM bores under the city, an elaborate mechanism works in the background. Pre-fabricated concrete segments which are prepared at casting yards and inserted for the construction of the tunnel are then installed by the machine forming a circular ring. The muck and rubble generated by the boring is removed with the help of muck cars for which temporary tracks are laid in the tunnel being bored.

The experts manning these machines are specially trained for the purpose. In the initial phase of Delhi Metro's construction, all the TBM operators and the necessary support staff came from abroad, mostly Germany, since the TBMs belonged to a German company. However, over a period of time, many Indian operators have also emerged on the scene who are now sought after for tunnelling projects across the country as well as in our neighboring nations.

The Delhi Metro Rail Corporation (DMRC) had also tied up with the Tunnel Training Academy in Kualalumpur, Malaysia, to train its engineers on the latest techniques and skills needed for doing underground tunnelling works using Tunnel Boring Machines. The Tunnel Training Academy established in Kualalumpur is unique as it is probably one of the few such institutions in the world which creates a simulated underground environment in which a trainee actually gets a feel of working with a Tunnel Boring Machine inside a tunnel.

The quantum of work at hand for the TBM operators and the entire support staff can be gauged from the sheer size and length of these machines. Each TBM weighs about 450 tonnes and is over 60 to 80 meters in length and, therefore, specialised training is mandatory for their operation as well as on their proper lifting and lowering at Metro work sites.

Delhi Metro's engineers have now built over a hundred kilometers of underground lines across the entire National Capital Region (NCR). This is indeed a major achievement as the tunnels have had to pass under many congested areas with dilapidated buildings which are not in a very stable condition. The tunnels have also passed under and close to historical monuments especially on the heritage line between ITO and Kashmere Gate.

Monitoring of these structures and ensuring safe tunnelling is another aspect which needs very meticulous planning and execution. Measures have to be taken to prevent any movement or settlement of the structures above. Settlement chances are prevented through grouting. Extensive instrumentation is done for monitoring of the structures and the terrain all along the alignment during tunnelling using ground settlement markers, tilt plates, bi-reflex targets, etc.

I began service with the Indian Railways but migrated to Delhi Metro when the latter was set up. I was really excited to be part of this massive engineering project, which was bringing in new technologies to Delhi, the city where I was born and brought up. Delhi Metro was a big civil engineering paradise with underground and elevated structures slated to come up in a big way. I was told that many underground sections would be built with special machines which tunnel below the surface without disturbance on the surface, viz. 'Tunnel Boring Machines'.

As these would take time to arrive in Delhi, I flew off to Mumbai to see a small sized TBM which was used for making a tunnel in Mumbai for the disposal of sewage waste into the deep sea. Wearing gum boots, helmet, a safety jacket and going 20 meters below the surface in a bucket was exhilarating. Of course, after that I did have the opportunity to visit many TBM sites.

Therefore, in conclusion, it can be certainly said that tunnelling within a congested and crowded city like Delhi has been a major engineering achievement for Delhi Metro's engineers. While the process has been extremely demanding and has required detailed planning and execution, the benefits for the people are for everyone to see today. It has also to be remembered that TBMs were used for the first time in the country for metro tunnels in Delhi. The experience gained is now helping a number of other cities in their metro construction.

***Editor** – Please read of a visit into the metro tunnel being excavated under the city of Kolkata on the following pages.*

Photos: Courtesy Delhi Metro Rail Corporation

About the author:

Anuj Dayal started as the railway man and then migrated to DMRC. You will see his name often in newspapers as the spokesman of the organisation. He can be reached at anujedcc@dmrc.org

World's longest tunnel

The world's longest rail tunnel is the Gotthard Base Tunnel at Erstfeld in Switzerland. Opened on May 31st 2016, the tunnel measures 57 kms. and cuts through the Swiss Alps.

It took 17 years to complete and cost 11 billion Euros. The tunnel helped reduce train time between Zurich and Milan by an hour.

Kolkata Metro

Under the City of Joy

J L Singh

Sometime towards the end of the last decade of the last century, I happened to travel to the City of Joy, Kolkata, or Calcutta to silver-haired old-timers like myself. Moving around the metropolis, I couldn't help note that there was a greater variety of vehicles on the roads in Calcutta than perhaps any other city. You see 4-wheeled cars and 3-wheeled autos, heavy trucks and light tempos, run-down buses and trams, myriads of motor cycles and scooters, bicycles and archaic hand-pulled rikshaws. You

Sets of pre-cast concrete sections used for lining the tunnel

see an odd horse-drawn cart and, occasionally, ponderous elephants. Unlike New Delhi, most roads are narrow and straining to accommodate the plethora of vehicles that vie for space. The pedestrian also jumps into the fray leading to amongst the most congested roads in not only the country but perhaps the whole world.

Enter the Metro. With the start of construction in 1972, the Metro was expected to be the panacea of all the transport ills of Calcutta. However, owing to various issues, it took 12 years to open a short 3.4 kms. section from Esplanade to Bhowanipur (now Netaji Bhawan) when the line had been planned to cover 16.45 kms. from Dum Dum to Tollygunje. It took more than a decade before the entire planned route was covered by 1995. Between 2009 and 2013, this line that runs in a North-South direction, was extended to Noapara in the North and New Garia towards the South. Covering only a short stretch and taking a long time to cover the entire length, the much awaited Metro did not have a significant impact on the transportation scene in the city. Since it covered only a fraction of the sprawling metropolis, it could not decongest the latter's roads.

In the meantime, Delhi Metro started construction in 1998 and opened its first line in 2002. The line was a runaway success and today Delhi Metro has more than 250 kms. of

Inside the tunnel. Note the walkway along the right

Entry to tunnel

routes and another 100 odd kilometres under construction. Unlike Delhi Metro though, Kolkata Metro is part of the Indian Railways and is one of its 17 zones. This is the only metro zone; the other 16 zones run regular trains. Delhi Metro acted as a catalyst for Kolkata Metro to expand and today, the latter is in the process of constructing its second line.

This second metro line will start from Howrah Maidan, just to the West of Howrah station of the Indian Railways. It will be an underground station and after passing under Howrah station, the line will bore its way beneath the mighty Hooghly River. The 520 meters under the river will be at a depth of 30 meters (roof of the tunnel to ground distance) while the average depth of the tunnel is only 17 meters elsewhere. The first six stations are to be underground. The remaining six stations will be elevated. The total length of the line is a little over 16 meters. While the first line is primarily North-South, this line takes an East-West direction.

Apart from drilling under the river, the line, comprising of two tunnels, passes below some of the most congested areas of the city. It passes beneath heritage structures like the 100-year old Colvin Court building, Maghen David Synagogue, St. Andrew's Church and Writers' Building. Two Tunnel Boring Machines (TBMs) from Herrenknecht AG of Germany are being used to excavate the pair of tunnels. One of the TBMs has been named Prerna and the other Rachna, both being named after daughters of employees of Kolkata Metro.

Six members of the Rail Enthusiasts' Society had visited the tunnel on 3 April 2017 when the boring under the river was being done. In February this year, this writer also had the

The Schoma diesel locomotive

One of the gantries that lifts wagons of rubble to the surface

privilege to travel into the tunnel that Rachna is boring. On that date, the actual excavations had moved far beyond the river and were being done somewhere in the bowels of the city under Writers' Building. However, entry into the tunnel is at Howrah Maidan, where the TBMs had been lowered into the ground and the tunnelling commenced. On reaching the entry point, you note two huge gantries. Stacked besides the gantries are pre-cast concrete sections that are the lining of the tunnel that is being dug out. These sections are laid in groups of 6 parts: when assembled they will be the lining of the circular tunnel. It was noted that one of the sections was smaller than the others. Each section has a rubber lining to make it watertight. Fitting of these sections

Pre-cast concrete sections lining the tunnel

in the tunnel is done simultaneously with the excavation of the tunnel itself by the TBM.

Two steel-frame staircases are used to descend to the tunnel level. Comprising of 10 flights of 10 steps each, you go down about 30 meters below ground level. As you go down, you see the two openings of the two tunnels about 50 meters away. You can also see rail tracks leading into the tunnels with small diesel locomotives and a large number of small open rail wagons in which the debris that is being excavated is loaded. The track is a one-meter wide temporary line that is laid as the tunnel goes further and further under the city. This track is used to transport men and material into the tunnel and carry the excavated debris out. The TBM itself, about 70 meters in length, does the actual cutting of the soil, transfers the rubble that is removed by a conveyor into the small wagons. These are then hauled back with the help of small diesel locomotives. The ones used here are of Schoma make.

The tunnel itself is lined right up to the point that the TBM is working. It is well-lit and has a walkway on one side for the use of workers and other staff. A telephone was also noted along this walkway. Since the tunnel is about half the length of the total line, forced ventilation is required to keep the air inside it clean. A huge duct can be seen at the top of the tunnel; this is for ventilation. On the side opposite the walkway, there are a number of electrical cables that run the length of the tunnel.

Earth mover that loads excavated debris into road vehicles

Working in a totally enclosed cramped space is an occupational hazard that the workers in the tunnel face each day. This is certainly not a job for a person who is even slightly claustrophobic. TBMs do make the work less arduous than the pre-machine days but it is exacting nonetheless. The citizens of all the cities that have metros need to recognize the efforts of these workers for the comfortable rides that they take for granted once the metro is built and operational.

Photos: Courtesy the author

About the author:
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Another Tunnel

The Jamalpur Tunnel

Rajat Kumar

275 meters! Not very impressive for a tunnel!

But the legend spread across the top of this rail tunnel at its entry changes your impression:

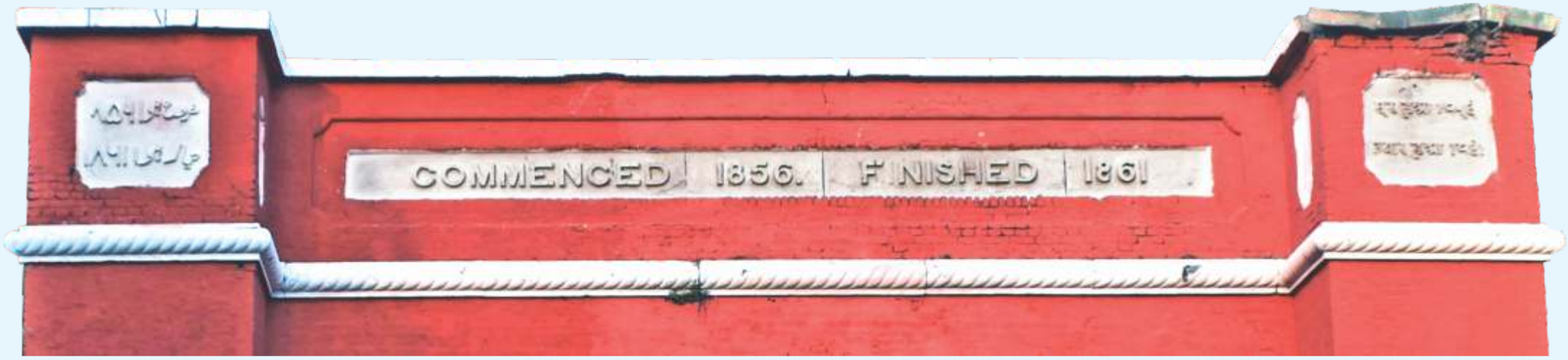
COMMENCED 1856 FINISHED 1861

This makes this nondescript little passage bored through the Rajmahal range of hills to the North East of Jamalpur town in Bihar one of the oldest tunnels in the country. The tunnels that cut through the Western Ghats on the Great Indian Peninsula Railway (GIP) from Bombay (now Mumbai) to Nasik (now Nashik) and to Poona (now Pune) were built at around the same time but came into use later. The only older tunnel is the one built by the GIP between Thane and Kalyan. The Jamalpur tunnel is also the only tunnel on the first route from Calcutta to Delhi that had been built by the East Indian Railway Company (EIR).

Thus, less than a decade since the commencement of commercial train operations out of Bombay in 1853 and only seven years after the first train chugged out of Howrah, the Jamalpur tunnel was in use on what is now the Sahibganj loop and was then the main line being constructed from Calcutta towards Delhi and the North West of the country.

The building of the tunnel was taken up by EIR in 1856. Established in 1845 in London, EIR was the first Indian rail

Western end of the Jamalpur tunnel



Container train approaching the tunnel from Jamalpur end

company to be incorporated, albeit in Britain with British share holders. It signed a contract with the East India Company in 1849 to construct and then operate an "experimental" line between Calcutta and Rajmahal. This line was to be 161 kms. (100 miles) long at an estimated cost of £1,000,000. The plan was to subsequently extend the line all the way to Delhi via Mirzapur. So, the so-called experimental line was far more than being merely experimental and finally did not only reach Delhi but went way beyond into what is now Pakistan.

Although the first rail company in the country, EIR was unable to be the first to actually operate trains. This honour went to the GIP that ran the first train on the 16th of April 1853 from Bori Bunder in Bombay to the suburb of Thane. One of the reasons for the delay by EIR was that the ship bringing the imported locomotives from Britain reached Australia owing to an error in navigation; the rerouting to Calcutta took its own time resulting in EIR losing the race of running the first train. Another hitch was that the ship bringing the coaches for the first train on EIR met with disaster on the high seas and sank; new coaches had to be built in India itself.

Thus, more than a year after the inaugural run in Bombay, the first train in the East steamed out of Howrah on the 15th of August 1854 for Hooghly, 37 kms. (23 miles) away. After this, progress was rapid. Traffic was opened to Pundooah by September 1854 and Burdwan by February 1855. Raniganj and its coalfields were reached at about the same time. Rajmahal was connected by October 1859. The first train ran from Howrah to Rajmahal via Khana (the present Sahibganj Loop) in July 1860. Bhagalpur, a stone's throw away from Jamalpur, was reached in 1861. Fortunately, work on the Jamalpur tunnel had been progressing well so that by the following year (1862) train services were running from Howrah to Jamalpur and all the way to Kiul, which now connects the Sahibganj loop to the mainline between Howrah and Mugalsarai.

To celebrate the completion of the line to Benaras (now Varanasi), a special train from Howrah all the way to Benaras was run on 5th February 1863. Apart from George Turnbull, the Chief Engineer, the train also carried the Viceroy, Lord Elgin. It is significant that the party spent the first night out of Howrah at Jamalpur after passing through the Jamalpur tunnel.

In the meantime, a large locomotive repair workshop had been set up at Jamalpur. It was the opening of this tunnel that led to the commencement of work on 8th February 1862 at this workshop.

Earlier this year (2018) on the 18th of February, accompanied by Sarveshwar Yaduwanshi and one of our retired professors, we decided to explore this tunnel. A finger of the Rajmahal hills stretches Northwards on the Eastern flank of Jamalpur town and almost reaches the Ganga River about 8 kms. to the North. It is this finger that has been pierced by the tunnel. Not doing so would have meant taking a circuitous route round the hills adding many kilometres to the length of track required.

The railway colony in which our hostel is located is also to the East of Jamalpur town, so that it is only a short distance to the tunnel. Walking past the Territorial Army camp and the diesel locomotive depot, we found ourselves walking along the rail line towards the tunnel which we could see about five to six hundred meters ahead. The line from Jamalpur station to Ratanpur, the station on the other side of the tunnel, is a single line only. While the traffic density was low, the single line served the purpose but with a major increase in the number of trains, the line is now a bottleneck and it is already planned to have a second tunnel to the North of this existing one.

Since the tunnel is the shortest route between Jamalpur and the villages on the other side, it is used as a highway by pedestrians, cyclists and even those on 2-wheelers. Fortunately, the tunnel is wide enough with sufficient space on the right of the line when you enter it from the Jamalpur side to allow this almost continuous stream of commuters to pass through. The hills are about 50-70 meters high at this point so that if you did not go through the tunnel, the only option was to climb over this ridge or take the much longer route around it.

As we were walking towards the tunnel, we heard the sound of a train coming from the Jamalpur side. It turned out to be a container train hauled by diesel locomotive No. 70711 WDG4D. This is a variation of the normal single-cab WDG4 and has a dual cab. The picture on the previous page shows how a cab has been added to the long hood end of the loco.

We were now at the Western end of the tunnel and could clearly read the legend at the top which proclaimed that the tunnel had started in 1856 and was completed in 1861. The

Bhagalpur-Danapur Intercity Express with loco No. 40211 WDG4D about to enter the tunnel from the Eastern end

legend is in English at the centre of the tunnel while on the two side, the same thing is recorded in Urdu to the left and Hindi to the right. We are not sure if the inscription was written when the tunnel was first built or was a later addition. It looks more like the latter.

Being a short tunnel with no curvature, you can see the other end from one side. Condition of the tunnel is good in spite of the fact that it is now 157 years since it was constructed. Reaching the other end, we heard the sound of a train coming from the Ratanpur side. Hauled by Locomotive No. 40211 WDG4D of Jamalpur shed, it was the Bhagalpur-Danapur Intercity Express.

We did not return through the tunnel but decided to climb over the hill. When on top of the ridge, we got some glorious views of Jamalpur town and could see a train approaching the tunnel. We were too far to know what train it was. We were told by the professor accompanying us that as recently as about 15 years back, a lot of quarrying for ballast was being done along the hillside facing Jamalpur. A network of rail lines to carry the quarried ballast can still be seen. The quarrying, however, has been discontinued. A major means of quarrying was by dynamiting the hillside. It is testimony to the skills of the engineers who constructed this tunnel that the blasts did not damage the tunnel in any way.

Most of the area where the quarrying used to take place has now been taken over by a diesel locomotive shed that was set up in the early 1990s. The shed has now diversified and homes a number of Diesel Electric Multiple Unit rakes as well. These take care of the commuter traffic of the area.

Photos: Archives of the Rail Enthusiasts' Society

About the author:
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Paronamic view of Jamalpur town from the top of the tunnel

Disaster Management

Bridge 249!

J Nagesh Babu

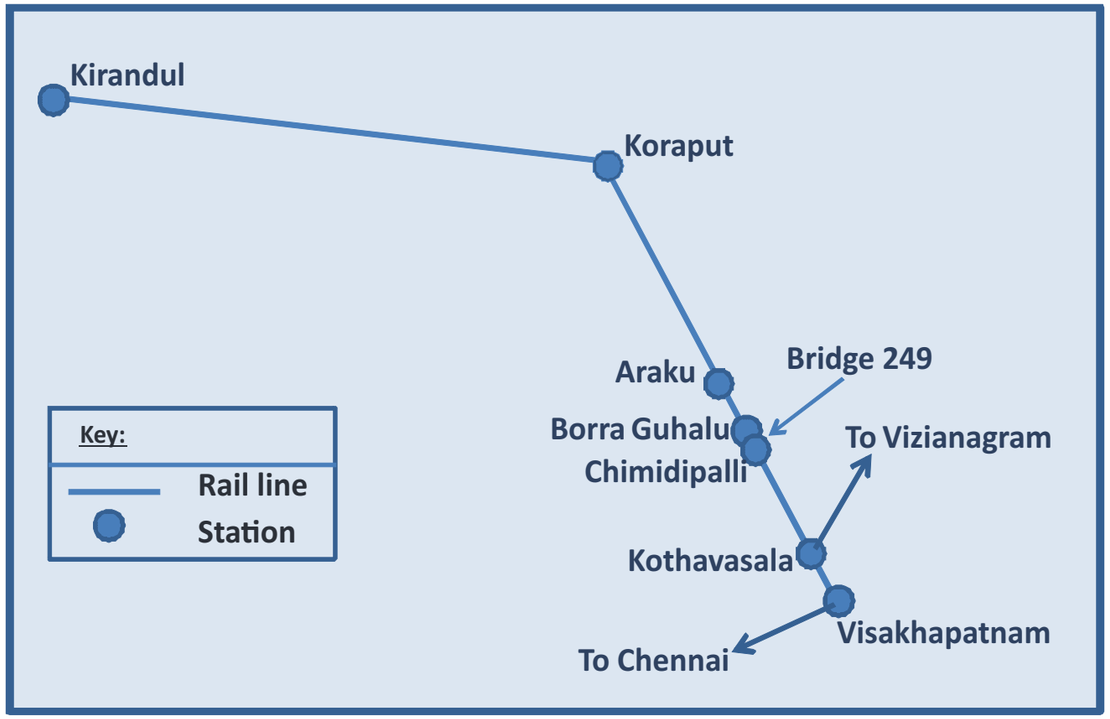
17.15 hrs...! 6th October 2017...!!

At this instant, disaster struck Bridge No. 249 on the Kothavalasa-Kirindul rail line (KK line). Incessant torrential rain in the upper reaches of the water channel that Bridge 249 spans caused a large boulder to crash into pier No. 1, severely damaging it and even dislodging the steel girders of the bridge. It is estimated that the boulder weighed 700 tonnes and was as big as a house. All train movement on the line stopped.

Going by the average age of various lines on the Indian Railways (IR), the KK line, on which the disaster struck, is a fairly recent one, a little over 50 years old. It was in 1960 that IR took up three projects: the KK line, Jharsaguda-Titlagarh project and the Biramitrapur-Kiriburu project, collectively referred to as the Dandakaranya-Bolangir-Kiriburu project. Of these, the KK line was completed and opened for traffic in 1966-67 as part of what was then the Waltair Division of the South Eastern Railway zone of IR. It has now been named as Visakhapatnam Division and after re-organisation of the railway zones, the Division became part of the East Coast Railway zone. The latter came into existence in 1996 but was fully operational only in 2003.

The Japanese aided line was built primarily to carry iron ore from the Bailadila mines in Chhattisgarh state to Visakhapatnam port. Initially a single line with diesel locomotives, the line is now electrified and doubling was approved in 2015. Electrification of this 445-km. line was taken up in the late 1970s and completed in phases by 1982.

After leaving Kothavalasa on the Visakhapatnam-Vizianagram route it passes through the picturesque and



The 120-T crane working on the central short girder

scenic Araku Valley in the Eastern Ghats. Prior to the building of the rail line to Kashmir, this was the highest Broad Gauge line in the country. The hilly terrain resulted in the need to build 58 tunnels and 84 major bridges. Bridge 249 is one of these bridges and is flanked by tunnels on both sides. In fact, on the Western flank, the 318-meter tunnel No. 32 is flush with the bridge while at the opposite end, tunnel No. 31 is about 200 meters away. There is no approach road to the bridge; this makes any work on it both difficult and time consuming. To add to the problems of the restoring team, the piers are 24 meters high and rebuilding one of them even in ideal conditions is no mean task. Using heavy machinery in this treacherous terrain was an added challenge.

The importance of the line can be gauged from the fact that it carries about 15 million tonnes of iron ore to Visakhapatnam port annually and generates a revenue of over ₹ 80 million daily. Closure of Bridge No. 249 spelt disaster for rail operations and getting the line open again became a critical and crucial imperative. With the bridge disabled, the freight had to be diverted to move by the Vizainagram-Rayagada-Koraput route, an additional 150 kilometers.

Response of the division was rapid and meticulous. The bridge comprised of 3 girders supported on 2 piers. Two 100-foot girders flanked a central 40-foot one. The first task, therefore, was to provide a temporary support for the 100-foot girder between the end of the bridge and the mutilated and crippled pier No. 1. Within a week of the accident, work on the building of a crib support was started and by 21st October, the support was completed. For

The dislodged rail lines

The trecherous terrain

additional safety, wire ropes were also used to support the girder. On the 23rd, the central 40-foot girder was lifted off the piers and removed with the help of a 120-tonne rail mounted crane of the railways.

While this work was being undertaken, a number of parallel activities were also addressed and undertaken. One of these was the building of a half kilometer long approach road to the foot of the damaged pier. This was crucial for

Building of the crib support

carrying men and material to the foundation level. By 24th October, the road was completed. Another parallel activity was the diversion of the water flow from the waterfall to the North of the bridge so that the building of the replacement pier could be undertaken. The water was diverted into a canal dug at the mountain top, a coffer dam being built to channelize the water into the canal. This activity was completed on the 23rd of the month.

This was followed by the critical activity of dismantling the damaged pier through controlled sequential blasting.

Temporary support ready

Starting on the 24th of October, the process was completed as planned in a week. The following week saw frenetic activity that included clearance of the foundation, fixing anchor rods for the new pier and laying of the levelling course. Raft reinforcement was completed by the 8th of November and concreting of the raft done in the next 3 days.

The actual pier construction was started on the 13th of November and completed in 11 days. This involved 12 lifts of 1.5 meters each. A total of 600 cu. meters of concrete was required for this mammoth task. While the concreting was being done, simultaneously cribs were erected around

Working on the damaged bridge

Birds' eye view of terrain

Partly dismantled pier

the pier for support of the framework and for inspection. It goes without saying that the work was carried out round the clock with no respite or rest. Most of the supervisory staff stayed at the site continuously in makeshift shelters.

It was indeed a great and significant day when the middle 100-foot girder was re-launched onto the new pier on the 1st of December 2017, followed by the central 40-foot girder on the next day. With the girders in position, laying of the track was a comparatively simple task and was completed in a day. Of course, an even more significant day was the 8th of December when a tower wagon did a trial run over the rebuilt bridge. There was no shortage of congratulatory smiles and well-earned relief. The assignment was completed when, on the 10th of December 2017, Locomotive No. 13210 WDG4 passed over the bridge.

Thus, against a self-imposed target of 60 days, the bridge was actually restored with two days to spare, a fitting proof, if any is needed, of the mettle of railway men specially when there is a crisis.

Photos: Courtesy the author

About the author:

J Nagesh Babu is a serving railwayman and was actively involved in the restoration of Bridge No. 249

Marking of the foundation of the new pier

Building of the new pier

Trip Report

The Maitree Express

by Sudakshina Kundu Mookerjee

It was a long cherished dream to travel to Bangladesh by the Maitree Express, crossing the border between the two countries that once used to be a united Bengal. Maitree Express started commuting between the capitals of the two Bengals, Kolkata (erstwhile Calcutta) in the West in India and Dhaka in the East in Bangladesh on April 14 2008, the day of the Bengali New Year. Old Chitpur yard was cleared and a passenger terminal was built to accommodate this international train set to travel 375 kms. from Kolkata International terminal to Dhaka Cantonment station. Initially, it used to take more than eleven hours to complete the journey as considerable time was spent at the border posts of Gede in India and Darshana in Bangladesh to complete immigration formalities. Since November 2017, the Kolkata terminal has been upgraded with an immigration office so that the formalities can be completed before the journey begins. Likewise, Dhaka Cantonment station has its immigration centre next to the arrival platform. The journey time has, therefore, been cut down by two hours. The train starts at 7.10 a.m. (IST) from Kolkata and reaches Dhaka Cantonment station around 4.10 p.m. (BST). There are four pairs of trains running between Kolkata and Dhaka, two pairs each of Indian Railways and Bangladesh Railway.

A long line of travellers at the Kolkata terminal

The train traces the route of the erstwhile Eastern Bengal Railway Company (EBR), a pioneering railway company that operated from 1857 to 1942 in the Bengal and Assam provinces of British India. EBR was established through an Act of British Parliament in August 1857, with the intention of providing rail connectivity to the area of Bengal lying to the East of the Hooghly River. It functioned independently till 1884, before being taken over by the Government and renamed Eastern Bengal State Railway. In 1887, the Calcutta and South Eastern Railway merged with it. The Railway reverted back to its old name "Eastern Bengal Railway" in 1915 and expanded in 1941 by including Bengal Dooars Railway. Soon Assam Bengal Railway was added to it and the railways jointly came to be known as Bengal and Assam Railway. Assam Railway merged with Oudh and Tirhut Railway to form the North East Railway zone of the Indian Railways on April 14 1952, with its head quarters in Gorakhpur. The Sealdah division of the erstwhile EBR became part of Eastern Railway zone. Remaining portion of Eastern Bengal Railway that fell in East Pakistan was first renamed Pakistan Railway and then changed to Pakistan Eastern Railway from 1962. After Bangladesh became independent in 1971, this railway became Bangladesh Railway.

The first tracks of EBR, laid between Calcutta and Kushtia in 1862, covered Sealdah-Ranaghat and Ranaghat-Gede lines of the present day Sealdah division. In Bangladesh, the track was part of the Chilahati-Parbatipur-Santahar-Darshana line. Our aim was to travel by this historical line and relive many of the stories of undivided Bengal that were handed down to us through generations. Rabindranath Tagore, the Nobel laureate and writer of the Indian National Anthem, spent his youth in Silaidaha, looking after his ancestral property. His reminiscences of East Bengal have mesmerized us. Many renowned litterateurs of Bengal who hailed from East Bengal left behind memorable impressions of this beautiful country.

Our dream came true when we boarded the Maitree Express from Kolkata station in the wee hours of March 3 2018. A long line of travelers had already queued up in front

of the immigration counter on the platform of the Kolkata Terminal, separated from the rest of the railway station by a barbed wired perimeter. Although all the passengers were advised to report two hours in advance, the immigration check was done rather efficiently and fast. Our traveling tickets were inspected, berths were allocated and we boarded the train that was already standing on the platform. The waiting hall has not come up yet, although the station has seen much improvement since its inception in 2008.

The Maitree Express ready to leave for Dhaka

It was not yet 6 a.m. and once the checking was done we were not allowed to leave the platform. So, it was a long wait for the scheduled departure at 7.10 a.m. It was Saturday and the rake was of Bangladesh Railway. The train was painted a deep green and marked in Bengali letters. Inside the compartment, all the instructions were in Bengali, a departure from the compartments of the Indian Railways where the notices are bilingual, in Hindi and English. All other features of the train were very similar to the trains run by its Indian counterpart. As we waited inside the compartment the prayer call of the Muezzin resonated from a nearby mosque, a call to usher in the day.

The train started precisely at 7.10 am. There was heavy security on the platform. Smartly uniformed Border Security Force (BSF) personnel of both genders boarded the train and stationed themselves near the exit doors. There were eleven coaches other than the engine and the power car. The entire train was air-conditioned. There were two categories of seats: AC first and AC Chair cars. While travelling from India each first class compartment has four seats. On the journey from Dhaka to Kolkata, six passengers share each of these compartments.

A view of the inside of the coach

The train traveled slowly, winding its way out of Kolkata station to meet the track that came from Sealdah North section. We went past South Dumdum, Belghoria, Agarpara, Khardaha, Barrackpur, Palta, Ichhapur, Shyamnagar, Jagaddal, Kankinara, Naihati, Halisahar, Kanchrapara, Kalyani, Simurali, Palpara, Chuadanga and

All instructions and notices in the train were in Bengali

Ranaghat. The track forked after Ranaghat and our train took an easterly turn towards Gede, the last post on the Indian side. After travelling past Bankimnagar, Santinagar halt, Majhdia and Baupin, it reached the border. The Indian Railway Catering and Tourism Corporation (IRCTC) was serving tea and coffee. The payment was done in Indian currency. The Bangladeshis who were going back from India spent their surplus Indian currency by buying loads of chips and other goodies.

Gede station, the last post on India

We reached Gede in about two and half hours, a distance of approximately 114 kms. The platform was highly fortified on all sides. Once again barbed wire fences separated the platform from the world outside. The BSF personnel disembarked from the train. There was a change of crew. The Indian side handed over the train to their counterparts from Bangladesh. The train stopped for a while and when it started again we slowly moved through the no-man's land and entered Darshana, the border post on the Bangladesh side, 130 kilometers away from the originating station. Our

Darshana, the first station in Bangladesh

mobiles had already stopped working at Gede. I carried an International roaming SIM, which I activated.

As soon as the train started, the "*Khansamas*", as the serving crew is called in Bangladesh, came in their starched white uniforms and white caps, to offer beverages. Lunch was served early. As there was no pantry car, the food was collected from Darshana and was served before it became too cold. The lunch packs, consisting of "Chicken *biryani*" were served before noon to those who cared to buy them. The *Khansama* was a very amiable young man. He volunteered to serve us snacks later if we cared to have more.

The "Khansama"

From Darshana, the train retraced the path laid down more than a century ago. We travelled past Joyrampur, Chuadanga, Mominpur, Munshigunge, Alamdanga, Halsa, Poradaha, Mirpur and Bheramara, the names ringing bells in our minds.

As we travelled across Bangladesh, the landscape turned greener. The semi-urban habitat of West Bengal was soon replaced by a rural, agrarian East Bengal. The crop appeared a little different. At this time of the year, after the autumn harvest, the fields on the Indian side cultivate vegetables and mustard. In Bangladesh, they were cultivating paddy. The fields were lush green with freshly planted saplings. There were mango orchards and banana plantations, interspersed with small hamlets, pristine ponds and tin-roofed huts under sprawling banyan trees. Here and there the green minarets of local mosques raised their heads. Other than these small differences, the entire landscape looked similar to the agrarian countryside of Malda or Murshidabad districts of West Bengal. Near Kushtia, there was heavy cultivation of tobacco as this area had many factories that rolled country made cigars or "*bidis*".

The train then came to Padma River that had to be crossed by the famous Hardinge Bridge. This 1.8 kms. long iron bridge, in Pabna district, was built in 1915 to link the West bank of this great expanse of water with the East. It was located between Bheramara to the West and Pakshi and Iswardih stations in the East. Before the train crossed the bridge there was an announcement in Bengali, requesting the passengers not to open the doors or lean out. They were also advised against using the toilets as that would lead to rusting of the iron and damage the century old historical structure. This bridge was damaged twice since its inception: once during World War II and again in 1971 when the Bangladesh war raged. Each time it was rebuilt and has stood the test of time. Naturally, we were anxious to cross it and witness the legendary Padma River for the first time. Unfortunately, at this point, the Padma is much narrower than we expected. However, the river was alive with motorized boats and barges, all overloaded.

Gradually the green fields gave way to small towns whose names had become legends to us from reminiscences of people who had relocated to India after partition in 1947 or after the Bangladesh war.

The journey was slow as we were traveling down a single line section. We had to stop a number of times to give way to other trains. These stations wore a very old world look as they still retained the stamp of the old EBR. The high roofed brick station buildings with arched doors, looked enchantingly like pictures of a bygone era. The slanting roofs on the platform balanced on curved iron pillars had a quaint character, which transported me back to the memories of undivided Bengal. There were long benches on the platforms where men in long *kurtas*, sporting beards, sat hunched with their women folk wearing colourful *burqas*.

The local trains that ran on these tracks had passengers

Quaint station platforms in Bangladesh

Iswardih station of the erstwhile EBR, now Bangladesh Railway

climbing all over the locos and sitting in hoards on the roof of the compartments, although it was not crowded inside. Train after train passed with passengers inside as well as huddled on the roof.

Soon, we crossed the mighty Yamuna River by the multi-purpose bridge called “Bangabandhu Setu”. Brahmaputra in Assam is renamed Yamuna in Bangladesh. The huge expanse of blue water shimmered in the sunlight. The golden sand banks gleamed. It was a wonderful sight, the vision of Bangladesh as a land of many rivers!

We gradually drew close to Dhaka. We crossed the famous town of Tangail. Once upon a time it was famed for weaving. Many of the weavers have since relocated to West Bengal

Dhaka Cantonment station, our final destination

and settled down in Fulia and Santipur towns of the district of North 24 Parganas. Tangail too has its quota of looms with their distinctive style of weaving.

The rural scenery had now given way to a suburban landscape. Taller buildings were raising their heads. The towns were getting more congested, much like the townships on the Indian side. Corrugated roofs were replaced by concrete structures. Pristine ponds changed to

Kamalapur station – the main railway station of Dhaka

over spilling drains and swamps, the inevitable stamp of urbanisation. We were entering Dhaka, one of the most crowded cities of the world. We crossed Tongi and finally the train came to a halt at the Dhaka Cantonment station.

We poured out of the train and queued up for customs. It was well past 4.30 in the evening by Indian Standard Time. Bangladesh time is 30” ahead of this.

It took us about half an hour to complete all formalities. The Cantonment station was of medium size with a “four window” booking counter outside the immigration office. Under a tarpaulin shade some plastic seats were kept for people to wait till their vehicles arrived. Since our pick up was held up by the famous traffic jam of Dhaka, it was late in arriving. We waited with great expectation, oblivious of the mosquito bites, savouring the delightfully pleasing memories of our train journey.

Photos: Courtesy Kaushik Majumdar

About the author:

Sudakshina Mookerjee is the member of Rail Enthusiasts' Society who is fond of travelling and painting

Waiting for customs check

Passengers ready to board the Maitree Express from Dhaka

Dhaka Cantonment station

Rewari Heritage Steam Loco Shed revisited

Loco 3438 YG, " Sultan" in steam

Two members of the Rail Enthusiasts' Society visited the Rewari Heritage Steam Loco Shed in April this year. For a rail fan, and particularly a steam buff, a periodic visit to the shed is a must. Starting with 9 steam locomotives, the shed now homes 11, the latest addition being locomotive No. WP 7000, which had been languishing in Bhusaval. It is still not operational but is being worked on and should be in steam by the end of June or so. The shed thus now homes 3 WPs, 1 XE, 1 AWE, 1 WL, 1 YP, 3 YGs and, of course, the Fairy Queen, EIR 22. Currently, WP/P 7200, XE 3634 and the Fairy Queen along with the 4 Meter Gauge locos are in a position to be steamed. On the day of the visit, Loco 3438 YG, named Sultan, was in steam. While it is a good sign if you do not hear the whooshing sound of steam leaking from any point on the locomotive, it adds to the grandeur and feeling of power of the locomotive when it starts with its cylinder drain cocks open. Jets of steam enveloping its front makes all steam buffs nostalgic.

Another addition to the shed is a coach simulator. It is similar to the coach simulator at the National Rail Museum.

It is the endeavour of the railways that other than the regular runs in winter and heritage runs on occasions, at least one loco is steamed every weekend. This is a must if the shed is to attract visitors as a dead loco is just an assembly of steel decorated with a few brass parts. It is the fire in its belly and the steam that brings it to life.

In spite of the fact that a total of more than 2000 WG class locomotives were built, with over 70% being manufactured domestically at the Chittaranjan Locomotive Works, there is no WG locomotive at the shed. The Rail Enthusiasts' Society hopes that this shortcoming is corrected soon. The WG loco was the mainstay of freight train operations before the advent of diesel and electric locomotives.

Preservation of Meter Gauge lines

The Ministry of Railways has identified five Meter Gauge (MG) lines for preservation. Project Unigage, which had been started in the early 1990s, had envisaged the conversion of all MG lines to Broad Gauge (1676 mm). Most of these MG lines were built by the erstwhile Maharajas and the bulk of them were covering semi-urban and the lesser visited areas. This made them historically important and, at the same time, scenic and picturesque. The Ministry of Railways has recognised this and decided that some of these lines, not yet converted, would be preserved for posterity.

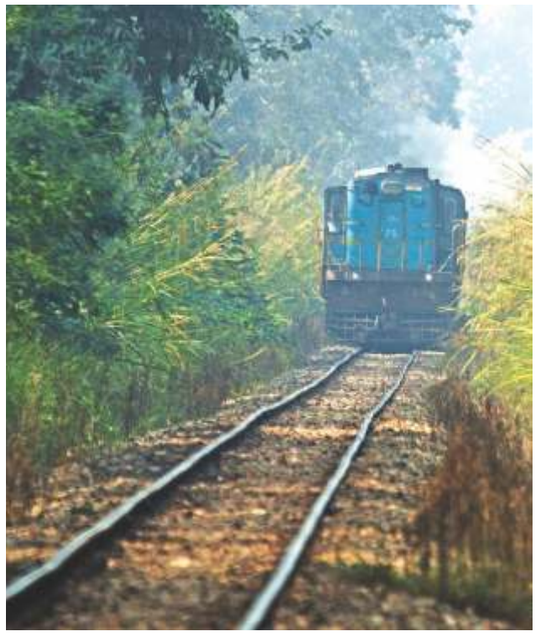
The five lines identified are:

- **The 42.27 kms. Visavadar-Talala line in Gujarat**
- **The 16 kms. Mhow-Patalpani-Kalakund line in Madhya Pradesh**
- **The 162 kms. Mavli Junction-Marwar Junction line in Rajasthan**
- **The 171 kms. Nanpur-Mailani line in Uttar Pradesh**
- **The 47 kms. Mahur-Harangjao line in Assam**

Except the last named, the other four lines are in working condition. The Rail Enthusiasts' Society had lobbied with the Ministry for the preservation of the Mhow-Patalpani-Kalakund and Nanpur-Mailani lines.

Photos: Archives of the Rail Enthusiasts' Society

The Nanpur-Mailani line



RAIL ENTHUSIASTS' SOCIETY

(Registration No: S-E/792/Distt. South East/2015)

The Rail Enthusiasts' Society, incorporated on the 28th of December 2015, aims to provide a platform for rail enthusiasts to disseminate knowledge, air their views and exchange ideas regarding the railways in India or overseas. Its first activity was to publish a magazine whose 7th issue you have in your hands. Other than issue of the magazine, we have organised enthusiast's trips/hikes, visits to construction sites, debates and quizzes amongst school children on the need for preserving rail heritage.

On the next page, you will find details of how you can become a member of the society. In case you are interested only in the magazine, the subscription rates are as follows:

Single copy	**₹ 150.00**
Annual subscription (4 copies)	**₹ 540.00**
5-year subscription (20 copies)	**₹ 2400.00**

Note:

1. The rate for the E-copy has not been worked out yet but would be less than that for the hard copy.
2. For overseas subscribers wanting a hard copy of the magazine, the rate charged will be as follows (to cover packaging and postage):

a. Single copy	**USD 9.00**
b. Annual subscription	**USD 32.00**
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3. For countries that do not deal in the US Dollar, please email a request to the Secretary of the society and we shall give you the rate in other currencies like the Euro or GBP.
4. The subscription rates for membership of the society for those residing in India include free delivery of the magazine as well. For members residing overseas, and wanting a hard copy, please email the Secretary and special rates will be fixed in each case to cover the cost of postage. Overseas members will get an e-copy free.
5. Libraries will be given an additional 5% discount over rates for subscription to the magazine.
6. Bonafide students' rates for membership, valid as long as they remain students, will be 50% of the normal rates. Such rates would not apply to Life membership.
7. For subscription to the magazine, please mail the completed form below to: The Editor, Rail Enthusiasts' Society, C-494, Defence Colony, New Delhi-110024 (India). A scanned copy can be sent by e-mail to **railenthusiast2015@gmail.com**

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RAIL ENTHUSIASTS' SOCIETY

(Registration No: S-E/792/Distt. South East/2015)

Membership of the Society

Membership of the society is open to individuals as well as Corporates. While individuals have the choice of three types of membership, for Corporates we have only membership for life.

Corporate Membership

This entails a one-time payment of ₹ 200,000/-. Membership gives the following to the Corporate:

- **Five copies of all magazines or supplements to the magazine that are published**
- **Concessional rates for any item such as artefacts, books or memorabilia on sale**
- **Invitation to 5 members of the organisation nominated by the corporation for any event or activity the society may organise**
- **Other benefits will be added in due course as and when more activities are added**

Rate for Corporate membership for foreign organisations will be US Dollars 4,000/-.

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- **Name of bank : State Bank of India**
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Visit our website : **www.railenthusiastindia.org.in**

Loco No. BK4

Displayed at the Ram Bagh Palace Hotel in Jaipur.

This loco was built by W G Bagnall in 1914 and bore Construction No. 2009. It worked on the Burdwan-Katwa Narrow Gauge (762 mm) railway and had a maximum speed of 30 kmph.

Burdwan-Katwa Railway was one of the four railways built by McLeod & Company more than a century back. Its 53 kms. connected Bardhaman (then Burdwan) and Katwa in West Bengal. The line was opened to traffic on 1 December 1915.

The line was taken over by the South Eastern Railway zone of the Indian Railways in 1967 and has been converted to 1,676 mm Broad Gauge. This coverted electrified line was opened in January this year (2018).

Photo: Courtesy Inder Dua