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CHAPTER – 1
INTRODUCTION & BACKGROUND

1.0 Introduction

1.1 General

The geography of Mumbai is like elongated strip (having relatively small land width), running in North South directions and surrounded by Arabian Sea on West and Thane creek on its East. Naturally, the main roots for Transport communications run North and South directions. Similarly it has been known that the present state of City of Mumbai has been brought by connecting old Seven Island, Colaba, Mahim, Parel. etc. From this it will be understood that the main land was bifurcated from the Island City due to presence of Thane Creek. With increase in activities within the City of Mumbai it was considered necessary also to develop areas in Main Land so that growth and developments does not get chocked. This need got further eventuated with opening of national economy with which besides usual trade and commerce activities in financial sectors also started expanding. As of this time, an all-weather port JNPT is already developed and giving excellent services. The new international Airport is also on the way of commencing near to Panvel on Main Land. Naturally, there is every need to have speedy road link between Main Land & the Island so that developments in hinterlands would happen rapidly. The following are broad strengths of Mumbai

1. Mumbai Contributes one third of Nations Tax Revenue.
2. It has two largest countries sea ports (Mumbai Port and JNPT)
3. It has two largest international airports.
4. It is head quarter of RBI and major financial agencies.
5. It is home of two largest stock exchanges.
6. It is house of Bollywood Industry.
7. It is tourist spot as well as sea face.
8. It caters excellent job opportunities in every sector.
9. The world's largest diamond exchange market.
10. Mumbai city that contributes over 6 per cent of India's gross domestic product (GDP).

Mumbai, with a population of over 20.2 million inhabitants as per 2011, it is the capital of the state of Maharashtra and is considered as the financial capital of the country. This island is narrow and long on a north- south axis and has an area of only 68.71 sq. km compared to 437.71 sq. km for Greater Mumbai and 4135 sq. Km for the MMR. The Mumbai Metropolitan Region is also one of the fastest growing regions in India and is

expected to be the largest metropolitan region of the world by the year 2031. A good number of studies have been undertaken on Mumbai Road Network needs and the earliest of this was around 1960. With typical geographical features the moment of traffic in the City is North South direction (& vice versa). Therefore, all these studies have not only recommended but also given emphasis on simultaneous establishing of East West links having adequate capacity to handle on coming Volumes. Development of Santacruze-Chembur link road joining (Eastern Express Highway & Western Express Highway) is an initiative of these studies. On similar line the corridor between Sewri & Worli has been recommended so that the Traffic on MTHL, Eastern freeway and Western freeway would achieve best exchange. In the background of advance actions on MTHL, it has become urgent now also to give impetus to establish this Corridor.

1.2 Background

Mumbai has changed considerably after it was first inhabited in the 1500s and its prominence and the constant pace of change have ensured that Mumbai of 2018 is not the same as Mumbai of 2008. In the last one decade, the city witnessed numerous changes including infrastructure developments such as the Mumbai Metro, Monorail, the Santacruz-Chembur Link Road, the Bandra-Worli Sea Link, Eastern Freeway and the new terminal at the Chhatrapati Shivaji International Airport. However, the changes that India's financial capital is now poised for is set to change the face of the city and its satellite cities in a much more prominent manner.

The Mumbai Trans Harbour Link (MTHL), also known as the Sewri-Nhava Sheva Trans Harbour Link, is a proposed 21.8 km, freeway grade road bridge connecting the Indian city of Mumbai with Main Land. When completed, it would be the longest sea bridge in India. The bridge will begin in Sewri, South Mumbai and cross Thane Creek north of Elephanta Island and will terminate at Chirle village, near Nhava Sheva. The road will be linked to the Mumbai Pune Expressway in the east, and Island City Mumbai. The sea link will contain a 8 lane highway, which will be 31 meters in width, in addition to edge strip and crash barrier.

MMRDA has been assigned the task of implementation of Mumbai Trans Harbour Link (MTHL) by the Government of Maharashtra. It has been planned with the basic objective of

1. Development of Mainland and reducing traffic pressure on Mumbai City
2. Facilitate decongestion on other transport systems

3. Improve fast connectivity between Island city and Main land

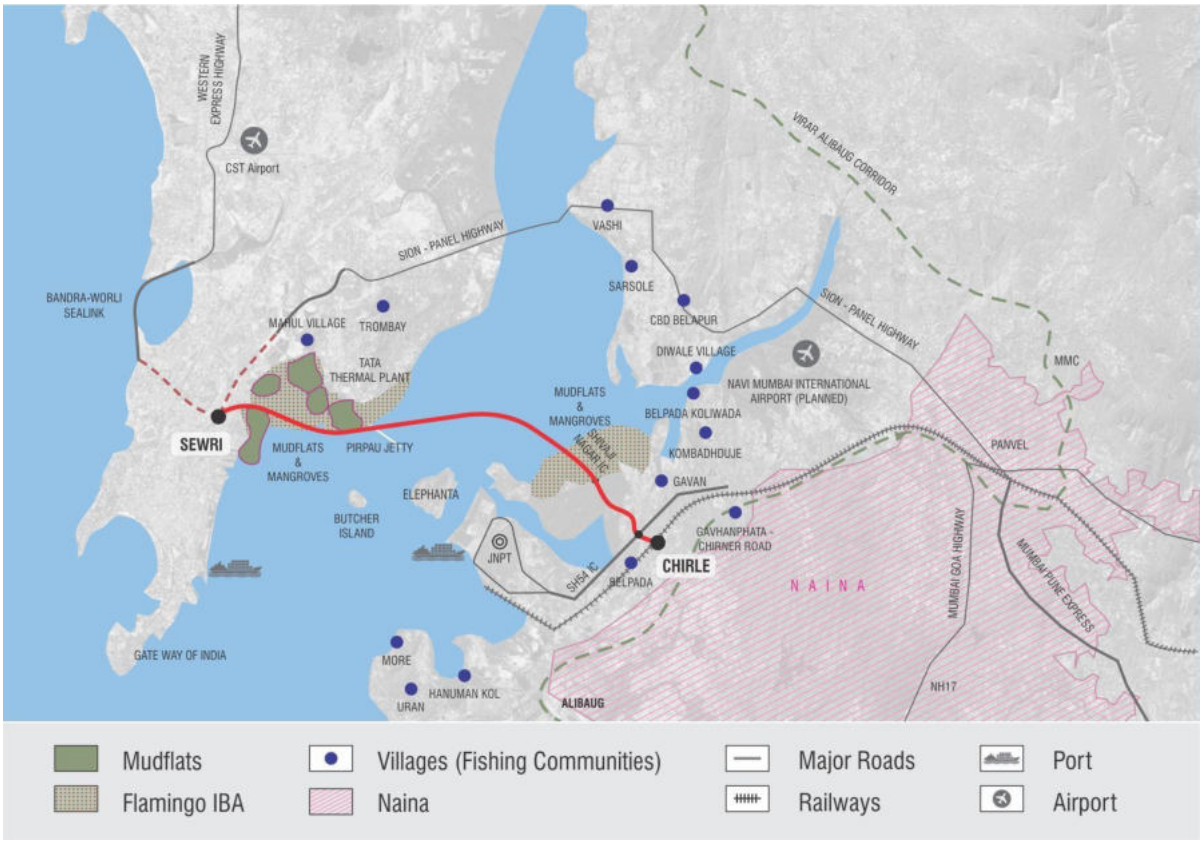


Figure 1. 1 Alignment Map of Mumbai Trans Harbour Link Project (MTHL)

1.3 Need of Project

It is to note that the said link was envisaged as back in year 1974 when it was known as the Main Land Link. However, with development of Sea Port etc. on Main Land the Alignment was modified and the Link was nomenclature as Sewri Nava Sewa link. The same link is now termed as Mumbai Trans Harbour Link (MTHL). Though this road connectivity was planned long back due to one or the other reason it had not become possible to start works on this. However, it is good that contract for MTHL construction has been awarded and it is matter of few years from now to see commissioning of this long awaited facility. It need not be emphasized that without proper dispersal arrangement any link in isolation cannot serve the planned purpose as for Eastern end at Nava Seva proper dispersal network has already been planned with which Traffic to-and-fro would be connected to parts of Maharashtra, Southern India, Goa and other Areas in the Coastal street along Arabian Sea. However though planning has been evolved (Reviewed and Modified) for Traffic dispersal arrangement at Sewri End final selection is awaited. It is expected that large volumes of Traffic would touch the Sewri End on

commissioning of MTHL but without there being proper dispersal arrangements for commuters to move in different direction (in the City) traffic dislocations would happen there by eating away the benefits of time saving.

The road network in Mumbai is mostly developed in North-South direction. Traffic from North through NH-8 (Ahmedabad – Mumbai), North-East through NH-3 (Indore- Nashik-Mumbai) and from East through NH-4 and Mumbai – Pune Expressway and NH-66 (Mumbai – Goa) enter/exit at the outskirts of the city and get connected to city road network. There are three main Express Highways viz. (i) Western Express Highway (WEH), (ii) Eastern Express Highway (EEH) and (iii) Sion Panvel Express Highway. Besides this there are 7 arterials viz. (i)Linking road, (ii) Swami Vivekanand (SV) Road, (iii) Lal Bahadur Shastri (LBS) Marg, (iv) Dr. Ambedkar road, (v) Veer Savarkar road, (vi) Dr. Annie Besant road, (vii) P. D'mello road running in North-South direction.

The Sewri-Worli road connector plan, which had been put on hold because of repeated delays in starting the Mumbai Trans-Harbour Link (MTHL) project, has been revived with a change in the original plan. As against an overhead bridge between Sewri and Worli, the portion across the Elphinstone (Prabhadevi) Road-Parel stretch will be underground in initial stage now it is also proposed elevated corridor by obtaining tunnel feasibility.

The 2+2 lane connector is estimated to handle around 15 % of the MTHL's expected traffic inclusive Traffic merging and demerging at Sewri Intersection traffic. MMRDA has appointed the contractor for the MTHL and work is already started. The connector, once built, will provide signal-free fast connectivity between MTHL and the Bandra-Worli Sea Link (BWSL)/Proposed coastal highway.

The effectiveness and viability of MTHL depends on its connectivity and proper dispersal system on Mumbai side. As part of this plan, Previously MMRDA has decided to

- Construct a rotary @ Sewri Railway Station to disperse the traffic in three direction i.e. Worli, Fort (Zakaria Bundar Road) & Chembur (Kidwai Road)
- Develop a dispersal system in the form of Sewri-Worli (East-West) Elevated Corridor or similar other options if any.
- The corridor is proposed to commence from the east side of Sewri Railway Station on the Harbour Line of Central Railway, proceed to Worli, and terminate on the Narayan Hardikar Marg (New Prabhadevi Road).

All above-mentioned points necessarily required to avoid conjunction at Sewri Railway Station and dispersal.

After study it is noted that the rotary option is not feasible as Technically & Financially. However, Rotary has been cancelled & Interconnection connectivity options are studies by up & down Ramps.

The Mumbai Metropolitan Region Development Authority (MMRDA) has revived plans for the four-lane Worli-Sewri elevated corridor, which will benefit approximate 35,000 motorists daily, once the Mumbai Trans-Harbour Link (MTHL) is completed. The project alignment having approx length 4.512km, originates from east side of sewri railwy station and end up on Narayan Hardikar Marg in Worli.

The development authority already has a Detailed Project Report (DPR) in place for the elevated @ 4.512-km long project. But with the Nariman Point-Kandivali Coastal Road project being taken up on the western sea front, the DPR will have to be altered and updated accordingly to have connectivity with Coastal Road as well as Bandra Worli Sea Link.

As per initial studies, this Connector project will contribute 15% of the vehicular traffic on MTHL. It has been conceptualized to have direct or signal-free connectivity between the two sea links. Those residing in western suburbs can directly head for Navi Mumbai or Mumbai-Goa Highway once they get on to Bandra Worli Sea Link and Sewri-Worli Connector.

Constructing the Connector would be a challenging task. As per the alignment plans, it will cross the Mumbai Port Trust (MbPT) and Harbour Railway lines at Sewri, and will follow on to Acharya Donde Marg in Parel. Thereafter cross over the Dr Babasaheb Ambedkar Road and heading to go over the Central and Western Railway lines at Parel-Elphinstone Road (Prabhadevi)Railway Stations. After this, it will have to go above the existing flyover at Senapati Bapat Road a height of 27 meters or 7th floor of a residential building and finally land at Worli.

Commuters from Navi Mumbai to Central and South Mumbai will have huge benefits in terms of time saved and a mostly trouble-free ride. Also travel from the city to Navi Mumbai will get a lot more easier. Long distance travelers from the western suburbs going towards Goa and south India are likely to use the BWSL-Sewri-Worli Link-MTHL instead of using the clogged Vashi Creek bridge. The elevated bridge will snake through

the congested areas of central Mumbai like Sewri, Parel, Elphinstone Road, Senapati Bapat Road, Worli Sea Face. The broad features of this elevated connector are as below.

1. It will be double decker corridor between SB road and Ambedkar road.
2. It will go over the Elphinstone Flyover @ SB road Hindamata flyover @ Ambedkar road.
3. It crosses Elphinstone road station road over bridge, passing above Central and Western Rail lines.
4. As a part of project, Elphinstone road station ROB will be reconstructed to ensure it is high enough. (# Recently, Elphinstone road station is renamed as Prabhadevi)

The Mumbai Metropolitan Region Development Authority **MMRDA** (henceforth referred to as "Client") is desirous of taking up implementation of elevated road between -End of MTHL @ Sewri to Worli sea link /Coastal road for segregating through traffic @ cross movements along entire corridor from surface level traffic. MMRDA has planned to complete concept plan and preliminary traffic study before taking up Detailed Project Report for the project. They have appointed Monarch Surveyors and Engineering Consultants Pvt Ltd (henceforth referred to as "Consultant") to carry out Detailed project report for the project vide vide work order No.ED/D-W DPR/WO/963/2017 dated 3.10.2017.

1.4 Coverage of Present Report

The present report covers the following under various chapters.

1. Introduction (this chapter)
2. Objective and Scope of work
3. Previous Studies
4. Project Appreciation
5. Traffic Surveys, Analysis & Forecasting
6. Engineering Surveys & Investigations
7. Alignment
8. Planning Criteria and Preliminary Design.
9. Environmental impact Assessment.
10. Project Cost
11. Project implementation Plan
12. Salient Features and Recommendations.

CHAPTER - 2
OBEJCTIVE AND SCOPE OF WORK

CHAPTER – 2
OBJECTIVE AND SCOPE OF WORK

2.0 OBJECTIVE AND SCOPE OF WORK

2.1 Objective of Assignment

The main objective of the consultancy services is to update the technical, economic and financial viability of the project and prepare the Detailed Project Report for Construction of Sewri to Worli Elevated Connector. The technical viability of the project shall be established taking into consideration of Ramp at Acharya Donde Marg which will disperse the future traffic coming from MTHL to Worli Sea link, Fort (Zakaria Bundar Road) & Chembur (Kidwai Road) and the alignment of Project crossing over monorail station and Elphinstone station flyover.

The Detailed Project Report would inter-alia best possible options for Interchange Ramp at Acharya Donde Marg. Since the Corridor under the study is proposed along the existing MCGM Road and for, some length through DP reservation along Drainage Channel Road etc. actions relating to land acquisition would not be relevant. However, at specific locations where there would be need, study will cover the details of land acquisition. Along the alignment of monorail pier locations for Elevated corridor need to be studied for its viability. Detailed study and various possibilities need to verify at Elphinstone station (Prabhadevi) as elevated corridor for Western Railway Churchgate to Virar passing over existing flyover at Elphinstone (Prabhadevi).

The primary objectives of the study are listed below:

- Topographic surveys on existing road for alignment planning and design.
- Traffic studies for assessment of lane requirement and interchange movements.
- Geotechnical investigations to study existing ground strata beneath the ground
- Suitability of Up and Down ramps at major intersections along the project corridor.
- Environmental studies
- Social Studies
- Preliminary design and lay out for Elevated corridor
- Preliminary design of Foundation, Substructure and Super structure.
- Environmental studies
- Integration with Existing grade separator facilities and Rail road structures,
- The traffic management measure with an aim to relieve traffic congestion at surface level to reasonable extent along the corridor,

- Updation of Detailed Project Report,
- Preparation of Bidding Documents and assistance in awarding of the contract.

2.2 Scope of Services

Scope of work is listed below in two stages

Stage -1 – Updation of DPR

- Updation of Detailed Project Report of the Sewri – Worli Elevated Corridor.
- Carry out detailed traffic survey including all present links and the future links affecting the traffic on proposed link.
- Carry out the topographical survey along the proposed alignment and area substantially covering the possible dispersal area.
- Geotechnical survey, detailed resettlement and rehabilitation survey, detailed land acquisition proposals and tree cutting proposals.
- Preparation of General Arrangement Drawings, detail drawings of foundations, substructure, superstructure and detailed cost estimates.
- Prepare the Environmental Impact Assessment.
- Feasibility of Sewri Interchange.

Stage -2 Bid Process Management

- Provide detailed specifications for Work
- Preparation of Bid documents
- Assist MMRDA in bid process appointment of PMC.

2.3 Work Methodology

The activities that are involved for the present assignment are highlighted in the following section. The stage wise outputs in the process along with the inputs required for the same is presented in the form of a flow chart and elaborated in following sections. The assignment is split into following phases:

- Project conceptualization with past study reports
- Preparation of feasibility report
- Financial analysis and financial structuring
- Updating of Detailed Project Report (DPR)
- Preparation of tender documents and assistance in bid-processes

Figure 2-1 shows the proposed methodology chart for carrying out various tasks of the project. The exact sequence is likely to vary during the course of the study, however a general guideline is proposed in the form of flow chart.

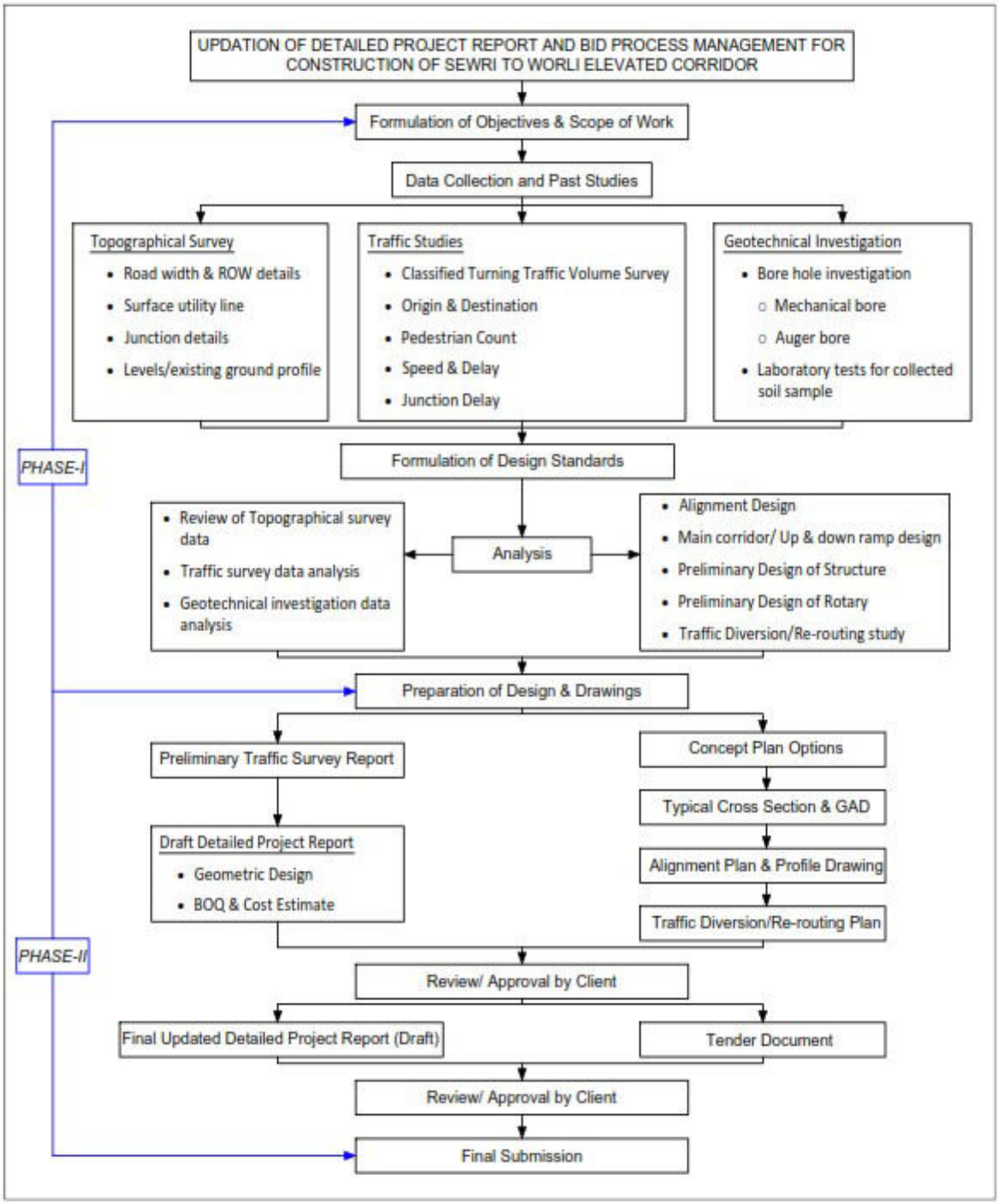


Figure 2. 1 Proposed Methodology Chart

2.4 Design Philosophy

The Technical proposal given in this report consists of designs, drawings and all technical details based on surveys and investigations stated in Section 2.2 above. The design standards adopted in the present design are in accordance with the codal provisions of India as stipulated by the Indian Roads Congress

(IRC), Indian Standards Specification (IS) and the Ministry of Road Transport & Highways. Deviations have been reviewed from projects of similar nature and considered in planning / design parameters only if required under unavoidable circumstances considering the dense urban conditions from the present codal provisions. These modifications in the design are adopted based on projects under similar situations at urban locations as “Good Engineering Practice” and after discussing with client. Especially, Entire planning and designing of elevated corridor is based on IRC; SP:90-2010 (Manual for Grade separators and Elevated Structures)

The designs and drawings presented as a part of this report are based on Study, Investigations and Designs followed up with consultation with MMRDA at various stages considering interfaces with on-going works. The consultants opine that the details provided in the present report will form the basis for detailed engineering designs and drawings prior to construction of the facility.

2.5 Deliverables

Following drawings & documents are proposed to be submitted as part of this Report:

- Topographic plan
- Plan & Profile drawing for Main elevated bridge, Intermediate up & down connected ramps
- Traffic report
- Utility report
- Tree report
- Geotechnical investigation report
- Structural General Arrangement Drawings
- Foundation, Sub-structure & Superstructure drawings
- Standard span, Obligatory span & Portal span details
- Retaining wall of Underpass & RE paneling for flyover ramp details, etc.
- BOQ, Cost estimates and rate analysis.
- Bid Documents for contractor,
- Bid Documents for PMC ,

CHAPTER - 3
PREVIOUS STUDIES

CHAPTER – 3
PREVIOUS STUDIES

3.0 PREVIOUS STUDIES

3.1 Review of Transport Facilities and Elevated road Proposal

Population and economic growth are likely to place further demand on the transport infrastructure of the city. Whilst efforts are being made in the form of the MUTP, the McKinsey report finds these inadequate and suggests that further investment must be made to ensure an adequate transport infrastructure according to benchmarks from other global cities. Another significant achievement will be by reducing the need for transport, or reducing the average commuting distance of the population. This will automatically decrease the pressure on the infrastructure. This can be achieved through the development of business districts in the suburbs (such as the Bandra-Kurla complex) that will reduce the need for north-south commuting. Adequate planning is required to ensure that while attempting to improve one parameter of the city needs the others should not suffer.

For every extra one million inhabitants in a developing world city, approximately 3.5-4 million public transport trips per day are required to be provided. The three main factors identified to contribute to increased travel demand are population growth, mobility rate (i.e. change in the number of trips per person per day), and increasing commute length due to physical expansion of the city. The following transport remedies hopefully fill this gap, with improved services lessening the traffic congestion and bridging the gap between eastern and western parts of the city.

1. Multi Modal Corridor (Virar-Alibug) ---- On going
2. Mumbai Metro Rail Project---- On going
3. Mumbai Mono Rail---- On going
4. MTHL---- On going
5. MTHL (Metro Link)
6. MUTP ---- Completed
7. MUTP –II---- On going
8. MUIP ---- On going
9. Extended MUIP---- On going
10. Eastern freeway---- Completed
11. Waroli sea Link ---- Completed
12. Coastal Road---- On going

13. Sewri to Worli Elevated Connector---- On going

With a view to develop an efficient road transportation network for Mumbai Mahanagar various studies had been undertaken mostly by PWD Govt. of Maharashtra from time to time. The focus however was that, the freeways (Now called as expressway) would run in south north direction and along east and west coasts of the city. With also a view, to have an efficient and direct connectivity Sewri Nahva link was proposed. In order to have a fast and efficient east-west link in island city Sewri Worli connector was also planned simultaneously, various studies and series of reports along with adjacent concurrent infrastructure projects were made in this concern like feasibility, alignment options inclusive tunnel option etc. The studies carried out are presented in brief to frame our further planning and updating.

3.2 Feasibility Study of East West Corridor

Consulting Engineering Services (I) Pvt Ltd (CES) had carried out the Feasibility study "East West (Sewri-Worli) Corridor and Sewri Interchange for MTHL Dispersal" in the year 2007. The various alternative alignments were discussed and the alignment as per details shown in the Table 3.1 below was proposed as the most feasible alignment.

Table 3. 1 Most feasible Alignment proposed in the 2007 Feasibility Report

S.N.	Chainage	Corridor Path
1	**+0+000 to 0+430**	**MTHL-** Acharya Donde Marg Bus Depo
2	+0.430 to +1.960	Along Acharya Donde Marg
3	+1.960 to +3+060	Along Jagannath Bhatankar Marg
4	+3+060 to +4+100	Drainage Channel Road
	+4+100 to +4+512	Narayan Hardikar Marg

3.3 Draft Feasibility Report for MTHL Feb 2012

For The principal objective of the assignment was to update the Techno-Economic feasibility study carried out earlier, assist MMRDA in bid process management and provision of Advisory Services for implementation of MTHL on a suitable PPP structure.

A second level grade separated junction (Interchange) at Sewri, on the East side of the Sewri Railway Station, is proposed to facilitate the dispersal of MTHL traffic through an interchange, which includes the under construction North-South elevated Eastern Freeway over Messent Road, the proposed East-West Sewri Worli elevated connector.

3.4 DPR for Elevated corridor.

The project report prepared by S, N. Bhobe suggests three alternatives Alignments as given below

Alignment No. I -: Route: Acharya Donde Marg- Jagannath Bhatankar Marg (upto Senapati Bapat Marg)- Sayani Road- Veer Sawarkar Marg- Narayan Hardikar Marg.

By considering inadequate geometry framed due to land restrictions and outcome of degree of curvature of the entire alignment, this alignment No.I seems very difficult to implement, hence the said alignment was not considered for further study.

Alignment No. II -: Route: Acharya Donde Marg- Jagannath Bhatankar Marg (upto Gokhale Road)- B.S. Marg- Appasaheb Marathe Marg – Veer Sawarkar Marg- Narayan Hardikar Marg.

Same as alignment No. I, This alignment No. II also follows inadequate geometry due to land restrictions and outcome of degree of curvature of the entire alignment, this alignment no. II seems very difficult to implement and difficult to operate the traffic during construction, hence the said alignment No. II was also not considered for further study.

Alignment No. III -: Route: Acharya Donde Marg- Jagannath Bhatankar Marg – Drainage Channel Road (Tunnel along the stretch) – Narayan Hardikar Marg.

This alignment has limitations due to the proposed underground Metro Rail and due to high cost involved.

The above suggested tunnel alignment does not become feasible. (Pl see Tunnel Feasibility 7.7)

3.5 Final Alignment

The discussion with the SRA & MCGM authorities regarding the slums along the Drainage Channel Road and on the alternative alignments with MMRDA was carried out. SRA & MCGM Authorities communicated that the process of rehabilitation for the slums along the drainage channel road is under progress and subsequently the Drainage Channel Road will be cleared of slums. After study of the alternative alignment the most feasible alignment is proposed in Figure 3.1.

A Four lane elevated corridor has been proposed all along the alignment and the total length of the proposed corridor is @ 4.512 Kms. The proposed alignment of the elevated corridor has been kept mostly along the alignment of existing roads The following map shown final proposed alignment of Elevated corridor.

Figure 3. 1 Alignment Map of Elevated corridor for Sewri--Worli

CHAPTER - 4
PROJECT APPRECIATION

CHAPTER – 4
PROJECT APPRECIATION

4.0 PROJECT APPRECIATION

4.1 The Project

Past CTS (By M/s Lea Associates) highlights the need of high quality transport consisting of urban freeways, Elevated corridors and different types of transit systems. The CTS recommended highway network comprises a significant road length running along the coastline of the city. The road network envisages a road running along the coastline from Nariman Point in the south to connect to Versova on the western flank of the city. Eastern Freeway runs along the eastern coast of the island city between south Mumbai to connect to Chembur and further to link to the eastern express highway at Ghatkopar. The proposed Sewri-Nhava Trans Harbour link will establish connectivity between Sewri on the main land and Nhava on the main land. The MTHL with the connecting road network and the multi modal Virar-Alibag corridor would complete a ring road around Mumbai. The proposed elevated corridor is fast feeder link in between MTHL and Coastal Road.

The geography of Mumbai is like elongated strip (having relatively small land width), running in North-South directions and surrounded by Arabian Sea on West and Thane creek on its East. Naturally, the main roots for Transport communications run North and South directions. Similarly, it has been known that the present state of City of Mumbai has been brought by connecting old Seven Island, Colaba, Mahim, Parel. etc. From this it will be understood that the main land was bifurcated from the Island City due to presence of Thane Creek. With increase in activities within the City of Mumbai it was considered necessary also to develop areas in Main Land so that growth and developments does not get chocked. This need got further eventuated with opening of national economy with which besides usual trade and commerce activities in financial sectors also started expanding. As of this time an all-weather port JNPT is already developed and giving excellent services. The new international Airport is also approved near to Panvel on Main Land. Naturally there is every need to have speedy road link between Main Land & the Island so that developments in hinterlands would happen rapidly.

A good number of studies have been undertaken on Mumbai Road Network needs and the earliest of this was around 1960. With typical geographical features the moment of

traffic in the City is North South direction (& vice versa). Therefore, all these studies have not only recommended but given emphasis on simultaneous establishing of East West links having adequate capacity to handle on coming Volumes. Development of Santacruze-Chambur link road joining (Eastern Express Highway & Western Express Highway) is an initiative of these studies. On similar line the corridor between Sewri & Worli has been recommended so that the Traffic on MTHL, Eastern freeway and Western freeway would achieve best exchange. In the background of advance actions on MTHL it has become urgent now also to give impetus to establish this Corridor.

Figure 4. 1 Location Map of Project

The effectiveness and viability of MTHL depends on its connectivity and proper dispersal system on Mumbai side. As part of this plan, MMRDA has decided to Construct a Interchange junction at Sewri Railway Station to disperse the traffic in three direction i.e. Worli, Fort (Zakaria Bundar Road) & Chembur (Kidwai Road). Also its necessary to Develop a dispersal system in the form of Sewri-Worli (East-West) Elevated Corridor or similar other options if any. The corridor is proposed to commence from the east side of Sewri Railway Station on the Harbour Line of Central Railway and proceed to Worli and terminate on the Narayan Hardikar Marg (New Prabhadevi Road). This Connector project will contribute 15% of the vehicular traffic on MTHL. It has been conceptualised to have direct or signal-free connectivity between the two sea links. Those residing in western suburbs can directly head for Navi Mumbai or Mumbai-Goa Highway once they get on to Bandra Worli Sea Link and Sewri-Worli Connector. Constructing the Connector would be a challenging task. As per the alignment plans, it will cross the Mumbai Port Trust (MbPT) and Harbour Railway lines at Sewri, and will follow on to Acharya Donde Marg in Parel. Thereafter cross over the Dr Babasaheb Ambedkar Road and heading to go over the Central and Western Railway lines at Parel-Elphinstone Road Railway Stations. After this, it will have to go above the existing flyover on Senapati Bapat Road at a height of 27 meters or 7th floor of a residential building and intersecting through Kamnagar Nagar (drainage pipe Line) finally land at Worli.

4.2 Importance

The Mumbai Metropolitan Region Development Authority (MMRDA) has revived plans for the four-lane Worli-Sewri elevated corridor, which it will benefit approximate 35,000 motorists daily once the Mumbai Trans-Harbour Link (MTHL) is completed. the project alignment having length @ 4.512km Sewri-Worli connector originates from east side of Sewri railway station at the interchange of MTHL and end up on Narayan Haldikar Marg in Worli. This will become only one Signal free elevated corridor which will join East and West Mumbai.

Sewri- Worli Elevated corridor mainly change all the traffic scenario of Mumbai as it will be only one direct connectivity to North through.

Figure 4. 2 MTHL Connection Roads from North- East- South

4.3 Present Scenario

Presently Sewri Railway Station act as dead end for Archarya Donde Marg. Eastern freeway don't have any connection ramp to get down as well as up from Archarya Donde Marg. Once The Mumbai Trans Harbour Link (MTHL), project completed there is no arrangement at Sewri west side to disperse the coming traffic from MTHL. Lot of construction of residential and commercial structures had taken place around Sewri Bus Stop and Sewri Railway Station. CST-Panvel Fast Rail Corridor is proposed in between Eastern Express Way & CTSM –Panvel (Harbour line) which is traversing at 23 m Height from ground. the Metro line is under DPR stage on sea side of Eastern Express Freeway. There is an existing FOB which crosses Acharya Dhonde Marg and the

alignment passes over the FOB Also temporary structures /stall are observed at the edge of footpath and will have to be vacated as per necessity.

Elevated corridor will go second level above monorail then it will cross Hindmata Flyover (Parel Flyover) then it will cross Elphinstone station(Prabhadevi) at second level above Churchgate-Virar Elevated corridor then it will cross Senapati Bapat Road on second level and finally it will cross Dr. Annie Basant Road and join Narayan Hardier marg.

4.4 Road Congestion and Vehicle population in Mumbai

As regards the road transport mode, CTS comments that increase in cars (137%), increase in two wheelers(306%), increase in autos(420%) and increase in taxies (125%) during the 1991-2005 period has created a lethal dose of traffic congestion which has categorised Mumbai urban agglomeration as one of the most congested regions in the world. The following table shows year wise vehicle population in Mumbai.

Table 4. 1 Most feasible Alignment proposed in the 2007 Feasibility Report

Year	Total	Pvt. Cars	Two Wheelers
2000-01	10.29L	3.65L	5.50L
2006-07	15.03L	4.64L	7.93L
2007-08	16.04L	4.92L	8.59L
2008-09	16.74L	5.03L	9.18L
2009-10	17.67L	5.14L	9.80L
20010-11	18.70L	5.50L	10.44L
20011-12	20.28L	6.21L	11.31L
20012-13	21.87L	6.72L	12.35L
20013-14	23.32L	7.23L	13.29L
20014-15	25.71L	7.97L	14.70L
20015-16	28.19L	8.50L	15.96L
20016-17	30.69L	9.2L	17.72L
#Total indicates Cars,2wheelars,Buses,Trucks			

The CTS also brings out a significant growth in the private vehicles in the city over the fifteen years period between 1991 and 2005. The growth of motorized vehicles has been reported to be about 9.7% per annum in this report and the CTS attributes this high growth of private vehicles in MMR to highly intolerable crowding levels in sub-urban

trains, increasing income levels, and easy availability of loans. Limited land mass with rapid increase in population in the city has compounded this growth.

Among other things, the CTS highlight the need of high quality transport consisting of urban freeways and different types of transit systems. Based on the data collected and study of parameters that impinge upon the travel demand the CTS report has projected the need of railway and highway network by the year 2031.The statistics indicates the actual need of fast tracks with adequate capacity augmentations in heart of Mumbai.

4.5 Demography

As per Census of India, population of Mumbai in 2011 is 15,495,706; of which male and female are 7,842,460 and 7,653,246 respectively. source: district census hand book Mumbai By census of India 2011.

4.6 Climate

The mean average temperature is 27.2 °C and average precipitation is 242.2 cm (95.35 inches).The mean maximum average temperatures is about 32 °C (90 °F) in summer and 30 °C (86 °F) in winter, while the average minimums are 25 °C (77 °F) in summer and 20.5 °C (68.9 °F) in winter. Mumbai experiences four distinct seasons.

4.7 Major Issues Identified

During site visit, our observation was concentrated on the challenges that are expected during construction of viaduct structure at the junctions with major roads & railway line. The same has been shown in Figures 4.3 & 3.3 hereafter:

Table 4. 2 Observations

Sr. No.	Observations
1.	As a part of Mumbai Trans Harbour Link (MTHL) project, East-West Corridor is proposed to disperse the traffic from MTHL. The idea is to drop the traffic directly to the intended destination without locking up with local traffic. Apart from that, all other developmental projects are focused to cater the traffic moving from North-South. There is no proper connection for the traffic moving East-West direction and vice versa. Therefore, the proposed corridor has to be designed to meet the following traffic as a part of dispersal of MTHL traffic The corridor takes off at Ch. 0+000 (Eastern side of SewriRailway station) at the end of MTHL close to Gadi Adda areas of MbPT Land. The dialog between MMRDA and MbPT authorities

Sr. No.	Observations
	has been hopefully going on regarding land issues for corridor.
2.	After the exit of MbPT land, the alignment crosses MbPT Road along with second level Eastern freeway. To Merging and demerging with these adjacent road lines like MbPT Road, Eastern freeway (second Level), RAK road etc. & grade separation with CTSM –Panvel (Harbour line) and proposed CST-Panvel Fast Rail Corridor with adequate up and down ramps is inescapable. Few encroachments are noted at road side which needs to remove with proper R and R.
3.	After passing the Sewri interchange (second level) alignment follows existing road alignment of King Edward road. Tokershi- Jivaraj road. Further crosses GD Ambedkar and Dr. SS Rao road. A foot over bridge at Ch 0+880 is noted @ 6 M above Ground. Secondly, Monorail alignment runs parallel from GD Ambedkar (Ch.1+110) to Khanolkar Chowk (Ch. 1+680) i.e. 580 meter in length. The monorail alignment is at second level and appropriate vertical clearances need to take into account.
4.	Alignment passes over Khanolkar Chowk along with monorail alignment, after crossing alignment passes over Hindamata Flyover along Dr.BR Ambedkar road Due to the construction of elevated monorail corridor instead of central pier, portal frame taken into account to keep monorail structural arrangement intact.
5.	After passing Khanolkar Chowk along with monorail overlap, alignment passes through Hindamata Flyover along Dr. Babasaheb Ambedkar road.The pier position of said Corridor is kept by Keeping Hindmata flyover width in Mind. The flyover is at second level. It is also better to provide connection with elevated corridor with up and down ramps to exchange the traffic along Dr.BR Ambedkar road. After getting possible land width for up and down ramp between level 2 / 3 and approval from MMRDA, the proposal for this connectivity will be taken in hand for final DPR stage.
6.	The alignment crosses Elphinstone railway station, ROB and Elphinstone flyover at Ch.2+410 respectively. The subjected area seems very busy with narrow streets .The Condition of Existing ROB is also not fair. This rail road structure constructed in pro-independence era and in UCR masonry. The new ROB proposal needs to consider for better safety and future need.
7	Proposed Churchgate –Virar elevated freight corridor is also passes at Elphinstone ROB. The level of this freight corridor is not fixed yet. After various meeting and discussions with Rail Authorities it is learnt that, The freight corridor is kept aside by Rail authority. Hence, we should go as per existing crossings and in

Sr. No.	Observations
	association with Railway concerns.
8	After crossing SB road at ch.2+790,alignment passes over Ghokhale road at ch. 3+110 and further moved towards Kamgarnagar Slum areas. The rehabilitation of this kamgarnagar is partially completed and balance part of the rehabilitation on the way of completion. At slump pocket of Kamagarnagar Proposed DP road alignment need to rectify in some extent by considering resettlement and rehabilitation point of view in association with MCGM authorities.
9.	Further corridor traverse through drainage channel named as cannel road with less road way width. At this stretch portal frames are proposed to avoid central piers to maximum utilization of existing road and to avoid conflict with drainage channel.
10.	Further alignment crosses Dr.Annie Besant Road at ch. 4+150 and gradually rest at ch 4+512 with smooth down grade which connects sea link and proposed costal road.

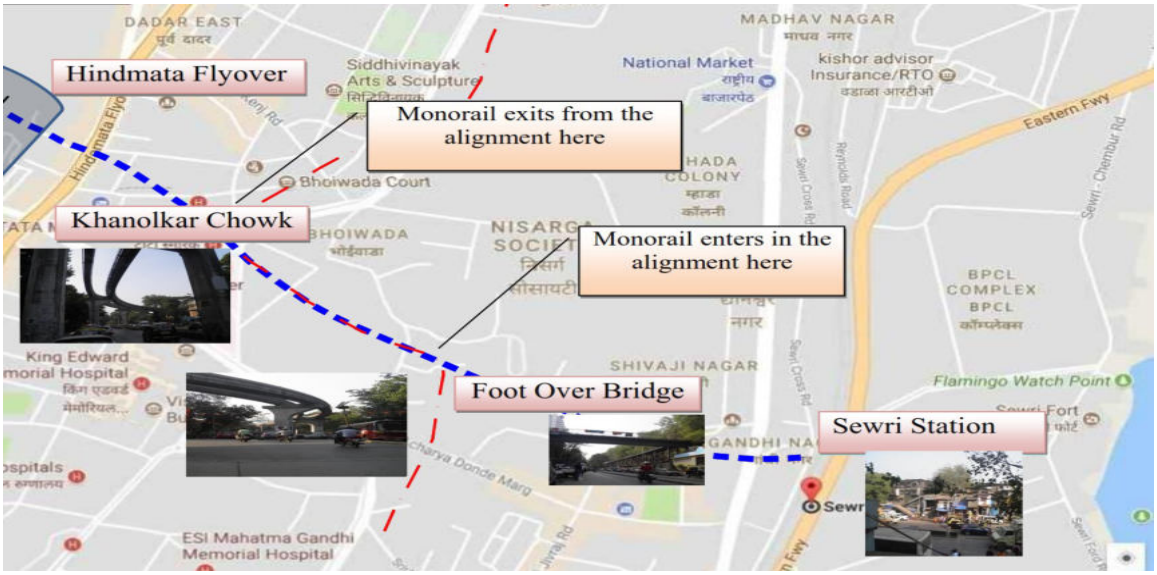


Figure 4. 3 Major Issues

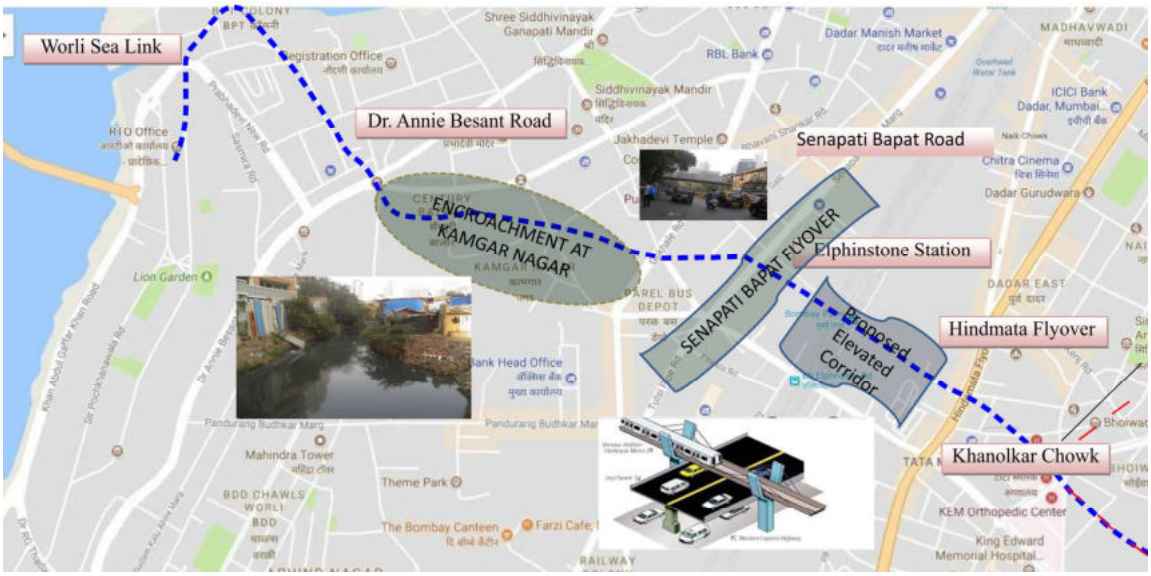


Figure 4. 4 Major Issues

The challenge for execution of works at these junctions lies in timely diversion of obstructing utilities, devising effective traffic diversion plans and ensuring that all safety & quality measures are in place during the construction phase. The same are explained below.

PROVIDING INGRESS/EGRESS

Major problem will consist in upholding the free flow conditions while serving the adjacent complexes and facilities. It is noted that several important institutions (Hospitals, Office buildings) are located and the issue will lie in providing adequate ingress/egress to the road network for the users of these institutions while preserving the free flow conditions on roads and on the major intersected routes.

EXISTING UTILITIES

There are numerous utility owners who own utility lines that run along & below the project alignment. It is noted that all the utility lines may not be well recorded and a proper utility strip plan has to be prepared inclose coordination with utility owners. This will help in relocation/diversion of utilities during execution.

QUALITY & SAFETY PROVISIONS

Giving due consideration to the complexity of the job, proper safety & quality measures have to be taken during execution of the project. The Consultant comprehends the seriousness of the issue that needs to be handled.

Detailed constraints & issues as expected at various locations are explained in next section.

4.8 Location-Wise Constraints & Issues Expected

Sewri Station & Eastern Freeway

CST-Panvel Fast Rail Corridor is proposed in between Eastern Express Way & CTSM – Panvel (Harbour line) which is traversing at 23 m Height from ground. It is also learned that Metro line is under DPR stage on sea side of Eastern Express Freeway.

The project starts from the eastern side of Eastern Freeway and will cross Eastern Freeway & Harbour Railway Tracks. Few encroachments have to be vacated from the footpath and road areas. Proper safety & traffic diversion plans especially during construction of bridge over tracks is envisaged.

Sewri Railway Station

Encroachment Surrounding Sewri Railway Station

Encroachment at Sewri Bus Depot

Existing Foot Over Bridge

Initial study shows that EWC gradient need to check between Sewri Bus Stop to G.D. Ambedakar road as Foot Over Bridge crosses the alignment. Level of Foot Over Bridge is approximately 6 m above GL and with considering; required clearance of about 8 m. Final Gradient and Alignment will decide demolition of existing Foot Over Bridge.

Foot Over Bridge

Conflict with Monorail Alignment

Project alignment is in conflict with Monorail alignment coming from G.D. Ambedkar Marg, running parallel to project alignment and going right from Khanolkar Chowk towards Dr. Earnest Borges Road.

It is expected that elevated corridor will go at 2nd level above monorail & the viaduct structure will rest on portal foundation that will come near footpath on either sides.

Monorail Station Near Haffkine

Monorail Enters in Alignment at GD Ambedkar Marg

Monorail Station Near Haffkine

Foundation of Pier for Elevated Corridor may on Footpaths

Major Junction (Hindmata Flyover)

Elevated corridor will cross the existing flyover at 2nd level. This is a major junction and it is well understood that execution of work has to be done in a planned manner. Utmost care is required to ensure that traffic is not disrupted during actual execution of works. All safety precautions have to be taken in full Force.

Hindmata Flyover (Parel Flyover)

Major Crossing at Elphinstone Crossing Western and Southern Raiway

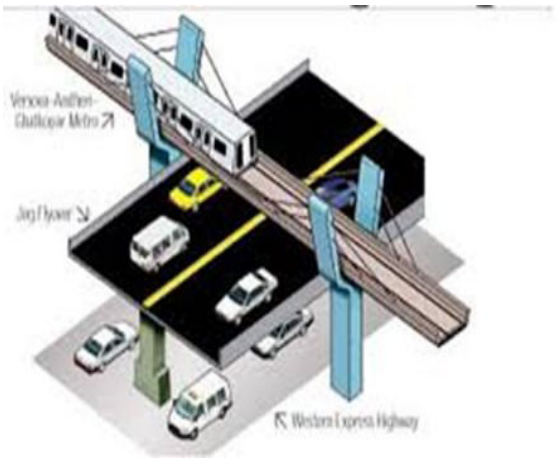
The execution of works at these major crossings is expected to be of most complex type. The centre line of elevated corridor and that of existing Elphinstone Bridge (ROB) is expected to coincide. The task becomes more herculean due to the planned Church gate Virar elevated corridor which is expected to go at 2nd level.

Biggest Challenges will be –

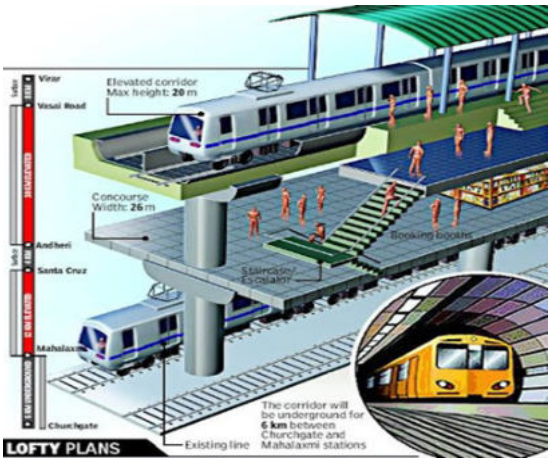
- Space constraint at bridge location
- Approval of GAD & Launching scheme from Railway for Pier
- Construction of Foundation & Substructure in close proximity to running tracks
- The sheer height at which the elevated structure is to be constructed

Elphinstone Station Flyover

Elphinstone Station Flyover



Churchgate Virar Elevated Corridor



Churchgate Virar Elevated Corridor

OTHER CONSTRAINS

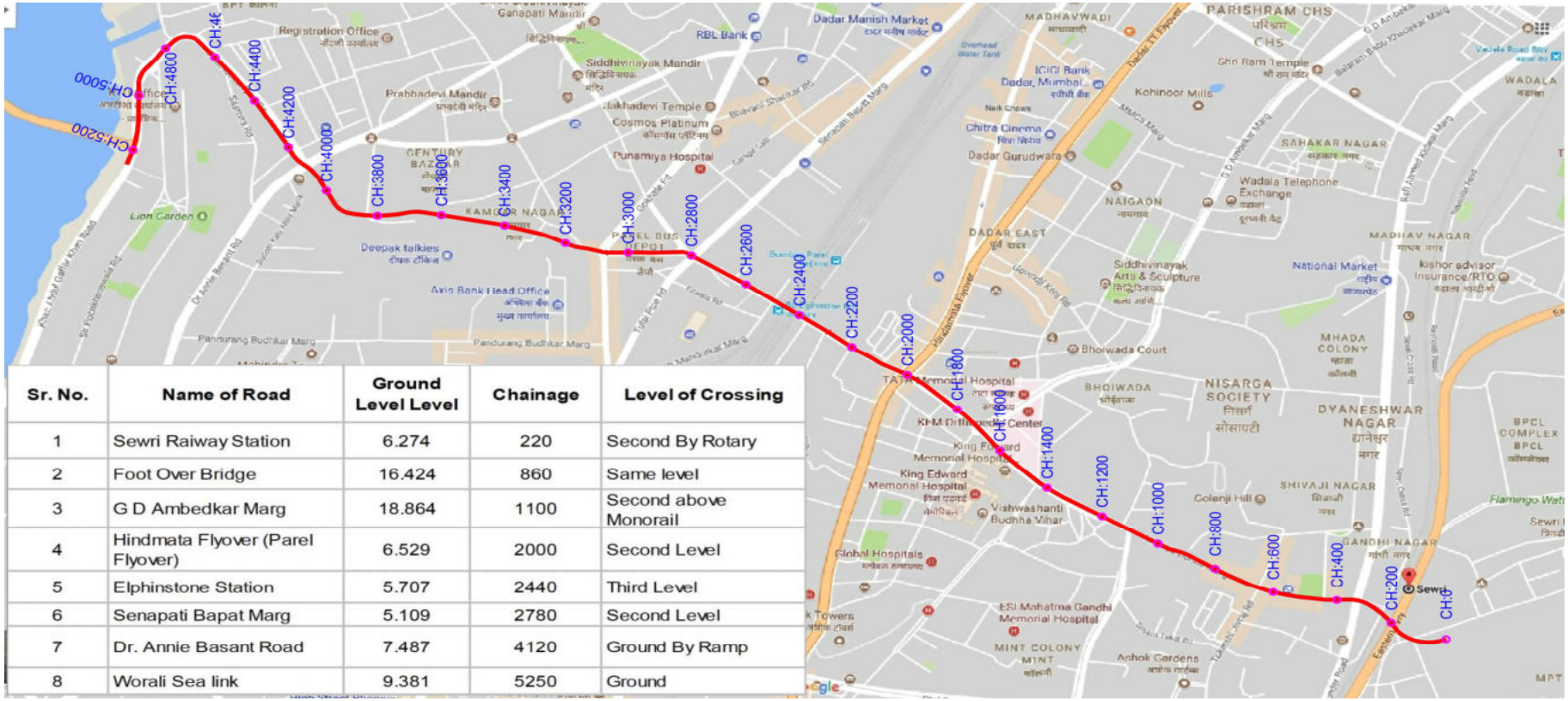
Senapati Bapat Road Flyover

Kamagar Nagar – Chanel Road

Joining Dr. Annie Basant Road through ramp Near Worli

4.9 Alignment

There are at least 2 alignments to every stretch of road. There is the horizontal alignment and the vertical alignment. When designing a roadway, you need to decide exactly where to place that roadway. The vertical alignment follows the horizontal alignment and it depend on its topography, but is referring to Sewri Worli Elevated Corridor vertical alignment goes as per different level due to different situation, structures coming along its stretch



Sr. No.	Name of Road	Ground Level Level	Chainage	Level of Crossing
1	Sewri Raiway Station	6.274	220	Second By Rotary
2	Foot Over Bridge	16.424	860	Same level
3	G D Ambedkar Marg	18.864	1100	Second above Monorail
4	Hindmata Flyover (Parel Flyover)	6.529	2000	Second Level
5	Elphinstone Station	5.707	2440	Third Level
6	Senapati Bapat Marg	5.109	2780	Second Level
7	Dr. Annie Basant Road	7.487	4120	Ground By Ramp
8	Worali Sea link	9.381	5250	Ground

Figure 4. 5 Alignment of Sewri – Worli Elevated Corridor

CHAPTER - 5
TRAFFIC SURVEYS, ANALYSIS & FORCASTING

CHAPTER – 5
TRAFFIC SURVEYS, ANALYSIS AND FORECASTING

5.0 TRAFFIC SURVEYS, ANALYSIS AND FORECASTING

5.1 Background

MMRDA has developed “Eastern Freeway Project” under JNNURM scheme of the Central Government. The Eastern Freeway is four lane corridors, which starts from S.V. Patel Junction on P. D’Mello Road and joins Ghatkopar-Mankhurd Link Road at Indian Oil Nagar. This corridor has facilitated speedy traffic movement from south Mumbai, Mumbai Port Trust and eastern Mumbai. The connectivity between these areas is improved and a fast corridor is now available between Island city and suburbs.

As a part of MTHL dispersal, East-West Corridor from Sewri to Worli was proposed to be implemented to disperse the traffic from MTHL to island city of Mumbai. The idea of dropping the traffic directly to the intended destination without locking up with local traffic was given due importance. The proposed corridor was designed so that the traffic from MTHL to suburban will take Bandra-Worli Sea link, to Haji Ali through Western freeway, which is proposed, and the traffic to Colaba or towards Wadala or Sion will take Acharya Donde Marg. A schematic alignment of Sewri – Worli is shown in Figure 5.1.

Simultaneously, the dispersal System at Sewri connecting Elevated corridor to Rafi Ahmed Kidwai Marg and that from Rafi Ahmed Kidwai Marg to Elevated Corridor were also planned.

Figure 5. 1 Alignment of Sewri – Worli Elevated Corridor

5.2 Sections of Worli Sewri Road

For in-depth understanding, the road net work in project area is divided into 4 sections. These are as given below (west to west):

Section 1 – Worli end to Dr. Annie Besant road junction

This section is about 402 M in length(CH 4+512 to 4+110). The land use along the road is not congested. The footpath along North side is encroached upon by hutments.

Section 2 – From Dr. Annie Besant Road Junction to Senapati Bapat Marg Junction

This section having length @ 1330 m (4+110 to 2+780) and passes through Kamgar nagar I & II having length of about 940 meters and rest of the section follows existing road

Section 3 – From Senapati Bapat Marg Junction to Dr. Ambedkar Road Junction on Acharya Donde Marg

Section length is about 820 m.(2+780 to 1+ 960) The land use is mainly retail business. This section experiences heavy parking. Lot of criss cross pedestrian movements occurs throughout day.

Section 4 – From Dr. Ambedkar Road Junction to R.A.Kidwai Road junction on Acharya Donde Marg.

The road length is approximately 1530m (+1+960 to +0+430). The road network in this section is very congested with large number of N.S. roads/lanes crossings. This section which is 880 m alone has 15 intersections with some of them with multiple roads. The land use is mainly residential with shopping on the ground.

Section 4A –R. A. Kidwai Road junction to MTHL

This section has all important N.S. roads crossing. The land use is residential housing middle income &high income households. Road is rather wide and has length of about m. 430

5.3 Traffic Surveys & Analysis

5.3.1 Traffic Surveys

To assess the existing traffic flow characteristics and travel pattern, the following primary surveys were conducted on identified locations along the project corridor.

- Classified Traffic Volume Count (CTVC) Survey
- Turning Movement Count (TMC) Survey
- Parking Survey

The traffic survey locations, their chainage and date of survey is presented in **Table 5.1**and **Figure 5.2**.

Table 5. 1 Traffic Survey Locations

Type of Survey	Location	Description	Period
Traffic Volume Count	TVC-1	Worli Bandra Sealink	13-Nov-17
	TVC-2	Near Elphinstone Road Merchants Association	07-Nov-17
	TVC-3	Elphinstone RUB	07-Nov-17
	TVC-4	Near Damodar Hall	07-Nov-17
	TVC-5	Near Parel Police Chowky	10-Nov-17
	TVC-6	Near Wadia Hotel	07-Nov-17
	TVC-7	Near ThakareUdyan	08-Nov-17
	TVC-8	Near Tata Hospital	08-Nov-17
	TVC-9	Near Sewri Hospital	07-Nov-17
	TVC-10	On Kidwai Road	10-Nov-17
	TVC-11	On Eastern Freeway	10-Nov-17
Turning Movement Survey	TMC-1	Bhoiwada Junction	08-Nov-17
	TMC-2	WorliBandra Sea Link Junction	13-Nov-17
Parking Survey	P-1	Sea Link Road	10-Nov-17
	P-2	National Chemist	10-Nov-17
	P-3	Wadia Hospital - Sewri Road	10-Nov-17
	P-4	BhoiwadaChowki	10-Nov-17
Speed and Delay	SD-1	PRABHADEVI NEW ROAD (4 rounds)	09-Nov-17
	SD-2	ACHAYA DONDE MARG (7 rounds)	10-Nov-17

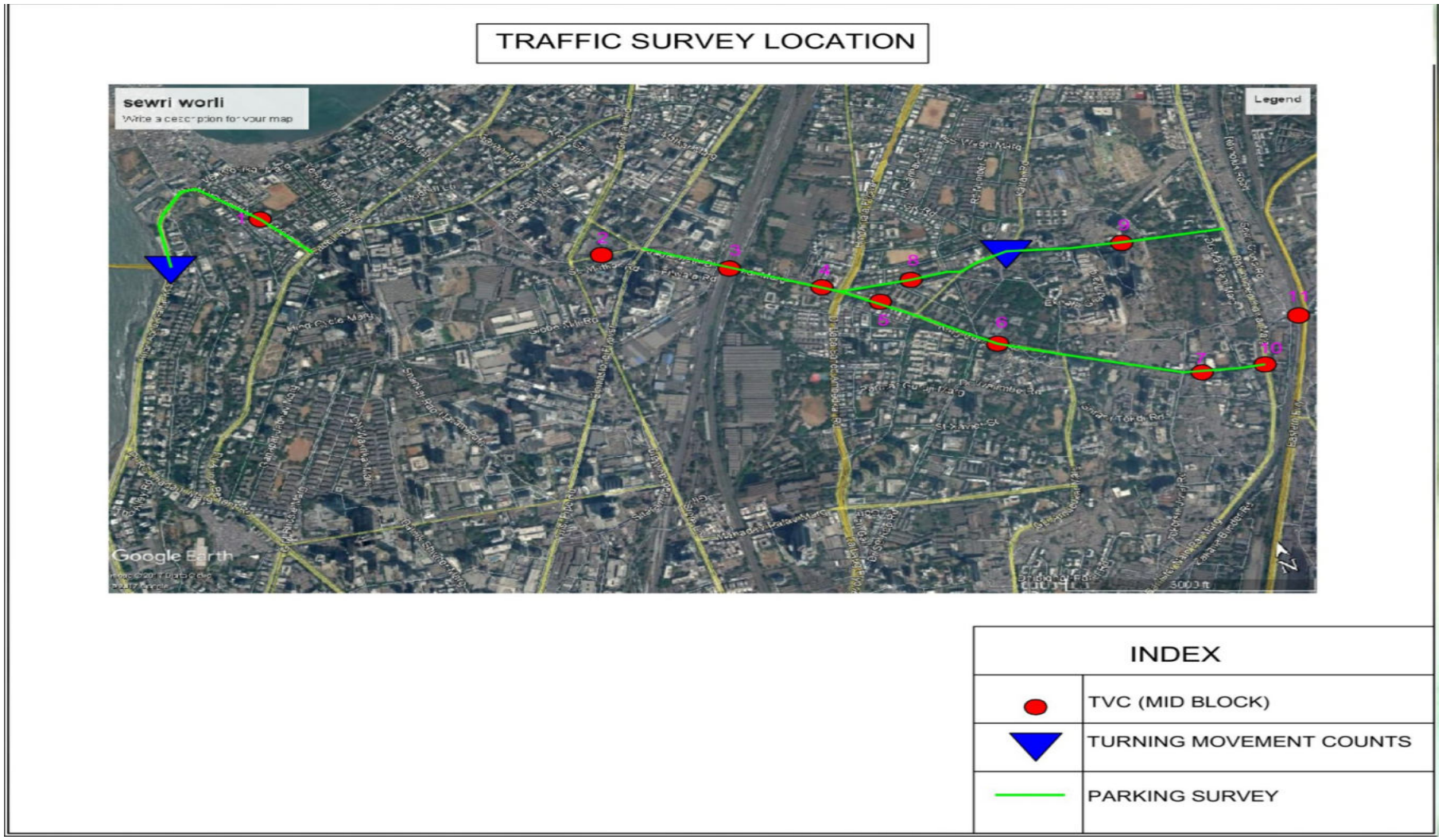


Figure 5. 2 Traffic Survey Location Map

Survey Methodology

5.3.1.1 Classified Traffic Volume Count (CTVC) Survey

The main objectives of Classified Traffic Volume Counts were to assess the traffic characteristics in terms of average daily traffic, hourly traffic variation, peak hour traffic, traffic composition and directional distribution.

Figure 5. 3 Photos Showing TVC Survey in progress

Traffic Volume Counts were conducted for one days at the eleven locations as listed in **Table 5.1** and shown in **Fig. 5.2**.

To carryout traffic counts, the vehicles were grouped under the various categories. Vehicle classification system adopted is given in **Table 5.2.**

Table 5. 2 Vehicle Classification System

Motorised Traffic	
2-Wheelers	
Auto Rickshaw	
Passenger Car: Car/Taxi/Jeep/Van	
Ambulance/Fire Tender/Hearse	
Bus	Mini Bus – Govt., School bus, Other Private
	Standard Bus – Govt., School bus, Other Private
Truck	Light Commercial Vehicle (LCV Passenger)
	Light Commercial Vehicle (LCV Goods)
	2/3-Axle Rigid Chassis Truck
	Multi Axle Truck (>4 Axle)
Others	Tractor
Non-Motorized Traffic	
Animal /Hand Drawn Vehicle	
Bicycle	
Cycle Rickshaw	

Mid-block volume count survey was conducted at three locations along the project corridor, one in each homogeneous section.

Traffic volume count was carried out manually by trained enumerators using hand tally method under the supervision of a Traffic Engineer. The traffic count data was recorded at 15-minute intervals for each vehicle group.

5.3.1.2 Speed & Delay survey

The speed & delay survey was conducted using the “Moving Car Observer Method” Prabhadevi New road and Acharya Donde Marg. The survey was conducted during peak period to obtain a basis for relating road network speeds, travel times and delays to the physical dimensions and design characteristics of the existing roads (including impacts of intersections) travel time and delay measurements, journey speed of traffic stream.

Total Four runs were made on the project corridor. Information on journey time, number of vehicles overtaken by the test car, vehicles overtaking the test car and any delays occurring en-route/junction were recorded during the survey. The test vehicle was run in

both directions of the traffic stream, the cause and duration of stoppages and other delays were recorded.

5.3.1.3 Intersection Turning Movement Survey

The Turning Movement Survey was conducted to obtain information on direction wise and mode wise turning movement of traffic at important intersections falling on the project road. The survey was conducted for peak hours at 2 locations and is given in **Table 5.1** and shown in **Fig 5.2.**The main objective of this survey is to assess control measures, the quantum of traffic entering and leaving the project corridor at the intersection. The peak hour directional movement data would be useful to plan the improvement scheme such as, at-grade intersections with or without provision of traffic signals, interchanges and for design of intersections, etc.

The surveys were carried out at selected major intersections by manual counting method. Enumerators for recording each type of turning movement (i.e. left turning, right turning and straight moving) were positioned strategically so that they could observe the turning vehicle and record appropriately. The turning movement count survey was carried out at 4 intersections.

5.3.1.4 Parking Survey

For Parking Study, two basic data components were required – parking supply and parking demand. Therefore, the Project Team surveyed parking availability and Occupancy i.e. the total amount of the parking supply that is occupied during the survey period. On street parking was counted for 16 hours i.e. between 8:00am to 8:00pm.

5.3.2 Data Analysis- Classified Traffic Volume Count

Traffic volume data collected from the location was computerized and analysed to study average daily traffic.

5.3.2.1 Passenger Car Equivalent (PCE) Factors

The various vehicle types having different sizes and characteristics were converted into equivalent passenger car units. The passenger car equivalents (PCE) factors for each category of vehicles, recommended by Indian Road Congress in IRC-106-1990, “Guidelines for capacity of urban roads in plain area” were used for this purpose and are presented in **Table 5.3.**

Table 5. 3 PCE Factors adopted for Study

Sr. No	Vehicle Type	Equivalent PCE Factors	
		Percentage composition of Vehicle type in traffic stream	
		5%	10% and above
	Fast Vehicles		
1	Two wheelers, Motor cycle or scooter	0.5	0.75
2	Passenger car, pick-up van	1	1
3	Auto-rickshaw	1.2	2
4	Light commercial vehicle	1.4	2
5	Truck or Bus	2.2	3.7
6	Agricultural Tractor Trailer	4	5
	Slow Vehicles		
7	Cycle	0.4	0.5
8	Cycle rickshaw	1.5	2
9	Tonga (Horse drawn vehicle)	1.5	2
10	Hand cart	2	3

Source: *IRC – 106 – 1990: Capacity of Roads in Rural Areas*

5.3.2.2 Average Daily Traffic (ADT) and Composition

Daily Traffic Volume by vehicle type and direction was summed and averaged for the entire survey duration to determine the average daily traffic (ADT) for the survey location. Summary of average daily traffic (ADT) for the section is presented in **Table 5.4** and graphically represented in **Figure 5.3**.

Table 5. 4 Average Daily Traffic at Classified Traffic Volume Count Location (Both Direction)

(In numbers)

Location No.	Name of Location	Total Vehicles	Total PCUs
TVC-1	Worli Bandra Sealink	12122	10106
TVC-2	Near Elphinstone Road Merchants Association	5115	4655
TVC-3	Elphinstone RUB	53032	49320
TVC-4	Near Damodar Hall	69689	64811
TVC-5	Near Parel Police Chowky	17518	16997
TVC-6	Near Wadia Hotel	33943	31567
TVC-7	Near ThakareUdyan	12614	11731
TVC-8	Near Tata Hospital	10601	9859
TVC-9	Near Sewri Hospital	14058	13073
TVC-10	On Kidwai Road	42670	39683

Location No.	Name of Location	Total Vehicles	Total PCUs
TVC-11	On Eastern Freeway	75081	69825

The location at TVC-1, witnesses average daily traffic (ADT) of 10,106 PCU (12,122 vehicles), whereas, the location at TVC-4 witnesses more traffic (ADT) of 64,811 PCU (69,689 vehicles) and TVC-2 observes minimum traffic (ADT) of 4,655 PCU (5,115 vehicles).

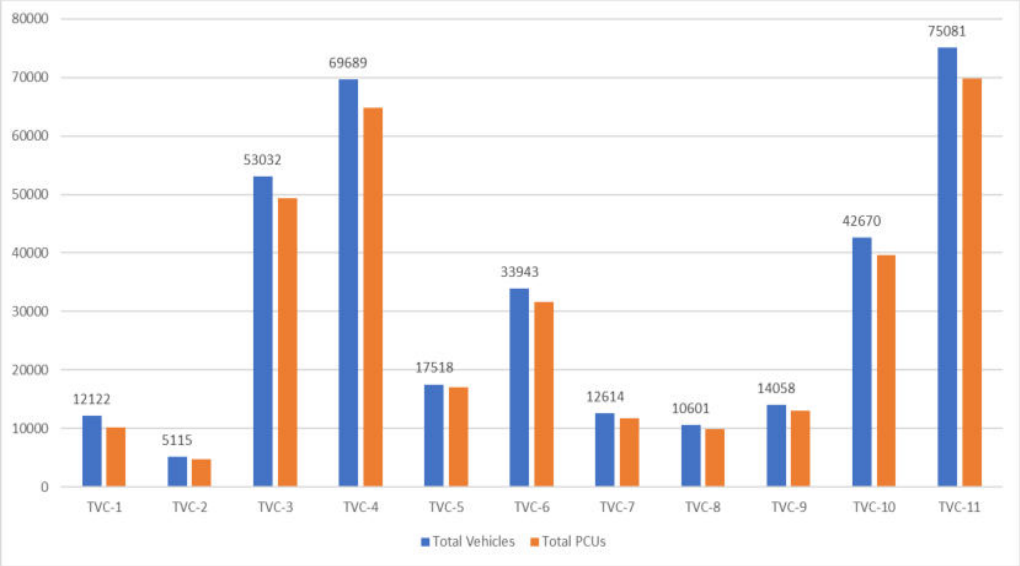


Figure 5. 4 Average Daily traffic

From the ADT observed at the eleven locations, it can be seen that the highest ADT (in PCUs as well as Vehicles) is observed near TVC-4 and lowest ADT near TVC-2.

Table 5. 5 Location wise variation of ADT

Section	Location		ADT in PCUs	Average Corridor Traffic (PCUs)	% Variation w.r.t Average Corridor Traffic
Worli-Sewri Link road	TVC-1	Worli Bandra Sea link	10106	29239	65%
	TVC-2	Near Elphinston Road Merchants Association	4655		84%
	TVC-3	Elphinston RUB	49320		-69%
	TVC-4	Near Damodar Hall	64811		-122%
	TVC-5	Near Parel Police Chowky	16997		42%
	TVC-6	Near Wadia Hotel	31567		-8%
	TVC-7	Near ThakareUdyan	11731		60%
	TVC-8	Near Tata Hospital	9859		66%
	TVC-9	Near Sewri Hospital	13073		55%

Section	Location		ADT in PCUs	Average Corridor Traffic (PCUs)	% Variation w.r.t Average Corridor Traffic
	TVC-10	On Kidwai Road	39683		-36%
	TVC-11	On Eastern Freeway	69825		-139%

5.3.2.3 Vehicle Composition

The percentage composition of classified vehicles at eleven locations on the project corridor is shown in **Table 5.6**, **Figure 5.5** to **Figure 5.15.**

Table 5. 6 Vehicle Composition at Classified Traffic Volume Count Location

(Both Direction)

(In Percentage)

Sr. No.	Name of Mid-Block Count Location	Car/Taxi	Auto	2-Wheeler	Bus	3W-LCV	LCV	Goods	NMV	Total
Location 1	Worli Bandra Sealink	64.9%	0.0%	34.0%	0.3%	0.2%	0.4%	0.1%	0.2%	100.0%
Location 2	Near Elphinstone Road Merchants Association	50.4%	0.0%	40.2%	5.6%	0.4%	0.8%	1.2%	1.4%	100.0%
Location 3	Elphinstone RUB	47.4%	0.1%	45.3%	1.5%	0.4%	4.6%	0.6%	0.1%	100.0%
Location 4	Near Damodar Hall	52.0%	0.0%	41.5%	1.3%	0.7%	3.0%	0.2%	1.3%	100.0%
Location 5	Near Parel Police Chowky	57.3%	0.4%	30.6%	5.3%	0.7%	3.6%	0.8%	1.3%	100.0%
Location 6	Near Wadia Hotel	62.2%	0.0%	31.8%	3.7%	0.0%	1.7%	0.4%	0.1%	100.0%
Location 7	Near ThakareUdyan	57.0%	0.0%	28.0%	7.9%	1.3%	4.0%	0.2%	1.6%	100.0%
Location 8	Near Tata Hospital	47.6%	0.4%	45.4%	1.7%	0.2%	2.2%	1.8%	0.5%	100.0%
Location 9	Near Sewri Hospital	55.0%	0.0%	40.4%	2.2%	0.0%	1.1%	0.5%	0.8%	100.0%
Location 10	On Kidwai Road	31.7%	0.0%	44.3%	1.5%	1.4%	15.6%	4.4%	1.2%	100.0%
Location 11	On Eastern Freeway	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%

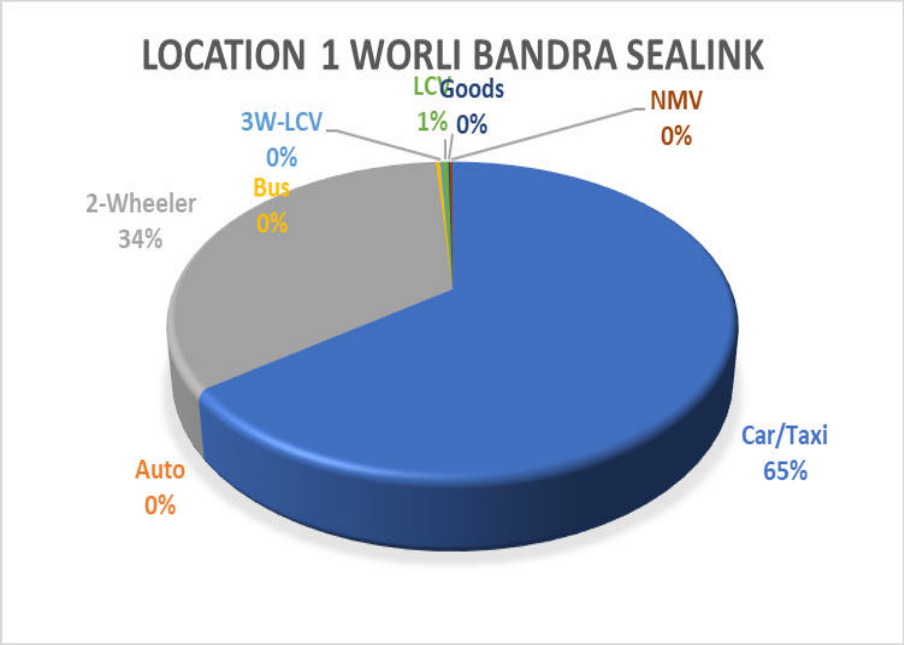


Figure 5. 5 Traffic Composition at atTVC-1

It can be seen that two wheelers and Car/Jeep/Taxi contribute to 34 percent and 65 percent respectively. On the other hand, trucks constitute 1 percent in total traffic.

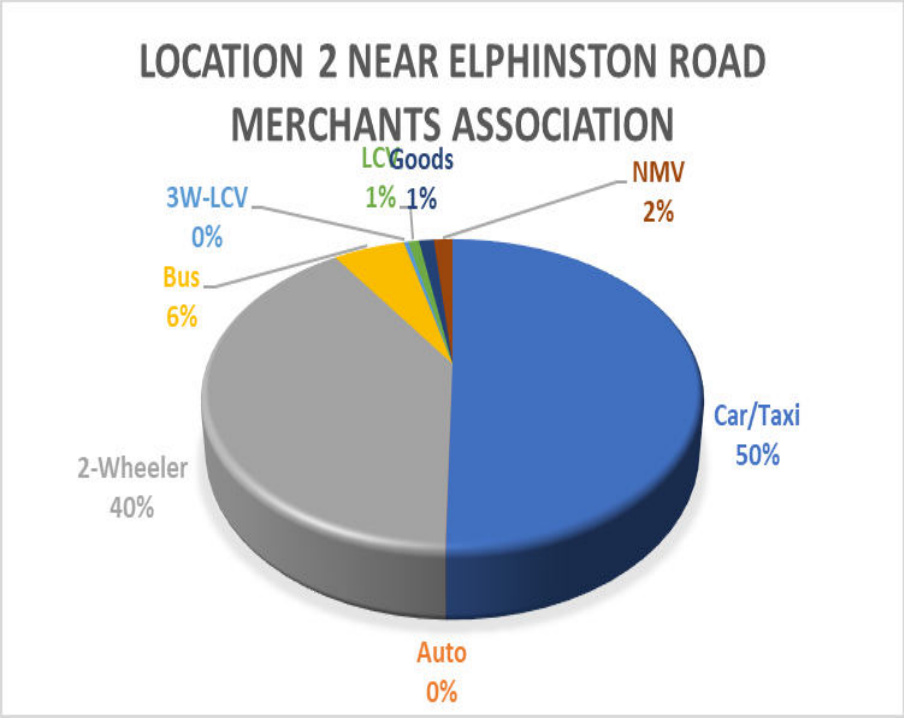


Figure 5. 6 Traffic Composition at atTVC-2

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 40 percent and 50 percent respectively. On the other hand, buses contribute to 6.0 percent, while trucks constitute 2 percent in total traffic.

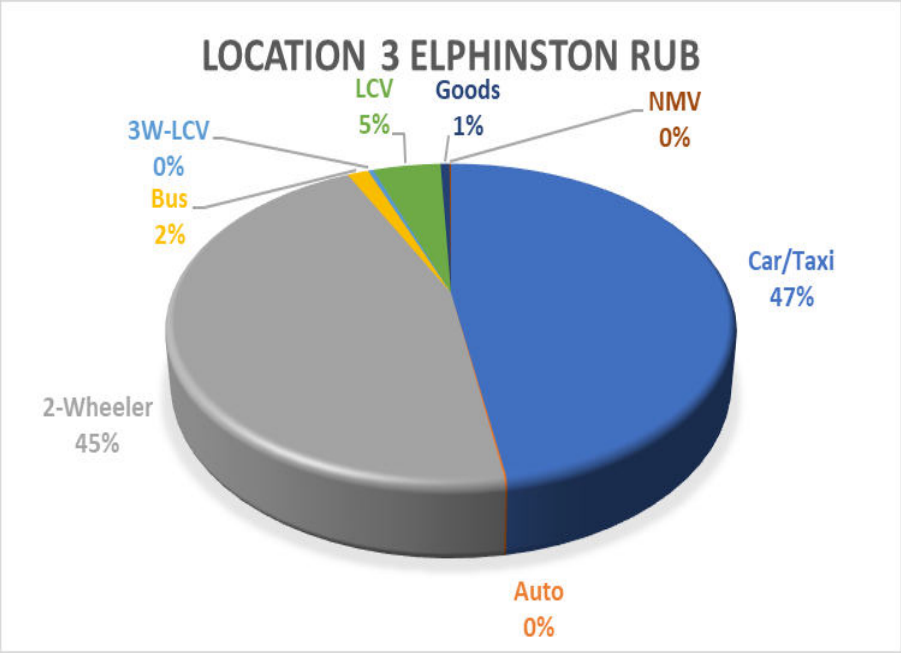


Figure 5. 7 Traffic Composition at TVC-3

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 45 percent and 47 percent respectively. On the other hand, buses contribute to 2.0 percent, while trucks constitute 6 percent in total traffic.

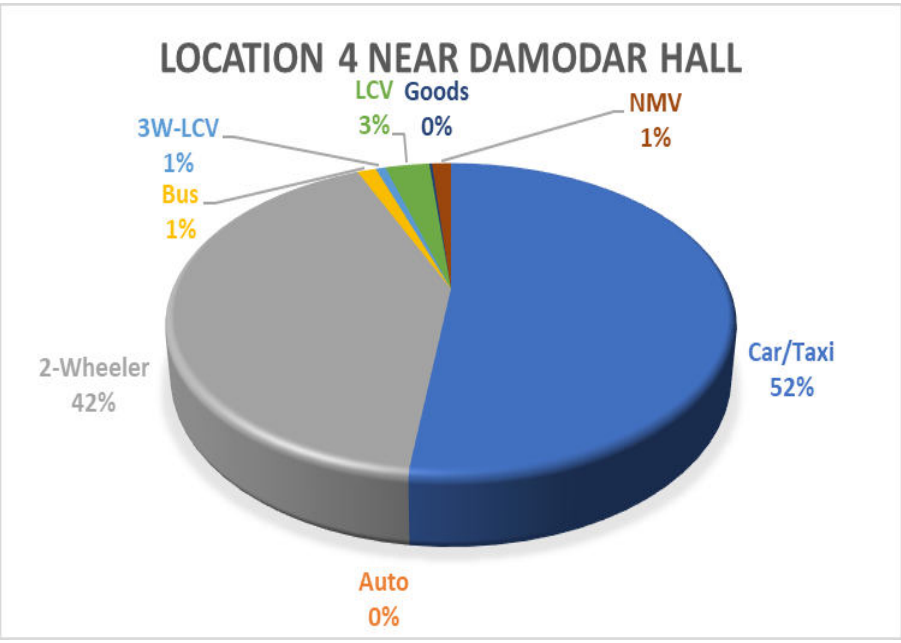


Figure 5. 8 Traffic Composition at TVC-4

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 42 percent and 52 percent respectively. On the other hand, buses contribute to 1.0 percent, while trucks constitute 3 percent in total traffic.

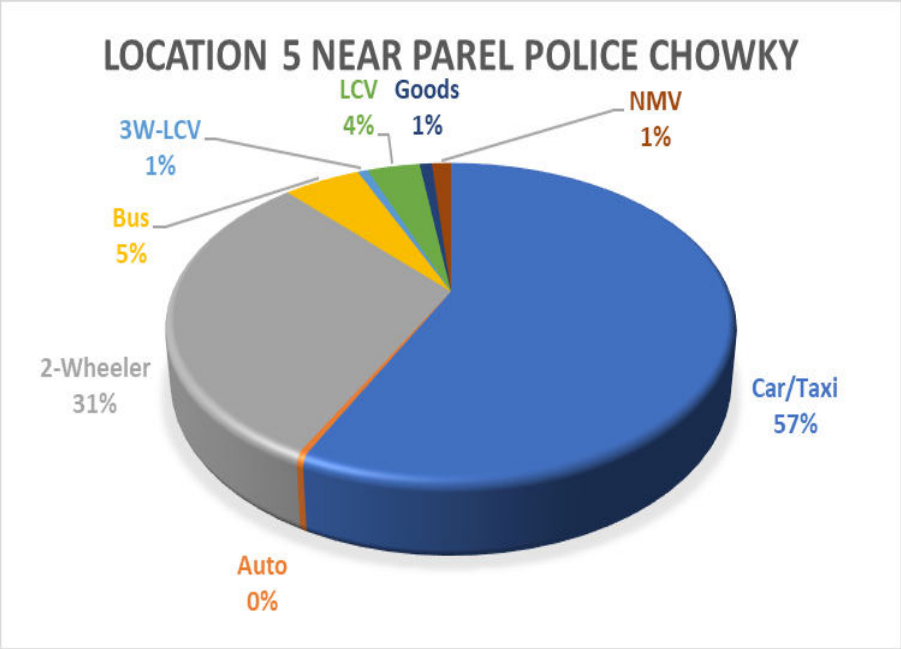


Figure 5. 9 Traffic Composition at TVC-5

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 31 percent and 57 percent respectively. On the other hand, buses contribute to 5.0 percent, while trucks constitute 6 percent in total traffic.

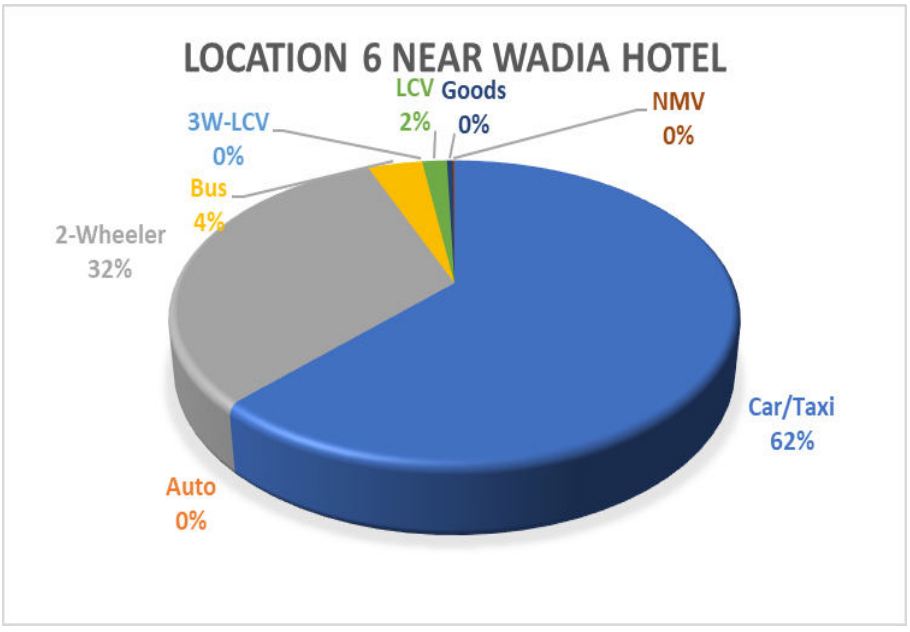


Figure 5. 10 Traffic Composition at TVC-6

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 32 percent and 62 percent respectively. On the other hand, buses contribute to 4.0 percent, while trucks constitute 2 percent in total traffic.

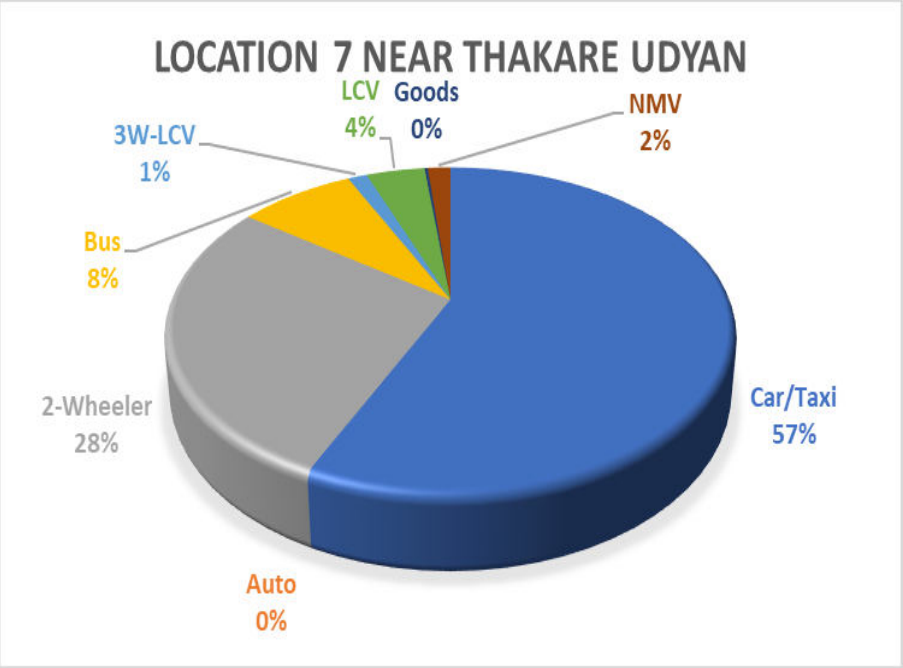


Figure 5. 11 Traffic Composition at TVC-7

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 28 percent and 57 percent respectively. On the other hand, buses contribute to 8.0 percent, while trucks constitute 5 percent in total traffic.

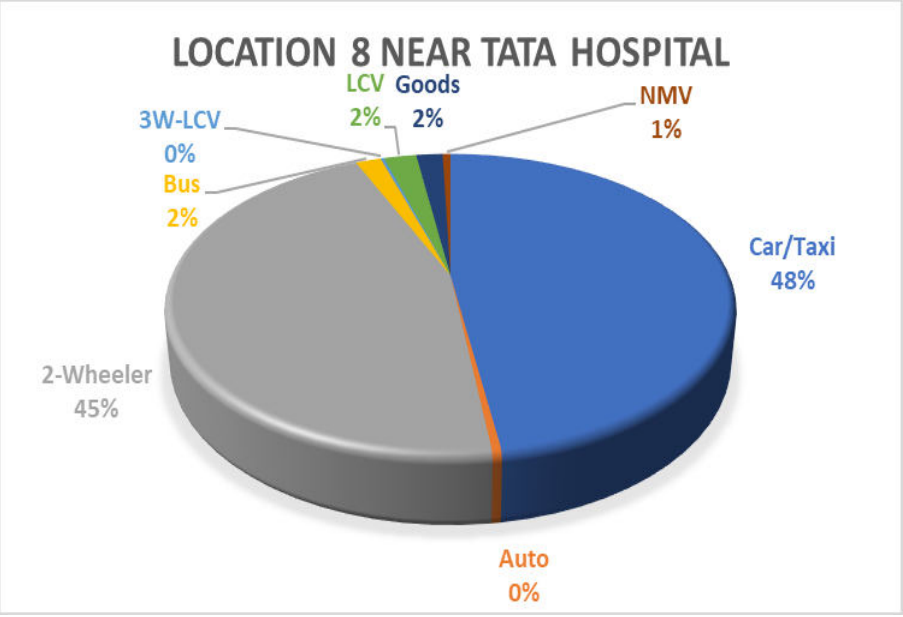


Figure 5. 12 Traffic Composition at TVC-8

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 45 percent and 48 percent respectively. On the other hand, buses contribute to 2.0 percent, while trucks constitute 4 percent in total traffic.

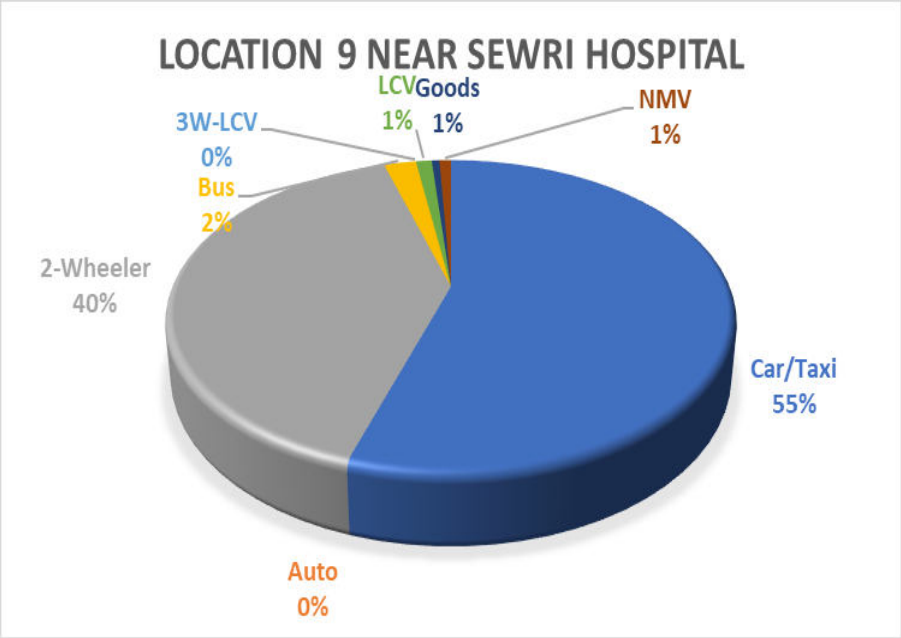


Figure 5. 13 Traffic Composition at TVC-9

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 40 percent and 55 percent respectively. On the other hand, buses contribute to 2.0 percent, while trucks constitute 2 percent in total traffic.

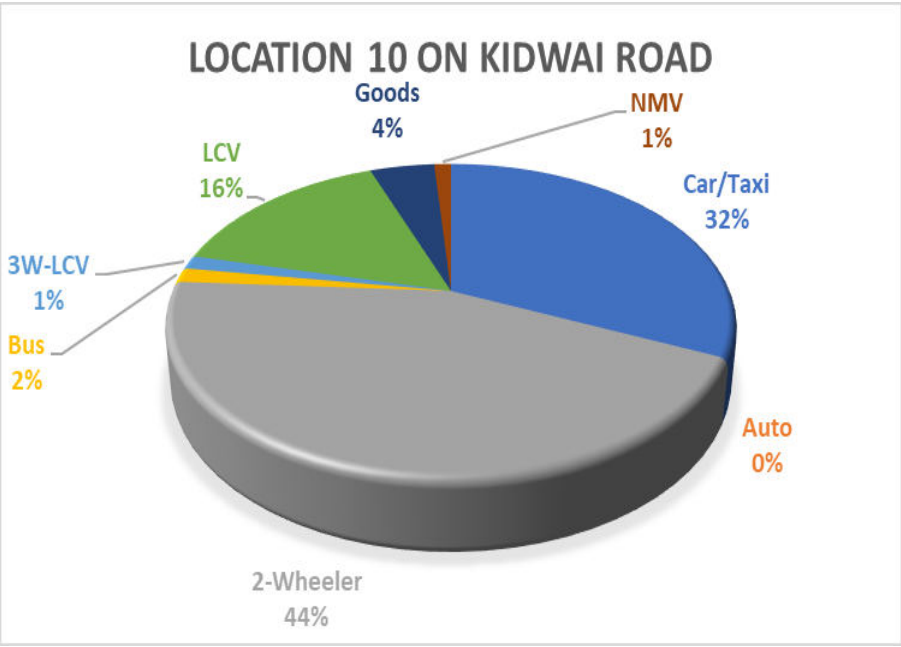


Figure 5. 14 Traffic Composition at TVC-10

It can be seen that two wheelers and Car/Jeep/Van/Taxi contribute to 44 percent and 32 percent respectively. On the other hand, buses contribute to 2.0 percent, while trucks constitute 21 percent in total traffic.

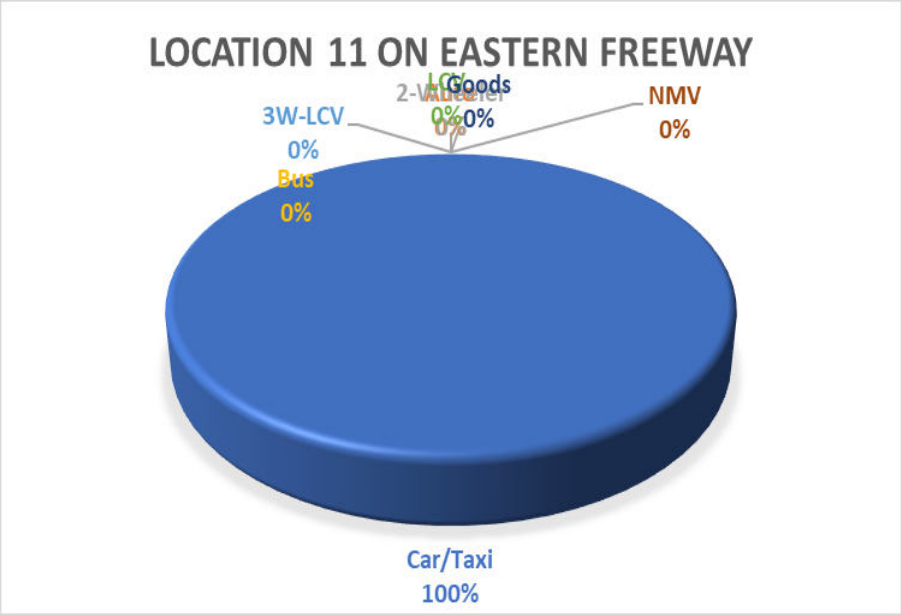


Figure 5. 15 Traffic Composition at TVC-11

It can be seen that Car/Jeep/Van/Taxi contribute to entire 100 percent.

5.3.3 Peak Hour Traffic

Peak Hour Traffic on the section is presented in **Table 5.7**.

Table 5. 7 Peak Hour Share at Project Road Sections

Location		ADT (PCUs)	Peak Hour Traffic (PCUs)	Peak Hour	Peak Hour Share (% to ADT)
TVC-1	Worli Bandra Sea link	10106	1275	11:00 to 12:00	12.62%
TVC-2	Near Elphinston Road Merchants Association	4655	523	19:00 to 20:00	11.23%
TVC-3	Elphinston RUB	49320	3234	18:00 to 19:00	6.56%
TVC-4	Near Damodar Hall	64811	3832	18:00 to 19:00	5.91%
TVC-5	Near Parel Police Chowky	16997	1716	17:00 to 18:00	10.10%
TVC-6	Near Wadia Hotel	31567	2163	17:00 to 18:00	6.85%
TVC-7	Near Thakare Udyan	11731	1119	14:00 to 15:00	9.54%
TVC-8	Near Tata Hospital	9859	888	17:00 to 18:00	9.01%
TVC-9	Near Sewri Hospital	13073	1061	11:00 to 12:00	8.11%
TVC-10	On Kidwai Road	39683	3015	17:00 to 18:00	7.60%
TVC-11	On Eastern Freeway	69825	5132	17:00 to 18:00	7.35%

The peak hour traffic is in the range of 5.91% to 12.62% in Average Daily Traffic. The peak hour is generally between 17:00 to 18:00 hours.

The maximum Peak Hour Traffic was observed at TVC-4 (3832 PCUs) i.e. about 5.91% in Average Daily Traffic during 18:00 to 19:00 hours.

The minimum Peak Hour Traffic was observed at TVC-2 (523 PCUs) i.e. about 11.23% in Average Daily Traffic during 19:00 to 20:00 hours.

5.3.4 Directional Distribution

The directional split of ADT showed that the flow in both the directions was evenly distributed on the section as shown in **Table 5.8**.

Table 5. 8 Directional Distribution of Traffic

Section	Location		Directional Split			Direction
Worli-Sewri Link road	TVC-1	Worli Bandra Sealink	58%	:	42%	Worli :Sewri
	TVC-2	Near Elphinstone Road Merchants Association	100%	:	0%	
	TVC-3	Elphinstone RUB	53%	:	47%	
	TVC-4	Near Damodar Hall	49%	:	51%	
	TVC-5	Near Parel Police Chowky	47%	:	53%	
	TVC-6	Near Wadia Hotel	34%	:	66%	
	TVC-7	Near Thakare Udyan	43%	:	57%	
	TVC-8	Near Tata Hospital	41%	:	59%	
	TVC-9	Near Sewri Hospital	47%	:	53%	
	TVC-10	On Kidwai Road	47%	:	53%	CST : Wadala
	TVC-11	On Eastern Freeway	49%	:	51%	

It is observed at TVC-2 i.e. Near Elphinstone Road Merchant Association, the traffic is one way from Worli to Sewri. For TVC-1 & TVC-2 directional split in percentage is 58:42 and 53:47 respectively. Whereas, towards Sewri the split changes in the range of 34%: 66% to 47%:53%. On Eastern Freeway, the traffic split in percentage is almost 49:51.

5.4 Seasonal Correction Factor (SCF)

To convert ADT to AADT the traffic in the month of the year in which survey is conducted is compared with the annual traffic to obtain the factor. This factor, termed as seasonality correction factor, is applied to the ADT to obtain the Annual Average Daily Traffic (AADT).

The seasonal correction factor is generally derived from secondary data sources such as past month wise traffic data on the project road, monthly toll revenue/toll traffic from

existing toll plazas or tolled bridges/highways in immediate influence highways, sale of motor fuel at different filling stations along the project highway, commercial check post entry data, etc.

Proxy for estimation of seasonality correction factor is the sale of monthly Petrol and Diesel at different filling stations along the project highway. Sale of motor fuel at different filling stations along the project highway was collected by the consultants.

For the present study the sale of motor fuel at different filling stations along the project highway was used to derive an appropriate seasonal correction factor for Passenger Vehicles and the goods vehicles was used to derive Seasonality Correction Factor.
The derived seasonal factors are detailed in **Table 5.9**.

Table 5. 9 Seasonal Factors

Month	Seasonal Factor	
	For Passenger Vehicles	For good vehicles
April	0.95	0.94
May	0.93	0.90
June	1.00	1.00
July	0.98	0.98
August	1.00	0.99
September	1.00	1.01
October	1.02	0.99
November	**1.05**	**1.08**
December	0.94	1.02
January	1.07	1.07
February	1.12	1.07
March	0.99	0.97

5.5 Average Annual Daily Traffic (AADT)

The Petrol is generally used by the Two Wheelers, Auto Rickshaw and part of Cars, whereas diesel is used by all buses, all commercial vehicles & part of Cars.
Considering the higher ratio of large vans among the cars, which use diesel, it is considered to apply seasonality factor based on combined Petrol and Diesel sales data for Passenger Vehicles and seasonality factor based on Diesel sales data for Goods Vehicles. Average Daily Traffic (ADT) was converted to Annual Average Daily Traffic (AADT) by applying seasonal correction factors.

Passenger Vehicles: 1.05

Goods Vehicles : 1.08

Summary of ADT and AADT on this project road is presented in **Table 5.10**.

Table 5. 10 Summary of ADT & AADT

Location No.		2 Wheelers	Car, Jeep, Taxi	3 Wheelers	Buses	Trucks	Cycles	Hand Cart / Animal Drawn	Total Vehicles	Total PCU
Location 1	ADT	4121	7865	20	33	61	20	2	12122	10106
	AADT	4327	8376	22	36	66	20	2	12848	10619
Location 2	ADT	2058	2576	20	285	102	68	6	5115	4655
	AADT	2161	2743	22	308	110	68	6	5418	4891
Location 3	ADT	25004	24667	187	728	2403	43	0	53032	49320
	AADT	26254	26271	202	787	2595	43	0	56151	51821
Location 4	ADT	30219	35672	326	866	1854	674	78	69689	64811
	AADT	31729	37990	352	936	2003	674	78	73763	68098
Location 5	ADT	5364	10031	185	927	781	224	6	17518	16997
	AADT	5632	10683	200	1001	843	224	6	18590	17859
Location 6	ADT	11254	20730	0	1273	628	22	36	33943	31567
	AADT	11816	22077	0	1375	679	22	36	36005	33167
Location 7	ADT	3718	7144	115	1044	441	152	0	12614	11731
	AADT	3904	7608	125	1127	477	152	0	13393	12326
Location 8	ADT	4949	4892	63	176	474	42	6	10601	9859
	AADT	5196	5210	68	191	512	42	6	11224	10359
Location 9	ADT	5895	7552	0	313	213	84	0	14058	13073
	AADT	6189	8042	0	338	230	84	0	14885	13736
Location 10	ADT	19966	13483	420	628	7712	359	102	42670	39683
	AADT	20964	14359	453	678	8329	359	102	45245	41695
Location 11	ADT	0	75081	0	0	0	0	0	75081	69825
	AADT	0	79961	0	0	0	0	0	79961	73366

5.6 Analysis of Major Intersection Turning Movement Data

These surveys were conducted at 2 junctions along the project corridor. The daily turning traffic at individual junctions is summarized in **Table 5.11** and daily traffic flow Diagrams in terms of PCU's is shown in **Figure 5.16 to Figure 5.17**. Data collected from survey was computerized and analysed to study hourly variation of traffic, peak hour share and modal composition at all the survey locations.

The maximum traffic has been observed at Junction of Bhoiwada (91,501PCU).

Table 5. 11 Summary of Traffic at Junctions

Location		Type	Daily Junction Volume**		Peak hour	Peak Hour PCU's
			Vehicles	PCU		
TMC-1	Bhoiwada Junction	5 Legged	91501	81290	19.00 - 20.00	9726
TMC-2	WorliBandra Sea Link Junction	T	72714	72140	17.00 - 18.00	6278

Note: ** Projected for 24 hrs

Traffic Composition

The composition of vehicles in the traffic stream at all the survey locations, **Table 5.12** brings out the following:

- Passenger vehicle category: Two wheelers constitute (17-37 per cent), cars constitute a major share of (45-81 per cent) while buses account for (1-3 per cent).
- Freight vehicle category : Trucks account for (01-14 percent).

Table 5. 12 Composition of Traffic (%)

Location		2 Wheelers	Car, Jeep, Taxi	3 Wheelers	Buses	Trucks	Cycles	Hand Cart	Total
TMC 1	Bhoiwada Junction	35.0%	59.2%	0.0%	2.4%	2.5%	0.9%	0.0%	100%
TMC 2	Worli Bandra Sea Link Junction	1.9%	98.0%	0.0%	0.1%	0.0%	0.0%	0.0%	100%

Composition of traffic observed at the count stations is presented in **Figure 2.16** to **Figure 2.17.**

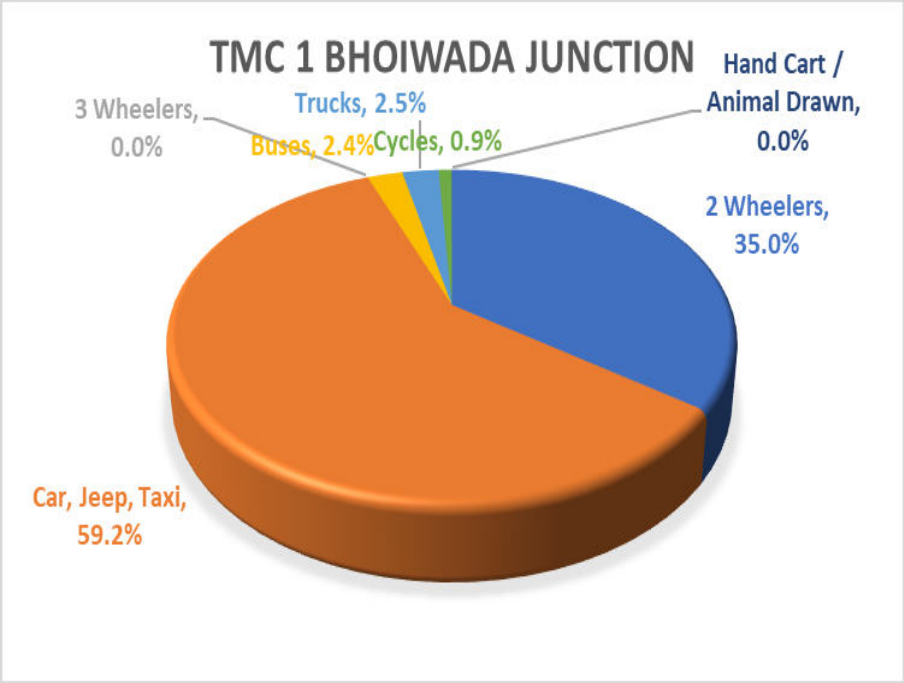


Figure 5. 16 Traffic Composition @TMC-1

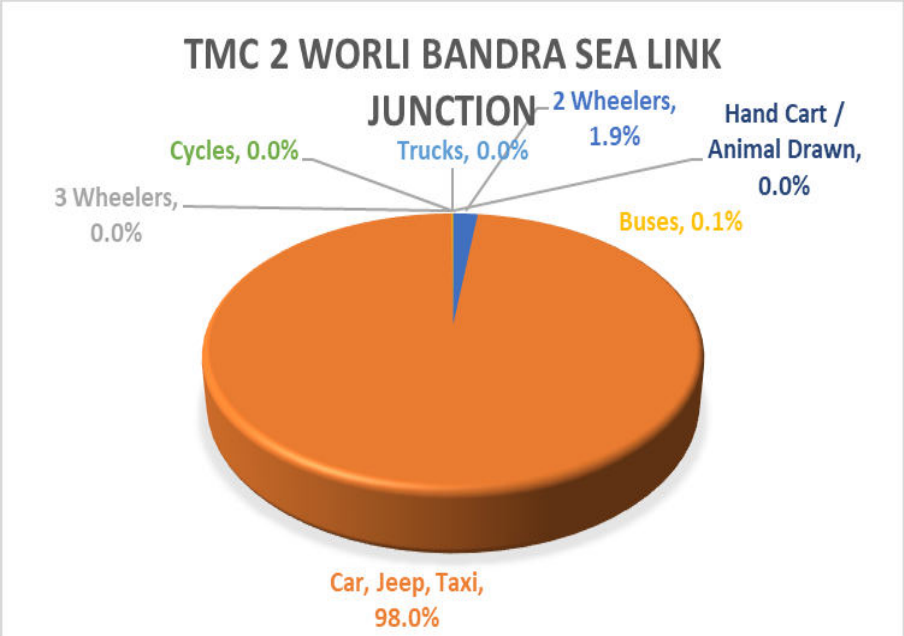


Figure 5. 17 Traffic Composition @TMC-2

The following figures show the flow diagrams for the Intersection Turning Movement count survey of 2 – Intersections.

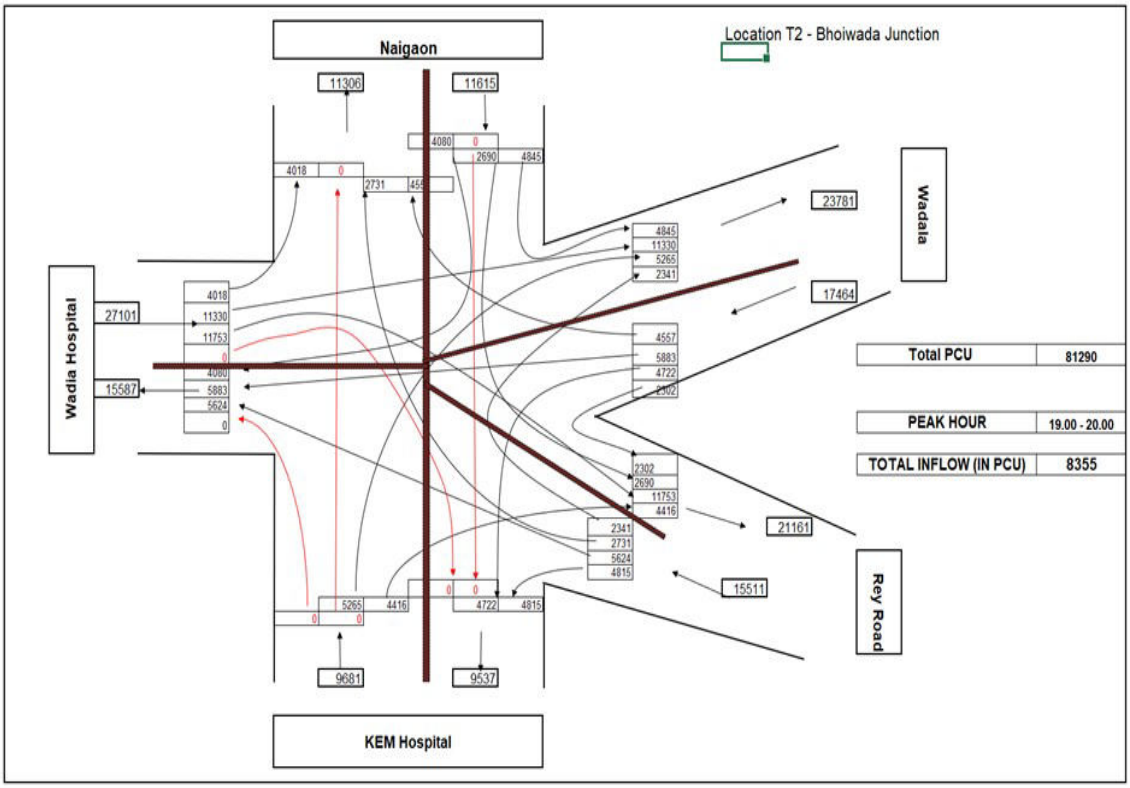


Figure 5. 18 TMC-1 (Daily Traffic in terms of PCUs)

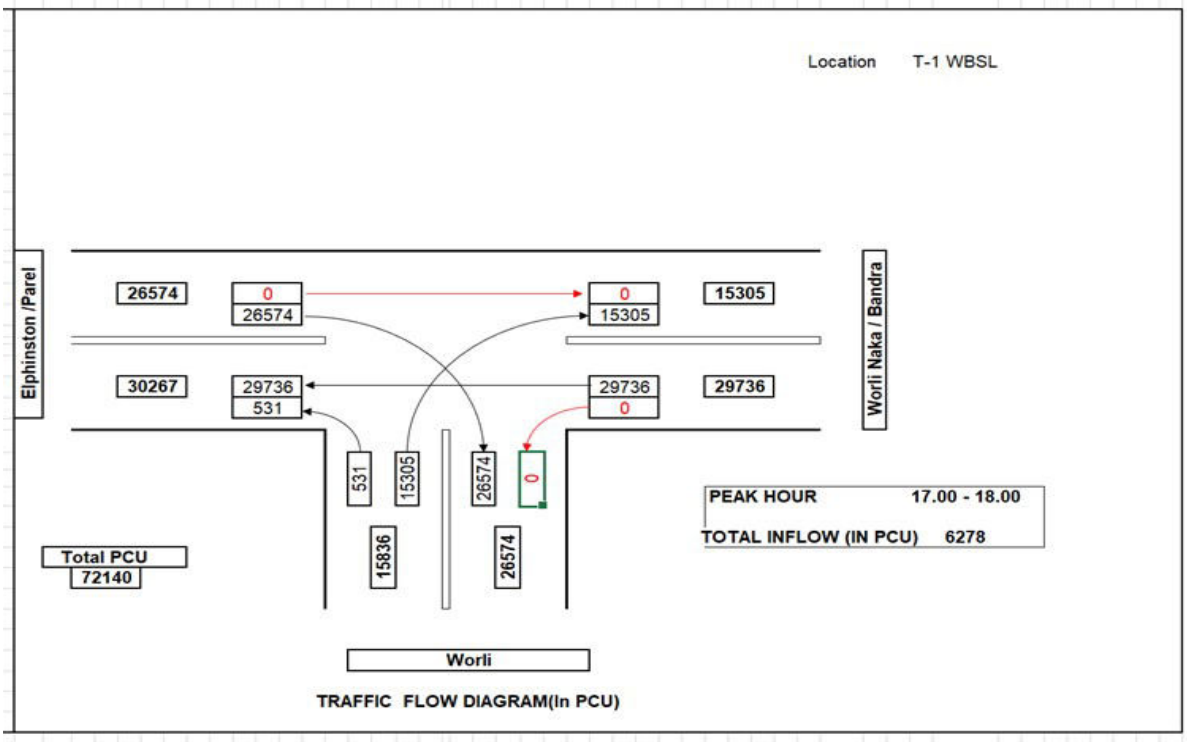
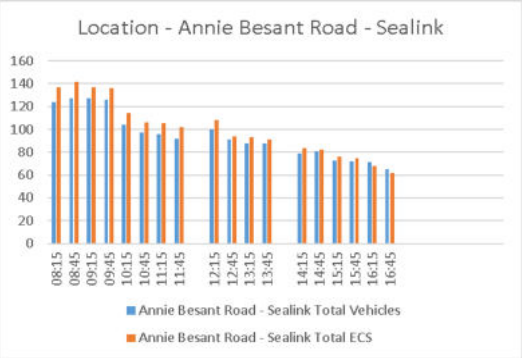


Figure 5. 19 TMC-2 (Daily Traffic in terms of PCUs)

5.7 Parking Survey

Parking surveys are intended to provide information on the parking demand, extent of the usage of parking facility and availability of parking space. In the present study, parking data was collected through out road which was divided into 5 sections. The surveys were conducted for 12 hours from 8:00am to 08:00pm. The parking characteristics have been analysed in terms of parking accumulation, composition of parked vehicles and parking duration. These are presented in below Figures & Table P1 to P5.



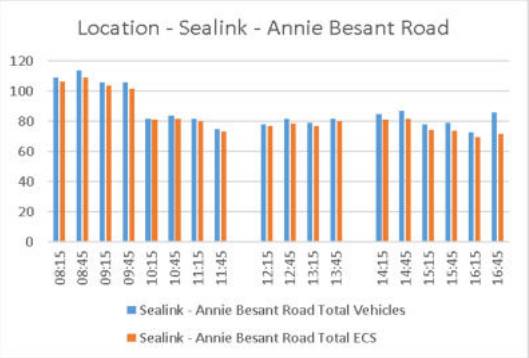


Table for P1- Annie Besant Road - Sealink

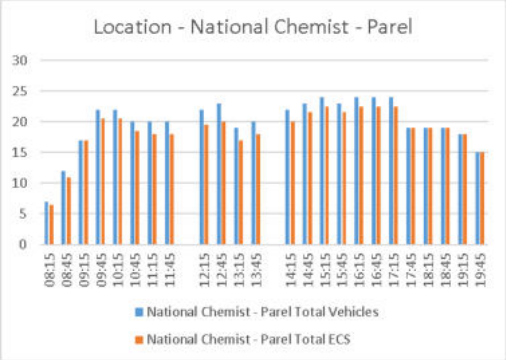
Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	127	141.5	24%	60%	16%	0%
12:00 to 14:00	100	108	23%	64%	13%	0%
14:00 to 16:00	79	83.5	23%	66%	11%	0%

Table for P1-Sealink - Annie Besant Road

Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	114	109	32%	60%	8%	0%
12:00 to 14:00	82	80	27%	66%	7%	0%
14:00 to 16:00	85	82	31%	62%	7%	0%

Maximum Parking Accumulation: The maximum accumulation generally occurs between 8:00 to 8:30 in the morning and between 4:30 to 5:00 in the evening period.

Composite of Parked Vehicles: Generally, on an average the four wheelers traffic constitute major share of parked vehicle.



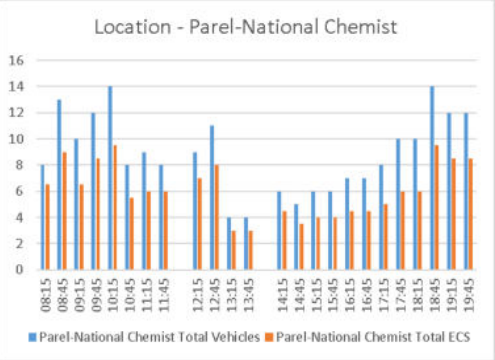


Table for P2-National Chemist - Parel

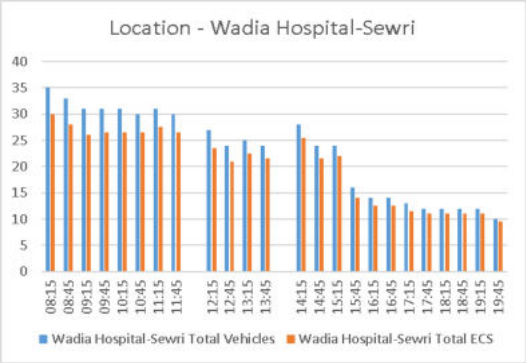
Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	22	20.5	14%	86%	0%	0%
12:00 to 16:00	24	22.5	13%	88%	0%	0%
16:00 to 20:00	24	22.5	13%	88%	0%	0%

Table for P2-Parel - National Chemist

Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	14	9.5	64%	36%	0%	0%
12:00 to 16:00	6	8	67%	33%	0%	0%
16:00 to 20:00	8	9.5	75%	25%	0%	0%

Maximum Parking Accumulation: The maximum accumulation generally occurs between 09:00 to 10:00 in the morning and between 6:30 to 7:00 in the evening period.

Composite of Parked Vehicles: Generally, on an average the four wheelers & two wheelers traffic constitute major share of parked vehicle.



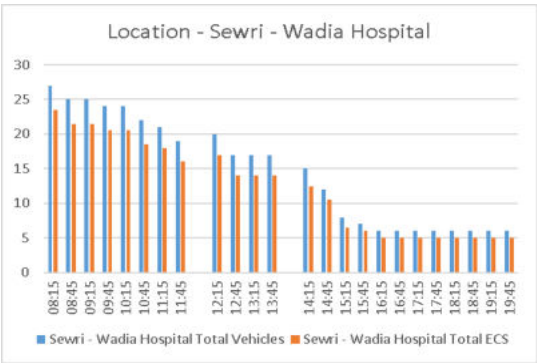


Table for P3-Wadia Hospital-Sewri

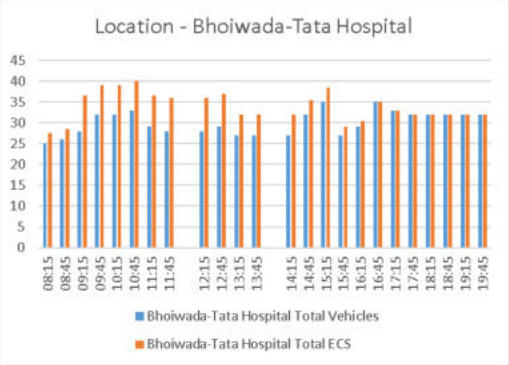
Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	32	40	22%	**56%**	22%	0%
12:00 to 16:00	35	38.5	23%	63%	14%	0%
16:00 to 20:00	33	35	27%	64%	9%	0%

Table for P3-Sewri-Wadia Hospital

Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep /Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	47	41	26%	74%	0%	0%
12:00 to 16:00	41	35.5	27%	73%	0%	0%
16:00 to 20:00	39	34.5	23%	77%	0%	0%

Maximum Parking Accumulation: The maximum accumulation generally occurs between 08:00 to 08:30 in the morning and between 2:00 to 2:30 in the evening period.

Composite of Parked Vehicles: Generally, on an average the two wheelers traffic constitute major share of parked vehicle.



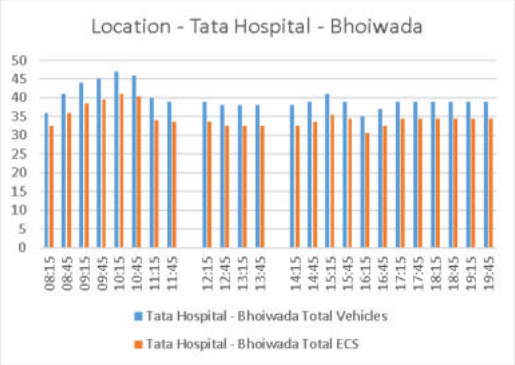


Table for P4-Bhoiwada-Tata Hospital

Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	32	40	22%	56%	22%	0%
12:00 to 16:00	35	38.5	23%	63%	14%	0%
16:00 to 20:00	33	35	27%	64%	9%	0%

Table for P4-Tata Hospital - Bhoiwada

Time Period	Max Vehicles	Max ECS	% Parked Vehicles			
			2 Wheeler	Car/Jeep/ Van/Taxi	Buses / Trucks	Other Slow Moving
8:00 to 12:00	47	41	26%	74%	0%	0%
12:00 to 16:00	41	35.5	27%	73%	0%	0%
16:00 to 20:00	39	34.5	23%	77%	0%	0%

Maximum Parking Accumulation: The maximum accumulation generally occurs between 10:00 to 10:30 in the morning and between 3:00 to 3:30 in the evening period. Composite of Parked Vehicles: Generally, on an average the four wheelers & two wheelers traffic constitute major share of parked vehicle.

Parking Stretch	Section of the exising Road	Space Occupied along the road (m)	Max parked vehicles during day	Space Occupied (m)
P1	Annie Besant Road - Sealink	1235	142	710
	Sealink - Annie Besant Road		127	635
P2	National Chemist - Parel	988	23	115
	Parel- National Chemist		14	70
P3	Wadia Hospital -Sewri	703	31	155
	Sewri - Wadia Hospital		24	120
P4	Bhoiwada-Tata Hospital	1691	35	175
	Tata Hospital - Bhoiwada		47	235

Parking is a serious issue in the study area and its management needs priority. Most sections of the SVP road experience heavy parking on both sides of the carriage way. The problem is more acute for a stretch between Central Railway R.O.B and VP road crossing. The parking consists mainly of 2-wheelers, cars, hand carts and light good vehicles. The two wheelers are even parked on the foot paths. There is double parking of vehicles along carriageway. A proper solution will have to be found out for regulating the parking.

5.8 Analysis of Major Intersection Turning Movement Data

Approach

Traffic movement on the sections project road as observed from OD surveys shows that, influence of Mumbai regions predominant. Accordingly, traffic projections have taken into consideration the transport demand arising out of future economic development in the contributing place of Mumbai region. Mumbai region is categorized in three distinct sub-

regions, namely, Mumbai Centre, Mumbai West and Mumbai East by the Motor Vehicle Department, Government of Maharashtra for easy bifurcation of vehicles registration.

Traffic forecast has been based on demand elasticity approach, wherein a relationship was established between traffic and socio-economic indicators. Traffic growth rates by vehicle type, for the project road corridor have been determined. The projection for future traffic involves critical analysis of some of the key Socio-economic indicators and the rate of change expected during the study period in the project influence area. These broadly include:

- Macro-Economic Scenario-Growth Rate(s) and Composition of Net State Domestic Product (NSDP)& Net District Domestic Product (NDDP), at the State and Project Influence Area (PIA level)
- PIA Economy, Sectoral Production and Potential
- PIA, Population and Urbanization
- Perspective Growth of PIA

The traffic growth rates established for this study are based on elasticity approach, wherein a relationship is established between traffic data and socio-economic indicators. The methodology thus adopted incorporates the perspective growth envisaged in the state economy and the changes in transport demand elasticities over a period as basic data input. It must be noted that the growth in agriculture and manufacturing sectors affect the growth of traffic in freight vehicles, while growth in income affects growth in passenger vehicles like two- wheelers, cars and buses. Traffic growth rates by vehicle type, for the project road corridor, have been determined for horizon years.

5.8.1 Past Trends in Traffic Growth & Economic Parameters

The trend growth rates for the vehicle registration data of Mumbai region, is worked out for various categories of vehicles. The trend analysis of vehicle registration data of Mumbai region gives the growth rates as presented below in **Table 5.13.**

Table 5. 13 Average Annual Growth Rates of Registered Vehicles in Mumbai Region

Regions	Average Annual Growth Rates (%) (Year 2004-05 to 2013-14)				
	Two Wheelers	Car/ Jeep/ Taxi	Auto	Bus	Goods Vehicle
1.Mumbai (Centre)	7.18	2.75	-	-2.64	-2.26
2.Mumbai (West)	9.02	9.63	0.92	6.93	5.08

Regions	Average Annual Growth Rates (%) (Year 2004-05 to 2013-14)				
	Two Wheelers	Car/ Jeep/ Taxi	Auto	Bus	Goods Vehicle
3.Mumbai (East)	9.67	8.30	0.50	5.26	3.59
Greater Mumbai Region (C+W+E)	**8.58**	**6.35**	**0.74**	**0.64**	**1.83**

Source: Several Years Reports of Motor Transport Statistics of Maharashtra, Motor Vehicle Department, Government of Maharashtra, Mumbai.

The trend growth rates of the economic parameters/variables namely NSDP/NDDP, PCI & Population is worked out for Mumbai region and the same has been presented below in **Table 5.14**:

Table 5. 14 Average Annual Growth Rates of Economic Parameters (%)

Vehicles Type	*Year 2004-05 to 2013-14* Mumbai Growth Rates (%)
NDDP	8.25
PCI	8.75
Population	0.82
Mnfctr + Agrcltr	N/A

Sources: Directorate of Economics and Statistics, Government of Maharashtra, Population Census, GoI & GoM, 2011 & 2001.N/A-Not Available.

5.8.2 Economic Perspective

The perspective growth rates for NSDP/NDDP are considered accordingly for the proposed project section road locations and reproduced in **Table 5.15**.

Table 5. 15 Perspective Annual Growth Rates of Mumbai& PIA in (%)

Period	Mumbai
Up to 2020	8.50
2020-2025	8.75
2025-2030	8.25
2030-2035	8.00
Beyond 2035	8.00

5.8.3 Transport Demand Elasticity

As stated earlier, we have used elasticity approach for determining the growth rates of future traffic. This involved establishing a quantitative relationship between traffic growth

as the dependent variable and growth in NSDP/NDDP or sectoral income, PCI and Population as the independent variable.

The analysis of the O-D survey data along the project corridor indicates a strong influence of Mumbai region in the traffic generation / attraction. As the traffic contribution is mainly from the districts of Mumbai regions, we have developed the transport demand elasticity's with respect to economic indicators of Mumbai. The methodology involved fitting log-log regression equations to the time series data. While PCI/NSDP/NDDP at constant prices is taken as independent variable for passenger vehicles, the combined income from agriculture and manufacturing is considered as independent variable for freight vehicles.

As regards the traffic data, we have used vehicle registration data of Mumbai region to determine the transport demand elasticity with respect to economic variables namely Per Capita Income (PCI), Net State Domestic Product (NSDP), Net District Domestic Product (NDDP) and Population for different categories of vehicles. Motor Cycles is based with PCI & Population, Cars/Auto/Bus is based with NSDP/NDDP & Population, and Trucks / Multi Axles is based on NSDP/NDDP. The following table gives the Independent Variable considered for estimating elasticity for different types of vehicles & combined Weighted Average. Elasticity values obtained are presented in **Table 5.16.**

Table 5. 16 Transport Demand Elasticities for Registered Vehicles (2004-05 to 2013-14)

Vehicle Type	Independent Variable	Combined with Weighted Average		
		Elasticity	R2	t-Statistic
Motor Cycles	PCI	**0.88**	0.82	6.12
	NDDP	1.00	0.98	20.02
	POPULATION	0.28	0.013	0.33
Cars	PCI	0.66	0.74	4.77
	NDDP	**0.78**	0.96	13.08
	POPULATION	0.39	0.04	0.59
Auto	PCI	**0.07**	0.53	3.00
	NDDP	0.21	0.69	4.26
	POPULATION	0.06	0.06	0.73
Buses	PCI	-0.07	0.13	-1.08
	NDDP	**-0.10**	0.25	-1.62

Vehicle Type	Independent Variable	Combined with Weighted Average		
		Elasticity	R2	t-Statistic
	POPULATION	-0.14	0.09	-0.91
Trucks/ M. Axles	NDDP	**0.05**	0.024	0.44
	Mnfctr + Agri.	0.00	0.00	0.00

The projected elasticity values adopted in the study are presented below in **Table 5.17.**

Table 5. 17 Projected Transport Demand Elasticities

(at Mumbai)

Period	T/W	Auto	Car	Bus	LCV	2AT	3AT	MAV
Up to 2020	0.94	0.72	0.11	-0.08	0.05	0.04	0.05	0.05
2020-2025	0.92	0.70	0.09	-0.10	0.03	0.02	0.03	0.03
2025-2030	0.87	0.65	0.04	-0.15	-0.02	-0.03	-0.02	-0.02
2030-2035	0.82	0.60	-0.01	-0.20	-0.07	-0.08	-0.07	-0.07
Beyond 2035	0.77	0.55	-0.06	-0.25	-0.12	-0.13	-0.12	-0.12

5.8.4 Projected Traffic Growth Rates

The projected rates of growth of traffic are based on projected vehicular elasticities and economic perspective of the PIA. The growth of passenger modes and goods modes are based on the respective vehicular elasticities and the perspective growth of the Mumbai. Prediction of the future growth accurately is difficult because of the various parameters affecting growth. Based on the experience in similar projects, two more growth scenarios have been considered for studying the impact on the traffic growth rates:

- *Low Growth Rates-Pessimistic Scenario (15% less growth than Normal scenario)*
- *High Growth Rates-Optimistic Scenario (7.5% more growth than Normal scenario)*

The projected annual average rates of growth for different modes of vehicles are presented below in **Table 5.18**.

Table 5. 18 Traffic Growth Rates

Period	T/W	Auto	Car	Bus	LCV	2AT	3AT	MAV
Normal Growth Scenario								
Up to 2020	4.6	4	5.1	4.9	4	3.2	4.1	4.1
2020-2025	4.6	4	5.1	4.9	4	3.2	4.1	4.1
2025-2030	3.9	3.4	4.5	4.2	3.4	2.6	3.5	3.5
2030-2035	3.5	3	4	3.7	2.9	2.2	3	3
Beyond 2035	3.1	2.6	3.6	3.4	2.6	1.9	2.7	2.7

5.9 Traffic Forecast on Sewri Worli link

The proposed Worli-Sewri Link will be a fast / direct West East connection between the proposed coastal road and MTHL. It will start from Worli where a connecting dispersal arm is proposed from Coastal road and will connect MTHL at Sewri in BPT area with alternative junction arrangements of direct ramps.

In between these two ends it will follow a path across the areas of Worli (West), Lower Parel, Elphiston Bridge, Parel T.T., KEM Hospital and Sewri. As a result, the proposed link will serve these important areas of contral Mumbai and help the traffic to approach either Western Freeway or MTHL.

5.9.1 The sections of Worli – Sewri Link

Looking to the Land use pattern and existing arterial road network it is considered appropriate to divide the Link into following sections (from West to East) as under :

Section 1: From Worli Bandra Sea Link upto Annie Besant Road

Section 2: From Annie Besant Road to Senapati Bapat Marg.

Section 3: From Senapati Bapat Marg to Ambedkar Road

Section 4: From Ambedkar Road to R. A.Kidwai Road (or MTHL)

5.9.2 Approach to traffic forecast

1. Irrespective of whether the Worli – Sewri Link will be fully elevated or full underground or partially Elevated and underground it is presumed that there will be some form of access to the Link at these 3 points namely Annie Besant Road, Senapati Bapat Marg and Ambedkar Road either direct or indirect.
2. Some portion of the traffic from Western Freeway coming on the worli Approach will have destination in the city area and some traffic will travel directly up to MTHL.
3. Similarly some portion of the traffic coming from MTHL and approaching Acharya Donde Marg will have O / D in intervening areas and some traffic will travel directly to Western Freeway.
4. In addition there will be some diversion from traffic on the existing East-West roads, to the proposed Worli-Sewri Link.
5. This diversion will mainly be of Cars / Taxies, Buses and LCVs as Heavy good vehicle will not be allowed on the Link.

5.9.3 Estimate of traffic to/from Western Freeway at Worli

The projected turning movement traffic at the proposed interchange at Worli has been given in the Figure 5.20 below.

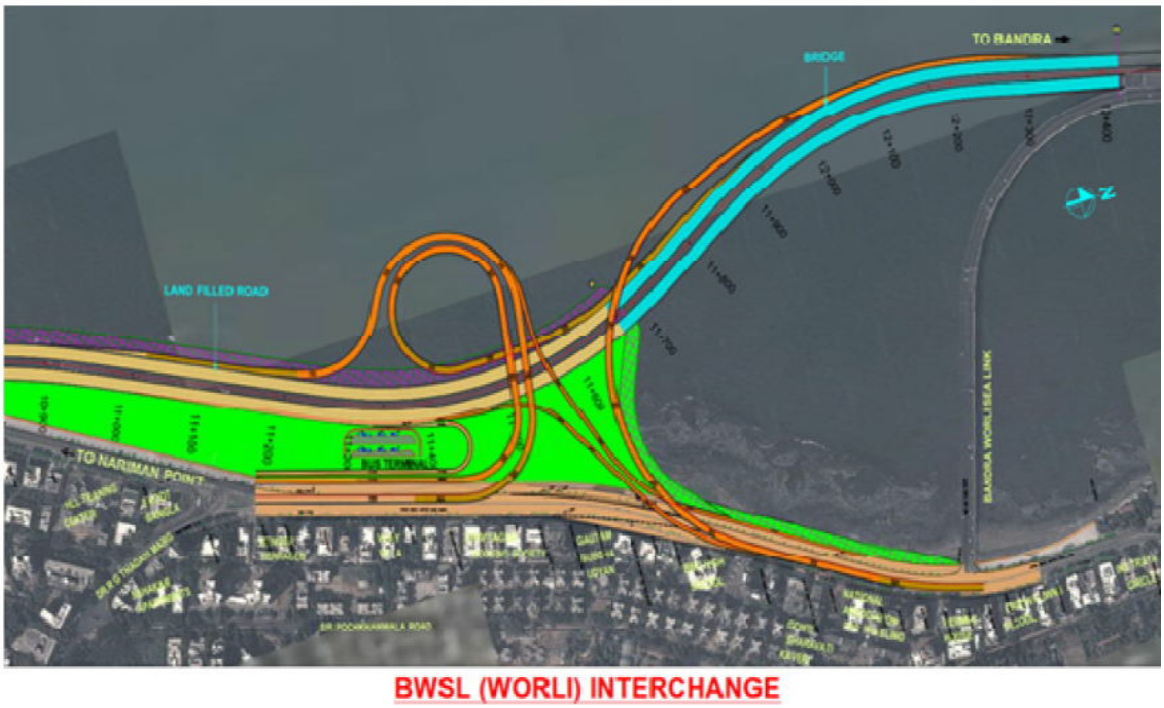


Figure 5. 20 BSWL (Worli) Interchange

5.9.4 Traffic from MTHL

In the previous chapter no 4 the traffic which will be destined to Worli-Sewri link was estimated. It will consist of direct traffic to and from MTHL as well as traffic to and from other connecting links like Eastern Freeway, R.A Kidwai road. The diagram is reproduced below at Figure no. 5.21.

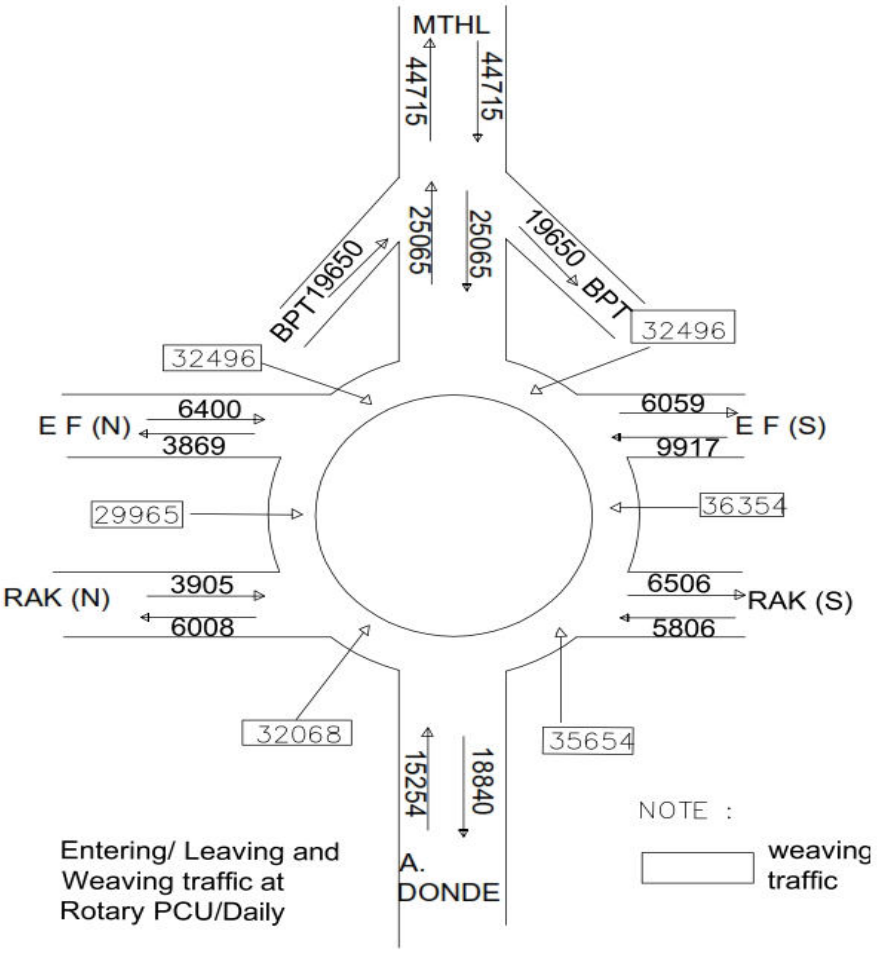


Figure 5. 21 Diagram

5.9.5 Section wise Traffic both from Coastal Road and MTHL

It is obvious that some traffic destined from/to both Western Freeway and MTHL will travel to / from respective sections. The destination of the traffic to different sections depending upon the vehicle category was estimated. Accordingly the traffic from Coastal Road and MTHL was assigned to different sections. The table 5.19 below show, the assigned traffic to different sections for the year 2021.

Table 5. 19 Section wise Traffic

Section	Vehicles				Total Vehicles	Total PCUs
	Cars from Western Highway (BWSL)	Cars from MTHL	Buses from MTHL	LCV from MTHL		
1	4912	7250	0	0	12162	12162
2	4366	10875	270	543	16054	16866
3	3821	14500	540	1629	20490	22384
4	3275	18125	1350	2715	25465	29522

5.9.6 Diverted traffic from Existing roads

As part of traffic surveys 24 hour Mid block counts were carried out at different locations on existing roads. For estimating the diversion the traffic counts from relevant location were considered. These are as under:

For section 1 – Relevant Location -TMC 1

Section 2 – (No relevant location)

Section 3 - (Relevant location- TMC 4)

Section 4 - (Relevant location -TMC 6)

Thus the 24 hour traffic on the existing roads was taken as basis for diversion. It was further estimated that about 7.5 % of existing traffic in relevant category will be diverted. Thus the section wise diverted traffic for the year 2017 was worked out as first step. It may be noted that section 2 of the alignment passes through open space and thus there is no question of diversion.

As the Link is expected to be operational is that year. The section wise diverted traffic for the year 2021 was estimated applying the appropriate growth factor and is given in the table 5.20 below.

Table 5. 20 Diverted Traffic

Link Sections	Year 2021				
	Diverted Traffic				
	Car/Taxi	Buses	Trucks	Total Vehicles	Total PCUs
1	3255	5	5	3266	3287
2	0	0	0	0	0
3	2995	74	156	3224	3684
4	1740	108	53	1901	2223

5.9.7 Total section wise traffic

The total section wise traffic will be the sum of assigned traffic from Western Freeway and MTHL as well as diverted traffic. This traffic for the year 2021 is presented in table 5.21 below

Table 5. 21 Total section wise traffic

Year 2021		
Link Sections	**Total Vehicles**	**Total PCUs**
1	15428	15449
2	16054	16866
3	23714	26068
4	27366	31746

5.9.8 Traffic projection for future years

The section wise estimated traffic of 2021 needs to be projected for future years. For this purpose the estimated traffic projections given in the latest DPR report for MTHL were considered as base and the simple annual growth rate for the period 2021-26, 26-31, 31-36, 36-41 have worked out for traffic component other than HMV and MAV. These growth rates were applied to estimate section wise future traffic. The projected section wise traffic for future years are presented table 5.22 below

Table 5. 22 Traffic Projection

Year 2021		Year 2026	Year 2031	Year 2036	Year 2041
Total Vehicles	**Total PCUs**	**Total PCUs**	**Total PCUs**	**Total PCUs**	**Total PCUs**
15428	15449	19252	22865	26507	29990
16054	16866	21018	24963	28939	32741
23714	26068	32486	38583	44728	50606
27366	31746	39561	46986	54470	61627

5.10 Capacity Analysis & Lane Requirement

5.10.1 Capacity Guidelines

Capacity analysis is the fundamental aspect of planning, design and operation of roads, and provides among other things, the basis for determining the carriageway width to be provided with respect to the volume and composition of traffic. Capacity of multi-lane (more than 2-lane) rural roads is more crucial in the design of carriageway, as there are no sufficient IRC guidelines on the same. Consultants have rationally worked out the capacity of 4/6 lane divided carriageways based on the guidelines / methods given by Indian Roads Congress (IRC) and Highway Capacity Manual (HCM).

Indian Roads Congress (IRC) has recommended capacity values for various lane configurations in IRC: 64-1990: Guidelines for Capacity of Roads in Rural Areas.

5.10.2 Recommended Design Service Volume for Multi-Lane Roads by IRC

IRC has recommended tentatively, a daily capacity of 70,000 PCUs for four-lane divided carriageways located in plain terrain (In absence of sufficient information about the capacity of multi-lane roads under mixed traffic conditions). This capacity will be applicable if the carriageway has reasonable good earthen shoulders on the either side, and a minimum 3.0 m wide central verge.

Provision of hard shoulders on dual carriageways can further increase the capacity. In case well designed paved shoulders of 1.5 m width are provided, the daily capacity of four-lane dual roads can be taken up to 80,000 PCUs. Consultants have calculated the Design Service Volume for various Levels of Service and presented in Table 5.23.

Table 5. 23 Maximum Design Service Volume in PCUs/day for Four-Lane Highways at various levels of service

Criteria	Level of Service				
	A	B	C	D	E
Max V/C Ratio	0.35	0.50	0.70	0.85	1.00
Max. Design Service Volume : (PCUs/day) 4-Lane Divided Carriageway	28,000	40,000	56,000	68,000	80,000

5.10.3 Highway Capacity Manual

Maximum Service Flow Rates at different Levels-of-Service calculated based on HCM guidelines for multi-lane highways are presented in Table 5.24.

Table 5. 24 Maximum Service Flow Rates in PCUs/day for Multi-Lane Highways at various levels of service

Criteria	Level Of service				
	A	B	C	D	E
Max V/C Ratio – HCM	0.28	0.41	0.59	0.81	1
Design Service Volume*: 4-Lane Divided Carriageway	35,448	51,906	74,694	1,02,546	1,26,600
6-Lane Divided Carriageway	53,200	77,900	1,12,100	1,53,900	1,90,000

Note: Design Service Volume is equivalent term for Max. Service Flow Rate used in HCM*

5.10.4 ADB Guidelines

ADB has recommended the following capacity standards (ADB III Road Project Guidelines) for different lane configurations:

Single Lane with earthen Shoulders : 6,000 PCUs/day

Two Lane Carriageway with earthen Shoulders : 30,000 PCUs/day

Two Lane Carriageway with Paved Shoulders : 35,000 PCUs/day

Four Lane Divided Carriageway with Earthen Shoulder : 1,00,000 PCUs/day

Four Lane Divided Carriageway with Paved Shoulder : 1,10,000 PCUs/day

The Service Flow Rate for various Levels of Service are calculated and presented in Table 5.25.

Table 5. 25 Service Flow Rate in PCUs/Day, Calculated from ADB Guidelines on Capacity Standards

Criteria	Level-of-Service				
	A	B	C	D	E
Max V/C Ratio	0.35	0.50	0.70	0.85	1.00
4-Lane Divided Carriageway with Paved Shoulder	38,500	55,000	77,000	93,500	1,10,000

Maximum Service Flow Rate calculated based on the IRC, HCM and ADB guidelines, as discussed and calculated above are presented in **Table 5.26 and Table 5.27** for comparison purpose.

Table 5. 26 Service Flow Rate in PCUs/Day for 4-Lane Divided Carriageway, Calculated based on IRC, HCM and ADB Guidelines

Criteria	Level of Service				
	A	B	C	D	E
Max V/C Ratio	0.35	0.50	0.70	0.85	1.00
IRC	28,000	40,000	56,000	68,000	80,000
HCM	44,310	63,300	88,620	1,07,610	1,26,600
ADB Guidelines	38,500	55,000	77,000	93,500	1,10,000

Table 5. 27 Service Flow Rate in PCUs/Day for 6-Lane Divided Carriageway, Calculated based on IRC, HCM and ADB Guidelines

Criteria	Level of Service				
	A	B	C	D	E
Max V/C Ratio	0.35	0.50	0.70	0.85	1.00
IRC	--	--	--	--	--
HCM	66,500	95,000	1,33,000	1,61,500	1,90,000
ADB Guidelines	--	--	--	--	--

5.10.5 Adopted Criteria for Lane Requirement

After reviewing the Indian Roads Congress (IRC), Highway Capacity Manual (HCM) and ADB Guidelines, Consultants have adopted the criteria, which suits to the multi-lane highway in Indian traffic conditions, and the same is presented in **Table 5.28**.

Table 5.28 Criteria for Lane Requirement (PCUs per Day)

Criteria	Level of Service				
	A	B	C	D	E
Max V/C Ratio-Adopted *	0.35	0.50	0.70	0.85	1.0
Design Service Volume					
2-Lane Carriageway	22190	31700	44380	53890	63400
4-Lane Divided Carriageway	44,310	63,300	88,620	1,07,610	1,26,600
6-Lane Divided Carriageway	66,500	95,000	1,33,000	1,61,500	1,90,000
8-Lane Divided Carriageway	88,690	126,700	1,77,380	2,15,390	2,53,400
10-Lane Divided Carriageway	1,18,280	1,68,980	2,36,570	2,87,260	3,37,960

5.10.6 Lane Requirement

Even though the elevated road is an urban facility, we are adopting the capacity standards worked out for highway on daily capacity basis. Taking in to account the projected demand on proposed east-west Elevated road presented para 3.13. and the adopted capacities for a four lane road given table 5.29. The lane requirement for east-west road for future years is presented in table 5.29 below.

As per IRC guidelines for Urban roads the Level of Service “C” is to adopted for selecting the Capacity as base and then decide the appropriate lane requirement.

Table 5. 29 Year wise Lane Requirement

Project Road Sections	2021		2026		2031		2036		2041	
	PCUs	Lanes	PCUs	Lanes	PCUs	Lanes	PCUs	Lanes	PCUs	Lanes
	31746	2	39561	2	46986	4	54470	4	61627	4

5.10.7 Recommendation

It may be observed from the above table that for section 1 and section 2 of the Worli-Sewri Link 2 lanes are sufficient to cater to the projected traffic upto future period till 2041 and beyond. However, for section 3 the lane requirement is 4 from the year 2036 and for section 4 the lane requirement is 4 lanes from the year 2031.

In order to maintain consistency in lane widths and to allow for unforeseen traffic growth it is recommended to adopt 4 lane width for entire section of the link right from the beginning.

CHAPTER - 5
ENGINEERING SURVEYS & INVESTIGATION

CHAPTER – 6
ENGINEERING SURVEYS & INVESTIGATION

6.0 ENGINEERING SURVEYS AND INVESTIGATIONS

6.1 General

As per requirements of the study, the Consultants had carried out different types of field studies, engineering surveys and investigations to gather data and information necessary for DPR Study. The aim of the investigations was to develop an adequate supportive database for selecting and preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The engineering investigations and surveys have been carried out in line with the specifications laid out in IRC-SP-19-2001 and IRC-SP-54-2000. The major aspects of surveys and investigations relevant to the present DPR cover the following:

Topographic Survey

- Fixing of GPS pillars and Benchmark pillars
- Carrying the benchmark levels from GTS benchmarks
- Traversing to transfer the coordinates to traverse stations
- Collecting the details and making drawing.
- Data processing and drawing in presentable format and checking at site.

Road Inventory and Road condition Survey

- Carriageway type/width (m)
- Land use and road side environment
- Right of way details
- Intersections and Junctions
- Geometric (Horizontal and Vertical)
- Data collection for Road structural distresses

Bridge Inventory and Bridge condition Survey

- Bridge type/category/width (m)
- Spanning
- Foundation/Substructures/Superstructure details
- Structural distresses and overall condition

Pavement Surveys and Investigations

- Pavement condition survey
- Pavement structural evaluation
- Pavement composition

- Subgrade characteristics and strength

Traffic

- Classified traffic volume count
- Turning movement count
- Intersection count
- Origin & Destination survey
- Axle loading spectrum

Drainage

- Inventory of cross drainage works and bridges
- Rain Drainage/Road surface drainage
- Condition and structural adequacy
- Hydraulic adequacy
- Road-side drainage

Soil and Material Investigations

- Borrow areas for locating suitable soils for use in embankment and sub-grade.
- Characteristics of road bed soil.
- Quarries for locating hard stone/granular materials for use in sub bases/ bases, bituminous mixes and concrete works
- Source of sand for use in DBM/BC layers and cement concrete works

Geotechnical Investigations

- Field Study.
- Standard Penetration Testing
- Groundwater Measurement

The data regarding the above aspects are required for the design and to establish the economic viability. The consultants carried out both "Secondary" and "Primary Surveys" for the Study. The Secondary Surveys covers the collection and compilation of the data so to assimilate the available information regarding the Project Road. The Primary Surveys were carried out to determine the current scenario and also to augment the available information. The analysis of available data was also useful while planning "Primary Surveys".

This chapter presents the findings of the field studies concerning road inventory, pavement investigations and analysis, bridge and cross drainage inventory and cross-drainage condition and interpretation of data. The basic data and results of investigation are compiled.

6.2 Topographic Surveys

6.2.1 General

Surveys and investigations form the backbone of any Project study. The primary data collected from the site not only provides a good picture of the site conditions, but also gives a good insight about the deficiencies and the scope for improvements. The primary data coupled with the good engineering acumen would lead to giving apt and economical recommendations for the improvements.

The material investigations for road construction have been carried out to identify the potential source of construction materials and to assess their general availability, nature and quantum of materials available for the project. This is one of the most important factors for stable, economic and successful implementation of the project within the stipulated time frame.

The prescribed engineering surveys and investigations have been carried out on the Project Road conforming to MORTH/IRC/BIS Specifications/Codes as per TOR to generate adequate database for preparing the most appropriate proposal. Following are the various engineering surveys and investigations carried out for the project.

The Consultants have undertaken topographical and preliminary material, geotechnical investigation, Pavement and cross drain condition surveys and Hydraulic surveys.

6.2.2 Methodology of Topographical Survey

The Topographical survey for Road was carried out in four ways

1. Horizontal Control Point
2. Horizontal Sub control Points
3. Vertical Control Points.
4. Detail Engineering Survey

6.2.3 Horizontal Alignment Framework

The topographical survey was carried out using Total Stations, DGPS and Auto Levels. The Basically Main frame works, Control point for Horizontal plane as well as Vertical plane have established using DGPS at every 3 kms. This is very useful to carry out close traverse and error distribution in horizontal plane. These control points were established on permanent structures available along the proposed corridor. These points were established in Zig–Zag manner at every 2 km Intervals. The following Table 6.1 presents list of DGPS control points.

Table 6. 1 Details of DGPS Control Points

ID	Easting	Northing	Elevation
A1	274058.002	2101822.275	5.663
A2	274149.094	2102034.979	5.720
A3	274044.866	2101695.556	5.834
A4	272825.064	2102620.417	8.955
A5	272804.093	2102595.891	8.774
A6	272720.849	2102723.460	7.044
A7	272618.439	2102801.521	6.307
B1	274006.996	2102020.019	6.553
B2	273994.628	2101871.122	6.610
B3	273961.585	2102000.010	11.718
B4	273690.402	2102040.748	12.089
B5	273502.768	2102151.561	23.045
B9	271915.408	2103259.150	4.426
B10	271861.105	2103192.303	4.586
B11	271663.929	2103196.282	4.553
B12	271662.464	2103249.850	4.559
B13	270293.662	2104020.896	7.711
B14	270363.993	2104055.374	7.110
B15	270469.906	2103951.768	6.483
B16	270600.207	2103782.523	6.452
B17	270668.441	2103661.514	6.317
B18	270711.551	2103569.658	6.497
B19	270928.129	2103686.530	5.745
B20	271463.688	2103530.515	4.649

Horizontal Sub control Points-

The Horizontal sub control points are the secondary control which was established in the frame of main control. The error is least minimized in this process. By using this horizontal sub control points further detail engineering survey work preceded without any error .The work in particular frame is based on individual sub control point. These points were established in Zig –Zag manner at every 200 meter to 250 meter Intervals. The following Table 6.2 presents list of Total station sub- control points.

Table 6. 2 Table Details of Sub-control points

ID	Easting	Northing	Elevation
A1	274058.002	2101822.075	5.663
S1	274089.390	2101864.355	6.585
S10	273400.932	2102196.454	17.099
S104	20480.020	23185.736	8.051
S11	273267.506	2102283.540	17.681
S11	273267.506	2102283.540	17.681
S12	273139.811	2102348.978	15.252

ID	Easting	Northing	Elevation
S13	273024.210	2102408.233	12.816
S14	272875.102	2102550.894	9.259
S15	272824.168	2102632.729	7.928
S16	272780.497	2102681.243	7.611
S17	272720.489	2102733.192	6.872
S18	272618.357	2102796.983	6.195
S19	272257.944	2103025.044	10.903
S2	274105.745	2101898.349	6.713
S20	272176.901	2103081.273	10.717
S21	271911.396	2103256.293	4.241
S22	271693.813	2103248.086	3.969
S23	271641.440	2103253.582	4.287
S24	271589.334	2103272.132	4.127
S3	274014.079	2101941.215	6.326
S4	274015.126	2101992.435	6.451
S5	273974.818	2101996.087	12.003
S6	273962.331	2101995.802	11.597
S7	273791.113	2102020.050	12.024
S8	273670.118	2102053.046	12.353
S9	273532.397	2102137.192	15.066
1	274044.867	2101695.591	5.791
2	274044.867	2101695.579	5.790
3	274149.057	2102034.919	5.724
4	274058.001	2101822.073	5.669
5	274006.926	2102019.952	6.550
6	274040.457	2102056.552	8.053
7	273961.471	2101999.960	11.635
8	273690.375	2102040.543	12.001
9	273303.465	2102243.854	18.201
10	272824.207	2102618.626	8.774
11	272803.286	2102594.028	8.546
12	272719.725	2102721.336	6.829
13	272617.112	2102799.114	6.172
14	271988.598	2103208.089	4.701
15	271912.828	2103254.447	4.185
16	271858.774	2103187.437	4.305
17	271693.805	2103248.087	3.969
18	271659.978	2103244.310	4.229
19	271661.602	2103190.688	4.199

6.2.4 Vertical Alignment Framework

This is establishment of bench marks carried out from GTS bench mark within overall road stretch by using GPS cross verified with auto level instrument. In this process levels

obtained by DGPS is cross-verified by auto level instrument. This bench mark frame work TBM`s are base points for each and every Z value. The manual and instrumental error is eliminated in this actual cross verification Process. The points were established at DGPS control and sub control points established along the proposed corridor. Apart from that levels revised through auto level values of' "Z" connected with All Control and Sub control points. These points were established in Zig –Zag manner at every 200 meter to 250 meter Intervals. In short, every control and sub control point acts as TBM. The list of Bench Marks on Project Corridor has been presented in Table 6.3

Table 6. 3 Details of TBM list

ID	Easting	Northing	Elevation
A1	274058.002	2101822.275	5.663
A2	274149.094	2102034.979	5.720
A3	274044.866	2101695.556	5.834
A4	272825.064	2102620.417	8.955
A5	272804.093	2102595.891	8.774
A6	272720.849	2102723.460	7.044
A7	272618.439	2102801.521	6.307
B1	274006.996	2102020.019	6.553
B2	273994.628	2101871.122	6.610
B3	273961.585	2102000.010	11.718
B4	273690.402	2102040.748	12.089
B5	273502.768	2102151.561	23.045
B9	271915.408	2103259.150	4.426
B10	271861.105	2103192.303	4.586
B11	271663.929	2103196.282	4.553
B12	271662.464	2103249.850	4.559
B13	270293.662	2104020.896	7.711
B14	270363.993	2104055.374	7.110
B15	270469.906	2103951.768	6.483
B16	270600.207	2103782.523	6.452
B17	270668.441	2103661.514	6.317
B18	270711.551	2103569.658	6.497
B19	270928.129	2103686.530	5.745
B20	271463.688	2103530.515	4.649
A1	274058.002	2101822.075	5.663

ID	Easting	Northing	Elevation
S1	274089.390	2101864.355	6.585
S10	273400.932	2102196.454	17.099
S104	20480.020	23185.736	8.051
S11	273267.506	2102283.540	17.681
S11	273267.506	2102283.540	17.681
S12	273139.811	2102348.978	15.252
S13	273024.210	2102408.233	12.816
S14	272875.102	2102550.894	9.259
S15	272824.168	2102632.729	7.928
S16	272780.497	2102681.243	7.611
S17	272720.489	2102733.192	6.872
S18	272618.357	2102796.983	6.195
S19	272257.944	2103025.044	10.903
S2	274105.745	2101898.349	6.713
S20	272176.901	2103081.273	10.717
S21	271911.396	2103256.293	4.241
S22	271693.813	2103248.086	3.969
S23	271641.440	2103253.582	4.287
S24	271589.334	2103272.132	4.127
S3	274014.079	2101941.215	6.326
S4	274015.126	2101992.435	6.451
S5	273974.818	2101996.087	12.003
S6	273962.331	2101995.802	11.597
S7	273791.113	2102020.050	12.024
S8	273670.118	2102053.046	12.353
S9	273532.397	2102137.192	15.066
1	274044.867	2101695.591	5.791
2	274044.867	2101695.579	5.790
3	274149.057	2102034.919	5.724
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7	273961.471	2101999.960	11.635
8	273690.375	2102040.543	12.001

ID	Easting	Northing	Elevation
9	273303.465	2102243.854	18.201
10	272824.207	2102618.626	8.774
11	272803.286	2102594.028	8.546
12	272719.725	2102721.336	6.829
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14	271988.598	2103208.089	4.701
15	271912.828	2103254.447	4.185
16	271858.774	2103187.437	4.305
17	271693.805	2103248.087	3.969
18	271659.978	2103244.310	4.229
19	271661.602	2103190.688	4.199

6.2.5 Utility Surveys

The details of existing underground utility services, likely to be affected due to the proposed Project segments are collected from various agencies operating/maintaining these utilities and will be examined for conflict with the proposed Elevated Road Structure and relocation has suggested wherever the situation demands with on-site protection measures. The proposed road corridor are elevated, however no need to shift utilities for whole length. After finalizing the location of Piles, the shifting of those areas utilities are required. For shifting of utilities are informed to concern authorities like MSEB, BSNL, MCGM sewerage and storm water department etc. In the DPR phase, the utilities have been identified and provision is made in the estimate. The detailed planning of Utility Relocation, Cost estimates, was prepared in association with concern. Balance additional provisions if any will be conducted during execution.

6.3 Inventory Survey

A detailed inventory was carried out along the proposed alignment corridor in order to collect relevant information in respect of:

- Terrain
- Land use
- Carriageway Details
- Median Details
- Shoulder Details
- Embankment Details
- Cross Roads/Junctions

The terrain has been found to be flat in nature throughout the corridor. Land use on both side are mostly of commercial and residential types. It is only commercial at some locations and or only residential at some. Carriageway is a rigid pavement type at all locations except at junctions and flyover and the width of the carriageway is around 13m. The corridor is a divided carriageway and the median width is 0.45m. The footpath is encroached by hawkers and various structures. The width of footpath varies from 2.5 to 3 m and then at Elphinstone it varies up to 3.5 m.

Some structures observed during the inventory are listed below:

1. Sewri Bus Stand
2. Prabhodhankar Thakre Udyan
3. Petrol Pumps
4. FOB starts on Footpath (Left side)
5. FOB crosses corridor
6. FOB ends (Right side)
7. Parel gaon Bus Stand
8. Mono rail in progress at GD Ambedkar Road
9. Wadiya Prasuti Gruh bus stand
10. Mono rail turning at Khanolkar Chowk.
11. Madkebuva Bus stand (Left and (Right)
12. Elphinstone Flyover in Stone masonry.
13. Elphinstone obligatory portion start
14. Elphinstone obligatory portion ends
15. Elphinstone Station
16. Elphinstone Bridge ends
17. Sai Mandir on left side Footpath

Junction Details observed in the corridor are given below:

- Prabodhankar Thakre Junction- 3 legged @ 0+445 km.
- Tokarshi Jeevraj Marg Junction- 4 legged @ 0+655 km
- G.D. Ambekar Marg Junction – 4 legged @ 1+115 Km.
- Dr. S.S. Rao Marg Jn. (Haffkine Institute Chowk)- 3 legged @ 1+445 km
- Wadiya Hospital Junction- 4 legged @ 1+710 km
- Dr. Babasaheb Ambedkar Junction- 5 legged @ 2+015 km

6.4 Traffic Survey

To assess the existing traffic flow characteristics and travel pattern, the following primary surveys were conducted on identified locations along the project corridor.

1) Classified Traffic Volume Count (CTVC) Survey
2) Turning Movement Count Survey (TMC)
3) Speed Delay Surveys

Traffic surveys are essential to appreciate the prevailing traffic and travel characteristics of the project influencing area. Traffic surveys were conducted during the month of November 2017.

6.4.1 Classified Traffic Volume Count (CTVC) Survey

The main objectives of Classified Traffic Volume Counts were to assess the traffic characteristics in terms of average daily traffic, hourly traffic variation, peak hour traffic, traffic composition and directional distribution. The table shows the traffic survey locations, their Chainage and date of survey.

Traffic Volume Counts were conducted for three days on this section. To carryout traffic counts, the vehicles were grouped under the various categories. Vehicle classification system recommended by IRC was adopted.

Traffic volume count was carried out manually by trained enumerators using hand tally method under the supervision of a Traffic Engineer. The traffic count data was recorded at 60-minute intervals for each vehicle group.

All traffic surveys have been carried out in accordance with the guidelines specified in IRC: 9-1972 and IRC: 102-1988. The traffic survey locations, their chainage and date of survey is presented in Table 6.4.

Table 6. 4 Traffic Survey Locations

Type of Survey	Location	Duration	Date of Survey
Classified Traffic Volume Count Survey (Mid-Block)	MSH 2	3 days	1. 23/03/2012 2. 24/03/2012 3. 25/03/2012
Classified Traffic Volume Count Survey (Mid-Block)	NH 4	3 days	1. 30/03/2012 2. 31/03/2012 3. 01/04/2012
Origin Destination Survey	Durgamata chowk MSH-2/NH-222	1 day	24/03/2012
Origin Destination Survey	Diva Naka NH4	1 day	31/03/2012
Origin Destination Survey	Katai Naka	1 day	30/03/2012
Intersection Turning Movement Count Survey	Durgamata chowk MSH-2/NH-222	3 days	1. 23/03/2012 2. 24/03/2012 3. 25/03/2012
Intersection Turning Movement Count Survey	Diva Naka NH4	3 days	1. 30/03/2012 2. 31/03/2012 3. 01/04/2012
Intersection Turning Movement Count Survey	Katai Naka	3 days	1. 30/03/2012 2. 31/03/2012 3. 01/04/2012

6.4.2 Turning Movements Count at Junctions

Junction counts were carried out at 3 locations. The objective to carry out junction count was to identify the type of control measures, traffic leaving and entering the project road from various directions, etc. The junction counts were carried out for 3 daysx24 hours.

6.4.3 Axle Load Surveys

Axle load is not conducted at site as only light vehicles are permitted on corridor.

6.5 Speed Delay Surveys

The Speed/Delay survey has been conducted on the study road during peak and off-peak hours on a normal day using moving observer method. The speed and delay survey also has been conducted during night time for the assessment of speeds. The average speeds on the study corridor have determined.

6.6 Pavement Condition Survey

Proposed alignment is planned newly and in elevated manner hence, no necessity of pavement condition survey. However material survey has been carried out by visual inspection and sample collection to ascertain the type of subsoil conditions.

6.7 Soil Survey

Proposed alignment is traversing in habited areas of busy streets which is mostly used for commercial and residential purposed. Mostly filled material is noted up to four to five meter in depth. This material is reclamation rested on paddy or marshy soil. The test results also indicates water level of the stretch.

6.7.1 Material Investigations.

Basic objective of material investigations is to identify the potential sources of construction materials along the project stretch, to ensure that adequate quantity of materials suitable for various structural components viz. Foundation, sub structure, super structure, wearing course, etc. is available.

Suitable sources have been identified along the project stretch by local enquiry, Internet etc. Sufficient numbers of quarries have been identified to ensure availability of material within economical leads. The information on the material sources was summarized with the following objectives:

- Identification of sources, indicating the locations and the status of quarries whether in operation or a new source. Identification of requirements for wearing surface of elevated corridor, allied works, cross drainage and other works. Testing and evaluation of material characteristics.
- A number of quarries for stone, sand gravel and borrow areas for earth have been identified. The samples were tested in the laboratory to evaluate their suitability for road construction. The details of quarries and borrow area locations along the project corridor have been furnished in the final DPR.

6.7.2 Cement, Steel, Sand and Bitumen

Cement bitumen, steel etc. are the manufactured materials. Bitumen is produced indigenously in India and is generally supplied from the nearest oil refinery. Chembur refinery is the nearest refinery to the project site.

Cement conforming to BIS specifications can be procured directly from factories or can be purchased from dealers of the factories in Mumbai areas adjacent to project road like Shiveri, Parel, Prabhadevi etc. The reinforcement steel of different grades conforming to BIS specifications is available. Hence there is no difficulty in respect of its availability in this project. An in-exhaustible quantity of Sand is available from Vaitarna River.

6.8 Geotechnical Investigations

6.8.1 General

A detailed geotechnical investigation was carried out along the proposed alignment of elevated corridor.

In the present study of East-West Corridor, detailed sub-surface information has been revealed through 39 nos. of borehole locations stretching from the Sewri Interchange area, traversing to Acharya Donde Marg, J. Bhatnagar Marg (Elphinston road), Kamnagar, and Prabhadevi new road before joining Khan Abdul Gaffar Khan Marg at Worli.

6.8.2 Objective of Investigation

The purpose of investigation is to explore subsurface conditions at specified locations to different depths in order to identify the thickness and sequence of various strata in the proposed project area. This investigation would supplement information for the design of foundation system as well as for studying the Ground Improvement requirements, if any.

6.8.3 Field Work

Drilling and sampling in soil and rock is carried out using rotary drilling rig. Borehole in soil is advanced using rotary drilling method, while NX size double tube core barrel with diamond bit is used to drill in rock. Water is circulated to cool the drilling bit. Ground water table is recorded after 24 hours of completion of drilling. On completion of drilling, soil samples were packed in plastic containers with proper identification tags. Rock cores wherever obtained were numbered and kept in core boxes.

6.8.4 Standard Penetration Testing

Standard Penetration Tests (SPT) has carried out to provide an indication of the density and/or consistency of the ground and to obtain disturbed samples for visual inspection and laboratory testing and classification. The results are given on the boring logs in Geotechnical Report and has expressed as an N-value is defined as the blow-count for 12” (300mm) penetration recorded after the seating drive of 15cm.

In the case of premature refusal conditions, the number of blows for a recorded penetration (including the seating drive) is noted.

6.8.5 Subsoil Profile

Sub-soil conditions described below are based on drilling and sampling in boreholes. Generalized sub-soil profile for each is described below.

Subsurface profile consists of silty clay with occasional layers of silty or clayey sand with varying consistency. Consistency of the soil improves with depth. Following table lists thickness of various layers (m) and corresponding range of SPT N. It is possible that the subsoil in field may not be in the same order as mentioned below

- Layer I : Backfill
- Layer II : Silty lay/Murum sitly clay)
- Layer III : Disintegrated rock
- LayerIV : Weathered basalt/Breccia

Bore hole no	Layer I	Layer II		Layer III	Layer IV	
	Thick	Thick	N	Thick	Thick	RQD
BH 2	3	3.5	12	-	17.5	0-74
BH 3	3	5	17-22	-	20.5	0-79
BH4A	3	3	15-17	1	18	0-72
BH4B	3	3	15-17	3	16	0-62
BH7	2	-	-	-	23	0-85
BH8	1.5	3	14-17	1.5	19	0-91
BH9	1.5	-	-	3	25.5	0-89
BH11	2.5	-	-	-	17.5	0-53
BH12	-	5.5	30-42	1	18	0-81
BH14	-	6	33-R	4.5	14	0-74
BH15	-	6.5	Nov-30	19.5	5.5	0-7
BH16	3	1.5	-	1.5	9	0-87
BH18	-	4.5	31-43	0.5	19.5	0-100
BH19	1.5	-	-	-	19.5	0-95
BH20	-	-	-	-	22	0-100
BH21	1.5	-	-	1.5	16	0-97
BH22	2	-	-	1	27	0-100
BH23	1.5	0.5	-	1.5	21	0-67
BH24	1.5	1.5	25	1.5	21.5	21-100
BH25	1.5	1.5	28	1.5	20.5	23-97
BH26	3.5	3	32	1.5	2	0-89
BH27	1.5	4.5	32-44	1.5	12.5	0-85
BH28	1.5	5.5	14-40	-	23	0-100
BH29	3.5	3.5	18-21	-	23	0-99
BH30	4	3	14-22	-	23	0-100
BH31	3	4	14-24	3	21	0-92
BH32	3	1.5	11	4.5	21	0-96
BH33	1.5	4.5	Nov-26	2.5	21.5	0-84
BH34	1.5	5.5	Dec-30	1.5	21.5	0-80
BH35	1.5	1.5	39	3	24	0-86
BH39	1.5	1.5	23	3	24	0-82
BH40	1.5	-	-	-	18.5	0-100
BH41	1.5	1.5	39	3	19	0-62

Bore hole no	Layer I	Layer II		Layer III	Layer IV	
	Thick	Thick	N	Thick	Thick	RQD
BH42	1.5	-	-	1.5	17	0-76
BH43	1.5	-	-	-	18.5	0-80
BH44	1.5	-	-	1.5	17	0-76
BH45	1.5	-	-	1.5	17	0-74

Boreholes BH1, BH5, BH6, BH36, BH37 & BH38 cancelled by client, Hence not reflected above.

6.8.6 Ground Water Level

Water level was encountered in the boreholes. It may be noted that this may not be true ground water level but level of water used for drilling and not dissipated. Correct method to determine ground water table is to install standpipe piezometer and monitor over long period of time. In the following table water level as measured on completion of drilling below the ground level existing at the time of investigation is tabulated.

Bore hole no.	Depth (m)
BH2	3.3
BH3	2.5
BH4A	1.1
BH4B	1.6
BH7	0.95
BH8	1.25
BH6	0.90
BH11	4.6
BH12	3.95
BH14	2.45
BH15	2.2
BH16	6.15
BH18	4.65
BH19	1.17
BH20	0.38
BH21	1.23
BH22	3.45
BH23	3.67
BH24	4.45
BH25	2.45
BH26	4.55
BH27	7.5
BH28	1.33
BH29	1.42
BH30	1.87
BH31	1.97
BH32	3.60

Bore hole no.	Depth (m)
BH33	4.19
BH34	5.45
BH35	2.90
BH39	1.5
BH40	4.15
BH41	2.97
BH42	2.97
BH43	0.5
BH44	0.5
BH45	0.5

6.8.7 Laboratory Testing

On completion of drilling samples were sent to the laboratory for further testing. Samples were classified in the laboratory and representative samples were selected for testing. Following tests were performed.

- Dry Density
- Soaked unconfined Compression Test & point load index test
- Percentage absorption and porosity

6.8.8 Engineering Analysis

Engineering analysis of the substratum was performed to determine net safe bearing capacity. Parameters obtained are based on various field and laboratory tests.

Subsoil consists of rock at variable depth. Column loads are expected to be heavy.

Alternate I: Foundations placed on rock

Alternate II: Bored cast in situ piles

Wherever competent rock is encountered up to maximum 5m depth open foundations on rock are recommended, otherwise 1.2m diameter bored cast in situ piles are recommended. Based on review of borehole logs and lab test results suitable design parameters are selected for pile design and bearing capacity/settlement calculations.

Alternate I: Open foundations on rock

Safe baring capacity for foundations placed on rock is determined as per procedure given in IS12070 “Code of practice for Design and Construction of Shallow Foundations on Rock. The procedure is based on RMR (Rock Mass Rating) concept. RMR is calculated as per the method given in IS 13365 (Part-1) “Quantitative Classification System of Rock Mass”. Determination of RMR takes into consideration following properties of rock stratum

- Strength of Intact rock material

- Rock Quality Designation
- Spacing of Discontinuities
- Condition of Discontinuities
- Ground water condition
- Orientation of Discontinuities
- Joint Orientation

It is mentioned in IS-12070 that if net allowable bearing capacity is determined based on RMR "settlement of raft foundation up to 6m thickness to be less than 12mm".

It may be noted that the referred IS code does not specify any limitations as far as width and shape of foundations placed on rock. In addition, there is no reference to factor of safety.

Alternate II: Bored cast in situ piles (method 1 & 2)

Pile capacity is calculated as per IRC-78 2014.

6.9 Conclusions & Recommendations

In the following table safe downward and uplift capacity (in Ton) of piles of different diameters socketed for 1D, 2D & 3D in rock.

Borehole	Pile diameter	Safe vertical capacity			Safe uplift capacity		
		1D	2D	3D	1D	2D	3D
BH2	1200mm	102	138	174	25	50	**75**
	1400mm	139	188	237	34	68	**102**
BH3	1200mm	496	555	613	41	82	**123**
	1400mm	675	755	835	55	111	**167**
BH4A	1200mm	78	102	126	17	34	**50**
	1400mm	107	140	172	22	46	**69**
BH4B	1200mm	216	255	294	27	55	**82**
	1400mm	294	247	400	37	74	**111**
BH7	1200mm	56	78	101	15	34	**48**
	1400mm	76	107	138	21	43	**64**
BH8	1200mm	92	114	137	15	32	**48**
	1400mm	125	156	187	21	43	**64**
BH9	1200mm	69	120	171	35	71	**106**
	1400mm	94	164	233	48	97	**145**
BH11	1200mm	692	809	947	89	178	**239**
	1400mm	942	1115	1289	121	242	**363**
BH12	1200mm	670	775	880	74	147	**221**
	1400mm	912	1055	1198	100	200	**300**
BH14	1200mm	150	182	213	22	44	**67**
	1400mm	204	248	291	30	60	**90**
BH15	1200mm	599	633	667	23	47	**71**
	1400mm	815	862	908	32	64	**97**

Borehole	Pile diameter	Safe vertical capacity			Safe uplift capacity		
		1D	2D	3D	1D	2D	3D
BH16	1200mm	685	806	926	84	168	**253**
	1400mm	933	1097	1261	114	229	**344**
BH18	1200mm	677	789	901	78	157	**235**
	1400mm	922	1074	1227	106	214	**320**
BH19	1200mm	75	98	120	15	32	**48**
	1400mm	102	133	164	21	43	**64**
BH20		**Rock from surface hence open foundations**					
	--	**placed on rock recommended**					
BH21		**Competent rock from 3m depth hence open**					
	--	**foundations placed on rock recommended**					
BH22		**Competent rock from 3m depth hence open**					
	--	**foundations placed on rock recommended**					
BH23		**Competent rock from 4.5m depth hence open**					
	--	**foundations placed on rock recommended**					
BH24		**Competent rock from 4.5m depth hence open**					
	--	**foundations placed on rock recommended**					
BH25		**Competent rock from 5m depth hence open**					
	--	**foundations placed on rock recommended**					
BH26	1200mm	197	233	268	24	49	**74**
	1400mm	268	317	365	33	67	**101**
BH27	1200mm	646	728	809	57	114	**117**
	1400mm	880	991	1102	77	221	**232**
BH28	1200mm	67	90	113	16	32	**49**
	1400mm	91	123	155	22	44	**67**
BH29	1200mm	231	270	309	27	54	**82**
	1400mm	314	367	420	37	74	**111**
BH30	1200mm	89	144	172	20	39	**58**
	1400mm	159	197	235	26	53	**79**
BH31	1200mm	89	144	172	20	39	**58**
	1400mm	159	197	235	26	53	**79**
BH32	1200mm	670	775	880	73	146	**220**
	1400mm	912	1055	1188	99	199	**299**
BH33	1200mm	686	806	927	84	168	**253**
	1400mm	933	1097	1261	114	229	**344**
BH34	1200mm	127	155	183	19	39	**58**
	1400mm	173	211	249	26	53	**79**
BH35	1200mm	258	308	359	35	70	**105**
	1400mm	351	420	488	47	95	**143**
BH39	1200mm	170	209	249	27	54	**82**
	1400mm	232	285	338	37	74	**111**
BH40	1200mm	72	95	117	15	31	**47**
	1400mm	98	129	160	21	43	**65**
BH41	1200mm	199	235	271	25	50	**75**
	1400mm	270	319	368	34	68	**102**

Borehole	Pile diameter	Safe vertical capacity			Safe uplift capacity		
		1D	2D	3D	1D	2D	3D
BH42	1200mm	253	301	349	33	67	**100**
	1400mm	345	410	475	45	91	**137**
BH43	1200mm	519	579	639	41	83	**125**
	1400mm	707	788	870	56	113	**170**
BH44	1200mm	148	219	255	24	49	**74**
	1400mm	250	298	347	33	67	**101**
BH45	1200mm	218	258	298	27	55	**83**
	1400mm	**297**	**351**	**406**	**37**	**75**	**113**

It anticipated that steel liner will be placed up to top of rock.It is recommended to perform initial pile load tests in all the three forms (vertical downward, uplift & lateral) for all the different diameters of piles used prior to start of actual piling work below the buildings. This is to confirm above recommended values. Quality control tests for piling as mentioned in relevant IS code shall be followed.

Open Foundations on rock

Conclusions and Recommendations are based on following accepted norms.

- Foundations should not fail in shear.
- Anticipated settlements should be less than allowable value.

Net safe bearing capacity to be adopted

Bore Hole No.	Depth m	Net Safe bearing capacity T/m2
BH-20	1.5	69
BH-21	3.0	110
BH-22	3.0	105
BH-23	4.5	70
BH-24	4.5	70
BH-25	5.0	70

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7 ALIGNMENT

7.1 General

The alignment designed for this elevated corridor is almost co insides the existing ground level load. Except few limited shifts the alignment proposed almost as existing alignment. The degree of curvature of existing alignment is fair while taking about Rise –Fall of the alignment, it is taken into account at critical locations where vertical clearances need to maintain .As you seen in previous Traffic Survey Chapter entire corridor of Sewri Worli is divided in four sections as shown below.

Section 1 – Worli end of Western Freeway to Dr. Annie Besant road junction

Section 2 – From Dr. Annie Besant Road Junction to Senapati Bapat Marg Junction

Section 3 – From Senapati Bapat Marg Junction to Dr. Ambedkar Road Junction on Acharya Donde Marg

Section 4 – From Dr. Ambedkar Road Junction to R.A.Kidwai Road junction on Acharya Donde Marg

7.2 Horizontal Alignment

Horizontal alignment for the grade separated elevated corridor is designed in accordance with IRC: 38-1988 “Guidelines of Design of Horizontal Curves for Highways and Design Tables”. Clause 10.3 of IRC: 86-1983 specifies minimum curve radius of horizontal curve for 50 Kmph as 105 m for 4% super-elevation. These guidelines will be followed for reasonably flat and less winding alignments. Depending on existing road geometry and site constraints modifications are made to provide sharper curve radius wherever required based on site specific considerations. For ramps and critical curves along main corridor, curve radius corresponding to 30 Kmph design speed is proposed.

Table 7. 1 Details of Horizontal Curve

Sr. No.	Curve Start Chainage	Curve end Chainage	Radius (m)	Arch Length	Total Curve Length	Transition Length	Delta angle	External Tangent	External Secant	Speed (Km/hr)
1	0+014	0+183	100.00	118.70	168.70	25	82.34	67.47	20.630	30 km/h
2	0+261	0+344	90.00	83.22	83.21	-	52.98	44.85	10.556	30 km/h
3	0+525	0+562	175.00	7.35	37.34	15	7.32	3.67	0.039	30 km/h
4	0+623	0+682	155.00	18.40	58.40	20	14.19	9.21	0.273	30 km/h
5	1+095	1+110	1200.00	14.76	14.76	-	0.70	7.38	0.023	80 km/h
6	1+249	1+369	400.00	9.43	119.43	55	9.23	4.71	0.028	80 km/h
7	1+408	1+574	700.00	95.58	165.58	35	10.69	47.87	1.635	80 km/h
8	1+610	1+623	1200.00	13.80	13.79	-	0.66	6.90	0.020	80 km/h
9	1+748	1+888	800.00	139.19	139.19	-	9.97	69.77	3.037	65 km/h
10	1+899	2+017	1200.00	117.21	117.21	-	5.60	58.65	1.433	80 km/h
11	2+038	2+088	1200.00	49.97	49.97	-	2.39	24.99	0.260	80 km/h
12	2+092	2+137	400.00	5.78	45.78	20	3.69	2.89	0.010	50 km/h
13	2+178	2+223	350.00	4.73	44.72	20	4.05	2.36	0.008	50 km/h
14	2+223	2+267	350.00	4.06	44.05	20	3.94	2.03	0.006	50 km/h
15	2+685	2+717	230.00	2.50	32.50	15	4.36	1.25	0.003	30 km/h
16	2+743	2+782	230.00	8.69	38.69	15	5.90	4.35	0.041	30 km/h
17	2+784	2+871	85.00	26.08	86.07	30	37.80	13.14	1.010	30 km/h
18	2+950	2+996	1200.00	45.99	45.99	-	2.20	23.00	0.220	65 km/h
19	3+018	3+119	155.00	10.55	100.55	45	20.53	5.28	0.090	50 km/h
20	3+306	3+399	700.00	23.62	93.62	35	4.80	11.81	0.100	80 km/h
21	3+582	3+674	155.00	1.98	91.98	45	17.36	0.99	0.003	50 km/h
22	3+756	3+968	155.00	171.87	211.86	20	70.92	95.97	27.308	30 km/h
23	3+982	4+086	230.00	74.13	104.12	15	22.20	37.39	3.019	30 km/h
24	4+093	4+189	230.00	26.27	96.27	35	15.26	13.15	0.376	50 km/h
25	4+399	4+470	360.00	30.25	70.25	20	8.00	15.14	0.318	50 km/h
26	4+660	4+794	55.00	43.67	133.67	45	92.37	23.06	4.638	30 km/h
27	4+875	4+976	85.00	40.74	100.74	30	47.68	20.77	2.500	30 km/h
28	5+095	5+262	400.00	107.01	167.01	30	19.62	53.82	3.605	65 km/h

7.3 Super Elevation on Curves

Super-elevation on horizontal curves will be attained as per IRC: 38-1988. The super elevation will be limited to 4 % as per Clause 10.2 of IRC: 86-1983 as the project area is in urban section.

7.4 Cross-Sectional Elements

Width of main corridor has a direct relationship with the traffic volume it is expected to serve and width available at ground level based on land acquisition and future widening of surface level road. The cross sectional elements considered in designing the proposed elevated road are shown in Table 7.2.

Table 7. 2 Cross Sectional Elements

Sr. No.	Description	Particulars	Unit	Value
1	Main Elevated Road	Carriageway	m	2 x 7.5
		Median	m	1.2
		Crash Barrier	m	2 x 0.5
2	Up & Down Ramps	Carriageway	m	7.5
		Median	m	-
		Crash Barrier	m	2 x 0.5
3	Up & Down Ramps	Carriageway	m	5.5
		Median	m	-
		Crash Barrier	m	2 x 0.5

7.5 Cross Slope

The cross slope / camber value adopted are shown in Table 7-3.

Table 7. 3 Cross Slope

Sr. No.	Particulars	Unit	Value
1	Main Elevated Road	%	2.5 *(Inverted)*
2	Up & Down Ramps	%	2.5

7.6 Vertical Alignment

The vertical geometry of the corridor along with ramps is designed as per guidelines given in IRC: SP:90-2010 and IRC: 92-1985. Clause 6.14 of IRC: SP:90-2010 states that the vertical gradient should be desirably kept at 3.5%, however, Clause 5.1.2 of IRC: 92-1985 states that the vertical gradient should be desirably kept at 4.0%, but in no case

exceed 6.0%. Vertical curves are provided at locations of change in gradient. The length of vertical curves is dependent on change in grade between two vertical straight and this will be as per IRC SP: 23-1993 “Vertical Curves for Highways”. The Tambe committee recommendations for critical locations are also taken into considerations. Considering the plain terrain along the project stretch, the consultants opine that it may not be practically possible to limit the vertical grade to 4.0%. This is considering provision of access to adjoining junctions / cross roads and road side facilities. These elements were discussed with MMRDA with presentation of plan and profile drawings

Table 7. 4 Details of Vertical Curve

Vertical Curve List										
No.	**PVI Station**	**PVI Elevation**	**Grade In**	**Grade Out**	**A (Grade Change)**	**Profile Curve Type**	**Profile Curve Length**	**K Value**	**Curve Radius**	**Design Speed**
1	-0+521.24m	20.500m		3.33%						
2	0+018.76m	38.500m	3.33%	0.00%	3.33%	Crest	120.000m	36	3600.000m	30 km/h
3	0+660.00m	38.500m	0.00%	-1.72%	1.72%	Crest	150.000m	87	8718.850m	30 km/h
4	0+830.00m	35.575m	-1.72%	2.71%	4.43%	Sag	162.825m	37	3678.871m	30 km/h
5	1+144.36m	44.081m	2.71%	-2.11%	4.81%	Crest	365.763m	76	7600.000m	80 km/h
6	2+092.88m	24.094m	-2.11%	0.00%	2.11%	Sag	86.392m	41	4100.000m	80 km/h
7	2+817.14m	24.094m	0.00%	-2.50%	2.50%	Crest	189.800m	76	7600.000m	65 km/h
8	3+217.56m	14.094m	-2.50%	0.25%	2.74%	Sag	112.457m	41	4100.000m	80 km/h
9	4+235.18m	16.592m	0.25%	-3.33%	3.58%	Crest	271.990m	76	7600.000m	50 km/h
10	4+512.45m	7.350m	-3.33%	0.48%	3.81%	Sag	156.217m	41	4100.000m	50 km/h
11	4+922.16m	9.304m	0.48%	-0.05%	0.53%	Crest	70.934m	134	13400.000m	30 km/h
12	5+282.82m	9.114m	-0.05%							

7.7 Feasibility of Tunnel Option

7.7.1 Preamble

The various alternative alignments were discussed and recommended the most feasible alignment with composition of homogeneous links like i) Acharya Donde Marg ,1.56 km ii) Jagannath Bhatankar Marg ,1.08 km iii) Drainage Channel Road,1 km iv) Narayan Hardikar Marg,0.240km.i.e 3.880km.

During 2012, project report for MTHL road project from Sewri to NH-4B having 22 KM length is completed and construction work for said MTHL link is in progress. Simultaneously, in 2013, MMRDA had prepared Detail Project Report for Extended link of MTHL was completed .In this report three alternatives Alignment were studied out of which one option was tunnel option which is kept aside due to the proposed underground tunnels, Metro Rail , construction feasibility etc. The final alignment is framed after the discussion with the MMRDA, SRA & MCGM authorities regarding the slums along the Drainage Channel Road. SRA & MCGM Authorities communicated that the process of rehabilitation for the slums along the drainage channel road is under progress and subsequently the Drainage Channel Road will be cleared of slums. After the discussions on the alternative alignments it was decided to finalize the Most Feasible alignment proposed in the previous studies as above and henceforth called as Final Alignment. Hence, the proposed alignment of the elevated corridor has been kept mostly along the alignment of existing roads.

The task of review and updating the said DPR has assigned to M/S Monarch by MMRDA. M/s Monarch reviewed all previous proposals, tunnel option, surface level option and elevated option and modified the DPR and summited to MMRDA in 2018. The Summary of Tunnel options studied during DPR stage is presented below.

7.7.2 General

During DPR updating M/s Monarch reviewed all previously recommended proposals by various agencies and studied options on three basic parameters as below.

1. Surface level road
2. Elevated road option
3. Tunnel

The Summary of tunnel option studied during DPR updating on following basic aspects.

1. Existing/ proposed Tunnels along the alignment
2. Geo technical condition
3. Socio economic impact
4. Geometrics of tunnel

5. Assessments of tunnel support system
6. Permanent Ventilation ,Lighting and Fire brigade system
7. Construction methodology
8. Cost.

7.7.3 Exiting Tunnels along the alignment

There are two SWD tunnels located at Chainage 0.320 Km (below Rafi Ahmed Kidwai road @ 48 meter below Existing GL) and Chainage 2.790 Km (below Senapati Bapat Road @ 60 meter below Existing GL).These two existing tunnel tubes are functional.

7.7.4 Proposed tunnels along the alignment

The construction of proposed metro line -4(Colaba-CSMT-Prabhadevi-Seepz) is in progress and crosses the proposed Sewri Worli corridor at chainage 4.120 km (below Dr. Annie Besant road @ 25 meter below Existing GL).

source –DPR by DMRCL Sept,2018.

7.7.5 Tunnel option – 1

Basically, important consideration of ground mass just above the crown of tunnel in terms of height is two times of width of tunnel. To keep height twice of width of tunnel (15 M +), vertical geometry should compromise with steep grades. On other hand, to follow vertical geometry in terms of least 3% grade norms, width: height ratio will not be maintained. To resolve this, tunnel alignment, Option -I planned in such a way that minimum theoretical overburden above the proposed/existing tunnels are being maintained with least compromise in ratio and grade percentage. This option starts at chainage 0.961 km after down ramp of third level elevated section just adjacent to proposed Monorail station. Tunnel ingress could not be possible before this chainage due to grade constraints on account of provision of statutory vertical clearances which needs to be provided for crossing of proposed CSTM- Panvel Harbor line and existing Eastern freeway. The Entry/Exit portal at this location becomes critical due to vertical geometry (entry) which negative (1 in 30 down), positive (1 in 75 up), Negative (1 in 25 down) and vice versa for exit. These are the maximum as smooth as possible grades in this option .As length of tunnel is about 2.677 km. The said tunnel is termed as **long tunnel** (1500+) .However ,In accordance with cl no. 2.8.3 and 7.1.3 of IRC:SP:91-2010,up to three percent grade is permitted for long tunnels (To avoid emissions of CO by traffic).therefore, the grades does not fulfills minimum requirements of vertical geometry. The horizontal geometry seems fair, as it fulfills design requirements of IRC:

SP: 91-2010. On the other hand, other critical issues noted under this option is presented table below and discussed under miscellanies head.

Sl.No.	Description of Tunnel alignment	Chainage	Remarks
1.	Length of tunnel	2+677 km	
2.	Start of Proposed Tunnel	0+961	Existing Foot Over Bridge near this location
3.	Monorail station	1+331 to 1+400	Station is on piles of 3 or 4 in a group.
4.	Parel Flyover @ Ambedkar Road	2+000	Pile foundations
5.	Senapati Bapat-Duel tunnel for SWD/water line crossing	2+750	Depth of existing tunnel 60 m below GL.
6.	Elphinstone flyover	2+800	Fdn Level
	End of Proposed Tunnel	3+638	Slum in Prabhadevi

From the above discussions, it is mandatory to propose tunnel at appropriate depth so as neither existing pile foundation for existing special structures (Flyovers, ROB, metro/Mono lines ,adjacent building etc) get affected nor overburden get reduced. However by doing so, required grades could not be maintained. Apart from this, space requirement for shaft near entry and exit ramp is not available and additional land acquisition in built up area will be required.

In addition to above following functional requirements are mandatory for double tube Uni- Directional tunnel as per cl no. 2.8.2.5of IRC: SP: 91-2010 for which space requirement are the major constraints in available ROW.

- Cross passage
- Ventilation
- Lighting
- Telephone @200 m
- Fire safety- Fire extinguisher @50m
- Egress – Egress shall have min. 2 mx 2.5 m height
- Provision of refuge to park at least 6 vehicles @750 m distance.
- Power Station

To overcome issues encountered during above mentioned tunnel alignment option -01, Consultant studied option II.

7.7.6 Tunnel option – 2

Option II is proposed in such a way that, it will traverse beneath the exiting tunnel keeping minimum theoretical overburden. Option II start at -2500 m beyond zero chainage towards MTHL elevated road and traverse towards Worli end in mud flat via Dr. Annie Besant road at chainage 6+250 .The broad issues presented table below.

Sl. No.	Description of Tunnel alignment	Chainage	Remarks
1.	Start of Proposed Tunnel	-2+500 towards MTHL	Variation in planned profile of MTHL at end .Variation in Existing ongoing Contract
2.	Length of Tunnel	8+750	
3.	Monorail station	1+331 to 1+400	NA
4.	Hindumata Flyover @ Ambedkar Road	2+000	NA
5.	Senapati bapat-Duel tunnel for SWD/water line crossing	2+750	Depth of existing tunnel 60 m below GL .and getting 10 m cover .
6.	Elphinstone flyover	2+800	NA
7.	Dr.Annie Besant rd – Proposed Metro Tunnel (Colaba-Prabhadevi-Seepz) for Metro U/G line crossing	4+110	Depth of existing tunnel 25 m below GL. and getting 10 m cover.
8	End of Proposed Tunnel	6+250	Mud Flat.

Due to Proposed metro line -4 (Colaba –Prabhadevi Seepz) at 25 m depth on Annie Basent road , option II needs to be proposed below the proposed metro line with minimum over burden. From this point with required up gradient, Worli end exit will open in deep Sea, where elaborate measure would be needed to support the tunnel approaches. Apart from this, connection to proposed Coastal road interchange proposed at Worli will not be possible and ultimate purpose of this connector will be defeated. There is another tunnel located below Rafi Ahmed Kidwai road @ 48 meter below Existing GL at Sewri end. Considering the 10m cover and required gradient, Sewri end exit will also open in the deep sea where elaborate measure would be needed to support the tunnel approaches. Also, it is necessary to change the profile of MTHL, which may

change entire scenario of on-going contract as construction work is already in progress. The merging and demerging @ eastern freeway would not be possible for this option.

In addition to above discussed functional requirements are mandatory for this option also.

7.7.7 Cost Impact

TBM tunneling of such dimensions has never been carried out in INDIA. For block estimate, TBM rates are escalated based on on-going Mumbai Metro works with assumed suitable factors. The TBM tunneling cost from MML3 package is in the range of Rs 150 crore per kilometer (tendered cost). This correspond to a TBM area of 34 sqm (6.6 m dia), the ratio of cross section of proposed tunnel is 9 (9 m dia i.e. 63.5 sqm) while the Lining ratio is assumed to be ~3.0. For the present level of detailing and in view of scarce information available, we recommend a factor of 2 for costing escalation from MMRC tendered costs. A cost of Rs. 300 crores per kilometer of tunnel is hence estimated.

Sr No.	Description	Unit	Rate in Cr	Qty		Amount in Cr.	
				Opt.-I	Opt.-II	Opt.-I	Opt.-II
1.	Shafts for TBM	No.	30	2	2	60	60
2.	Tunnel Portion Length	km	300	2.60	8.75	780	2625
3	Egress & Ingress Protection Vulnerable	no	7	4	6	28	142
4	Ventilation, lighting fire brigade etc	Lum sum	50	1	1.5	50	75
	Total					1168	3277
5	Investigation design etc	5%				58.4	163.85
6	Cost of Balance length Construction @ 212 Cr / Km (On prorate Basis of current Project cost					318.00	
	Grand total					**1281.9 cr**	**3047.10 cr.**
						OPT -I	OPT -II

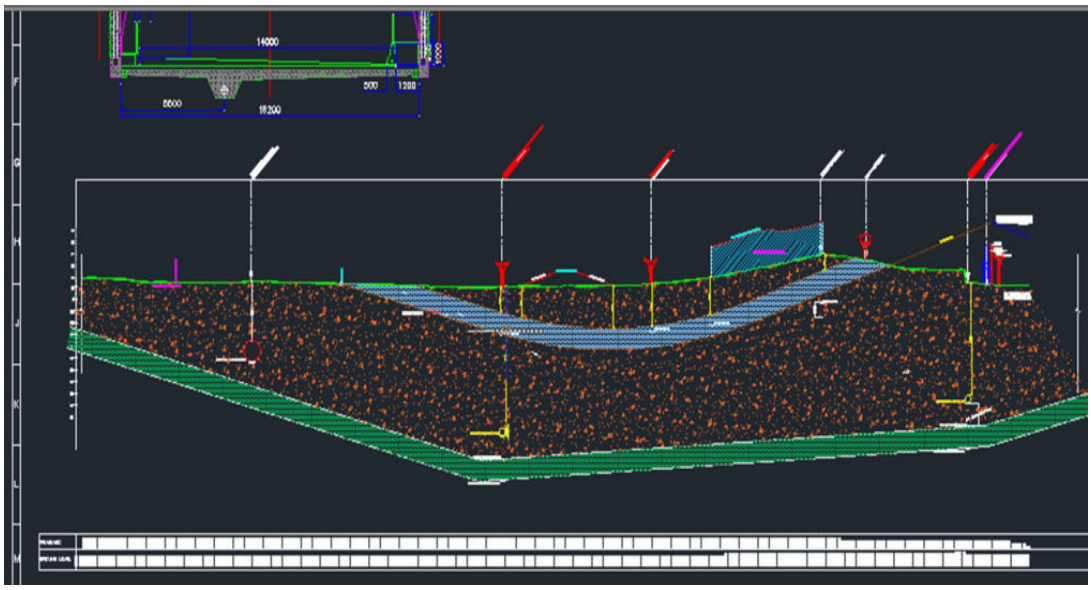
7.7.8 Summary of Major issues

a) Gradient constraints due to existing and proposed Tunnels along the alignment.
b) Sufficient space is not available for Tunnel ingress and egress in option and in option II , Tunnel ingress and egress will be falling in deep sea due to required gradient constraints
c) Construction of MTHL is in progress and any change in the proposal due to connectivity with tunnel will delay the project completion schedule.

d) Modification in available diameter TBM is required resulting at least one-year delay over and above excess cost implication for modifications in TBM. Also one-year delay will push ahead the targeted completion date of Sewri – Worli project which is not worthwhile as Sewri – Worli link will act as dispersal system for MTHL.
e) The alignment after traversing over Parel village more or less runs through the chronic waterlogged area happening with high tide and heavy rain almost every year. The DP reservations calls part of this alignment has drainage channel road and old storm water drain constructed during British Regime do exist in a good length of alignment. This channel finally leads to love groove pumping station. The topography along this alignment indicates that, in the history of the city this path was exchanging the sea water from east to west and vice versa. Naturally, the strata would be full of deposits of marine and organic clay and it would be necessary to penetrate to much deeper level so that good quality rock would be available to resist the pressure getting develop at tunnel interface.
f) Dewatering during excavation would also be a challenge in this area as a controlled Well Point System would also need to challenges due to sudden drop of water table and Subsequent sinking
g) Normally, for Metro tunnels a station is located at every one to 1.5 km also the construction of Metro station is done by open excavation (Top-Down or Bottom –Up) method. In case of this road tunnel there would not be any in between station and ventilation provision would be very critical.
h) A sufficient number of ventilation shafts would become necessary mainly since this facility being used by Automobiles. However, constructing ventilation shafts above flood levels in food prone areas would be a challenge by itself .Even slightest Mal functioning would bring enormous risk and it would not be prudent to go for it.
i) The tunnel invert would be generally above 20 to 30 meter below ground and with the incidence of very high water table (1 or 2 meters below ground).The probability of leakages in the tunnel would increase and for keeping this facility working well very elaborate dewatering arrangement would be need. Besides the stand by arrangement etc. alternative source of supply would be needed which will also impact the cost and feasibility.
j) The terminating point at Worli end would be almost at existing ground level and bringing this facility in tunnel (and at about 30 meters below) to ground level would need large ramp lengths and may also need remodeling of existing roads at intersecting points particularly for Option I. Any such requirements would demand go cost and time, so also such remodeling would call this locations having impacts on account of loss of time, cost and environmental degradation during construction phase.
k) The tunnel construction if it happens in solid hard rock neither would generally nor require any strengthening measure, if however the situation is contrary precast rings etc. would be needed there by adding cost and effort.
l) Tunnel excavation would lead to huge quantity of muck. It`s removal would need special considerations. Disposal of this huge muck quantity at safe distance and on main land would involve time and cost. Utilization of useable excavated quantity would not be feasible, due to very short length; muck disposal would have constraint in the background of environmental construction.
m) Project cost will increase considerably

7.7.9 Recommendations

In the above background, It would be prudent not to depart from the earlier concept of developing this connector link on surface, elevated etc. considering complex proposition to take it a tunnel. We also note that, the assurance of quality and durability starts at proposal planning stage and hence need to go for a sound proposal like elevated road.



Tunnel Profile

7.8 Details of Alignment

Traffic requirement for next 20 years is analysed and calculated and finally four lane Elevated corridor having total width 16 m (3.75 m Single lane) is adopted for entire corridor of 5.050 Km. The proposed alignment of the elevated corridor has been kept mostly along the alignment of existing roads.

Chainage 0+00 to 0+170: The proposed alignment for Sewri-Worli (East-West Corridor) for MTHL dispersal starts from Chainage 0.00 i.e. 600 m before Sewri Interchange. Proposed starting level of Sewri Worli Elevated corridor will be at Ch. 0+000 & RL of starting point 26.074 m and height above ground level is 19.474 m. This proposed height of corridor from ground level is taken as per details received from MTHL project.

Chainage 0+170 to 0+270: This corridor, Elevated corridor crosses Existing Eastern Freeway @ Ch. 0+188 at RL. of 31.456m, the height difference between Eastern freeway & corridor is 13.866m & after that Sewari station crosses @ Ch. 0+226 at RL of 31.500m, the height difference between Rail & proposed corridor is 24.52m.

Chainage 0+270 to 0+400: This elevated corridor connectivity to merging & demerging of Kidwai road Traffic.

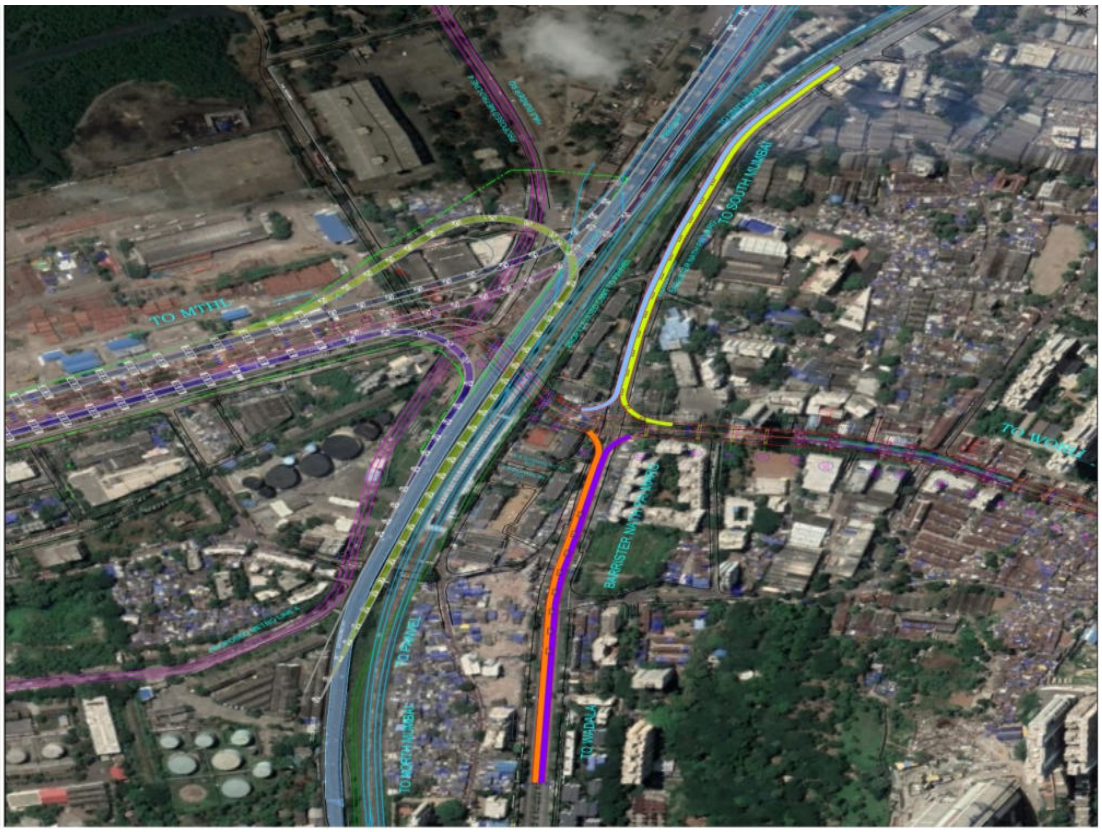
As per scope of the work, we have also explored alternative traffic dispersal system for MTHL Project which would provide all-way connectivity between all major links meeting at Sewri by introducing the concept of Elevated Rotary. The Elevated Rotary necessitated changes in BDD redevelopment scheme & also involved additional land acquisition from MbPT. The implementation of elevated Rotary would also require major changes in the Sewri interchange which is part of Package-1 of the MTHL project.

During the visits of the JICA's Fact Finding Missions to MMRDA in November 2018 and in December 2018, the concept of Elevated Rotary in lieu of Sewri Interchange was discussed. JICA's Fact Finding Missions suggested that no major change in the scope of Package-1 of the MTHL project (Sewri Interchange) shall be made.

Accordingly, the we have prepared alternate possible traffic dispersal systems without any change in the scope of Sewri Interchange in contract of Package-I of MTHL Project. The revised dispersal system includes up & down ramps to and from Sewri-Worli connector to Rafi Ahmed Kidwai Road. The up & down ramps to and from Sewri-Worli Connector to Acharya Donde Marg are also proposed.

The revised dispersal system includes up & down ramps to and from Sewri-Worli connector to Rafi Ahmed Kidwai Road. The up & down ramps to and from Sewri-Worli Connector to Acharya Donde Marg

Sr. No	Description	Length of Vaiaduct	Length of Approach	Width
1	Arm 01 (MTHL to CSMT)	453.70	139.15	3.75
2	Arm 02 (MTHL to A. Donde Marg)	157.50	151.80	4.25
3	Arm 03 (A. Donde Marg to MTHL)	406.58	151.80	4.25
4	Arm 04 (MTHL to R.A Kidwai Marg)	393.01	117.20	3.75
5	Arm 05 (CSMT to A. Donde Marg)	436.81	139.14	3.75
6	Arm 06 (A.Donde to R.A Kidwai Marg)	453.70	117.20	3.75



Chainage 0+400 to 0+520: At this stretch the proposed corridor run at single level no major disturbances are noted. The width of stretch is four lane with paved shoulder.

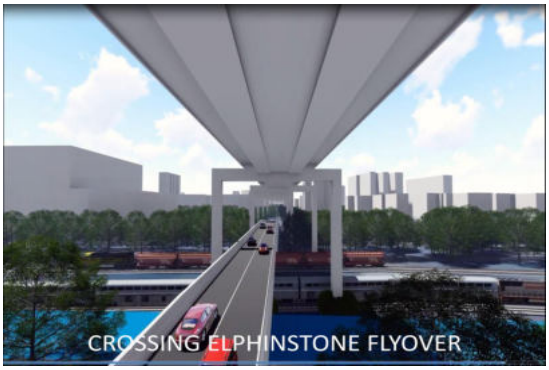
Chainage 0+520 to 0+840: This stretch runs in central portion over Acharya Donde Marg. The four lane elevated corridor, Central Two lane width are connected Acharya Donde Marg by ramp & adjacent lanes pass through elevated corridor as it is.

Chainage 0+840 to 1+108: At this stretch project corridor passes through elevated corridor & only foot over bridge are noted @ Ch. 0+880. There are no any obstruction are noted at this stretch of elevated corridor.

Chainage 1+108 to 1+697: At this stretch existing Monorail line are introduced @ Ch. 1+108. The Monorail runs parallel to elevated corridor up to Ch. 1+697. The monorail station crosses @ Ch. 1+381, the RL. of monorail is 29.579m & elevated corridor @ 42.593m. The Dr. SS Rao Marg crosses at Ch. 1+443, which is existing road, the height difference between existing road & elevated road, is 28.028m.

Chainage 1+697 to 2+240: At this stretch elevated corridor runs parallel to Acharya Donde Marg & elevated corridor crosses Vasant Ramji Khanolkar Chowk @ 1+712, the RL. of elevated corridor 35.306m & height difference is 24.959m. After that Hindmata Flyover on Ambedkar Road crosses @ Ch. 2+017 & RL. of elevated corridor is 26.297m & RL. of top of Hindmata flyover is 13.600m.

Chainage 2+240 to 2+720: At this stretch of elevated corridor & existing Elphiston ROB runs parallel over each other. The existing ROB ramp starts at Ch. 2+240 & end at Ch. 2+720. The elevated stretch is straight throughout the stretch, the RL of elevated stretch is 24.094m. The Elphiston ROB is crosses at Ch. 2+458, the clearance between elevated corridor & Elphiston ROB is 12.126m.



Chainage 2+720 to 2+850: At this Chainage alignment of Elevated Corridor passes through Elphinstone Station to Senapati Bapat Road Flyovers. It crosses about 5.52 m above Senapati Bapat Flyover. The Senapati bapat road flyover crosses at Ch. 2+800, RL. of elevated corridor is 23.667m, RL. of Senapati bapat road flyover is 15.200m.

Chainage 2+850 to 4+200: At this Chainage alignment of Elevated Corridor passes from Senapati Bapat Road Flyovers to Parel Bus Depot then Kamgar Nagar and finally crosses Dr. Annie Besant Road, Veer Sawarkar Road & J.B. Temkar Road. In this alignment Elevated Corridor gradually decreases from level of 23.023m to 15.837m which is continued after Senapati Bapat Flyover. The Dr. Annie Besant Road crosses @ Ch. 4+130 & J.B. Temkar Road @ Ch. 4+185.

Chainage 4+200 to 4+512: At this Chainage of Elevated Corridor passes from Dr. Annie Besant Road to New Prabhadevi Road, which further connected to Worli sea link. In this alignment Elevated Corridor gradually decreases from level of 15.837m to 9.116m.

7.9 Details of Alignment

Table 7. 5 Width of Carriageway

Chainage		Width of Carriageway (m)	Remark
0+00	0+300	7.5 + 7.5	Corridor
0+300	0+520	3.75 +7.5 + 7.5 + 3.75	Corridor
0+520	0+832	7.5+7.5 (Both End) 3.75+3.75 (Central Up/Down Ramp)	Corridor
0+832	4+512	7.5+7.5	Corridor

Table 7. 6 Ht. of Substructure & Gradient of Corridor

Alignment	Chainage		Height of Substructure (m)			Gradient	
			Max. Level	Min. Level	Ht. Above GL (m)	Up	Down
MTHL dispersal & Starting of Sewri Worli Elevated Corridor	0+00	0+170	14.674		8.859	1 in 25	
Corridor crosses Railway line at Sewri End	0+170	0+460	36.650		31.092	Horizontal	
Corridor passes through Sewri Bus Depot to GD Ambedkar Marg	0+460	1+110	40.86		22	1in 42 (1+150 to 1+600)	1in 30 (0+900 to 1+150)
Corridor passes through GD Ambedkar Marg to Khanolkar Chowk	1+110	1+960	41.20	31.28	22.5	-	1in 48
Corridor passes through Khanolkar Chowk and crosses Hindmata Flyover at Parel	1+960	2+060	31.49	24.32	18.7	-	1 in 48
Corridor passes through Parel to Elphinstone Flyover	2+060	2+410	23.6	23.21	12	Horizontal	
Corridor passes through Elphinstone Flyover to Senapati Bapat Road	2+410	2+800	23.4	23.2	14.53	Horizontal	
Corridor passes through Senapati Bapat Road, Parel Bus Depot , Kamgar Nagar	+2+800	4+100	23.4	15.10	8.64		1in 40
Corridor passes through Annie Besant Road and enters to Narayan hardilar Road	4+100	4+200	15.10	10.72	4.659		1in 40
Corridor meets ground on Narayan hardilar	4+200	4+512			0.00		1in 30

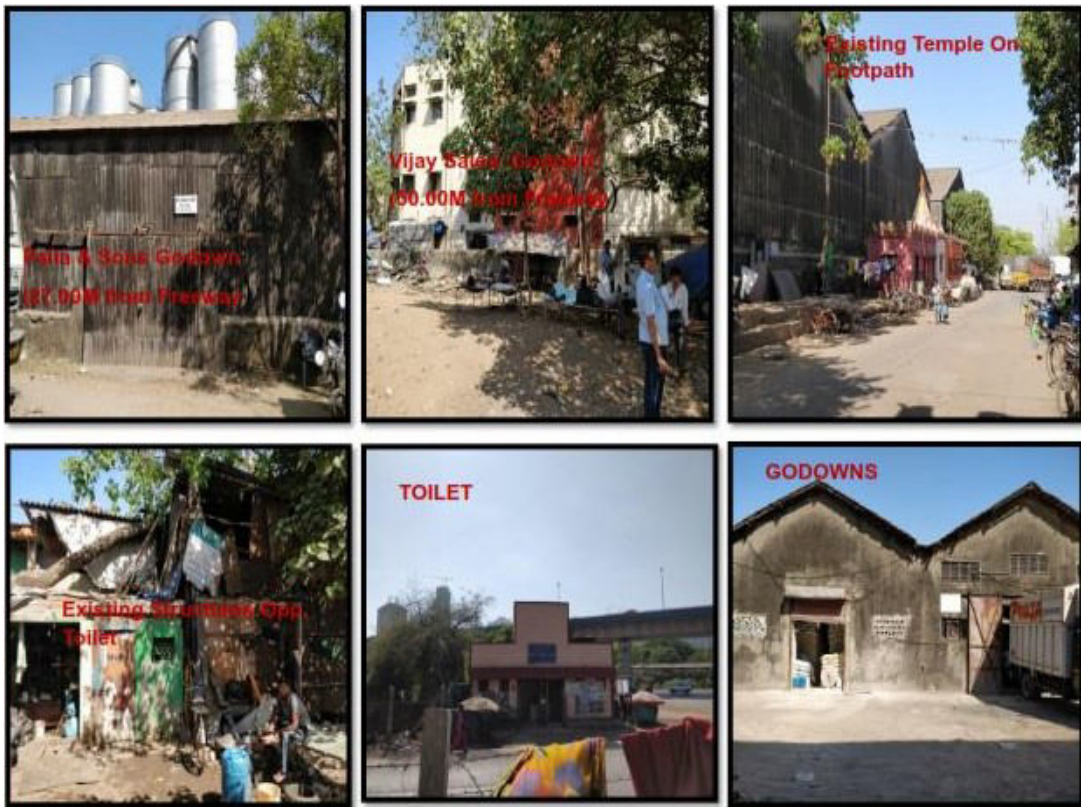
Table 7. 7 Details of Obligatory Spans

Obligatory Span No.	Obligatory Span details	Obligatory Pier Location		Span (m)	Obligatory Superstructure Type
1	Crossing Proposed Mumbai Metro Line 4A	0+120	0+170	50.0	
2	Crossing Eastern Freeway , Sewri Station , Proposed Elevated CSMT Panvel	0+170	0+270	96.0	
3	Crossing at Rafi Ahmed Kidwai Marg with ramp connectivity	0+326	0+376	50.0	
4	At Acharya Donde Marg & Tokarsi Jeevraj Marg	0+630	0+680	50.0	
5	Crossing G.D. Ambedkar Marg & Entry of Monorail	1+091	1+144	52.5	
6	Crossing Monorail Station	1+341	1+426	85.0	
7	Crossing At Lalbag Marg Bhaykhala & Monorail exist point	1+686	1+736	50.0	
8	Crossing of Hindmata Flyover on Ambedkar Road	1+960	2+060	100.0	
9	Start of Elphinston Bridge	2+195	2+245	50.0	
10	Crossing Elphinston ROB	2+407	2+506	98.1	
11	Crossing Senapati Bapat Flyover	2+783	2+835	52.5	
12	Junction crossing NM. Joshi Road	3+062	3+112	50.0	
13	Crossing New Prabhadevi road	3+112	3+162	50.0	
14	Crossing Annie Besant & Veer Sawarkar Road	4+097	4+147	50.0	
15	Crossing junction of Temkar Marg and New Prabhadevi Road	4+147	4+197	50.0	

7.10 Major Issues In Alignment

7.10.1 Dispersal at Sewri End (East side of Sweri Station)

The project starts from the eastern side of Eastern Freeway and will cross Eastern Freeway & Harbour Railway Tracks before meeting the proposed Sewri Interchange. Few encroachments have to be vacated from the footpath and road areas. Proper safety & traffic diversion plans especially during construction of bridge over tracks is envisaged.



7.10.2 Thakre Udyan -

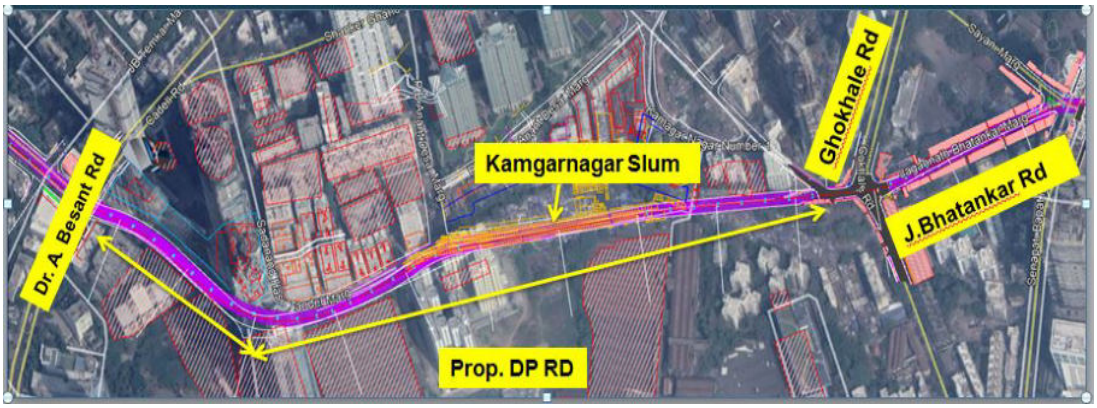
There are some aprx.10 to 12 low level structures near the Probhodankar Thakre Udyan (Aacharya Donde Marg) which are very close to the proposed alignment, which may be affected during course of construction.

7.10.3 Elphinstone Station -

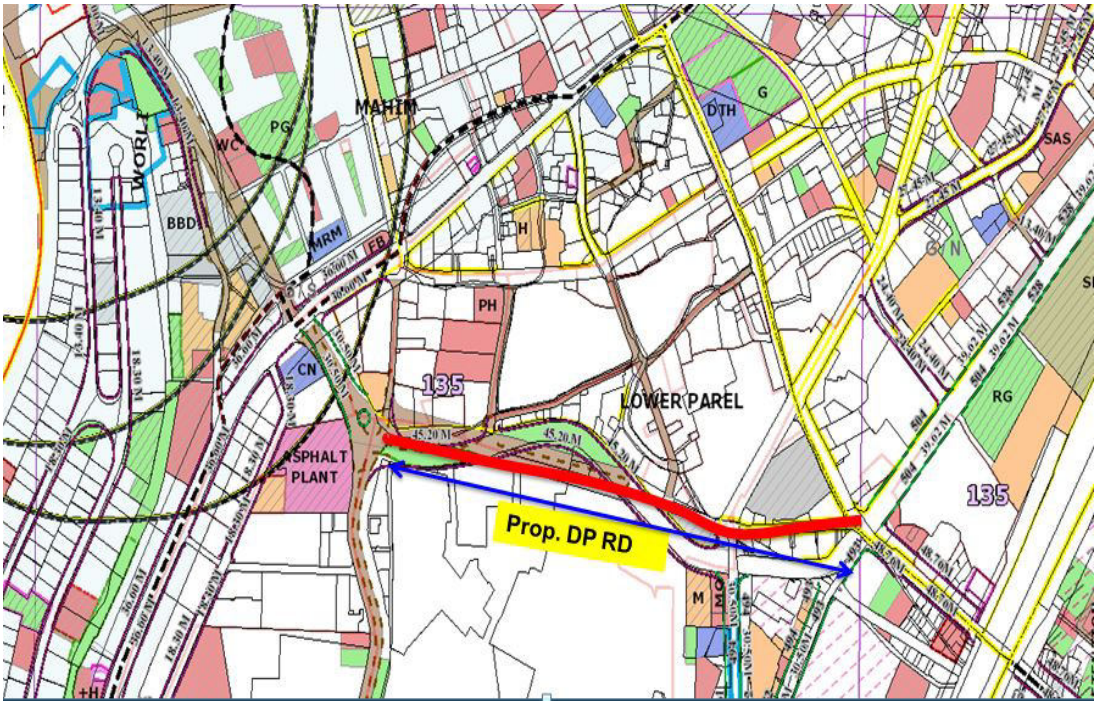
There are 2 buildings (G+3) in dilapidated condition near the Elphinstone Station which are very close to the proposed alignment which may be affected during course of construction.

7.10.4 Kamgar Nagar II -

Proposed Sewri- Worli Elevated Connector alignment is passing along Existing Road except Kamgarnagar area. Alignment traverses through Jagannath Bhatankar Marg and after crossing Gokhale road Junction, it reaches at Dr. Annie Besant Road in between Ghokhale Chowk and Dr. Annie Besant Road, alignment traverses through Proposed DP Road.



Slum pocket is located along Proposed DP Road named as Kamgarnagar.



A time bound programme by SRA (Slum Rehabilitation Authority, Mumbai) is required to resolve the issue of Kamgarnagar Slum before initiating Tender Process.

CHAPTER - 8
PLANNING CRITERIA AND PRELIMINARY DESIGN

CHAPTER – 8

PLANNING CRITERIA AND PRELIMINARY DESIGN

8 PLANNING CRETERIA AND PRELIMINARY DESIGN

8.1 Planning of Elevated Corridor

The considerations which guide the decision making in planning and design of elevated road in Mumbai urban areas are:

- Elimination / reduction of conflicting traffic streams
- Hierarchy of the intersecting roads after merging of MTHL traffic.
- Feasibility with respect to available space and minimum land acquisition
- Intersection traffic characteristics including junction delay considerations
- Present development level and proposed development pattern for the influence area
- Lack of alternative routes / modes.
- Utilities present at the project location, feasibility of shifting / relocation
- Other major infrastructure projects planned and integration of same.
- Cost and Economic considerations
- Traffic diversions and management during construction

8.2 Planning Criteria

The following paragraphs briefly highlight the various design considerations and standards used for the present proposal. It is important to review the design criteria in the context of Mumbai urban development – especially with due consideration to traffic flow, existing road networks, development pattern, available right of way, existing road geometric conditions like degree of curvature and rise/fall etc.

The Indian Roads Congress and the Ministry of Surface Transport and Highways specify various guidelines and specifications for elevated roads, flyovers, junctions and other facilities pertaining to elevated roads. These specifications are largely based on the theoretical considerations and ideal situations which are seldom available in urban situation for a city like Bangalore. Hence, in the present proposal, certain changes and modifications in the design standards are reviewed and adopted under extreme conditions keeping in view the site constraints.

8.3 Design Basis of elevated corridor

Design standards for the Design of Horizontal and Vertical Geometry and other road elements are used referring following guidelines of Indian Roads Congress:

- IRC: SP: 90-2010 “Manual for Grade Separators & Elevated Structures”
- IRC: 92-1985 “Guidelines for the Design of Interchanges in Urban Areas”
- IRC: 86-1983 “Geometric Design Standards for Urban Roads in Plains”
- IRC: 106-1990 “Guidelines for Capacity of Urban Roads in Plain Areas”

Various Design standards considered in the project are briefly stated below.

The horizontal geometry will be designed in accordance with Clause 10 of IRC: 86-1983 generally. Following considerations are made in horizontal geometry design

- Minimum disturbance to existing structures, which are already constructed, based on inputs from MMRDA in various meetings/discussions.
- To maintain existing road horizontal geometry to the extent possible.
- Road widening considering building lines/compound walls on either side of existing carriageway.
- Vertical alignment/grade to be governed by immediate access to properties /rail – road grade separated structures (Existing and proposed), adjoining junctions, interchanges and road ends.
- Rise and fall of existing road in design of the facility.

The geometric design parameters were discussed with MMRDA and presented to Hon. Chief Engineer to obtain approval. The consultant had explained various site-specific issues / constraints, which would affect planning and design of third level corridor and opinion of the experts, were taken in further designs.

8.4 Design Speed

The design speed for elevated corridor in proposed link is generally governed by the existing road plan, building lines, possible land acquisition extents, utilities and heterogeneous traffic flow. The most critical sections governing the design speed is the turning movement of vehicles on curves and available sight distance to plying traffic. As per IRC, design speed for sub arterial road is 60 Kmph and Collector Street is 50 Kmph. For the project stretch, most of length is on straight reach with very flat horizontal curve. However, little short section on the project road is with very sharp curvature where increased design speed cannot be followed without land acquisition. Considering above factors, design speed of 50 Kmph is adopted for design of geometry at this section of road. For exceptional locations and ramps, design speed of 30 Kmph is adopted.

8.5 Design Life

It is proposed to adopt a design life of 100 years for the bridges & viaducts along the corridor. The minimum design lives to be adopted for various structural elements are as given below in the table 8-1:

Table 8. 1 Design Life

Structural Element	Proposed Design Life (in years)
Foundations	100 Yrs.
Piers	100 Yrs.
Superstructure	100 Yrs.
Bearings	50 Yrs.
Expansion Joints	50 Yrs.
Parapets/Crash Carriers	50 Yrs.

8.6 Geometric Standards

The Project Corridor shall be designed for the following geometric design standards:

Table 8. 2 Design Parameters

Parameter	Value
A) FOR MAIN CORRIDOR	
Design Speed	80 km/hr
Carriageway Width	2 x 7.50 m
Desirable min. Horizontal Radius	600 m
Absolute min. Horizontal Radius	250 m
Stopping sight distance	180 m
Maximum vertical gradient	3.3%
Minimum vertical curve	60 m
Maximum Super Elevation	4 %
Prohibited users	Two-wheelers, Three-wheelers, Pedestrians, bicycles, hand or animal drawn vehicles

8.7 Structural Design

The project consists of elevated road between Sewri and Worli with entry and exit ramps at proposed elevated Sewri interchange and Hindamata flyover and at the end of the corridor. There are few stretches of the corridor at which corridor super structure supported on Portal type structure. The substructure and superstructure elements are with prefabricated structural steel at ROB at Elphiston railroad structure.

The pile foundation, pile cap and deck slab in superstructure shall be with cast in place concrete. The structural design shall be based on the Indian Standard Codes for Roads supplemented by the International Standard Codes wherever the form:

Table 8. 3 Indian Standard Codes

IRC:5-2015	Standard Specifications and Code of Practice for Road Bridges, Section -I, General Features of Design (Eighth Revision),
IRC:6-2017	Standard Specifications and Code of Practice for Road Bridges, Section II, Loads and Stresses,
IRC:18-2000	Design Criteria for Pre stressed Concrete Road Bridges (Post-Tensioned Concrete).
IRC:21-2000	Section III - Cement Concrete (Plain & Reinforced).
IRC:24-2010	Standard Specifications and Code of Practice for Road Bridges, Section V, Steel Road Bridges
IRC:45-1972	Recommendations for estimating the resistance of soil below the maximum scour level in the design of well foundations of bridges.
IRC:78-2014	Standard Specifications and Code of Practice for Road Bridges, Section VII, Foundations and Substructure (Revised Edition),
IRC:83-2015	Standard Specifications and Code of Practice for Road Bridges, Section IX, Bearings (Elastomeric Bearings), Part-II (Second Revision)
IRC:SP:33-1989	Supplemental Measures for Important Bridge Structures.
IRC:SP:64-2005	Guidelines for the Analysis & Design of Cast-in-place Voided Slab Superstructure.
IRC:SP:65-2005	Guidelines for the Design & Construction of Segmental Bridges.
IS:875 (Part 1)-1987	Practice for Building and Structures – Dead Loads.
IS:875 (Part 2)-1987	Practice for Building and Structures – Imposed Loads.
IS:875 (Part 3)-1987	Practice for Building and Structures – Wind Loads.
IS:2911-1987 (Part I, Section 1)	Code of Practice for Design and Construction of Pile Foundations (Driven Cast in Situ Piles).
IS:1893-2000	Criteria for Earthquake resistant Design of Structures.
IS : 2911 - 1987 (Part I, Section 2)	Code of Practice for Design and Construction of Pile Foundations, Precast Concrete Piles.
IS : 2911 - 1980 Part III	Code of Practice for Design and Construction of Pile Foundations, under reamed Piles.
IS : 2911 - 1985 Part IV	Code of Practice for Design and Construction of Pile Foundations, Load Test on Piles.
AASHTO	Guide Specifications for Design and Construction of Segmental Concrete Bridges, 1989 with revisions.

Notwithstanding the above, before the start of the work, all design parameters including the various codes & specifications to be adopted shall be got approved.

Design Specifications and Codes for viaduct portion across Railway tracks (within Railway Area) / R.O.B. for structure within Railway area, provision as per following Indian Railway Standard Code shall be made.

(1) Code of Practice for Plain, Reinforced, and Pre-stressed Concrete for General Bridge Construction (Concrete Bridge Code) Second Revision – 1997.

(2) Code of Practice for the design of sub-structures and foundations for Bridges (Bridge sub-structures foundation code).

(3) Specification for RCC/PSC for the construction, Rehabilitation of Concrete Bridges and structures on Central Railway (open line) issued on 1/12/2000.

8.8 Design Loads

The structure shall be designed for various loads as per IRC 6-2000 as described below.

1) Dead Load of Superstructure
2) Superimposed Dead Loads
3) Vehicular Live Load
4) Breaking force
5) Active Earth Pressure
6) Earth Pressure due to Live Load Surcharge on backfill
7) Centrifugal force
8) Bearing Friction
9) Wind force
10) Earthquake force
11) Collision Load

Density for different materials to be considered for design –

Prestressed Concrete - 2.6 t/m3

Reinforced Concrete - 2.5 t/m3

Plain Cement Concrete - 2.4 t/m3

Wearing Coat - 2.2 t/m3

Soil (Dry) - 1.8 t/m3

Soil (Saturated) - 2.1 t/m3

The particular loading applicable to the project are enumerated below:

- For all the structures, vehicular live load shall be considered as per the provisions of IRC: 6 - 2000 as applicable for different widths of Carriageways.
- For overall movement of the bridge, the temperature difference of ±25°C shall be considered as per provisions in IRC: 6-2000. The distribution of temperature

difference between top & bottom deck will also be considered according to the Code.

- Wind Loads : Full wind force on live load and structure, applied perpendicular to the structure, or 65% wind force perpendicular to traffic direction and 35% wind force parallel to traffic direction on live load and structure whichever produces the worst effect shall be considered.
- Earthquake Load: Structures will be designed for Zone III according to IRC - 6, soil foundation factor b = 1.0 (bearing piles on rock) and importance factor I =1.5. Horizontal Seismic Coefficient for longitudinal and transverse direction will be calculated using the provisions published in Journal - 'INDIAN HIGHWAYS' of January 2003 amendments to IRC provision of seismic forces (Cl. No. 222). Earthquake load thus calculated shall be applied in the longitudinal or transverse direction; whichever produces the maximum effects.
- Collision Loads on Pier: Collision loads of 100 Tonnes parallel and 50 Tonnes transverse to the carriageway shall be considered for the piers located at junctions / road crossings etc. according to IRC 6 : 2000 Table 7. For additional safety, a reinforced concrete wall 1.0 m high with sand in-fill cushion shall be provided around the periphery of the piers of obligatory spans across major cross roads.
- Centrifugal Force: In the curved decks, the effects of centrifugal force as specified in IRC 6: 2000 in the deck, bearings and substructure shall be included.
- Load combinations: Load combination Groups I to VII shall be considered in accordance with IRC 6 - 2000.

8.9 Broad Details of proposed Corridor

The proposed alignment of the corridor is as given in Table below:

Table 8. 4 Details of proposed alignment

Main Structural Object	Chainage
Viaduct starts at end point of MTHL Sewri link ramp	0+000 to 0+120
Proposed Metro Rail crossing	0+120 to 0+170
Crossing of Eastern Freeway & Sewri station & Proposed Elevated CSMT Panvel	0+170 to 0+265
Crosses R.A. Kidwai Marg, along Acharya Donde Marg up to start of UP & DOWN Ramp	0+265 to 0+520
UP & DOWN Ramp for connecting Acharya Donde Marg	0+520 to 0+840
Parallel to Acharya Donde Marg up to G.D. Ambekar Marg	0+840 to 1+090
G.D. Ambekar Marg with Monorail crossing up to Monorail station	1+090 to 1+340

Main Structural Object	Chainage
Monorail station to end of Monorail crossing up to Lalbag Marg Bhaykhala	1+340 to 1+740
Lalbag Marg Bhaykhala to Crossing of Hind Mata flyover	1+740 to 2+055
Hind Mata flyover to start of Elphistion ROB	2+055 to 2+404
Elphistion ROB	2+404 to 2+509
Elphiston ROB end to Senapati Bapat road	2+509 to 2+845
Up to Gokhale Road (Along J. Bhatankar Marg)	2+845 to 3+100
Up to Dr. Annie Besant Road (Along Kamgar nagar)	3+100 to 4+140
Solid Ramp Portion (Along New Prabhadevi Road)	4+140 to 4+512

8.10 Wearing coat for Corridor & Ramps

It is proposed to design the Pavement wearing coat on structural portions for a service period of at least 10 years. The specifications for the pavement will be adopted in conjunction with the deck design and accordingly to the anticipated temperature and traffic volume.

The design of the pavement will allow its renewal economically without causing any damage to the structure. The minimum thickness of the asphalt pavement proposed for the design shall be 87.5 mm which will include the waterproofing membrane also. The 87.5 mm thick pavement shall comprise of the following three layers

- waterproofing layer
- Middle Layer – 75 mm th. Bituminous concrete
- Top Layer – 12.5 mm paver laid mastic asphalt with stone chips on top.

8.11 Preliminary Grade separated elevated road Design

8.11.1 Span Arrangements

Proposed viaduct for MTHL dispersal from Sewri Interchange to Worli is located in the area where ground profile is level in most of the area and slightly undulating where the alignment passing through fully developed locations and busy stretch.In general, Pile foundations will be adopted for most of the portion of viaduct since rock is available at larger depth. The proposed MTHL dispersal alignment has to pass over the proposed Churchgate-Virar Elevated Rail Corridor at the Elphinstone Bridge Location and also required to pass over the ongoing Monorail Project for a small stretch of approx. 600 m along the Acharya Donde Marg. Due to this, the height of substructure will be mostly in the range of 16m to 26m for the corridor upto the Junction of Senapati Bapat Marg. Thereafter the alignment starts falling with a down gradient of 1 IN 160. Along the

Drainage Channel Road the height of sub-structure falls from 14m to 6 m. The corridor crosses the Dr. Annie Besant Road with a clearance of approx. 6m and from there on the alignment has been proposed to be kept at a down gradient of 1 in 40 to attain the G.L.

For the monorail part & Railway Span at Elphinston Bridge, it is proposed to provide portal substructure arrangement as there is no scope to provide single pier substructure. For rest of the corridor single pier sub-structure is proposed.

Precast Segmental type superstructure for 4 lane main carriageway is proposed except for the Railway Spans at Sewri & Elphinstone Bridge. For the Railway Spans at Sewri & Elphinstone Bridge it is proposed to provide superstructure made up of structural steel .Considering the height of the substructure it is proposed to provide spans in the range of 20 to 25m. To cross the Railway Spans at Sewri Interchange Area & Elphinstone Bridge, existing Flyovers, existing junctions along the corridor, obligatory spans has been provided. The spans will be proposed considering smooth traffic flow and according to geometry and orientation of the intersection of the road below, the pier locations will be fixed. Also the spans will be adjusted to maintain uniformity and standardization.

8.11.2 Safety

The design shall be safe and robust with a reasonable allowance for unforeseen loads and varying geotechnical conditions.

8.11.3 Inspect ability and Maintainability

Bridge components such as bearings, expansion joints, lamp posts and items of instrumentation shall be designed such that they are easy to replace. Provisions shall also be made to ensure easy access and an adequate level of safety during inspection and maintenance operations.

CHAPTER - 9
ENVIRONMENTAL IMPACT ASSESMENT

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9 ENVIRONMENTAL IMPACT ASSESMENT

9.1 Introduction

As per notification of 14th September 2006 under the provision of Environment (Protection) Act 1986, there are mainly four chapters and 26 sections. Chapter 2 has general powers for Central Government and Chapter 3 mainly relates to Prevention, Control & Abatement of Environmental Pollution. Expansion or modernization of any activity (if population load is to exceed the existing one) or new project listed in the schedule of notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central or State Government in accordance with the procedure specified in the notification. As such EIA is mandatory for such type of developmental projects.

Accordingly the objective of the EIA Study will be to assess the environmental sustainability of the project and minimize the environmental impacts of the various environmental factors.

Objectives of Environmental (Protection) Act 1986

- Regulation of Discharge
- Handling of Hazardous substances
- Speedy response to accident threatening environment
- Deterrent punishment to those who endanger human environment, safety and health.

Restriction of areas in which any industry

- Shall not be carried out or
- Shall be carried out subject to certain conditions

9.2 Baseline Environment

The assessment of baseline environmental conditions of various environmental attributers, which may be affected by the proposed project, is a pre-requisite for an Environmental Impact Assessment (EIA) study. An overview of the various environmental attributes viz. air quality, noise levels, land use, heritage monuments etc have been presented in the following paragraphs.

9.2.1 Geographical and Environmental Setting of the Project

The Table 9.1 gives the Environmental setting along with the topographical features of study area within the 10 km.

Table 9. 1 Geographical and Environmental Setting of the Project

Sr.	Item	Details
1	Location	**Sewri Worli Railway Station to Worali Sea Link** Sewri Interchange area, traversing to Acharya Donde Marg, J. Bhatnakar Marg (Elphinstone road), Kamnagar, and Prabhadevi new road before joining Khan Abdul Gaffar Khan Marg at Worli.
2	Latitude/ Longitude	Chainage 0 – N 18° 59' 55'', E 72° 36' 82'' Chainage 5800 – N 19° 42' 67'', E 72° 48' 59''
4	General Elevation	5m average
5	Soil type	The predominant soil cover in Mumbai city is sandy whereas in the suburban district, the soil cover is alluvial and loamy.
6	Climatic conditions	Avg Max Temp is 31.2 °C, Avg Min Temp is 23.7 °C. The average total annual rainfall is 2146.6 mm.
7	Nearest Highways	Eastern Freeway, Sion-Panvel Highway, NH-4 and NH-3
8	Nearest Rly. Station.	Sewri Railway Station
9	Nearest Airport	Santacruz Mumbai Airport
10	Present site land status	Heavily Built up with residential, commercial structures
11	Nearest Water Bodies.	Arabian Sea
12	Archeologically Importance place.	Sewri Fort & Worli Fort
13	Seismic zone	Seismic Zone III as per IS: 1893 (Part-I) 2002.

9.2.2 Topography and Geology

The proposed project of construction of elevated corridor Sewrito Worali road falls in the typical urban setting having congested areas with high rise residential and commercial buildings.

The geology of the region is typical of the west coast i.e. clayey soil underlain by basalt rock formations.

9.2.3 Climate and Meteorology

The historical data collected from India Meteorological Department (IMD) and other secondary sources to represent the metrological conditions of the project area has been

reviewed and presented below:

Temperature

India Meteorological Department (IMD) records indicate that Mumbai experiences tropical coastal climate. The moderating effects of the nearby sea and the fairly high amount of relative humidity in the atmosphere have restricted the variability. The seasonal variations of temperature follow closely the course of the sun. January is invariably the coldest month and May the warmest. With the onset of monsoon in early June there is a reversal of the temperature curve and the temperature during the period of monsoon remains very nearly uniform at about 270C. The slight rise in temperature in October falls gradually till it reaches the coldest month in January. Based on past data, the mean daily temperature during the year varies from 240C to 330C. Highest recorded temperature is 40.60C. The mean daily maximum and minimum temperatures for the Mumbai region are given in Table 9.2.

Table 9. 2 Maximum and Minimum Temperature at Mumbai

Month	Temperature	
	MD Max	MD Min
January	31.8	16.9
February	29.9	17.5
March	32.7	20.7
April	32.0	23.2
May	32.8	26.5
June	32.7	27.5
July	31.2	25.9
August	29.8	25.2
September	31.2	24.8
October	32.6	23.8
November	34.3	21.8
December	33.4	19.0

Note: MD Max – Mean Daily Maximum, MD Min- Mean Daily Minimum

Source: India Meteorological Department

Wind

The predominant direction of wind during October to May is from north-east in the mornings and north-west during the afternoons. However, during the monsoon months

i.e. June to September, the wind is predominant from the south-west quarter, both in the morning and afternoon. The maximum wind speeds for most of the time during the year is from north-west quarter with strong winds predominant during south –west monsoon period. The average wind speed and direction for Mumbai is presented in Table 9.3. The wind speed is observed to be between 4.8 km/hr to 12.7 km/hr.

Table 9. 3 Wind Direction and Wind Speed at Mumbai

Month	Morning (08:30 hrs.)		Evening (17:30 hrs.)	
	Direction	Average Speed (kmph)	Direction	Average Speed (kmph)
January	NE	5.7	NW	5.7
February	NE	6.9	NW	6.9
March	NE	7.8	NW	7.8
April	S	9.0	NW	9.0
May	SW	9.3	W & NW	9.3
June	W	11.8	W	11.8
July	W	12.7	W	12.7
August	W	10.5	W	10.5
September	W	7.7	NW	7.7
October	E	4.8	NW	4.8
November	E	4.8	NW	4.8
December	E&W	4.9	NW	4.9

Source: Draft Regional Plan of MMRDA (1998-2011)

Humidity

The Relative Humidity (RH) ranges between 61% to 87% in the monsoon period. Between Novembers to January i.e. in the winter months, the relative humidity varies from 57% to 72%. The Relative Humidity generally is higher than 60% throughout the year. The monthly variation of relative humidity in the region is shown in Table 9.4

Table 9. 4 Relative Humidity in Mumbai

Month	Relative Humidity	
	Mean Maximum (%)	Mean Minimum (%)
January	81	23
February	82	34
March	86	37
April	85	45
May	81	60
June	80	63
July	87	74
August	92	80
September	90	66
October	88	59
November	81	37
December	82	26

Source: India Meteorological Department

Cloud Cover

Skies are mostly overcast during the monsoon months i.e. starting from May right till September. During the winter and the post monsoon seasons skies are generally clear. Maximum number of overcast days is observed during the month of May.

Rainfall

Monsoon generally sets in around the second week of June and continues till late September. July and August are the wettest months all over the region. There is hardly a day without rain, in these two months. Towards the later part of the season, there are breaks in between, when the oppressive hot weather is associated with high humidity along the coast. The average rainfall in the region is nearly 2000 mm. Average monthly rainfall for Mumbai is indicated in Table 9.5.

Table 9. 5 Normal Rainfall at Mumbai (Based on 50 years data)

Month	Rainfall in mm
January	4.1
February	2.0
March	1.5
April	1.5
May	18.3
June	464.8
July	613.4
August	328.9
September	286.0
October	64.5
November	17.5
December	2.3
Annual	1804.8

Source: India Meteorological Department

Cyclone

The west coast is subject to occasional severe cyclonic storms. These storms normally occur in the period of May/June and October/November.

Visibility

The visibility in this area is normally good except high peaks of hills which are not visible clearly from a distance of more than 5 km. Foggy condition prevail during winter and

heavy rains. As per the atmospheric visibility data obtained from IMD, the number of days during which visibility is poor (upto 4 km) are very few. Visibility is 4 to 10 km during 25% of the days in the year. The number of days with poor visibility is maximum during the month of December. Visibility during evening is much better than the early morning hours.

9.3 IMPACT ASSESSMENT

The environmental impacts are categorized as either primary (direct) or secondary (indirect). Primary impacts are those which are attributed directly by the project whereas secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns or social and economic activities due to the proposed project. Typically, the potential direct and indirect impacts of the present project are listed below:

- Air pollution;
- Noise;
- Ecology;
- Traffic
- Utilities
- Landscape;
- Social.

9.3.1 Structure of the Assessment:

The assessment consists of the following:

- Review of history of the project and the brief details of the proposed project including the suggested construction methodology
- The assessment of various impacts on different environmental attributes with mitigation measures to ameliorate the same. The impacts are identified for pre-construction, construction and operation stages of the project on various environmental parameters and site-specific issues both during project construction and operation phases of the project.
- The recommended EMP, both for construction and operation phases of the project. Also suitable environmental monitoring plan/ schedule for the key environmental parameters, recommended mitigation measures, and Institutional strengthening/ environmental risk and disaster management plan.
- The magnitude of the impacts with respect to the environmental aspects needs to be studied in detail and accordingly the process for detailed study has been initiated.

Assessment of Impacts

The reconnaissance of the proposed project site has been carried out and the final alignment has been studied keeping in mind environmental aspects. Primarily following parameters are identified which would have impacts due to the proposed corridor. These include:

- ❖ Impact due to alignment
- ❖ Impact due to construction work
- ❖ Impact due to project operation

9.3.2 Impact Due to alignment and mitigation measures

9.3.2.1 Change of Land Use:

Throughout the project, the alignment is elevated carriageway. On Sewri side the alignment passes mainly through Government Land and from the Sewri Depot the alignment passes over the existing roads along the corridor. As such there is very minimum impact on the land use pattern.

9.3.2.2 Mitigation measures:

The project shall be developed with a view to minimizing the need for land acquisition keeping in view the functional requirements and in accordance with the government regulations.

a) Ecology & Biodiversity:

The project area consists of main & arterial roads including residential & commercial establishments. As such every less disturbance will be caused to Ecology & Biodiversity. The trees lost will be very less and compensatory afforestation will be taken.

Mitigation measures:

Care will be taken to minimize damage to ecology & biodiversity and to restore biodiversity. Pollution prevention plans will be evolved to minimize/ prevent pollution at source.

b) Loss of Historical & Cultural Monuments:

No. historical/ cultural monuments will be affected as result of the proposed development.

Mitigation measures:

Surveillance monitoring will be carried throughout entire construction period.

9.3.3 Impacts Due to Project Construction.

a) Air Pollution:

Impact on Ambient Air Quality during construction stage is anticipated. The adverse impact will be primarily due to transportation of construction material, loading & unloading of construction materials and plying of construction vehicles. Emissions from these sources will have temporary but not significant impact on air quality.

Mitigation measures:

- Dust suppression of haul roads, unsealed roads and work areas using a water truck;
- Damping of stockpiles, primarily using water;
- Trucks carrying soil, sand or stone will be covered with traps to avoid spilling and blowing by wind from quarry to the site of construction;
- Regular maintenance of all construction machinery and vehicles;
- Exhaust & noise emissions of construction equipment's will adhere to emission norms as laid out by MoEF/CPCB;
- The contractor shall ensure that batching plant is located away from the residential areas.

b) Noise Pollution:

The main sources of noise during construction are construction equipment and the vehicles used for transporting various materials at the construction site. The magnitude of impact from noise will depend upon types of equipment to be used, construction methods and also on work scheduling. Effect of increase in noise levels will be significant during night time near the residential area located close to the site. Operation of construction machinery e.g. hot-mixer, bulldozer, loader, backhoes, concrete mixer, etc will lead to rise in noise level to the range between 80-95 dB (A).

Mitigation measures:

- Special acoustic enclosures shall be provided for individual noise generating construction equipment like DG sets. The special acoustic enclosures may be provided by way of noise shields.
- Provision of earplugs to the construction workers working close to the noise generating source
- Generation of high noise to be avoided between 10 p.m. and 6 a.m. in residential and sensitive areas.

c) Construction & Labour Camps:

Construction camps include workers' residential areas and the grounds where equipment

is stored and serviced and where materials are stockpiled. Careless construction camp design and management can lead to serious environmental degradation including

- sewage and garbage pollution;
- depletion of fauna and flora through illegal harvesting (poaching);
- infrastructure overloading- health services,
- sewage treatment,
- schooling
- law enforcement; and
- Spills from construction equipment operation and servicing.

Mitigation measures:

- Proper sanitation including toilets and bathrooms will be provided to the labour camps.
- Sewage and other wastages generated in the labour camps would be treated properly and disposed in proper manner.
- The casting yard will be located as far as away from the habitation.

d) Siting of Borrow and Quarry Material Areas

Construction will require transportation and handling of materials in large volumes. The volume of natural materials required is so large that careful consideration needs to be given to identify the sources. The transportation of these materials could severely over load the existing road network. Transportation of other materials like cement, steel will aggravate the situation. Some of the basic materials like aggregates -coarse & fine, murum can be procured locally from the surrounding quarries.

Significant impact on geological resources is anticipated to occur at quarry sites and borrow area due to the requirement of huge construction material. It will be ensured that sand (It is proposed to use crushed stone sand instead of dredged sand), aggregates and other quarry material be procured from licensed quarries. It would be ensured that borrow and quarry areas that have been identified are approved and authorized to operate by competent authorities.

Also, during construction phase, it is recommended that the opening up of new borrow pits shall be in accordance with the IRC: 10-1961 specifications. Top soil (upto 150 mm) to be preserved and reused as the resurfacing material for the berms, slopes and central verge of the road where plantation / grasses will be developed.

Mitigation measures:

- Quarrying should not be done up to ground floor level, as it results in preventing flooding and letting the surrounding water into the quarry-pits. It is also unsafe for the population in the surrounding area who might meet with accidents and may accidentally drown in the collected water.
- Quarrying should be done in benches i.e. at an angle and at regular angles. A
- Bench of 5 m should be provided before the next higher up slope is cut.
- The sequence should be from the rear to front from aesthetic point of view.
- After the work is over, the quarry site should be planted with shrubs and trees of indigenous variety to merge within the existing landscape.
- Quarries should be carefully levelled to avoid de-stabilisation of slope and the general landscaping will be easier due to rock and soil content.

9.3.4 Impacts Due to Project Operation.

a) Air Pollution:

During operation stage of the Sewri-Worli Elevated corridor, major impact will be on the air quality due to the vehicles plying on the corridor. The impacts have been predicted along the alignment based on the existing levels of air quality, traffic, meteorology etc.

Mitigation measures:

- Road Furniture/Signboards will be put along the approach roads and at project building requesting motorists to avoid idling or/and stoppage of the vehicles at non-designated places.
- Continuous monitoring of parameter such as CO will be carried out by installing monitoring stations on both the ends of the bridge. A mobile monitoring van will also have a vigil on the bridge for air quality monitoring.
- Micrometeorological station is proposed on the Sea Link which will continuously monitor wind speed, wind direction, relative humidity, and temperature. This will facilitate the knowledge of meteorological factors which are important and have co-relation with the ambient air quality.

b) Noise Pollution:

During operation stage of the Sewri-Worli Elevated corridor, major impact is expected on Noise levels due to the vehicles plying on the corridor.

Mitigation measures:

- Road Furniture/Signboards will be put along the approach roads and at project building requesting motorists to avoid idling or/and stoppage of the vehicles at non-

designated places.

- Provision of noise barriers all along the corridor.
- Micrometeorological station is proposed on the Sea Link which will continuously monitor wind speed, wind direction, relative humidity, and temperature. This will facilitate the knowledge of meteorological factors which are important and have co-relation with the ambient air quality

9.4 ENVIRONMENTAL MANAGEMENT PLAN

9.4.1 Construction Stage

As discussed above the construction stage of Sewri to Worli East-West corridor will involve impacts of different magnitudes on the different environmental components but these would be of purely temporary nature. The need for an accurate evaluation and planning of mitigation measures for risks associated with construction activities such as accidental spillages and consequent damage to the surrounding environment in terms of loss of flora and fauna etc. is of prime importance. Other possible locations where safety measures will be useful include the locations of Hot Mix plants, casting yard, batching plants, quarries and labour-camp sites. The mitigation measures are proposed in the Table 9-6.

A) Operation Stage

The operation stage will essentially entail monitoring activity along the corridor. The monitoring for pollutants specified in the Monitoring Plan will serve two purposes. In addition to checking the efficacy of the protection/mitigation/enhancement measures implemented, this will help verify the predictions made as a part of the impact assessment. The measures adopted and/or to be adopted during the different stages of the project have been detailed in Table 9-1.

The mitigation measures recommended will become part of Tender Documents. The major instruments of Environmental Management will be provided in the Tender Document.

9.4.2 EIA Action Plan:

- The action plan for Environment Impact Assessment will consist of the following:
- To carry out the preliminary environmental screening to assess the direct and induced impacts due to the project
- To document the baseline conditions relevant to the project with the objective to establish the benchmarks

- To assess the potential significant impacts and identify the mitigative measures to address these impacts adequately
- To carry out analysis of alternatives incorporating environmental concerns
- To plan for plantation of trees along the existing road in accordance with MCGM Tree authority policy

Table 9. 6 Environment Management Plan

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
Construction Phase:			
Borrow pits and quarry sites development	• Only existing and licensed/approved quarries and borrow areas will be used. • Resurfacing and landscaping of the borrow pits.	Contractor	**MMRDA**
Prevention of erosion and scouring	• Stabilizing embankment with appropriate technique.	Contractor	**MMRDA**
Water logging and stagnation of water in borrow pits	• Uncontrolled digging of borrow pits will be avoided to prevent water accumulation, which results in breeding of vector disease.	Contractor	**MMRDA**
Drainage system	• Providing adequate drainage structure • Avoiding obstruction of existing drainage during filling	Contractor	**MMRDA**
Site for storage and construction camp	• Casting yard and the labour camp shall be located at the suitable locations. The mitigation measures would be implemented to ameliorate the impacts.	Contractor	**MMRDA**
Location of Hot Mix and Batching Plant	• Hot mix and batching plants will be located away from habitation.	Contractor	**MMRDA**
Water quality	• Prior permission of the concerned Engineer and regulatory authorities shall be taken regarding discharging or disposing of any material arising from the execution of works.	Contractor	**MMRDA**
Air quality	• Vehicles carrying construction material shall be covered to avoid spilling • Asphalt mixing plant shall be over 500 m away from any communities and 300 m from the road as far as possible • Water sprinkling in morning & evening hours at Construction yard and unpaved sections of the road to avoid dust generation	Contractor	**MMRDA**
Noise level	• Stationary equipment shall be placed as far away as possible from inhabited areas to minimise noise impacts	Contractor	**MMRDA**

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
	• Construction activities will be scheduled near habitation • Provision of using ear plugs by workers exposed to high noise levels		
Tree plantation and enhancement measures	• Prepare action plan in consultation with Forest Dept. • Budget allocation • Implementation of action plan	Contractor	**MMRDA**
Basic amenities and sanitation facilities for construction labours	Adequate Sanitary facilities will be provided to the workers to avoid health related problem • □ Periodic health check-up will be done	Contractor	**MMRDA**
Sewerage & solid waste disposal at construction camp	• Proper sanitation facilities at construction workers camp • Collection of domestic refuse and its suitable disposal	Contractor	**MMRDA**
Fuel for construction labours	• Adequate supply of fuel (kerosene) shall be provided to construction labours to avoid felling of trees for cooking and other household activities	Contractor	**MMRDA**
Traffic management	• Secure assistance from local police for traffic control during construction phase. • Safety measures will also be undertaken by installing road signs and marking for safe and smooth movement of traffic.	Contractor	**MMRDA**
Occupation health & safety	• Labours will be equipped with proper safety gears like helmets gloves and gumboot • Periodic health checkup of construction worker.	Contractor	**MMRDA**
• **Operational Phase:**			
Air quality	• Monitor periodically ambient air quality at suggested locations • Enforcing different control measures to minimise the air pollution	Contractor	**MMRDA**

Project Related Issues	Action to be Taken	Responsible/Supervising Organization/Authority	
		Implementation	Supervision
Noise level	• Periodic monitoring of ambient noise levels at suggested locations • Erecting signboards at sensitive and residential locations prohibiting use of horns • Growing road side plantation to prevent the noise levels.	Contractor	**MMRDA**
Maintenance of road side plantation	• Plantation will be undertaken on an aggressive note as per Green Belt Management plan • Employment of people for the maintenance of plantation along the ROW in the initial 3 years	Contractor	**MMRDA**
Road safety and traffic Management	• **Prepare and administer a monitoring system on road accidents** • **Adequate number of proper signs with clear visibility shall be installed along the road**	**Contractor**	**MMRDA**

CHAPTER - 10
PROJECT COST

CHAPTER – 10

PROJECT COST

10 PROJECT COST

10.1 General

Traffic requirement for next 20 years is analysed and calculated and finally 4 lane carriageway Elevated corridor having total width 17.10 m (3.75 m Single lane) is adopted for entire corridor of 4.5121 Km. This corridor will be fully elevated and the proposed alignment of the elevated corridor has been kept mostly along the alignment of existing roads. MTHL six lanes will continue as four lane corridor and at Sewri, dispersal ramps are proposed which includes up & down ramps to and from Sewri-Worli connector to Rafi Ahmed Kidwai Road. The up & down ramps to and from Sewri-Worli Connector to Acharya Donde Marg are also proposed. Provision of Six arms in addition to six sewri interchange arms for traffic dispersal in all four direction. Elevated corridor lands at worli which facilate connection to Worli Sea Link and coastal road .

As a part of this Detailed Engineering study, detailed cost estimate has been prepared based on Detail Project Report and General Arrangement Drawings.

10.2 Estimates

The Administrative approval to the project was received in the 132nd Authority meeting held on 23.03.2013 amounting to Rs 517 Cr. The scope of the administrative approval estimate includes construction of Elevated road for the length 4.30 Km for the width of 17 meter .The project also includes construction of ROB at Elphinstone (Prabhadevi) station and Sewri station . This cost doesn't includes Sewri Interchange.

Revised Administrative approval to the estimate amounting to Rs 1276 Cr is received in the 147th Authority meeting held on 27.2.2018.

10.3 Cost Estimate Criteria

In general following major considerations in the cost estimate with configurations proposed in the GAD & Cross-sections prepared and site requirements and all others aspects are

- Four lanes elevated corridor with 17.10 m width & 4.512 km.in length

Sr. No.	Description	Chainage		Length (m)	Structural Arrangement
		From	To		
I	ROB	0+000	0+170	170	Resting on Individual Pier
II	Sewri ROB	0+170	0+266.33	96.33	Steel Truss bridge resting on Capsule type Pier
III	Elevated connector	0+266.3	1+340	1073.67	Box Girder Resting on Indiviual Pier
IV	Down & Up RAMPs for Acharya donde marg & RA Kidwani Marg	0+520	0+830	310	Box Girder Resting on Indiviual Pier
V	Obligatory span (Steel Structure)	0+520	1+425	905	Steel Truss bridge resting on Portal type Pier.
VI	Elevated connector	1+425	1+960	535	Box Girder resting on Portal Pier and Single System
VII	Obligatory span (Steel Structure) Crossing Hindamata Flyover	1+960	2+060	100	Steel Truss bridge resting on Portal type Pier.
VIII	Elevated connector	2+060	2+407	347	Box resting Portal System Girder on Pier
IX	Design & construction of supporting piers for Reconstruction of Exising Elphinstone ROB (98.1 approaches(168 M +197 M) at Level 1 and ROB for Sewri Worli Elevated Road at second level	2+240	2+347	107	ROB
X	Additional spans at 1st level ROB for Vehicular Under pass and staircase on approach road	2+347	2+407	60	ROB
XI	Design & construction of supporting piers for Elphistone ROB (first level & second level)	2+407	2+505.1	98.1	Suoerstructure work shall be carried out by MRIDC

Sr. No.	Description	Chainage		Length (m)	Structural Arrangement
		From	To		
XII	Additional span at first level adjacent to Vehicular Under pass	2+505.1	2+505.1 to 2+565.10	60	
XIII	Dismentling of existing approaches & reconstruction	2+565.10	2+561.10	142	
XIV	Obligatory span	2+780	2+832.5	52.5	Plate Girder resting on Portal Pier System
XV	Elevated connector	2+832.5	to 3+060	227.5	Box Girder resting on Portal Pier System
XVI	Obligatory span	3+060	3+160	100 (2 x 50)	Plate Girder resting on Portal Pier
XVII	Elevated connector	3+160	4+100	940 (2 x 50)	Box Girder resting on Portal Pier System
XVIII	Obligatory span	4+100	4+200	100 (2 x 50)	Plate Girder resting on Portal Pier
XIX	Elevated connector	4+200	4+395.6	195.6	Box Girder resting on Portal Pier System
XX	Approach Worli side	4+395.6	4+512	116.4	RE Wall

- Dispersal system at sewri Sewri with six arms providing ramps at as below

Sr no	Description	Length of Viaduct	Length of Approach	Width
1	Arm 01 (MTHL to CSMT)	453.70	139.15	3.75
2	Arm 02 (MTHL to A. Donde Marg)	157.50	151.80	4.25
3	Arm 03 (A. Donde Marg to MTHL)	406.58	151.80	4.25
4	Arm 04 (MTHL to R.A Kidwai Marg)	393.01	117.20	3.75
5	Arm 05 (CSMT to A. Donde Marg)	436.81	139.14	3.75
6	Arm 06 (A.Donde to R.A Kidwai Marg)	453.70	117.20	3.75

➢ Construction of Two ROBs at Sewri railway station and Elphinstone railway station

3	Rail Over Bridges	Span	Width	RTL	Type of superstructure
3.1	Sewri station	96.00	17.00	31.276	Steel Truss
3.2	Elphistone Station				
	(a) 1st level	98.10	17.2	13.84	Steel Truss
	(2) 2nd level	98.10	17.00	24.47	Steel Truss

- UP and Down at end of corridor on New Prabhadevi approach on Worli.
- Protective Paint.
- Road marking, Traffic singes & Road Furniture.
- Lump sum provisions are made for Utility shifting, Contingencies, Environmental impact assessment.

10.4 Rates

All the rates are taken from Govt. of Maharastra Public Works Department Scheduled Rates 2019-20. Majority of the items are as per SOR, while for few items for which SOR rates are not available, Fair Market Rates are proposed.

Quarry location is Turbhe for sand, metal & other earthwork materials. Cement is from Chembur Refinery and Steel from Kalamboli. Average lead is 30 km considered.

10.5 Recapitulate

Sr No	PARTICULARS	ESTIMATED COST for T.S(Rs Cr)
1	Bridge Elevated Structure (Excluding ROB's & Steel Obligatory)	372.36
2	All Ramps	135.40
3	Obligatory Steel	190.03
4	Cost of Elevated Bridge Via duct Portion,Ramps. Elevated Obligatory Span Portion.	696.79
	Cost of ROBS	113.82
	Total cost	
	a. Casting Yard Development @2 %	14.8
5	b. Design charges @ 1% of	8.1
6	c. Quality Control @ 1%	8.1
7	d. Cost towards the expenditure in	7.4

8	e. As per revised circular issued by Dy. Directorate of Insurance Maharashtra State vide letter No. Ţ. ं□व न □ - 2314/ द य क कप □त र ₹मे/ स क □ण/ अ □व - 3,व द न □क 31/03/2015, Insurance provision page 5 SSR @ 0.5 %	4.06
9	Sub Total 4	42.61
10	Total 3+4	854.22
	Add GST @ 12%	102.51
	D) Provisional cost	
	a. Rent charges of Casting Yard	40
11	b Contingencies @ 5% of 8	47.8
12	c. Utility Relocation @ 10% of 8	87.8
	d. Escalation @ 15 % (for 3 years) of8	143.51
	e Environment management Plan @ .25	2.0
	Total of Provisional cost cost D	321.23
	Technical sanction cost E	**1277.96**

CHAPTER - 11

PROJECT IMPLIMENTATION PLAN

CHAPTER – 11
PROJECT IMPLIMENTATION PLAN

11 PROJECT IMPLIMENTATION PLAN

11.1 General

Road infrastructure facilities planned for a fast growing city like Mumbai should be reliable, affordable, sustainable and environmentally friendly. The facility should reduce traffic congestion problem including at surface level with minimum obstruction to traffic during construction. Elevated roads are proposed to meet general traffic needs and to eliminate or reduce negative impacts caused by traffic. A new elevated road will be proposed when the existing road network no longer meets the requirements of traffic demand and when these requirements cannot be satisfactorily met or eliminated through road improvements.

Generally, project execution is associated with a number of problems and limitations. In order to overcome the risks associated with project execution, it is very much essential to have proper project implementation program that could ensure better control over all aspects of the project including costing and resources mobilization.

Project implementation planning is the process of identifying the list of activities involved in a project arranged in sequence and fixing time frame for successful execution of the project. It also includes periodic monitoring of the activities from start till end. Implementation planning is critical to ensure that the outcomes are delivered as per schedule.

11.2 Implementation Plan

The implementation plan should provide the following information in a clear, easy-to-read format

- Project phases and timelines (note that the implementation plan does not require a detailed timeline—and ‘at-a-glance’ timeline that provides a summary of key milestones and decision points would be more useful)
- The deliverables associated with each phase
- The major activities for each deliverable
- Key milestones
- Who is responsible for the delivery of each major activity
- Any interdependencies

Portfolio business and program delivery managers must check the implementation plan to ensure that targets are achievable and appropriate.

An effective implementation plan should -------

- Be concise
- Be capable of being understood by non-expert users
- Present a clear line of sight from the Government's objective through inputs and outputs to expected outcomes and benefits
- Outline the assumptions made in planning
- Clearly outline timeframes and project phases, especially where there are interdependencies with other programs/measures or critical requirements
- Clearly articulate the decision objectives of the planning
- Identify standards and quality controls to be used during implementation
- Explicitly identify and address the implementation challenges and how change will be managed (including risks and issues)
- Be precise about source of risks, likelihood of occurrence, consequence and mitigation strategies

11.3 Project Phasing

The proposed elevated road project will be implemented in three stages starting from conceptualization including funding, execution and management. The three main stages of implementation are

Stage-1: Preparation of DPR

Stage-2: Submission and Project Approval

Stage-3: Construction

It is proposed that Stage - I activities will be carried out by Design Consultants, Stage II shall be largely within the purview of MMRDA and the Project Implementation Unit and finally Stage - III activities will be carried out by the contractor which shall be monitored by the Project.

Management Consultants and the same will be over seen by MMRDA. The details are explained below.

Stage-1: Preparation of DPR

The first stage of the project consists of conducting field surveys and investigations for data collection, analysis of field investigation data, project conceptualization with alternative options and other design related activities. This stage of activity also involves

finalizing land acquisition ventures, development strategy, architectural guidelines and tendering. The scope of services to be rendered by the design consultants has already been listed out in Chapter 6 of this report. The time frame envisaged for this stage is about 6 months from the date of issue of work order.

Stage-2: Submission and Project Approval

The next stage of project implementation deals with review and approval of project report and proposal by various agencies involved with the project, including Stage Level Nodal Agency PWD/MSRDC, Local Level Municipal Corporation (MCGM) and later on by Central Ministry MoUD/MoRTH. External consultant's role will be limited to providing clarifications on Technical issues and related information as necessitated by the reviewing agencies. The proposal should include project structure, timeline, cost-benefit analysis and budget which are necessary in assigning a dedicated budget to the project. The proposal has to be approved against

- Concept, design and project proposals
- administrative and financial approval
- land acquisition
- others (including Police approval for temporary road closure and traffic diversion)

Stage-3: Construction

The third and last stage of project implementation deals with construction of the proposed elevated road. On approval of project proposal and allocation of fund, eligible contractor will be selected for construction work through tendering activities. The actual construction work starts after signing of Contract agreement and issuing of work order to the contractor. The entire construction activity can be classified into eight sub-sections as follows.

Phase-1: Includes mobilization of men, material and construction machineries to the project site. Construction of site office and appointment of technically skilled site engineers and/or workers also comes under this phase. After mobilization and establishment of site office, designs are standardized, activity schedule shall be prepared and time frame shall be fixed for execution and completion of each of the activities.

Phase-2: This is actually the first stage of construction activity which includes land acquisition, removal of temporary / permanent structures existing within proposed road boundary, shifting of on and underground utilities and site clearance. Traffic

diversion and rerouting shall be done before starting foundation excavation and pilling activity.

Phase-3: The next stage of construction activity includes removal of existing structures, road crust and excavation (for pier foundation, and road drains) and back filling.

Phase-4: This stage mainly deals with foundation related works like boring & casting of piles, construction of pile in all soils with/ without permanent steel liner, routine & lateral load test on piles etc.,

Phase-5: After construction of pile cap, steel piers are erected with pier cap and bearings. During the course of action other structural works like construction of Abutments, retaining walls and RE walls are also performed.

Phase-6: The next stage of construction activity deals with superstructure work which involves erection of girders and bracings, launching of box girders and slab casting if any for elevated road. After deck slab, crash barriers are constructed as a part superstructure work.

Phase-7: On completion of foundation, substructure and superstructure works the next stage of construction activity shall be road works. This includes elevated road overlaying, integrating with ramps wearing coats

Phase-8: The last stage of construction activity deals with finishing work like road marking, kerb painting, lighting and electrification, road arboriculture, installation road signs, signals and other road safety appurtenances. Piers, girders and bracings of elevated structure shall be painted with all-weather / weather resistant paint. Any other minor works left out shall be completed before handing over the site.

The whole of construction period is expected to last for about 36 months including monsoon period from the date of handing over of site to the Contractor.

11.4 Project Execution

It is estimated that the work envisaged under this project would involve a period of 36 months from date of hand over of site. The tendering stage, which will be done as per tender clause/ act for the execution of civil works, may take another 2 months prior to the construction stage.

CHAPTER - 12

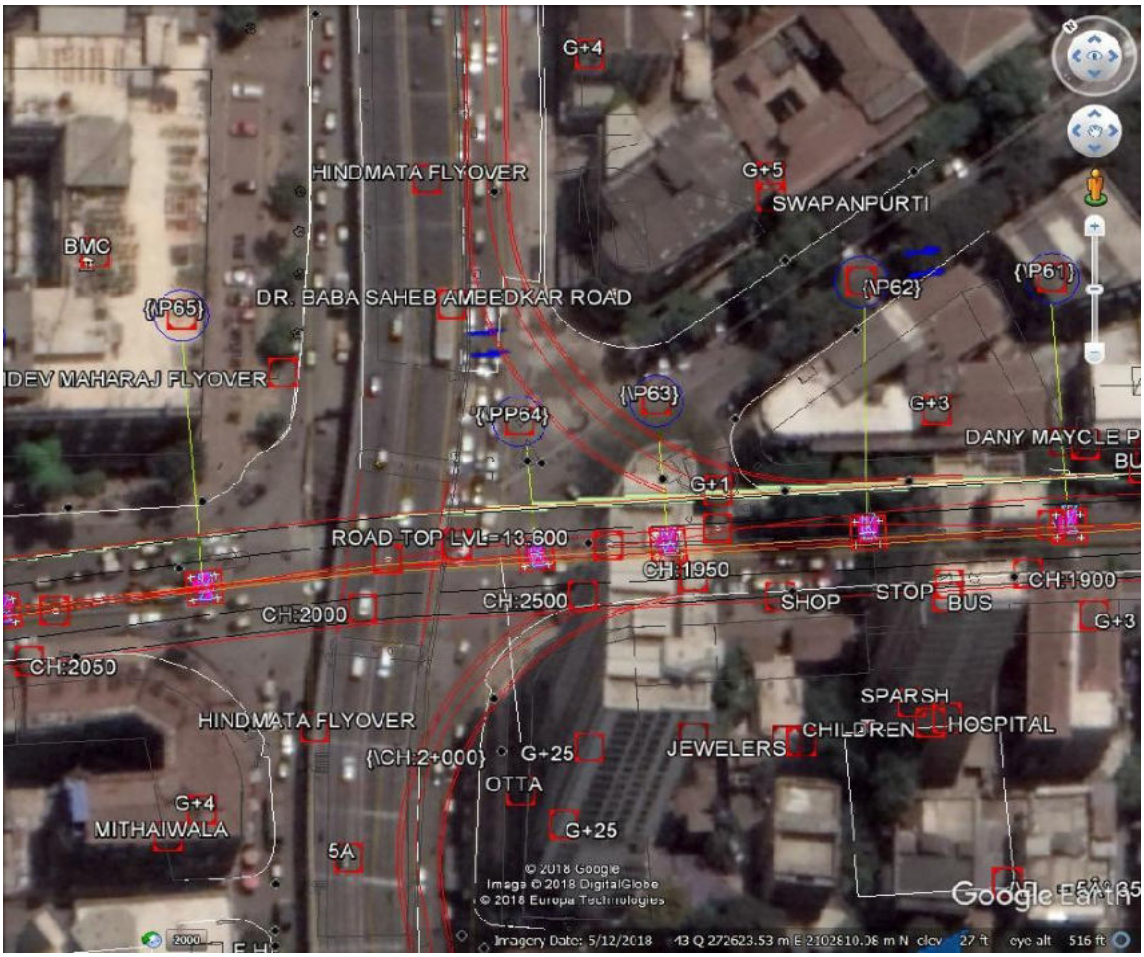
FEASIBILITY REPORT OF INTERMEDIATE RAMPS

CHAPTER – 12

FEASIBILITY REPORT OF INTERMEDIATE RAMPS

12 FEASIBILITY REPORT OF INTERMEDIATE RAMPS

12.1 Down and Up Ramps At Dr. Ambedkar Road



A. The provision of Down Ramp at Dr. B.R. Ambedkar road was thought of. The Parel Flyover ends at a distance of 190 m from the junction. However the down ramp from the proposed elevated corridor has to go to a minimum distance of 650 m with a falling gradient of 1 in 30 since the RTL of the proposed corridor is 21 m above the ground level. The down ramp cannot be matched with the existing flyover since there is difference of 13.8 m in RTL of the proposed corridor and exiting Dr. Ambedkar flyover. Also the available slip road width is only 5 to 7 m and as such there is no space for locating the Piers of the down ramp and the building at the Junction corner is obstructing the turning of the down ramp.

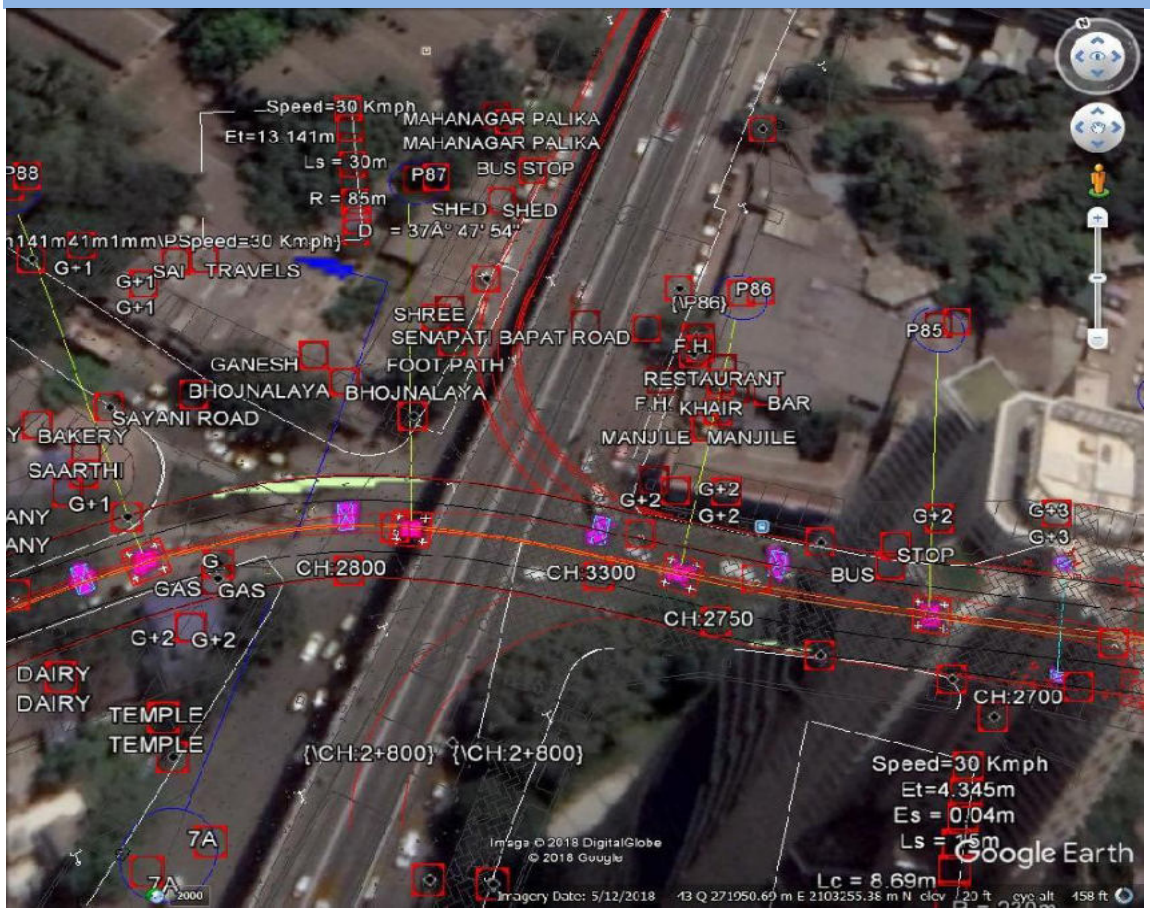
B. Up Ramp from Dr. B.R. Ambedkar Marg (towards CST):

On the North side of the Ambedkar Road Junction, Parel Flyover ends at 190 m. The Hindmata Flyover starts at a distance of 65 m after the Parel flyover. The Hindmata flyover is having length of 450 m and thereafter the Nana Shankar sheth Flyover starts at a distance of 160m. As such the up-ramp is required to start at a distance of 695 m from the DR. Ambedkar Road junction. The available slip road width varies from 9 m to 11 m. and construction of up-ramp will reduce the slip road width only to 3.5 m to 4.5 m in the solid ramp portion.

12.2 UP AND DOWN RAMPS AT ELPHISTONE STATION BRIDGE

The alternative of bringing down the elevated corridor to the 1st level at Elphinston Bridge was also studied. However due to space restrictions on both side approaches of the Elphinston Bridge, the option was not found workable. Property line clear width at some places is only 16 m.

12.3 UP AND DOWN RAMP AT SENAPATI BAPAT MARG GE



A. Down Ramp to Senapati Bapat Marg (towards South Mumbai

The down ramp (towards South Mumbai) at Senapati Bapat Marg was studied. However since the Sewri-Worli Elevated corridor is required to be taken up at 2nd Lvl at Elphinston Bridge due to existing rail bridge, the RTL of the proposed Sewri-Worli elevated corridor at the Senapati Bapat Road junction is 23.696 above the ground level. The down ramp cannot be matched with the existing flyover since there is difference of 18.215 m in RTL of the proposed corridor and exiting flyover. The down ramp at Senapati Bapat Marg has to be of 550 m length with a minimum gradient of 1 in 30. The down ramp meets the ground near Gawda Junction (Gokhale Road crossing) where there is no space to accommodate the solid ramp. Therefore the down ramp will be required to be taken upto 892 m from the Senapati Bapat Road crossing junction.

The available slip road width is only 9.5 m in the solid ramp portion of the proposed down ramp and also the available slip road width near the Gawda Junction is only 6 to 7 m. Hence the proposal of providing the down ramp is found unfeasible.

B. Up Ramp at Senapati Bapat Marg

Up ramp from Senapati Bapat Marg was also considered in the concept but again due to height of the proposed East-West Corridor, the up ramp has to be started 550 m from the Senapati Bapat Rd junction. However there is no space to provide extra width for joining this ramp because of obstruction due to existing buildings. Hence the proposal is unfeasible.

In addition we have studied the possibility of providing up-ramps & down ramps at many arterial roads such as Dr.S.S. Rao Marg, Dr. Ernest Borges Marg, Gokhale Road, New Prabhadevi Road, Tandel Marg etc. along the proposed alignment of the East-West (Sewri- Worli) Elevated Corriodr. However due to insufficient width of these roads and height of the elevated corridor, it is not feasible to provide ramps at these arterial roads.

CHAPTER - 13

SALIENT FEATURES & RECOMMENDATIONS

CHAPTER – 13

SALIENT FEATURES & RECOMMENDATIONS

13 SALIENT FEATURES & RECOMMENDATIONS

13.1 Salient Features

- The proposed Sewri to Worli (East-West) Elevated corridor will play a major role in making the proposed Mumbai Trans Harbour Link (MTHL) more effective and viable as it will facilitate the dispersal of the MTHL traffic.
- The proposed elevated corridor will facilitate the Western bound traffic of MTHL to take up the Worli-Bandra Sea Link/Proposed coastal road without any traffic snags for quick dispersal to their destination saving the valuable time & money.
- The project alignment will be helpful for the Eastern Freeway traffic which wishes to go to Western Suburbs like Bandra, Andheri, Borivali etc. and vice-versa.
- The project alignment will also be helpful for the South-West Mumbai traffic which wishes to go to MTHL & Wadala by Eastern Freeway.
- The project proposal follows Techno economical feasibility.
- The project proposal is recommended for construction.
- This is fully access controlled signal free fast connectivity.
- This corridor runs at third level without conflicting existing ground level /second level local traffic and various rail facilities.
- As compare with benefits of project, this proposal is economically most viable.

13.2 Recommendations

By considering major hinders discussed in draft report, the proposed elevated corridor is recommended to construct at third level along with second level Eastern freeway at Sewri interchange. The rail road structures need to tackle carefully in association with Railway authorities. Portal frame are recommended at critical locations by considering land restrictions.