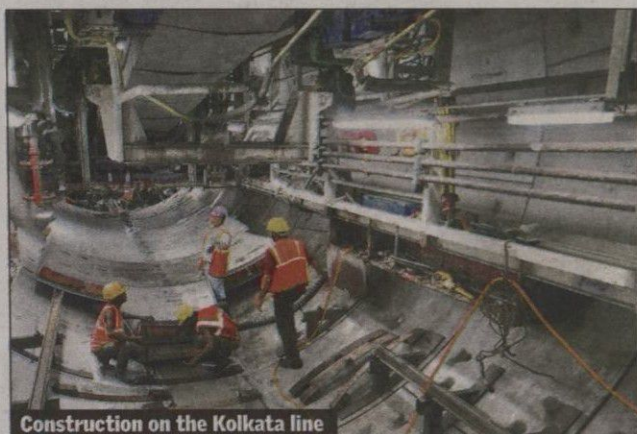


HOW TUNNELS ARE HELPING METRO LINES CROSS RIVERS

As metro connectivity expands in India's biggest cities, new challenges keep cropping up. One of them is rivers on metro routes. While metro lines can be built over them, some cities are tunneling underneath them. But building train tracks and stations underground isn't easy. Experts need to study the river and the soil beneath to map out a safe route. While Chennai has launched services on an under-river tunnel, similar projects are underway in Kolkata and Mumbai. A look at how metro lines are going underground

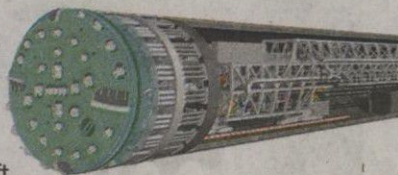
	Mumbai	Chennai	Kolkata
RIVER	MITHI	COOUM	HOOGHLY
ROUTE	On the Colaba-Seepz line	On the 21-km Washermanpet-Airport line in phase 1	On Salt Lake Sector 5-Howrah line
LENGTH OF TUNNEL	153 metres	270 metres	520 metres
STATUS	Work underway	Open	Built, but not yet open
DEPTH	22m	30m	30m



Construction on the Kolkata line

Tunneling:

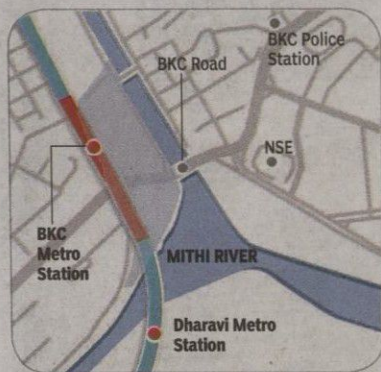
Special tunnel boring machines, meant for operation in soft ground conditions, are used. The machines, however, are very slow, digging only a few metres every week



Challenges:

The presence of a water body can affect the ground underneath it in unpredictable ways, making the tunneling process very dangerous. The process requires prior knowledge of soil and rock composition to safely tunnel through

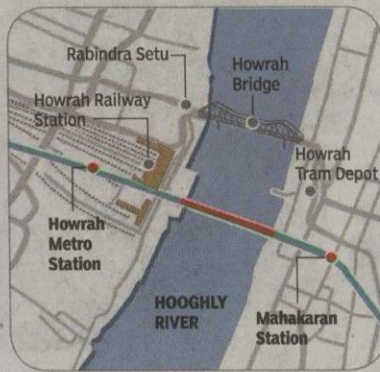
Mumbai: Three tunnels to come up under Mithi between Dharavi & BKC stations. While twin tunnels will be for normal Metro train movement, the third will be for reversing and parking. A station will also be underwater



Chennai: The twin tunnels linking Chennai Central and Government Estate Station are part of the last 10km stretch of phase 1 inaugurated this year. In phase 2, Chennai Metro will pass beneath the Adyar river



Kolkata: The twin tunnels under the Hooghly between Mahakaran and Howrah Metro stations on East-West corridor are ready. The tunnels have walkways for evacuation of passengers in case of emergency



NEW YORK HAS HAD TUNNELS UNDER RIVERS FOR MORE THAN 100 YEARS

New York subway, US

- 16 city subway lines are at least under a riverbed, if not underwater
- Majority were built in the late 1800s and early 1900s

Channel Tunnel

- Connects UK and France by rail
- The 50km tunnel that goes up to 75m deep was built in 1994

Seikan Tunnel, Japan

- World's longest undersea tunnel at 53.9km, connects a small island to Japan
- Built in 24 years at a cost of \$6.5 billion

Marmaray Tunnel, Turkey

- The 13.5km long tunnel in Istanbul goes under the Bosphorus Strait
- Opened in 2013, it connects Europe and Asia