NATIONAL HIGHWAY AUTHORITY OF INDIA

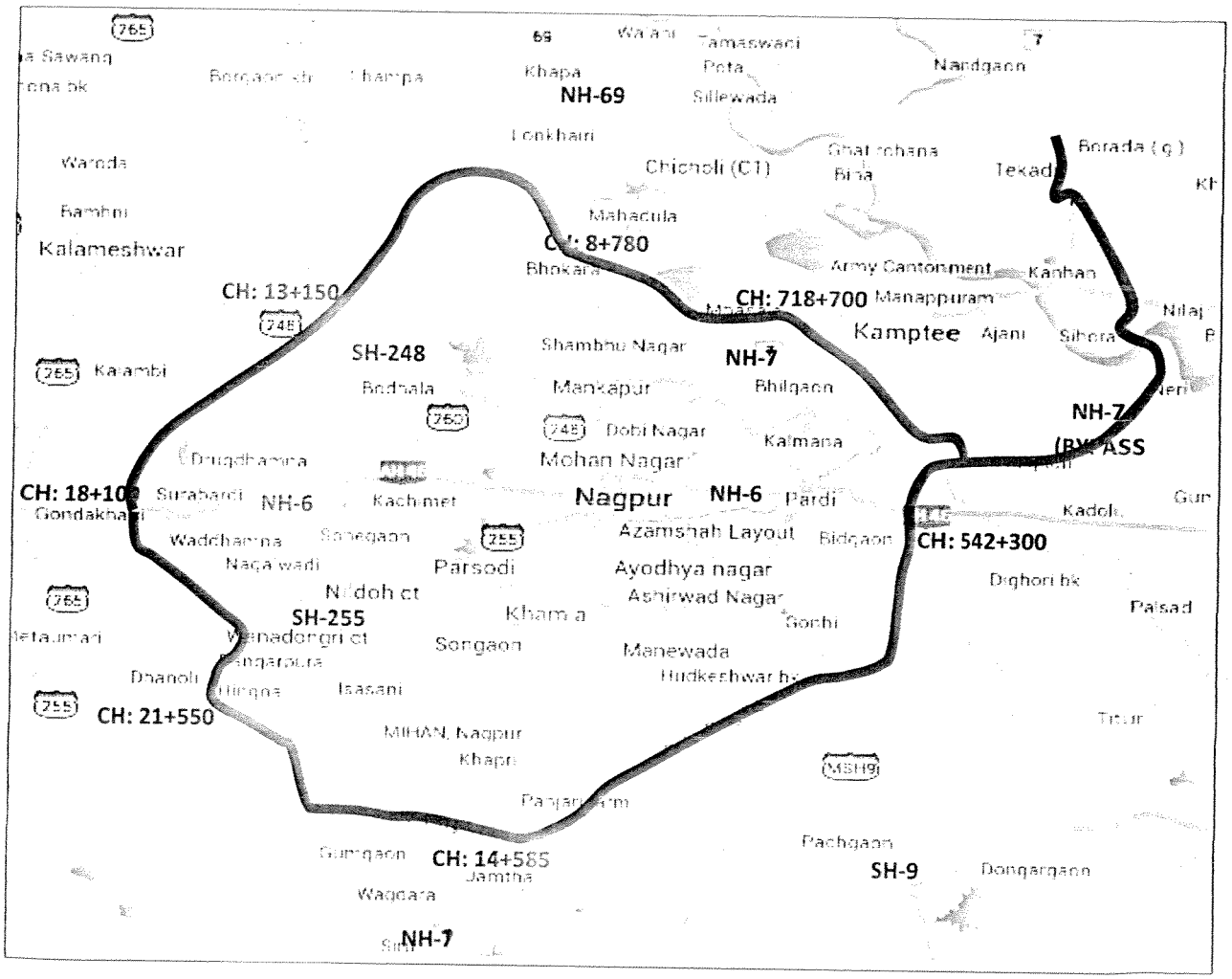
(Ministry of Road Transport & Highways)

Consultancy Services for Preparation of Feasibility cum Preliminary Design for Construction of Stand Alone Ring Road/Bypasses for Nagpur City in the State of Maharashtra under NHDP Phase VII.

FINAL FEASIBILITY CUM PRELIMINARY DESIGN REPORT

EXECUTIVE SUMMARY

PACKAGE–II(From Km 34+000 to Km 62+035)



SEPTEMBER-2015 (Hybrid Mode)

UPHAM INTERNATIONAL CORPORATION

Joint Venture With

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Executive Summary

1.1 Introduction

Good transportation systems are lifeline to the area they serve. Roads bring about all-round development in the region. A good road network helps in the success of all development activities, be it in the sphere of movement of people and goods, agriculture, commerce, education, health, and social welfare, or even maintenance of law, order and security.

After the successful launching of NHD Programmes up to Phase-VI, Government has approved NHDP Phase-VII. Under this programme, construction of 700 km of standalone ring roads/bypasses as well as grade separators, flyovers, elevated road, tunnels, road over bridge, under passes etc at an estimated cost of Rs. 16,680Crore through PPP route on BOT (Toll) mode with a maximum VGF of 40%. NHDP-VII is scheduled for completion by Dec. 2014

Under this phase, The National Highways Authority of India (NHAI) invited proposals to conduct a feasibility study and prepare a preliminary design report for the construction of standalone ring road / bypass for the Nagpur City in the State of Maharashtra. This Project has been awarded to Upham International Corporation JV with SA Infrastructure Consultant Pvt. Ltd., Ghaziabad.

1.2 Scope of Study

The project study consists of preparation of the following:

Stage I: Inception Report (IR) including Quality Assurance Plan (QAP)
Stage II: Strip Plan showing various alternatives
Stage III: Draft Feasibility/viability Report
Stage IV: Final Feasibility/viability Report
Stage V: Technical Schedules
Stage VI: Other Reports

Stage 1 – QAP and Inception report were submitted on 6th March 2012.

Stage II – Strip Plan showing various alternatives alignment had been presented on 7th May 2012. During presentation on alignment alternatives; consultant have present three alternative options with merits and demerits of the alignment; out of them option-II has been finalised and same has been recommended by Nagpur Improvement Trust. After that further discussions regarding alignment with PIU they have suggested option-I except realignment at two locations because in this option land already acquired by PWD except realignment locations for construction of outer ring road. The Consultants have requested for the approval of the same. The written approval of the same is pending. Consultant have continued the study on alignment option-I. Accordingly, investigations and design works has been continued.

Strip plan with alternatives / Alignment Report were submitted on 07-05-2012 & 30-05-2014.

Stage III – Draft Feasibility / Viability Report were submitted on 14-07-2014 & 21-07-2014.
Stage IV – Final Feasibility / Viability Report were submitted on 27-11-2014
Stage V – Technical Schedules were submitted on 21-07-2014 & 27-11-2014.
Revised Final Feasibility Report with revised schedules were submitted on 23-07-2015 & 03-08-2015.

1.3 Organization of this Report

Project is divided into two Packages as follow:-
Package – I : From Km 0+500 to Km 34+000 (Design Length 33+500 Km)
Package-II : From Km 34+000 to Km 62+035 (Design Length 28+035 Km)
Here Package-II is discussed:

1.4 Project Description

Nagpur is the largest city in central India and the second capital of the State of Maharashtra. It has been cited as one of the future global cities. It is famous for the Nagpur Orange and is known as the "Orange City" for being a major trade centre of oranges cultivated in the region. It is a fast growing metropolis and is the third most populous city in Maharashtra after Mumbai and Pune, and also one of the country's most industrialized cities. It is the 13th most populous city and 13th largest urban agglomeration in India.

The major roads that are serving Nagpur city are as follows:

- NH-6: Hajira - Kolkata National Highway
- NH-7: Varanasi - Kanyakumari National Highway
- NH-69: Nagpur - Obaidullaganj National Highway
- SH-255: Nagpur - Seloo State Highway
- SH-248: Nagpur - Warud State Highway
- SH-9: Nagpur - Chandrapur State Highway

The consultant have studied the Project alignment into four sections

Section A: This section (length 21+060 km) is the part of newly four lane constructed NH-7 bypass for Kamptee. It starts at km 705+470 near Tekadi Village and ends at km 542+300 of NH-6 (Nagpur- Kolkata Road) near Kapsi village. Any improvement in this section is not required.

Section B: This section (length 21+040 km) is also the part of newly four lane constructed NH-7 bypass for Nagpur. It starts at km 542+300 of NH-6 near Kapsi village and ends near Gabsi Manpur village at km 14+585 of existing NH-7 (Nagpur-Kanyakumari Road). Any improvement in this section is not required.

Section C: In continuation of section B, PWD Nagpur Division have proposed Outer Ring Road for Nagpur City and they have constructed eccentrically placed two lane road between NH-7 and NH-6 (Nagpur-Amravati Road) in 22.235 km length. Further improvement for ring road purpose is required in this section.

Section D: In continuation of section C, PWD Nagpur Division had acquired the land for construction of balance part of outer ring road. This PWD alignment ends at crossing of NH-6 and NH-7 bypass near Kapsi village. Detailed study and alignment options are required for this section.

In continuation of the above; the Consultants have studied three alternate options (Option–I, II and III) and out of which option–I is recommended based on the merits of the proposed alignment.

Table 1.1: Main Features of Alignment Section – C

Sr. No.	Design Chainage (Km)	Description of Existing Land mark	Remarks
1	0+000	Junction with NH-7 and NH-7 bypass near Gabsi Manpur Village at km 14+585 of NH-7.	Full Cloverleaf type four lanes Grade Separator constructed.
2	**0+500**	**Start of Grade Separator approach.**	**(Project Start Point)**
3	1+085	Crossing with Railway line. (Central Railway: Nagpur – Hyderabad Branch)	Two Lane ROB constructed.
4	5+520	Vena River Crossing.	Two lane Major Bridge constructed.
5	6+030	Crossing with MDR-44 at Km 26+000	At grade Intersection with existing Road.
6	13+180	Crossing with SH-255 at Km 21+550	At grade Intersection with existing Road.
7	14+845	Vena River Crossing.	Two lane Major Bridge constructed.
8	22+235	Ends of section C, crossing with NH-6 at Km 18+100.	At grade Intersection with existing Road.

Table 1.2: Main Features of Alignment Section – D

Sr. No.	Design Chainage (Km)	Description of Existing Land mark	Remarks
1	22+235	Crossing with NH-6 at Km 80+100 near Gondakhairi village	Divided Four Lane Road with Paved Shoulder.
2	28+650	Crossing with Major District Road.	Two lane bituminous road.
3	33+155	Crossing with SH-248 at Km 13+150 near Fetari village	Two lane bituminous road
4	38+605	Crossing with Railway line near Bharatwada railway station.	Central Railway: Nagpur – Bhopal Branch.
5	42+180	Crossing with Major District Road.	Two lane bituminous road.

Sr. No.	Design Chainage (Km)	Description of Existing Land mark	Remarks
6	45+900	Crossing with NH- 69 at Km 8+780.	Divided Four Lane Road Paved Shoulder including both side service road.
7	46+900	Crossing with Railway line.	Central Railway: Godhani – Koradi NTPC Branch.
8	50+810	Crossing with Railway line.	South East Central Railway: Kalmana – Chindwana Branch.
9	52+890	Canal crossing	
10	53+800	Crossing with NH-7 at Km 718+700.	Two lane bituminous road
11	55+070	Canal crossing	
12	55+710	Crossing with SH-341	Two lane bituminous road
13	61+550	End of section D Junction with NH-7 bypass at Km 722+600.	Divided Four Lane with Paved Shoulder.

1.5 Improvement Proposal

The project stretch is in the State of Maharashtra. The project road is a proposed ring road for the city of Nagpur which will also act as a standalone bypass. Section wise alignment has already explained above, out of which improvement is required for section-C of 21.735 km length and three alternatives alignment options was proposed for section-D. Among these options, option-I, with a length of 39.070 km was recommended. At the end of the project T-junction has been created with NH-7 Bypass. Therefore trumpet interchange has been proposed for this junction. One side approach length of this interchange is 495m. Therefore total project length including section-C, section-D, and one side approach length of interchange is 61.535 km.

Package-II comprises the section of new alignment starts at Design Chainage km 34+000 near Fetari Village or after 845 m beyond the crossing with SH-248 (Katol Road) at km 13+150 of SH-248 and run 11+655 km length towards NH-69 (Bhopal Road) and cross the NH-69 at km 8+780 of NH-69 near Kodari Tharmal Power Station, after that run 7+915 km length towards NH-7 (Varanasi Road) and cross the NH-7 at km 718+700 of NH-7 near Kapsi Village, again run 7+735 km length towards Kamptee Bypass for NH-7 and intersect at km 722+600 of Kamptee bypass, Trumpet Interchange has been proposed for this intersection, after approach length of 495m for loop and ramps, end at Design Chainage km 62+035 (Design Length 28+035 Km) in the State of Maharashtra.

1.5.1 Proposed Right of Way (ROW)

Details of proposed Right of way (ROW) are given in table below as per project requirement.

Table 1.3: Details of Proposed Right of Way (ROW)

Sl. No.	Design Chainage (In Km)		ROW LHS+RHS (In m)	Remarks
	From	To		
1	34+000	36+680	30+30	
2	36+680	39+070	Varies between 60 to 410	Entry & Exit Ramp, Truck Lay Bye, Rest Area with Public Facility
3	39+070	46+175	30+30	
4	46+175	46+675	110+110	Entry & Exit Ramp with Public Facility
5	46+675	54+370	30+30	
6	54+370	54+865	100+150	Entry & Exit Ramp with Public Facility
7	54+865	57+535	30+30	
8	57+535	58+330	75+75	Toll Plaza
9	58+330	59+635	30+30	
10	59+635	62+035	30+30	

1.5.2 Details of Land Acquisition

Extra lands to be acquired for accommodation of toll plaza, Entry & Exit Ramp, Realignment, Truck Lay byes, Rest Areas, Public facility and Junction improvements. Land acquisition details are given in table below.

Table 1.4: Details of Land to be acquired

Sl. No	Design Chainage (Km)		Available ROW (m)	Width to be acquired (m)	Area to be acquired (Hac.)	Remarks
	From	To				
1	36+680	39+070	60	60 - 410	26.70	Realignment, Truck Lay Byes, Rest area, Public Facility
2	46+175	46+675	60	160	8.00	Entry & Exit Ramp
3	54+370	54+865	60	190	9.50	Entry & Exit Ramp with Public Facility
4	57+535	58+330	60	90	7.20	Toll Plaza
5	59+635	62+035	0	60	15.95	Realignment, Trumpet Interchange
Total Extra Land to be acquired					**67.35**	**Hac.**

1.5.3 Slip Road/Service Road

Slip Road / Service road has been proposed at given below locations:

Table 1.5: Slip Road/ Service Road Locations

Sl. No.	Design Chainage (In Km)		Length (In km)	Carriageway Width (In m)	Side (LHS/RHS/ Both Side)
	From	To			
1	35+620	36+590	0+970	7.0	RHS
2	37+700	38+570	0+870	7.0	Both Side
3	38+650	39+030	0+380	7.0	Both Side
4	40+890	40+960	0+070	7.0	RHS
5	42+170	44+520	2+350	7.0	LHS
6	44+520	45+880	1+360	7.0	Both Side
7	45+880	46+230	0+350	10.0	Both Side
8	46+630	46+880	0+250	7.0	Both Side
9	53+830	54+380	0+550	10.0	Both Side
10	59+000	59+380	0+380	7.0	LHS
11	60+370	60+990	0+620	7.0	LHS
12	60+990	61+540	0+550	7.0	Both Side

1.5.4 CD Structures

As per recommended Alignment option following CD structures are proposed.

Major Bridge: Details of additional major bridge is given below.

Table 1.6: Details of New Major Bridge

Sl. No.	Name of Bridge	Design Chainage (In Km)	No. of Spans with Span Length (In m)	Total Width (In m)
Nil				

Minor Bridge: The project alignment crosses drains and canals at 9 locations. At these locations four lane minor bridge has been proposed. Details are given below.

Table 1.7: Details of New Minor Bridge

Sl. No.	Name of Bridge / Nala	Design Chainage (In Km)	No. of Spans with Span Length (In m)	Total Width (In m)
1	Drain	35+895	2 x 8	12.5 + 12.5
2	Drain	40+095	2 x 10	12.5 + 12.5
3	Drain	41+350	1 X 10	12.5 + 12.5
4	Drain	41+935	1 X 10	12.5 + 12.5

Sl. No.	Name of Bridge / Nala	Design Chainage (In Km)	No. of Spans with Span Length (In m)	Total Width (In m)
5	Canal	52+890	1 X 30	12.5 + 12.5
6	Drain	54+230	1 X 10	12.5 + 12.5
7	Canal	55+070	1 X 45	12.5 + 12.5
8	Drain	56+630	3 x 5	12.5 + 12.5
9	Drain	60+420	2 x 8	12.5 + 12.5

Culverts: There are 78 numbers of new culverts has been proposed in the new alignment section. Details are given in table. Summary of types of culvert are given in table below.

Table 1.8: Summary of Type of Culvert

Sl. No.	Type of Culvert	No of Culvert	Improvement proposal
1	Box Culvert	33	New Construction as per Roadway Width
2	HP Culvert	45	

Table 1.9: Details of New Culvert

S. No.	Design Chainage (Km)	Details of Additional New Culverts		
		Type of Culvert	No. of Spans	Span length x Vertical Clearance (m)
1	34+270	Box Culvert	1	4 x 3
2	34+390	Box Culvert	1	3 x 3
3	34+850	HP Culvert	1	1.2 (Dia.)
4	35+250	HP Culvert	1	1.2 (Dia.)
5	35+830	Box Culvert	1	6 x 3
6	36+280	Box Culvert	1	6 x 3
7	36+650	Box Culvert	1	3 x 3
8	36+940	Box Culvert	1	6 x 3
9	37+250	HP Culvert	1	1.2 (Dia.)
10	37+800	HP Culvert	1	1.2 (Dia.)
11	38+000	HP Culvert	1	1.2 (Dia.)
12	38+325	Box Culvert	1	6 x 3
13	38+930	Box Culvert	1	3 x 3
14	39+365	Box Culvert	1	3 x 3
15	39+675	Box Culvert	1	3 x 3
16	39+850	Box Culvert	1	3 x 3
17	40+440	Box Culvert	1	6 x 3

S. No.	Design Chainage (Km)	Details of Additional New Culverts		
		Type of Culvert	No. of Spans	Span length x Vertical Clearance (m)
18	41+140	Box Culvert	1	3 x 3
19	41+690	HP Culvert	1	1.2 (Dia.)
20	42+440	HP Culvert	1	1.2 (Dia.)
21	42+690	Box Culvert	1	3 x 3
22	42+780	Box Culvert	1	3 x 3
23	43+130	HP Culvert	1	1.2 (Dia.)
24	43+530	HP Culvert	1	1.2 (Dia.)
25	43+890	HP Culvert	1	1.2 (Dia.)
26	44+290	HP Culvert	1	1.2 (Dia.)
27	44+560	Box Culvert	1	4 x 3
28	45+290	Box Culvert	1	2 x 2
29	46+190	HP Culvert	1	1.2 (Dia.)
30	46+490	HP Culvert	1	1.2 (Dia.)
31	46+830	HP Culvert	1	1.2 (Dia.)
32	47+090	HP Culvert	1	1.2 (Dia.)
33	47+390	HP Culvert	1	1.2 (Dia.)
34	47+630	HP Culvert	1	1.2 (Dia.)
35	47+990	HP Culvert	1	1.2 (Dia.)
36	48+290	HP Culvert	1	1.2 (Dia.)
37	48+560	HP Culvert	1	1.2 (Dia.)
38	48+890	HP Culvert	1	1.2 (Dia.)
39	49+390	HP Culvert	1	1.2 (Dia.)
40	49+690	HP Culvert	1	1.2 (Dia.)
41	49+990	HP Culvert	1	1.2 (Dia.)
42	50+290	HP Culvert	1	1.2 (Dia.)
43	50+590	HP Culvert	1	1.2 (Dia.)
44	50+990	HP Culvert	1	1.2 (Dia.)
45	51+290	HP Culvert	1	1.2 (Dia.)
46	51+590	HP Culvert	1	1.2 (Dia.)
47	51+890	HP Culvert	1	1.2 (Dia.)
48	52+190	HP Culvert	1	1.2 (Dia.)
49	52+490	HP Culvert	1	1.2 (Dia.)
50	53+010	Box Culvert	1	6 x 3
51	53+220	HP Culvert	1	1.2 (Dia.)
52	53+510	Box Culvert	1	6 x 3
53	53+690	HP Culvert	1	1.2 (Dia.)

S. No.	Design Chainage (Km)	Details of Additional New Culverts		
		Type of Culvert	No. of Spans	Span length x Vertical Clearance (m)
54	53+900	Box Culvert	1	4 x 3
55	54+130	HP Culvert	1	1.2 (Dia.)
56	54+590	Box Culvert	1	4 x 3
57	55+290	HP Culvert	1	1.2 (Dia.)
58	55+490	HP Culvert	1	1.2 (Dia.)
59	55+915	Box Culvert	1	6 x 3
60	56+230	HP Culvert	1	1.2 (Dia.)
61	56+830	Box Culvert	1	4 x 3
62	56+990	HP Culvert	1	1.2 (Dia.)
63	57+270	Box Culvert	1	4 x 3
64	57+410	Box Culvert	1	6 x 3
65	57+790	HP Culvert	1	1.2 (Dia.)
66	58+090	Box Culvert	1	3 x 3
67	58+420	Box Culvert	1	2 x 2
68	58+615	Box Culvert	1	3 x 3
69	58+990	Box Culvert	1	3 x 3
70	59+260	Box Culvert	1	3 x 3
71	59+585	HP Culvert	1	1.2 (Dia.)
72	59+880	HP Culvert	1	1.2 (Dia.)
73	60+185	HP Culvert	1	1.2 (Dia.)
74	60+495	Box Culvert	1	2 x 2
75	60+905	HP Culvert	1	1.2 (Dia.)
76	61+025	Box Culvert	1	3 x 2
77	61+140	HP Culvert	1	1.2 (Dia.)
78	61+195	Box Culvert	1	3 x 3

1.5.5 ROB/ RUB

Nagpur city is located at almost centre of the India. Therefore railway network for the city is developed as a radial type. Railway line from Nagpur towards other important cities of India is running mainly in five different directions. Out of which four Railway line crosses the proposed ring road alignment and another cross the Godhni - Koradi Thermal Power Railway line. Railway over Bridge (ROB) has been required at these four crossing locations. Four lane ROB at four location has been proposed. Details of these ROB are given in table below.

Table 1.10: Details of ROB

Sr. No.	Design Chainage (Km)	No. of Spans with Span Length (In m)	Total width (In m)	Railway Zone
1	38+605	2x18 + 1x30 + 2x18	12.5+12.5	Central Railway
2	46+900	1x15 + 1X30 + 1X15	12.5+12.5	Central Railway
3	50+810	4X30	12.5+12.5	South East Central Railway
4	56+400	3X30	12.5+12.5	South East Central Railway

1.5.6 Flyover

Grade-separated junctions with flyover and service road are proposed at locations with high traffic volume as well as intersection of Ring road with National Highway and State Highway. Location of flyovers is given in the table below.

Table 1.11: Location of Flyover

Sl. No.	Design Chainage (In Km)	Type of Cross Road	No. of Spans with Span Length (In m)	Total Width (In m)
1	45+900	NH-69	2x30	12.5+12.5
2	53+800	NH-7	1x15 + 1x30 + 1x15	12.5+12.5
3	61+550	NH-7 Bypass	2x30	12.5+12.5

1.5.7 Vehicular and Cattle/Pedestrian Underpasses

Underpasses are necessary for cross movement of local traffic, animals and pedestrians. The RCC box of dimensions 12.0m x 5.5m has been proposed for vehicular underpass. In case of pedestrian/ cattle underpasses, box of sizes 6.0m x 3.5m has been proposed. List of new proposed Vehicular and Cattle/Pedestrian Underpass are given in below tables:

Table 1.12: List of New Vehicular Underpass

Sl. No.	Design Chainage (In Km)	Type of Cross Road	No. of Spans with Clear Span Length x Vertical Clearance (In m)	Total Width (In m)	Remarks
1	42+190	MDR	1x12x5.5	12.5+12.5	Above Cross Road
2	55+710	SH-341	1x12x5.5	12.5+12.5	Above Cross Road

Table 1.13: List of New Cattle/Light vehicular Underpass

Sl. No.	Design Chainage (In Km)	Type of Cross Road	No. of Spans with Clear Span Length x Vertical Clearance (In m)	Total Width (In m)
1	34+545	VR	1x6x3.5	12.5+12.5

Sl. No.	Design Chainage (In Km)	Type of Cross Road	No. of Spans with Clear Span Length x Vertical Clearance (In m)	Total Width (In m)
2	36+580	VR	1x6x3.5	12.5+12.5
3	40+910	ODR	1x6x3.5	12.5+12.5
4	44+520	ODR	1x6x3.5	12.5+12.5
5	49+115	VR	1x6x3.5	12.5+12.5
6	52+000	ODR	1x6x3.5	12.5+12.5
7	59+015	ODR	1x6x3.5	12.5+12.5
8	60+375	ODR	1x6x3.5	12.5+12.5

Summary of structures in the project alignment are given below:

Table 1.14: Summary of structures in the project alignment

Sl. No.	Type of Structure	No.
1	Major Bridge	Nil
2	Minor Bridge	09
3	Flyover	03
4	ROB	04
5	Vehicular Underpass	02
6	Cattle pass	08
7	Pipe Culverts	45
8	Box Culvert	33

1.5.8 Entry & Exit Ramp

Entry and exit ramps for entering into or existing from the project highways have been proposed. Minimum 30m turning radius for inner edge and desirable length for acceleration and declaration lane has been proposed as per IRC: 92-1985. List of these ramps are given in table below.

Table 1.15: List of Entry & Exit Ramp

Sl. No.	Design Chainage (In Km)	Side (LHS/RHS/Both side)	Remarks
1	37+200	Both Side	Entry & Exit with Truck Lay Bye
2	46+430	Both Side	Entry & Exit with NH-69
3	54+630	Both Side	Entry & Exit with NH-7

1.5.9 Proposed Toll Plaza

The project road is envisaged to be developed on a commercial basis. In this section, traffic flow is sufficient to sustain revenue model. Direct tolling method of revenue generation by constructing toll plaza has been proposed by the consultants. Proposed toll plaza location given in table below.

Table 1.16: Location of Toll Plaza

Sl. No	Toll Plaza Location (Design Chainage in km)
1	Toll Plaza at km. 57+935

1.5.10 Truck Lay bye

A truck lay bye of 50 numbers of truck capacities is provided at design chainage 37+500 near Bharatwada Railway station. All basic facilities like rest place, facility to stay overnight, restaurants, drinking water, toilets along with disposal system for waste materials are provided at all lay byes.

Table 1.17: Location of Truck Lay-byes

Sr. No.	Design Chainage (Km)	Side
1	37+500	LHS

1.5.11 Rest Area

Space would require having fuel refilling station, service station, first aid medical assistance, emergency accident relief and vehicle breakdown facilities etc. Alongside of project road, a rest area is proposed at km 37+500 on left side which will provide much needed break and relief to long hauled motorist and bus commuters and will house restaurant, telephone booth, parking, drinking water kiosk, small book stall, necessary goods shop, public toilets etc.

1.6 Traffic Survey, Analysis and Demand Forecast

It is very important, that the existing information on traffic flow, commodity movement and traffic pattern is required in order to assess the traffic behaviour on a project road. To collect such information to satisfy the Terms of Reference (TOR) and project requirements, following various types of traffic surveys were carried out:

1. Classified Traffic Volume Count (CVC) Survey
2. Origin & Destination Survey
3. Axle Load Survey
4. Speed & Delay Survey

1.6.1 Classified Volume Count Survey

The objective of classified traffic volume count survey is to estimate traffic intensity on the project road. Seven Days Classified volume count survey has been carried out at eight outer cordon locations given in table below.

Table 1.18: Traffic Volume Count Survey Location

Sl. No.	Type of Survey	Location Code	Survey Location	Road Name
1	Traffic Volume Count	TVC - 01	Gatawali Police Station	Amravati Road (NH-6)
		TVC - 02	Katol Naka	Warud Road (SH-248)
		TVC - 03	Diamond Dhaba	Bhopal Road (NH-69)
		TVC - 04	Bhilgaon Naka	Varanasi Road (NH-7)
		TVC - 05	Kapsi Village	Bhandara Road (NH-6)
		TVC - 06	Umred Toll Naka	Umred Road (SH-9)
		TVC - 07	Wardha Road Naka	Hyderabad Road (NH-7)
		TVC - 08	YCC College	Hingna Road (SH-255)

The seasonal correction factors are used to convert Average Daily Traffic (ADT) to Annual Average Daily Traffic (AADT). The Annual Average Daily Traffic for all traffic survey locations is presented in table below:

Table 1.19: Annual Average Daily Traffic (AADT)

Classification of Traffic	TVC-01	TVC-02	TVC-03	TVC-04	TVC-05	TVC-06	TVC-07	TVC-08
2-Wheeler	14387	9482	21361	25583	6713	9386	11856	16785
Car/ Van/ Jeep/ Taxi	5548	3605	11019	6575	4628	5009	11521	3190
Auto Rickshaw	2520	145	1157	1811	448	588	280	2184
Tata Magic	122	32	352	884	100	296	226	115
Bus	613	236	423	468	534	542	1333	446
Mini Bus	110	92	87	71	158	378	684	161
LCV	4479	724	897	947	2794	1047	2842	986
2/3 Axle Truck	3159	576	844	644	4330	1047	3110	472
MAV	531	121	318	271	2269	112	1710	243
Agri. Tractor	23	6	13	3	27	4	42	7
Agri. Tractor+ Trailor	14	12	20	9	35	15	57	13
Cycle	2921	221	531	1565	1271	1060	371	4470
Cycle Rickshaw	21	20	22	27	26	49	16	56
Animal Drawn Vehicles	2	4	2	7	3	0	4	0
Others	2	14	45	5	58	7	17	19
Total Vehicle	34452	15290	37091	38870	23394	19541	34070	29147
Total PCU	37574	12968	30382	29059	38708	18680	44842	21858

1.6.2 Axle Load Survey

Axle Load Survey is required to know the existing loading characteristics of the vehicles. The Survey was conducted at one location for a Period of 24 hours. The road side direct interview method was adopted.

Traffic loading has a significant impact on pavement performance and pavement design because of the damage that vehicles cause to a road depends on several factors such as gross load, tyre pressure, type of load, number of wheels and type of wheel configuration, number

of repetitions. The knowledge of axle loading pattern and the spectrum of axle loads of vehicles using a highway system are necessary in the development and application of realistic pavement design and maintenance procedures. The main objective of the axle load survey is to determine a Vehicle Damaging Factor (VDF) of each commercial vehicle and their axle load spectrum / distribution and expected damage on pavement and extent of over loading.

Table 1.20: VDF Values on Outer Cordons

Types of Vehicle	Raipur To Nagpur (NH-6)	Nagpur To Raipur (NH-6)	Average Value of A &B	Average of all Vehicles
	VDF (A)	VDF (B)		
LCV	0.30	1.73	1.01	8.38
2- Axle	3.43	8.90	6.16	
3 Axle	6.62	9.37	8.00	
MAV	12.49	24.23	18.36	

1.6.3 Origin-Destination (O-D) & Commodity Movement Survey

Origin-Destination survey was conducted to assess by passable traffic from OD analyses, traffic entering to Nagpur city from various outer cordon/radial roads. Survey was conducted at the given below locations and 30 zones were identified for traffic assignment on proposed ring road.

Table 1.21: Origin-Destination Survey Location

Sl. No.	Type of Survey	Location Code	Survey Location	Road Name
1	Origin & Destination Survey	OD - 01	Kondali Toll Plaza	Amravati Road (NH-6)
		OD - 02	Katol Toll Naka	Warud Road (SH-248)
		OD - 03	NH-69 Railway Crossing (Near Ring Road)	Bhopal Road (NH-69)
		OD - 04	Ramtek Toll Plaza	Varanasi Road (NH-7)
		OD - 05	Kapsi Village	Bhandara Road (NH-6)
		OD - 06	Umred Toll Naka	Umred Road (SH-9)
		OD - 07	Booti Bori Toll Plaza	Hyderabad Road (NH-7)
		OD - 08	Hingna Toll Naka	Hingna Road (SH-255)

Analysis of O-D matrices shows that the 17% passenger vehicles moving within Nagpur city area while 17 % passenger vehicles bypassing it. About 30% passenger vehicle moving internal to external and 36% trips from external to internal. Average values of all survey location for Trip Characteristics of Passenger Vehicle are given in table below.

Table 1.22: Trip Characteristics of Passenger Vehicle

S. No.	Loc. No.	I-I	I-E	E-I	E-E	Total
1	OD-01	0%	37%	53%	10%	100%

S. No.	Loc. No.	I-I	I-E	E-I	E-E	Total
2	OD-02	12%	34%	52%	2%	100%
3	OD-03	40%	26%	24%	11%	100%
4	OD-04	0%	15%	22%	63%	100%
5	OD-05	18%	40%	33%	9%	100%
6	OD-06	9%	46%	39%	6%	100%
7	OD-07	0%	31%	48%	21%	100%
8	OD-08	76%	12%	11%	1%	100%
9	**All OD**	**17%**	**30%**	36%	**17%**	**100%**

The result shows that the 8% goods vehicles moving within Nagpur City area while 30% passenger vehicles bypassing it. About 31% goods vehicle moving internal to External and 31% trips from external to internal. Average values of all survey location for Trip Characteristics of Goods Vehicle are given in table below.

Table 1.23: Trip Characteristics of Goods Vehicle

S. No.	Loc. No.	I-I	I-E	E-I	E-E	Total
1	OD-01	0%	39%	33%	28%	100%
2	OD-02	1%	45%	38%	16%	100%
3	OD-03	24%	21%	26%	28%	100%
4	OD-04	0%	16%	14%	70%	100%
5	OD-05	9%	33%	35%	24%	100%
6	OD-06	9%	33%	35%	24%	100%
7	OD-07	0%	25%	32%	44%	100%
8	OD-08	50%	34%	11%	6%	100%
9	**All OD**	**8%**	**31%**	31%	**30%**	**100%**

1.6.4 Speed-Delay Survey

Speed and delay survey was carried out on existing commercial vehicles routes within Nagpur city, to obtain the information on the average journey time, journey speed and running speed. Speed and delay survey corridors are given in figure below.

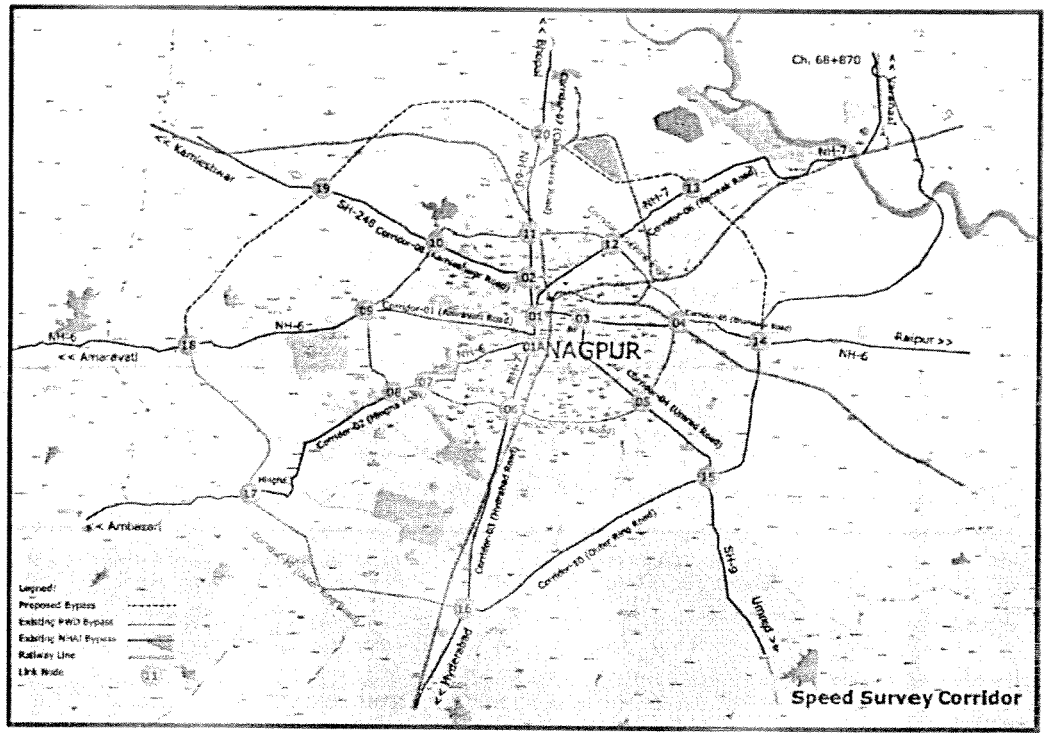

Figure 1.1: Speed and Delay Survey Corridors

The speed and delay survey analysis has been carried out for peak hours and off peak hours. Subsequently average speeds are estimated along each individual links of these study corridors identified for this survey. The analysis of journey speed and running speed is carried out for each corridor. The corridor wise analysis is presented in the table below.

Table 1.24: Corridor wise Traffic Speeds

Corridor	Journey Speeds (Kmph)			Running Speeds (Kmph)		
	Peak Hour Speeds	Off Peak House Speeds	Average Speeds	Peak Hour Speed	Off Peak Hour Speed	Average Speeds
1	28.11	30.16	29.14	30.92	35.20	33.06
2	29.39	36.35	32.87	32.22	59.31	45.77
3	34.27	40.29	37.28	44.36	86.63	65.49
4	25.25	27.71	26.48	29.05	34.86	0.00
5	25.12	26.32	25.72	29.89	36.35	33.12
6	27.74	30.71	29.22	30.46	37.02	33.74
7	21.45	21.88	21.67	25.84	29.43	27.63
8	32.57	36.61	34.59	34.20	43.22	38.71
9	33.02	37.05	35.04	37.52	50.24	43.88
10	63.79	70.24	67.01	63.79	76.53	70.16

1.6.5 Traffic Demand Forecasting

Forecasting the traffic is very essential for planning and designing of any infrastructure facility, especially when it is being taken up on commercial format. The growth of traffic is an important factor in deciding the expected traffic in the future years. The realistic scenario estimated traffic growth rates are given in table below.

Table 1.25: Traffic Growth Rates for Motorized Vehicles (%)

Mode	Up to 2015	2016 to 2020	2021 to 2025	2026 to 2030	2031 to 2035	2036 to 2040	Beyond 2040
Car	10.6	10.1	9.6	9.2	8.8	8.4	8.1
Buses	5.9	5.6	5.3	5.1	4.9	4.7	4.5
LCV	12.4	11.7	11.2	10.7	10.2	9.8	9.4
Truck	6.3	6.0	5.7	5.4	5.2	5.0	4.8
MAV	15.0	14.3	13.6	13.0	12.5	12.0	11.5
2-W	10.4	9.8	9.4	8.9	8.6	8.2	7.9

1.6.6 Estimation of Diverted Traffic Along Project Road

Generally, the main factors leading to diversion are distance saving, time saving, level of service, condition of road, facilities available along the road, specific points to be reached, toll rates sensitivity etc. The consultants have carried out traffic modelling using Trans CAD Software to estimated diverted traffic along proposed road. The entire project stretch is divided into six homogeneous section described below.

Table 1.26: Homogeneous Section of Project Corridor

Sl. No	Name of Homogeneous Section	Cross Road Network		Design Chainage (km)		
		From	To	From	To	Length
1	HS-1	NH-7 (Wardha Road)	SH-255 (Himgana Road)	0+500	13+185	12+685
2	HS-2	SH-255 (Himgana Road)	NH-6 (Amravati Road)	13+185	22+235	9+050
3	HS-3	NH-6 (Amravati Road)	SH-248 (Katol Road)	22+235	33+155	10+920
4	HS-4	SH-248 (Katol Road)	NH-69 (Bhopal Road)	33+155	45+655	12+500
5	HS-5	NH-69 (Bhopal Road)	NH-7 (Varanasi Road)	45+655	53+570	7+915
6	HS-6	NH-7 (Varanasi Road)	NH-6 (Bhandara Road)	53+570	61+800	8+230

Section wise estimated diverted traffic along project corridor is given below.

Table 1.27: Estimated Diverted Traffic along Project Road during Base Years (2013)

Classification of Traffic	HS-1	HS-2	HS-3	HS-4	HS-5	HS-6
Car	5596	7311	6584	8459	6207	4172
Mini Bus	44	30	30	30	59	30
Standard Bus	73	145	131	348	378	131
Auto	1062	3997	2951	1250	1366	553
2 W	14215	18678	6919	12195	11003	6410
LCV	1846	3300	1613	2224	1512	1559
2/3 Axle Truck	654	974	538	1018	799	960
MAV	479	392	9	319	334	479
Total Vehicle	**23969**	**34827**	**18825**	**25843**	**21658**	**14334**
Total PCU	**20937**	**30763**	17732	**24721**	**20465**	**15802**

1.6.7 Capacity Analysis and Level of Services

Capacity analysis is fundamental to the planning, design and operation of roads. It is a valuable tool for evaluation of the investment needed for the future improvements. The capacity figures used for determining the desired carriageway width in differing terrain w.r.t. traffic volume and composition are as per IRC: 64-1990. As per IRC 64:1990, it is recommended that on major arterial routes LOS-B should be adopted for the design purpose. On other roads under exceptional circumstances, LOS-C could also be adopted for design. For LOS-C, Design service volume can be taken as 40 % higher than those for LOS-B.

For the purpose of augmentation of the facilities and up gradation of the project highway, the design service volume for the plain terrain condition and level of Service B & C is shown in table below.

Table 1.28: Design Service Volume for Different Lane Configurations

Lane Configuration	Design Service Volume (PCUs per day)	
	Level of Service B	*Level of Service C*
2-Lane	15000	21000
2-Lane with Paved Shoulder	18000	25200
4-Lane	35000	49000
4-Lane with Paved Shoulder	40000	60000
6-Lane	60000	84000

1.6.8 Lane Requirement

Based on that growth rate estimated Capacity & Design Service Volume, the number of lanes required for entire section of the project road is worked out and is presented below:

Table 1.29: Lanning Requirement for the Project Corridor

Sl. No	Name of Homogeneous Section	4 – Lane		4 – Lane With PS	
		LOS-'B'	LOS-'C'	LOS-'B'	LOS-'C'
		35000	49000	40000	60000
1	HS-1	2024	2031	2027	2035
2	HS-2	2016	2023	2019	2028
3	HS-3	2028	2035	2030	2039
4	HS-4	2021	2028	2023	2032
5	HS-5	2024	2031	2027	2036
6	HS-6	2030	2037	2033	2041

1.7 Design Standards and Proposals

The Consultants have referred to the latest IRC publications and MOSRT&H circulars regarding design standards to be applied for National Highways in India. International standards such as "A Policy on Geometric Design of Highways and Streets, 2004, published by the American Association of State Highway and Transportation Officials" (AASHTO) and Transportation Association of Canada (TAC) Geometric Guidelines for Canadian Roads (1999) have also been referred for comparison purposes.

In addition with reference to recent projects of similar 4 lane capacity, the design standards are chosen in such a way to give optimum adoptability to project conditions.

The proposed ring roads are proposed to be designed as per the IRC: SP: 84-2014
The basic design parameters that are proposed to be adopted are described as under;

Table 1.30: Design Parameters

Sr. No.	Design Parameter	Value Adopted
1.	Design Speed (Plain Terrain)	100Kmph
2.	Level of Service (Stable Flow)	B
3.	Right of Way	60 m and 80 m
4.	Lane Width	3.5m
5.	Paved Shoulders	1.5m
6.	Earthen Shoulders	2.0m
7.	Median (Raised)	4.5m
8.	Foot Path cum Utility Corridor	2.0m
9.	Service Roads/Slip Road	7.0/10.0m

Sr. No.	Design Parameter	Value Adopted
10.	Pavement Camber Main Carriageway	2.5%
11.	Camber Paved Shoulders	3.5%
12.	Embankment Slopes with Turfing	50%
13.	Embankment Slopes with Pitching	33%
14.	Min. Sight Distance	180m
15.	Minimum radii	400m
16.	Super elevation	5 %
17.	Vertical Gradient (plain terrain)	3.3%

1.7.1 Pavement Design

Pavement is designed for flexible pavement in accordance with "IRC: 37-2012 Guide lines For the Design of Flexible Pavements".

The design life of the pavement is considered for 15 years.

The pavement design is carried out on their traffic volume, no of homogeneous sections, lane capacity derived, design traffic, axle load results of the zone, VDF values and the CBR values achieved from testing samples from local borrow areas.

The entire project stretch is divided into six homogeneous sections. Calculated MSA value of these sections is given below.

Table 1.31: Calculated MSA Value for 15 Years Design Period

Road Section	Homogeneous Section	Design Chainage (km)		MSA Value
		From	To	
Wardha Road to Hingna Road (NH-7 to SH-255)	HS-1	0+500	13+185	89.88
Hingna Road to Amravati Road (SH-255 to NH-6)	HS-2	13+185	22+235	83.80
Amravati Road to Katol Road (NH-6 to SH-248)	HS-3	22+235	33+155	31.05
Katol Road to Bhopal Road (SH-248 to NH-69)	HS-4	33+155	45+655	71.47
Bhopal Road to Varanasi Road (NH-69 to NH-7)	HS-5	45+655	53+570	62.03
Varanasi Road to Bhandara Road (NH-7 to NH-6)	HS-6	53+570	61+800	79.43
			Average Value	69.61

Depending on these MSA values the pavement for all homogeneous sections has been designed accordingly and average value is adopted for the project.

Table 1.32: Crust Composition Based on IRC 37:2012

Homogeneous Section	HS-1	HS-2	HS-3	HS-4	HS-5	HS-6	Average Value
ESAL (MSA)	90	84	31	72	68	80	**70**
BC (mm)	50	50	40	45	45	45	**45**
DBM (mm)	110	110	100	100	100	110	**110**
WMM (mm)	250	250	250	250	250	250	**250**
GSB (mm)	230	230	230	230	230	230	**230**
Sub Grade (mm)	500	500	500	500	500	500	**500**

Pavement is designed for rigid pavement in accordance with "IRC: 58-2011 Guide lines For the Design of Plane Jointed Rigid Pavements for Highways". Summary of the pavement design is given below.

Table 1.33: Crust Composition Based on IRC: 58-2011

Sl. No.	Pavement Layer	Layer Thickness (mm)
1	PQC	300
2	DLC	150
3	GSB (Drainage Layer)	150

1.8 Cost Estimate

Cost Estimate for Package – II From km 34+000 to km 62+035 of 28.035 km length is given below.

Table 1.34: Project Cost for Package –II (From km 34+000 to km 62+035)

Sr. No.	Item of Works	Total (In Rs)	Total (In Cr)
A	**Civil Construction Cost**		
1	Site Clearance	8931052	0.89
2	Earthwork	740303844	74.03
3	Non-Bituminous Courses	321296920	32.13
4	Bituminous Courses	86239875	8.62
5	Concrete Pavement	1247745201	124.77
6	Major / Minor Bridges, ROBS, Flyovers, Underpasses and Culverts	1524577739	152.46
7	Drainage and Protective works	689112166	68.91
8	Traffic Signs, Marking and Road Appurtenances	50569920	5.06
9	Miscellaneous Items	362500	0.04
10	Wayside Amenities	62244152	6.22
11	Highway Traffic Management System (HTMS)	33360000	3.34

Sr. No.	Item of Works	Total (In Rs)	Total (In Cr)
12	Toll Plaza (Other Miscellaneous work like electrifications, canopies, toll booths, lighting arranagements, computer networking systems etc.)	60000000	6.00
A	**Total Civil Construction Cost (on which project would be bid out)**	**4824743369**	**482.47**

Note: - Pavement for main carriageway and entry & exit ramp shall be rigid type and Service road shall be flexible type.

1.9 Recommendations

The summary of the above studies and their results, findings and conclusions, are as follows.

1.9.1 Nagpur Ring Road

Nagpur is the largest city in central India and the second capital of the state of Maharashtra. It has been cited as one of the future global cities. It is famous for the Nagpur Orange and is known as the "Orange City" for being a major trade centre of oranges cultivated in the region. It is a fast growing metropolis and is the third most populous city in Maharashtra after Mumbai and Pune, and also one of the country's most industrialized cities. It is the 13th most populous city and 13th largest urban agglomeration in India. Nagpur municipality had a population of 2,405,421 and the urban agglomeration had a population of 2,523,911.

Nagpur is an emerging metropolis. In 2004, it was ranked the fastest growing city in India in terms of the number of households with an annual income of Rs 1 crore (10 million) or more. Nagpur has been the main center of commerce in the Vidarbha region since its early days and is an important trading location.

The present road network system is highly congested due to poor road network planning owing to disorganised urbanisation. This city has major road networks such as NH-6, NH-7, NH-69, SH-255, SH-248, SH-9 etc.

- The proposed ring road alignment is 61.535 km in length which is divided into two packages. Package-I from km 0+500 to km 34+000 of 33.5 km length and Package-II from km 34+000 to km 62+035 of 28.35 km length..
- It is revealed from the capacity analysis results, the project road require 4 lanes with paved shoulder (LOS C) for capacity augmentation and efficient movement of traffic up to horizon year 2038; after that, 6lanning will be required as per the traffic growth on respective homogeneous sections.
- The Project will be implemented on Hybrid Mode.
- **The estimated civil construction cost for package – II would be 482.47Cr.**