

Tunnel boring machine arrives for city's first underground Metro

The machine will start its tunnel drive in October, and will next see sunlight only after a year, boring from Dharavi through Shitaladevi before emerging at the Dadar Metro station



Construction work on at Naya Nagar in Dharavi. Prashant Nadkar

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MUMBAI, SEPTEMBER 4

HAVING ARRIVED at the Mumbai Port Trust on Monday, the first of 17 tunnel boring machines for the Colaba-seepz Metro Rail will soon prepare to crush rock and soil underground to eventually change the way the city travels to work, giving Mumbai its first underground subway system. The arrival of the tunnel boring machine (TBM) marks the kick-off for the most critical part of this Metro Line, that of tunnelling 51 km in two years, with machines and operators working 15 to 25 metres underground, or as deep as a four-storey building placed underground.

The first machine, disassembled and despatched from a factory in Guangzhou, China, will be transported from the port on 17 extra-large trailers that will follow an elaborate traffic plan to reach Naya Nagar in Dharavi. Once the machine is fully assembled, it will cut and grind its way back into sunlight only after a year, covering 2.5 km from Dharavi through Shitaladevi to Dadar.

The Mumbai Metro Rail Corporation (MMRC), which is building the 33.5-km under-

ground Metro line, has meticulously planned the journey of each TBM, from the port through congested roads to various construction sites where 25-metre deep launching shafts or excavated pits await. "From Wednesday onwards, over two or three days, the trailers will drive to the Naya Nagar Metro Rail site, a 3,500-sq metre plot from where 404 families were rehoused in Kurla earlier," says Ashwini Bhide, Managing Director of MMRC. "The trailer movement will happen mostly at night, to avoid choking the roads." By September 15, work will begin to lower the parts of the TBM into the shaft.

A highly sophisticated and complex machine, "like an aircraft" as described by MMRC's Director (Projects) SK Gupta, the Earth Pressure Balance TBM will be assembled bit by bit over the next 45 days by engineers and technicians employed with the Metro contractor, the German manufacturer Herrenknecht and various consultants.

First, the cutterhead, erector, screw conveyor and the tailskin shield will be lowered into the shaft. The initial 'tunnel drive' begins with the rest of the machine still overground, connected via hydraulics. "The machine pushes itself in using



Engineers at the factory acceptance test of the first tunnel boring machine in a manufacturing facility in Guangzhou, China. The machine has arrived at MbPT. Photo courtesy: MMRC

reaction from a frame it rests against, and as it bores ahead the erector places the precast concrete segments inside the tunnel surface," says Gupta. The precast segments are being manufactured in bulk. With six segments for forming a ring of concrete inside the tunnel, the entire Metro Line 3 requires 40,000 such rings, or 2.4 lakh precast segments. The TBM also grouts the area between the tunnel and the concrete ring.

"For every inch the machine moves, we will have slurry," says Gupta of the MMRC's big challenge of transporting the hundreds of tonnes of crushed rock and soil. The slurry will move through the machine's conveyor

to muck buckets that will then be transported back out of the tunnel.

The rest of the TBM will be lowered into the shaft in stages once it starts forward on its preset trajectory, monitored by trained engineers using GPS and proprietary survey systems and software. Once assembled entirely, the TBM will be over 100 metres in length, about as long as a football field. The actual tunnel drive starts in late October, and will end around the same time in 2018.

The operators working underground will spend their shifts, including lunch-hour, in air-conditioned cubicles inside the machine from where the

TUNNELLING, IN NUMBERS

17 TBMs

■ Manufactured by companies headquartered across the world, but all built in China. Seven of these are refurbished TBMs, purchased from metro rail contractors in New Delhi and Singapore.

100 METRE

■ The length of an average TBM, about the length of a football pitch

40,000

CONCRETE RINGS LINE THE TUNNEL INTERIOR

■ At 6 precast concrete segments to a ring, the line needs 2.4 lakh segments

9,20,000

STEEL BOLTS WILL JOIN THE CONCRETE SEGMENTS

■ But with the concrete segments fit snug and compressed, supporting on another, these bolts actually become redundant. Many tunnel systems remove these bolts later

cutter head is operated, returning overground only at the end of a shift. The TBM is self-sufficient, with a toilet and its own sanitation system. To reach the head of the machine and to return overground, operators will hitch a ride on wagons placed on temporary rail tracks. The latter, almost like narrow gauge train tracks, will transport muck cars outward and supplies inward. Ventilation systems and blowers will be augmented as the tunnel progresses.

According to Bhide, the other 16 TBMs are also set to arrive soon, between now and February 2018.