2059 17/08/2022

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No. GOA/PWD/CE(NH,R&B)/F. Gen /2022-23/ 245
Government of Goa,
Office of the Chief Engineer (NH, R & B),
Public Works Department,
Altinho, Panaji Goa.

2701C

Office of the P.C.C.F
Inward No. 6640
Book No. 5/22
Date 16/08/2022

Dated: - 16 /08/2022.

To,
The Chief Conservator of Forests,
Department of Forests,
Government of Goa,
Van Bhavan,
Altinho, Panaji-Goa.

29.836 Ha.

Sub: - Diversion of 32.085 ha of forest land for widening of four laning of existing Goa/Karnataka Border (Anmod to Mollem Section) NH-4A from Km. 84.133 to Km. 97.000 in the State of Goa in North & Wildlife & Eco-Tourism (North) Goa Division in favour of Executive Engineer, Public Work Department, WD-XV(NH), Ponda, Goa. – reg.

Ref:- 1) F.No.4-GOC1237/2020-BAN/1026 dt: 01/01/2021.
2) No. GOA/PWD/CE(NH,R&B)/F.Gen/2021-22/243 dt: 22/10/2021.
3) No.4/1/PWD/WD XIV(NH)/21-22/ASW/219 dt: 03/01/2022.
4) No.3/76/2022-23/PWD/WDXIV(NH)/ADM/325 dt: 20/06/2022.

Sir,

This has reference to above references and discussions held during various meetings on the issue of technical feasibility of constructing a tunnel in Karmal Ghat section as part of 4 laning of NH 66 in Madgaon – Karwar section.

As has been emphasized over and again, the strata in this section is very fragile and tunneling is not an advisable option. The strata is either loose soil or fragmented rocks which already have water bodies within and water channels passing through. These water bodies get disrupted when the natural strata is disturbed.

Konkan Railway Corporation Limited has constructed number of tunnels in Konkan region and the change of strata starting at Pernem tunnel going for entire Goa is more than obvious. A report on the subject obtained from KRCL is enclosed and may kindly be perused. Your kind attention is drawn specifically to page 6 and page 9 to 13. Your specific attention is also drawn to para 1, page 9, quote "It is the completion of these soft soil tunnels that delayed and determined the completion of Konkan Railway Line" unquote. It is also worth noting that a 238 mts. tunnel in Honnavar (Karnataka) in similar strata took 38 months to complete (page 12). The time to complete 1.5 Km. tunnel can well be imagined.

1176 16/8/22

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It is pertinent to mention that Konkan Railway tunnels are about 6.4 mts. wide whereas the two tube tunnels each for 3 lane road will be atleast 15 mt. wide and the increase in the technical challenges, cost and time requirements will be exponential. The KRCL report has also highlighted the cost and time escalations already faced just for a 6.4 mt. wide tunnel. In contrast the proposed widening of NH 66 along the existing route will save on both the resources of time and money.

As on date the traffic density on the stretch is about 28300 PCU, which already much needs a 4 lane highway. Once the forest diversion is permitted the four laning along the existing alignment can be completed in about 3 years time, whereas if tunneling is opted for, the four laning will be delayed by atleast about 5 years as the process will start with topographical survey, alignment approval by MoRTH technical investigations, preparation of DPR, approval of DPR by MoRTH, tendering and award of work wherein the execution itself alone is likely to take a minimum of 4-5 years. By 2030, the traffic density on the stretch will be about 48000 PCU and the movement of traffic on this inadequate width of highway will be nightmare.

In view of the KRCL report and aforesaid, it is once again requested that the proposal of diversion of 28.18 ha. of forest land for 4 laning of NH 66 along the existing alignment in Karmal Ghat section may kindly be recommended to MoEF&CC.

Yours faithfully,

16/8/22

Encl: As above.

(D.C. Gupta)
Chief Engineer (NH, R & B)
P. W .D.

Copy to:-

1. OSD to Hon'ble PWD Minister.
2. The Principal Chief Engineer, PWD, Altinho, Panaji-Goa.
3. The Superintending Engineer, CO. IX (NH), PWD, Altinho, Panaji – Goa.
4. The Executive Engineer, W.D. XIV (NH), PWD, Margao – Goa.
5. Concerned file.
6. Guard file.

①
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Tunnelling – The Challenge on Konkan Railway

Konkan Railway was the single largest railway project executed in our country after independence. This was the first project on Indian Railways that required extensive tunnelling. In the construction of Konkan Railway, tunnelling was its most challenging and critical activity. Completion of tunnelling ultimately decided the commissioning of this project.

Salient Features of Konkan Railway

Gauge	:Broad Gauge (1676 mm)
Length	:738.941 KM
Ruling Gradient	:1:150 (Compensated)
Number of Stations	:67
Number of Major Bridges	:179 (with a total linear waterway of 19.823 KM)
ROB, RUB & FOB	:367
Number of Minor Bridges	:1701 (with total linear waterway of 5.58 KM)
Number of Tunnels	:91 (Total length 84.496 KM)
Longest Tunnel	:6.5 KM (Karbude Tunnel)
Longest Bridge	:2.065 KM (on Sharavati River)
Tallest Viaduct	:64 meters in height (on Panvel River)
Track Structure	:Rails 52 Kg (90 UTS) LWR laid on monoblock PSC Sleepers @ 1540 per KM

Cost of Work in 1998	: Rs. 2520 Crores
Financing Cost	: Rs. 1035 Crores
Total Completion Cost in 1998	: Rs. 3555 Crores

The importance of tunneling to Konkan is reflected in its logo. The shape of the logo is a cross section of a tunnel.

कोंकण रेल

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सादर सेवा

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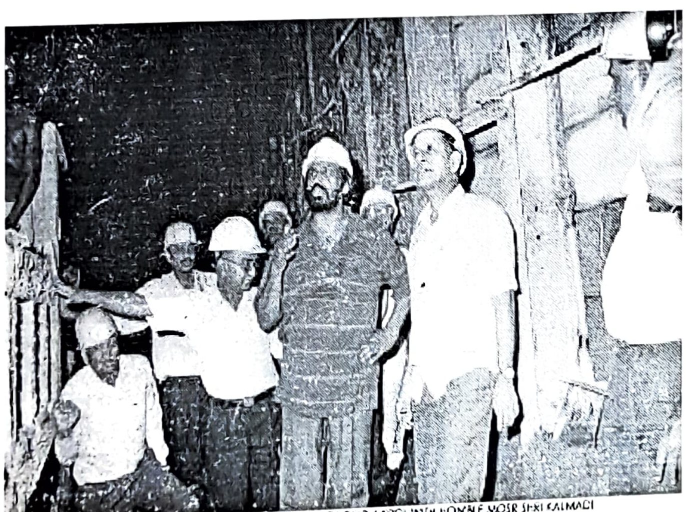
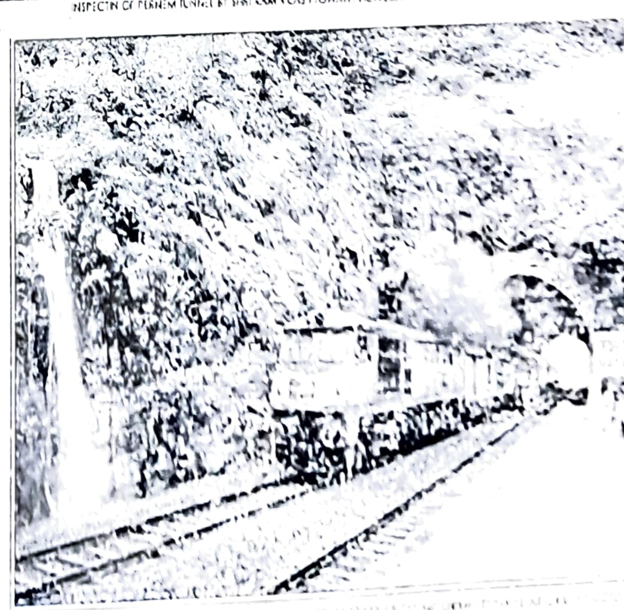


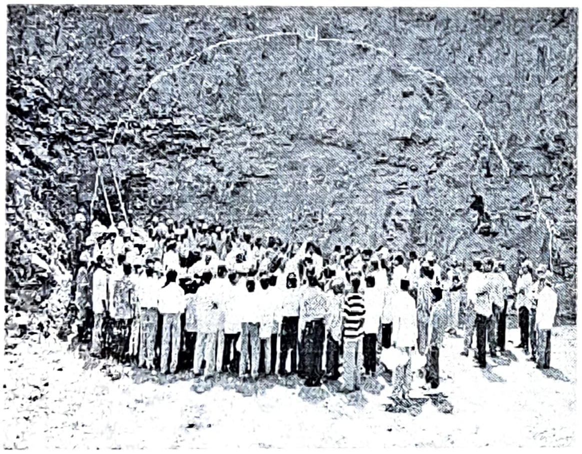
TUNNEL INSPECTION BY DR E SREEDHARAN, EX-CMD / KRCL WITH HON'BLE MOSR SHRI KALMADI

INSPECTION OF PERNEM TUNNEL BY SHRI RAM VILAS PASWAN, HON'BLE MR

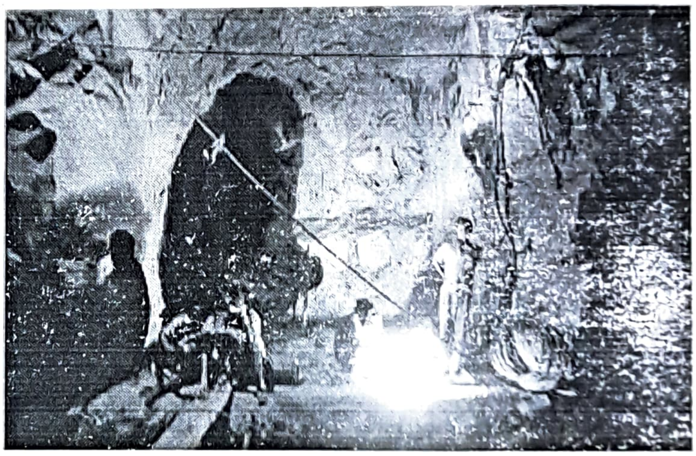


Even when the project was being conceived, it was envisaged that tunnelling would be a critical activity. The many uncertainties and unforeseen problems encountered during tunneling delayed these works much beyond the deadlines set.

Almost 11% of the total length of Konkan Railway line is through tunnels. 91 tunnels constitute 84.80 km of this line and of this 54.92 km is in Ratnagiri District alone. Till the commissioning of railway tunnels in Jammu & Kashmir, Karbude Tunnel of Konkan Railway which is 6.506 KM long was the longest Railway tunnel in the sub continent. The other long tunnels were Nathuwadi (4.389 KM), Tile (4.077 KM) and Berdewadi (3.976 KM). There are seven tunnels on Konkan Railway which are more than 2 KM long. Most of these long tunnels were through hard rock and did not give rise to any unforeseen problems.



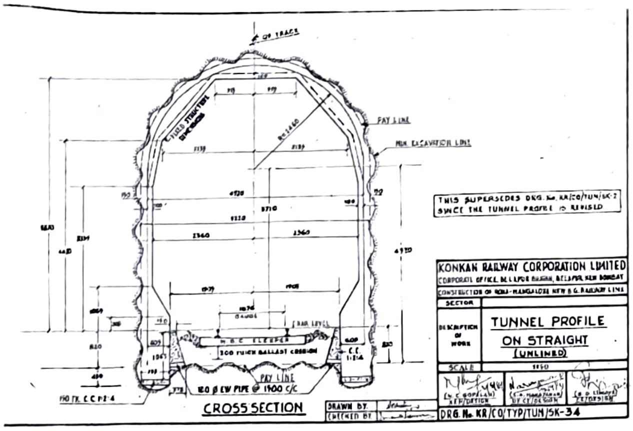
PROFILE MARKING FOR INTIAL BLAST

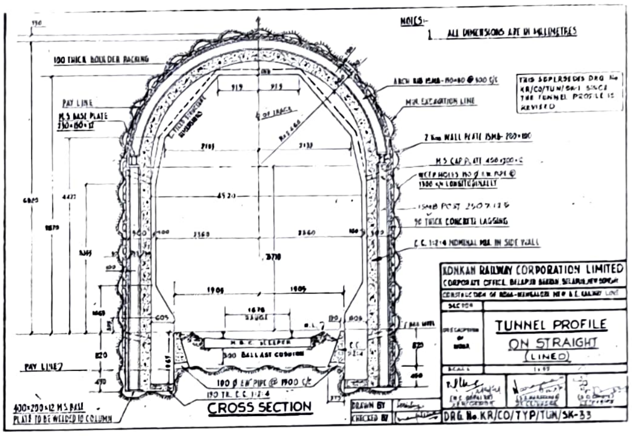


WORK IN PROGRESS IN ROCK TUNNEL

As tunneling was the most critical activity, there was a clear strategy required to be in place before execution including decisions on section of the tunnel, methodology of execution, machinery to be deployed etc.

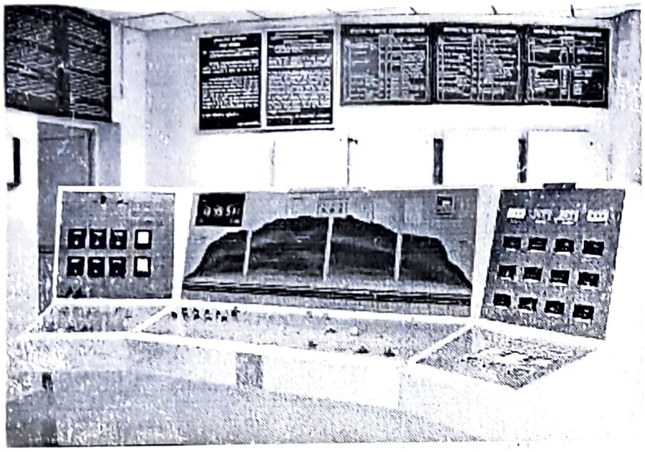
It was decided in the planning stage itself that the tunnel sections would be suitable for future electrification. Standard sections were prepared for unlined tunnels in straight and curves. Similarly standard sections were provided for lined sections in straight and curves. All tunnels longer than 2 KM and which were mostly on a straight alignment were provided with ballastless track.



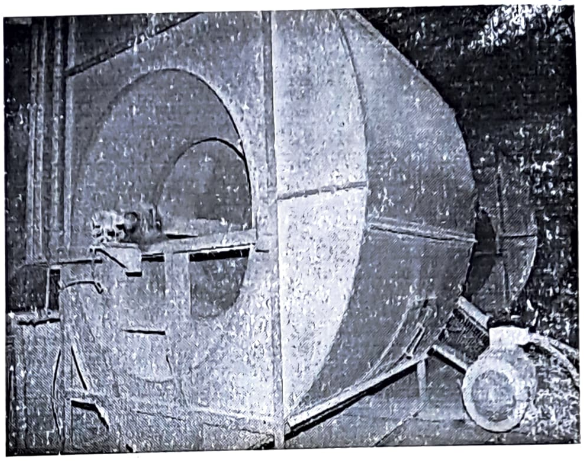


BALLASTLESS TRACK IN KARBUDE TUNNEL

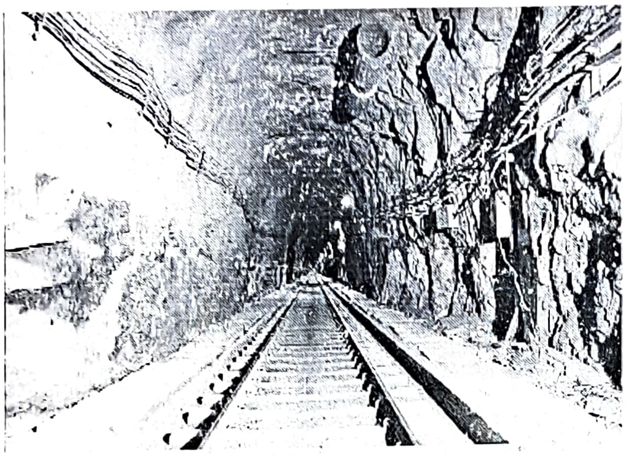
Given the experience of fumes in long tunnels on Indian Railways, it was decided to provide artificial forced ventilation to tunnels that were longer than 2 KM on Konkan Railway. All tunnels on Konkan Railway have been provided with lighting. Recently all light fittings in tunnels have been replaced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



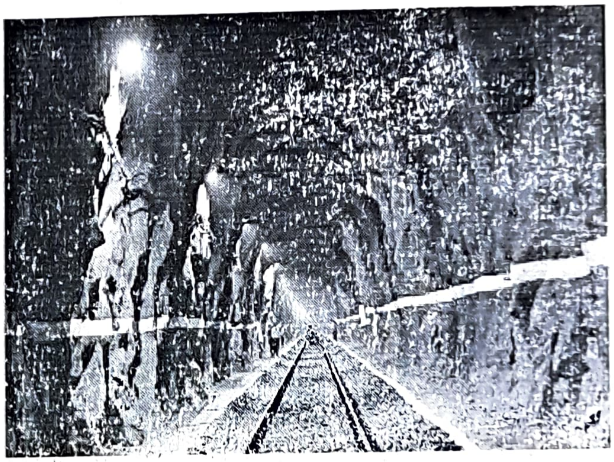
VENTILATION CONTROL ROOM IN KARBUDE TUNNEL



VENTILATION FANS FOR KARBUDE TUNNEL



CONVENTIONAL VENTILATION SYSTEM IN OTHER LONG TUNNELS

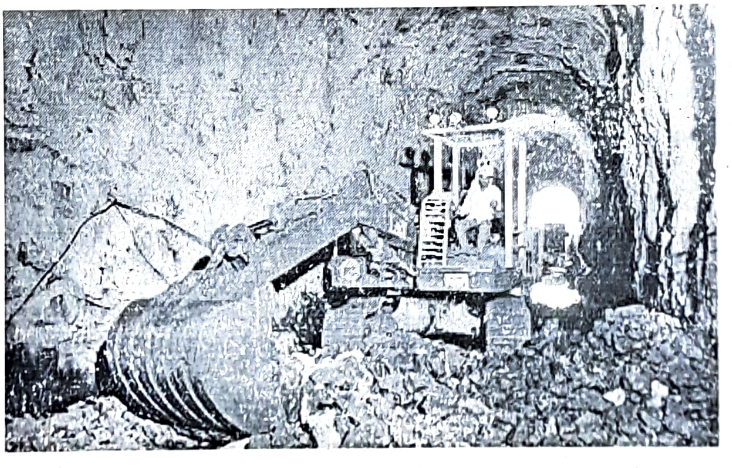


LED TUNNEL LIGHTING

To expedite tunnelling excavation in hard rock, Konkan Railway after scrutiny of tunnelling machinery in the international market chose the Atlas Copco jumbo drills and Haaglund loaders that were manufactured in Sweden. These equipment were provided to contractors who were constructing long tunnels, free of charge. However consumables, power, water spares etc was at their cost. For movement these machines use diesel power. For drilling and mucking these machines use electrical energy, which avoided building up of fumes inside the tunnel while working.

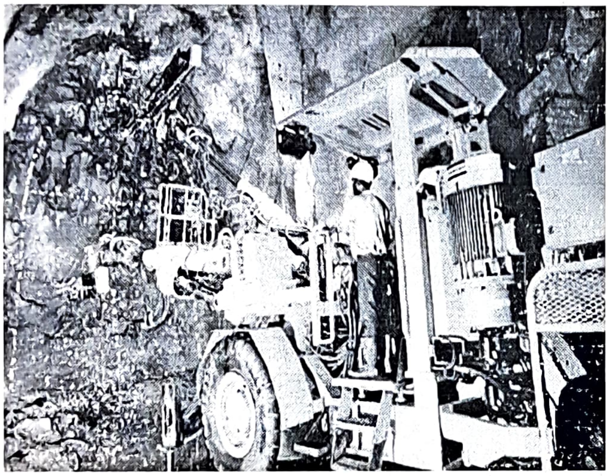
Before the finalization of tenders for tunnelling, soil investigation was carried out for all tunnels. Fairly accurate data was available for most tunnels. The soil investigation was necessary to determine the section, execution method and supports required. Strata was determined by boring and actual collection of samples. While most cases the nature of strata was correct, however in 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. By drill blast using conventional equipment, progress of around 100 to 120 mts per month was achieved. This was only possible because of availability of suitable equipment that could work in tunnels with our dimensions. Initially Terex loaders were deployed. With increased requirement of customized machines for tunneling in Konkan Railway, 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 equipment facilitate faster mucking of blasted material.

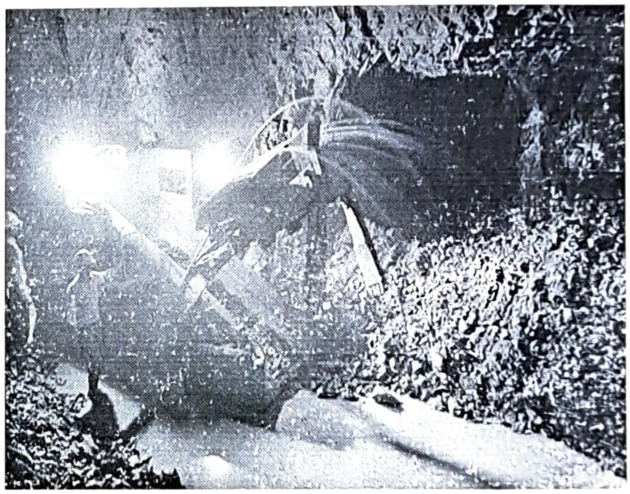


EXCAVATOR WORKING IN A TUNNEL

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 drill jumbo worked very satisfactorily. It was equipped with two drills of 45 mm dia which could complete a 4m hole in two minutes. Standard explosives available initially were of 32mm dia and subsequently 40mm dia slurry explosives were introduced to suit the dia of holes made by the Atlas Copco drill jumbo. Usage of these explosives reduced the requirement of explosives 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 as compared with conventional 32 mm dia explosives and therefore mucking time also reduced. The Hagg loaders broke down frequently and required heavy maintenance and hence there was huge requirement of spare parts for this machinery.



ATLAS COPCO JUMBO DRILL



HAGGLUND LOADER CARRYING OUT MUCKING

HAGGLUND LOADER MOVING INTO TUNNEL

A typical drill blast and mucking method consists of preparation of face, drilling, charging of explosives, blasting, scaling of fractured rock after blast, or blasted rock. This whole process constitutes a cycle. A cycle time in the conventional method varied from 25 hrs. to 30 hrs. with a pull of 2.2 to 2.7 mts. And with a monthly progress of around 45m to 70m being achieved. Using the Atlas Copco Jumbo & Hagg loader, the cycle time could be brought down to less than 12 hours. The least cycle time recorded was 4 hrs 25 minutes in Nathuwadi tunnel and a progress of 180mts being achieved in 1995.

NATHUWADI TUNNEL

The cost of operation of these imported equipment which were efficient was comparatively more when compared to the conventional drill blast technique. This was because of cost of spares, consumables, water and electricity required for operation of these machines. There was a reluctance on the part of contractors to use the equipment provided by Konkan Railway. They preferred the drill blast in hard rock with conventional equipment.

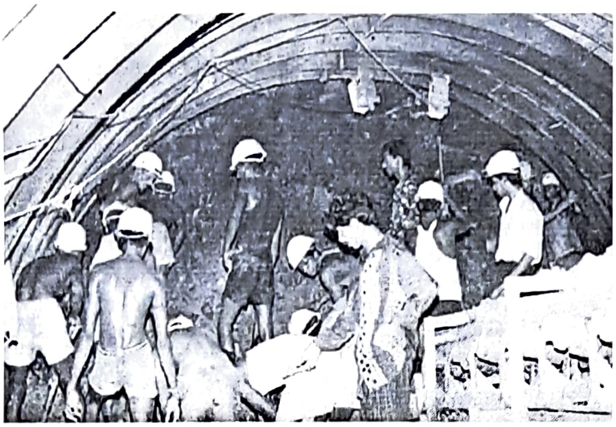
Using Atlas Copco drill jumbos only 19.06 KM of hard rock tunneling was completed. This was around 25.5% of the total hard rock tunneling on Konkan Railway. 58.76 KM of hard rock tunneling was completed using conventional equipment.

In areas where loose fragmental rock, soft rock and highly jointed rock was encountered, these areas were provided with steel supports & lining or rock bolting & shotcreting. After completion of the project, unlined portion of rock tunnels are being rock bolted and shortcreted in a phased manner to avoid any loose fall during train operations.

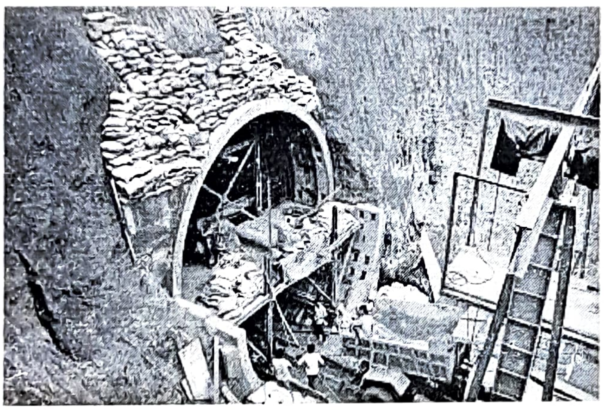
Of the 84.80 KM of tunneling, only 6.98 KM of tunneling was through soft soil, which was around 8% of the total tunneling done on Konkan Railway. It is the completion of these soft soil tunnels that delayed & determined the completion of Konkan Railway line. There were seven tunnels on Konkan Railway where considerable length of soft soil was encountered. Four of these tunnels were in Goa (Pernem, Old Goa, Verna and Padi) and three were in Karanataka (Byndoor, Honnavar & Bhatkal tunnels)

All the soft soil tunnels had whitish yellow lithomargic clay with isolated boulders in some instances. The stand up time of this soil reduces further when it is mixes with seepage water and reduces even further during the monsoon when seepage increases considerably.

With the past experience of tunnels constructed in soft soil on Indian Railways, a two stage process was adopted in its execution ie Heading & Benching. Heading in the top semicircular portion of the tunnel where height is about 3.4mts and width around 6.4mts. 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 in heading. Tippers were used for moving out the excavated earth. The excavation is proceeded in stages of 0.5m or even less depending on standup time after which 15MB 150 x 75 or ISMB 200 x 100 arch sections are placed and connected to the previous arch section through tie rods. At the spring level of the arch rib, they are connected through wall plates, which were usually ISMB 200x100 sections. 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 mts in heading, benching was started. Benching was taken up metre by metre using small excavators. During benching again depending on the strata and stand up time, the length of bench cut had to be reduced. The arch rib and the wall plates below it is supported with ISMB 250 x 125 columns at the time of benching. Each column was connected by tie rods. Behind the columns is placed 1 M length laggings. The gap between the laggings and excavated earth was filled with boulders. This was then followed by concrete lining along the sides and the arch. This was the standard method for soft soil tunnels that was initially adopted.



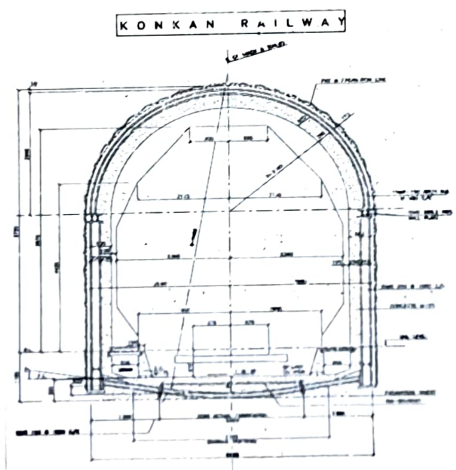

HEADING WORK IN PROGRESS




BENCHING WORK IN PROGRESS

However, with 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. Even after forepoling, we had a number of instances when the face itself used to collapse ahead, creating huge cavities above. Here we had to go in first for filling up these cavities before going ahead by pumping concrete or by cement grouting in other instances. Even after forepoling, cavity filling etc, was done, there were instances when there was no stand up time. Then we went ahead by drift tunneling where in a rectangular opening is created with steel supports. This size of the drift was just enough for a man to work in the drift area. The area around the drift was cleared in small portions and the arch was connected in segments. Progress here was inch by inch. To provide stability at the wall plate which at time used to fail when benching was done, concreting was also done at the springing level covering the wall plates to provide rigidity and stability when the bench below is excavated. Another change from the standard methodology was filling of concrete behind laggings instead of boulders. When the drift methodology also failed, extensive grouting was done and then the drift was again attempted.

When benching was done and as the invert of the tunnel had no cross support, the side walls of the completed tunnel with vertical supports together collapsed. This again necessitated a major design change. The important change that was made in the original design was providing a steel inverted arch between the columns and then concreting the invert. Even after all these changes to the original design for soft soil tunneling, there were a number of tunnel hazards where the entire heading and benching collapsed together, especially in Pernem & Old Goa. 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 more.

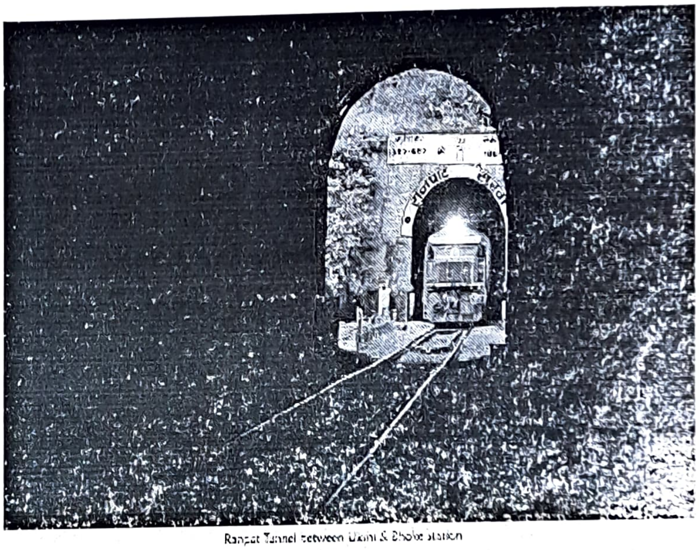


CROSS SECTION
TUNNEL PROFILE
LINED
IN SOFT SOIL
BOTTOM CLOSED

Because of repeated failures in these tunnels and the cost involved in restoration, the contractors who took up the work gave up these works and they had to be finally taken up departmentally.

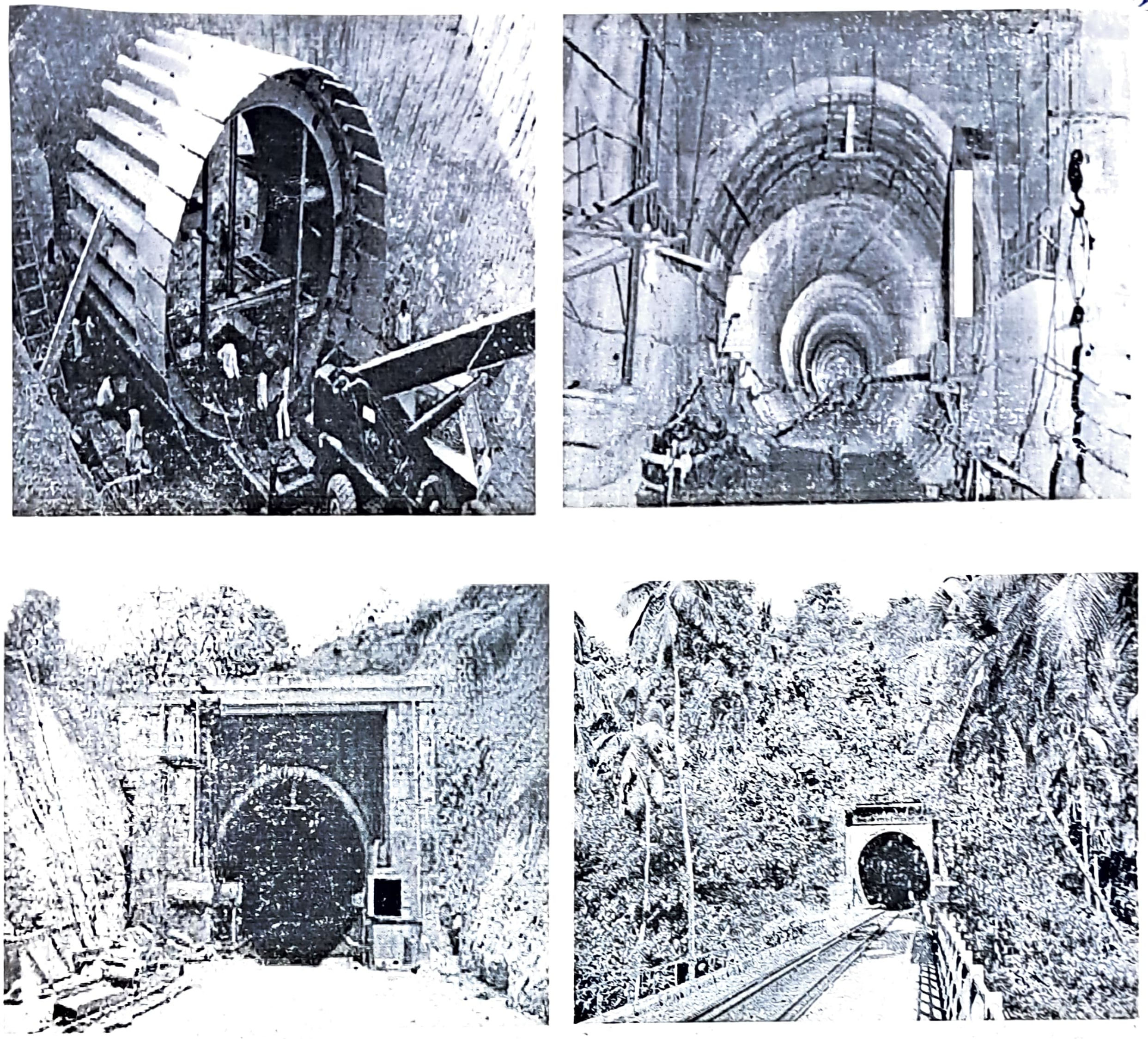
The dedication with which workmen, Contractors and Engineers tackled the collapsed portions with temporary supports and then going for regular supports and concreting it thereafter to make the area stable needs to be commended. Progress was achieved inch by inch and these works were completed only because of the perseverance of all those involved in spite of causalities when accidents look place.

Completion of soft soil tunnels in Konkan Railway is a story of grit and determination in spite of repeated failures.



Ranpat Tunnel between Ukshi & Bhoke station

In the Honnavar Tunnel which was also a soft soil, it was decided to go in for a shield tunnel. The shape of the tunnel in cross section was circular and was different from the close to horseshoe shape adopted in other tunnels. As the shield moved forward, the rear portion of the tunnel was supported by precast segments. Given the unpredictable nature of soil, tunnelling by shield driving was very slow. For completing 238 Meters of this shield tunnel, it took nearly 38 months. As the progress was not satisfactory this method was discontinued and the balance portion of this tunnel was completed by conventional soft soil tunneling methods.



SHIELD TUNNEL AT HONNAVAR

Soft soil tunneling became the most critical activity on Konkan Railway due to very poor progress. A number of foreign experts were brought in to suggest solutions. However, the solutions were either quite expensive or not practical. Also it would have required considerable time to mobilize machinery for completion of the remaining work. However, it is the old conventional methods which though primitive, was what saw these soft soil tunnels through.