METRO TUNNEL THAT WILL GO RIGHT UNDER MITHI RIVER P3

COLABA-BANDRA-SEEPZ LINE

A 170-m Metro tunnel that will go right under Mithi river

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INKY SLUDGE and garbage float placidly on the surface of the water. But beneath the riverbed at the mouth of the Mithi river in Mahim-Bandra Kurla Complex, precision engineering and all manner of precautions are in place as sophisticated machines set out this week to bore tunnels 10 metres below Mumbai's mother drain. As work continues on India's first completely underground Metro Rail line, the section between the Dharavi and Bandra Kurla Complex stations will also witness India's second under-river tunnelling for a mass transit project, after similar subway tunnel construction beneath the Hooghly in Kolkata.

The alignment of the Colaba-Bandra-Seepz Metro line, being constructed by the Mumbai Metro Rail Corporation Ltd (MMRCL), runs from Prabhadevi beneath Mahim Causeway or Lady Jamshetjee Road before turning gently into the city's suburbs at Mahim, where it will run beneath the Western Railway tracks, a patch of mangroves near Dharavi and the Sion-Mahim Link Road before turning into Bandra Kurla Complex. Here, a part of the BKC Metro station and a 170-metre section of tunnel will be constructed right under the Mithi river, only a little over a kilometre from where it empties into the sea.

After the Dharavi station, to be built at a depth of 15 metres below ground, the route subsequently runs under the Mahim creek up to the Income Tax Office, where excavation for the BKC station is at an advanced stage. Further north, the route runs under the Bharat Nagar and Valmiki Nagar slums towards CST Road before it reaches the next station at Mumbai University's Kalina campus.

"When tunnelling below a water body, you have to almost feel the ground, watch it closely and see how it's behaving, to understand to what extent it needs to be supported," says Director (Projects) S K Gupta of MMRCL, explaining the all-round excitement about the coming milestone.

Will the soil, silty in places and sandy or gravelly elsewhere, behave as anticipated; will the weak points in the sub-strata emerge just as per the meticulous mapping and scientific soil testing surveys done previously, what last-minute additional precautions will be needed — these will be the challenges facing a team of consultants and engineers associated with MMRCL, the section contractor and the tunnelling experts over the coming weeks.

A 153-metre section of the tunnels at BKC station, a good part of which will be in the water body, are to be built by the New Austrian Tunnelling Method (NATM), a tunnelling system designed so as to use the strength of the soil or geological formation around the tunnel to support it. The BKC station, with a wider and longer box, is envisioned as a two-platform, three-line station where the third line is meant to provide stabling and sick-siding or emergency turnaround services. Work on the horseshoe shaped tunnels has begun very slowly over the past few weeks, but is expected to make real progress in the coming few days. The ceiling of these tunnels will be 8.5 metres to 12.5 metres below the riverbed.

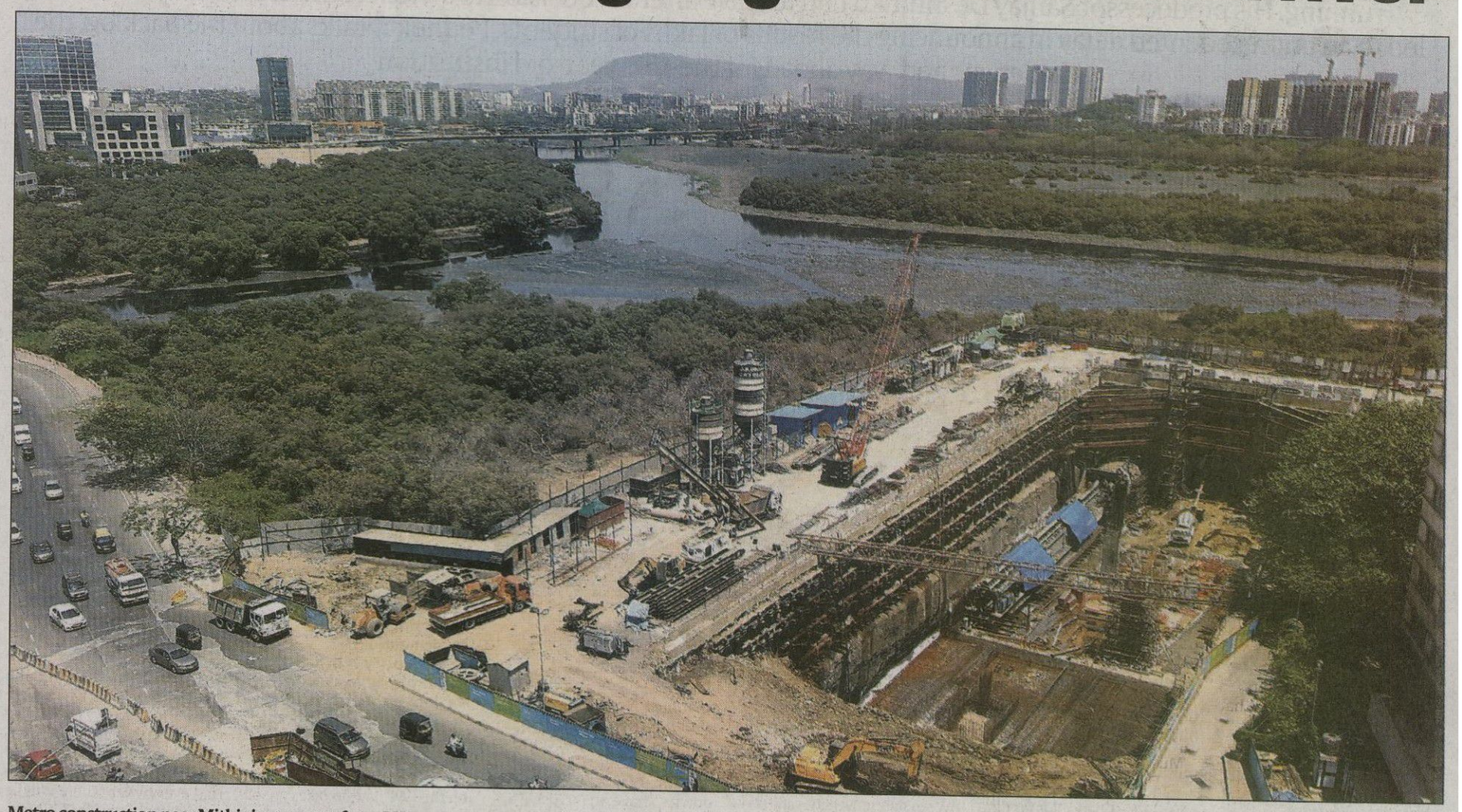
One advantage of the NATM machines is that while other Tunnel Boring Machines or TBMs need to achieve a breakthrough at the farther end and be retrieved through a second shaft, NATM machines can be halted and reversed — as required for the BKC station's third line. But the real reason to use NATM in such sub-strata is that the design relies on the strength of the surrounding rock or soil to support the tunnel, while shotcrete protection is provided to minimise damage to the rock. Shotcrete is concrete sprayed immediately upon tunnelling, the concrete helping to improve the soil or rock's internal cohesion. As the tunnelling machine advances, the construction of the permanent lining takes place immediately behind the machine's excavation face, the machine placing and affixing the precast concrete segments that form the inner ring. The shotcrete reinforces the support ring too, the thickness of the concrete depending on the weakness of the soil.

Other support measures for NATM tunnels include wire mesh and lattice girders, also to reinforce the strength of the surrounding terrain, as well as rock bolts and steel arches affixed to prevent collapsing loose soil or water from entering the tunnel.

Gupta explains that it is conventional tunnelling, but in small sections to minimise risk. Simultaneously, pre-drilled holes will be used to place steel pipes that will provide added support for the tunnelling machine as it advances. Called fore piling or fore poling, this helps support a weak roof adjoining the machine with the help of 32 mm or 40 mm steel rods. 'Weep-holes' may be drilled in the shotcrete also, to avoid build-up of water pressure on the lining.

Once the ring of precast segments is installed, the gap between the excavated radius and the radius of the precast ring is filled with grouting. In fact, according to MMRCL engineers, the only risk is during the tunnelling — once the permanent lining is erected, the balance is restored.

The rings in the section below the river will also have special gaskets, almost double the size of those used in the tunnels along the rest of the line. These will be specialised gaskets with improved waterproofing to ensure long-lasting watertight segments. Embedded into each polymeric gasket is a vulcanised polychloroprene hydrophilic strip. This is cutting edge science and care to detail — hydrophilic polymers are basically those that swell in contact with water, forming a physical bond, such as in ultra-absorbent diapers. In the gaskets for the precast rings under the Mithi, the ultra absorbent polymers will help withstand higher pressure that water may exert. Burrowing in soil, and especially in loose soil, is inherently dangerous, but this process is designed meticulously in order to be safe, according to the MMRCL. It is also painstakingly slow, progressing only a few metres every week, and tunnelling under the Mithi is expected to continue right into October. "Weak spots have been identified and designed for. People know beforehand and are prepared in terms of resources and equipment. And they are a qualified set of people overseeing the work," says Gupta.



Metro construction near Mithi river as seen from BKC. *Pradip Das*

ABOVE TUNNEL, NATURE PARK

NOT FAR above the dramatic underwater tunnelling, the 35-acre Maharashtra Nature Park or Mahim Nature Park is deserted on a scorching May afternoon. But this former garbage dump that is now an island of green, home to over 300 species of plants, is a whisker or about 500 metres from where tunnelling between Dharavi and BKC stations will take place. Just over a kilometre away, towards the north-west from the nature park, is BKC station.

There will also be tunnelling under a patch of mangrove forest that relies for its survival on the Mithi's estuarine mudflats, a breeding ground for a variety of flora and fauna. Together, this area is a natural drainage basin for the city.