CHAPTER 92

Legal Compliance in Construction of Tunnel: Issues and Challenges

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ABSTRACT

Tunnel projects are crucial for infrastructure development and economic growth in India, where over 1000 such projects are currently underway, it is essential to understand and be aware of the legal as well as technical challenges faced during tunnel construction, since delays of these projects can have cascading impact on Indian economy. This study underscores the technical and technical challenges encountered, drawing lessons from the Mumbai-Ahmedabad High-Speed Rail (MAHSR), Pillur III Water Tunnel Project in Coimbatore. It highlights issues such as delays in completion and cost overruns due to complex regulatory clearances, land acquisition, and geological uncertainties that can disrupt progress. To mitigate these challenges, the study recommends for streamlined approval processes through Single Window Systems, comprehensive geological surveys prior to construction, the adoption of the Construction Manager at Risk (CMAR) model, better pre-construction surveys and improved dispute prevention mechanisms.

Keywords: Regulatory clearances; Land acquisition; Geological uncertainties; Single window systems; Legal challenges.

1.0 Introduction

With the Union Budget 2023-2024 allocating ₹7.5 lakh crore for capital expenditure, these investments are critical to boosting economic productivity. Currently, 1,726 tunnels spanning 3,600 km are in various stages of development. Approximately 75% (by number) and 62% (by length) of these have been completed, while 22% (number) and 36% (length) are under construction. The remaining 3% (number) and 2% (length) have been recently awarded. However, delays due to technical and legal challenges threaten to disrupt this progress, potentially causing cascading economic impacts. Addressing these issues is imperative to sustain the sector's growth and align it with India's infrastructure ambitions (New building materials & construction world, 2024).

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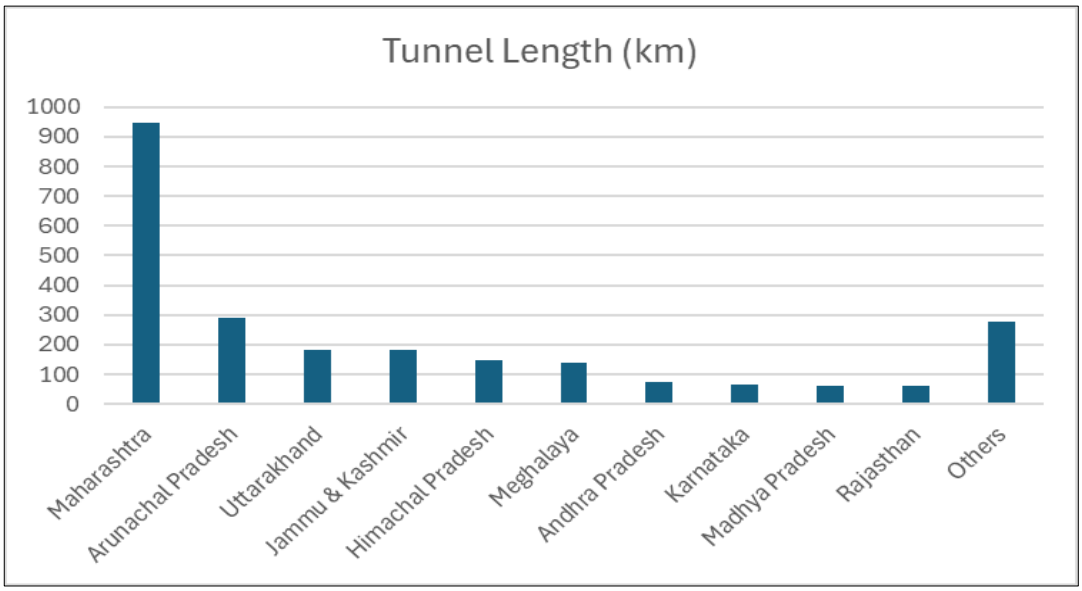
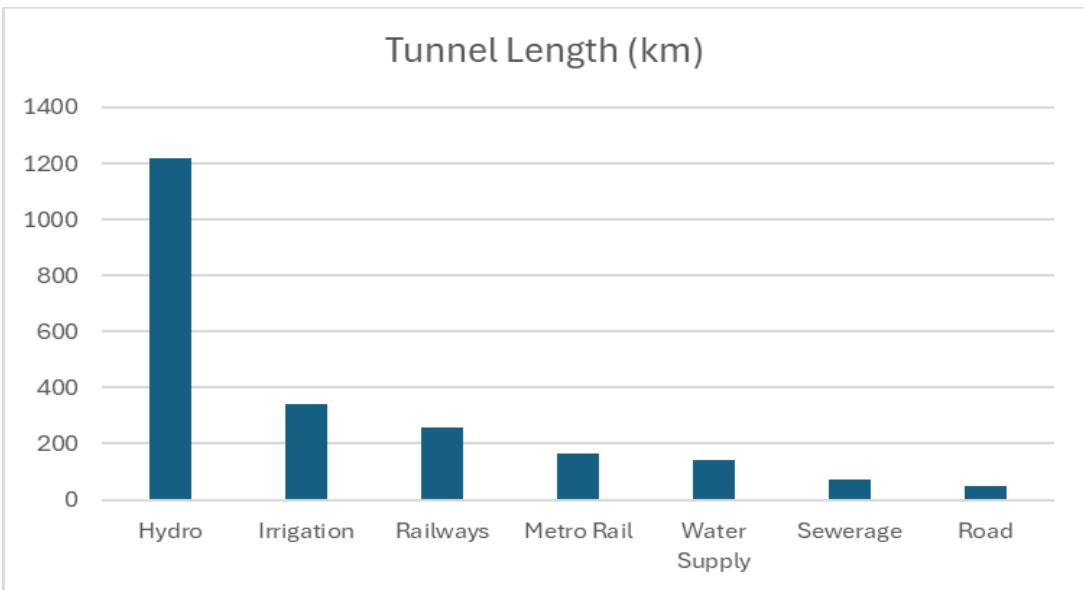
Figure 1: State-wise Upcoming Tunneling Projects in the Pipeline - In Terms of Tunnel Length (km)



Source: What's driving growth of India's tunnelling industry: New building materials & construction world, 2024

Figure 2: In Terms of Completed Tunnel Length- Sector-wise



Source: What's driving growth of India's tunnelling industry: New building materials & construction world, 2024

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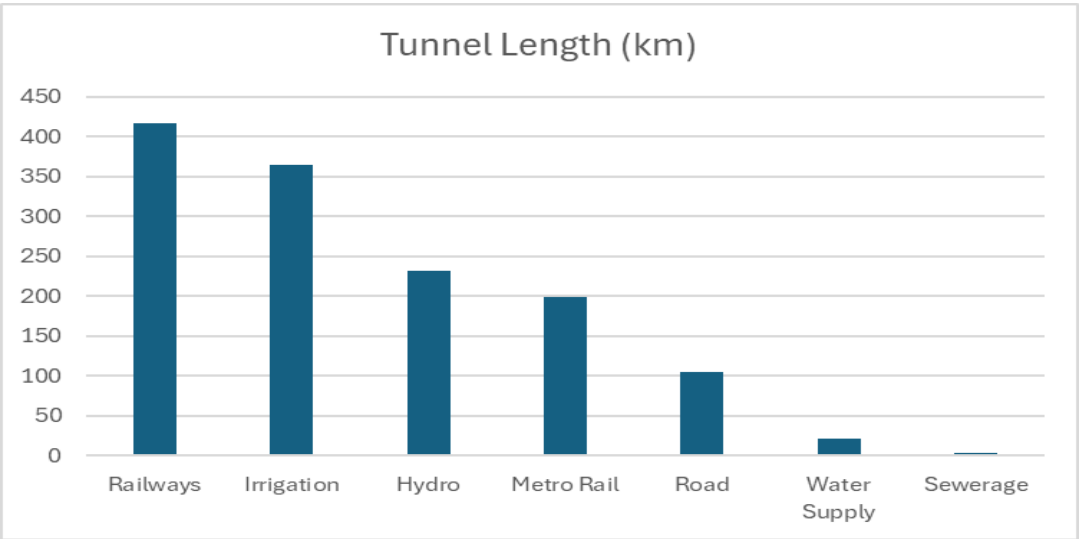
Figure 3: Under Construction Tunnel Length- Sector-wise



Source: What's driving growth of India's tunnelling industry: New building materials & construction world, 2024

2.0 Methodology

This study adopts a dual-method approach combining doctrinal and non-doctrinal methodologies. The doctrinal method involves analyzing legal documents such as statutes, case laws, academic articles, and government reports to evaluate the legal framework for tunnel construction. This analysis identifies gaps in current regulations and compares them with global practices to propose improvements. The non-doctrinal method is based on practical insights gained from an internship at the Pillur III Water Tunnel Project in Coimbatore, Tamil Nadu. Data collection included daily site observations of construction activities such as drilling, blasting, and rock support installation. Contract documents and DPRs were reviewed to validate field observations. Additionally, a phone interview with the project manager of KSR Infracon provided insights into challenges like labor mobilization due to Covid, delays from Client side in providing Water-pipeline design. Validation processes involved cross-checking field observations with DPR data and interview responses to ensure accuracy and reliability. This integrated methodology provides a balanced perspective on the technical and legal aspects of tunnel construction.

3.0 Literature Review

Various studies highlight the multifaceted challenges in tunnel construction. Bommakanti, (2024) detailed the Kolkata Metro's underwater tunnelling through difficult soil,

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solved by specialized TBMs and watertight construction involving pre-cast segments and difficult grouting procedures. Gleason (2024) addressed workforce shortages impacting project execution, advocating for specialized education. Diwakar *et al.* (2022) emphasized geological risks in Himalayan tunnels like rock bursts and squeezing due to the region's low tolerance of geology, movements of tectonic plates, and the complexity of geological structure and composition, requiring enhanced surveys. Ayat *et al.* (2021) analyze 47 Pakistani tunnel projects, finding that geological uncertainties caused 63% of cost overruns, while procurement irregularities added 15-20% to timelines.

Vazquez *et al.* (2021) showcased Bois d'Arc Lake tunnel's wetland access solutions through CMAR which facilitated collaboration between the design team and the contractor, allowing for constructability reviews and identification of cost-saving opportunities. Wang *et al.* (2016) used modelling to address fault fracture zones' impact on tunnel stability, validating that the presence of a fault fracture zone significantly reduces the stability of the surrounding rock, making the tunnel more prone to collapse. Sharma *et al.* (2013) explored metro rail project selection balancing technical, financial, and social factors. Zhang *et al.* (2020) systematize 49 delay factors in Chinese subway tunnels, ranking 'unforeseen geological conditions' and 'TBM breakdowns' as the most severe (4.82/5 severity index), followed by financing delays (4.67) and design changes (4.53). The study by Ekaksorn *et al.* (2024) evaluates structural risks to buildings near tunneling projects, focusing on soil movement-induced impacts. Using Bangkok's MRT Blue Line Project as a case study, it assesses pile settlements, differential settlements, and building angular distortion. The study highlights the role of accurate simulations in mitigating structural damage and ensuring building safety in dense urban areas.

4.0 Issues and Challenges

Tunnel construction faces several challenges. Land Acquisition Issues lead to delays due to resistance from landowners over the compensation valuation and resettlement measures, with the RFCTLARR Act, 2013 often faltering due to poor coordination and deficient framework. Regulatory Delays occur because projects require multiple approvals from authorities like the Fire Department, the Central Ground Water Authority (CGWA requiring NOCs for groundwater extraction), the Airport Authority of India (AAI mandated by the Aircraft (Amendment) Act, 2020), Coastal Zone Management Authority (CRZ governed by the Coastal Regulation Zone Notification, 2019), Archaeological Department (under the Ancient Monuments and Archaeological Sites and Remains Act, 1958), Forest Department (under the Forest Conservation Act, 1980), and National Board for Wildlife (governed by the Wildlife Protection Act, 1972), necessitating a single-window clearance mechanism to streamline the process. Disputes over Contractual Ambiguity related to risk allocation and geological uncertainties clauses, emphasizing the need for clear contract provisions. Technical Challenges arise from complex geology, skill gaps among TBM operators, and inadequate geological surveys, leading to unforeseen obstacles and costly delays.

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4.1 Critical analysis of LARR Act, 2013

India's Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013, while aiming to ensure fair compensation and transparency, faces critical challenges in implementation. The ambiguous definition of 'public purpose' under Clause 2 allows land acquisition for private ventures under public benefit claims, sparking disputes (Ashwin Mahalingam, Aditi Vyas, 2011). Compensation calculations rely on outdated land values (Indian Stamp Act, average sale prices) and lack clear criteria for 'similar land,' fostering litigation (Clause 26). States like Gujarat and Maharashtra exempt projects (defence, industrial corridors) from Social Impact Assessments (SIAs), prioritizing mutual consent and higher compensation, while 14 states (e.g., Assam, Rajasthan) have modified rules under Section 109, delegating land valuation and project execution to state committees (Amit Gupta, 2019). Rehabilitation provisions remain vague, with unresolved job guarantees for displaced families (Dhanmanjiri Sathe, 2015). Overlapping state-central laws and corruption further complicate implementation, leading to delays, inadequate resettlement, and hindered infrastructure projects like tunnels, as outdated compensation frameworks and procedural ambiguities fail to address direct/indirect costs or ensure timely resolutions.

4.2 Regulatory clearance

India ranks 63rd in the World Bank's Ease of Doing Business Index, reflecting significant challenges in fast-tracking regulatory clearances for large infrastructure projects. While financing, technology, and foreign investment approvals have improved, land and environmental clearances remain major bottlenecks. Environmental approvals, mandated by the Ministry of Environment, Forest, and Climate Change, are often delayed due to public interest litigations and NGO activism. Projects require multiple approvals from Central, State, and local authorities, including permits for utility relocation, tree cutting, and NOCs from various ministries, leading to poor coordination and conflicting requirements. Land acquisition and Resettlement & Rehabilitation (R&R) processes vary across states, further complicating implementation. For instance, delays in the Udhampur-Ramban and Ramban-Banihal sections of NH-44 were caused by pending land acquisition, relocation of HT towers, clearance for tree felling, and shifting of a mosque (Civil Society vs State of Jk & Ors, 2021). Many approvals lack defined timelines, making project scheduling unpredictable and increasing costs while delaying completion.

4.3 Case laws

M/S The Exchange Agencies vs. Delhi Metro Rail Corporation Ltd., 2010, dealt with structural damage to an adjacent building during metro construction, with the Delhi High Court awarding ₹3,37,900 and 12% annual interest to the plaintiff, emphasizing mitigative strategies during tunneling. In Jamshed Noshir Sukhadwalla And 4 Ors vs. Union of India and 11 Ors, 2018, the Bombay High Court rejected a stay order sought to protect Zoroastrian fire temples from metro tunnel construction, prioritizing infrastructure development. Sivakumar vs. Chennai

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Metro Rail Limited, 2019, involved residents opposing metro construction at Thiruvika Park; the Madras High Court dismissed their plea but directed park restoration and tree planting.

R.C. Joshua vs State Of Tamil Nadu, 2024, challenged land acquisition for a metro project under the Tamil Nadu Acquisition of Land for Industrial Purposes Act; the Madras High Court upheld the acquisition, interpreting 'industrial purpose' broadly. Civil Society vs State of JK & Ors, 2021, addressed delays in NH-44 sections due to land acquisition and forest clearances; the Jammu and Kashmir High Court directed coordination by the Chief Secretary and appointed a Nodal Officer for compliance. Afcons Infrastructure Ltd vs Nagpur Metro Rail Corporation Ltd., 2016, involved disqualification from bidding on a viaduct tender; the Supreme Court upheld NMRCL's decision, emphasizing deference to tender document interpretation. Lastly, Delhi Airport Metro Express Pvt. Ltd. vs Delhi Metro Rail Corporation Ltd., 2021, revolved around termination notice validity due to structural defects; the Arbitral Tribunal sided with DAMEPL, awarding substantial termination payment later restored by the Supreme Court.

4.3.1 PILLUR III Project, Coimbatore, Tamil Nadu, 2022

Pillur III Project in Coimbatore aimed to improve water supply by constructing a 900-meter tunnel through Kattan Hills. The methodology included a reinforced concrete portal, laser surveys, geological investigations via probe holes (assessing water and gases), and rock classification (Classes I-VI) determining the needed support systems. Trial blasts were conducted, and controlled blasting was performed using non-electric detonators with wet drilling for dust control. After blasting, rock surfaces were immediately cleaned using water or compressed air, and steel supports, rock bolts, and wire mesh were installed. Adverse Geological Occurrences were addressed with chemical grouting or ground freezing. Excavated materials were managed responsibly, drainage systems were implemented, and adequate site illumination was maintained. The Environmental Monitoring Plan controlled vegetation removal, managed earthworks and blasting activities, prevented soil erosion, and safely stored pollutants. Used newer, well-maintained vehicles, and fitted equipment to reduce air and noise pollution. Monitoring compliance with environmental requirements. Concluding, this study helped the researchers understand the technical challenges arising from a tunnel project.

4.3.2 Mumbai-Ahmedabad High-Speed Rail (MAHSR) project

The Mumbai-Ahmedabad High-Speed Rail (MAHSR) case study effectively addresses the objectives of analyzing technical and legal challenges in tunnel construction and evaluating regulatory compliance frameworks in India. Technically, the project highlights complexities like constructing India's first 21 km undersea tunnel using Tunnel Boring Machines (TBMs) to navigate geologically unstable zones and protect marine ecosystems. These engineering feats were overshadowed by legal hurdles, including protracted land acquisition under the RFCTLARR Act, 2013, which mandated Social Impact Assessments (SIAs) and prolonged negotiations with affected communities, particularly in Maharashtra and securing approvals

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from 14+ agencies (e.g., MoEF&CC, NBWL) and litigation over mangrove destruction in CRZ-I zones, exemplify India's fragmented clearance processes. Delays in forest clearances (e.g., 21,997 mangroves destroyed, pending compensatory afforestation) and legal disputes over buffer zones around protected areas escalated costs by ₹50,000–70,000 crore and delayed completion by 5 years. The MAHSR case highlights the need for streamlined processes, such as single-window clearances, specialized tribunals for land disputes, to mitigate such delays in future infrastructure projects. For a developing nation like India, such inefficiencies in regulatory frameworks refrains foreign investment and halts any new infrastructure. Delays and cost overruns in such type of Capital heavy infrastructure can have cascading impact on our economy.

5.0 Conclusion

This study emphasizes the importance of addressing challenges in tunnel construction to avoid delays and cost overruns that can cause cascading impact on Indian economy. By analyzing real-world cases like the Kolkata Metro's underwater tunnelling challenges, Delhi Metro's structural defects, and Himalayan geological risks, key risks such as land disputes, contract ambiguities, geological uncertainties, and environmental concerns were identified. Proactive planning is essential, and best practices to mitigate these risks include implementing a Single Window System (SWS) for streamlined regulatory approvals (as seen in India's PM GatiShakti initiative. Managing Geological risks by deploying pre-construction surveys using Ground Penetrating Radar (GPR) and 3D seismic mapping, as employed in Kolkata's East-West Metro, alongside site-specific solutions like microseismic monitoring in the Himalayas and pre-excavation grouting for fault zones. The Construction Manager at Risk (CMAR) delivery model can be advantageous for tunnel projects because it involves the contractor early in the design phase, allowing for constructability reviews and identification of cost-saving opportunities without compromising design integrity. As followed in the Bois d'Arc Lake project, this collaborative approach between the owner, contractor, and design team enables proactive and collaborative problem-solving, efficient risk management, and timely delivery, making it well-suited to address the unique challenges and uncertainties in a typical tunnel construction. Urban design optimization through multi-criteria analysis to compare underground vs. elevated corridors using cost, security, and social impact metrics and standardized designs i.e., reusing designs for stations/tunnels wherever possible to cut costs and delays. Reduce costs, while big data-driven demand forecasting and phased construction prevent overinvestment.

Dispute prevention relies on precise contract terms (avoiding issues like Delhi Metro vs. DAMEPL) and joint inspections/third-party audits. Environmental safeguards like binding restoration plans and pre-commiting to restoration of green space (Sivakumar vs. Chennai Metro Rail Limited, 2019) and structural protection measures to mitigate settlement issues caused by underground excavation preventing damage to adjacent buildings and infrastructure by maintaining soil stability and minimizing settlement helps mitigate litigation risks. Together,

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these practices—spanning technical innovation, legal clarity, and community engagement—ensure tunnel projects align with India's ambitious infrastructure vision, transforming delays into opportunities for sustainable growth and reinforcing infrastructure's role as a catalyst for national development.

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