Development of 8-lane SPUR Starting from Km 26.582 of Vadodara - Mumbai Expressway Main Alignment (Design Chainage km. 0+000 of SPUR) and terminating at proposed junction with the Multi-Modal Corridor of MMRDA (Design Chainage of SPUR km. 79.783) in the state of Maharashtra (Total Length is 79.783 km)

Feasibility Report

1.0 INTRODUCTION

National Highways Development Project (NHDP) Phase-VI is for development of 1000 km of expressways and includes construction of about 379 km long Vadodara-Mumbai Expressway originally proposed to be implemented under Public Private Partnership mode and to be executed as Design, Build, Finance and Operate (DBFO) contracts. The National Highways Authority of India (NHAI) commissioned the services of Intercontinental Consultants and Technocrats Private Limited (ICT) for carrying out consultancy services for "Preparation of Feasibility cum Detailed Design Report for Vadodara – Mumbai Expressway under NHDP Phase-VI. The consultants commenced services from 12th February 2009.

During the feasibility study of the expressway it was noted that the proposed start point of VM expressway on NH8 at Mumbai end would pose a serious problem of safe and quick dispersal of traffic from the expressway and also would not serve the purpose of connecting directly to major traffic generators like Jawaharlal Nehru Port Trust (JNPT) port and to Mumbai-Pune expressway. Currently the traffic bound for Gujarat and further north from JNPT and NH4 follows Thane-Ghodbandar road which is already congested. This traffic has to pass through congested road network of Mumbai Metropolis from southward destination and the goods earmarked for export and import also find difficulty in commuting to and from JNPT and Navi-Mumbai. Therefore it would be prudent to connect the proposed expressway to major traffic generators like JNPT and to Mumbai – Pune expressway. To ensure proper dispersal of traffic a proposal for providing a SPUR connection to the expressway originating at about km 27 of the expressway and connecting to Mumbai Pune expressway and JNPT port was mooted in the year 2009. The SPUR will not only connect to these major traffic generators but will also result in better dispersal of traffic in the Mumbai Metropolitan Region.

A presentation on the alignment options for the SPUR was made to Chairman and other senior officials of NHAI and the proposal for SPUR was accepted in principle. Consequently a 94.390 km long SPUR connection to Mumbai Pune expressway and JNPT was also included in the scope of work vide NHAI letter NHAI/V-M Expressway/DM/2008/216 dated 16th November 2009. The Consultants have accordingly explored various alternative alignments for SPUR and evaluated these in terms of travel length, environment & social impacts, cost, connectivity etc. It may be mentioned that a Comprehensive Transportation Study for the Mumbai Metropolitan Region (MMR) has been done in 2008-2009 by the Mumbai Metropolitan Region Development Authority (MMRDA). In this study the future road network for the MMR has been suggested. This network envisages construction of a link from NH4 to NH8 to freeway standards. The alignment options studied for SPUR generally follows the links identified in this study and have been modified to suit site conditions. An index map

showing the proposed Vadodara Mumbai expressway and SPUR to JNPT is given in **Figure-1** below:

Figure -1 Index map showing proposed Vadodara Mumbai Expressway and SPUR

2.0 ALIGNMENT OPTIONS

As mentioned above, a Comprehensive Transportation Study for the Mumbai Metropolitan Region has been done in 2008-2009 by the Mumbai Metropolitan Region Development Authority (MMRDA). This network envisages construction of a link from NH4 to NH8 to freeway standards. The alignment options studied here generally follow

the links identified in this study and have been modified to suit site conditions. The Consultants have studied **six alternative alignments** for the connection to JNPT and Mumbai Pune Expressway. The alignments are depicted in the **Figure-2.**

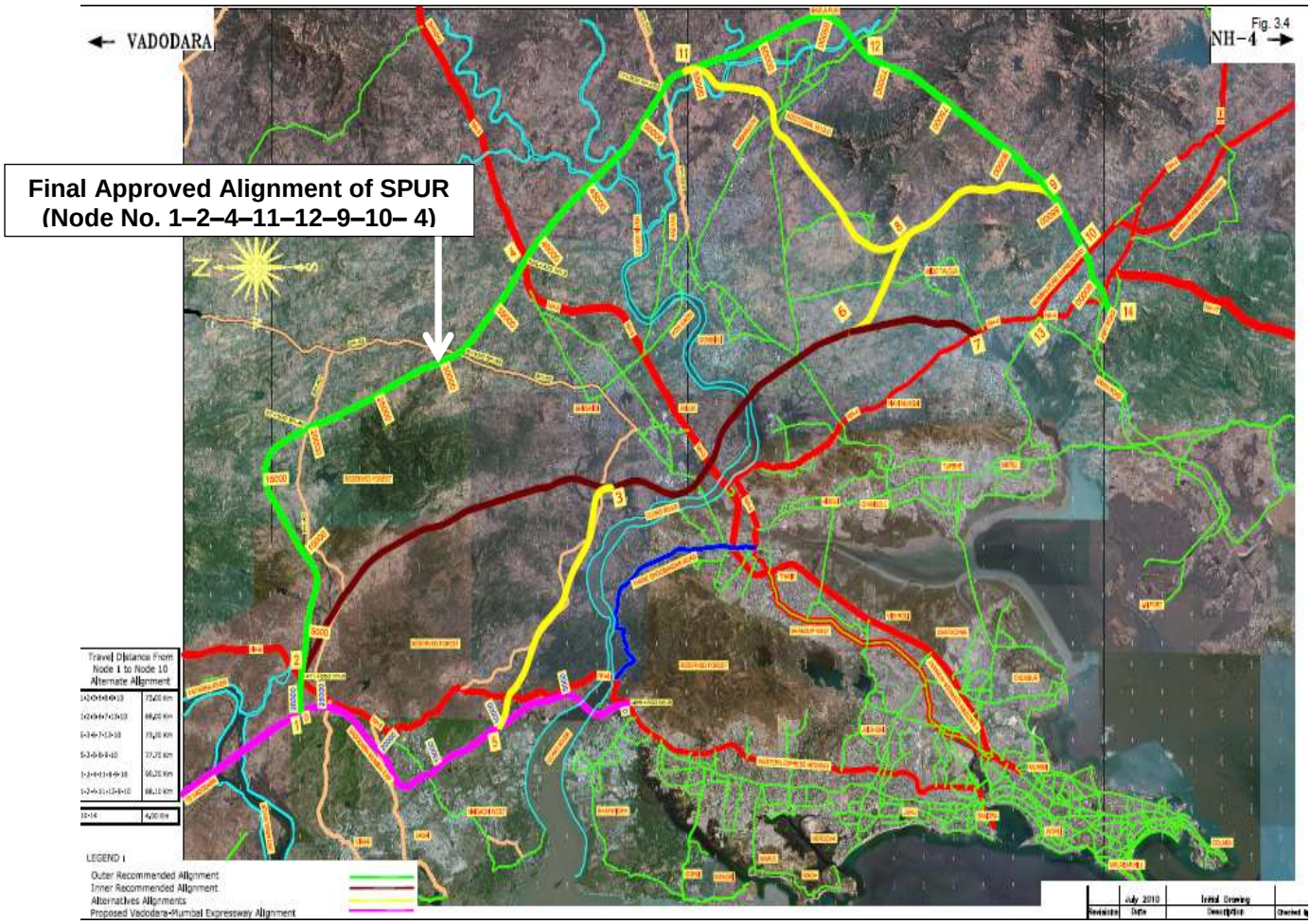


Figure-2 Alignment Options of Proposed SPUR of Vadodara – Mumbai Expressway

The various alternate alignments were presented to NHAI Officials and it was desired that the SPUR alignment should be synergized with the other developments being envisaged in the Mumbai Metropolitan Region by the Government of Maharashtra.

Subsequently on 9th April 2010 a presentation of the alignment of the expressway and the SPUR was made to the Chief Secretary, Government of Maharashtra in which senior officials of the NHAI, MoRTH, State PWD, State Revenue and Forest Department, City and Industrial Development Corporation (CIDCO) and the Mumbai Metropolitan Region Development Authority (MMRDA) were present. In the presentation, the SPUR to JNPT was approved in principle. The Chief Secretary appointed a committee under the Chairmanship of Divisional Commissioner Konkan Region to look into the selection of the alignment. The other members of the committee included CGM NHAI; Chief Engineer (NH) PWD; Chief Conservator of Forest, Thane; Chief Engineer MMRDA; Collector Thane; Additional Chief Transportation Engineer, CIDCO and Additional Collector (Tribal), Jawhar, Thane. The committee held 5

meetings between April 2010 to August 2010 after joint site visit and the final report of the committee was submitted to Chief Secretary on November 2010.

The committee recommended the alignment of the main Vadodara Mumbai Expressway in Maharashtra and the SPUR to JNPT (Node No. 1–2–4–11–12–9–10– 4). The Government of Maharashtra accepted the recommendations of the committee. **A formal approval of the alignment was communicated by the Government of Maharashtra vide their letter NHP2010/CR81/NH1 dated 03/2/2011 addressed to Chairman NHAI**.

3.0 SPUR ALIGNMENT

Further to the approval of the alignment, the subsequent year-wise developments on SPUR are as follows:

Year- 2011: The proposed SPUR of Vadodara Mumbai Expressway is a Greenfield alignment. Government of Maharashtra approved SPUR alignment starts at km 26+300 of the main Vadodara Mumbai Expressway near Vasai with ramp type interchange and ends at km 24.476 of NH-4B near Panvel. **Length of SPUR was 94.390 km**.

Year-2013: A meeting was held on 13th September 2013 under the Chairmanship of Secretary, MoRTH regarding Vadodara-Mumbai Expressway (VME). Based on the progress of land acquisition and other pre-construction activities, NHAI asked repackaging of the project. As decided by the NHAI, the development of SPUR has been included in Phase II of the VM Expressway project.

Year- 2014 to 2019: In further stage it was observed that, ribbon development occurred along the alignment of Main expressway from Km 0 to Km 26.3 (Phase-III) and land acquisition in this stretch could not be taken up due to large scale development and public resistance. To avoid large scale demolition of residential & commercial structures, Government of Maharashtra also gave NOC to delete Phase-III (Km 0 to Km 26.3) of main expressway. Hence, the SPUR is to be designed in continuity of the Vadodara Mumbai Expressway at meeting point.

In later stage, MMRDA planned to develop a Multi-Modal Corridor (MMC) which connects SPUR alignment at km 79+800 and further connect at JNPT and Aulibag. During the meeting between MMRDA & NHAI, it was decided to have a common corridor of MMC & SPUR beyond km 79+783 (village Morbe) to JNPT.

During the meeting held on **22nd March 2019** in the office of Regional Officer (NHAI) Mumbai, it is decided that:

- ✓ Start point of SPUR will be at Km 26+582 after introduction of one curve for free flow traffic from expressway to SPUR and vice versa;
- ✓ SPUR will be initially developed up to km 79+783 i.e. the proposed junction with the Multi-Modal Corridor of MMRDA.
- ✓ Development of the remaining section (up to JNPT) shall be clubbed with the development of Multi-Modal Corridor and shall be taken up later.

Hence, length of the SPUR alignment to be developed in the initial stage is 79.783

km. The alignment of SPUR has already been included in the Mumbai Metropolitan Regional Plan 2016-36 of MMRDA. An index map showing the SPUR alignment is shown in **Figure-3.**

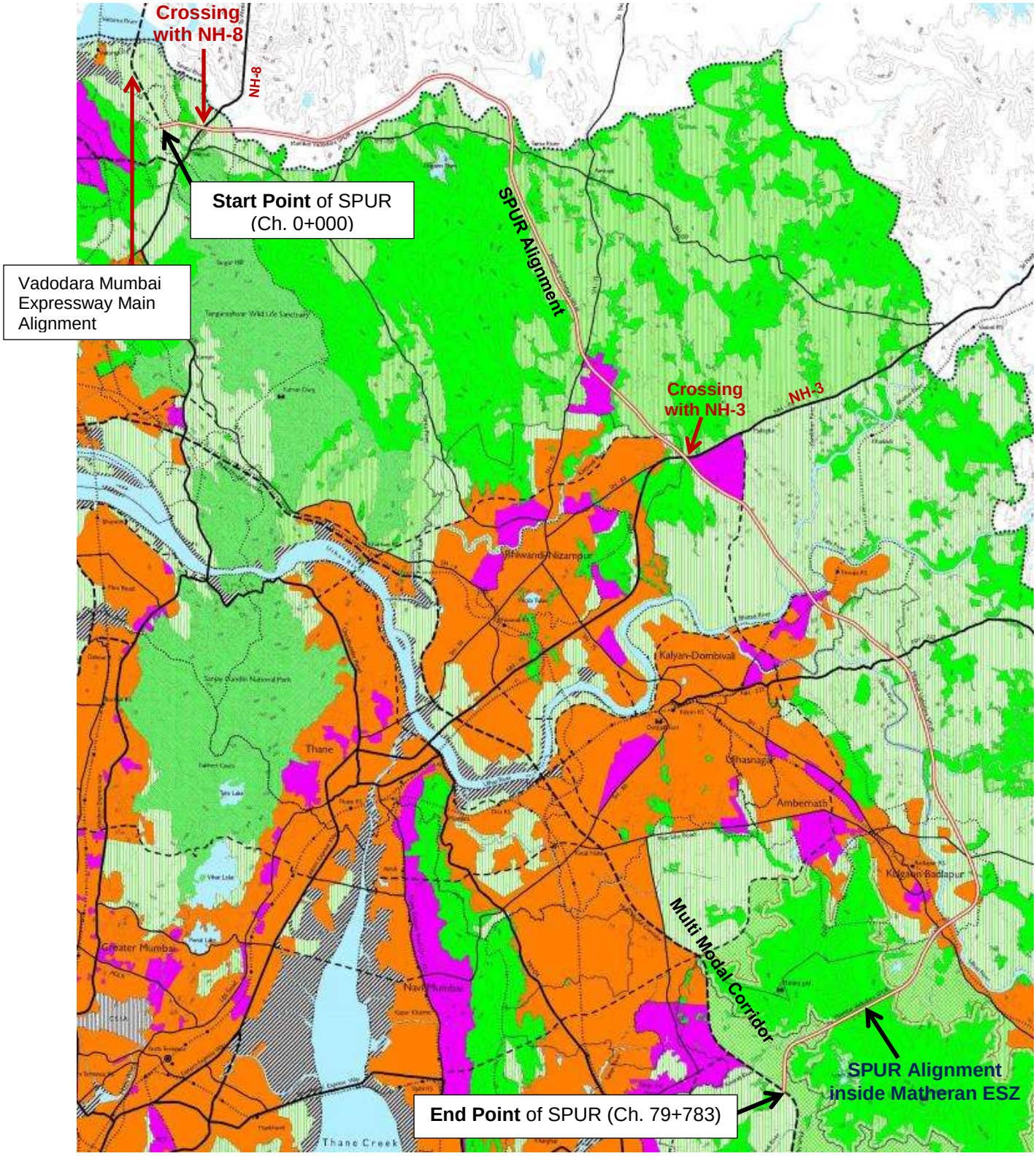


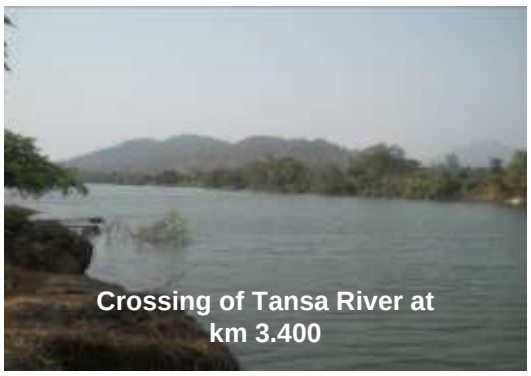
Figure-3 Index Map showing the SPUR Alignment

This Feasibility Report deals with SPUR of Vadodara Mumbai Expressway from Km 0+000 to Km 79+783.

4.0 PROJECT LOCATION

The proposed SPUR of Vadodara Mumbai Expressway is a greenfield alignment. The project road starts at km 26+320 of the Vadodara Mumbai Expressway main alignment at Koshimb village of Palghar district (Ch. 0+000) and terminate at the proposed junction with the Multi-Modal Corridor of MMRDA in Morbe village of Raigad district (Ch. 79+783). **Total length of the SPUR alignment is 79.783 km;** out of which 18.864 km (Ch. 0+000 to 18+864) lies in Palghar district, 55.336 km (Ch. 18+864 to 74+200) lies in Thane district and remaining 5.583 km (Ch. 74+200 to 79+783) lies in **Raigarh district** of Maharashtra.


Crossing with NH8 at Km 1.860


Crossing of Tansa River at km 3.400


Crossing of SH-35 at km 31.300


Crossing with NH3 at km 38.260

5.0 DESCRIPTION OF SPUR ALIGNMENT

5.1 Section from Ch. 0+000 to crossing of NH8 (Ch. 1+860)

The SPUR alignment takes off from km 26.320 of the main expressway in Vasai at Palghar district and crosses NH8 at km 1.860. The chainage of NH8 at the crossing point is 372+045. At NH8 full cloverleaf is proposed. There is one village road and one track crosses in this section. The section is in plain / rolling terrain.

5.2 Section from Ch. 1+860 to 39+750 (Interchange on NH-3)

The alignment in this section crosses the Tansa River at km 3.400 and then moves westwards parallel to Tansa River in the valley between the hills of Tungareshwar and Damna reserved forest upto km 18.850. Then the alignment crosses Tansa River and moves down southwards. After crossing Tansa River, the alignment enters into Thane District at Ch. 18+864. The alignment crosses SH-35 at km

31.300 and NH-3 at km 38.260. Due to difficult terrain at crossing location and land constraint, a offset (double trumpet) interchange has been proposed on NH-3 at Km 39.748.

The alignment in this section is in plain/rolling terrain. In this section the alignment has 4 major bridges, 12 minor bridges, 7 Vehicular Underpasses, 19 Pedestrian Underpasses, 3 flyovers and 17 Cattle Under passes.

5.3 Section from km 39.750 (offset interchange on NH3) to 52.810 (NH222)

The alignment moves in the south easterly direction after crossing NH3. The alignment crosses the two tributaries of Ulhas river at km 45.400 (Vatsa River) and at km 47.300 (Kalu River).The alignment lies mostly in plain terrain. Recently Maharashtra Government planned to build Maharashtra Samurddhi Mahamarg from Nagpur to Mumbai. As per plan the expressway will take up from Km43+00 of SPUR. In this section the alignment has 2 major bridges, 1 minor bridge, 1 Vehicular Underpass, one flyover, 3 vehicular overpasses, 3 Pedestrian Underpasses and 6 Cattle Underpasses. It crosses a railway line at km 47.940 where an ROB is proposed. The interchange at NH222 is a partial cloverleaf mainly catering to movement to and from Mumbai Metropolitan Region (MMR).

Crossing with Kalu River at km 47.300

Crossing with Railway line at km 47.940

5.4 Section from 52.810 (NH222) to km 67.960 (SH 43 near Badlapur)

The alignment in this section moves parallel to Ulhas River on its western side. It passes the Badlapur village on the west side and turns south west before crossing Ulhas River at km 67.200. Then the alignment crosses Mumbai-Karjat (central railway) and SH-43 near Sape village at km 67.960.

In this section the alignment has one major bridge, 2 minor bridges, 2 Vehicular Underpasses, 3 Vehicular overpasses 6 Pedestrian Underpasses, 3 Cattle Underpasses and one ROB cum major bridge.

Crossing with NH-222 at km 52.810

Crossing with Railway line at km 67.500

5.5 Section from 67.960 (SH 35) to km 79.783 (MMC Marge ing near Morbe)

During discussion with NHAI, it was decided to provide a double trumpet interchange on SH-43 to cater to the traffic flow from the recently planned logistic park near village Sape. Thereafter the alignment moves westwards and enters the hills of the Matheran Eco-Sensitive Zone / Reserved Forest. A 4.39 km long tunnel is proposed which will go under the Matheran Eco-Sensitive Zone. Length of tunnel inside Matheran Eco-Sensitive Zone is 3.88 km. **This tunnel will preserve the ecology of the Matheran**. The alignment enters Raigarh district at km 74.200.

The Monitoring Committee for Matheran Eco-Sensitive Zone has approved the proposal of SPUR inside the Matheran ESZ vide letter dated April 16, 2013. The SPUR alignment has also been included in the **Zonal Master Plan for Matheran Eco-Sensitive Zone.**

As explained above, Mumbai Metropolitan Region Development Authority (MMRDA) is planning to construct a Multi Modal Corridor (MMC). The MMC meets the proposed SPUR alignment at Km 79+783. As decided during the meeting with MMRDA and NHAI, the development of the remaining section of SPUR up to JNPT (NH4B) shall be clubbed with the development of MMC and shall be taken up later. In this section the alignment has one major bridges, 2 minor bridges and 2 Cattle Underpasses.

West side portal of Tunnel at Matheran

East side portal of Tunnel at Matheran

6.0 SOCIO-ECONOMIC PROFILE OF PROJECT INFLUENCE AREA

The SPUR alignment lies in Palghar, Thane and Raigarh Districts in the State of Maharashtra. Palghar and Thane District forms a part of North Konkan Region which lies between the Sahyadri hills in the east and the Arabian Sea in the West. It has coastal line of about 113 km. District headquarter of Thane is about 25 km from the international airport and 35 km from the main downtown of Mumbai City. Whereas the district head quarter of Palghar is on the coast.

The total geographical area of Thane district is 4,214 sq. km, Palghar district is about 4,697 sq. km and Raigad district is about 7,152 sq. km. The maximum temperature ranges from 28.0°C to 35.2°C and the minimum temperature remains between 16.3°C and 26.5°C. The normal annual rainfall over the Palghar & Thane districts ranges from 1900 mm to 2600 mm while annual rainfall over the Raigarh district ranges from 2200 mm to more than 3000 mm in the plains and it is above 5000 mm in the hills during the South-West monsoons in the months of June to September. Generally highest rainfall is recorded in the month of July. Paddy, fruits and cereals are principal crops of Palghar & Thane districts while paddy, pulses, mango and oil seeds are principal crops of Raighar district

Thane is the third most industrialized district in the State. The main products of these industries are Drugs, Textiles, Adhesives, Plastics, Rubber, Steel, Pharmaceuticals, Engineering, Fertilizers, Electronics & Chemicals.

Total population of project impacted districts, as per Census 2011, is nearly 13.7 million in which a majority of population falls in the district of Thane. The population of the project influence districts is presented in **Table-1**.

Table-1 Total Population of the Project Affected District

Name of Stat	Name of District	Total Population
Maharashtra	Palghar	29,90,116
	Thane	8,070,032
	Raigad	26,34,200
	Total	**136,94,348**

7.0 TRAFFIC SURVEY AND ANALYSIS

To estimate the expected traffic movement on V-M Expressway and the SPUR, traffic surveys were conducted on the important roads in the vicinity of the proposed alignment. These are: NH-8, NH-6, NH4, NH4B, Mumbai Pune expressway and state highways cutting across the proposed V-M Expressway and the SPUR alignments. Manual classified traffic volume / occupancy survey at 25 locations, Intersection turning movement survey at 27 locations, one day Origin-Destination survey at 13 locations, and axle load survey at 4 locations were carried out during April-May, 2009 and Dec 2009.

The average daily traffic PCU/Day in these count stations was found to be varying from 7402 vpd to 67709 vpd or 13148 PCU/Day to 107591 PCU/Day. NH8 is carrying traffic in the range of 50,000 to 80,000 PCU per day. The average journey speed on Mumbai-Vadodara section of NH 8 was found to be in the range of 50-60 km/ hr. to 80-90 km/hr., where as the speed within MMR is about 30 – 50 km/hr. The Vehicle Damage Factor (VDF) as assessed on NH-8 section for 2 axle vehicles varies from 2.04 to 5.86 whereas VDF for 6 axle vehicles were in the range of 19.48 to 25.69.

Speed-flow equations were also developed for different category of roads in the influence area. The origin-destination details were collected from the trip makers during the O-D Survey on sample basis. The vast data and information collected as part of the traffic and travel surveys were utilized in assessing the traffic estimates for the proposed Expressway facility, and for identifying the locations of toll plazas and interchanges. The O-D survey samples revealed that the proportions of different categories of trips (internal-internal, internal-external and external-external) captured in the sample was more or less uniform in all the locations of O-D survey.

From the data collected in willingness to pay survey, a detailed analysis of the acceptable toll rates for various categories of passenger and goods traffic was done. The analysis has shown the sensitivity of acceptable toll rates to the distance and frequency of travel, the commodity transported or purpose of travel. The basic willingness to pay for better service was established from the WTP survey and large proportion of both car users and trucks have expressed willingness to pay toll rates higher than the normal NH toll rates.

The traffic zone system developed for the study area comprises of 89 traffic zones. The traffic zone system has been developed in such a manner so as to identify the traffic originating and destined from various important cities, ports and industrial areas located in the influence area of proposed expressway. The district level zoning system has been adopted outside the immediate influence area of expressway alignment while the block level zoning system has been developed to study the traffic demand pattern from/to the areas located close to the alignment. This zoning scheme has been used for the development of the Regional Transport Demand Model (RTDM).

The consultant developed a RTDM (i.e. the influence area of the proposed expressway) considering number of parameters during the process of transport demand generation, distribution and assignment on the road network of study area.

In order to consider comprehensive network deterrence, the parameters which encompass the main cost component of travel between a pair of zones, accounted in the Generalised Cost equation were developed for various modes and road categories. The generalized cost equation adopted for the RTDM has the following form:

$$\mathbf{GC = (CF_t * VOC_t) + (CF_d * VOC_d) + Toll\ Fee}$$

Where, CFt is the cost function affecting the VOT and CFd is the cost function

influencing the VOC. The toll charges for using a particular link of the network is considered in the overall cost of travel in the network for a particular mode. The generalized cost equation therefore captures both the direct and indirect cost to the road user in the adopted network. The toll rate for the expressway is considered as 1.25 times the NH8 toll rates.

The equilibrium assignment technique has been used for traffic assignment in this study. In this method, the trip matrices derived are assigned on the network based on All-or-Nothing assignment before updating the cost. Once the trips are assigned on the network, the cost is updated using the generalized cost function which has an in-built V/C function (speed-flow function) in it. With the updated cost of each link, the trips are again getting reassigned in the way that no trip maker can reduce his path costs by switching routes on the network based on the user equilibrium concept. The model assignment was validated using data on NH-8.

The error level was within + 10%, the model and is considered validated for use in the forecast. Using the growth rates estimated from transport elasticity and the trend, mode wise trip ends were projected for different horizon years (2015, 2020, 2025, 2030, 2035 and 2045).

Based on the traffic survey conducted in year 2009, and the DPR for VM Expressway was submitted in 2012. Further as per the instruction of NHAI, the Consultant carried out traffic surveys on selected locations in 2016 to update the traffic figures, analysis and forecast. Based on the observed traffic volumes in the year 2016, the estimated traffic of the expressway sections and competing road links (NH-8 and NH-4) was revised.

The traffic estimates for VME were carried out earlier by adopting toll rates for expressway 1.25 times that of NH toll rates. However, during the meetings held with NHAI in April 2017 it was discussed that the Base Toll Rates of Expressway are 1.25 times that of NH toll rates. The effective toll rates of VME including the structures are 1.8 times. Hence, the traffic estimates for VME have been revised by considering higher toll rates. This has resulted in lesser traffic being diverted on VME as compared to the previous traffic estimates.

The section wise traffic assignment for the SPUR for various horizon years is given in **Table-2**.

Table-2 Section wise Estimated AADT for SPUR (PCU per day with toll 1.8 times NH toll), revised in 2017

Section No.	Chainage (Km)		Estimated AADT (in PCU)				
	Start	End	2021	2025	2030	2035	2045
1	0+000	1+860	9,972	12,146	14,469	15,711	18,953
2	1+860	39+748	15,744	19,236	22,837	24,467	28,512
3	39+748	52+810	23,184	28,353	33,519	35,441	40,056
4	52+810	90+610	22,362	27,338	32,293	34,094	38,302
5	90+610	94+390	11,199	13,789	16,217	16,700	17,627

7.1 Capacity Analysis for SPUR Sections

As per Section 6.3.4 of IRC:SP-99 "*Capacity Analysis*", design service volumes for four lane, six lane and eight lane expressway were considered as given in **Table-3**.

Table-3 Capacity and Service Volumes at Various LOS for 4, 6 and 8 lane Expressway

Peak Hour Proportion	Design Service Volume (LOS B) in PCU/Day		
	4-lane	6-lane	8-lane
6%	86,000	1,30,000	1,73,000
8%	65,000	98,000	1,30,000

Based upon the traffic volume in futures years as given in table 2 and design service volume mentioned in **Table-3**, it is appropriate to provide 4-lane facility so that the Spur operates within the desired LOS B.

Since the expressway from Vadodara to Mumbai has been proposed to be 8 lane configurations in the opening year and keeping the continuity, **SPUR** also **proposed as 8 lane facility**. The matter was also discussed in the meeting held on 22nd March 2019 in the office of RO, Mumbai, NHAI has agreed in principle.

8.0 CONFIGURATION OF PROPOSED ALIGNMENT

As discussed above, SPUR has been proposed to be 8 lane configuration and all structures will be eight lane from the opening year. The details of proposed cross sections for 8 lanes are as follows:

Table-4 Configuration of Proposed SPUR Alignment

Sl. No.	Element	Section Description
1.	Carriage way	Dual carriageway : 2 x 4 x 3.75 (8 lane)
2.	Paved shoulder	3.0 m on outer edge of each carriageway
3.	Earthen shoulder	2.0 m on outer edge of each carriageway
4.	Flushed Median	6.0 m including edge strip

Width of proposed Right of way (**PROW**) is **100 m in general** and 120 m width has been proposed at connecting road locations. At location of truck parking, toll plaza and interchanges, extra land has been proposed as per the actual design requirement. The **Typical Cross Sections** of the proposed SPUR are given at the end of this report.

9.0 TOPOGRAPHIC SURVEYS

The topographic survey was conducted in a width of 200m either side of the proposed alignment to capture the ground levels and all the existing physical features like rail, road, rivers, canals, houses etc. The main control points for the topographic survey were fixed using Global Positioning System (GPS). Twin Pillars of size 15cmx15cmx45cm were fixed along the proposed ROW at an interval of 2kms and GPS observations were recorded. To cover up the gaps between two consecutive pair of GPS control Points,

temporary control points were fixed using pegs/nails at an interval of 100m to 200m. The X and Y grid coordinates of these Bench Marks pillars were fixed by Total Station traverse and the levels were fixed with the help of leveling. The elevations (Z value) of all the GPS control pillars were established by carrying out differential leveling from one GTS Benchmark to another GTS Benchmark. Based on the GPS and Traverse control points, the Easting (X), Northing (Y) and MSL Height (Z) coordinates of all important manmade and natural topographical features along the alignment within a corridor of 200m on either side of alignment were recorded using Total Stations having automatic data recording devices with appropriate feature codes.

10.0 SOIL AND MATERIAL INVESTIGATION

The investigations of soil and material covered all relevant aspects of investigation for road embankment along proposed alignment and other construction materials. Required tests as specified in BIS standards, TRRL and MORTH specification were carried out on soil, quarry material and water samples available along alignment of SPUR from identified borrow area, quarries and sources to assess the suitability for their use in construction.

Suitable and sufficient soil from borrow area for construction of embankment and sub-grade are available along the SPUR. The average lead distance is 5 km up to km 65 of the alignment. After km 65, for some sections of the project road, haulage for the selected earth required for embankment and particularly sub-grade construction could range up to 10 Km. Lime soil stabilization, improving subgrade CBR by using geocell technology, or reinforcing the subgrade by using geotextile / geogrid are the proposed options that can be considered as alternative to obtaining quality fill materials from comparatively high lead distances. The design CBR for the SPUR varies from 8 % and 10 %.

A total of 37 soil samples were collected along the length of the entire project corridor of SPUR. Six (6) stone quarries (privately owned) were identified along the SPUR at a lead distance of 0.1 km to 35 km as the potential source of coarse aggregates. The quantity available in the identified quarries is adequate meeting the requirements for the construction of the project roads.

A total of three (3) sources were identified along the SPUR as potential sources for sand. The lead distance from the project vicinity is found in the range from 1.0 km to 25.0 km for the SPUR. Sands of all the sources can be used in any kind of filling work for SPUR qualify for pavement works. Stone dust available from crusher plants is suitable for use in concrete and in all the layers of pavement structure.

Manufactured materials like cement, structural steel and bitumen conforming to the relevant IS codes and complying with the provisions made in the specifications of MORT&H are available in Maharashtra.

The quantity of the construction material to be utilized in the proposed development of SPUR has been estimated and given in **Table-5**.

Table-5 Details of Construction Material

S. No.	Item	Unit	Quantity*
1	Cement	MT	8,68,000
2	Aggregate	MT	61,76,000
3	Sand	MT	41,28,000
4	Water	KL	32,00,000
5	Bitumen	MT	2,200
6	Diesel	KL	24,000
7	Earthwork in fill	Cum	2,35,47,340
8	Earthwork in cut	Cum	61,40,289
9	Tunnel excavates (50% rock & 50 % earth)	Cum	23,35,041

*Note: Quantity of construction material may change at DPR Stage

11.0 HYDRAULIC AND HYDROLOGICAL INVESTIGATION

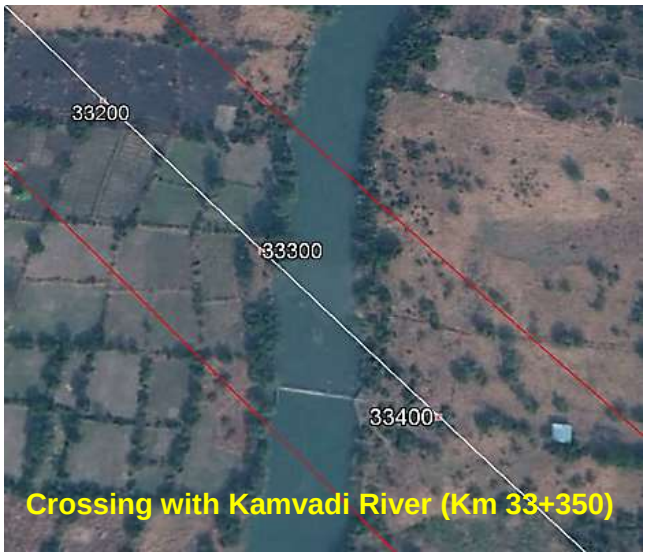
The proposed alignment runs through regions having varied hydro-meteorological characteristics apart from being distinctly different in terms of land use, land cover and soil parameters. The study area comes under **subzone 5(a)** as demarcated by CWC for estimating Design Flood.

Hydrological and hydraulic investigation of the study area has covered collection and analyses of field data including past performance of the nearby existing bridges and other roads across the streams crossing (upstream / downstream) the proposed alignment, historical flood data (Discharge, HFL etc. as available) of major rivers from agencies like CWC, Irrigation Departments of Maharashtra. The hydraulic information of the canals likely to cross the proposed alignment has also been collected from concerned agencies. Stipulations and provisions of extant IS / IRC Codes, Federal Highway Administration (FHWA) and Guidelines of Inland Waterway Authorities of India (IWAI) have also been followed for hydrological and hydraulic design of the bridges. The stipulations of IRC-78 have been adopted for estimating the scour depth. The following table summarizes the return period adopted for design:

Table-6 Flood Return Period adopted for Design

Sl. No.	Design Parameter	Adopted Return Period Flood
1.	Waterway for bridges / culverts	100 Years
2.	HFL for Bridges	100 Years

The proposed SPUR alignment is crossing Tansa River at Km. 3+400 & 18+850, Tributory of Tansa River at Km. 13+545, Kamvadi river at Km. 33+350, Bhatsal River at Km 45+400, Kalu River at Km 47+300, Barvi River at Km 57+600, Ulhas River at Km 67+200 and also crosses streams & local nala at several locations. After thorough analyses, **8 major bridges and 17 minor bridges** on rivers / nala / Stream have been proposed in this section.

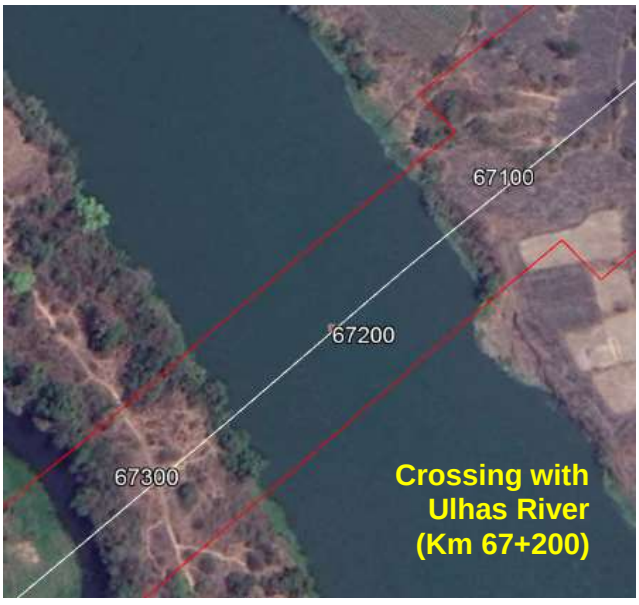

33200
33300
33400
Crossing with Kamvadi River (Km 33+350)


47200
47300
47400
Crossing with Kalu River (Km 47+300)


3200
3300
3400
3500
Crossing with Tansa River (Km 3+400)


18900
18800
Crossing with Tansa River (Km18+850)


57500
57600
57700
Crossing with Barvi River (Km 57+600)


67100
67200
67300
Crossing with
Ulhas River
(Km 67+200)

12.0 DRAINAGE STUDIES AND PRELIMINARY DESIGN OF CULVERTS

The construction of the expressway embankment will unavoidably obstruct the natural overland flow and to some extent distort the natural flow regime of the local channels. Suitable bridge / culvert openings have, therefore, been proposed across natural drainage channels with a view to pass the discharges with minimal disturbances caused to the natural flow regime. In addition to these bridges / culverts, localized drainage arrangements consisting of longitudinal toe drains and additional culverts have been proposed to divert the overland flow (which would otherwise meet the natural stream at some downstream point) intercepted by the expressway embankment into the nearest natural drainage channel. Drainage of Embankment has been ensured through the provisions of Shoulder Drains / Chute Drains, Roadside Toe Drains and Median Drains.

Box culverts have been preferred to pipe culverts to get rid of the general shortcomings (number of joints inviting weak points, difficulty in maintenance etc.) of a pipe culvert structure. A total of 123 box culverts are proposed in this section. The minimum size proposed is 2mx2m.

To meet the demand of the local population for connection of their field channels, 35 nos. pipe culverts of size 1.2m diameter have been provided. The exact location of these culverts will however be decided in consultation with local people at the time of execution.

The 24 Hour maximum rainfall of 25 Year return Period has been taken as the design rainfall. 100 year discharge has been used as check flood for the culvert structures.

The hydraulic calculations for culverts have been done with the help of Hydraflow extension software of Autodesk, Inc which follows the methodology of hydraulic design of culverts as set forth in Hydraulic Design Series Number- 5 - Hydraulic Design of Highway Culverts that is prepared for the U.S. Federal Highway Administration (FHWA). The maximum downstream velocity (corresponding to check flood i.e. 100 year flood) for the culverts has been considered as 4 m/sec with rip rap / concrete protection. In no case, the Hw/d ratio (governing head water elevation) has been considered more than 1 for the safety of the pavement layers. The estimated carrying capacity of culverts for optimum longitudinal slopes is tabulated below:

Table-7 Estimated Carrying Capacity of Culverts for Optimum Longitudinal Slopes

Size	Capacity	Longitudinal Slope
2 X 2	8.50	0.3% to 0.5%
3 X 2	13	0.3% to 0.5%
3 X 3	19	0.3% to 0.5%
4 X 3	26	0.3% to 0.5%
5 X 3	32	0.30%
6 X 3	39	0.30%

Note: 1. Limiting downstream velocity : 4 m/sec (check flood) with riprap protection.
2. Hw / D Ratio =< 1, for safety of embankment

13.0 GEOMETRIC DESIGN STANDARDS FOR SPUR

Manual on Specifications & Standards for Expressway published by the Indian Road Congress (IRC:SP : 99-2013) has been followed for geometric design of the proposed SPUR.

The Terms of Reference specifies 120 kmph design speed for the proposed SPUR. The proposed SPUR is passing mainly through plain terrain. The geometric design standards for the proposed SPUR have therefore been developed considering the design speed of 120km/hr which commensurate with this terrain.

As discussed above, based on the design standards and the result of the traffic assignments the SPUR is designed as 8 lane divided carriageway with 6.0 m wide median. The carriageway width is 15m with 3.0m wide paved and 2.0m wide earthen shoulders. The inside edge strip is 0.75m wide is proposed.

The proposed SPUR is planned to be access controlled and access will be available at limited locations with interchanges. Based on the traffic analysis, interchanges have been proposed at 4 locations.

There are 46 numbers of horizontal curves. All the curves are having radius more than 1000m.

14.0 PAVEMENT DESIGN

The pavement designed has been carried out for new 8 lane (4 x 2) divided carriageway including connecting roads and interchanges. The option studies are

- Option 1: Conventional flexible pavement
- Option 2: Flexible pavement with Cement Treated Base and sub-base
- Option 3: Rigid pavement

The detailed traffic surveys for the entire project road were conducted in March – May 2009 and updated in March 2016. Based on the traffic data and interchange locations, the SPUR is divided into five (5) homogeneous sections whereas 4 homogeneous sections fall in this section.

Based on test results of borrow areas available, the project stretch can be broadly divided into three homogeneous sections with design CBR 8% and 10%. Vehicle Damage Factors (VDF) for each vehicle type have been assigned on the basis of axle load survey, standard axle load, legal axle load, legal maximum Gross Vehicle Weight (GVW) and consideration that on expressways there will be control on the vehicle loading. Lane distribution of commercial vehicle has been taken as per IRC: 37.

Design period of the proposed SPUR has been considered as 20 years for the Flexible Pavement (first three options) and 30 years for rigid pavement. The design traffic for the flexible pavement for the SPUR is in the range of 60 to 185 msa. The flexible pavements

of connecting roads are designed for a maximum traffic load of 10 msa.

The flexible pavement is designed as per IRC 37, using IITPAVE software for stress-strain calculations. The design of pavement is done by using 90% reliability fatigue and rutting equations.

The Flexible pavement composition has been worked out to be 50 mm BC, 140mm DBM, 250mm WMM and 300 mm GSB with functional overlay after 5 year. The pavement composition for connecting road has been estimated to be 40mm BC, 50 mm DBM, 250mm WMM and 300mm GSB.

Keeping in view the high intensity of design traffic, Cement Treated Base (CTB) may be considered to fully replace the conventional granular base like Wet Mix Macadam (WMM). The pavement composition for the main carriageway for the full design period of 20 years is 50mm BC, 100 mm DBM, 100 mm AIL, 150 mm CTB and 300 mm CTSB. The functional overlay is proposed in every 5^{th} year.

The Option 3 of rigid pavement has been designed to withstand the cumulative effect of the axle load repetitions of different commercial vehicles applied over the design life of 30 years. The pavement composition for rigid pavement has been designed as 330mm. 150mm DLC, 300mm GSB with separation membrane.

Thus, looking in terms of the investments required for initial construction of the pavement for the new carriageway for the project road, Option-1 of conventional flexible pavement turns out to be cheaper from initial construction cost. Flexible pavement with CTB and CTSB has the lowest life cycle cost. The difference of life cycle cost between Option-2 and Option-3 is marginal.

The aspect of the VOC has not been captured in the life cycle cost analyses. According to the study conducted by CRRI in 1992, it has been seen that there is a fuel consumption savings of 14 % on concrete surfaces. Therefore, total transportation cost will be lesser if rigid pavement vs flexible pavement is considered. Therefore, **rigid pavement is recommended**. However the connecting roads are proposed for use of local traffic and very short length. Considering maintenance, flexible pavement has been recommended for connecting roads only.

15.0 STRUCTURES

Deck configuration of new bridges / structures has been kept as per proposed road cross section of Expressway keeping in view the guidelines issued by NHAI time to time and. All bridges / structures shall have two independent carriageways of 4-lanes each with median between the two carriageways. Overall deck width of each carriageway has been kept 21.25m to match with the width of approach embankment. However structures falling within the area of acceleration lane/ deceleration lane shall have additional lane/lanes as per requirement. All structures are proposed to be eight lane in the opening year.

Efforts have been made to ensure that the type of structures selected will be innovative, cost effective and suitable for construction by locally available material and technology in shortest possible time. Keeping this in view the following type of structures has been proposed which may be simply supported or continuous as per site requirement:

Superstructure

- Span upto 10m : RCC solid slab / RCC box
- Span 10m to 20m : RCC voided slab
- Span 15m to 25m : RCC precast beam and cast in situ slab
- Span 24m to 30m : PSC Precast girder and cast in situ slab
- Span 30m to 60m : Pre-cast post tensioned girder or steel plate girder with cast in situ RCC slab / PSC box girder
- Span > 60m : PSC box girder cantilever type construction/ Extradosed type
- Railway Over Bridge (ROB) Railway portion : Steel plate girder with RCC deck slab composite type superstructure as per Railways' Circular.
- Vehicular Over Bridge (VOB) : RCC Integral Structure / PSC Precast Girder with cast in situ RCC deck slab composite type.
- Vehicular Underpass (VUP) : RCC Box / Portal type
- Pedestrian Underpass (PUP) : RCC Box

Substructure

- Abutment : RCC wall type
- Pier : RCC circular/wall/ornamental type

Foundation

- Major Bridges : Well / Pile / Open
- Minor Bridges : Well / Pile / Open
- R.O.B. / Flyovers / Interchanges : Open / Pile

In deciding the span arrangement and selection of type of superstructure the following points have been given due consideration:

- Generally single span bridges of long spans have been preferred. However in multi-span bridges of less than 30m individual span deck continuity has been provided for better riding quality of the road.
- Efforts have been made to provide long span or continuous superstructure as far as practicable, for better ridding quality.
- Steel girders with RCC slab composite type superstructure have been proposed on ROBs as per Railways' requirement.
- As far as possible precast RCC/PSC/girder and slab or segmental PSC box or pre-fabricated steel girder type superstructure have been adopted for fast track construction.

Single span RCC/PSC girder type bridges have been provided at the gas pipeline crossings to keep ROW of gas pipeline free from the road embankment / structures. A total of 117 numbers of different structures comprising of 8 major bridges, 17 minor bridges, 4 interchanges, 1 ROB, 1 ROB cum Major bridge, 4 flyovers, 2 minor bridges on gas line, 8 vehicular overpasses, 12 vehicular underpasses (size 12m x 4.0m), 30 Pedestrian underpasses (size 12m x 4.0m) and 30 cattle-passes (size 12m x 4.0m) have been proposed in this section. In addition to above 3 underpasses have been proposed in interchange area.

16.0 DESIGN OF INTERCHANGE

The SPUR will be fully access controlled with access allowed through interchanges only. A total of 4 interchanges are proposed in this section of SPUR. The list of interchanges with configuration is given in **Table-8**.

Table-8 Configuration of Interchanges

Sl. No.	Location (km)	Connecting Road	Type of Interchange	Remarks
1.	1.860	NH 8	Full Cloverleaf	Based on the anticipated turning movements a partial cloverleaf has been planned. However provision for converting it to full cloverleaf in future has also been made.
2.	39.748	NH 3	Double Offset Interchange	The location of crossing of NH3 is in hilly terrain and it lies in a reserved forest area. It is also built-up in two quadrants. Hence a double offset interchange has been planned.
3.	52.810	NH 222	Partial Cloverleaf	Based on the anticipated turning movement a partial cloverleaf is planned with loops in the diagonally opposite quadrants
4	68.974	SH 35	Double Offset Interchange	Due to land constraint at crossing location, a double offset interchange has been planned.

17.0 DESIGN OF TUNNEL

The alignment crosses Matheran Eco Sensitive Zone near km 71 with altitude of 625m above MSL. A tunnel of length 4.390 km has been proposed in this section and the details are given in the following section.

It is proposed to construct a 4.39 Km long twin tube 6-lane tunnel across Western Ghats (between km 71.6 to km 76.2), about 15 Km North-East of Panvel and 20 Km southeast of Kalyan as part of the SPUR. The alignment of the tunnel has been optimized keeping in view the topography and disposition of the hill range across the finalized recommended highway alignment in this stretch. Two D-shaped straight tunnel tubes are proposed with carriageway including paved shoulder and edge strip of 18.75m for 2x4 lane traffic. The unidirectional tunnel tubes are aligned parallel at spacing of about 55.70 m from center line of one tube to center line of another tube. Lay byes are also required to be provided at interval of 750m inside the tunnel. Single lane cross

passages for connecting the two tubes are also provided at spacing of about 300 m. The twin tubes are aligned in N60°E – S60°W direction approximately. The maximum overburden cover along the tunnel alignment is of about 550 m. Based on the geological set up and the geological features of the tunnel site, geometrics and traffic requirements, the typical functional cross-section of the mined tunnel and cut and cover sections have been designed in accordance with IRC: SP: 91 – 2010 "Guidelines for Road Tunnels" and IRC:SP:99-2013. The proposed tunnel sites are approachable from existing highways from Panvel and Kalyan.

ENGINEERING CHARACTERISTICS OF THE TUNNEL

a) Tunnel Axis- N60°E-S60°W

b) Twin tube tunnels

Left tube:

- Length of open cut - 60m on Vadodara side (northeastern) portal
  100m Panvel side (southwestern) portal
- Length of Mined Tunnel - 4396m
- Cross-sectional Area - 231.28 Sq. m

Right tube:

- Length of open cut - 30 m Vadodara side (northeastern) portal
  150 m Panvel side (southwestern) portal
- Length of Mined Tunnel - 4380 m
- Cross-sectional Area - 231.28 Sq. m

c) Horizontal Alignment

The horizontal alignment of the tunnel is straight.

d) Vertical Alignment

The vertical alignment of the tunnel has up gradient of 0.7% and down gradient of 0.5% with a vertical curve of 300m in between.

e) Functional Cross-section of Tunnel

- Traffic Lane - 3 Nos.
- Traffic Lane Width - 3.75 m
- Paved shoulder on either side of carriageway - 3.0 m on left side and 0.75 m on right side
- Pavement Thickness - PQC M40, 0.330m (Rigid pavement)
- Pavement Camber - 2.5%
- Crash Barrier Width - 0.50 m

- Drain Wall Thickness - 0.200
- Drain Floor Thickness- 0.200
- Railing Height - 1.2 m

f) Lay Byes – 5 nos. on each side

g) Emergency Exist – 14 nos.

18.0 TOLLING STRATEGY AND PLANNING OF TOLL PLAZAS

Closed tolling system has been recommended for the expressway. Only ramp toll plazas have been provided at the interchange locations and mainline toll plazas have been proposed only at the start and at the end. The user will register at entry and pay at exist. Hence the user will be charged for the exact distance travelled.

The analysis to determine the number of toll lanes or toll booths in each toll plaza has been done on the basis of Queuing Theory by assuming the closed system of tolling on the expressway and as per requirement of TOR. Smart-card based tolling system, Electronic Toll Collection system – Crawl through and Electronic Toll Collection system-Non-stop are to be used to achieve toll transaction speed of less than 10 seconds (per vehicle per lane)

19.0 USER FACILITIES AND ROAD FURNITURE

As per the Terms of Reference (TOR) wayside amenities should be provided at an interval of 50km. However since the expressway is designed for a speed of 120kmph, it will take less than half an hour to cover a distance of 50km. Hence it is proposed to increase the distance between wayside amenities to 75-100km. Therefore **two wayside amenities** are planned along the SPUR. These facilities will have all the provisions required for the travelers and as per TOR. In addition smaller parking areas with toilet facilities are proposed at 4 locations (2 each side) on the SPUR, and truck parking areas are proposed at 2 locations (one either side) for SPUR.

The traffic signs and markings to provide information, guidance, warning and mandated requirements to the users of the expressways will be provided on the basis of the draft Guidelines and Manual for Expressways being finalized by the Ministry of Road Transport & Highways and NHAI and the Manual on Uniform Traffic Control Devices (MUTCD), FHWA, USA.

Thrie Beam-type metal beam longitudinal edge barriers will be provided on outer edges at the top of embankment throughout the length to protect any out of control vehicle from falling. Thrie beam metal barriers are also proposed in median for both side carriageways.

To prevent unauthorized entry, restrict encroachment and stay away of cattle & animals; RCC boundary wall has been proposed throughout the SPUR alignment.

20.0 ADVANCED TRAFFIC MANAGEMENTS SYSTEM (ATMS)

The Expressway shall be provided with ATMS facilities to acquire data automatically and utilize the same for managing traffic as well as facilitate the travel through the corridor with least hazard, as the motorists will be informed in advance about the situation ahead. Basically, the ATMS will have the complete capability of incident management and to meet the requirements of the safety of users. ATMS will provide information to the users on real time basis for the traffic flow conditions and incidents ahead, and for this purpose, there would be a control centre and outdoor equipment located at strategic locations along the entire corridor and connected through a transmission medium. The ATMS shall among many things comprise following sub-systems:

- Communication backbone
- Emergency Communication System
- Mobile Communication System
- Variable Message Sign System
- Meteorological Data System
- Automatic traffic counter-cum-classifier system
- Central Control Room (CCR)
- Weigh in motion for axle load measurement
- Power Supply System.

21.0 LAND ACQUISITION

The proposed land acquisition for SPUR is tentatively 1241.551 Ha out of which 1081.891 ha is private land and 222.66 ha is government land. Actual figure will be provided in the EIA Report after completion of Joint Measurement Survey.

22.0 MANPOWER REQUIREMENT

Approximately 300 workers both skilled and unskilled shall be employed for construction of the proposed project. Preference shall be given to local employment. The construction of the proposed project shall be completed in four years.

23.0 ROAD SAFETY FEATURES

The various considerations made for the safe design of expressway and different road safety features are given hereunder. Indian Road Congress (IRC) codes and Design Manual for Roads & Bridges (DMRB, UK) guidelines and Manual for Uniform Traffic Control Devices (MUTCD, US Dept. of Transportation) have been followed in proposing and designing road safety features of the expressway. The expressway has been designed for same level of safety considerations throughout.

- General
- Alignment

- Interchanges
- Non-motorized User Provision
- Road Signs, Pavement Marking & Lighting
- Roadside Hazards
- Intersection Arrangements on Slip roads of Interchange
- Way Side amenities, Toll Plazas & Truck Lay byes

It may be worth mentioning that the expressway is designed as access controlled facility and 120 kmph speed has been kept for the design of main carriageway. The expressway being a green field project, the development plan for enroute area, forecast traffic volumes, mix of traffic likely to be used and the physical constrains imposed by topography have been considered on road safety point of view. In addition, the cross sectional parameters such as width of lane, shoulder and median, and side slope also have been examined which have direct bearing with safety of the expressway. Direct access to the expressway has been avoided and lay byes have been provided to enhance the safety level of the expressway.

The interchange arrangements provided at 4 locations on the SPUR will safely transfer vehicles at these locations whereby possible accident risks due to at-grade conflicts have been avoided. The interchanges have been provided with adequate acceleration and deceleration lanes and ramps also have been designed for 80kmph. The interchanges will be provided with gantry mounted signs and flag type direction signs apart from chevron signs for delineation of ramps and slip roads.

All vulnerable road users like pedestrians and cyclists shall have no access to the expressway and are segregated from the exposure of fast moving traffic. They shall cross the expressway through underpasses. Service road has been provided to cater the slow moving and local traffic. Non-motorized users will not be allowed to use high speed expressway. At all interchanges, shoulder and gantry mounted advanced directions signs will be provided. Pavement markings will be done for traffic lane line, edge lines and hatching.

The proposed expressway will be on embankment of height more than 4m with side slopes of embankment of 2(H):1(V). Longitudinal edge barriers will be provided on both the edges at the top of embankment throughout the length to protect any out of control vehicle from falling. W-type metal beam crash barriers will be provided as edge barriers. Properly designed edge barriers have been provided on entry/exit ramps and loops of interchanges. Crash barriers have also been provided on the median edge at the approaches to structures.

24.0 PROJECT COST

Estimated project cost is given in Table-9.

Table-9 Item wise Detailed Project Cost

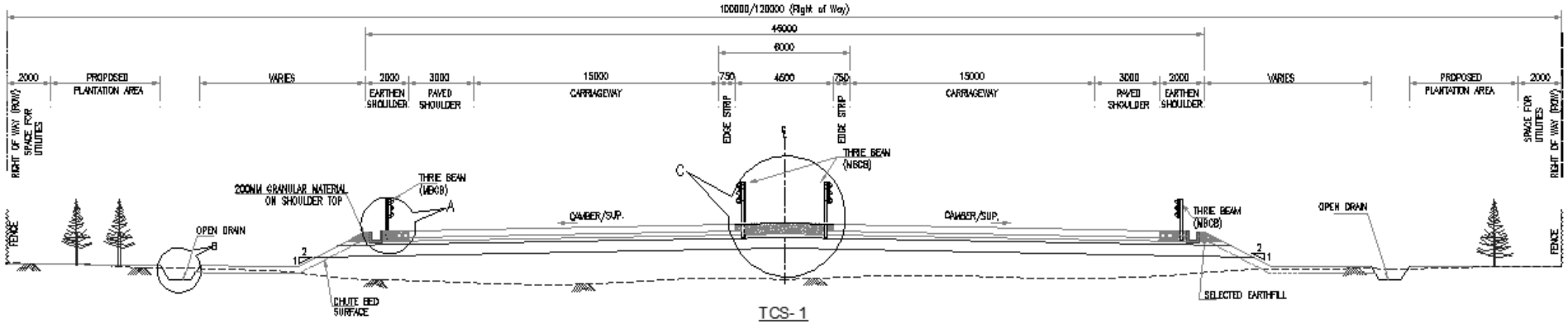
Sl. No.	Description	Amount (Rs.)
1	Site Clearance and Dismantling	3,06,05,509.00
2	Earthwork	5,28,76,45,402.00
3	Granular Sub base and Base Course	3,63,30,31,912.00
4(A)	Cement Concrete Pavement	9,18,18,32,130.00
4(B)	Bituminous Course	17,02,65,402.00
5	Culverts	2,62,09,04,992.00
6(A)	Major Bridges	2,29,75,57,300.00
6(B)	Minor Bridges, Canal Bridges and Gas Pipe Line Bridges	1,53,69,80,300.00
6(C)	Interchanges, Flyovers and ROB's	2,79,72,11,100.00
6(D)	Underpasses / Overpasses	3,69,88,77,800.00
6(E)	Elevated Bridge	2,86,01,82,000.00
7	Drainage and Protection Works	4,84,46,80,600.00
8	Traffic Signs, Markings and Other Appurtenances.	25,02,61,031.00
9	Miscellaneous	1,09,68,31,860.00
10	Horticulture	26,71,92,525.00
11	Tunnel	13,96,58,81,867.00
A	***Total Civil Cost***	***54,53,99,41,730.00***
B	Add Contingencies @ 3% on (A)	1,63,61,98,253.00
C	Construction Supervision Charges @ 3% on (A)	1,63,61,98,253.00
	Sub Total (A+B+C)	***57,81,23,38,236.00***
D	Environment and Mitigation cost	15,19,47,528.00
E	Land Acquisition ,Resettlement and Rehabilitation Cost	52,15,39,91,178.00
F	Cost for Shifting of Utilities	1,63,61,98,253.00
	GRAND TOTAL (A+B+C+D+E+F)	**1,11,75,44,75,195.00**
	Cost in Crores	**11,175.45**
	Project Cost per km	**139.87 Cr**

25.0 SALIENT FEATURES OF THE PROPOSED DEVELOPMENT

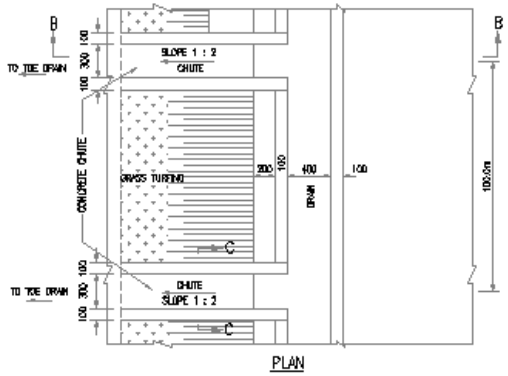
Table-10 Salient Features of the Proposed Development

Features	Description
Proposed Project	Development of 8-lane SPUR Starting from Km 26.582 of Vadodara - Mumbai Expressway Main Alignment and terminating at proposed junction with the Multi-Modal Corridor of MMRDA in the state of Maharashtra. It is a green field alignment
Location of the proposed project road	The proposed project road starts at km 26+582 of the Vadodara Mumbai Expressway main alignment at Koshimb village of Palghar district (Ch.

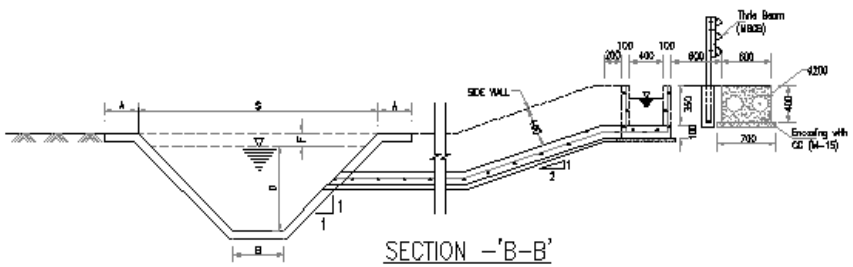
Features	Description
	0+000) and terminates at the proposed junction with the Multi-Modal Corridor of MMRDA in Morbe village of Raigad district (Ch. 79+783).
Total Length	**79.783 km**
Latitude & Longitude	Start Point : 19°29'19.45"N, 72°52'58.78"E End Point : 19° 4'2.93"N, 73°10'50.07"E
Village & Tehsil	The proposed alignment of VME-SPUR is passing through 64 villages and 6 Tehsils (Vasai, Wada, Bhiwandi, Kalyan, Ambarnath, Panvel)
District en-route	3 districts namely Palghar, Thane and Raigarh ▪ 18.864 km (Ch. 0+000 to 18+864) lies in Palghar district, ▪ 55.336 km (Ch. 18+864 to 74+200) lies in Thane district and ▪ 5.583 km (Ch. 74+200 to 79+783) lies in Raigarh district
State	Maharashtra
Terrain	Mainly plain except 4 km is passing through hilly terrain with elevation ranges from 25m to 622m AMSL
Seismic Zone	Zone III (having moderate seismic intensity) - as per IS: 1893, Part I, 2002
River Crossing	Tansa River (Km 3+400 & 18+850), Tributory of Tansa River (Km 13+545), Kamvadi river (Km 33+350), Bhatsal River (Km 45+400), Kalu River (Km 47+300), Barvi River (Km 57+600), Ulhas River (Km 67+200)
PROW	100m / 120m
Design speed	120km/hr
Carriage way	Dual carriageway : 2 x 4 x 3.75 (8 lane)
Shoulder	Paved Shoulder: 3.0 m, Earthen shoulder: 2.0 m
No. of bridges	Major bridge: 8; Minor bridge: 19
No. of culverts:	158 (123 box culverts and 35 pipe culverts)
Interchanges	4
ROBs	2
Flyovers	4
Vehicular overpass	8
Vehicular underpass	12 + 3 (Size 12 m x 4.0 m)
Pedestrian underpass	30 (Size 12 m x 4.0 m)
Cattle underpass	30 (Size 12 m x 4.0 m)
Service roads	9.990 km (on both sides)
Tunnel	4.390 km long twin tube 6 lane tunnel
Wayside amenities	2
Truck parking	2
Toll Plaza including on interchanges	5
Land Acquisition	Approx. 1241.551 Ha (1081.891 ha private & 222.66 ha government land)
Project Cost	Rs. 11,175.45 Crore (per Km cost is Rs. 139.87 Cr)



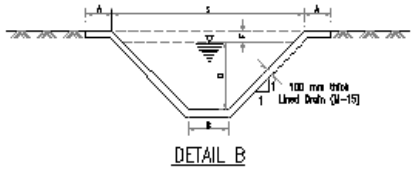
TCS- 1
TYPICAL CROSS SECTION OF EXPRESSWAY
8-LANE DIVIDED C/W WITHOUT CONNECTING ROAD



PLAN



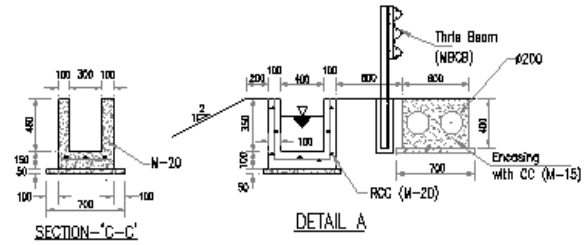
SECTION –'B–B'



DETAIL B

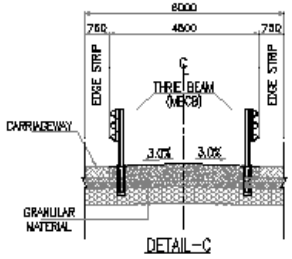
Detail of Drain – "B" (Toe Drain)

S. No.	Dimensions(in mm)				
	A	B	D	F	S
1	400	600	790	150	2480



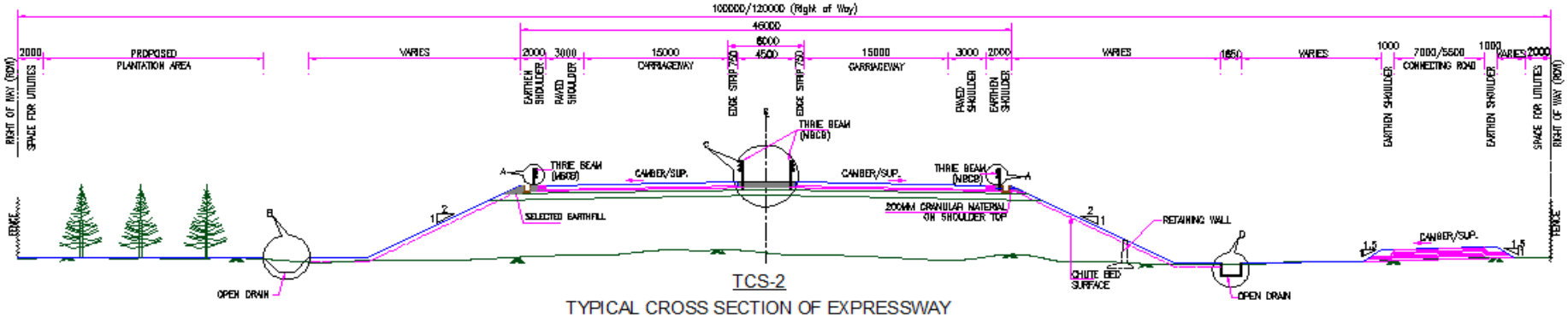
SECTION–'C–C'

DETAIL A



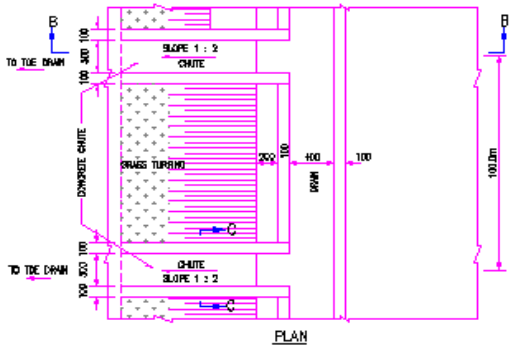
DETAIL–C

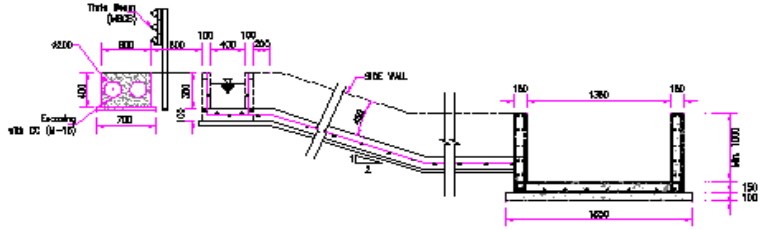
Notes:
1. All Dimensions are in mm unless otherwise specified.

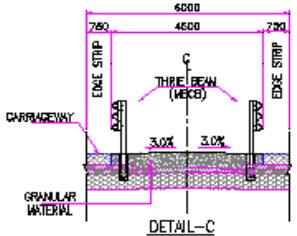


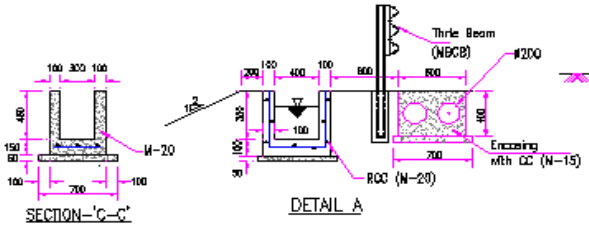
TCS-2

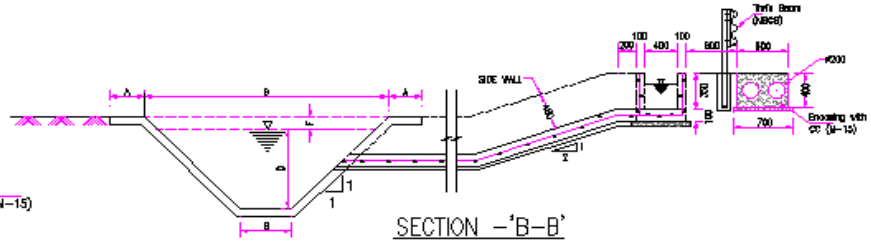
TYPICAL CROSS SECTION OF EXPRESSWAY
8-LANE DIVIDED C/W WITH
RIGHT SIDE CONNECTING ROAD

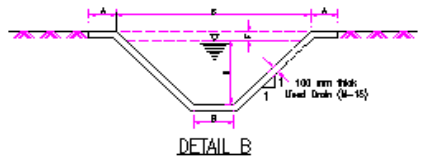












Detail of Drain – "B" (Toe Drain)

Sl. No.	Dimensions (in mm)				
	A	B	D	F	S
1	400	800	700	150	2480

Notes:
1. All Dimensions are in mm unless otherwise specified.
2. Retaining wall shall be provide to restrict Toe Line, wherever required to accommodate within PROW