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CHALLENGES AND REMEDIES DURING CONSTRUCTION OF THE NORTH-SOUTH CORRIDOR OF PUNE METRO THROUGH DECCAN BASALTIC ROCKS – A CASE STUDY

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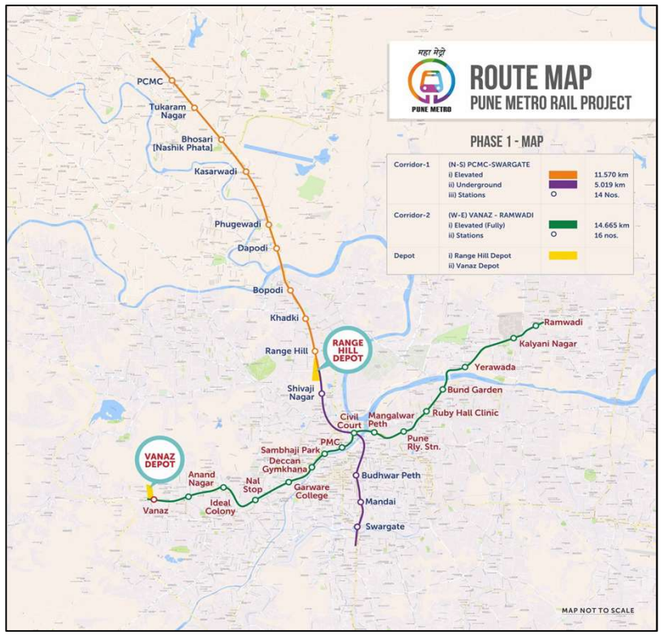
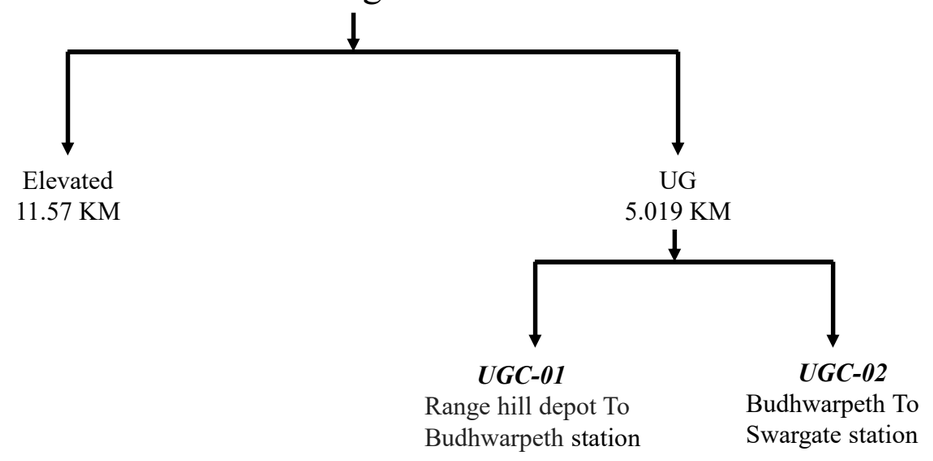


- The Pune Metro Rail Corporation is implementing its Line-1 and Line-2 presently.
- Line 1 – PCMC To Swargate



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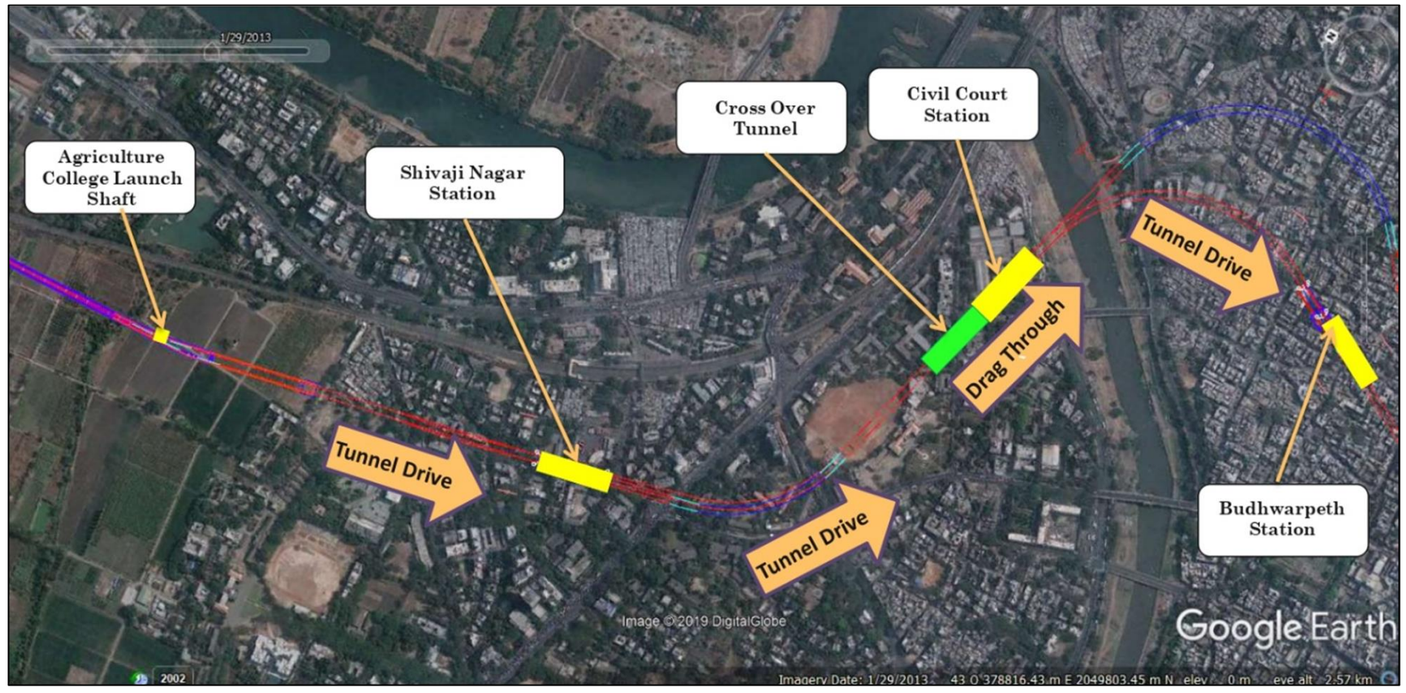
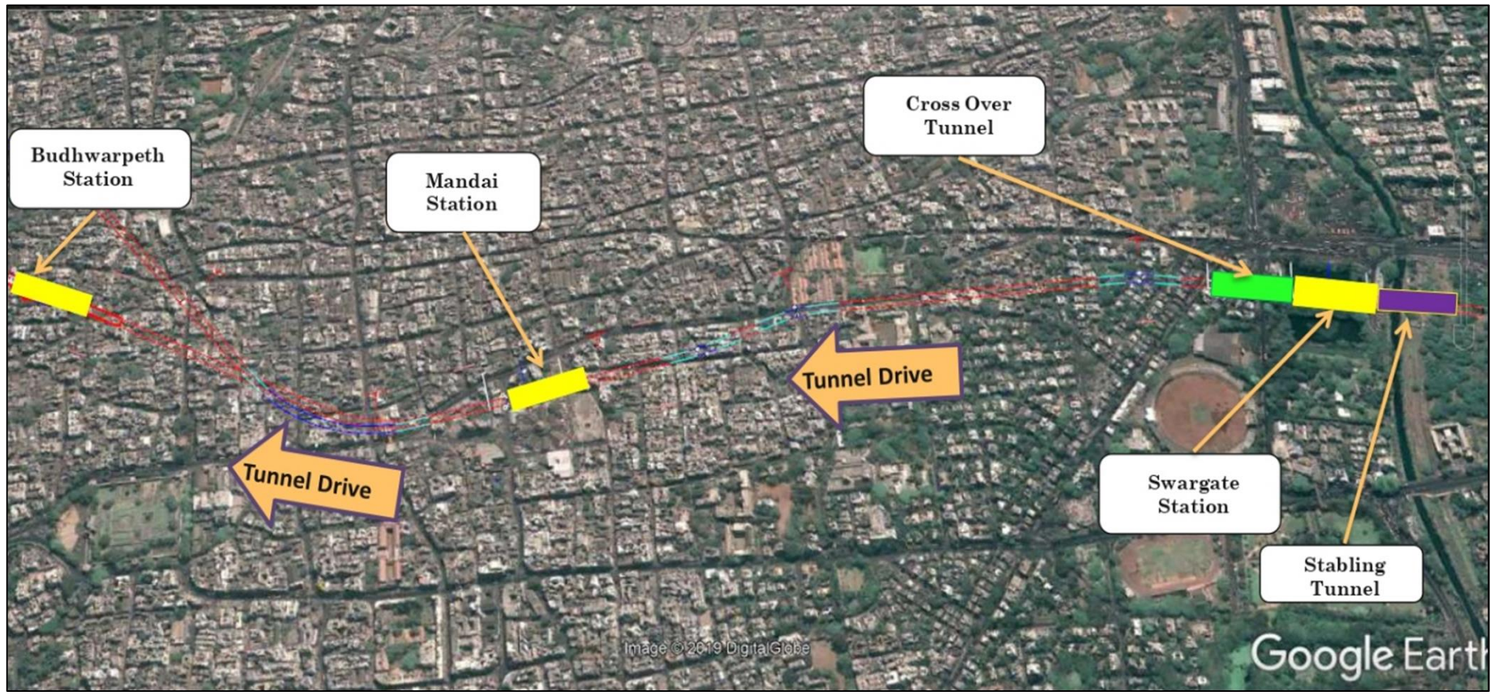
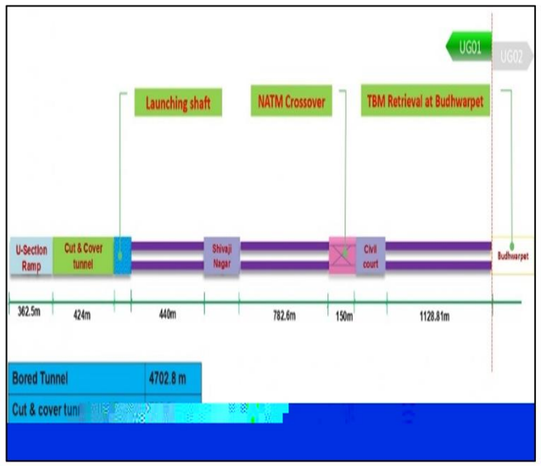



Budhwarpeth Station
Mandai Station
Cross Over Tunnel
Tunnel Drive
Tunnel Drive
Swargate Station
Stabling Tunnel
Image © 2019 DigitalGlobe
Google Earth

Project Silent Features:

- In this project, 5 Underground Stations are constructed by cut & cover construction method and NATM method.
- Tunnels between adjacent stations are bored by utilizing EPB (earth pressure balance) hard rock TBM (Tunnel Boring Machine)
- Two cross over tunnel are constructed by NATM (New Austrian tunnelling method)



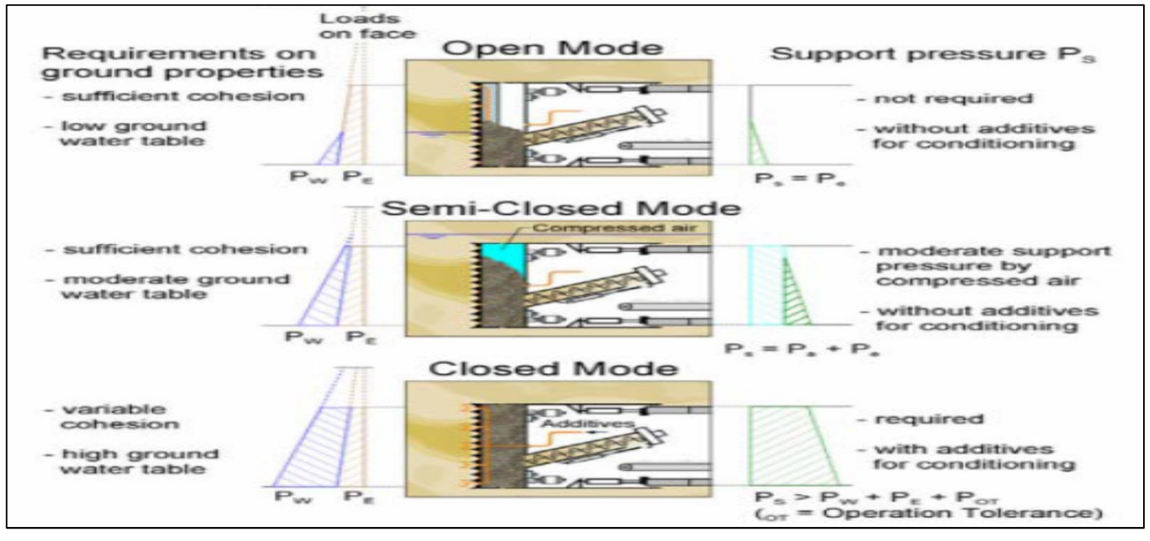
Geology of the Project Area:

- The area of Pune city and surrounding is underlain by Deccan Volcanic Basalts of Upper Cretaceous to Eocene age.
- The project alignment is set in the stratigraphic domain of an approximately 250m thick Pahoehoe flow, Karla Formation. Karla Formation is present in the three directions of the Pune city.
- Presence of red boles at critical places such as bottom of station areas and on the top of crown of tunnel have a significant impact on the design and construction of the underground structures. They are high water bearing zones, confined/perched aquifers. A red bole horizons are observed in the Swargate station 12m from BGL.

Construction Methodology:

For the safe excavation, the main tunnels are made by TBM, the stations are excavated by cut and cover technique and the cross over are constructed by NATM technique.

1- By Using TBM



2- Cut & Cover Method

- For construction, bottom-up technique was used due to presence of rocky strata.
- The length-width-height of excavated zone of civil court station was 150x26x31m.

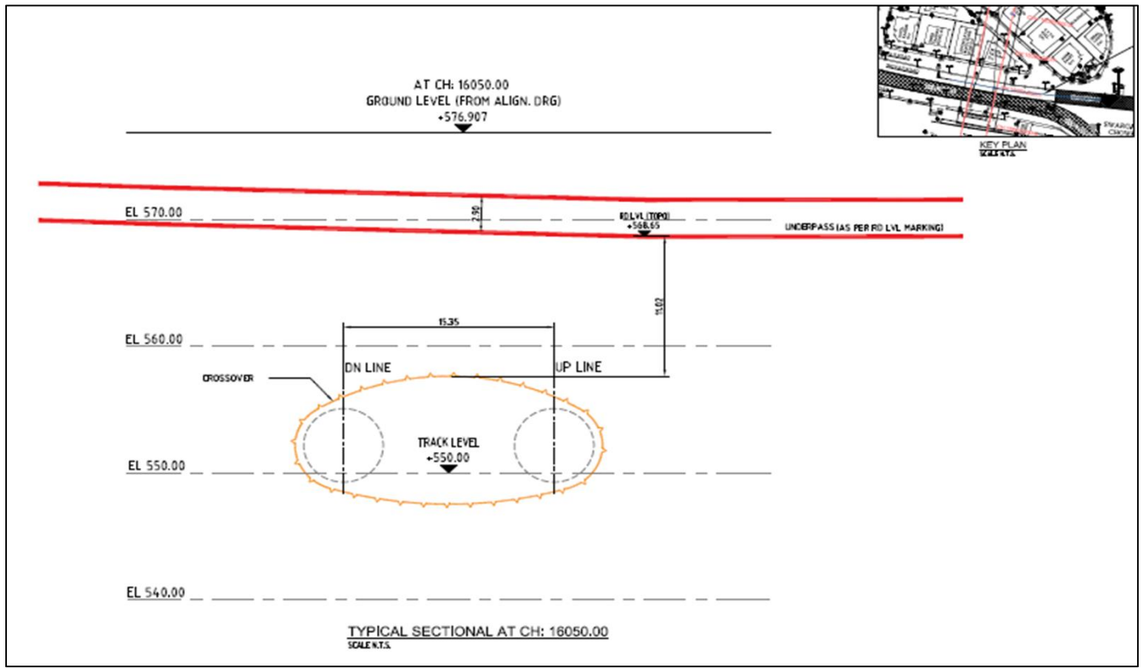
3- NATM

- The New Austrian Tunneling Method (NATM) is one of the most popular observational method of tunneling.
- It is based on concept that the surrounding rock mass not only acts as a loading element for also as a supporting structure to carry the load.

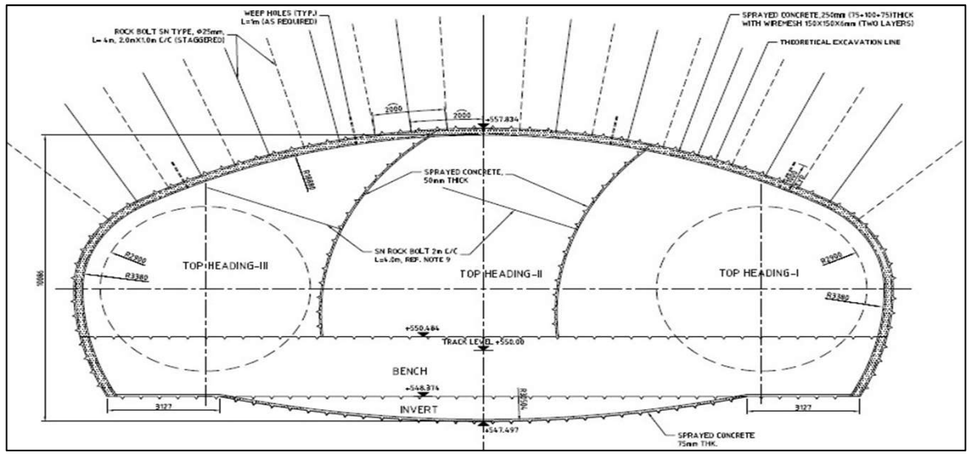
Major Engineering Challenges During Construction:

1-Excavation in vicinity of severe category / heritage structures

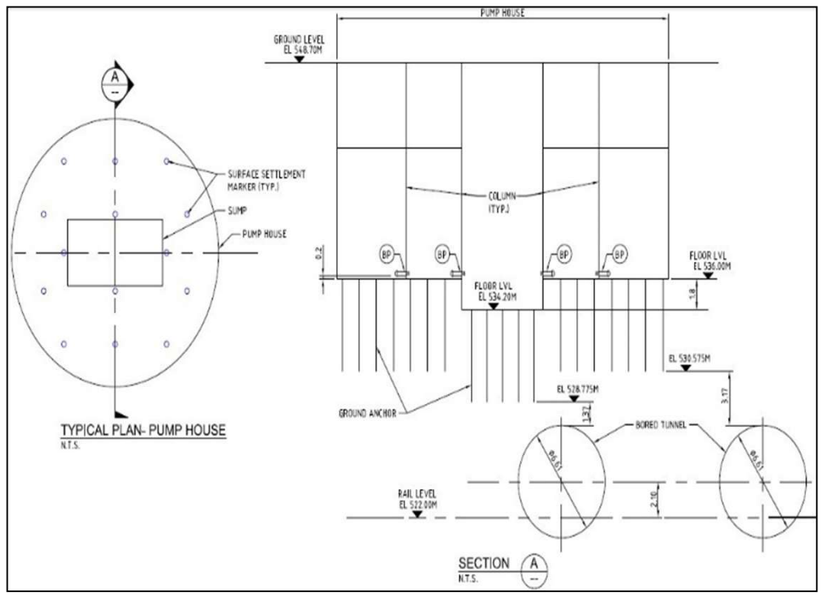
2- Excavation below major roads and deep underpass of the city



- The full face of NATM crossover is divided in 4 parts i.e. top heading 1,2,3 and invert for Sequential excavation. But below the underpass and critical ground structure, all the top headings again divided in 3 parts and invert in 2 part at the site for 1m face advancement.



3-Excavation below existing deep foundations



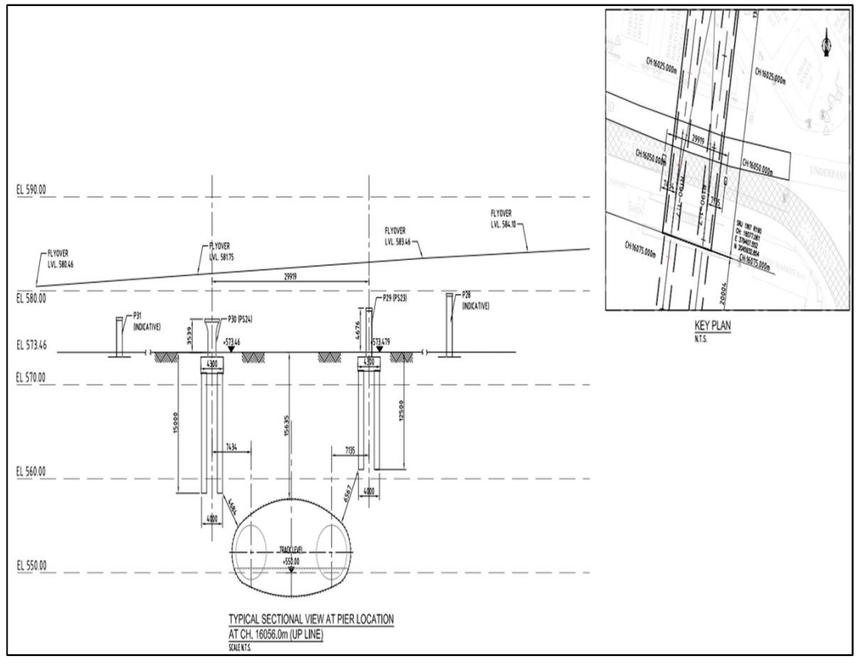
Pump house structure at kasaba peth

- The TBM tunnel alignment is passing below a pump house approx. Ch. 13150m downline near kasaba Peth area.
- The pump house building is directly located above the downline tunnel and clear distance of 1.37m is available from the TBM shield outer diameter to bottom level of rock anchors installed below raft foundation of the building.

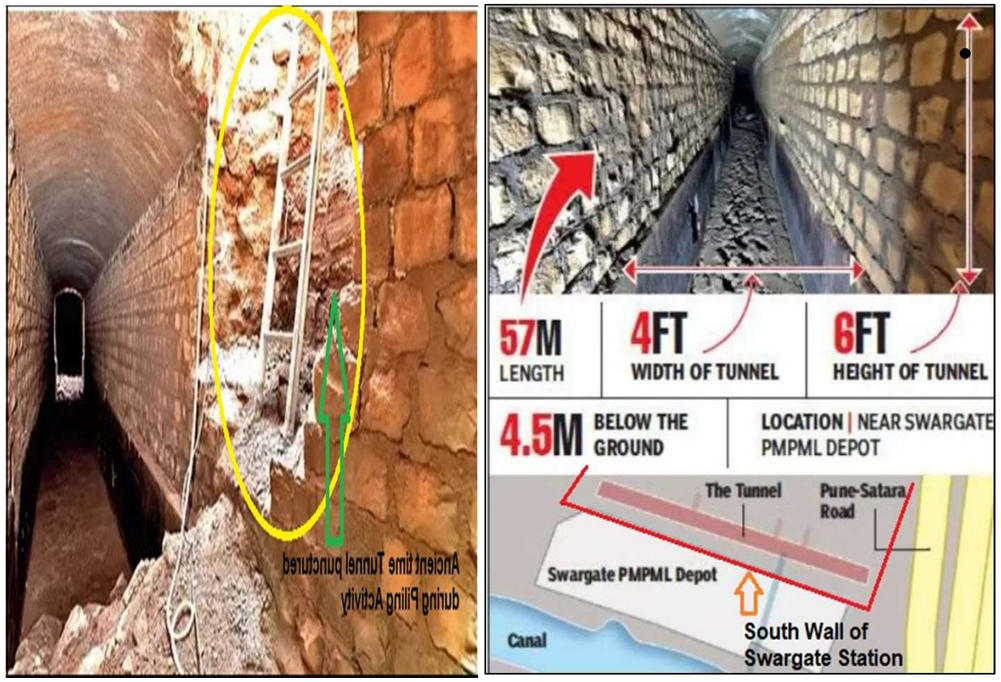
Flyover at NATM cross over, swargate

The distance between piling of flyover piers (P30) and (P29) from NATM tunnel periphery was 4.6m and 6.5m.

The excavation of NATM tunnel at swargate below the critical structure (Flyover and Underpass) was done by adopting all the controlled blasting techniques.

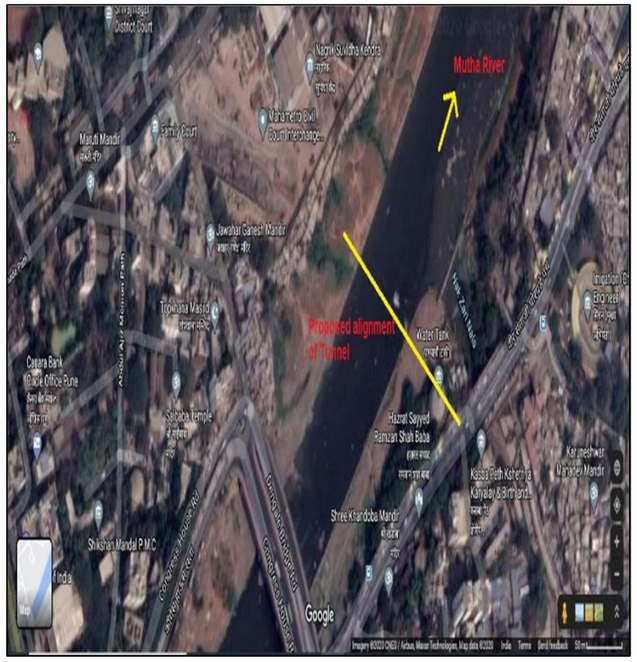


4 - Ancient buried structures

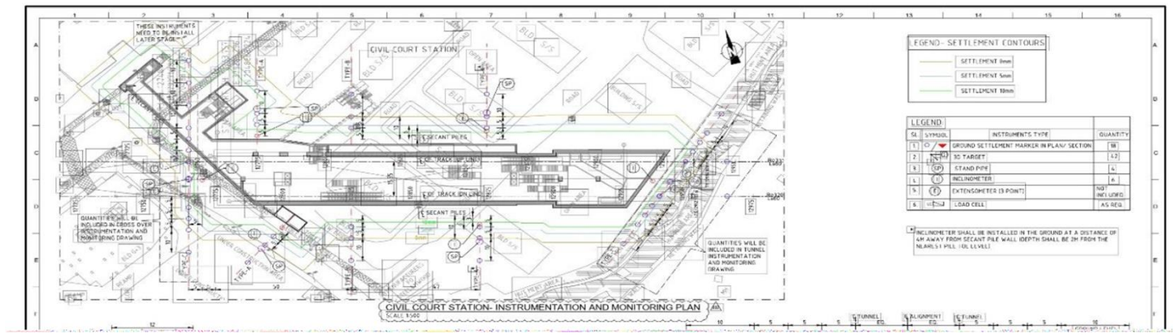


- A buried tunnel punctured at the south head wall during the piling activity at swargate station.

5 - TBM Tunneling Below Mutha River



Instrumentation and Monitoring:



showing the instrumentation & monitoring plan of civil court station

- The ground settlement markers (GSM) installed in the vicinity of station excavation shows a maximum surface settlement of 2mm which is within the designed value.
- The building settlement points (BSM) installed on the buildings show a maximum building settlement of 2mm.
- The monitoring data of inclinometers show a maximum horizontal displacement of 5mm.
- The load cells installed on the rock bolts in the secant pile supporting system shows 2.1 ton change in load which is not significant change
- The crack meters installed on the buildings show no change in crack width (0mm).
- The tilt-plates installed on the buildings show very minor tilt within the allowable design limit.
- During the excavation of station box and crossover NATM tunnel at civil court station all the vibrations are restricted below 5mm/sec. only few are recorded up to 6-7mm/sec.

Conclusion:

- The ground improvement measures improve soil standup time during excavation and allow the installation of optimized initial support while providing safe excavation.
- Ground improvements also serve to control ground water, reduce ground loss and potential surface settlements and minimize the tunnel deformations during excavation.
- Proper instrumentation and monitoring of existing structures was done which was based on the settlement analysis and construction impact assessment of the structures in the influence zone by various types of instruments.
- The temporary rock support based on design drawing have also been reviewed during excavation and optimized which significantly reduced the time and cost for completion of station box.

Wishing & praying for a speedy and safe rescue of our fellow tunnellers in silkayara

Thank You