STUDY NOTES · BASIC CONCEPT

What Is an Undersea Rail Tunnel, and How Is India's First Such Tunnel Being Constructed?

Science & Technology

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1. Introduction

India's first undersea rail tunnel is being constructed beneath **Thane Creek in Maharashtra** as part of the Mumbai–Ahmedabad High-Speed Rail Corridor, commonly known as the bullet train project.

The tunnel is a major engineering undertaking involving deep excavation, specialised tunnelling equipment, structural waterproofing and continuous safety monitoring.

The undersea section is approximately 7 km long and forms part of a larger underground tunnel section of about 21 km between Bandra Kurla Complex (BKC) in Mumbai and Shilphata in Maharashtra.

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2. Key Features of the Project

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Mumbai-Ahmedabad Bullet Train: L&T, Afcons In Race To Construct 21 km Long Tunnel Including 7 Km Undersea Pat

Press Release Page | Press Information Bureau

Feature	Details

Project	Mumbai–Ahmedabad High-Speed Rail Corridor
Implementing agency	National High Speed Rail Corporation Limited (NHSRCL)
Location	Beneath Thane Creek, Maharashtra
Undersea section	Approximately 7 km
Larger underground section	Approximately 21 km
Tunnel configuration	Single tube accommodating two tracks
Deepest construction point	Approximately 114 metres below Parsik Hill
Main construction methods	Tunnel Boring Machine (TBM) and New Austrian Tunnelling Method (NATM)

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Important distinction: The deepest point being approximately 114 metres below Parsik Hill does not mean the entire undersea tunnel lies 114 metres below the seabed. Depth varies along the alignment and depends on the reference surface being measured.

3. What Is a Tunnel Boring Machine?

A **Tunnel Boring Machine (TBM)** is a specialised machine that excavates underground passages through soil or rock while supporting the surrounding ground.

Its major components may include a cutting head, excavation and material-removal systems, ground-support mechanisms and equipment for installing tunnel-lining segments.

The project uses a slurry-based Mixshield TBM in challenging urban ground conditions. Pressurised slurry helps stabilise the excavation face and manage groundwater pressure, reducing the risk of ground collapse and surface settlement.

4. Major Engineering Challenges

HS2 Unveils £3bn Contracts | Rail News

Geological uncertainty

Variations in rock, soil and fractured geological formations can complicate excavation and affect construction speed.

Systemaufbau Tunnelabdichtung druckwasserhaltend | Sika Österreich

Water pressure and leakage

Water pressure can force groundwater into excavated sections. Waterproof lining, sealing systems and controlled excavation help protect the tunnel.

Мониторинг технического состояния тоннелей и жд путей. Проекты мониторинга туннелей и железнодорож

Ground settlement

Excavation near buildings and roads may cause ground movement. Sensors help engineers monitor settlement and respond to abnormal changes.

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Passenger safety

The completed tunnel requires appropriate ventilation, fire detection, emergency communication, evacuation arrangements and operational safety systems.

5. TBM versus the New Austrian Tunnelling Method

Feature	TBM	NATM
Basic approach	Mechanical excavation using a rotating cutterhead	Excavation in stages with support adapted to ground conditions
Ground support	Machine shield and installed lining systems, depending on design	Shotcrete, rock bolts and other engineered supports
Best suited for	Long tunnel drives with suitable geological and geometric conditions	Sections where flexible excavation and support methods are advantageous

Feature	TBM	NATM
Key advantage	Controlled excavation and efficient installation of tunnel lining	Adaptability to changing ground conditions
Main considerations	High initial cost, assembly requirements and geological suitability	Requires careful monitoring and timely ground support

The Mumbai–Ahmedabad project combines both methods for different sections of the underground alignment.

6. How Is Tunnel Safety Maintained?

Construction safety depends on continuous monitoring rather than relying on initial engineering designs alone.

Important measures include:

1. **Ground monitoring:** Settlement points and displacement sensors track movement near the tunnel.
2. **Structural monitoring:** Strain gauges and other instruments help assess changes affecting the tunnel and surrounding structures.
3. **Waterproofing:** Seals and tunnel-lining systems reduce the risk of water ingress.
4. **Atmospheric monitoring:** Sensors can detect hazardous gases and oxygen deficiencies.
5. **Emergency preparedness:** Safe access, emergency refuge arrangements, communication systems and evacuation planning are essential.

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The precise systems required depend on the final design, construction stage and operating conditions.

7. Significance for India

Infrastructure modernisation: The project advances India's capacity to construct complex underground transport systems.

Technology development: Domestic engineers and contractors gain experience in tunnel excavation, monitoring and waterproofing technologies.

Economic connectivity: The larger high-speed rail corridor is intended to improve connectivity between Mumbai and Ahmedabad, two major economic centres.

Skill development: Large infrastructure projects generate demand for specialised workers, engineers and safety professionals.

Future applications: Experience gained may support other urban rail, underground transport and infrastructure projects where similar geological conditions arise.

However, these benefits depend on timely completion, cost control, safe operations and effective integration with the wider transport network.

8. Environmental and Safety Considerations

Undersea and urban tunnelling can affect groundwater patterns, generate construction waste and cause noise and vibration. Careful management is necessary to limit these impacts.

Environmental safeguards should include monitoring groundwater conditions, managing excavated material responsibly, limiting surface disturbance and protecting sensitive creek ecosystems. Safety audits and emergency-response exercises should continue through construction and operations.

Conclusion

India's first undersea rail tunnel beneath Thane Creek is a major development in high-speed rail infrastructure. It demonstrates how specialised excavation methods, waterproofing and real-time monitoring can address difficult underground conditions. **Its lasting value will depend on engineering quality, passenger safety, environmental protection and the successful integration of the tunnel into the Mumbai–Ahmedabad high-speed rail corridor.**

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