Executive Summary

* 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 Consultants Pvt. Ltd., Ghaziabad.

* 1. 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. 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 61+800 (Design Length 27+800 Km)

Here Package-I is discussed.

This report is submitted as Stage 4 – Revised Final Feasibility Report for Nagpur City.

Revised Final Feasibility Report consists of:

1. Main Report
2. Drawings

I Plan & Profile

II GAD

1. Cost Estimate
2. Rate Analysis
   1. Project Description

Nagpur is the largest city in central India and the second capital of the State of [Maharashtra](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/Mumbai) and [Pune](http://en.wikipedia.org/wiki/Pune), and also one of the country's most industrialized cities. It is the [13th most populous city](http://en.wikipedia.org/wiki/List_of_most_populous_cities_in_India) 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](http://en.wikipedia.org/wiki/Varanasi) - [Kanyakumari](http://en.wikipedia.org/wiki/Kanyakumari_(town)) National Highway
* NH-69: Nagpur - [Obaidullaganj](http://en.wikipedia.org/wiki/Obedullaganj) 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+170 | Crossing with Railway line near Bharatwada railway station. | Central Railway: Nagpur – Bhopal Branch. |
| 5 | 41+950 | Crossing with Major District Road. | Two lane bituminous road. |
| 6 | 45+655 | Crossing with NH- 69 at Km 8+780. | Divided Four Lane Road Paved Shoulder including both side service road. |
| 7 | 46+665 | Crossing with Railway line. | Central Railway: Godhani – Koradi NTPC Branch. |
| 8 | 50+580 | Crossing with Railway line. | Central Railway: Kalmana – Chindwana Branch. |
| 9 | 52+645 | Canal crossing |  |
| 10 | 53+570 | Crossing with NH-7 at Km 718+700. | Two lane bituminous road |
| 11 | 54+835 | Canal crossing |  |
| 12 | 55+480 | Crossing with SH-341 | Two lane bituminous road |
| 13 | 61+305 | End of section D  Junction with NH-7 bypass at Km 722+600. | Divided Four Lane with Paved Shoulder. |

* 1. 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 61.300 km.

Package-I of the project stretch having total Design Length 33+500 Km comprises the section of

1. Reconstruction of existing bypass (flexible Pavement) between NH-7 (Wardha Road) and NH-6 (Amravati Road) from km 0+500 to km 22+150 (Design Chainage Km 22+235) (Design Length 21+735 Km) and
2. New alignment from NH-6 (Amravati Road) to 845 m beyond the crossing with SH-248 (Katol Road) at km 13+150 of SH-248 near Fetari Village (Design Chainage km 34+000) (Design Length 11+765 Km) in the State of Maharashtra.
   * 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 | 0+500 | 7+500 | 40+40 |  |
| 2 | 7+500 | 8+300 | 75+75 | Toll Plaza |
| 3 | 8+300 | 12+400 | 40+40 |  |
| 4 | 12+400 | 12+900 | 150+100 | Entry & Exit Ramp with Public Facility |
| 5 | 12+900 | 21+350 | 40+40 |  |
| 6 | 21+350 | 21+850 | 100+150 | Entry & Exit Ramp with Public Facility |
| 7 | 21+850 | 22+230 | 40+40 |  |
| 8 | 22+230 | 22+510 | 30+30 |  |
| 9 | 22+510 | 23+010 | 100+100 | Entry & Exit Ramp |
| 10 | 23+010 | 32+300 | 30+30 |  |
| 11 | 32+300 | 32+800 | 100+100 | Entry & Exit Ramp |
| 12 | 32+800 | 34+000 | 30+30 |  |

* + 1. 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 | 7+500 | 8+300 | 80 | 70 | 5.60 | Toll Plaza |
| 2 | 12+400 | 12+900 | 80 | 170 | 8.50 | Entry & Exit Ramp with Public Facility |
| 3 | 21+350 | 21+850 | 80 | 170 | 8.50 | Entry & Exit Ramp with Public Facility |
| 4 | 22+540 | 23+040 | 60 | 140 | 7.00 | Entry & Exit Ramp |
| 5 | 32+140 | 32+640 | 60 | 140 | 7.00 | Entry & Exit Ramp |
| **Total Extra Land to be acquired** | | | | | **36.60** | **Hac.** |

* + 1. Service 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 | 11+500 | 12+160 | 0+660 | 7.0 | Both Side |
| 2 | 12+900 | 13+160 | 0+260 | 10.0 | Both Side |
| 3 | 15+600 | 17+200 | 1+600 | 7.0 | RHS |
| 4 | 21+750 | 22+550 | 0+800 | 10.0 | Both Side |
| 5 | 28+620 | 29+330 | 0+710 | 7.0 | Both Side |
| 6 | 32+790 | 33+150 | 0+360 | 10.0 | Both Side |

* + 1. CD Structures

As per recommended Alignment option following CD structures are proposed.

**Major Bridge:** The project alignment is crossing the vena river at two locations two lane major bridges exists. Additional two lane new bridge has been proposed at this location. Details of additional major bridge are 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)** |
| 1 | Bridge Over Vena River | 5+521 | 3 x 28.3 | 12.5 (RHS) |
| 2 | Bridge Over Vena River | 14+840 | 4 x16 | 12.5 (RHS) |

**Minor Bridge:** The project alignment crosses drains and canals at 25 locations. Out of 25 locations, two lane minor bridges exist at 14 locations, where additional two lane new bridge has been proposed and Left at eleven location 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 | 2+250 | 3 X 7 | 12.5 (RHS) |
| 2 | Drain | 3+702 | 3 X5 | 12.5 (RHS) |
| 3 | Drain | 4+974 | 3 X 10.55 | 12.5 (RHS) |
| 4 | Drain | 6+348 | 3 X 10 | 12.5 (RHS) |
| 5 | Drain | 6+425 | 3 X 10 | 12.5 (RHS) |
| 6 | Drain | 7+247 | 3 X 9 | 12.5 (RHS) |
| 7 | Drain | 8+461 | 3 X 7.45 | 12.5 (RHS) |
| 8 | Drain | 13+804 | 4 X 10 | 12.5 (RHS) |
| 9 | Drain | 16+908 | 2 X 6 | 12.5 (RHS) |
| 10 | Drain | 18+097 | 5 X 9.4 | 12.5 (RHS) |
| 11 | Drain | 18+398 | 3 X 9.8 | 12.5 (RHS) |
| 12 | Drain | 19+469 | 2 X 9 | 12.5 (RHS) |
| 13 | Drain | 20+596 | 1 X 8.9 | 12.5 (RHS) |
| 14 | Drain | 21+917 | 1 X 7 | 12.5 (RHS) |
| 15 | Drain | 23+200 | 1 x 10 | 12.5 + 12.5 |
| 16 | Drain | 24+560 | 1 x 10 | 12.5 + 12.5 |
| 17 | Drain | 25+070 | 1 x 10 | 12.5 + 12.5 |
| 18 | Drain | 25+680 | 1 x 10 | 12.5 + 12.5 |
| 19 | Drain | 28+900 | 1 x 10 | 12.5 + 12.5 |
| 20 | Drain | 29+570 | 1 x 12 | 12.5 + 12.5 |
| 21 | Drain | 31+420 | 1 x 10 | 12.5 + 12.5 |
| 22 | Drain | 31+470 | 1 x 10 | 12.5 + 12.5 |
| 23 | Drain | 31+740 | 1 x 10 | 12.5 + 12.5 |
| 24 | Drain | 33+310 | 2 x 7 | 12.5 + 12.5 |
| 25 | Drain | 33+720 | 1 x 10 | 12.5 + 12.5 |

**Culverts:** There are 37 numbers of culverts exist in the existing two lane road. Widening up to four lane configuration of these culverts has been proposed. Details are given in table. There are 32 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 | 2 | Widening as per Roadway Width |
| 2 | HP Culvert | 35 |
| 3 | Box Culvert | 11 | New Construction as per Roadway Width |
| 4 | HP Culvert | 21 |

**Table 1.9: Details of Widening of Culvert**

| **Sl. No.** | **Design Chainage**  **(In Km)** | **Type of Culvert** | **No. of Spans with Clear Span Length x Vertical Clearance**  **(In m)** | **Detail of Widening Scheme** |
| --- | --- | --- | --- | --- |
| 1 | 1+967 | HP Culvert | 1x1.0 (Dia) | Up to the Roadway width. |
| 2 | 2+340 | HP Culvert | 3x1.2 (Dia) |
| 3 | 2+458 | HP Culvert | 3x1.0 (Dia) |
| 4 | 2+684 | HP Culvert | 1x1.0 (Dia) |
| 5 | 4+467 | HP Culvert | 1x1.0 (Dia) |
| 6 | 5+030 | Box Culvert | 1 x 3 x 4 |
| 7 | 6+105 | HP Culvert | 2x1.2 (Dia) | Up to the Roadway width. |
| 8 | 6+212 | HP Culvert | 2x1.2 (Dia) |
| 9 | 6+866 | HP Culvert | 1x1.0 (Dia) |
| 10 | 8+139 | HP Culvert | 1x1.0 (Dia) |
| 11 | 8+790 | HP Culvert | 1x1.0 (Dia) |
| 12 | 9+163 | HP Culvert | 1x1.0 (Dia) |
| 13 | 9+325 | HP Culvert | 2x1.0 (Dia) |
| 14 | 9+544 | HP Culvert | 1x1.0 (Dia) |
| 15 | 9+749 | HP Culvert | 1x1.0 (Dia) |
| 16 | 10+291 | HP Culvert | 1x1.0 (Dia) |
| 17 | 10+392 | HP Culvert | 1x1.0 (Dia) |
| 18 | 10+845 | HP Culvert | 1x1.0 (Dia) |
| 19 | 11+072 | HP Culvert | 1x1.0 (Dia) |
| 20 | 11+464 | HP Culvert | 1x1.0 (Dia) |
| 21 | 11+534 | HP Culvert | 1x1.0 (Dia) |
| 22 | 12+032 | HP Culvert | 1x1.0 (Dia) |
| 23 | 12+371 | HP Culvert | 1x1.0 (Dia) |
| 24 | 12+732 | HP Culvert | 1x1.2 (Dia) |
| 25 | 14+483 | HP Culvert | 2x1.0 (Dia) |
| 26 | 15+177 | HP Culvert | 1x1.0 (Dia) |
| 27 | 15+433 | HP Culvert | 1x1.0 (Dia) |
| 28 | 16+120 | HP Culvert | 1x1.0 (Dia) |
| 29 | 17+940 | HP Culvert | 2x1.0 (Dia) |
| 30 | 18+680 | HP Culvert | 1x1.2 (Dia) |
| 31 | 19+021 | HP Culvert | 1x1.0 (Dia) |
| 32 | 19+768 | HP Culvert | 1x1.0 (Dia) |
| 33 | 19+901 | HP Culvert | 4x1.0 (Dia) |
| 34 | 20+003 | HP Culvert | 2x1.0 (Dia) |
| 35 | 20+287 | Box Culvert | 1 X 5 x 3.4 |
| 36 | 21+835 | HP Culvert | 4x1.0 (Dia) |
| 37 | 21+940 | HP Culvert | 1x1.2 (Dia) |

**Table 1.10: Details of New Culvert**

| **Sl. No.** | **Design Chainage**  **(In Km)** | **Type of Culvert** | **No. of Spans with Clear Span Length x Vertical Clearance**  **(In m)** | **Total width**  **(In m)** |
| --- | --- | --- | --- | --- |
| 1 | 22+500 | HP Culvert | 1 x1.2 (Dia.) | Up to the Roadway width |
| 2 | 22+850 | HP Culvert | 1 x1.2 (Dia.) |
| 3 | 23+070 | Box Culvert | 1 x 6 x 4 |
| 4 | 23+500 | HP Culvert | 1 x1.2 (Dia.) |
| 5 | 23+800 | HP Culvert | 1 x1.2 (Dia.) |
| 6 | 24+140 | Box Culvert | 1 x 3 x 3 |
| 7 | 24+160 | Box Culvert | 1 x 2 x 2 |
| 8 | 24+810 | HP Culvert | 1 x1.2 (Dia.) |
| 9 | 24+970 | Box Culvert | 1 x 2 x 2 |
| 10 | 25+350 | HP Culvert | 1 x1.2 (Dia.) |
| 11 | 26+100 | HP Culvert | 1 x1.2 (Dia.) |
| 12 | 26+450 | HP Culvert | 1 x1.2 (Dia.) |
| 13 | 26+795 | Box Culvert | 1 x 6 x 3 |
| 14 | 27+200 | Box Culvert | 1 x 4 x 3 |
| 15 | 27+570 | HP Culvert | 1 x1.2 (Dia.) |
| 16 | 27+950 | HP Culvert | 1 x1.2 (Dia.) |
| 17 | 28+100 | Box Culvert | 1 x 3 x 3 |
| 18 | 28+160 | Box Culvert | 1 x 3 x 3 |
| 19 | 28+200 | Box Culvert | 1 x 3 x 3 |
| 20 | 28+800 | HP Culvert | 1 x1.2 (Dia.) |
| 21 | 29+300 | HP Culvert | 1 x1.2 (Dia.) |
| 22 | 29+900 | HP Culvert | 1 x1.2 (Dia.) |
| 23 | 30+200 | HP Culvert | 1 x1.2 (Dia.) |
| 24 | 30+500 | HP Culvert | 1 x1.2 (Dia.) |
| 25 | 30+800 | HP Culvert | 1 x1.2 (Dia.) |
| 26 | 31+100 | HP Culvert | 1 x1.2 (Dia.) |
| 27 | 31+970 | HP Culvert | 1 x1.2 (Dia.) |
| 28 | 32+100 | Box Culvert | 1 x 6 x 3 |
| 29 | 32+300 | HP Culvert | 1 x1.2 (Dia.) |
| 30 | 32+600 | HP Culvert | 1 x1.2 (Dia.) |
| 31 | 32+900 | Box Culvert | 1 x 3 x 3 |
| 32 | 34+000 | HP Culvert | 1 x1.2 (Dia.) |

* + 1. 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 one Railway line crosses the proposed ring road alignment of Package-I. Railway over Bridge (ROB) has been required at this crossing location. Two lane ROB is already constructed at this location and two lane additional ROB has been proposed. Details of ROB is given in table below.

**Table 1.11: Details of ROB**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **Design Chainage (Km)** | **No. of Spans with**  **Span Length**  **(In m)** | **Total width**  **(In m)** | **Railway Zone** |
| 1 | 1+085 | 2x18 + 1X24 + 2x18 | 12.5 (RHS) | Central Railway |

* + 1. 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 1.12: 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 | 13+185 | SH-255 | 1x15 + 1x30 + 1x15 | 12.5+12.5 |
| 2 | 33+155 | SH-248 | 1x15 + 1x30 + 1x15 | 12.5+12.5 |

* + 1. 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 3.0m or 6.0m x 4.5m has been proposed. List of new proposed Vehicular and Cattle/Pedestrian Underpass are given in below tables:

**Table 1.13: 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 | 6+030 | MDR-44 | 1x12x5.5 | 12.5+12.5 | Above Cross Road |
| 2 | 22+235 | NH-6 | 1x60x5.5 | 12.5+12.5 | Below Above Cross Road |
| 3 | 28+650 | MDR | 1x12x5.5 | 12.5+12.5 | Above Cross Road |

**Table 1.14: 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 | 4+280 | VR | 1x6x3.5 | 12.5+12.5 |
| 2 | 11+500 | ODR | 1x6x3.5 | 12.5+12.5 |
| 3 | 17+205 | VR | 1x6x3.5 | 12.5+12.5 |
| 4 | 19+000 | VR | 1x6x3.5 | 12.5+12.5 |
| 5 | 26+300 | VR | 1x6x3.5 | 12.5+12.5 |
| 6 | 28+145 | VR | 1x6x3.5 | 12.5+12.5 |
| 7 | 30+100 | VR | 1x6x3.5 | 12.5+12.5 |

Existing road section already has two numbers of cattle/ pedestrian underpass. Both underpasses are two lane configurations. Therefore widening up to the four lane configuration of both the underpasses is proposed. Details are described below.

**Table 1.15: List of Widening of Existing Cattle/Pedestrian Underpass**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **Design Chainage**  **(In Km)** | **Type of Cross Road** | **No. of Spans with Span Length x Vertical Clearance**  **(In m)** | **Widening Side** |
| 1 | 4+772 | VR | 1x6x4.3 | RHS |
| 2 | 14+454 | VR | 1x7x4.5 | RHS |

**Summary of structures in the project alignment are given below:**

**Table 1.16: Summary of structures in the project alignment**

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **Type of Structure** | **No.** |
| 1 | Major Bridge | 02 |
| 2 | Minor Bridge | 25 |
| 3 | Flyover | 02 |
| 4 | ROB | 01 |
| 5 | Vehicular Underpass | 3 |
| 6 | Cattle pass | 9 |
| 7 | Pipe Culverts | 56 |
| 8 | Box Culvert | 13 |

* + 1. 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 1.17: List of Entry & Exit Ramp

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Design Chainage**  **(In Km)** | **Side**  **(LHS/RHS/Both side)** | **Remarks** |
| 1 | 12+700 | Both Side | Entry & Exit with SH-255 |
| 2 | 21+600 | Both Side | Entry & Exit with NH-6 |
| 3 | 22+750 | Both Side | Entry & Exit with NH-6 |
| 4 | 32+600 | Both Side | Entry & Exit with SH-248 |

* + 1. 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 1.18: Location of Toll Plaza**

| **Sl. No** | **Toll Plaza Location (Design Chainage in km)** |
| --- | --- |
| 1 | Toll Plaza at km. 7+900 |

* 1. 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. 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 1.19: 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 1.20: 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. 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 1.21: 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. 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 1.22: 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 1.23: 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% |
| 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 1.24: 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. 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.

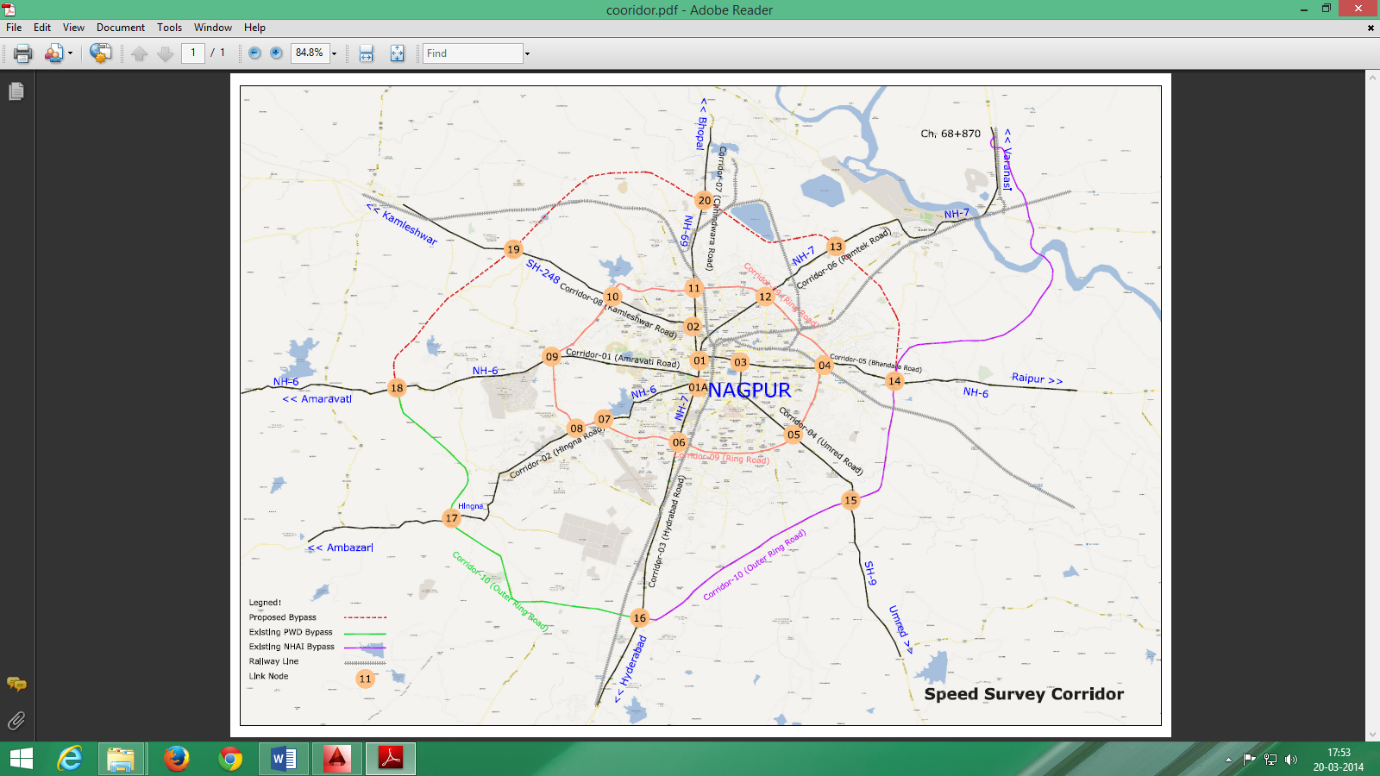


Figure 1.1: Speed and Delay Survey Corridors

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 1.25: 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. 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 1.26: 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. 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 1.27: 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 1.28: 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. 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 1.29: 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. 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 1.30: 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. 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 1.31: 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 |
| 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. 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 1.32: 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 1.33: 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 1.34: 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. Cost Estimate

Cost Estimate for Package – I From km 0+500 to km 34+000 of 33.5 km length is given below.

**Table 1.35: Project Cost for Package – I (From km 0+500 to km 34+000)**

| **Sr. No.** | **Item of Works** | **Total  (In Rs)** | **Total  (In Cr)** |
| --- | --- | --- | --- |
| **A** | **Civil Construction Cost** |  |  |
| 1 | Site Clearance | 12289164 | 1.23 |
| 2 | Earthwork | 605171223 | 60.52 |
| 3 | Non-Bituminous Courses | 331111169 | 33.11 |
| 4 | Bituminous Courses | 53362897 | 5.34 |
| 5 | Concrete Pavement | 1489515066 | 148.95 |
| 6 | Major / Minor Bridges, ROBS, Flyovers, Underpasses and Culverts | 1090892759 | 109.09 |
| 7 | Drainage and Protective works | 536893809 | 53.69 |
| 8 | Traffic Signs, Marking and Road Appurtenances | 58056540 | 5.81 |
| 9 | Miscellaneous Items | 4699140 | 0.47 |
| 10 | Wayside Amenities | 71122918 | 7.11 |
| 11 | Highway Traffic Management System (HTMS) | 40200000 | 4.02 |
| 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)** | **4353314685** | **435.33** |

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

* 1. Recommendations

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

* + 1. Nagpur Ring Road

Nagpur is the largest city in central India and the second capital of the state of [Maharashtra](http://en.wikipedia.org/wiki/Maharashtra). It has been cited as one of the future global cities.  It is famous for the [Nagpur Orange](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/Mumbai) and [Pune](http://en.wikipedia.org/wiki/Pune), and also one of the country's most industrialized cities. It is the [13th most populous city](http://en.wikipedia.org/wiki/List_of_most_populous_cities_in_India) and [13th largest urban agglomeration](http://en.wikipedia.org/wiki/List_of_million-plus_agglomerations_in_India) 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](http://en.wikipedia.org/wiki/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 61.30 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 61+800 of 27.80 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 – I would be 435.33 Cr.