Traffic Impact Study of the Proposed Short Tunnel between Hebbal Flyover Junction and Veterinary College

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Executive Summary

The Hebbal junction, being one of the major hubs connecting the airport and Bengaluru city, consistently experiences heavy congestion and low traffic speeds. To mitigate this problem, a six-lane short tunnel road of 2.228 km is proposed by state government between the Esteem Mall and the Veterinary College, passing through Hebbal, a major catchment area in Bengaluru.

To assess the traffic impact and whether any alternatives are feasible for the proposed short tunnel, this study adopts a scenario-based evaluation for 2027, 2031 and 2041, comparing a Business-as-Usual (BAU) scenario against the implementation of the short tunnel or the underground metro system. The study analyses the impacts of the Volume-to-Capacity ratio (V/C ratio) and project cost, as well as discrepancies in the project's DPR. The following impacts were noted:

I. **V/C ratio**: Under the Business as Usual (BAU) scenario, traffic between the Airport and Bengaluru faces extreme congestion at Hebbal Junction. While the BAU Road + Tunnel scenario aims to ease the 2.2 km stretch around Hebbal Junction, it fails to provide relief before entry or after exiting. In contrast, the BAU Road + Metro scenario projects a massive relief, substantially reducing V/C ratios.

II. **Congestion Relocation**: The proposed Hebbal short tunnel merely shifts congestion rather than solving it. Because the unexpanded surface roads at both entry and exit points retain a high V/C ratio, congestion shifts to new choke points near the Veterinary Hospital and Esteem Mall. This congestion leads to spillover effects, reducing the short tunnel's effectiveness to zero.

III. **Cost Per Person**: A capital-cost benefit analysis shows that the underground metro is substantially more financially viable than the proposed short tunnel, costing ₹0.86 per passenger (₹2.26 Lakhs/PPHPD) compared to ₹5.23 per passenger (₹13.74 Lakhs/PPHPD) for the tunnel. Because the short tunnel is approximately 6.12 times more expensive across both metrics, implementing an underground metro delivers greater financial benefits per passenger while requiring less than one-sixth of the taxpayer funding needed for the road tunnel.

IV. **Discrepancies in DPR**

- The DPR's traffic analysis artificially inflates congestion and relies on arbitrary diversion estimates (50%–80%) by using deflated design capacities rather than standard empirical methods.
- The proposed horizontal curve radius of 60 m near the Esteem Mall exit may result in a reduction in the capacity of the short tunnel.
- From the perspective of serviceability, there is a significant flooding risk of the short tunnel during the rainfall event, as its entry is the point of lowest elevation on the Hebbal Lake side. Hence, the tunnel may not remain serviceable during rainfall events.
- The short tunnel project has not addressed several geotechnical problems that may arise from the cut-and-cover section between the flyover pier and the lake boundary. Hence, constructing a tunnel without a safe geotechnical assessment may affect the existing structure

The study recommends prioritising sustainable, high-capacity public transport alternatives, such as the metro, over short road tunnels, as they provide superior network-wide Volume-to-Capacity (V/C) reductions and the best Benefit-to-Cost ratio. Ultimately, agencies should focus on reducing traffic volume through efficient public transport systems, such as the MRTS, to sustainably decongest the city, curb pollution, and improve residents' quality of life.

1. Introduction

The rapid growth of Bengaluru has placed increasing demands on its urban transportation infrastructure, with congestion becoming a persistent challenge along several major corridors. The growing dependence on road-based travel has particularly affected key junctions and arterial routes that accommodate substantial cross-city and regional traffic. In this context, improving mobility through high-capacity and sustainable transport solutions has become an important consideration in the city's long-term transportation planning.

Hebbal Junction is a critical location, as shown in Figure 1. The diagram serves as a major interchange between the Airport, central Bengaluru, Yeshwanthpur, and KR Puram directions. The Bellary Road corridor between Hebbal Junction and Mekri Circle experiences substantial traffic congestion during peak periods, resulting in considerable delays and increased travel times. Despite the provision of multiple grade-separated facilities, including ramps, loops, and elevated road infrastructure, congestion remains a significant concern along the corridor.

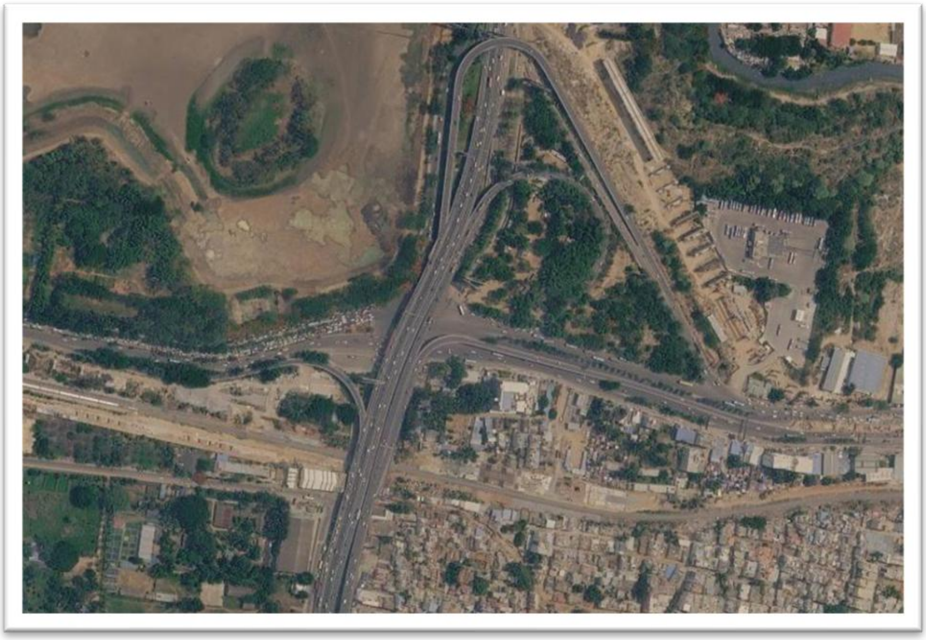

Figure 1: Hebbal Junction, Bengaluru (Source: Google Maps)

To improve traffic flow through this section, the Government of Karnataka has proposed a short-cut-and-cover tunnel of approximately 2.228 km between Hebbal Flyover Junction and the Veterinary College, as shown in Figure 2. The proposed alignment extends for approximately 2.228 km through relatively plain terrain. Of the total length, approximately 1.750 km comprises the cut-and-cover section, while the remaining 0.478 km is provided as an open-cut section. The underpass is designed for an operating speed of 60 km/h. It passes beneath existing railway infrastructure and the proposed Metro corridor, and connects to the existing service roads along the corridor.

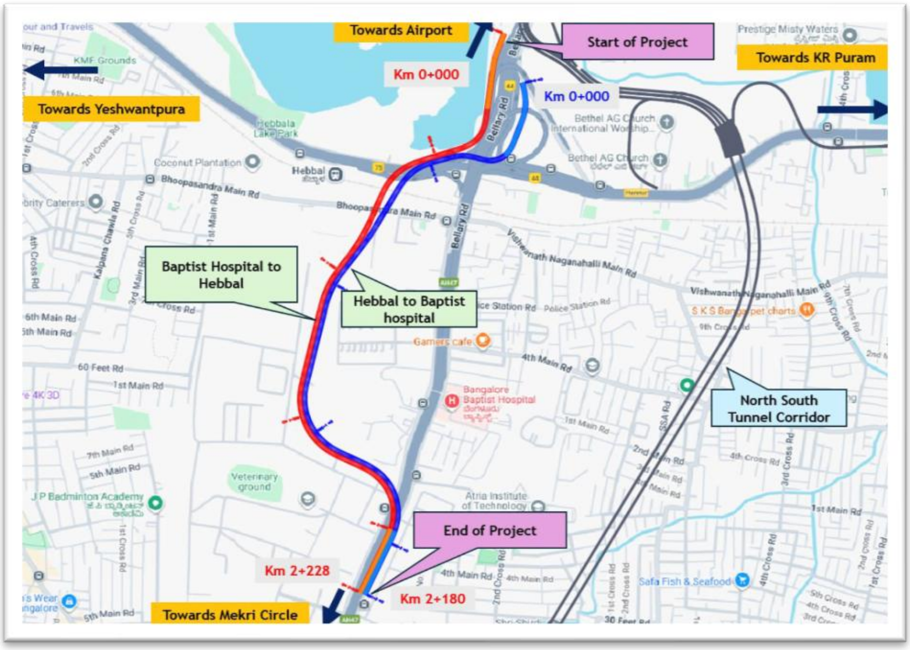

Figure 2: Short Tunnel from Hebbal to Veterinary Ground
[Image Source: Revised Final Detailed Project Report Volume – I Main Report]

However, the proposed alignment also traverses the catchment area of Hebbal Lake, introducing an additional environmental consideration for the project. In parallel, the proposed Bengaluru Metro Phase-3 is expected to provide high-capacity public transport connectivity through the Hebbal region. The presence of these alternative interventions creates an opportunity to examine whether additional road infrastructure or a mass transit-oriented solution would provide greater benefits over the longer term.

2. Scenario Assessment

To systematically assess the impacts of the proposed underground tunnel near Hebbal Junction, this study employs a scenario-based traffic-flow assessment framework. The methodology considers existing travel characteristics, scenario development, and transport network performance to assess the effects of the proposed infrastructure interventions.

Accordingly, this study evaluates the proposed short tunnel and an underground metro alternative through a scenario-based assessment. Three scenarios are considered:

Scenario	Title of Scenario	Description
1	Business as Usual (BAU)	Existing infrastructure at Hebbal Junction
2	BAU Road + Tunnel	The proposed short tunnel complements the existing infrastructure at Hebbal Junction.
3	BAU Road + Metro	Existing infrastructure at Hebbal Junction is complemented by the metro instead of a short tunnel.

The key outcomes of the assessment include changes in the Volume-to-Capacity (V/C) ratio of the existing road network under each scenario and a comparative evaluation of the cost incurred per person for the proposed interventions.

3. Comparative assessment between scenarios

The model for Bengaluru was run, and the flow values were determined using a four-stage travel demand modelling at the Hebbal Junction. The V/C ratio was calculated, and the data are presented in Tables 1 and 2. Forecast Volume-to-Capacity (V/C) ratios for traffic travelling from Bangalore to the Airport and from the Airport to Bangalore, respectively, across three future milestones: 2027, 2031, and 2041. A V/C ratio approaching or exceeding 1.0 indicates severe road congestion, where traffic volume exceeds the road's physical capacity.

Table 1. V/C ratio for Bangalore to the Airport at various locations on the road

Scenario	Year		
	2027	2031	2041
Entry of Tunnel			
BAU	2.58	2.79	2.75
BAU Road + Tunnel	2.58	2.79	2.75
BAU Road + Metro	2.58	2.79	2.75
Hebbal Junction			
BAU	2.12	2.34	2.42
BAU Road + Tunnel	1.06	1.17	1.21
BAU Road + Metro	0.05	0.06	0.06
Exit of Tunnel			
BAU	2.12	2.34	2.42
BAU Road + Tunnel	2.12	2.34	2.42
BAU Road + Metro	2.12	2.34	2.42
Mekhri Circle			
BAU	1.26	1.56	1.38
BAU Road + Tunnel	1.26	1.56	1.38
BAU Road + Metro	1.26	1.56	1.38

Table 2: V/C ratio for the Airport to Bangalore at various locations on the road

Scenario	Year		
	2027	2031	2041
Entry of Tunnel			
BAU	2.81	3.14	3.31
BAU Road + Tunnel	2.81	3.14	3.31
BAU Road + Metro	2.81	3.14	3.31
Hebbal Junction			
BAU	2.09	2.32	2.19
BAU Road + Tunnel	0.82	0.91	0.86
BAU Road + Metro	0.03	0.04	0.03
Exit of Tunnel			
BAU	2.02	2.23	2.11
BAU Road + Tunnel	2.02	2.23	2.11
BAU Road + Metro	2.02	2.23	2.11
Mekhri Circle			
BAU	2.45	2.67	2.11
BAU Road + Tunnel	2.45	2.67	2.11
BAU Road + Metro	2.45	2.67	2.11

NOTE: Detailed calculations are provided in Annexure A.

3.1. Business As Usual (BAU) Scenario

Under the BAU baseline scenario, the route from the Airport to Bangalore faces critical bottlenecks, with ratios exceeding capacity at the Tunnel Entry, reaching 2.79 by 2031, and the Junction peaking at 2.42 in 2041. Meanwhile, the Airport-to-Bangalore direction experiences heavy congestion peaking at 3.31 in 2041. A V/C ratio of 2.42 indicates that the traffic demand significantly exceeds the available road network capacity. Since a V/C ratio of less than 1.0 is generally considered desirable, a value of 2.42 represents a substantial capacity deficiency, with demand exceeding available capacity by approximately 142%. This level of oversaturation indicates severe congestion, increased travel delays, reduced network operating efficiency, and potentially higher vehicular emissions and fuel consumption. Consequently, persistent capacity constraints of this magnitude can adversely affect overall network performance and productivity.

3.2. BAU Road + Tunnel Scenario

When evaluating the proposed infrastructure interventions, the BAU Road + Tunnel scenario demonstrates significant but highly localised improvements. Introducing a tunnel effectively halves the V/C ratio at the junction. Still, it has no impact at the tunnel's entry or exit, bringing congestion down to manageable levels only at the junction. However, it is worth noting that the tunnel provides absolutely zero relief before entry and after exit, as V/C ratios at these locations shall remain identical to the baseline BAU scenario across all measured years, indicating that the tunnel merely shifts the congestion point.

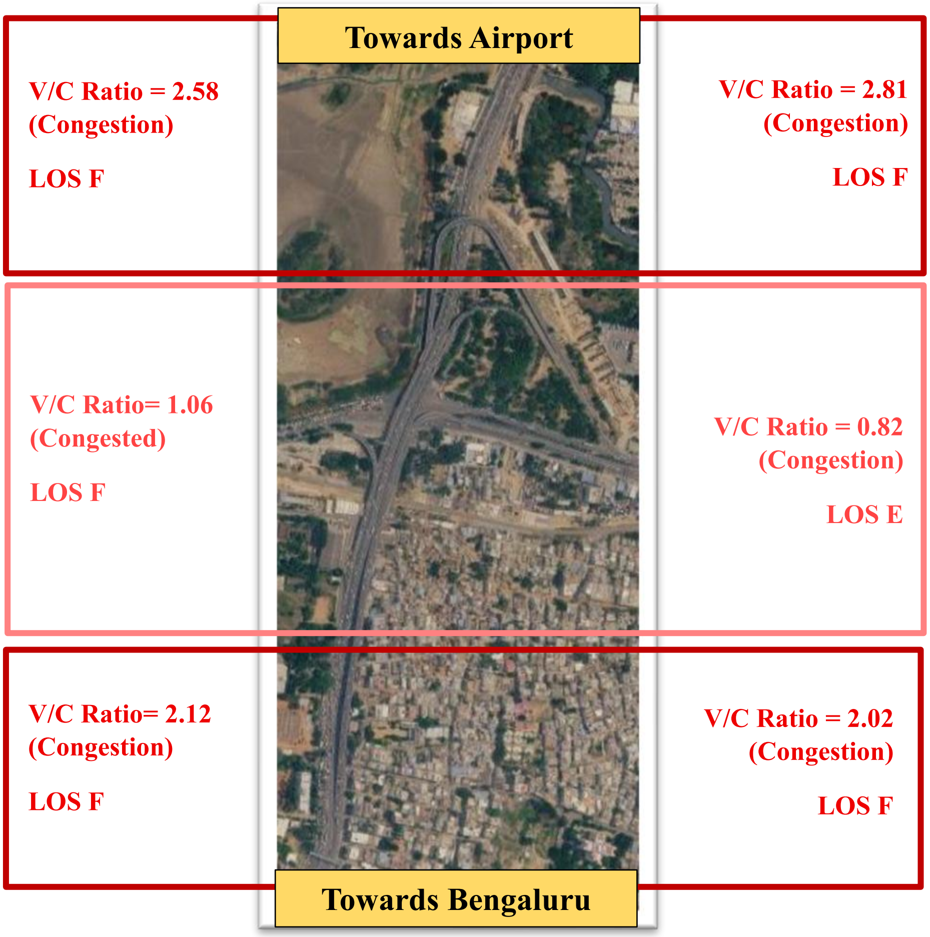

Figure 3: Shift of congestion point by Short Tunnel for 2027

Figure 3 shows how the short tunnel project serves as a façade for resolving traffic from Bangalore city to the Airport and back at the Hebbal Junction. The straight-flowing traffic in the tunnel section may ease the 2.2km stretch, but it will result in another choke point near Veterinary Hospital on one side and the Esteem Mall on the other side. Even after the implementation of a short tunnel, the LOS at the junction from Bengaluru to the Airport at the intervening stretch remains at LOS E. Whereas, the opposite lane at the junction and the entry exit locations of the short tunnel remain at LOS F. These choke points would also have a spillover effect, and the tunnel's effectiveness would drop to zero.

The queues generated at Hebbal Junction would eventually reach to Mekhri Circle, which also has a high V/C ratio, increasing the queue lengths at both junctions. The congestion at the tunnel exit, towards Bengaluru, will eventually form a queue inside the tunnel itself. The exact prediction of queue lengths and congestion values needs microsimulation and detailed data, which have not been conducted in this study.

3.3. BAU Road+ Metro Scenario

The BAU Road + Metro scenario reveals a drastic reduction in vehicular traffic pressure, with V/C ratios across all nodes dropping to low levels at the junction. This suggests that the underlying forecasting model anticipates a good modal shift, from private vehicles to the metro system along this specific route. This creates a stark contrast between localised road relief and highly aggressive public transit interventions that are an actual solution to congestion. Although assuming a three-track metro line, analogous to the three-lane tunnel configuration, yields V/C ratios of 0.05 and 0.03 for 2027, a single-track analysis would also have revealed V/C ratios of 0.15 and 0.09, respectively, giving LOS A until 2041.

3.4. Comparison of the V/C Ratio with DPR for 2027

The values calculated in DPR are compared with those calculated by the IST Lab. The V/C ratios are calculated for Hebbal Junction. The DPR has considered different scenarios for traffic diversion. The V/C ratio values reported here are based on a 50% diversion[1]. A 50% traffic diversion was assumed, based on the equitable distribution of traffic lanes between the existing road network and the proposed tunnel.

Table 3 Comparison of V/C values of DPR and IST Lab at Hebbal Junction for 2027

Link	BAU		BAU Road+ Tunnel		BAU Road + Metro	
	DPR	**IST Lab**	**DPR**	**IST Lab**	**DPR**	**IST Lab**
Bangalore to Airport	2.14	2.12	0.60	1.06	-	0.05
Airport to Bangalore	2.65	2.09	0.50	0.82	-	0.03

According to the Indian Highway Capacity Manual (Indo-HCM), as cited in Tables 6 and 7 of the DPR, the capacities for both directions (Bangalore Airport to Bangalore) should be 4,200 and 2,700, respectively. However, the DPR incorrectly uses them as 3,600 and 2,400. **This underestimation of capacity inflates the V/C ratio in the BAU scenario in DPR, demanding an urgent increase in capacity**. **The BAU Road + Tunnel scenario**, **as reported** in the DPR, shows a significant reduction in the **V/C ratio (2.14 → 0.60 and 2.65 → 0.50),** which was not found to be accurate based on the **four-stage modelling results (2.12→1.06 and 2.09→0.82)**. Hence, the analysis shows that the V/C ratio remains high even after the implementation of a short tunnel.

When Metro is implemented as an intervention, the V/C ratio decreases significantly due to its higher passenger capacity. Metro is therefore the best solution to reduce congestion at Hebbal Junction and nearby areas. This connection would further help more passengers on BMRCL line 3A to reach the Airport.

4. Cost-Benefit Analysis

The cost–benefit analysis was conducted to compare the per-passenger cost of implementing the proposed short tunnel and underground metro from a capital-cost perspective. The capital cost was divided among all passengers using the facility over the same period. The analysis indicates that the per-passenger cost for the short tunnel is ₹5.23, compared with ₹0.86 for the underground metro. If we divide the capital cost by passengers per hour per direction (PPHPD), the cost–benefit analysis compares the per-passenger cost of implementing the proposed short tunnel and underground metro. The analysis indicates that the short tunnel costs INR 13.74 Lakhs/PPHPD, whereas the underground metro can be built at INR 2.26 Lakhs/PPHPD. **Thus,**

[1] Table 26: Scenario 4 Peak Hour Traffic Forecast -50% Traffic Diversion to the Proposed Underpass-2027 in REVISED FINAL DETAILED PROJECT REPORT VOLUME – I MAIN REPORT

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from both perspectives, the per-passenger cost of the short tunnel is approximately 6.12 times higher than that of the underground metro. This indicates that, in terms of cost incurred per passenger, the underground metro provides a substantially more favourable outcome than the proposed short tunnel. Therefore, the analysis suggests that implementing an underground metro rather than a short tunnel would yield greater cost savings and economic benefits per passenger.

Hence, for similar benefits, the short tunnel project requires 6 times as much taxpayer money as the metro.

5. Discrepancies Identified in the DPR and Drawings

5.1. V/C Miscalculations:

Flawed capacity assumptions and unscientific diversion estimates compromise the DPR's traffic modelling. The Hebbal flyover's divided carriageway, comprising three airport-bound lanes and two city-bound lanes, **warrants design capacities of 4,200 PCU/h and 2,700 PCU/h** based on DPR Table 6 benchmarks and INDO HCM 2017 Capacity Manual. However, **the DPR adopted deflated capacities of 3,600 PCU/h and 2,400 PCU/h, thereby artificially inflating the baseline V/C ratios (2.65 and 2.14)** to **overstate congestion** and to showcase the dire need for the alternative infrastructure. Furthermore, allocating tunnel traffic using arbitrary diversion brackets (50%-80%) in Tables 14 to 29 bypasses standard empirical methods, such as stated-preference surveys or combined corridor capacity assessments, thereby undermining the proposal's technical credibility.

5.2. Probable capacity reduction due to speed reduction

In the short tunnel near the Esteem Mall exit, there is a 60m radius curve that reduces the speed from 60km/h to 40km/h. This speed reduction will reduce capacity and may cause a queue, affecting the sole objective of providing a short tunnel.

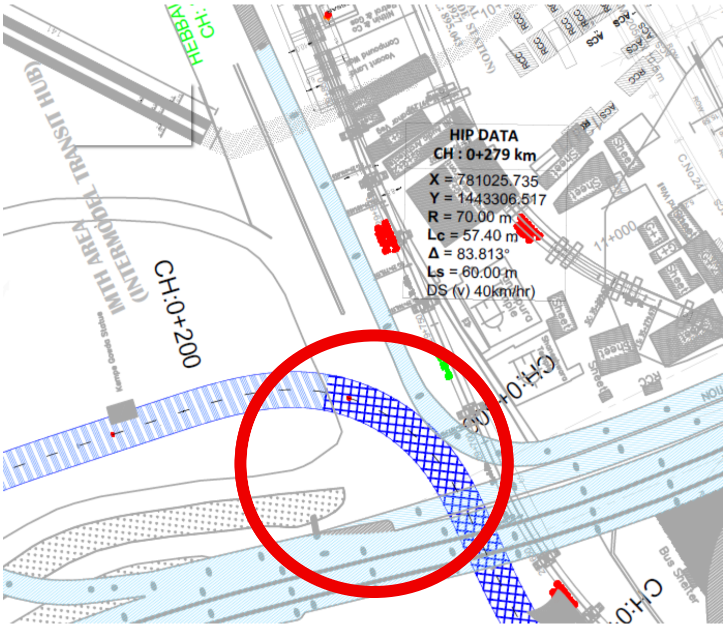

Figure 4: 60m curve radius of Short Tunnel

5.3. Urban Flooding Risk Assessment

Most of the underpasses in Bangalore experience a severe reduction in capacity due to increased water depth. Since the tunnel is in a low-lying area near Hebbal Lake, as shown in Figure 5The image is very likely to be flooded during rainfall events. Such scenarios and evacuation plans for flooding conditions are not clearly addressed in the DPR.

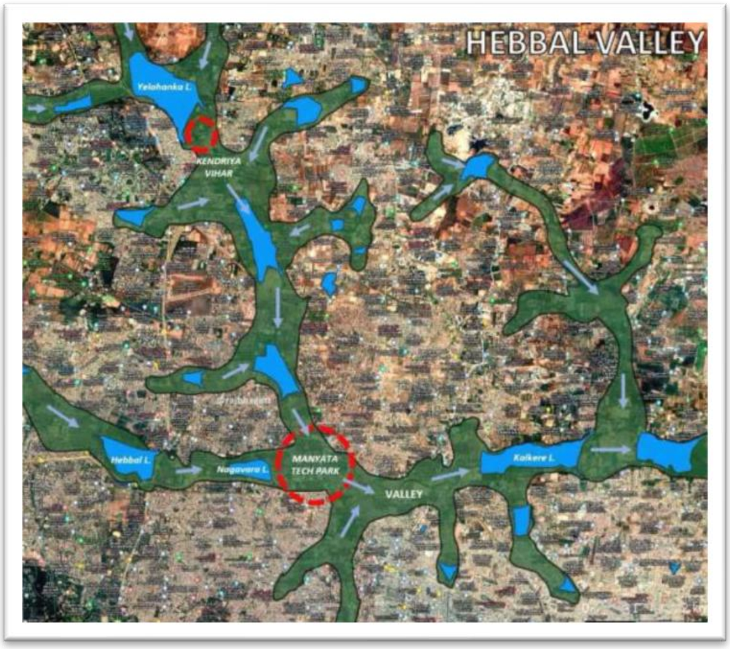

Figure 5: Regional Hydrology Map of Hebbal Valley
[Source: Figure 29, Pg. 102 of Revised Final Detailed Project Report Volume – I Main Report]

5.4. Impact of Existing Flyover Loading on Tunnel Foundation Design

The tunnel is planned in the section between Hebbal Lake and the existing elevated infrastructure, as shown in Figure 6.

Figure 6: Present layout of the Ground Level of Hebbal Junction from Bangalore to the Airport [Source: Google Street View]

Figure 6 shows the piers of the existing flyover. Given the very limited soil support between the lake boundary and the flyover pier, there is a high likelihood that the open- and cut-section of the upcoming short tunnel may compromise the foundations of the existing flyover piers, rendering them unserviceable. This crucial aspect is not addressed in the DPR's geotechnical analysis.

6. Conclusions

The study assesses the traffic impacts of the proposed 2.228 km short-cut-and-cover tunnel between Hebbal Flyover Junction and Veterinary College under three scenarios: BAU, BAU Road + Tunnel, and BAU Road + Metro, for the horizon years 2027, 2031, and 2041. The four-stage demand modelling for volume calculation and hence V/C ratio analysis indicates that while the tunnel provides short-term traffic relief at Hebbal Junction, its benefits diminish over time. The congestion is expected to eventually approach LOS F conditions due to increasing demand, even after the short tunnel is implemented. Bottlenecks are present at the exit of tunnel, possibly due to a sudden capacity reduction that results in queue formation. The cost-benefit analysis further indicates that the tunnel imposes approximately six times the cost on taxpayers compared with the metro alternative. In contrast, the metro provides more sustained improvements in network performance. Further MRTS alternatives reduce dependence on private vehicles, thereby reducing Vehicle Kilometre Travel (VKT), fuel consumption, and emissions. This offers a more economically efficient and sustainable long-term mobility solution. The MRTS intervention would finally provide better environmental conditions and Quality of life for the city's residents.

7. Recommendations

From the study, the following recommendations are made:

1. The alternatives that can effectively lower the V/C ratio for a longer period and for the larger network levels, such as MRTS, should be adopted.
2. When reducing the V/C ratio, the agencies must not only focus on increasing the capacity of the road infrastructure, but also on reducing the volume on roads through MRTS interventions.
3. The alternatives should also be thoroughly compared based on the cost of the project and the benefit to society. The solution that has the best Benefit-to-Cost ratio (such as for MRTS) must be adopted.
4. The present study shows that a continuous metro corridor is far more efficient than the introduction of a short tunnel road, as it provides better capacity at much lower cost.
5. An efficient public transport project, in contrast to private vehicles, is known to reduce pollution and drastically improve the quality of life of the inhabitants of the city. Hence, it is highly recommended to opt for MRTS to decongest the city.

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7. Ms. Ann Das, Research Scholar, IST Lab, IISc Bengaluru

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Annexure A

Calculation of the V/C ratio for various scenarios

A1: Considered locations:

Location	Latitude, Longitude
Exit of the tunnel	13.049712250468945, 77.5928829088363
Junction	13.042844374749977, 77.590449647348
Entry of Tunnel	13.03250022986925, 77.5879406099894
Mekhri Circle	13.01668443204788, 77.58403315843842

A2: Calculations for Bangalore to the Airport

Year 2027

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	10835.90	8916.53	8916.53	5300.56
Capacity	4200.00	4200.00	4200.00	4200.00
V/C	2.58	2.12	2.12	1.26

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	10835.90	8916.53	8916.53	5300.56
Capacity	4200.00	8400.00	4200.00	4200.00
V/C	2.58	1.06	2.12	1.26

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	4200.00	4200.00	4200.00
The passenger capacity of the road	5040.00	5040.00	5040.00	5040.00
Volume of Road	10835.90	8916.53	8916.53	5300.56
Volume (PPHPD)	13003.08	10699.84	10699.84	6360.67
Capacity (PPHPD)	5040.00	212040.00	5040.00	5040.00
V/C	2.58	0.05	2.12	1.26

Year 2031

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	11714.13	9843.51	9843.51	6554.59
Capacity	4200.00	4200.00	4200.00	4200.00
V/C	2.79	2.34	2.34	1.56

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	11714.13	9843.51	9843.51	6554.59
Capacity	4200.00	8400.00	4200.00	4200.00
V/C	2.79	1.17	2.34	1.56

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	4200.00	4200.00	4200.00
The passenger capacity of the road	5040.00	5040.00	5040.00	5040.00
Volume of Road	11714.13	9843.51	9843.51	6554.59
Volume (PPHPD)	14056.95	11812.22	11812.22	7865.51
Capacity (PPHPD)	5040.00	212040.00	5040.00	5040.00
V/C	2.79	0.06	2.34	1.56

Year 2041

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	11556.22	10146.19	10146.19	5815.43
Capacity	4200.00	4200.00	4200.00	4200.00
V/C	2.75	2.42	2.42	1.38

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	11556.22	10146.19	10146.19	5815.43
Capacity	4200.00	8400.00	4200.00	4200.00
V/C	2.75	1.21	2.42	1.38

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	4200.00	4200.00	4200.00
The passenger capacity of the road	5040.00	5040.00	5040.00	5040.00
Volume of Road	11556.22	10146.19	10146.19	5815.43
Volume (PPHPD)	13867.47	12175.43	12175.43	6978.51
Capacity (PPHPD)	5040.00	212040.00	5040.00	5040.00
V/C	2.75	0.06	2.42	1.38

A3: Calculations for the Airport to Bangalore

Year 2027

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	11796.00	5648.00	8472.00	10269.00
Capacity	4200.00	2700.00	4200.00	4200.00
V/C	2.81	2.09	2.02	2.45

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	11796.00	5648.00	8472.00	10269.00
Capacity	4200.00	6900.00	4200.00	4200.00
V/C	2.81	0.82	2.02	2.45

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	2700.00	4200.00	4200.00
The passenger capacity of the road	5040.00	3240.00	5040.00	5040.00
Volume of Road	11796.00	5648.00	8472.00	10269.00
Volume (PPHPD)	14155.20	6777.60	10166.40	12322.80
Capacity (PPHPD)	5040.00	210240.00	5040.00	5040.00
V/C	2.81	0.03	2.02	2.45

Year 2031

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	13176.19	6250.99	9376.48	11205.49
Capacity	4200.00	2700.00	4200.00	4200.00
V/C	3.14	2.32	2.23	2.67

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	13176.19	6250.99	9376.48	11205.49
Capacity	4200.00	6900.00	4200.00	4200.00
V/C	3.14	0.91	2.23	2.67

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	2700.00	4200.00	4200.00

The passenger capacity of the road	5040.00	3240.00	5040.00	5040.00
Volume of Road	13176.19	6250.99	9376.48	11205.49
Volume (PPHPD)	15811.42	7501.19	11251.78	13446.59
Capacity (PPHPD)	5040.00	210240.00	5040.00	5040.00
V/C	3.14	0.04	2.23	2.67

Year 2041

BAU

	Exit of the tunnel	at Junction	Entry of Tunnel	Mekhri Circle
Volume	13901.41	5918.24	8877.36	8877.36
Capacity	4200.00	2700.00	4200.00	4200.00
V/C	3.31	2.19	2.11	2.11

BAU Road +Tunnel

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Volume	13901.41	5918.24	8877.36	8877.36
Capacity	4200.00	6900.00	4200.00	4200.00
V/C	3.31	0.86	2.11	2.11

BAU Road + Metro

	Entry of the tunnel	at Junction	Exit of Tunnel	Mekhri Circle
Capacity in PCU of Road	4200.00	2700.00	4200.00	4200.00
The passenger capacity of the road	5040.00	3240.00	5040.00	5040.00
Volume of Road	13901.41	5918.24	8877.36	8877.36
Volume (PPHPD)	16681.69	7101.89	10652.83	10652.83
Capacity (PPHPD)	5040.00	210240.00	5040.00	5040.00
V/C	3.31	0.03	2.11	2.11

Note: The total passenger capacity of the metro was estimated by assuming that the existing three-lane configuration in each tunnel direction is entirely replaced with metro infrastructure.

Annexure B

Calculation of Cost-Benefit Analysis

Cost per passenger for the short tunnel from the total passenger perspective

A	Total length of the proposed tunnel[2]		2.228 km
B	The capacity of each lane of the proposed tunnel		1400 PCU/h
C	Average Car Occupancy[3]		1.2 per Car
D	Daily vehicle capacity	B * 24	33600 PCU
E	Daily Passenger Trips	D * C	40,320 Persons
F	Annual Passenger Trips	E * 365	1.47 Crore
G	30 Year cumulative short tunnel passenger trip		44.15 Crore
H	Cost of one lane of the Proposed Short Tunnel[4]		INR 230.8 Crore
	Cost per passenger for the short tunnel	H / G	INR 5.22 /Person/Lane

Cost per passenger for the underground metro from the total passenger perspective

I	Total length of the proposed tunnel		2.228 km
J	Capacity of the proposed Underground Metro		69000 PPHPD
K	Cost per km for underground metro[5]		INR 700 Crore/km
L	Total Cost of the underground metro line	A * K	INR 1559.6 Crore
M	Daily Passenger Capacity for three lanes in both directions	J * 24	9.94 Crore
N	Annual Passenger Capacity	N * 365	60.44 Crore
O	30 Year metro passenger trip		1813.32 Crore
	Cost per passenger for the underground tunnel	L / O	INR 0.86 /Person

Cost per passenger for the Short Tunnel from the PPHPD perspective

A	Total length of the proposed tunnel		2.228 km
B	The capacity of each lane of the proposed tunnel		1400 PCU/h
C	Average Car Occupancy		1.2 per Car
D	Total passengers in the short tunnel	B * C	1680 Persons
E	Cost of one lane of the Proposed Short Tunnel		INR 230.8 Crores
	Cost per passenger for the short tunnel	E / D	INR 13.74 Lakh/Person

Cost per passenger for the underground metro from the PPHPD perspective

F	Capacity of the metro		69000 PPHPD
G	Cost of underground metro per km		INR 700 Crore
H	Total cost of the underground metro	G*A	INR 1559.6 Crore
	Cost per passenger for the underground metro		INR 2.26 Lakh/Person

[2] Final Revised Detailed Project Report Volume 1 Main report by Rodic Consultants Pvt. Ltd; Page 39 of 233
[3] Verma A. (2026), "Economic and Environmental Assessment of Double Decker for Bengaluru Phase-3 Metro Corridors", Technical Report Prepared for MoHUA, IISc Sustainable Transportation Lab., IISc Bangalore, India
[4] Final Revised Detailed Project Report Volume 1 Main report by Rodic Consultants Pvt. Ltd; Page 37 of 233
[5] Detailed Project Report For 2 Corridor of Bangalore Metro Phase-3 by RITES Ltd; Page 4-5