



Government of Karnataka

**PUBLIC WORKS DEPARTMENT,
NATIONAL HIGHWAYS DIVISION, KALBURAGI**



Government of India

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**"WIDENING/RE-CONSTRUCTION TO FOUR LANE
FROM KM 0.000 TO KM 15.870 STARTS NEAR
MIRIYAN TELANGANA/KARNATAKA BORDER AND
ENDS AT CHINCHOLI SECTION OF NH-167N IN
KALABURAGI DISTRICT IN THE STATE OF
KARNATAKA UNDER ANNUAL PLAN 2023-24."**



DETAILED PROJECT REPORT

VOLUME – I : Main Report



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EXECUTIVE SUMMARY

0.1 Background

Ministry of Road Transport and Highways (MORTH), Government of India has decided to upgrade two lane National Highways to at least two lane with shoulder standards and some of these stretches are proposed for Four Lane . The work would be taken up for up gradation on corridor concept.

In this concern, Ministry of Road Transport and Highways entrusted M/s Vistaara Infra Consultants for the task of carrying out preparation of Detailed Project Report for "Widening/Re-Construction to Four Lane from Km 0.000 to Km 15.870 starts near Miriyan Telangana/Karnataka border and ends at Chincholi Section of NH-167N in Kalaburagi District in the State of Karnataka under Annual Plan 2023-24".

0.2 Project Site Description

Project road is located in Karnataka, the third largest state in India. The State is bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamil Nadu States in the South and by the State of Andhra Pradesh in the East

Chicholi is a Taluk Headquarter and is a developed town in the district of Kalaburagi which is popular for its toordal and limestone deposits. The existing town stretches of chincholi and Miriyan has poor geometry due to presence of more than 16 curves and restricted ROW.

Presently, average speed of only 40 kmph to 60 kmph is achievable on the town stretches. The length of built-up stretch is around 5.0 Km. Existing ROW available varies between 20 to 30m which is not sufficient to accommodate 4L+PS with curve improvements. At many locations geometric improvement would be very difficult due to presence of commercial and residential properties very close to the existing ROW boundary and cost of land is also very high

Along the project road total 13 nos. of structures were found as per inventory and condition survey of Bridge and CD structures. Out of these, 4 nos. are Minor bridges and 1 Major Bridge, Remaining 8 nos. (5nos. Pipe Culverts and 3 nos. Slab Culverts) are CD structures

0.3 Methodology

The Consultants propose to perform the studies and carry out all the needed activities for fulfilling the objectives. The general approach of the Consultants would be to tailor their services in a logical manner in order to fulfil each of the objectives in the best possible manner with due diligence. This would include:

- *Deploying a balanced team of well-qualified and experienced experts in the related disciplines;*
- *Planning and sequencing the various activities so that the work is completed in all respects within the stipulated time and no requirement is lost sight of;*
- *Using modern equipment for surveys, field investigations etc. so as to maintain a high level of accuracy; and*
- *Extensive use of modern computer facilities available in-house with the Consultants.*

0.4 Socio Economic Profile

Socio-economic studies, comprising demographic aspects, macroeconomic indicators and main economic sectors provide an overview of the socio-economic setup of the Karnataka state and the relative position of the project area districts within the state. The analysis forms the basic input for estimating future traffic growth rates.

Analysis of traffic movement on project road (OD surveys) indicates that traffic flow is mainly influenced by the Karnataka state. Thus, the state of Karnataka forms the broad influence area. Growth of traffic on the project road depends on existing development and future prospects of the connecting regions

The state of Karnataka has the credit of being the economic powerhouse of India, contributing significantly towards the Indian economy. It provides a linkage between the Northern and Southern states of India. It also leads in the IT sector, accounts for country's productive capital, generates employment in IT sector, and attracts both domestic and foreign direct investments. Karnataka attracts very large number of tourist traffic mainly because of various world famous tourist places located in Karnataka.

Socio-economic studies, comprising demographic aspects, macroeconomic indicators and main economic sectors provide an overview of the socio-economic setup of the Karnataka state and the relative position of the project area districts within the state. The analysis forms the basic input for estimating future traffic growth rates.

The perspective growth of the state economy forms the basis for traffic demand forecasting. The economic perspective for the state has been developed taking into consideration the past performance of the economy of the state and the economic growth envisaged in the future.

The annual average growth in overall GSDP of Karnataka during 11th plan was 7.2 percent as against all India average of 8.0 percent. The average growths in industry and services sector were 5.3 and 10.3 percent in Karnataka as compared to 6.7 and 9.9 percent at all India level.

During the year 2012-13, which is the 1st year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 6.1 percent against all India growth of 5.1 percent. During the year 2013-14, which is the 2nd year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 7.2 percent against all India growth of 6.9 percent. During the year 2014-15, which is the 3rd year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 7 percent against all India growth of 7.4 percent. Considering the state economy in 11th five-year plan, the performance of past economy and the current low growth trend, it is likely that the state economy will be able to maintain growth rate of 6.0 percent in the initial period up to 2017, and the state economy can be expected to strengthen to touch 7.00 percent during 2023-2027, and stabilize at 6.75 percent after 2028.

0.5 Design Standards

Design standards relevant to the project road along with the broad list of design parameters and the relevant IRC codes/specifications have been compiled under the following heads:

- ◇ *Design Standards Related to Geometric Design and Road Capacity*
- ◇ *Design Standards Related to Pavement Design*
- ◇ *Design Standards Related to Road Drainage*
- ◇ *Design Standards Related to Road Furniture and Appurtenances*
- ◇ *Design Standards Related to Bridges and CD Structures*

0.6 Engineering Surveys and Field Investigations

The following primary surveys were conducted as per standard practices to assess condition of road and CD structures, soil characteristics, traffic characteristics etc., to assess the needs of reconstruction/ strengthening/ widening and geometric improvement for the existing project road:

- Road Inventory Survey
- Pavement Condition Survey
- FWD Survey
- Axle Load Surveys
- Existing Pavement / Sub grade Investigations

- Soil and Material Investigations
- Inventory and condition survey of bridges and culverts

In addition all the relevant secondary data have been collected from the concerned departments and discussions were held with all the concerned officials.

0.6.1 Road Inventory and Pavement condition Survey

An inventory of the Project Road was carried out through dimensional measurement and visual inspection. Features like chainage, terrain and land- use, height of fill or depth of cut, width of pavement and shoulders, railway crossing, important road junctions and geometric deficiencies, utilities etc., were recorded.

The project highway traverses through plain and hilly terrain. The table below depicts the division of the project road into different terrain classes.

Terrain Classification

Sl No	Terrain Type	Percentage
1	Plain	60
2	Rolling	10

To catch the condition of road and pavement in a tabular format, Road/Pavement condition survey has been carried out by visual means. Carriageway of project road has flexible pavement. It is observed that the pavement condition of project road is generally in good to fair condition. At few places cracks and other distresses are developing and require preventive measures. The observed pavement condition of the project road, based on crack area, pot-hole area, and ravelling area, has been divided into three categories, Good, Fair and Poor.

Summary of Pavement Condition

Sl. No.	Condition	Percentage (%)
1	Good	43.00
2	Fair	47.00
3	Poor	10.00
Total		100

0.6.2 Axle Load Survey

The Vehicle Damage Factor (VDF) is an index characterizing the traffic loading for a highway and is defined as a multiplier for converting the number of commercial vehicles of different axle loads to Standard Axle Loads (SAL).

Vehicle Damage Factors

LCV	0.1
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Standard Bus	0.4
2 axle Truck	4.7
3 axle Truck and MAV	3.6

0.6.4 Sub grade investigations

Based on the detailed study of pavement condition, Benkelman Beam deflection testing results, the pavement investigations were carried out in order to study the in-situ strength of the materials. The test pits of 0.6 x 0.6 m were dug at 0.9 m from the edge of the existing pavement. The test activities that were carried out in test pits include:

- Pavement Composition
- In-situ Density at sub grade
- Collection Sub grade Samples for Laboratory Test

0.7 Traffic Survey, Data Analysis and Traffic Forecast

Estimation of traffic over the project corridor is an essential step towards establishing the project viability. The objective was to assess the prevailing traffic & trip (O-D) characteristics and to accurately assess the project tollable traffic, in order to reasonably assess the financial returns. This includes conducting field traffic surveys, data analysis and estimation of tollable traffic. The present traffic surveys have been planned in a way to obtain all the necessary information and data deemed necessary for development of the project.

Summary of Traffic Volume

Vehicle Type	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average Daily Traffic (ADT)	AADT
2-W	5623	6492	5509	6080	6179	6016	5936	5936
3-W	558	797	1446	641	674	689	740	740
Car/Jeep/Taxi/Van	616	575	658	628	615	606	640	640
Mini Bus	2	1	166	2	0	3	25	25
School Bus	6	9	6	10	9	10	9	9
Bus (Govt.)	195	183	169	197	202	203	191	191
Bus (Pvt.)	6	3	32	5	3	7	9	9
Mini LCV	236	246	304	236	246	258	264	264
LCV	244	258	298	263	263	257	268	268

2-Axle Truck	258	266	311	284	287	275	292	292
3-Axle Truck	273	281	327	294	301	286	300	300
MAV (4-6 Axles)	481	431	445	477	465	465	456	456
7++ Axles	3	2	80	8	8	4	16	16
Tractor	9	16	16	25	20	18	17	17
Tractor+ Trailor	57	62	52	67	66	67	59	59
Cycle Rick.	16	6	36	19	16	17	20	20
Hand Cart	0	0	5	2	2	0	2	2
Car	2	2	8	6	3	4	4	4
Bus	3	3	4	4	4	4	3	3
LCV	0	0	2	0	0	0	0	0
Truck	0	0	1	0	0	0	0	0
Motorised	8572	9627	9834	9227	9345	9172	9222	9229
Non-Motorised	16	6	41	21	18	17	22	22
Total	8588	9633	9875	9248	9363	9189	9244	9251
Motorised	9259	9730.5	11151	9849	9894	9740	9893	9893
Non-Motorised	32	12	87	44	38	34	46	46
Total	9291	9742.5	11238	9893	9932	9774	9939	9939

0.7.2 Forecasted Traffic

By applying the vehicle wise traffic growth rates as above to the base year traffic the projected traffic (in terms of AADT) for Realistic Growth Rate has been worked out and presented in able below.

Section wise Projected Traffic for the Project Road (AADT)

Year	Km 7+000, Near Chandapur	
	Total vehicles	Total PCU
2022	9251	9939
2023	9714	10436
2024	10199	10958
2025	10709	11506
2026	11245	12081
2027	11807	12685
2028	12397	13319
2029	13017	13985
2030	13668	14684

2031	14351	15419
2032	15069	16190
2033	15822	16999
2034	16613	17849
2035	17444	18741
2036	18316	19679
2037	19232	20662
2038	20194	21696
2039	21203	22780
2040	22264	23919
2041	23377	25115
2042	24546	26371

0.7 Improvement Proposal

0.7.1 Commercial

The base year (2023) average annual daily-classified commercial traffic volume based on the classified traffic volume count surveys carried out for the project road is given below;

Commercial Traffic Volume

Sl. No	Vehicle Type	CVPD (In nos.)
1	LCV	268
2	Bus	209
3	2 Axle	292
4	3 Axle	300
5	MAV	456
Total		1525

0.7.2 Proposed Improvements

- *Geometric Improvements*
- *Strengthening and Widening of Existing Pavement and Reconstruction/New Construction*
- *Pedestrian Facilities (Footpath and Zebra range)*
- *Road Furniture and Appurtenances*
- *Junction Improvements*
- *Way Side Amenities*
- *New Construction/Widening/Strengthening/Maintenance/Rehabilitation of Existing Bridges and CD Structures*

Improvements to Horizontal Alignment and Longitudinal Profile

The horizontal geometry shall be developed as per IRC standards to cater to the design speed of 100kmph in plain terrain and 40kmph on Hilly Terrain. Site clearance, tree cutting and utility shifting are proposed to ensure removal of obstructions so that adequate sight distance is obtained. Vertical curves at several

locations have been provided as per the design based on IRC standards.

Design of Flexible Pavement

The design of flexible pavement for widening and new construction is based on IRC: 37-2018. The design period is 20 years from the year 2021. CBR value of 10% is considered for pavement design. The recommended pavement composition for main carriageway and service road details are given below:

Pavement Composition for Main Carriageway

Design MSA (15 years)	Crust Composition in mm				
	BC	DBM	WMM	GSB	Total
Thickness	40	80	250	200	540

Pavement Composition for Service Road Carriageway

Design MSA (15 years)	Crust Composition in mm				
	BC	DBM	WMM	GSB	Total
Thickness	40	50	250	200	540

Summary of Existing Structures

Sl No.	Type of Structure	No. of Structures
1	Culvert	8
2	Minor Bridge	4
3	Major Bridge	1
	Total	13

0.7.3 Drainage

Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road in addition to preserving the valuable road assets created. Pavement structure including sub grade must be protected from any ingress of water otherwise over a period of time it may weaken the sub grade by saturating it and cause distress in the pavement structure. Hence, rapid dispersal of water from pavement and sub grade is a basic consideration in road design. Also, quick drainage takes away the water from pavement's surface and reduces chances of skidding of vehicles.

The requirements of road drainage are essentially based on IRC: SP-42 "Guidelines on Road Drainage". Camber of 2.5% is provided for the carriageway in rural sections and 3% camber for shoulders is considered adequate. For better drainage, 3% camber is proposed in village/town limits as suggested during the technical committee meeting. For longitudinal drains, a minimum longitudinal gradient of 0.3 percent shall be ensured for satisfactory drainage.

The total length of drain proposed is 5010m.

0.7.5 Utility Crossing

To avoid frequent cutting of road for laying/maintaining/repair of utility services especially near settlements it is proposed to have 600 mm diameter NP-4 Pipe along with inspection box/chamber, at every 1 Km intervals across the roadway for full width (9m minimum) near settlement locations and at every 5 Km interval in rural sections.

0.7.6 Construction Period

As the project road passes through plain and hilly terrain, two years of construction period is suggested. Further availability and experience in use of modern construction equipment and plants indigenously and acquaintance with modern construction technologies by most of the contractors justify the construction period suggested.

At present there are few underground and over-ground utilities running along the roadside close/within ROW. For widening, some of these may need relocation, which shall be established by detailed surveys during implementation. These may have to be relocated to the extent possible at the extreme edge of the available ROW. This aspect has to be given due importance in coordination with concerned utility & service departments (electricity, telephone, water and sewer) regarding relocation and space requirements especially in Urban limits.

0.8 Road Furniture and Safety Features

For the safety of traffic, road furniture are provided at appropriate locations along the project road as per relevant guidelines/ standards and specifications of IRC and MoRT&H. At the road intersections, the use of traffic control devices and other road furniture has been considered. The common types of street furniture, which are proposed to enhance road safety, reduce accidents and improve flow conditions, are road markings and road signs and traffic control devices at junctions. This chapter deals with the various road furniture proposed for the project road integral to proposals along with safety of the road users.

Safety of a road is the ability of the road to carry an adequate number of vehicles with minimum delay and inconvenience, which is highly dependent on the orderly movement of stream. Orderly flow of traffic is obtained when motorists were provided with intelligent and reliable regulation and information on the road and at the roadside. Effective traffic signs at the roadside are the basic necessity for maintaining the road safety. Road marking and road sign should be easily

recognizable and readable under any condition of light. The visibility of road sign during night greatly depends on the amount of reflected beam against the incident light. High visibility of traffic signs is obtained by using reflective sheets, which possesses high level of reflectivity which can be obtained by glass bead (Spherical), corner-cube prismatic (triangular) and cat's eye (macro-sphere) structure, embedded in the reflecting sheets. The visibility of a road sign depends upon, retro reflective property of sheets used in road signs, intensity of primary light sources at the road, height of driver's eye and luminance caused by the headlight beam of the vehicle on road sign and by reflected beam on driver's eye. To maintain the retro reflectivity, the signs shall be cleared from dust accumulated and oil vapour of vehicle exhaust.

Total numbers of 5373 road studs proposed along the project road. A total of 138 Cautionary, 76 Informatory and 15 Mandatory Signboards proposed at appropriate locations along the project road. 3660m of Crash Barrier is proposed along project road at various locations.

Road Furniture details include:

- *Road Markings*
- *Road Stud or Reflective Pavement Markers (RPM)*
- *Road Signs*
 - ✓ *Cautionary, Mandatory and Informatory signs*
 - ✓ *Direction sign Boards*
 - ✓ *Overhead sign Boards*
- *Guard Posts*
- *Road Delineators (Hazard Markers) and Chevron Signs*
- *Crash Barriers*
- *Kilometre stones*
- *200m stones and boundary stones*
- *Footpaths*
- *Rumble strips and Road humps*
- *Bus bays / bus stops*
- *Landscaping*
- *Junction improvement*
- *Utility Crossings*
- *Lighting*

0.9 Project Cost

Quantities of each of the item have been estimated based on the improvement proposals suggested and by making use of the typical cross sections/standard drawings developed.

Therefore, the estimated civil Cost is 242.34 crores excluding GST and the Total Project cost of balance work is Rs 392.96 crores.

Table 11.2
Abstract of Cost Estimates

Bill No.	Item	Amount (in Rs.)	Total Amount (in Cr.)	Total Amount in %
1	Site Clearance and Dismantling	4832555.00	0.48	0.20%
2	Earthwork and Subgrade	481185586.00	48.12	19.86%
3	Granular Sub-Base and Base Courses	487616899.00	48.76	20.12%
4	Bituminous Pavement Works	425591432.00	42.56	17.56%
5	Drain Works	72112714.00	7.21	2.98%
6	Road Furniture (Traffic Signs, Road Marking Street Light, High Mast Light & Others)	105940559.00	10.59	4.37%
7	Protection Works (Pitching, Turfing, Toe Wall/Guard Wall, RE wall, Retaining Wall & River Training)	429505961.00	42.95	17.72%
8	CROSS ROAD PIPE CULVERTS	9208059.00	0.92	0.38%
9	PIPE CULVERT	7335283.00	0.73	0.30%
10	BOX CULVERT	51345098.00	5.13	2.12%
11	SLAB CULVERT	74907521.00	7.49	3.09%
12	MINOR BRIDGE	189606177.00	18.96	7.82%
13	MAJOR BRIDGE	42680541.00	4.27	1.76%
14	VEHICULAR OVER PASS (VOP)	35166026.00	3.52	1.45%
15	Project Facilities (Bus Bay, Bus shelter, Rain Water Harvesting, etc)	6349056.00	0.63	0.26%
A	Civil Construction Cost	2423383467.00	242.34	
B	Utility Shifting Cost Excl GST	68141349.00	6.81	
1	IC/Pre-operative expenses @1% of (A+B) above	24200000.00	2.42	
2	Financing Cost (2% of debt amount)	19600000.00	1.96	
3	Interest during Construction	87300000.00	8.73	
C	Estimated Project Cost	2622624816.00	262.26	
D	GST @ 18% on C	472072467.00	47.21	
E	Centages			
1	Contingencies @ 1% on (A)	24233835.00	2.42	
2	Supervision Charges @ 1.5% on (A)	36350752.00	3.64	
3	Agency charges @ 3% on (A)	72701504.00	7.27	
4	Maintenance charges @ 2.50% on (A)	60584587.00	6.06	
5	Price Escalation charges @ 5% on (C)	131131241.00	13.11	
	Sum of E	325001919.00	32.50	
F	Pre-construction Activities			
6	Land Acquisition cost	503991153.00	50.40	
7	Afforestation (291 x 411.27 x 10) + 15.87 x	5957795.70	0.60	

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	300000			
	Sum of F	509948948.70	50.99	
	Total Project Cost	3929648150.70	392.96	

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CHAPTER 1 INTRODUCTION

1.1 General

Ministry of Road Transport and Highways (MORTH), Government of India has decided to upgrade two lane National Highways to at least two lane with shoulder standards and Four lane. The work would be taken up for up gradation on corridor concept. Therefore, corridor include widening to 4 lane with paved shoulder to have a better facility in a long continuous stretch.

In this concern, Ministry of Road Transport and Highways entrusted M/s Vistaara Infra Consultants for the task of carrying out preparation of Detailed Project Report for "Widening/Re-Construction to Four Lane from Km 0.000 to Km 15.870 starts near Miriyan Telangana/Karnataka border and ends at Chincholi Section of NH-167N in Kalaburagi District in the State of Karnataka under Annual Plan 2023-24".

1.2 Project Location

Project road is located in Karnataka, the third largest state in India. The State is bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamil Nadu States in the South and by the State of Andhra Pradesh in the East. The State extends to about 750 km from North to South and about 400 km from East to West, and covers an area of about 1,91,791 sq.km.

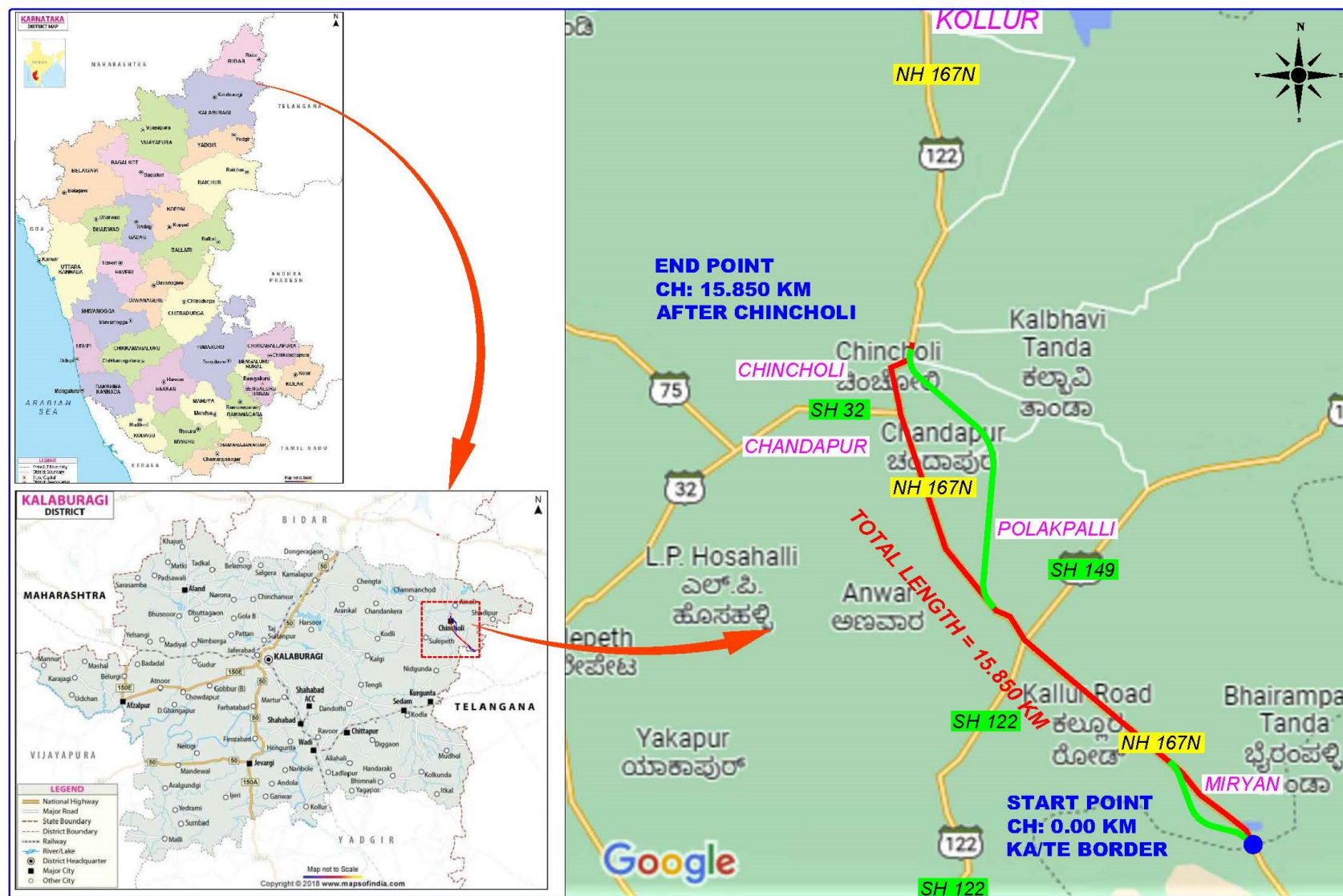
This national highway is starting from its junction with NH-167 near Mahabubnagar connecting Kodangal, Tandur in the state of Telangana, Chincholi and terminating at its Junction with NH-65 near Bapur in the state of Karnataka. NH 167N is declared as NH on 07.04.2021. The total length of this highway in the state of Karnataka is about 49.09 km in terms of existing alignment. Status of NH-167N in state of Karnataka is summarized below:

Sl No	Stretch Name	From	To	Length	Carriageway	Present Status
1	Miriyan to Konchavaram	0.00	15.70	15.70	2 Lane	Proposed to be developed to 4L+PS under current annual plan.
2	Chincholi City Limits	15.70	16.50	0.80	4 Lane	
3	Chincholi - Bapur	16.50	49.09	32.59	2 L+ PS	Improved by KRDCL in the year August 2019 and DLP is upto August 2027

The project stretch starts at Km 0.000 near Telangana Border and ends at Km

15.750 of NH-167N near Chincholi. Total length of the project corridor is 15.870 Km. Map showing location of the project road shown in Figure 1.1.

Figure 1.1: Key Map



1.3 Objective of the Study

The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project reports for rehabilitation and upgrading of the existing road to Two/Four Lane configuration.

The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis.

The Detailed Project Report will inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analysis, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding. The consultant will, along with Feasibility Report, clearly bring out through financial analysis the preferred mode of implementation on which the Civil Works for the stretches are to be taken up

Detailed project preparation shall incorporate aspects of value engineering, quality audit and safety audit requirement in design and implementation.

1.4 Scope of Services

General Scope of Services shall cover but not limited to the following major tasks.

- ❖ Review of all available reports and published information about the project road and the project influence area;
- ❖ Detailed reconnaissance Survey;
- ❖ Identification of possible improvements in the existing alignment and bypassing congested locations with alternatives, evaluation of different alternatives comparison on techno-economic and other considerations and recommendations regarding most appropriate option;
- ❖ Traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years;

- ❖ Inventory and condition surveys for road;
- ❖ Inventory and condition surveys for bridges, cross-drainage structures, other Structures, river Bank training/Protection works and drainage provisions;
- ❖ Detailed topographic survey
- ❖ Pavement investigations;
- ❖ Sub-grade characteristics and strength: investigation of required sub-grade and sub-soil characteristics and strength for road and embankment design and sub soil investigation;
- ❖ Identification of sources of construction materials;
- ❖ Detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment. Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc.
- ❖ Identification of the type and the design of intersections;
- ❖ Design of complete drainage system and disposal point for storm water
- ❖ Value analysis / value engineering and project costing;
- ❖ Economic and financial analyses;
- ❖ Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground) and the scheme for their relocation, trees to be felled, transplanted and planted and land acquisition requirements including schedule for LA: reports documents and drawings arrangement of estimates for cutting/ transplanting of trees and shifting of utilities from the concerned department;
- ❖ To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up.
- ❖ Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources.

1.5 Structure of the Report

The DPR comprises of following chapters:

Volume I: Main Report

- *Chapter 1* : *Introduction*
- *Chapter 2* : *Project Site Appreciation*
- *Chapter 3* : *Indicative Design Standard*
- *Chapter 4* : *Methodology for Feasibility Study*
- *Chapter 5* : *Socio Economic Profile*
- *Chapter 6* : *Traffic Survey and Analysis*
- *Chapter 7* : *Improvement Proposal*
- *Chapter 8* : *Street Furnitures*
- *Chapter 9* : *Cost Estimate*

Volume II: Cost Estimate

Volume III: Drawing Volume

CHAPTER 2 PROJECT SITE APPRECIATION

2.1 General

The project team has visited the project site in the month of June 2023 for appreciation of the project area. The following things were observed during the site visits and through corresponding collected data.

Project road is located in Karnataka, the third largest state in India. The State is bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamil Nadu States in the South and by the State of Andhra Pradesh in the East.

The project stretch starts at Km 0.000 near Telangana Border and ends at Km 15.750 of NH-167N near Chincholi. Total length of the project corridor is 15.870 Km.

This national highway is starting from its junction with NH-167 near Mahabubnagar connecting Kodangal, Tandur in the state of Telangana, Chincholi and terminating at its Junction with NH-65 near Bapur in the state of Karnataka. NH 167N is declared as NH on 07.04.2021. The total length of this highway in the state of Karnataka is about 49.09 km in terms of existing alignment. Status of NH-167N in state of Karnataka is summarized below:

Sl No	Stretch Name	From	To	Length	Carriageway	Present Status
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3	Chincholi - Bapur	16.50	49.09	32.59	2 L+ PS	Improved by KRDCL in the year August 2019 and DLP is upto August 2027



*Start of Project Road, Km 0.000
(NH-167N)*



*End of Project Road, , Km 15+750
(NH-167N)*

2.2 Project Road

Total length of the project road is 15.870 Km.

2.2.1 Road Section

Chincholi is a Taluk Headquarter and is a developed town in the district of Kalaburagi which is popular for its toordal and limestone deposits. The existing town stretches of chincholi and Miriyan has poor geometry due to presence of more than 16 curves and restricted ROW.

Presently, average speed of only 40 kmph to 60 kmph is achievable on the town stretches. The length of built-up stretch is around 5.0 Km. Existing ROW available varies between 20 to 30m which is not sufficient to accommodate 4L+PS with curve improvements. At many locations geometric improvement would be very difficult due to presence of commercial and residential properties very close to the existing ROW boundary and cost of land is also very high

The entire project road falls in the district of Kalaburagi in the state of Karnataka. The project road starts at starts at Km 0.000 near Telangana Border and ends at Km 15.750 of NH-167N near Chincholi.

Start and end point coordinates of the project road are as follows:

Section	Start			End			Length (m)
	Chainage	Latitude (N)	Longitude (E)	Chainage	Latitude (N)	Longitude (E)	
Miriyan to Chincholi	0+000	17°21'26.9"	77°30'07.5"	15+750	17°27'54.4"	77°25'26.8"	15.75

The Key Map of the project road is shown in Figure 2.1.

Figure 2.1: Key Map



2.2.2 Villages/Towns

There are 1 major settlements along the road from Miriyan to Chincholi. Few of the settlements are congested and pass through the market area. The major settlements along the project road are given below in

Table Error! No text of specified style in document..1: Settlements along the Project Road

S. No	Chainage (Km)		Length (Km)	Name of village
	From	To		
1	4+000	5+000	1.0	Kalluru

2.2.3 Carriageway width

The existing road has two lane bituminous configuration without paved shoulder for most of the stretch. The average width of the carriageway is 7.0m. No service roads exist in the project road. The details of existing lane configuration are presented in Table Table 2-2.

Table 2-2: Details of existing lane configuration

Lane Configuration	Length (Km)	Percentage (%)
Two lane without paved shoulder	5.89	76.38

2.2.4 Terrain

The terrain on the projects stretch is plain Terrain and detailed in Table 2.3.

**Table 2.3
Terrain Classification**

Terrain	Percentage
Plain	60%
Rolling	40%

2.2.5 Land Use

The land use along the stretch is of mixed in nature with agricultural, Forest, Barren Land and Mining.

2.2.6 Habitats Enroute

The road section passes through Green Field.

2.2.7 Alignment and Road Safety

The horizontal alignment of the project road is not straight but is with few sharp curves. There exist few sharp curves which needed to be corrected to bring them to proper design standards. The embankment height varies from 0.5 m to 1.0 m except at the approaches of cross-drainage structures.

2.2.8 ROW

During reconnaissance survey the Existing Right of Way (EROW) information is collected from site. The available clear right of way based on the inventory is found to be around 30m in forest area and around 20m to 30m in remaining locations.

Apart from this, village maps are collected from the revenue department. The existing right of way presented in the village maps are found to be mostly matching with the collected data. As per village map, right of way varies from 20m to 30m in other than forest locations.

2.2.9 Pavement Condition.

This project road has bituminous pavement mostly in fair to good condition except at few locations where longitudinal cracking, distress, ravelling and pot holes are observed.

2.2.10 Major and Minor Junctions

5 Major Junctions and 4 minor junctions are observed along the project road. The details of the major junctions and minor are presented in Table 2.5 and Table 2.6.

Table Error! No text of specified style in document.3: Details of Major Junctions

S. No	Chainage (Km)	Location	Type	Side
1	0+500	Miriyan (Connecting Arm)	T	RHS
2	2+650	Miriyan (Connecting Arm)	T	RHS
3	7+650	SH-172 Junction	X	BHS
4	9+450	Chincholi (Connecting Arm)	T	LHS
5	15+600	Chincholi (Connecting Arm)	T	LHS

Table 2.4: Details of minor Junctions

SL. No	Chainage (Km)	Location	Type
1	6+530	Chettinad Cement Factory	Y
2	8+445	Poalakupalli Tanda	Y
3	10+315	Polakupalli to limestone Mine	X
4	12+780	Chandapura to Kalbhavi	X

2.2.11 Utilities

Utilities such as electrical / telephone poles and transformers are observed along the project road. Low Tension and High-Tension lines also cross the project road in many locations. There are OFC cables passing at some sections of the project road. Bus bay / Bus shelters.

The details of bus shelters are given in Table 2.7.

Table 2.7: Details of bus shelters

Sl No	Chainage	Side
1	6+550	LHS
2	7+650	LHS

2.3 Bridges and CD Structures

2.3.1 General

A detailed condition survey along with visual inspection of the existing structures has been carried out by the concerned key professionals to assess and ascertain the existing condition/ characteristics of the bridges and other CD structures. Inventory of bridges includes but is not limited to recording relevant technical data for each structure such as name, location, type of structure, span arrangement, clear height, length, type of material, carriageway width etc.

Project is a Green filed alignment. Five pipe culvert, Three Slab Culverts, Four Minor Bridges and One Major Bridge observed along the Project stretch.

**Table 2.3
Existing structures on Project stretch**

Sl No.	Type of Structure	No. of Structures
1	Culvert	8
2	Minor Bridge	4
3	Major Bridge	1
	Total	13

CHAPTER 3 INDICATIVE DESIGN STANDARDS

3.1 General

Planning and design of roads & CD structures, pedestrian facilities and street furniture essentially based on the design standards as stipulated in relevant IRC standards and MoRT&H specifications. Whenever, the codes/standards are silent on some of the aspects, the same will be planned/designed based on sound engineering practices and consultant's experience in similar projects. Design standards relevant to the project road along with the broad list of design parameters and the relevant IRC codes/specifications detailed in Table 3.1.

Table 3.1
Design Standards

Sl.No.	Design Parameters	Reference Code
1	Geometric Design Standards • Carriageway width • Shoulder • Footpath • Median • Camber • Super elevation • Horizontal Alignment • Vertical Alignment	As per IRC:SP:73-2018, IRC SP:84 – 2019, IRC:38-1988, IRC:73-1990, IRC:86-1983 & IRC:SP:23-1983
2	Road Furniture • Road Markings • Road Signs • Road Delineators	As per IRC:35-2015 As per IRC:67-2012 As per IRC:79-1981
3	Pedestrian Facilities	As per IRC:103-1988
4	Road Capacity	As per IRC:64-1990
5	Pavement Design	As per IRC:37-2018 and IRC:58-2015
6	Overlay Design	As per IRC:81-1997
7	Road Drainage	As per IRC:SP:42-1994 & IRC:SP:50-2013
8	Culverts & Bridges	As per relevant IRC codes and MORT&H specifications
9	Utility Services	As per IRC:98-2011

Design standards (as appropriate) have been elaborated under the following heads:

- ◇ *Geometric Design and Road Capacity*
- ◇ *Pavement Design*
- ◇ *Drainage*
- ◇ *Road Furniture and Appurtenances*
- ◇ *Bridges and CD Structures*
- ◇ *ROB/RUB and Grade Separators*
- ◇ *Pedestrian/Passenger Facilities*

3.2 Design Standards Related to Geometric Design and Road Capacity

Design standards related to road geometric and road capacity along with the suggested design values/standards and recommended values based on site conditions and data analysis detailed in Table 3.2. Design standards relevant to NH have been detailed. Few of the design standards have been elaborated further.

Table 3.2
Geometric Design Standards and Road Capacity

Geometric Design Standards and Road Capacity					
Sl.No.	Design Parameters	Design Values*			
	Geometric Design Standards				
1.	Design Speed	Ruling Design Speed (Desirable)		Minimum Design Speed	
	NH (Plain & Rolling Terrain)	100 kmph 60 kmph		80 kmph 40 kmph	
	NH (Mountainous & Steep)				
2.	Geometric Design Standards				
	• Land Width	Plain & Rolling Terrain	Mountainous & Steep Terrain		
		NH – 30-60m (built-up/ open areas)	NH – 20-24m (built-up/ open areas)		
	• Carriageway Width	Two lane carriageway without raised kerbs – 7.0m Two lane carriageway with raised kerbs – 7.5m Four lane carriageway with 4.5m median – 19m			
	• Roadway Width (Two lane road)	Width of roadway shall depend upon the width of carriageway, shoulders and the median.			
	• Shoulder width (Plain and Rolling Terrain)	Type of Section	Width of Shoulder (m)		
			Paved	Earthen	Total
		Open country with isolated built up area	2.5	1.5	4.0
		Built up area (2-lane section)	2.5	-	2.5
		Approaches to grade separated structures	2.5	-	2.5
		Approaches to bridges	2.5	1.5	4.0
	• Footpath	Minimum width – 1.5m			
	• Camber (on straight sections i.e. without super elevation)	1.7-2.5 % for paved carriageway; (2.5 % for flexible pavement & 2.0 % for rigid pavement) 0.5% steeper than carriageway camber for earthen shoulders			
	• Kerb	Barrier/Semi-barrier/Mountable (Semi-barrier recommended)			
	• Super elevation	Limited to 7 percent.			
	• Minimum Radius of Horizontal Curve	In conformity with the speed adopted			
	• Extra Widening at Curves	75-100m - 0.9 m 101-300m – 0.6 m Nil for Radius above 300 m			

Sl.No.	Design Parameters	Design Values*		
	Geometric Design Standards			
	• Gradient ○ Plain/Rolling	Ruling/Limiting Gradient – 2.5 % (1 in 40)/3.3% (1 in 30) Minimum Gradient for Drainage – 0.5 % (lined drains) & 1.0 % (unlined drains)		
	Design Service Volumes			
3.	Nature of Terrain	Plain	Rolling	Mountainous
	Design Service Volumes in PCU/day (LOS B)	10,000	8500	6000

(* -As per Ministry Notification No. RW/NH-33044/28/2015/S&R (Dated: 26/05/2016) Reference Code: IRC: 73-1990 – “Geometric Design Standards for Rural (Non-urban) Highways”, ** - IRC: 64-1990 – “Guidelines for Capacity of Roads in Rural Areas & IRC:SP:73-2018 – “Manual of specifications & standards for two laning of highways with paved shoulder)

a) Terrain Classification

The terrain classification system recommended by IRC is as below. The project road passes through plain/rolling terrain and accordingly the relevant standards related to each terrain for NH have been detailed.

Terrain	Cross - Slope (%)
Plain and rolling	Up to 25
Mountainous	More than 60

b) Design Speed

The design speed is the guiding criteria for co-relating features such as sight distance, curvature and super elevation; upon which the safe operation of the vehicle depends. The proposed design speed for different terrain categories are detailed in Table 3.2. Although both ruling (desirable) and minimum design speeds are recommended on sections through plain, rolling & built-up area and mountainous terrain, design speeds are not recommended to be changed at intervals of less than 5 km in plain and rolling terrain and 2.5 km in hilly terrain, unless required due to specific reasons, like presence of built-up area, approaches to major bridges etc.,

c) Right-of-Way (ROW)

As per IRC standards, two laning shall be accommodated within existing ROW to the extent possible. However, additional land, if required for accommodating the two laning cross section, improvement of geometrics, realignment, junctions, bypasses etc., ROW of 30m shall be acquired by the Authority. For bypass, right of way shall be 40-60m depending upon the provision of the carriageway.

d) Traffic Lanes, Carriageway and Width of Shoulders

The Project Road is proposed to be constructed as a 2/4-lane with paved shoulder road. The width of 2-lane carriageway is 7.0m in rural sections and 7.5m in urban sections and the width of 4-lane carriageway is 14.0m + 5.0m Median in rural sections and 14m + 2.5m Median in urban sections typically. It is proposed to provide 1.5m wide paved shoulder and 2.0m wide earthen shoulders on either side in plain/rolling terrain in rural sections and 1.5m wide footpath cum drain (0.6m wide clear lined drains), with perforated precast covered slab) in urban sections. Additional width of carriageway/paved area/unpaved area is required to accommodate various facilities such as toll plazas, bus bays, truck lay bye, highway traffic management system (HTMS) and other way side amenities.

e) Side Slopes

For fill sections, the following side slopes proposed:

Fill height up to 3.0 m	2H: 1V and 1.5H: 1V
-------------------------	---------------------

For tank bund sections Gabion Mattresses and for high embankments reinforced earth walls/ Gabion wall are envisaged as appropriate. These treatments are proposed since the conventional slope treatments need flatter slope, which involves considerable width of land to be acquired or it encroaches in to water body. However, in order to meet safety standards, embankments greater than 3m in heights will have crash barrier on the outer verge of the highway

f) Sight Distance

Visibility is an important requirement for the safety of travel on highways. Sight distance is relevant for the design of summit vertical curves and visibility at the horizontal curves apart from the requirements during safe stopping and overtaking. Head light sight distance (at least equal to SSD) governs the design of valley curve. The sight distance values depend on speed as detailed below:

<i>Design Speed (km/hr)</i>	<i>Safe Stopping Sight Distance (m)</i>	<i>Overtaking Sight Distance (m)</i>	<i>Intermediate/Mini mum Sight Distance (m)</i>
100	180	640	360
80	120	470	240
60	90	340	180
40	45	165	90

g) Radius of Horizontal Curve

According to IRC design standards, the minimum radius of Horizontal curves for different terrain conditions are as detailed below:

Terrain	Radius of Horizontal Curves (m)	
	Ruling Minimum	Absolute Minimum
Plain and Rolling	400	250
Mountainous and Steep	150	75

h) Vertical Curves

Vertical curves will be designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values will be adopted wherever this is economically feasible. Valley curves will be designed for headlight sight distance. The K values for design controls and minimum length of vertical curves is detailed below:

Terrain	'K' value for summit curves		'K' value for valley curves		Minimum length of curve (m)
	Desirable	Minimum	Desirable	Minimum	
Plain	74	38	42	28	60
Rolling	38	18	28	18	50
Mountainous	8	5	10	7	30

Vertical profile of the existing and proposed carriageway would be based on the designs using the comprehensive topographic data. Vertical control points in finalizing the vertical alignment shall be fixed judiciously in order to:

- ◇ *Optimize the Earth work*
- ◇ *Reduce the length of structures like grade separated structure, RoB, Underpass, etc.*
- ◇ *Make available acceptable clearances for high-tension lines as well as for various categories of existing/proposed roads.*
- ◇ *Safe guarding the heritage structures.*
- ◇ *Maintaining the accessibility to road side developments/properties*

IRC recommends Minimum longitudinal gradients of 0.2% for effective longitudinal drainage. In flat section of alignment even zero percent grade, existing would be maintained to avoid needless profile change. The drainage will be effected by camber only. Efforts shall be made to keep the grade and line smooth with mild gradients consistent with character of terrain. Vertical curves shall be provided at places where the grade changes. The vertical alignment designed shall be simple in application, and would be safe, comfortable in operation, pleasing in appearance and adequate for drainage. The major control for safe operation on summit curves will be the provision of adequate sight distance for design speed.

Special attention will be made in the coordination of horizontal and vertical alignment to ensure pleasing aesthetics and safety.

i) Junction Improvements

Comprehensive junction improvements to cater the geometric needs will be

proposed at all major junctions along the project road. All other important junctions along the project will be designed to cater the geometric needs. Pedestrian crossings will be proposed as per IRC guidelines.

3.3 Design Life for Grade Separated Structures (Traffic Projection)

As per IRC:92-2017 - "Guidelines for the Design of Interchanges in Urban Areas", for the purpose of traffic projection a 20 year horizon period is considered. The grade separators are designed to cater the traffic anticipated in the next 20 years.

3.4 Design Service Volume

As per IRC: 64-1990 - "Guidelines for Capacity of Roads in Rural Areas", design service volumes corresponding to LOS 'B' will be adopted for design of rural roads. Design service volumes for different lane configurations corresponding to LOS 'B' is presented in Table 3.2. However, on other roads under exceptional circumstances, LOS C could also be adopted for design. Under these conditions, traffic will experience congestion and inconvenience during some of the peak hours which may be acceptable.

However As per circular from Ministry of Road Transport & Highways; Ref No. RW/NH-33044/37/2015/S&R (Dated: 26/05/2016), "the planning for up-gradation of the existing 2-lane highways with paved shoulder shall be started before the end of design life, so that by the time the threshold capacity of the road is reached the 4-lane highway will be already constructed. As such, there will be no discomfort to the road users and the Level of Service 'B' would also be achieved. The traffic at which up gradation from 2-lane with paved shoulder to 4-lane will trigger, is indicated as for plain terrain - 10000 PCU, rolling terrain - 8500 PCU and mountainous/steep terrain - 6000 PCU.

3.5 Design Standards Related to Pavement Design

Pavement design plays a vital role in highway/street design, as the economic returns are directly dependent on the performance of the pavement. Design standards related to pavement design are essentially based on the guidelines given in IRC: 37-2018 - "Guidelines for Design of Flexible Pavements" and IRC: 58-2015 - "Guidelines for the Design of Plain Jointed Rigid Pavements for Highways". Overlay design are essentially based on IRC: 115-2014 - "Guidelines for structural evaluation and strengthening of flexible road pavements using Falling Weight Deflectometer (FWD) Technique" / IRC: 81-1997 - "Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique" IRC: SP: 73-2018 - "Manual of specifications & standards for two laning of highways with paved shoulder". The suggested design values/standards and recommended values based

on site conditions and data analysis are detailed in Table 3.3.

Table 3.3
Pavement/Overlay Design Standards

Sl.No.	Design Parameters	Reference Code / Design Values
1.	Pavement Design	IRC: 37-2018- "Guidelines for Design of Flexible Pavements" and IRC:58-2015-"Guidelines for Design of Plain Rigid Pavements for Highways"
	• Traffic Growth Rate	Estimated Annual Growth Rates
	• Design Life	Widening (Stage Construction): • 20 years for subgrade, base and subbase
	• Vehicle Damage Factor	Derived values based on Axle load survey. If these values are less than national average, then national average will be used.
	• Lane Distribution Factor	As per IRC:37-2018
	• Minimum Thickness	Sub grade – 600 mm Sub base – 150/200 mm (<10 msa / >10 msa) Base – 225/250 mm (<2 msa / >2 msa) Binder Course – BM/DBM (<5 msa / ≥5 msa) Bituminous Surfacing – Desirably 40mm thick, to prevent ingress of water through surface and to have adequate/better stiffness.
2.	Overlay Design	IRC: 115-2014 - "Guidelines for structural evaluation and strengthening of flexible road pavements using Falling Weight Deflectometer (FWD) Technique / IRC: 81-1997 - "Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection Technique"
	• Design Life	15 years
	• Correction Factors	Temperature Correction Factor Correction for Seasonal Variation (inclusive of correction for moisture content, soil type and rainfall)
	• Minimum Thickness	From structural considerations recommended minimum bituminous overlay thickness is 40 mm BC (minimum) or 50mm BM (as required) + 40mm BC. 40mm BC is recommended so as to have adequate/better stiffness.
3.	Wearing Course Material (Options)	Bituminous Concrete/Polymer Modified Bitumen/Crumb Rubber Modified Bitumen
4.	Mastic Asphalt	Near junctions, roundabouts and bus stops. Over major/minor bridges

3.5.1 Approach for Pavement Design

Designs for new pavement and overlays shall be produced in accordance with Indian and International practice. Generally the paved shoulder is structurally designed to carry 10 to 20 % of the traffic load the design lane is expected to carry. However the structural drainage system of the paved shoulder is required to be integrated with that of the carriageway pavement. The later condition thus requires the thickness of pavement structure to be the same thickness as that for the traffic lanes since the lower layer of the sub-base for the carriageway is extended to the full width of formation for the lateral drainage of any water percolating into the

pavement. Therefore the drainage requirement overrules the design thickness required to carry traffic load. Construction requirements demand that the carriageway pavement layers be extended to shoulders as this ensures constructional ease, quality and speed. Some economy can, however, be effected in the shoulder pavement structure by replacing the DBM with WMM, but the thickness of wearing course should be kept the same as it will facilitate the completion of this layer in one operation without creating any joint between the carriageway and shoulder pavement.

3.6 Design Standards Related to Road Drainage

Drainage of water from pavement surface is of paramount importance as far as preserving the road assets created by investing huge funds in addition to maintaining the structural soundness and functional efficiency of the road. Design standards related to road drainage are essentially based on the guidelines given in IRC: SP: 42-2014 – “Guidelines on Road Drainage” and in IRC: SP: 50-2013– “Guidelines on Urban Drainage”. The suggested design values/standards are detailed in Table 3.4.

Table 3.4
Design Standards Related to Road Drainage

Sl. No.	Design Parameters	Design Values
1.	Camber	2.0-2.5 % (bi-directional) for paved carriageway 3-5% for earthen shoulders
2.	Longitudinal Gradient	Minimum 0.3-0.5% for satisfactory drainage
3.	Drain Type	Unlined trapezoidal open drain in rural areas RCC U-box drain with precast RCC slab in urban location Hume pipe culvert across cross roads

3.7 Design Standards Related to Road Furniture and Appurtenances

Utility and importance of the road is greatly enhanced by installing road furniture and appurtenances at appropriate locations along the project road, which ensures improved road safety. Planning and design of road furniture and appurtenances are as per the guidelines stipulated in IRC. Detailing of each of these components has been done so as to integrate the same with the road improvement scheme. The suggested design values/standards are detailed in Table 3.5.

Table 3.5
Design Standards Related to Road Furniture and Appurtenances

Sl.No.	Design Parameters	Reference Code / Design Values
1.	Road Markings	IRC: 35-2015- “ Code of Practice for Road Markings”
2.	Road Signs	IRC: 67-2012- “ Code of Practice for Road Signs”
3.	Road Delineators	IRC: 79-1981- “ Recommended Practice for Road Delineators”
4.	Pedestrian Facilities	IRC: 103-2012- “ Guidelines for Pedestrian Facilities”

5.	Road Humps	IRC: 99-1988- " Tentative Guidelines on the Provision of Speed-Breakers for Control of Vehicular Speeds on Minor Roads"
6.	Metal Beam Crash Barriers	At locations where embankment height is more than 3m

In addition to the above measures various other integral road components have been planned so as to achieve the maximum and optimal use of the carriageway with no/least interference to traffic flow at the same time ensuring adequate facilities to other road users especially pedestrians. All the encroachments, if any shall be cleared within the ROW to ensure the optimal use of the carriageway width.

3.8 Design Standards Related to Bridges and CD Structures

Design Standards & Codes of Practices The Design Standards and the loading to be considered are generally based on the requirements laid down in the latest editions of IRC/ IS codes of practices & standard specifications, and guidelines of Ministry of Surface Transport. Additional technical references would be used wherever the provisions of IRC/ IS codes are found inadequate.

For items not covered in the above specifications, provisions of following standards will be followed in the given order of priority:

- i. *Provisions of IS codes of practices; and*
- ii. *Relevant provisions of BS codes of practices*
- iii. *Sound Engineering Practice, Technical Literatures/Papers & provision of relevant codes of other nations.*

3.9 Grade Separation and intersection

Grade separators at road crossing shall be provided if the peak hour junction traffic is in excess of 10000 PCU (as per IRC: 92-1985 – "Guidelines for the design of interchange in urban areas"). However if this limit is reached within the next 20 years, the tentative design for a grade separation shall be prepared and the cost of land will be included in the cost estimate. This is in accordance with IRC: 62-1976.

3.10 Warrants for ROB/RUB

Warrant for provision of ROB/RUB will be as per IRC: 62-1976-"Guidelines for Control of Access of Highways". Grade separated railway crossing shall be provided if the product of ADT (fast vehicles only) and the number of trains per day exceeds 50,000 within the next five years. For new construction such as grade separated railway crossings shall be provided when this figure exceeds 25,000 (as per IRC: 62-1976).

3.11 Pedestrian / Passenger Facilities

3.11.1 Footpaths

For footpath, precast concrete blocks using controlled concrete of M20 grade is proposed. Kerbs are of semi-barrier type and mountable type (near approaches to road side properties) and are proposed for painting. For the purpose of drainage of water collected on the road surface, system of RCC U-box and gratings are proposed at suitable intervals (15m).

Footpath grill barriers are proposed as part of road safety measures in short lengths near bus stops, intersections, in front of market places, shopping areas, religious places, school entrances, recreation grounds etc., to prevent haphazard movement of pedestrians. This greatly contributes in reduction of side friction and fulfills the objective of optimal utilization of carriageway.

3.11.2 Illuminated Pedestrian Crossings (Zebra Range)

To enhance the safety of pedestrians crossing the road (especially near bus stops, educational institutions, market places, hospitals etc.,) illuminated pedestrian crossings have been proposed at locations of pedestrian crossings. Raised pedestrian crossings using Interlocking Concrete Block Pavement (ICBP) are proposed at locations of passenger activities. The pedestrian crossings could be made conspicuous through a special reflector incorporated in luminaries. These luminaries provide maximum lighting (vertical levels) in a plane perpendicular to the roadway centerline. They are positioned in front of pedestrians, to obtain the maximum contrast against the surroundings. The luminaries in the Zebra range will be fitted with a metal halide lamp when the rest of the road is illuminated with HPSV and vice versa. Color contrast in zebra range makes the pedestrian distinctly visible to the driver approaching the crossing. Further Driver's attention can also be caught by a change of colour in the light sources and higher illumination level (>40 lux) as compared to the illumination level (30 lux) on the road so that the bright lit pedestrian is visible against the relatively less bright background. Positioning the luminaries 1.50m in front of the pedestrian crossing at a height of 6m optimizes photometric performance. Luminaries should also be suspended 50cms out from the pavement over the road. Colour of the poles is also kept as that of zebra crossing so as to give the pedestrian right to cross. In this way they will stand proud of the line of other luminaries. These luminaries are all weather proof.

3.11.3 Bus bays / Bus stops

Bus bays

The typical bus bay consists of deacceleration and acceleration lanes with stopping lane of 5/7m wide, 15/30/45m long. Adequate arrangements also needs to be made to drain off surface water.

Bus Stops

Bus stops at suitable locations (spaced at intervals of about 1km) will be proposed along the project road. Bus bays (minimum 7.0 m wide) are proposed (as per the guidelines given in IRC: SP: 73 - 2015) at locations where the right of way is adequate so as to ensure smooth entry/exit of buses without hampering the free flow of vehicles on the carriageway. The outer edges are suitably sloped at suitable locations to make it friendly to the physically challenged. Aesthetically pleasing bus shelter, facility for alighting and boarding, waiting, lighting, display panels etc., will be encompassed. At locations of existing bus stops where the provision of bus bay is impossible from space considerations provision will be made for bus stops with bus shelters with markings to delineate the bus stop location with necessary signboards and markings.

3.12 Other Relevant Standards for Design

The other relevant standards considered, which shall be followed during detailed design of streets are as presented in the Table 3.6.

Table 3.6
Other Relevant Standards

Sl No.	Description	Specification
Utilities Standards		
1.	<i>Maximum depth of laying for Utility Lines</i>	
	Trunk Sewer line	More than 1.5 m
	Water supply line	
	Service line	0.6 – 1.0 m
	Trunk line	1.0 – 6.0 m
	Electric cable	
	LT cable	0.6 – 1.0 m
	HT cable	1.5 – 2.0 m
	Telecommunication (OFC) cable	
	Directly laid	0.6 – 1.0 m
	Laid in ducts	1.0 - 2.0 m
	Gas mains & lines Carrying combustible material	2.0 – 3.0 m
2.	<i>Minimum cover over the top of service line</i>	0.6 m
3.	<i>Clearance for Utility Lines (Minimum)</i>	
	Horizontal Clearance	
	Distance between Electric Cables & W/S lines, HT/LT	1.0 m
	Distance between Electric Cables & OFC	1.0 m
	Poles erected for various purpose of Street lighting, electric power, telecommunication lines in urban area	
	For roads with raised kerbs	

Sl No.	Description	Specification
	Minimum (from the edge of raised kerb)	300 mm
	Desirable (from the edge of raised kerb)	600 mm
	For roads without raised kerbs	
	Minimum (from the edge of carriageway)	1.5 m
	Vertical Clearance	
	Distance between Electric Cables & W/S lines, HT/LT	1.0 m
	Distance between Electric Cables & OFC	1.0 m
	For ordinary wires and lines carrying very low voltage up to and including 110 volts e.g telecommunication lines	5.5m
	For electric power lines carrying voltage up to and including 650 volts	6.0m
	For electric power lines carrying voltage exceeding 650 volts	6.5m

(Source: IRC: 98-2011 – Guidelines on Accommodation of Utility Services on Roads in Urban Areas)

3.13 Lighting

Highway lighting shall be provided in urban and semi-urban areas of the project road. Lighting will also be provided in rest areas, toll plazas and at interchanges. IS: 1944 (Part I and II) 1970 shall be followed in regard to lighting installations.

3.14 Landscaping

The landscaping will take into account the overall functional and aesthetic aspect and at the same time they will be in harmony with the surrounding and shall add to the beauty of road-scape.

Where possible, plantation will be made within the right of way at appropriate selected locations such as medians, islands near junctions, extra widths of footpaths, near bus bays/ bus stops etc. Strip of grassing near the edges of road boundary induces aesthetic appearance in addition to delineating the road boundary. Small shrubs or grassing on the medians and islands near the junctions will have a soothing effect to the road. Also tree plantation will have bearing in reducing noise and air pollution like other environmental enhancement/mitigating measures. This item could be proposed for private sponsorship.

3.15 Utility Corridor

Two metre wide strip of land at the extreme edge of ROW shall be kept for accommodating utilities, both over as well as underground. Provisions contained in IRC: 98-2011 "Guidelines on Accommodation of Utility Services on Roads in Urban Areas" shall be followed to accommodate utility services in built-up areas of Project Highway. Utility ducts in the form of 600 mm diameter NP-4 Pipe across the Project Highway along with inspection box/chamber at a spacing of 1 km shall be provided for crossing of underground utilities in built up areas.

3.16 Rest Areas and Wayside Amenities

The rest areas shall be provided at the locations given in Schedule 'C'. Rest areas shall be provided by the concessionaire on the lands included in the site and procured by the Authority. Within the areas so provided, the concessionaire shall construct and operate, or cause to be constructed and operated, facilities such as toilets, telephones, cafeteria, restaurant, parking for cars, buses and trucks, dormitory, rest rooms, shops for travel needs, fuel stations and garage, first aid, etc. In approximately 2 Hectares of land, the following minimum facilities shall be provided.

Cafeteria/Restaurant for seating 50 persons; Toilets (separate for ladies and gents) (WC - 5 nos.; Urinals - 10 Nos.); Dormitory with 20 beds; drinking water facility; parking for 100 trucks and 50 cars in addition to STD/ISD Telephone Facility, Shops and First Aid Facilities. The facilities shall be provided keeping in view the expected peak hour traffic. The whole area shall be elaborately landscaped to provide a pleasing environment.

3.17 Highway Landscaping

Trees shall be planted in rows and on either side of the road with staggered pitch as per the IRC: SP: 21-2009. Indicative arrangements for plantation of trees shall be in accordance with the MoRTH Technical Circular No. NHI-41 (34)/69 dated.RT

CHAPTER 4 METHODOLOGY FOR DPR STUDY

4.1 General

The Consultants propose to perform the studies and carry out all the needed activities for fulfilling the objectives. The general approach of the Consultants would be to tailor their services in a logical manner in order to fulfil each of the objectives in the best possible manner with due diligence. This would include:

- *Deploying a balanced team of well-qualified and experienced experts in the related disciplines;*
- *Performing in a diligent way by continuous interaction and coordination among various specialisation for exchange of information and timely completion.*
- *Regular interaction with the client on various aspects of work being performed*
- *Planning and sequencing the various activities so that the work is completed in all respects within the stipulated time and no requirement is lost sight of;*
- *Using modern equipment for surveys, field investigations etc. so as to maintain a high level of accuracy; and*
- *Extensive use of modern computer facilities available in-house with the Consultants.*

To ensure timely completion, the following aspects will be taken care:

- *Preparing a detailed project schedule and getting it approved by the Client*
- *Entrusting the close monitoring of the progress of the work to the Project Leader as one of his most important tasks*
- *Taking quick remedial measures in case of any delays / slippages.*

The methodology adopted in carrying out the feasibility study and various steps involved are discussed briefly in the following paragraphs. Various tasks associated with surveys, investigations, planning, design and improvement of project road are separately dealt with in relevant chapters.

4.2 Task Series

Based on the extensive and long-standing experience in similar projects, the Consultants have broken down the activities to be carried out by them into well-defined tasks so that the work is completed systematically following a step-by-step procedure. The Task Series listed below followed by a succinct description of the activities to be performed under each Task.

The objectives of the services are:

- *Prepare a Feasibility Report identifying a technically, financially and economic viability of the project.*
- *Prepare detailed project reports for rehabilitation and upgrading of the existing road sections to 2+PS/4-lane carriageway configuration.*
- *The viability of the project designed as a partially access controlled facility shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on all technical aspects*
- *Preparation of detailed project report*

4.3 Sequence of Activities

The broad methodology, prepared on the basis of the Terms of Reference (TOR), has been generally followed, with certain additions and modifications as felt necessary and discussed with NH officials during conducting the study, the consultants have evolved a methodology wherein the work has been divided into a set of Task Series that are listed below.

Task Series and Individual Task Elements

Sr. No.	Description of Task
1	Initial Activities
1.1	Project Start-Up and Inception
1.2	Team Mobilization & Start-up Meeting
1.3	Secondary Data Collection and review
1.4	Reconnaissance Survey
1.5	Standards and Code of Practices
1.6	Finalization of Traffic Survey Stations and Locations
1.7	Preparation of Quality Assurance Plan
2	Traffic Survey
2.1	Traffic Survey and Analysis
2.2	Review Past Traffic Data
2.3	Classified Traffic Volume Count using ATCC
2.4	Origin Destination and Commodity Movement Survey
2.5	Turning Movement Survey
2.6	Axle Load Survey
2.7	Speed-Delay Survey
3	Engineering Survey
3.1	Engineering Surveys/Investigations
3.2	Reconnaissance and Alignment
3.3	Topographic survey using LIDAR technology
3.4	Longitudinal & Cross Sections
3.5	Details of utility services using GPR & other physical features
4	Pavement Survey
4.1	Road and Pavement Investigations
4.2	Road Inventory Survey

Sr. No.	Description of Task
4.3	Pavement Investigation
4.4	Subgrade Characteristics and Strength
4.5	Roughness Survey
4.6	Strengthening of flexible road pavement using Benkelman beam deflection technique.
5	Cross Drainage Survey
5.1	Investigations for Bridges and Structures
5.2	Inventory of Bridges, Culverts and Structures
5.3	Hydraulic and Hydrological Investigation
5.4	Condition Survey for Bridges, Culverts and Structures
5.5	Geotechnical Investigations and Sub-soil explorations
6	Material Survey
6.1	Material Investigations
7	Design Work Desk Study
7.1	Detailed Engineering Design
7.2	Design Standard
7.3	Geometric Design
7.4	Pavement Design
7.5	Design of Embankments
7.6	Design of Bridges & Structures
7.7	Drainage Design
7.8	Traffic Safety features, Road Furniture and Road Markings
7.9	Arboriculture and Landscaping
8	Miscellaneous Engineering work
8.1	Toll Plaza
8.2	Weighing Station, Parking Areas and Rest areas
8.3	Office cum Residential Complex for PIU
9	Environment & Social Study
9.1	Environmental & Social Impact Assessment
9.2	Environmental Impact Assessment
9.3	Social Assessment
9.4	Reporting Requirements of EIA
9.5	Reporting Requirements of RAP
10	Cost Estimate
10.1	Estimation of Quantities and Project Costs
10.2	Rate Analysis
10.3	Detailed Estimates for Quantities and Project Cost
11	Economic Study
11.1	Viability and Financing Options
11.2	Economic Analysis
11.3	Financial Analysis

4.3.1 Start-up meeting

Start-up meeting will be held with the concerned officials of client before commencement of works. The proposed methodology and work programme will be discussed. The data requirements and their sources will be identified. Support and assistance needed for surveys and investigations will be discussed and finalised so that

the studies are carried out as per the time schedule. The Consultants also propose to hold meetings with Karnataka Public Works, NHAI, Ports & Inland Water Transport Department (KPWP&IWTD), Water Supply and Sewerage Board, Telecom Department, Electricity Board, Forest Dept. etc. for collection and compilation of available data as required.

4.3.2 Collection of available data and Documents

Data collection will be taken up according to the project needs from identified sources with the assistance of Client. Among other things, the data would include;

- ◇ *Road Inventory;*
- ◇ *Road condition, year of original construction, year & type of major maintenance/rehabilitation works;*
- ◇ *Condition of Bridges& cross-drainages works;*
- ◇ *Sub-surface, geotechnical, hydraulic data & drawings of existing structures*
- ◇ *Topographic maps of the area*
- ◇ *Right of Way of existing roads,*
- ◇ *Historical traffic data, accident data, rain fall& Flood data.*
- ◇ *Origin-destination & commodity movement characteristics if available*
- ◇ *Axle load spectrum and Speed & delay characteristics if available*
- ◇ *Socio-economic conditions of the project influence area*
- ◇ *Plans for area development (Master Plans if any), which inter-alia includes roads, bridges, industry and other economic activities in this area*
- ◇ *Climate and Geology*
- ◇ *Availability of construction materials*
- ◇ *Schedule of Rates*
- ◇ *Recent acquisition rates for different types of land, proposed/ongoing/recently completed works along the project road etc.*
- ◇ *Previous reports or estimates made as available will also be collected.*

4.3.3 Review of available reports

The collected data/documents will be reviewed to assess their suitability for the assignment& will be made use for the preparation project reports and to identify gaps if any. Client will be informed about the details of data gaps. All information, available data and reports that are collected will be treated as confidential. The data so collected will be analysed checked for validity before arriving at any conclusions.

4.3.4 Reconnaissance Survey

Reconnaissance survey of the project road has been carried out by the engineers of the consultant's team. Data recorded include, the existing network and features such as, curves and road sections requiring improvements, likely raising sections, badly damaged sections, poor sight distance, etc., The information so obtained will be utilised to study site characteristics, associated problems (such as poor drainage locations/flood prone locations which needs to be improved, accident prone locations for improvements, curves & road sections requiring widening, road sections under urban administration, badly damaged sections, etc., if any) and for identifying possible solutions. Identification of type of underground strata by reconnaissance in the neighbouring area to collect information level of water table, rock features, type of soil etc. will also be part of the reconnaissance. Other relevant details such, as terrain type and soil type would also be collected. These data would be used for carrying out detailed planning and programming of surveys and investigations (finalisation of homogeneous road sections for further surveys/investigations) to suit the project requirements.

4.3.5 Review of Methodology and Work Programme

Based on discussions held during the start-up meetings and information/data obtained from reconnaissance survey, the methodology and work programme will be further reviewed and finalized. Any modification to scope of work that may appear necessary will be identified, and finalized after discussion with Client, prior to commencement of subsequent tasks. *The consultant will support the client, in preparing the time table for technical and financial implementation of the project.*

4.4 ENGINEERING SURVEYS

Senior professionals of the Consultants will undertake a close reconnaissance of the project corridor and will have discussions with Client's Engineer-in-charge of the project so as to finalize the survey activities to be carried out.

4.4.1 Road Inventory and Condition Surveys

A detailed inventory of road sections will be carried out by the consultant's team comprising of Engineers of the consultants team by making use of well-structured inventory data formats. Data format is included in Annexure (if not given, will be as per IRC). Various data to be collected during the road inventory broadly include:

Consultant team conducted the road inventories on all of the project corridors, recording the permanent features of the road and adjacent land use.

- ✓ *Terrain / Gradient*
- ✓ *Carriageway type and width*

- ✓ *Surface Type and Condition*
- ✓ *Shoulder, Median, Footpath - type and width*
- ✓ *Drain type and width*
- ✓ *Right of Way*
- ✓ *Embankment or cut and approximate height*
- ✓ *Soil Type*
- ✓ *Land use Type on either side of the road section*
- ✓ *Road Geometry (Horizontal/vertical curvature)*
- ✓ *Utility data*
- ✓ *Trees*
- ✓ *Details of Habitat en-route*
- ✓ *Details of Junctions/cross roads en-route*
- ✓ *Gradient/Terrain type*
- ✓ *Water table/HFL*
- ✓ *Bus/Auto Stops, parking bays& petrol bunks*
- ✓ *All other details as indicated in RFP*

All the above information will be compiled and presented in the form of tables and strip plans for easy understanding. The data captured with respect to road geometry will be made use of to identify the curve locations where there is a scope for improvement in road geometry. Major junctions that could be improved will also be identified for additional detailed topographic survey.

4.4.2 Pavement Condition Survey

The pavement condition survey will be carried out in accordance with RFP (pro-forma)/IRC/AASHTO. Data format is included in Annexure. The Consultants will carry out all the needed surveys and investigations with the following objectives:

- ◇ *To have an up to date record of road assets;*
- ◇ *To have a clear understanding of road side features including condition, land use, drainage characteristics etc.; &*
- ◇ *To assess the condition and strength data for improvement proposals and related designs.*

4.4.3 Visual Condition Survey

Visual condition survey of the road sections will be carried out by travelling along the project road and noting down the pavement condition such as extent of cracking, patching, rutting, ravelling, pot holes etc., shoulder condition such as surface, drop, potholes, evenness and type and condition of side drains by visual observations in a well-structured data format. The data so collected will be compiled and presented in the form of tables and pie charts for easy understanding. This data along with the

data on soil type (visual) will be used to assess the pavement condition, which facilitates in selection of homogeneous sections for Benkelman beam deflection study tests/ test pit and any other investigations.

4.4.4 Topographic Surveys

The main objective of the topographic survey is to capture the essential ground features at the study areas for working out improvements. Before starting topographic survey all the survey instruments will be checked for errors and approved by the site engineer. Latest calibration certificate for the instruments will be presented by the survey agencies for verification.

LiDAR is a remote sensing technology which uses laser pulses for the scanning and measure 3D dimension of an object with a 3D Data Capture. It performs point cloud scanning by bombarding millions of laser points and measures the reflected scan. LiDAR can be mounted on various platforms like terrestrial, mobile and airborne, depending upon the object to be scanned. The data accuracy of the LiDAR scanner varies from cm to mm. This accuracy can be obtained as per the requirement of application. The application of LiDAR has a variety of role in roads & highways. The data can be used for various calculation and analysis for the roads & highways like pavement analysis, road asset management, road damage assessment, as-built documentation etc.,

Continuous movement of heavy vehicles, rains and other factors, Road Mapping through LiDAR Technology damages the road pavement which accounts for several road accidents. To avoid these damages, continuous monitoring & maintenance of the road pavement is necessary. LiDAR has significant role in it due to high accuracy and density. It can scan more than 80 kms of the roads in a single day and the data is captured with high accuracy. These scanned data are further analyzed to generate the road pavement profile along with crack patterns and road markings. This complete process takes 3 to 4 days and decision makers can take decision on basis of these pavement profile data. Using LIDAR technology the authorities can save more time and cost incurred in this process otherwise.

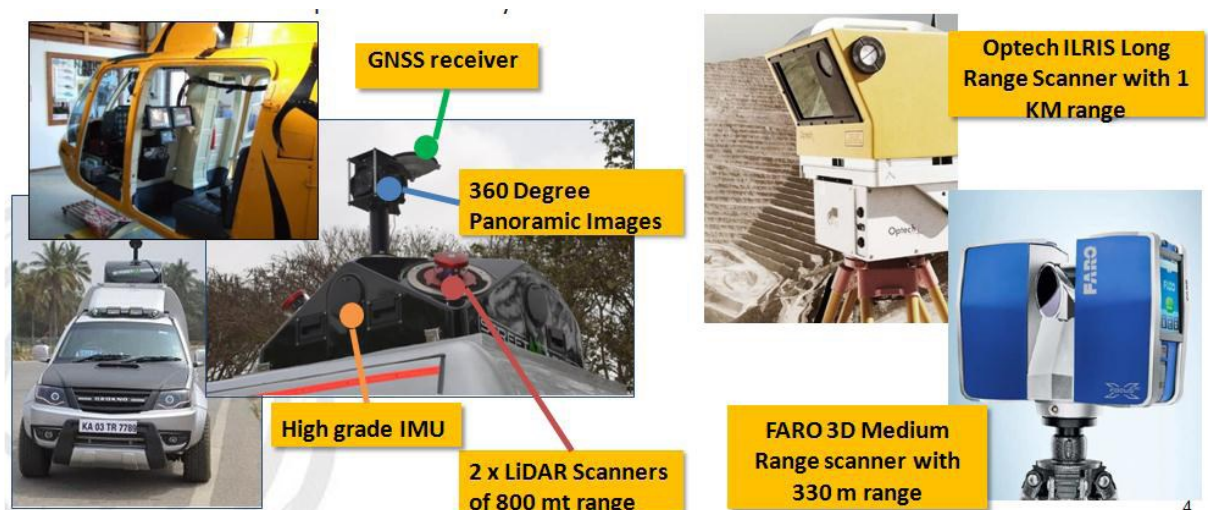
Road Asset Management and as-built documentation are other activities which government has initiated countrywide. Both the activities require high precision and accuracy under DPR or feasibility report for road expansion or new road development. LiDAR here also plays an important role along with the 360 degree view panoramic camera. LiDAR captures all road assets like sign boards, signals, tolls plaza, buildings, Utility poles & Cables, divider, etc. With its geo-referenced 3D dimensions along with true pictures. The entire 3D model is developed on the basis of these inputs with high accuracy and further helps decision makers to take effective and robust decision

The surveyed alignment will be referenced with respect to permanent benchmarks, control pillars etc., as detailed in RFP. The scale of topographic mapping is kept as 1:1000 for general route alignment and longitudinal sections (1:100). Cross sections are plotted to a scale of 1:100.

The surveyor will maintain a field book, in which all relevant observations would be noted along with field sketches. The topographic survey will be carried out for the project road conforming to the procedure and quality controls documented below using LIDAR technique.

A basic laser scanner instrument combines a pulsed laser emitting the beam, a scanner deflecting the beam towards the scanned area, and an optical receiver subsystem, which detects the laser pulse reflected from the target.

Before start the Mobile LiDAR, one or more DGPS shall be observing the GNSS & GLONAS data with data interval of 1 second. This DGPS acts as base point and LiDAR GPS Acts as rover. It's necessary a base station within 20 km range to align the Mobile LiDAR Data. Once the Base station starts, Mobile LiDAR has to fix on the top of vehicle & height to be recorded. After switch on the Mobile LiDAR, initialization of instrument shall be practiced. First 5 minutes of static observation and 10 minutes dynamic observation is necessary in an open sky area. A good initialization practice helps the LiDAR sensor system to verify and activate its IMU & GPS Position.



LiDAR Survey equipment

The LiDAR Operator can check the position accuracy & ideal speed of vehicle for surveying. And surveyor can adjust the camera brightness, colours and interval of image recording based on site condition. The Details of the corridor shall be covered

with millions of Points per second. The eight (8) Cameras attached in the LiDAR shall cover photograph of the corridor at regular distance. While the survey activity is going on, the operator can see the data recording, data storage, data quality, images and GPS accuracy. Once the survey practice is over for a session, again the vehicle shall be stopped on open sky area and again the static and dynamic initialization to be recorded.



Typical View of the Drawing Produced from LiDAR Survey

4.4.4.1 Control points on Permanent locations

To initiate the traverse survey, Two basic Reference stations using DGPS and one Reference line of adequate length will be permanently established on the project road, so that the results of survey can be verified at any time in future. These permanent reference points will be placed at a convenient position, well protected, so that it is not disturbed in future. Also the control points will be established at every 5 km intervals on top of permanent structures like concrete platforms, top of culvert head walls, bridges and three inch nails can be used to fix points on road portion which is marked with Yellow colour paint. Benchmarks will also be established along the project stretch at every 250m intervals on permanent locations.

4.4.4.2 Traverse and Levelling survey

Traversing will be carried out by open traverse method using one second accuracy total station. Local Co-ordinate system will be used for the survey and it will be oriented towards the North direction. Control levelling will be carried out by connecting all traverse stations for the purpose of height control. Survey of India GTS Benchmark will be connected with the project if possible and double tertiary levelling

method will be adopted. Digital Level Instrument of standard model with 1mm accuracy will be used.

4.4.4.3 Detailed Topographic survey

Topographic survey will commence after establishing traverse and completing levelling survey. Detailed topographic survey will be carried out generally up to a distance of 30m on both sides of the centre line of existing road. Longitudinal sections will be chosen at every 50m intervals and cross sections will be taken at 5m intervals, up to a distance of 30m from the existing centre line of the road. In addition to that, cross section levels will be taken at every 25m interval at curves.

All the features on either side, along the project roads will be captured which includes electrical poles and lines, telephone pole and lines, high tension lines and towers, water/Oil/Gas pipe lines above ground, manholes, all OFC lines, tree positions, building lines, type of buildings (kutcha / semi pucca / pucca / shops / houses etc.), existing road pavement edges, shoulders, median, centre line of carriageway, footpaths, side drains at regular intervals, kerb top and bottom, kilometre / hectometre stones, places such as temples, temple mast, mosque, church, grave yard, bridges and cross drainage structures etc.. All such captured features will be shown in drawings.

4.4.4.4 Final Drawings

It is to be ensured that all survey drawing lines are provided as 3D poly line. If a line is continuous like the centre line of carriageway it will be considered as one 3D ploy line in the drawing and should not be broken. All topo features, permanent control points, benchmarks and traverse stations will be presented in the topo survey drawings. Drawings will be presented in 100m gird intervals.

4.4.5 Road Roughness Survey

Roughness is an overall indicator of the quality of a pavement at a particular point of time and it adversely affects not only the vehicle riding quality but also the road user costs. The survey will be carried out using Bump Integrator of similar instrument to know the condition of existing pavement and to identify the maintenance requirements. Roughness surveys will be conducted only for the location identified for overlay and not for the sections identified to be reconstructed based on the reconnaissance / pavement condition survey.

4.4.6 Falling Weight Deflectometer (FWD) Survey

The strengthening of flexible pavements is based on the pavement rebound deflections obtained from the deflection survey conducted by the Falling Weight Deflectometer (FWD), testing equipment following the guidelines of IRC: 115-2014.

KUAB Falling Weight Deflectometer (FWD) a non-destructive pavement testing device was used, which provides an accurate data on pavement response in terms of a typical deflection bowl, simulating actual wheel loads in both response and duration, which allows rapid measurement of pavement deflection under load than traditional methods.

A dynamic load is generated by the dropping of a mass from a pre-set height onto a 300 mm diameter plate. The magnitude of the load and the pavement response are measured by a load cell and geophones. One geophone is located immediately under the load, whilst the others are located at variable offsets at 200, 300, 450, 600, 900, 1200, 1500, and 1800mm as per Clause 4.6 in IRC: 115

The FWD is integrally mounted on a trailer which is towed by a dedicated vehicle. All testing is controlled by a personal computer which is located in the vehicle towing the FWD. As a result, only one operator is required to conduct a survey on most occasions making it less labour intensive.

The test load can be varied between 20 and 250 KN to meet the requirements of the particular task and the pavement response to four different magnitudes of load can be measured during any test sequence.

A typical sequence can be completed in approximately one minute. Highly accurate deflection bowl measurements are possible which help in doing large-scale deflection surveys.

4.4.7 Inventory and Condition Survey - Bridge/Structures

A detailed inventory and condition survey of all bridges/VUP's, cross drainage structures and other structures along the road stretches will be carried out by engineers of the consultants team in accordance with IRC-SP: 35-1990 who stop at each structure location to record inventory and visual survey to assess the structural condition, including any damage by making use of well-structured inventory data format. Signs of distress such as spalling, cracking, leaching, inadequate cover, settlement, corrosion etc., will be captured. Condition survey assists in assessing the need and extent of structural maintenance, rehabilitation and replacement. The condition survey would also collect and interpret data on material of (Rock/Soil) and hydraulic efficiency which shall be used on firming up the GADs. *During condition survey of the CD structures, vegetation or other obstruction if any will be cleared and the condition data will be captured comprehensively so as to enable to develop appropriate improvement proposals.* Data format used for carrying out inventory and condition survey of culverts and bridges have been prepared as per IRC: SP-35-1990

"Guidelines for Inspection and Maintenance of Bridges" and are enclosed in Annexure. Various data to be collected during the inventory include:

- ✓ *Type of structure*
- ✓ *Dimensions*
 - *Total length*
 - *Carriageway width & overall width*
 - *Vent size*
 - *Height of deck from river or stream bed*
- ✓ *Type of superstructure*
- ✓ *Type of substructure*
- ✓ *Type of railing*
- ✓ *Type of bearings*
- ✓ *Materials used in construction*
- ✓ *Visual condition of*
 - *Superstructure*
 - *Substructure*
 - *Railing*
 - *Wearing coat*
 - *Drainage spouts*
 - *Expansion joints*
- ✓ *Condition of protection work*
- ✓ *Condition of vents at inlet, outlet and inside*
- ✓ *Types and conditions of walls (headwalls, wing walls and return walls)*
- ✓ *Information about HFL (from telltale marks, recorded markings and local enquiry)*
- ✓ *Channel characteristics.*

Other tests such as supplementary testing for bridges in distressed condition and evaluation of load bearing capacity may also be done as per relevant codal provisions and will be in line with the stipulations of RFP. All the data so captured will be presented in tabular form as per IRC-SP: 35-1990.

Visual observations carried out during the condition survey would be mainly to find out the distresses. In addition to the superstructures, the masonry substructures were inspected to locate cracks and loose mortar in joints, especially for pier and abutments.

The detailed report of inventory and condition survey will be presented in the form of tables (structure wise) for easy understanding as a part of detailed Feasibility/project report.

4.4.8 Test Pit investigation Surveys

Test pit investigation survey of the road sections in the entire road section will be carried out coinciding with the locations of BBD tests. Test pit investigation survey will be carried out at every km. Test pit investigation surveys will be assessed on new proposed alignment and also additional test pits based on heterogeneity of road section and investigations will be done as required. Testing will be done so as to match the location of one of the BBD test in that segment of the road section (Min 500 m interval).

For each section, test pits of 1.5 m x 1.5 m will be dug at pavement-shoulder interface up to 1.5 m depth (depth of up to 500mm below subgrade level is ensured). In-situ tests to determine field density such as Core Cutter test or sand replacement test depending upon the soil type will also be done. Soil samples will be collected and tested in laboratory for:

- ◇ *Field moisture content*
- ◇ *In-Situ density*
- ◇ *Classification tests*
- ◇ *Atterberg limits*
- ◇ *Compaction (heavy) test*
- ◇ *CBR on 4-day soaked samples*
- ◇ *Swelling index; and*
- ◇ *Other tests as per RFP*

Subgrade characteristics and strength parameters so determined are required in respect of:

- ◇ *Existing sub grade for designing reconstruction/new construction and for checking strengthening requirements of existing pavement by CBR method*
- ◇ *Prospective borrow material for use as subgrade in case of new alignment, bypasses, reconstruction and raising stretches, and of service roads*

Swelling index tests will also be performed on soil samples collected at subgrade level to assess the requirements of additional embankment layers below the subgrade layer. It is proposed to study carefully the swelling index values for sub grade soil samples having PI above 20 (which are considered to have medium to high/very high swelling potential). For all the prospective borrow soil for use in subgrade, laboratory tests on the same lines will be conducted for evaluating suitability and for determining design CBR. The test data will be analyzed and will be presented in tables.

4.4.9 Hydrology and drainage/hydrological investigations

The consultant will conduct and provide a complete description of the features of the area in order to verify the capacity of existing bridges and culverts and to determine high flood levels along the project road and also other features like drainage pattern, vegetation, and necessary hydrological data for storm water and sub-surface drainage. The hydrological investigations will be carried out in accordance with IRC: 5-1998 and IRC: SP-13-2004 keeping in view the stipulations of RFP and supplemented by other relevant information. Hydraulic calculations will be made to verify vent way dimensions and to develop improvement proposals incorporating type of crossing, drainage system, protection works etc.,

The available topographic maps of the influence area will be studied to demarcate broadly the catchment areas and to assess the run-off characteristics. Information on past floods and their effects on the existing road and bridges will be collected from records and interviewing the local officers and residents. Design flood levels and discharges will be established using this data and information.

The hydraulic and hydrological studies will be carried out to develop data on the drainage characteristics of the area, the design discharge of rivers, streams and other waterways, and the HFL will be used for the design deck level of bridges. The guidelines of "IRC: SP: 13-2004, Guidelines for Design of small Bridges and Culverts" will be adopted for discharge estimation.

On the basis of findings from the hydrological studies, design of bridges and culverts will be carried out. Design guidelines for new structures will be evolved, generally in accordance with the IRC/MORT&H standards and codes. Data available from the flood control department regarding the width of waterway and required clearance of existing bridges will be considered for fixing the span arrangements and for devising the construction method. The foundation system of the existing bridges will be studied to decide the provisions that are to be provided for structures on the widened portion of the alignment.

4.4.10 Geotechnical and Sub Soil Investigations

4.4.10.1 Alignment Soil Investigation

To understand the existing sub grade characteristics, pits are dug in the carriageway-shoulder interface to obtain the soil samples for carrying out in-situ and laboratory tests.

Large pits were excavated at 250 m interval to collect the following data:

- Pavement composition
- DCP-CBR of sub-grade

- Soil characteristics (type, grain size analysis, and Atterberg limits) of sub-grade
- FMC and FDD of sub-grade
- Modified Proctor densities
- Soaked & unsoaked lab CBR of sub-grade

4.4.10.2 Sub-Soil Investigation

Test pits and other investigation as detailed in task series will also be carried out at all the locations where new CD works are proposed. The Consultants will conduct sub surface investigations at all bridge and grade separator/interchange/ROB locations (new/reconstructed) as set out in RFP and relevant codal provisions. Staged programme will be suggested so as to take up the detailed investigations during phase 2. Borehole locations will be finalized based on length of the bridge as detailed in Table 4.1.

Table 4.1
Borehole Locations

Overall Length of Bridge	Bore Hole Locations
6 to 30m	At one abutment location
30 to 60m	At one abutment location and at least one intermediate location between abutments for structures having more than one span
More than 60m	At each abutment & Pier location

4.4.11 Materials Investigations

The project will require different type of construction materials, which include:

- ◇ *Soil for embankment, subgrade and shoulder*
- ◇ *Granular materials for sub-base, drainage layer and backfill*
- ◇ *Stone aggregates and sand for pavement courses and cement concrete*
- ◇ *Water for portability and use for construction specially in case of cement concrete*
- ◇ *Also Fly ash/Slag as replacement material*

For the proposed fill/ subgrade, sub base material all the tests as detailed Task will be conducted and for stone aggregates flakiness test, aggregate impact value test, soundness test and stripping test will be conducted to assess their suitability. The Consultants will collect information on availability and suitability of above materials from existing sources/approved quarries (utilizing the approved quarry chart as furnished by KPWD and in discussion with KPWD officials).

Further the prevailing market rates of construction materials such as sand, aggregates, Moorum, cement, Fly ash/Slag and steel will also be gathered through enquires at market places near the project road. Their quality, source and associated

leads (as derived from the lead charts based on approved quarries) will also be gathered.

The findings of material survey will be presented as a part of the Detailed Feasibility/Project report which will include tabulated laboratory test results on the sub grade soils at the various locations, quarry charts of the various quarry materials. Based on these investigations, the optimal haulage distances for the various materials will be determined and used in the analysis of rates for the work items.

It will be ensured that no material will be used from the right-of-way except by way of levelling the ground as required from the construction point of view, or for landscaping and planting of trees etc. or from the cutting of existing ground for obtaining the required formation levels.

4.5 TRAFFIC STUDIES & ANALYSIS

4.5.1 Study and Review of Available Past Traffic Data

Historical traffic data related to project road would be collected from the respective division/sub division office of the statistical unit of NHPWD/KPWD. The data so obtained will be reviewed for their consistency and to estimate the growth rates for use in traffic forecast.

4.5.2 Traffic Surveys

The Consultants will conduct primary traffic surveys (vehicular count) and other traffic studies at all the strategic locations in the project area in consultation with the client to establish the baseline data for traffic projections. Traffic surveys will be conducted as per IRC: SP-19-2001 and IRC: SP-41-1994. All the traffic data collection will be supervised by engineers of the consultant's team. Traffic survey will be conducted using videography or ATCC.

4.5.3 Origin and Destination Surveys

Origin-Destination (O-D) surveys would be conducted for passenger and freight vehicles at random sample basis in both directions by adopting roadside interview (RSI) method. These surveys would be conducted continuously for one day on a working day. Data regarding origin, destination, trip purpose, trip length, travel time for passenger vehicles and in addition commodity type, its value and load carried by goods vehicles would be obtained. Sample size will be as per SP: 19 to ensure that the data is statistically significant.

The O-D surveys would be conducted at selected locations, which will be finalised in discussion with client, in order to study the origin destination pattern of the traffic on

the project road. The locations will be so selected such that they also fulfil the objective of assessing the toll able traffic. *OD surveys will be conducted both on the project roads and on alternate roads as per provisions of RFP.*

Vehicles need to be stopped with the help of police. Assistance of the concerned authorities would be required by the Consultants to stop the vehicle for interview.

4.5.4 Axle Load Surveys

Axle load survey of freight vehicles will be conducted along the project road for 24 hours on random sample basis (minimum of 20%). VDF values will be computed adopting AASHTO equivalency factors and if VDF obtained is less than national average then national average will be adopted for pavement design.

4.5.5 Data Compilation and Analysis

Data collected from primary surveys will be compiled into a presentable form. The collected data will be analysed with respect to traffic volume to assess the peak hour traffic volume, composition, daily variations etc. To convert vehicular counts to equivalent passenger car units the PCU factors as indicated in IRC: 64-1990 – “Guidelines for Capacity of Roads in Rural Areas” will be adopted. The data will be computerised to identify hourly traffic flows and turning movements at intersections. The data so collected would be analysed to identify suitable remedial measures for handling traffic at intersections such as underpasses, flyovers and interchanges etc. Seasonal factor will be derived based on past traffic data/other proxy variables such as sale of petroleum/diesel or toll data to convert ADT in to AADT. Homogeneous sections will be established to assess the likely traffic loading on each of the sections. Travel pattern will be established by comprehensive traffic zoning system, which clearly depicts the influence area of the project road. O-D matrices for each vehicle type will be prepared. O-D data will be analysed to assess the potential toll able traffic and likely diversion on the existing alternate roads. Axle load survey data will be analysed adopting AASHTO equivalency factors to obtain VDF for use in pavement design. Willingness to pay survey data will be analysed to assess the extent of toll the user can pay for the improved facility. Speed and delay survey data will be analysed to assess the prevailing speeds, extent of delays – location and reasons so as to formulate appropriate relief measures. Past data of accidents along the project road is used to identify black spots and to develop improvement measures. This will also be an input to economic analysis.

4.5.6 Traffic Demand Estimate

Traffic demand estimates will be done as set out in RFP and establish possible traffic growth rates in respect of all categories of vehicles, taking into account the past

trends, annual population and real per capita growth rate, elasticity of transport demand in relation to income and estimated annual production increase. The other aspects including socio-economic development plans and the land use patterns of the region having impact on the traffic growth, the projections of vehicle manufacturing industry in the country, development plans for the other modes of transport, O-D and commodity movement behavior will also be taken into account while working out the traffic demand estimates.

The values of elasticity of transport demand will be based on the prevailing practices in the country. The complete background including references for selecting the value of transport demand elasticity will be provided.

The traffic demand estimates will be done for the period of 30 years. The demand estimates will be done assuming three scenarios, namely, optimistic, pessimistic and most likely traffic growth. The growth factors will be worked out for five-yearly intervals.

Traffic projections will be based on sound and proven forecasting techniques. The traffic projections may also bring out the possible impact of implementation of any competing facility in the near future. The demand estimates will also be take into account the freight and passenger traffic along the major corridors that may interconnect with the project. Impact of toll charges on the traffic estimates will be estimated.

The methodology for traffic demand estimates described in the preceding paragraphs is for normal traffic only. In addition to the estimates for normal traffic, the Consultants may also work out the estimates for generated, induced and diverted traffic. The traffic forecasts will also be made for both diverted and generated traffic.

Overall traffic forecast thus made will form the basis for the design of each pavement type and other facilities/ancillary works.

4.5.7 Toll Rate Surveys

Consultants will carry out Stated Preference surveys along the project road route to estimate the acceptable user fee levels for the different vehicle categories. The questionnaire will be used to record the response by trained staff will be properly structured so as to avoid ambiguities. The scenarios in the questionnaire will represent the current speed, vehicle operating costs (VOC) and travel time levels and the probable effect on them due to traffic growth for both "do-minimum" (i.e. no improvement and widening) and "with project" (i.e. improvement and widening implemented) cases. The findings of these surveys will be compared with the user fees being collected for the ongoing projects in the country. As the sample sizes for

these surveys are generally low as compared to other interviews, the sample will be selected judiciously.

The detailed toll analysis will be taken into account traffic diversion rates and willingness/ability to pay. The analysis may bring out an appropriate toll structure and the mechanisms for toll increases.

The analysis will be carried out with the user fee levels linked to various benefits to the users. The proposed methodology for data collection and analysis will be finalized in consultation with CLIENT.

4.6 DESIGN STANDARDS

Detailed design standards are essentially based on IRC/MORT&H guidelines and specifications, which will be reviewed before preparing detailed design. These are dealt separately in Chapter 3.

4.4.1 Preliminary Design

Based on the data collected during inventory and investigations and subsequent analysis, the consultants will prepare preliminary designs for:

- ◇ *Road widening and alignment readjustment – Geometric designs & typical cross sections;*
- ◇ *Pavement new construction/reconstruction/rehabilitation and strengthening – Pavement design (As per IRC:37-2012& IRC:58-2015)& Overlay design (As per IRC:81-1997);*
- ◇ *Shoulder treatment – Shoulder drainage;*
- ◇ *Structural/hydraulic rehabilitation/reconstruction – Plans and GADs;*
- ◇ *Interchange/Junction treatments – standard layout plans; and*
- ◇ *Provision of roadside facilities, bus stops, lay byes etc.,*

4.4.2 Options for Improvement of Roads

Based on the data collected during inventory and investigations and subsequent analysis, the consultants will develop preliminary designs and furnish the options for improvement of roads and drains kilometer wise. The various options for improvement along with the approximate cost (capital costs and maintenance costs) will also be estimated along with merits and demerits of each of the options and submitted as a part of detailed feasibility report to the client to enable in taking up decisions and selection of suitable option for detailed engineering designs. Further consultants will prepare preliminary strip maps, typical cross sections and design drawings for the final option.

4.4.3 Options for Improvement of Culverts and Bridges

Based on the data of culvert and bridges collected during inventory and subsequent in depth study and detailed site observations, the consultants furnish the options for improvement/replacement/rehabilitation of the culverts and bridges as appropriate. The various types of repairs required such as minor repairs/major repairs and maintenance required such as minor maintenance/major maintenance for each of the culverts and bridges along with the cost estimates will be prepared. The various options for improvement along with the approximate cost will also be estimated and submitted as a part of detailed feasibility report to the client to enable in taking up decisions and selection of suitable option for detailed engineering designs.

4.4.4 GTS

For survey of project road, reference points of Survey of India (Great Trigonometric Survey) will be considered for topographical alignment plan with various details and the data captured during surveys will be kept in GTS elevations.

4.4.5 Design Standards

The Consultant has evaluated the design standards proposed for recently completed / ongoing studies for the development of similar highways in India, and formulate the design standards for the project road, keeping in view the local requirements, IRC:SP:73-2018 and other relevant IRC standards, guidelines of the MORT&H and international practices.

4.4.6 Geometric Designs

Based on the design standards evolved and finalised, preliminary designs of horizontal and vertical alignment was made using MX Road software.

Horizontal Alignment: Horizontal alignment depends on the existing constraints on site and the widening proposals of the project roads. The Consultant designed the horizontal alignment based on the site conditions assessing the requirement of Eccentric/Concentric widening of the road. The horizontal alignment was designed in accordance with IRC Design Standards IRC:SP:73-2018 "*Manual of Specifications and Standards for Two Laning of Highways with paved shoulder*", IRC:73-1980 "*Geometric Design Standards for Rural (Non-Urban) Highways*", IRC:86-1983 "*Geometric Design Standards for Urban Roads in Plains*", and IRC:38-1988 "*Guidelines for Design of Horizontal Curves for Highways and Design Tables (First Revision)*", however the due considerations were given for constrained locations where safety enhancements were discussed in consultation with client officials.

Vertical Alignment: The vertical alignment was designed as per the provisions of the IRC:73-1980 "*Geometric Design Standards for Rural (Non-Urban) Highways*" and

IRC:SP:23-1983 "*Vertical Curves for Highways*" based on the proposed lane configurations finalised for each of the project roads. Vertical profile of undivided and divided carriageways was designed based on Sight distance in general and where possible to Intermediate Sight Distance (ISD).

On ground verification on the final design of the highway alignment was carried out. The Consultant made an effort to formulate possible typical cross-sections based on various land use/ terrain and constraint conditions along the project roads.

4.4.7 Design of Intersection Layouts

The nature, volume and intensity of projected traffic along the selected corridor were studied to devise efficient traffic management scheme. Data from the traffic surveys, such as volume count and estimated traffic dispersal characteristics at intersections will form the basis for designing necessary traffic dispersal layout plan for ensuring a smooth flow of traffic. Network connectivity of the project influence area was studied in depth and if alternate suitable route is available relevant intersections will be considered for closure.

In view of the likely interference of crossroad traffic to the main road and detailed improvement scheme was finalised based on the guidelines of IRC: SP: 41-1994 "*Guidelines on Design of At-Grade Intersections in Rural & Urban Areas*". Maximum efforts will be made to segregate the slow moving traffic from the main carriageway traffic.

4.4.8 Pavement

4.4.12.1 Design of Pavement

Pavement is a very critical component for the project highway. The requirements of pavement design was analysed in depth taking into account relevant design parameters, such as traffic projection, design cumulative Equivalent Standard Axle, materials characteristics and the climatic conditions.

The cumulative Equivalent Standard Axle was made available from the traffic forecast model. An appropriate fixed value for the ultimate design life and the progression of Equivalent Standard Axle values for different vehicle categories was established for the project road. Vehicle damage factors were available from the axle load survey

Both rigid and flexible pavement options were exercised. Life cycle cost analysis was carried out in order to decide the most viable option. Rigid pavement was designed as per the provisions contained in "IRC: 37-2012, Design of Flexible Pavement".

4.4.12.2 Drainage and Protection Works

The drainage requirements for the project roads and adjoining areas were assessed through the Digital Terrain Model (DTM) prepared using topographic survey data. Pavement internal and external drainage were ensured by providing drainage layer

and camber respectively. Longitudinal slopes in roadside ditches and central drain were proposed ensuring generation of self-cleansing velocity at the time of storm. Catchment analysis using Rational Method/project specific unit hydrograph has to be undertaken for the hydraulic design of the drain channel. The shape of the channels will be fixed to facilitate easy and economical construction and easy maintenance. Suitable drainage system was planned for the super-elevated carriageway and other key areas, with a view to ensuring easy collection and disposal of storm water. A network will be conceptualised from runoff till final disposal and its continuity was ensured at each critical point.

River protection works where required to safeguard the cross drainage structures was designed based on the provisions contained in IRC:89-1997 "*Guidelines for Design & Construction of River Training & Control works for Road Bridges*".

4.4.12.3 Design of Bridges and Cross Drainage Structures

The alternatives for the structural system, span arrangements, form of the superstructure, foundation system etc. was explored keeping in view the aesthetic and environmental requirements, functionality, physical and sub-soil conditions. The foundation system for the existing bridges on or in the vicinity of the project road was studied while deciding the requirements for the new facilities.

The proposals for new major and minor bridges will be based on the following considerations in 2-lane:

- The deck width will be 16 m for new bridge of 2-lane in 2-lane section.
- Footpath / Safety Kerb with crash barriers will be provided on both sides for all new 2-lane bridge in 2-lane section.
- The retained bridges will be widened wherever required and wherever feasible based on the type of superstructure, substructure and foundation to match with proposed 16m width.
- Piers and abutments of the new bridge will be in line with those of old structure. In the case larger span lengths are adopted, the foundations will be in line with that of old bridge with alternate foundations omitted.
- Aesthetic considerations to suit the surroundings were taken care of while designing the structure. To improve the riding quality suitable larger span lengths will be proposed in place of small span lengths to reduce the number of expansion joints, wherever it is found feasible.

Structural design was carried out using STAAD/MIDAS software and in-house developed design sheets, and drawings were prepared with adequate detailing to ensure the completeness of the design. The provisions contained in relevant IS/ IRC codes are followed while selecting design parameters and drawing details. Emphasis was given to maximize the usage of locally available construction material.

All functional culverts were extended to have widths equal to the road formation. Proper jointing arrangement was developed for the extension of culverts. All new culverts were box type. Buried / malfunction culverts were to be replaced with box culverts after adjudging the disposal locations.

4.4.12.4 Miscellaneous Designs

Safety and uninterrupted traffic flow are of special importance in urban sections of the project road, and these were considered in providing road furniture and appurtenances as indicated below.

- Traffic signs and road markings
- Safety barriers viz. delineators, guard rails, guard posts, crash barrier etc.
- Drain, median kerbs
- Roadside facilities viz. lay-byes
- Locating cross utility ducts in built up and agricultural areas
- Other road furniture, such as pedestrian guard rail, metal beam crash barrier etc.

4.7 LAND ACQUISITION, UTILITY & RESETTLEMENT PLAN

4.7.1 Land acquisition & Resettlement plan

Based on the finalized layout plan, land acquisition plans will be prepared by overlaying the recommended ROW on the revenue maps along the alignment. All lands required for project works will be clearly marked on revenue survey maps with survey numbers, part numbers, structure details, khata holder etc., so as to enable easy and timely land acquisition.

The consultant will prepare Resettlement and Rehabilitation Plan and assess feasibility and effectiveness of income restoration strategies and suitability and availability to relocation sites.

4.7.2 Utility Details

All details of utility lines will be captured as detailed in topographical survey and preliminary plan will be prepared showing shifting and relocations of existing utility services after discussion with the client and the concerned agencies. For each utility application on behalf of department in relevant forms with shifting fee will be filed with relevant authorities/local offices.

Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground) and the scheme for their relocation, trees to be felled : reports documents and drawings arrangement of estimates for

cutting of trees and shifting of utilities from the concerned department will be prepared;

4.8 ENVIRONMENT SCREENING, SOCIAL IMPACT ASSESSMENT & RESETTLEMENT ACTION PLAN

4.8.1 Environmental screening

The consultant will undertake the detailed environmental and social impact assessment in accordance with the standard set by the Government of India for projects proposed to be funded by CLIENT.

Environment impact assessment or initial environment examination will be carried out in accordance with RFP (ADB's Environmental Assessment Requirements of ADB 1998 guidelines for selected infrastructure projects 1993 as amended from time to time / World Bank Guidelines / Government of India Guidelines, as applicable).

EIA Study has been carried out based on the guidelines prescribed by MoEF for Environmental Impact Assessment. Consultant has collected available data, reports and published information from secondary sources that are relevant to understanding the baseline as pertaining to physical and biological environments in the Study Area of the road corridor. The data and documents of major interest included, but not limited to, the following:

- Survey of India (SOI) maps
 - District planning series maps
 - Climate data
 - Census data
 - Information on Environmental setting
 - Social baseline of the road corridor
 - Other studies carried out in the area for other projects implemented or proposed
- Baseline environmental and social conditions in the project region has been studied based on available secondary data/reports collected from the respective State and Central Government Departments and other organisations in the region. To establish the terrestrial environmental status, available data for following environmental attributes has been collected, reviewed and presented based on the availability of data:
- Meteorology
 - Ambient air quality
 - Noise levels
 - Surface and ground water quality
 - Soil quality

- Ecology

4.8.2 Social Impact assessment

Base line socio-economic and census survey will be conducted to assess the impacts on the people, properties and loss of livelihood. The socio-economic survey will establish the benchmark for monitoring of R&R activities.

A social assessment is conducted for the entire project to identify mechanisms to improve project designs to meet the needs of different stakeholders.

4.8.2.1 Social Surveys for Land Acquisition & Socio-economic profile

Proposed corridor widening/improvement project will most likely involve extensive social impact surveys and investigations. Consultant will carry out the surveys at the project corridor site. Social survey will be conducted in the project corridor to understand the existing scenario of the Project Influence Area (PIA).

Socio-economic profile of the project area will be established based on review of secondary data during the preliminary screening stage and subsequently by conducting primary surveys during detailed assessment stage.

To establish the Socio-economic profile using secondary data, following data shall be reviewed:

- Regional profile – population characteristics, etc.
- Demographic features of the people in the area

Subsequently, primary social impact assessment/socio-economic survey shall be carried out along the project corridor. The resettlement plan which accounts for land acquisition and resettlement impacts would be based on a 25% socio-economic survey and 100% census survey of project affected people which provide the complete assessment of the number of affected households and persons, including common property resources.

Various details to be assessed will include:

- Scope for land acquisition
- Identifying vulnerable, BPL, indigenous people, women, child labour etc.
- Number and categorisation of existing structures (Pucca, semi Pucca and Kutcha buildings)
- Identifying the common Property Resources (CPRs)
- Details of title holders, and non-titleholders such as tenants, encroachers, squatters
- Impacted SC/ST population
- Demographic features of the people in the area

- Existing commercial establishments
- Public property resources including religious and cultural properties, etc.
- Approximate market value of the land
- Perception of the people about the project and expected compensations
- Possible rehabilitation sites available in the vicinity, etc.

4.8.2.2 Stakeholder Identification and Consultations

The social impact assessment team will identify and list the project stake holders. This list will include institutional stake holders, community stake holders and others. The stake holder consultations will be a continuing process throughout the course of the study. Consultations shall be carried which will include Informal/Community Consultations, Formal and Institutional Consultations.

4.8.2.3 Identifying of Social Impact Assessment

Social impacts will be identified and assessed on the affected persons in the area, based on the social surveys and social impact assessment studies. Adverse direct/indirect social impacts which are likely to be impacted:

- Land
 - Indigenous people
 - Structures
 - Livelihood
 - Crops/trees
 - Access to community infrastructure/public utility lines
- Once the direct/indirect impacts have been estimated, mitigation measures as per the approved policies and costs thereof can be planned.

4.8.2.4 Resettlement Action Plan

Consultant will identify the Project Affected People (PAP) and accordingly prepare a Resettlement Action Plan, based on the current Government of India Land Acquisition and Resettlement and Rehabilitation policies as well as the applicable Social Safeguard Policies.

On the basis of the census and social surveys, Resettlement and Rehabilitation Plan will be prepared assessing the feasibility and effectiveness of income restoration strategies and suitability and availability to relocation sites. Once direct impacts have been estimated, mitigation measures as per approved policies and costs thereof can be planned. Based on identified impacts the “**Entitlement Matrix**” for the project affected people will be developed.

Patterns in previous assessments guide this analysis, and expert judgment and field investigations will be used to see whether the study case follows the typical patterns or is it developing uniquely. Being able to show potentially affected people that

significant impacts are being incorporated into the assessment is critical to the success of this process.

4.9 Rate Analysis and Cost Estimates

Construction activities will be abstracted by the respective engineering specialists including the land acquisition cost, maintenance cost, rehabilitation and resettlement and accommodation works, cost estimates for each item based on the prevailing market rates in the State based on the MORTH's standard data book. Andhra Pradesh Schedule of Rate is used for the item wise rate analysis.

Based on the preliminary land acquisition plans, utility relocation plans and cost of land, Land acquisition report is prepared.

4.9 FINANCIAL/ECONOMIC VIABILITY

4.9.1 Construction Cost Estimates

The Consultants will prepare preliminary estimates of quantities with an accuracy of +/- 10% of the works using latest NH rates applicable to Karnataka state considering actual lead distances for materials. Provision will be made in the estimate for unforeseen contingencies and project management consultant's fee.

4.9.2 Financial Analysis/Economic Costs

The detailed study of the financial viability of the project under a commercial format and under different user fee scenarios and funding options will be taken up. The Consultants will submit and finalize in consultation with the client the format for the analysis and the primary parameters and scenarios that should be taken into account while carrying out the commercial analysis. The Financial analysis for the project will cover financial internal rate of return, projected income statements, balance sheets and fund flow statements and may bring out all relevant assumptions. The sensitivity analysis will be carried out for a number of probabilistic scenarios.

The financial analysis would cover identification, assessment, and mitigating measures for all risks associated with the project. The analysis will cover, but be not limited to, risks related to construction delays, construction costs overrun, traffic volume, revenue shortfalls, operating costs, exchange rate variations, convertibility of foreign exchange, interest rate volatility, non-compliance or default by contractors, political risks and force majeure.

The consultant will identify current road user and road maintenance costs using highway investment model such as HDM-4 or IRC:SP-30 and will produce valid current estimates of such costs (VOC, VOT – RUC) for the project road in its present

and improved state. The various inputs such as vehicle characteristics, road characteristics, pavement characteristics, traffic characteristics, maintenance strategies and all associated costs, etc., will be input to the model and these input values will be based on actual investigations/enquires/designs finalized.

Financial viability analysis helps to identify whether an investment is justified or not. In other words, it helps to assess whether the project can function on standalone basis along with providing adequate returns to various stakeholders of such investments.

The viability study starts with preparing a month-wise expenditure curve based on the Block cost estimates. Here the expenditures that will be incurred for each month during the project construction period will be matched with the source of funds. Keeping in the mind, that the project shall be developed through PPP, Equity and Debt components will be considered as the main source of funds for the project. However, the said capital structure may be modified, if required, by including capital grant, interest free debt instruments etc so as to improve the overall viability of the project. The cost of debt component and the extent of financial leveraging possible for the project shall be considered based on prevailing market conditions. Once the monthly expenditure curve on Block cost components are charted out, the funding cost debt viz., cost on debt raising cost, interest during construction will be capitalized along with provision for contingencies, cost for project management consultancy, pre-operative expenditures and preliminary expenditures for deriving the project landing cost.

Various mode of execution of the project development will be studied. BOT mode of project development will be studied and if it found that the BOT mode is not viable, other modes viz., JV / SPV with Government of Andhra Pradesh, Grant from Government of Andhra Pradesh / Government of India, Annuity mode and EPC format will be explored by the consultant in consultation with the Roads & Buildings, NH wing, Government of Andhra Pradesh.

Similarly, the operating expenses including the repairs and routine maintenance, staff cost, collection cost, administrative expenses etc. incurred during the operation of the business will be estimated and projected for a period of 30 years. These expenses will be compared against the overall revenue generated by the project to derive net revenue for the project.

Financial viability assessment shall be carried out so as to assess project's return by using IRRs, NPVs and Pay back method. Further to this, Debt service Coverage Ratio (DSCR) and Average Debt Service Coverage Ratio (ADSCR) will be assessed to verify the debt repayment ability of the project.

The financial viability study would be touching the following areas:

- Estimating Project landing Cost in line with development schedule
- Estimating project revenues by assessing vehicular profile, traffic growth, considered toll rates and revenues from commercial development
- Estimating routine maintenance
- Estimating operating expenses
- Projecting cash flow considering project construction period, operation period and funding mix
- Assessing financial viability with a horizon of 30 year period with IRR, NPV, Pay Back period and Debt service coverage ratio
- Sensitivity analysis based on; delay in construction period, construction cost overruns, traffic volume, revenue shortfalls, operating costs and interest rate volatility.

The viability study will be carried out through a tailor made financial model prepared using MS Excel. The financial model will carry provisions for statutory compliance in terms of depreciation – both Income Tax Act and Companies Act along with the assumptions on economic environment.

4.9.3 Economic Benefits

The economic benefits will be expressed in terms of:

- ◇ *Savings in vehicle operating cost*
- ◇ *Savings in road expenditure*
- ◇ *Savings in time cost*
- ◇ *Savings in reduction in accident cost*

The consultant will undertake evaluation of the economic viability of the project for twenty years following the completion of the rehabilitation of the project road. The economic costs of construction to the design standards proposed will be compared with the relevant level of economic user benefits arising from implementation of the project at that design level.

The economic viability will be expressed in terms of the economic internal rate of return and the net present value at a discount rate of 10%. The analysis in terms of first year rate of return will be given to indicate optimum year of rehabilitation and opening of the road. Sensitivity analysis on the results of final option will be made by varying the key variables such as construction cost and benefits by +/- 15% or other level as finalized with the client.

The Economic analysis will account ongoing, proposed road and transport infrastructure projects and future development plans in the project areas. The benefits and cost streams are worked out for the project using HDM – IV. The economic analysis will cover mainly the following aspects:

- Assessing the capacity of existing roads and the effects of capacity constraints on Vehicle Operating Costs (VOC)
- Estimation of VOCs for the existing road situation
- Estimation of quantity Economic benefits: Quantity of Economic benefits will be estimated considering various parameters such as reduced congestion, travel distance, road maintenance cost savings and reduced incidence of road accidents.
- Estimation of the Economical Internal Rate of Return (EIRR) for roads over 15 year period.
- Savings in time.

EIRR and Net Present Value (NPV) will be worked out “with” and “without time and accident savings”. Sensitivity Analysis will be carried out to examine the effect on economic viability of the project due to change in the level of the key input factors, including construction cost, variation in traffic etc., Sensitivity of EIRR and NPV will be worked out for different scenarios.

4.10 Technical Specifications & Bid Documents

The Consultant prepared detailed technical specifications for the items, which are not covered under the MoRT&H specifications, and also specify quality control norms for the construction works. The specifications given in MoRT&H specifications (Fifth Edition) are modified as per the project specific needs. All specifications are made consistent to drawings, cost estimates and with respect to each other.

The bid documents are based on the standard form of bidding documents being issued by the National Highways Authority of India for EPC modes of procurement, Standard Civil works. In order to have consistency among all the packages, standardisation of bid documents for all packages are formulated and used across all the EPC contracts. The documents comprises of pre-qualification document, instruction set to bidders, draft concession agreement, project schedules.

CHAPTER 5 SOCIO - ECONOMIC PROFILE

5.1 Introduction

Socio-economic profile provides an overview of Karnataka's socio-economic set up and the relative status of the area in which the project lies. The primary purpose of such a profile is to provide the basic inputs for estimating future traffic growth rates. This Chapter provides information on population, economic activities and discusses its economic perspective, giving emphasis to those sectors of economy, which contribute to traffic generation.

The state of Karnataka has the credit of being the economic powerhouse of India, contributing significantly towards the Indian economy. It provides a linkage between the Northern and Southern states of India. It also leads in the IT sector, accounts for country's productive capital, generates employment in IT sector, and attracts both domestic and foreign direct investments. Karnataka attracts very large number of tourist traffic mainly because of various world famous tourist places located in Karnataka.

5.2 Socio-Economic Profile

Socio-economic studies, comprising demographic aspects, macroeconomic indicators and main economic sectors provide an overview of the socio-economic setup of the Karnataka state and the relative position of the project area districts within the state. The analysis forms the basic input for estimating future traffic growth rates.

Analysis of traffic movement on project road (OD surveys) indicates that traffic flow is mainly influenced by the Karnataka state. Thus, the state of Karnataka forms the broad influence area. Growth of traffic on the project road depends on existing development and future prospects of the connecting regions.

Kalaburagi is a district in Karnataka, India and the district headquarters is Kalaburagi. As of Census 2011, Kalaburagi Has a population of 5,33,587.

5.2.1 Demographic Features

Following Table gives comparative picture of the various socio-economic indicators for the Project Area (Villages in which the project road stretches over) with Project Districts and the State

**Table 5.1:
Demographic Profile at a Glance**

Sl No	Particulars	Karnataka	Kalaburagi	Chincholi
1	Population	52850562	2566326	254287
2	Sex Ratio	965	971	991
3	SC Population	8563930	648,82	91280
4	ST Population	3463986	65,259	9601
5	Literacy Rate (%)	57.58	64.85	60.07
6	Main Workers	19364759	844237	95017
7	Marginal Workers	4170032	242791	26080
8	Non Workers	29315771	1479298	133190
9	Cultivators	6186932	207305	25616
10	Agricultural Workers	3783852	284917	46107
11	Household Industry	795212	16347	1149
12	Other workers	8598763	1335668	22145

The population of the project area is only 4.8% of State's population. The literacy rate is comparatively high in Kalaburagi District area (64.85%) while the Project Area is having a lesser percentage of literates (60.07%).

The detailed demographic particulars are provided in the following tables. (Table 5.2 to Table 5.4)

**Table 5.2
Demographic Profile at a Glance**

Project Affected State / Districts/Project Area	Population		
	Male	Female	Total
Karnataka	26898918 (50.90)	25951644 (49.10)	52850562
Kalaburagi	1301755 (50.72)	1264571 (49.28)	2566326
Chincholi	127748 (50.23)	126539 (49.77)	254287

**Table 5.3
Population Density**

Sl. No.	Project Affected State / Districts	2011
1	Karnataka	275
2	Kalaburagi	234

**Table 5.4
Decadal Growth Rate of Population in the State/Districts**

State/Union territory/District	Decadal growth rate	
	1981-1991	1991-2001
Karnataka	21.12	17.25
Kalaburagi	NA	NA

5.2.2 State Income: Net State Domestic Product (NSDP)

The rate of change in Net State Domestic Product NSDP at constant prices is the main economic indicator for measuring the real growth in the economy.

The NSDP of Karnataka (at constant 2010-11 prices) is estimated at Rs.8, 48,692 Crores for 2017-18 having grown from, Rs. 7, 82,018 Crores in 2016-07 showing growth of 8.5 percent.

Per capita Income is a crude measure of human welfare in terms of consumption of goods and services. Per Capita State Income (i.e. per capita NSDP) of Karnataka at current prices is estimated at Rs.1, 74,551 during 2017-18 as against Rs.1, 57,436 in 2016-17 with an increase of 10.9%. The Per Capita National Income is expected to reach Rs.1, 11,782 during 2017-18 from Rs.1, 03,870 during 2016-17 with an increase of 8.3%. The level of per capita State income at constant (2011-12) prices for the year 2017-18 is estimated to reach Rs.1,29,362 as compared to Rs.1,20,496 achieved in 2016-17.

5.3 Main Economic Sectors

5.3.1 Agriculture

In Karnataka, the majority of the population (about 70 percent) depends on agriculture as the main source of livelihood. It contributes to about 15.36 percent to the NSDP in 2016-17. The areas covered under Kharif crop in Karnataka amounts to 67.19 Lakh hectares, Rabi crop amounts to 31.08 lakh hectares and summer crop amounts to 5.15 Lakh hectares (2016-17). On account of timely and widespread rainfall in major parts of the State, except during August in some parts and excess rainfall during June/July, good summer sowing would be taken up fully in targeted area in view of adequate water storage in major and minor irrigation reservoirs of the State during 2016-17. As such, the food grain production is likely to be 99.99 lakh tonnes against target of kh 107.65 tonnes.

5.3.2 Industry

Karnataka has been spearheading the growth of Indian industry, particularly in terms of high-technology industries in the areas of electrical and electronics, information & communication technology (ICT), biotechnology and, more recently, nanotechnology. The industrial structure of Karnataka presents a blend of modern high-tech capital goods and knowledge intensive industries on the one hand and traditional consumer goods industries on the other. Bangalore the capital of Karnataka has the credit of being rated as one among the top Ten Hi-tech cities of the world.

The overall organized industrial sector of Karnataka has registered 1.42% growth in 2016-17 as compared to 2015-16. Within the organized industrial sector, Mining sector shows the highest growth of 12.59% followed by the manufacturing sector 2.47% and Electricity sector registered negative growth of 7.96%. As a result of this moderate growth was observed.

Karnataka was one of the first states to announce its IT policy in 1997. This was an important catalyst for the growth of IT industry in the state. Karnataka has emerged as and continues to be the most preferred destination for all global information technology (IT) and biotechnology (BT) industries domestically, due to numerous favourable factors such as a Pro-active Government, Talent pool of highly trained professionals, Investor friendly opportunities, Industry friendly Labour Laws, Salubrious Climate, Absence of Natural Calamities and a cosmopolitan social life in the cities particularly in Bangalore. Under the State's IT policy, several infrastructure facilities are proposed in Mysore, Hubli, Manipal & Mangalore apart from Bangalore to help the development of IT industry. The setting up of IT industries under this policy is with an objective of earning valuable foreign exchange through software exports. The industry contributes to over 25% of the State's GSDP.

Information technology (IT) sector in Karnataka has emerged as one of the main growth drivers of Karnataka's economy. Information Technology activity in Karnataka is largely concentrated in Bangalore. In recent years, other parts of Karnataka have also seen a growth in IT related activities. Karnataka is home to over 3500 IT companies, contributing to over 32 billion USD (Rs. 2.20 lakh crore) of exports, giving direct employment to over 10 lakh professional and creating over 30 lakhs indirect jobs. The industry contributes to over 25% of the State's GSDP. The share of Karnataka in IT exports is nearly 38% of the country's exports.

Karnataka is the first State to roll out multi sector start up policy in 2015-2020 in the country aiming towards a globally competitive start up eco system. The objective is to set-up 20,000 technology Start-ups by 2020. Bengaluru is now also known as the Startup Capital of India and it is reported that nearly 30% of the start-ups are from Bengaluru.

Karnataka has played a key role in India's emergence as a significant player in the global biotechnology industry. There are over 950 plus biotech units in the country out of which 380 companies and about 194 biotech start-ups are in Karnataka. This number continues to grow with most of the well-known companies continuing to choose Karnataka for their operations. The biotech export revenues contribution of Karnataka is Rs.33351 crore (USD 4.91 bn.). Karnataka has put in place a strong policy framework to provide all requisite resources for enhancing this industry's research and development capabilities.

5.3.3 *Export performance of Karnataka*

Karnataka has carved out a niche for itself in the global market as the knowledge and technology capital of the Country. Karnataka apart from coffee, spices, silk, cashew nuts, handicrafts and agarbathies is also exporting electronic and computer software, engineering goods, readymade garments, petrochemicals, gems and jewellery, agro and food processing products, chemicals, minerals and ores, marine products, etc. Karnataka accounts for more than one third of electronics and computer software exports from the country. It is also a leader in exports of readymade garments, gems and jewellery, petrochemicals and engineering commodities from Southern Region.

Karnataka ranks 1st in software/service exports and stands 4th in merchandise exports in the national export basket. Karnataka's exports amounted to about Rs. 548890 crore in 2016-17 which constituted about 18.78% of the Country's exports in that year. The share of merchandise exports in the National exports constitutes around 7.10% and software / service exports around 39% for the year 2016-17. The other commodities which have substantial share in Karnataka's exports in 2016-17 are engineering (62%), cashew (40%), basic chemicals, pharmaceuticals and cosmetics (19%). Plastic (14%), Iron and ore (13%).

5.3.4 *Mining*

Karnataka State is abundant in mineral resources which cover an area of 1.92 lakh sq.km. The state is having valuable minerals deposit such as iron ore and manganese in Bellary, Chitradurga, Tumkur, Uttara Kannada and Chikkamangaluru districts. Besides these ores, chromium (chromite) deposits in Hassan and Mysore districts, Aluminium (Bauxite) reserves in Belgaum, copper (malachite) reserves in Hassan, Chitra Durga and Raichur are also found.

During the year 2017-18, up to November 2017 the Department of Mines and Geology has not granted any mining lease, where as in previous year department has granted 2 mining leases for Limestone one at Bagalakote district to an extent of 8.10 hectares and another at Belagavi district to an extent of 798.10 hectares. In Ballari district I Iron ore mining lease is granted to an extent of 38.70 hectares.

In 2017-18, upto November 2017 the Department of Mines and Geology has granted 180 Quarry leases for Building Stone and other minor minerals. For Ornamental Granite 11 Quarry leases were granted. Where as in previous year 244 Quarry leases for Building Stone and other minor minerals, for Ornamental Granite 11 Quarry leases were granted.

The Department of Mines and Geology has realized revenues of Rs.1293.14 crores

as against the target of Rs.1707.43 crores upto November 2017 and as against the annual target of Rs.2667.86 crores for the year 2017- 18. Details of royalty collections from 2013-14 to 2017-18 (upto November 2017) are provided Table 5.6.

Table 5.5
Royalty collected by Dept of Mines and Geology, Karnataka

Year	Target	Achievement (Rs. Crore)
2013-14	1412	1367
2014-15	1750	1795
2015-16	2048	1847
2016-17	2411	2185
2017-18	2668	1293

5.3.5 Transport

Road transport plays a vital role in the economic and social development of the state.

Roads

As on 2016-17, Karnataka has a good network of roads with a total length of 2,61,967 Kms. Twenty seven National Highways pass through the state and have a length of 6,572 km. State Highways cover 19,578 km while Major District roads account for 49,909 km, rural roads account for 1,77,542 kms and Municipal Roads & Other Roads accounts for 8366 Kms.

Road Transport

The total number of motor vehicles in the state went up from 1.47 Crore in 2014-2015 to 1.89 Crores during 2017 (upto Nov).

Railways

The efficient railway network accounts for a large share in movement of bulk cargo as coal, iron, ore etc., as well as finished products. At present, the railway route length in the state spans 3281 km. In the entire state there are 367 railway stations.

Airports

The country's fifth Green field airport, Kempegowda International Airport at Bangalore has been developed at Devanahalli at a cost of Rs. 2470 crore as a passenger and cargo hub under PPP model. This airport commenced its commercial operation in May 2008, by handling 9.8 million passengers per year. It handled over 25.04 million passengers in calendar year 2017 with over 600 aircraft movements a

day. The airport also handled about 314,060 tonnes (346,190 short tons) of cargo. The airport consists of a single runway and passenger terminal, which handles both domestic and international operations. A second runway is being constructed and is expected to be operational by September 2019 while a second terminal is in the early stages of construction. In addition, there is a cargo village and three cargo terminals. Airside infrastructure is also being further strengthened to cater to increased number of Aircraft movements. Kempegowda International Airport, one of the few profitable Indian airport operators, had reported a profit of Rs 104 crore on revenue of Rs 628 crore for the year ended March 2013.

Government of Karnataka has awarded to M/s. Jupiter Aviation and Logistics Limited (JAL), on Design, Build, Operate and Transfer (DBOT) basis to establish a "Green-field Airport" at Hassan near Bhuvanahalli on Public-Private-Partnership. Similarly the works for development of airports at Shimoga and Gulbarga has also been awarded and airport construction at Gulbarga is in progress.

The existing airport at Mysore has been operationalized. However, few flights are being operated from this airport for commercial reasons. In Bellary, the Government is developing a new airport on PPP basis.

The existing airport at Hubli is being upgraded to International standards. At Mangalore airport, the second runway and new terminal building complex have been constructed. Minor airports at Shimoga, Gulbarga, Bijapur and Hassan are being developed on PPP basis through private operators.

5.3.6 *Tourism*

The state of Karnataka, tourist's paradise, is famous for its natural scenic beauty, fascinating flora and fauna, varied wildlife, rich history, vivid culture, majestic architecture, artistic temples, masterpieces of architectural excellence. Karnataka attracts very large volume of tourist traffic mainly because of world famous tourist places such as Mysore (Palace, Brindavan gardens, SR Patna-Tippu Sulthan palace, Bird sanctuary etc.), Golgumbaz (Bijapur), Belur, Halebeedu, Shravanabelagola, cave temples at Badami and Aihole, world heritage sites at Hampi and Pattadakal, National parks (Bannerghatta – Bangalore & Bandipur), wild life sanctuaries (Bandipur, Bhadra, Nagarhole, Dhandeli & Ghataprabha), Hill stations (Nandi hills, Kemmanugundi & Madikeri), water falls (Jog falls – highest water falls in Asia, Abbey falls & Sivanasamudra), 320 km long coastline dotted with unspoiled beaches, Beaches (Gokarna, Udupi, Mangalore & Karwar) and dam cum picnic spots (TB dam, Ghattaprabha dam & KRS dam). Several famous temples at Dharamasthala, Kollur, Sirsi, Mysore, Bangalore, Gokarna, Karkala, Moodabidri, Sringeri, Udupi etc., attract very large number of pilgrimages. Bangalore has its own cosmopolitan culture retaining traditional and cultural facets of the state and

attracts very large number of tourists from all over the world. Salubrious climate, peaceful environment, rich culture and heritage of Karnataka coupled with good infrastructural facilities attract people from all parts of the world.

Department of Tourism (DoT) and Karnataka State Tourism Development Corporation (KSTDC) is actively promoting tourism in the state and has high rate of patronisation from people of Karnataka and other states of the country apart from the continued patronisation of foreign tourists. Considerable infrastructure in terms of lodges/rest places, cottages, restaurants etc., has been developed by DoT/KSTDC at most of the tourist locations.

Karnataka provides a destination extraordinary for all kinds of tourists, for all tastes and preferences. The details of tourist arrival in Karnataka are presented in Table 2.2 and the tourist flow in to the State has continuously increased from 3.67 Crore in 2006 to 10.23 Crore in November 2017. Karnataka Tourism has been conferred with 3rd place for the Best State/ UT under Comprehensive Development of Tourism category by Ministry of Tourism, Govt. of India.

5.3.7 Economic Performance of Karnataka

The time series data of state income at constant (2004-05) prices for NSDP (by industry of origin) of PIA state of Karnataka and PIA district has been studied to assess the past performance of influencing state economy.

In recent years, Karnataka has emerged as the leader among Indian states in terms of its macroeconomic fundamentals. It is now the fastest growing state in the Indian economy. With a favourable investment climate, it has also become one of the favourite destinations for foreign direct investments (FDI) in the country.

Karnataka, which has traditionally been one of the growth leaders in the country, has fallen behind in 2007-08. It has registered a lower rate of growth in its gross state domestic product (GSDP) compared to the national average. During the 10th five year plan, the performance of the state's economy in terms of real growth has lagged marginally compared to the growth rate at the all India level. The annual average growth in overall GSDP of Karnataka during the 10th plan period was 7.2 percent against all India average of 7.8 percent. The average growth in agriculture (including forestry and fishing) was 1.1 percent against all India average of 2.5 percent. The poor rainfall in the state during the first two years of 10th plan has pulled down the state's economy in this sector and the average growth of state in industry and service sectors was 9.3 and 8.9 percent respectively against 9.2 and 9.4 percent at all India level.

Karnataka has made notable progress in all sectors during the course of the 11th

Five Year Plan. As far as overall growth is concerned, the increase in State Income has been satisfactory in spite of the global slowdown in recent years. The increase in State Gross Domestic Product was 7.2% during the 11th five year plan. The agricultural sector has particularly performed well by achieving a growth of 5.1% during the 11th plan. The major factor for the slow growth in the industrial sector was the global slowdown witnessed since the beginning of 2008. Due to an uncertain and challenging macroeconomic situation globally and nationally, and the widespread drought situation in the State, the economy could not grow at the pace as planned during 11th five year plan. However, the Government is optimistic about the 12th Five Year Plan, during which the State Government intends to consolidate the strategies and achievements made so far by intensifying governance reforms, ensuring effective targeting of subsidies and better monitoring, and instituting a process of informed decision making through independent evaluation.

The NSDP and its sector wise share for Karnataka state are detailed in Table 5.7.

Table 5.6
Net State Domestic Product (Rs. in million at 2004-05 prices) and Sector Wise Share for
Karnataka State

Sector and Share	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
Primary	305950	334430	323540	368880	373660	384810	441990	404950	408980	451310	471650
Share in SDP	20.57%	20.39%	17.87%	18.10%	17.12%	17.62%	18.35%	16.33%	15.65%	16.09%	15.67%
Secondary	391300	419010	505940	550240	577910	549880	608580	624400	603280	652380	683730
Share in SDP	26.31%	25.54%	27.94%	27.00%	26.47%	25.18%	25.27%	25.17%	23.09%	23.25%	22.71%
Tertiary	790040	886870	981380	1118980	1231520	1248940	1357600	1451060	1600240	1701920	1855330
Share in SDP	53.12%	54.07%	54.19%	54.90%	56.41%	57.20%	56.37%	58.50%	61.25%	60.66%	61.62%
NSDP	1487290	1640310	1810860	2038100	2183090	2183630	2408170	2480410	2612500	2805610	3010710
PCI	26882	29295	31967	35574	37687	37294	40699	41492	43266	46012	48907

Net State Domestic Project (NSDP) of Karnataka (at 2004-05 prices), in 2014-15 was Rs. 3010710 million having increased from Rs. 1487290 million in 2004-05, registering an average annual growth rate of 7.37 percent.

The share of the tertiary sector in NSDP in the year 2014-15 was the highest at 61.62 percent, followed by secondary at 22.71 percent and primary at 15.67 percent. The share of the primary sector in NSDP has decreased from 20.57 percent in 2004-05 to 15.67 percent in 2014-15. The share of the tertiary sector increased from 53.12 percent to 61.62 percent over the same period, which is in tune with the classic model of growth and development of an economy. The share of the secondary sector in NSDP showed a decrease from 26.31 percent in 2004-05 to 22.71 percent in 2014-15. The per capita income in real terms, i.e. at constant (2004-05) prices, increased from Rs. 26882 in 2004-05 to Rs. 48907 in 2014-15

registering an average annual growth of about 6.23 percent.

The performance of the state economy and its different sector shares has been studied.

The Average annual growth rates are detailed in Table 5.8.

Table 5.7
Average Annual Growth Rates of State Income for Karnataka State

Sector and Share	2004-05 to 2014-15
NSDP	7.37
Primary	4.67
Secondary	5.96
Tertiary	8.96

5.4 Economic Perspective – State Level

The perspective growth of the state economy forms the basis for traffic demand forecasting. The economic perspective for the state has been developed taking into consideration the past performance of the economy of the state and the economic growth envisaged in the future.

The annual average growth in overall GSDP of Karnataka during 11th plan was 7.2 percent as against all India average of 8.0 percent. The average growths in industry and services sector were 5.3 and 10.3 percent in Karnataka as compared to 6.7 and 9.9 percent at all India level.

During the year 2012-13, which is the 1st year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 6.1 percent against all India growth of 5.1 percent. During the year 2013-14, which is the 2nd year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 7.2 percent against all India growth of 6.9 percent. During the year 2014-15, which is the 3rd year of the 12th plan period, the overall real growth in GSDP in Karnataka was around 7 percent against all India growth of 7.4 percent. Considering the state economy in 11th five-year plan, the performance of past economy and the current low growth trend, it is likely that the state economy will be able to maintain growth rate of 6.0 percent in the initial period up to 2017, and the state economy can be expected to strengthen to touch 7.00 percent during 2023-2027, and stabilize at 6.75 percent after 2028.

Prediction of the future growth accurately is difficult because of the various parameters affecting growth. Based on the experience in similar projects, two more growth scenarios have been considered for studying the impact on the traffic growth rates:

- ◇ *Low growth rates-Pessimistic scenario (15% less growth than Normal scenario)*
- ◇ *High growth rates-Optimistic scenario (7.5% more growth than Normal scenario)*

The perspective growth rates envisaged for Karnataka are presented in Table 5.9.

Table 5.8
Perspective Growth Rates of PIA State

Period	Karnataka
Normal Growth Scenario	
Up to 2017	6.00
2018-2022	6.50
2023-2027	7.00
2028-2032	6.75
Beyond 2032	6.75
Low Growth Scenario	
Up to 2017	5.10
2018-2022	5.53
2023-2027	5.95
2028-2032	5.74
Beyond 2032	5.74
High Growth Scenario	
Up to 2017	6.45
2018-2022	6.99
2023-2027	7.53
2028-2032	7.26
Beyond 2032	7.26

CHAPTER 6

TRAFFIC SURVEYS, DATA ANALYSIS AND TRAFFIC FORECAST

6.1 General

Project road is located in Karnataka, the third largest state in India. The State bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamil Nadu States in the South and by the State of Andhra Pradesh in the East. The State extends to about 750 km from North to South and about 400 km from East to West, and covers an area of about 1,91,791 sq.km. The national highway is starting from its junction with NH-167 near Mahabubnagar connecting Kodangal, Tandur in the state of Telangana, Chincholi and terminating at its Junction with NH-65 near Bapur in the state of Karnataka. NH 167N is declared as NH on 07.04.2021. The total length of this highway in the state of Karnataka is about 49.09 km in terms of existing alignment. This chapter presents traffic study and its data analysis carried out by the consultants. The results of analysis will form inputs for designing the pavement, Road cross section, estimation of toll able traffic, traffic forecast and toll revenues apart from providing mandatory inputs for planning wayside amenities, and for economic and financial analysis.

6.2 Traffic Surveys

Estimation of traffic over the project corridor is an essential step towards establishing the project viability. This includes conducting field traffic surveys, data analysis and estimation of toll able traffic. The present traffic surveys have been planned in a way to obtain all the necessary information and data deemed necessary for development of the project.

The basis for identification of traffic survey locations is Consultant's field reconnaissance surveys and the as per the suggestion made by the client. To establish the traffic flow characteristics and travel pattern on the corridor, the following surveys were conducted at different locations of project road.

- ◇ *Traffic Volume Count Survey*
- ◇ *Axle Load Surveys*

6.2.1 Traffic Survey Locations

Traffic Survey location for carrying out traffic surveys were selected based on site reconnaissance and as per the suggestion made by the client. The time schedule (Table 6.1) for the surveys was prepared as per the requirements of the study.

Table 6.1
Traffic Survey Location and Schedule

Type of Survey	Duration	Location	Date of Survey
Classified Volume Count	7 Days	Chandapur	16 to 22 May 2023

6.2.2 Methodology for Traffic Surveys

For carrying out these surveys, the vehicles were grouped into the following categories as detailed in Table 6.2.

Table 6.2
Vehicle Classification System

Motorised Traffic		Non-Motorised Traffic
2-Wheelers Auto Rickshaw Passenger Car: Car/Van/Taxi/Jeep		Bicycle Cycle Rickshaw Animal Drawn Vehicle/Hand Cart
Bus	Mini Bus – Govt., School bus & Other Pvt.,	
	Standard Bus – Govt., School bus & Other Pvt.,	
Truck	Light Commercial Vehicle (LCV)	
	2-Axle Rigid Chassis Truck	
	3-Axle Rigid Chassis Truck	
	Multi Axle Truck	
Others	Heavy Construction Machinery/Earth Moving Equipment	
Farm Vehicle	Agricultural Tractor (Ag T)	
	Agricultural Tractor & Trailer (Ag TT)	

6.2.2.1 Mid-block Classified Traffic Volume Count

The surveys were conducted round the clock for 7 days for both directions separately using video counting method.

6.2.2.2 Turning Movement Survey

The turning movement survey was conducted to obtain the information on direction-wise and mode-wise turning movement of traffic at one important intersections falling on the project road. The survey was conducted for 24 hours.

Traffic counting was carried out manually by trained enumerators, using hand tally. The count data was recorded with 15-minute interval using hand tallies and total per hour for each vehicle category in each direction was computed. The traffic volume count data was processed using the commonly used spread sheet package. The processed hourly traffic volume data has been compiled direction-wise.

The peak hourly directional movement data would be used to plan the improvement scheme such as, at-grade intersections with or without provisions of traffic signals, grade-separation, Interchanges etc., and for design of intersections.

6.3 Data Analysis

6.3.1 Mid-block Traffic Volume Count Analysis

6.3.1.1 Passenger Car Equivalents

Different vehicle types having different size and characteristics were converted into equivalent passenger car units. The Passenger Car Unit values (PCU) suggested by the Indian Roads Congress in IRC-64-1990 "Guidelines for Capacity of Roads in Rural Areas" have been adopted and the same are given in Table 6.3.

Table 6.3
Values of PCU Factors adopted for the Study

Vehicle Type	PCU	Vehicle Type	PCU
Car/Jeep/Taxi	1.0	Auto Rickshaw	1.0
Mini Bus/ LCV	1.5	Agricultural Tractor	1.5
Standard Bus	3.0	Agricultural Tractor Trailer	4.5
2/3 Axle Truck	3.0	Animal Drawn Vehicle	6.0
MAV	4.5	Cycle	0.5
Two Wheeler	0.5	Cycle Rickshaw	2.0

Source: IRC: 64-1990: Guidelines for capacity of Roads in Rural Areas

6.3.1.2 Average Daily Traffic

Hourly traffic data collected at the count station for each day was totalled to obtain the daily traffic volumes. The seven-day traffic volumes were then averaged out to obtain the Average Daily Traffic (ADT) at survey stations. A summary of daily traffic along with the Average Daily Traffic is presented in Table 6.4.

Table 6.4
Traffic Volume at, Near Chandapur

Vehicle Type	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average Daily Traffic (ADT)	AADT
2-W	5623	6492	5509	6080	6179	6016	5936	5936
3-W	558	797	1446	641	674	689	740	740
Car/Jeep/Taxi/Van	616	575	658	628	615	606	640	640
Mini Bus	2	1	166	2	0	3	25	25
School Bus	6	9	6	10	9	10	9	9
Bus (Govt.)	195	183	169	197	202	203	191	191
Bus (Pvt.)	6	3	32	5	3	7	9	9
Mini LCV	236	246	304	236	246	258	264	264
LCV	244	258	298	263	263	257	268	268
2-Axle Truck	258	266	311	284	287	275	292	292
3-Axle Truck	273	281	327	294	301	286	300	300
MAV (4-6 Axles)	481	431	445	477	465	465	456	456
7++ Axles	3	2	80	8	8	4	16	16
Tractor	9	16	16	25	20	18	17	17
Tractor+ Trailor	57	62	52	67	66	67	59	59
Cycle Rick.	16	6	36	19	16	17	20	20
Hand Cart	0	0	5	2	2	0	2	2
Car	2	2	8	6	3	4	4	4
Bus	3	3	4	4	4	4	3	3
LCV	0	0	2	0	0	0	0	0
Truck	0	0	1	0	0	0	0	0
Motorised	8572	9627	9834	9227	9345	9172	9222	9229
Non-Motorised	16	6	41	21	18	17	22	22
Total	8588	9633	9875	9248	9363	9189	9244	9251
Motorised	9259	9730.5	11151	9849	9894	9740	9893	9893
Non-Motorised	32	12	87	44	38	34	46	46
Total	9291	9742.5	11238	9893	9932	9774	9939	9939

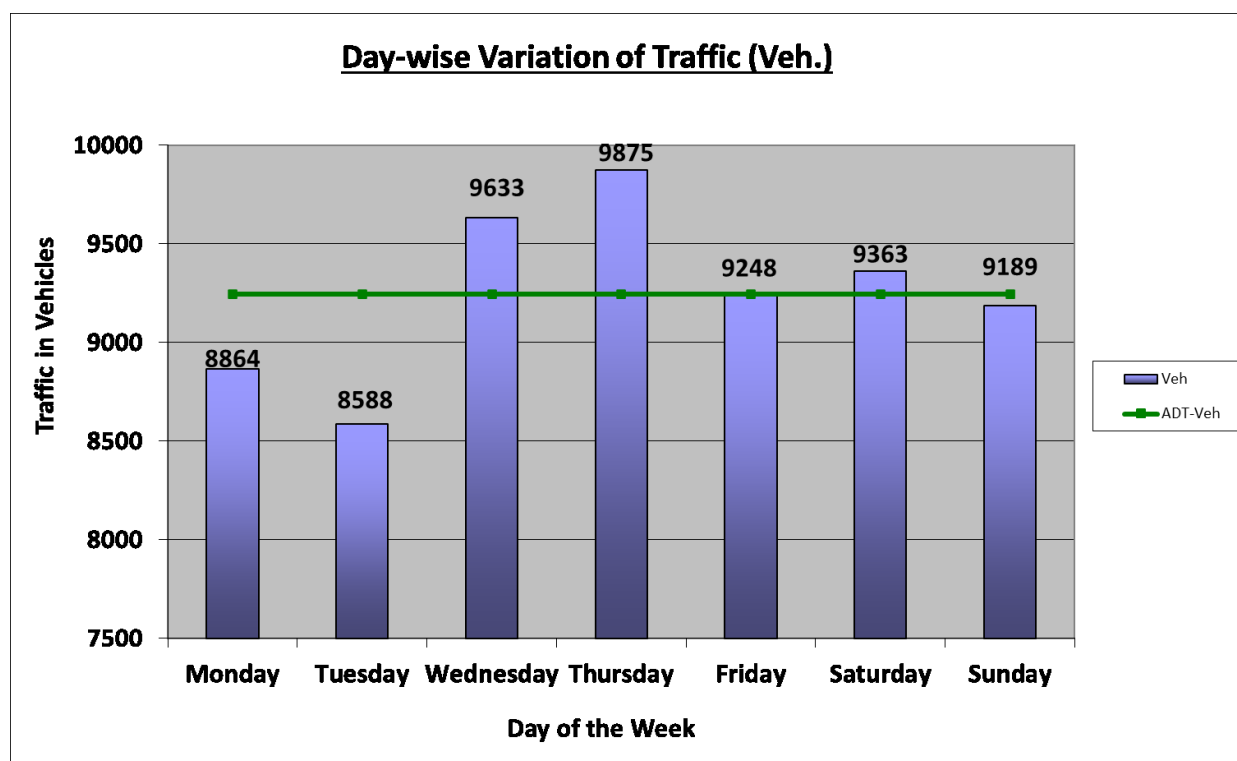


Figure 6.1: Daily Variation of Traffic, Near Chandapura

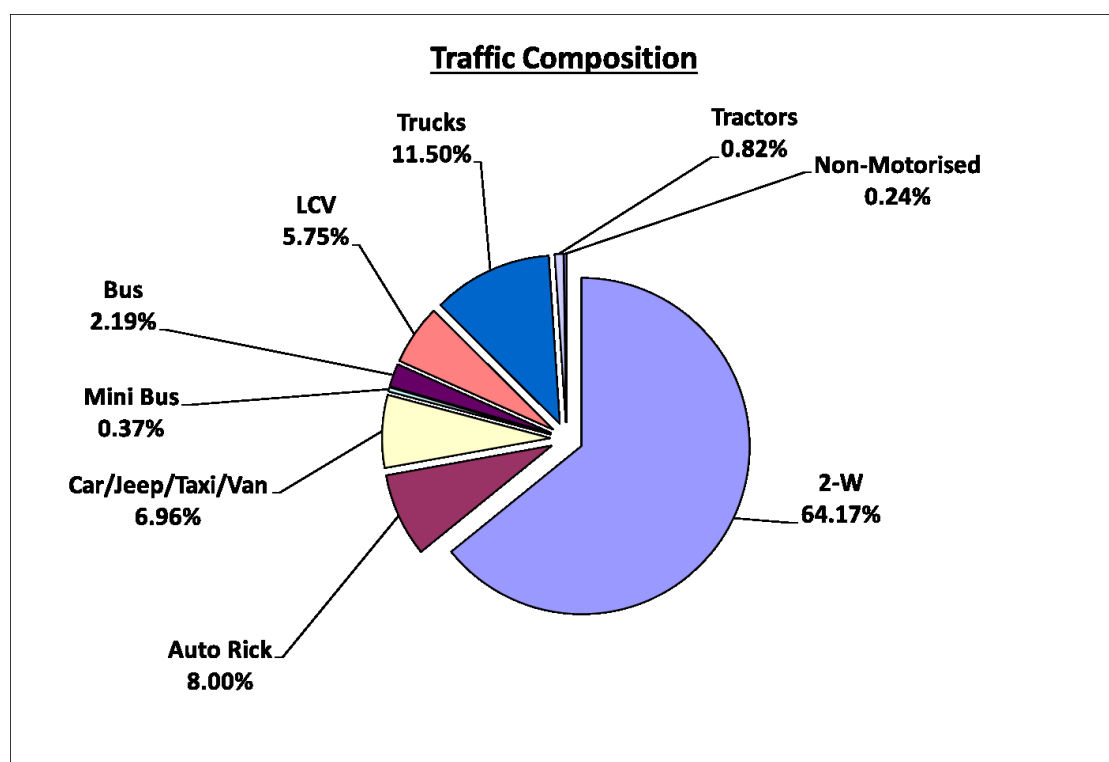


Figure 6.3: Traffic Composition at, Near Chandapura

6.4 Traffic Forecast

6.4.1 Assessment of Growth Rates

Long term forecasting of traffic on the project road during the time horizon of the study is required for design of highway and assessing the economic and financial viability of the proposed investment. To establish the future traffic growth rates, following approaches have been explored. For this purpose, a study of past trends in traffic growth is undertaken. However, the traffic growth rates established for this study are based on elasticity approach, wherein a relationship is established between traffic data and socio-economic indicators. The methodology thus adopted incorporates the perspective growth envisaged in the state economy and the changes in transport demand elasticities over a period of time as a basic data input. It must be noted that the growth in agriculture and manufacturing sectors affect the growth of traffic in freight vehicles, while growth in income affects growth in passenger vehicles like two- wheelers, cars and buses. Traffic growth rates by vehicle type, for the project road corridor have been determined upto the horizon year 2041.

- ◇ *Growth of registered motor vehicles*
- ◇ *Past Traffic Growth Rates*
- ◇ *Transport demand elasticity approach*

6.4.2 Growth Rate based on Vehicle Registration

An alternative approach is to explore the registered motor vehicles growth in the influence area and assume a growth rate equal to the average growth of vehicle registration. Such an assumption may not be correct, unless the area of influence is well defined and the general development pattern of influence area remains same. However, this would be an alternative approach in the absence of any additional information or usable past traffic data on the project road.

6.5 Transport Demand Elasticity Approach

Elasticity in the present context is defined as the ratio of percentage change in traffic to the percentage change in socio-economic parameters. The concept of developing regression equation to express dependent variable in terms of one or more independent variable is widely used in transportation engineering for variety of purposes. In the present case, the dependent variable is the registered motor vehicles in the zone of influence (State). The preferred dependent variable would have been past traffic on the project road. However, due to inconsistencies in past traffic data, number of registered motor vehicles is taken as dependent variable. The independent variables are socio-economic parameters. The choice of

independent variable depends upon vehicle type under consideration. It is logical to relate growth in cars and two wheelers with per capita income and buses/commercial vehicle growth with NSDP.

The Consultants have used elasticity approach for determining the growth rates of future traffic. Consultants have developed the transport demand elasticities with respect to economic indicators of PIA state. A data base was compiled on the basis of time series data of registered vehicle and NSDP of PIA state. A regression analysis was carried out on the database to arrive at the transport demand elasticity. The data series of different categories of vehicle with respect to income of PIA state was considered. This involved establishing a quantitative relationship between traffic (number of registered vehicles) as the dependent variable and NSDP or sectoral income as the independent variable for passenger and freight vehicles. The methodology involved fitting log-log regression equations to the time series data. This methodology is in line with the guidelines given in IRC:108-1996 "Guidelines for Traffic Prediction on rural Highways". The transport demand elasticities by vehicle type in the horizon year are presented in Table 6.5.

Table 6.5
Transport Demand Elasticity by Vehicle Type Using State Vehicle Registration Data

Vehicle Type	Independent Variable	PIA state		
		Elasticity	R ²	t-Statistic
Motor Cycles	PCI	1.60	0.93	10.61
	NSDP	1.36	0.94	11.98
Cars	PCI	2.26	0.93	11.12
	NSDP	1.92	0.95	12.65
Auto	PCI	0.91	0.89	8.53
	NSDP	0.77	0.90	8.99
Buses	PCI	2.68	0.82	6.45
	NSDP	2.28	0.84	6.84
Trucks	NSDP	1.83	0.94	11.83

Vehicle registration data represents all vehicles registered in the state, but does not indicate actual number of vehicles plying on the road owing to vehicles taken off the road due to lack of fitness certificate. Consequently, the elasticity values based on registration data are usually higher than those based on actual traffic, hence there is a need to moderate elasticity values obtained from vehicle registration data. In order to arrive at realistic future elasticities for the project road, various factors relating to vehicle technology changes besides character of traffic and travel pattern on the project road have been considered.

High elasticity of cars being witnessed now is because of large demand facilitated by financing schemes and loans. Factors like growth of household incomes

(particularly in urban areas), reduction in the prices of entry-level cars, growth of the used car market, changes in life style, growing personal incomes, desire to own a vehicle facilitated by availability of loans/financing schemes on easy terms, etc. have all contributed to the rapid growth in ownership of cars. However, such trend would slow down and elasticity can be expected to decline. The elasticity obtained by using registered vehicles is actually an overestimate for the traffic moving on sub-urban and inter-city routes. In view of all this, combined with the travel pattern of vehicles moving on the road, elasticity value obtained by using registration data has been moderated for cars.

Over the years there is a change in passenger movement with more and more persons shifting towards personalized modes. Moreover, the buses are usually plying on fixed pre-decided routes.

With the changing freight vehicle mix in favor of LCV for short distance traffic and 3-axle / MAV for long-distance traffic, higher elasticity's values for these have been considered as compared to 2-axle trucks. Considering the ongoing technical advancements in automobile industry, some of the standard two axle trucks would gradually be replaced by three axle truck and MAV's, leading to reduction in number of trucks. This shift has already started taking place in different parts of the country.

Elasticity values in the initial period are related to moderate past elasticity values. Generally the spread of economic development induces changes in the spatial distribution of activities and corresponding changes in transport demand elasticity. As regions become more and more self-sufficient, the need for long-distance transport diminishes. Accordingly, it was assumed that transport demand elasticity, for both freight and passenger traffic, would tend to decline over time, despite growth in per capita income.

6.6 Elasticity values suggested by IRC (Road Development Plan: Vision 2021)

The derived elasticity values are compared with the elasticity values as suggested by IRC (Road Development Plan: Vision 2021) and these elasticity values are as detailed in Table 6.6.

Table 6.6
Elasticity values suggested by IRC (Road Development Plan: Vision 2021)

Vehicle category	2001-2006	2006-2011	2011-2016	2016-2021
Truck/MAV	1.5	1.4	1.2	1.1
Car	1.7	1.6	1.5	1.4

Generally these elasticity values could have been used in the absence of time series relevant data on socioeconomic indicators and vehicle registration data.

6.7 Elasticity values as per Asian Development Bank (ADB) guidelines

Asian Development Bank has formulated guidelines on traffic forecasting road sector projects. ADB has recommended a set of elasticity values for traffic forecasting and are presented in Table 6.7

Table 6.7
Elasticity values as per Asian Development Bank Guidelines

Vehicle category	2003-2006	2006-2011	2011-2016	2016-2021
Two Wheeler	2.3	2.3	2.1	2.1
Car	2.0	2.0	1.8	1.8
Bus	1.6	1.6	1.5	1.5
Truck/MAV	2.0	2.0	1.9	1.9

6.8 Suggested Elasticity values

It is observed that the elasticity values as suggested by IRC are lower than the elasticity values as suggested by ADB guide lines.

Reviewing the estimated elasticity values based on travel demand elasticity approach, guidelines of ADB & IRC on elasticity values and considering the current scenario, the estimated elasticity values were moderated. The elasticity values adopted for horizon years are presented in Table 6.8.

Table 6.8
Projected Transport Demand Elasticity by Vehicle Type in the Cardinal Years

Period	Two Wheeler	Auto	Car	Bus	LCV	2AT	3AT	MAV
Up to 2014	1.10	0.90	1.30	1.20	1.30	0.65	1.10	1.15
2015-2020	1.05	0.80	1.25	1.10	1.20	0.50	1.00	1.00
2021-2025	1.00	0.70	1.20	1.00	1.15	0.35	0.75	0.90
2026-2030	0.95	0.65	1.15	0.95	1.10	0.20	0.60	0.85
Beyond 2030	1.10	0.90	1.30	1.20	1.30	0.65	1.10	1.15

6.9 Forecasted Traffic

By applying the vehicle wise traffic growth rates of 5 percent as per IRC base year traffic the projected traffic (in terms of AADT) and presented in Table 6.9.

Table 6.9
Section wise Projected Traffic for the Project Road (AADT)

Year	Km 7+000, Near Chandapur	
	Total vehicles	Total PCU
2022	9251	9939
2023	9714	10436
2024	10199	10958
2025	10709	11506
2026	11245	12081
2027	11807	12685
2028	12397	13319
2029	13017	13985
2030	13668	14684
2031	14351	15419
2032	15069	16190
2033	15822	16999
2034	16613	17849
2035	17444	18741
2036	18316	19679
2037	19232	20662
2038	20194	21696
2039	21203	22780
2040	22264	23919
2041	23377	25115
2042	24546	26371

6.10 Capacity Analysis

Capacity analysis for project road on different sections is generally carried out to define the LOS offered by road under the prevailing roadway and traffic conditions. These conditions include design hour traffic, vehicle composition, directional traffic, lane width and type of terrain. The project road passes through fairly plain terrain and observed directional distribution of traffic is 50/50.

Capacity Augmentation

Indian Road Congress has recommended capacity values for various lane configurations in "Guidelines for Capacity of roads in rural areas" (IRC: 64-1990).

Capacity and design service volumes for various lane configurations are specified in IRC: 64 – 1990, 'Capacity of Roads in Rural Areas', IRC-SP: 73-2018 'Manual of Specifications and Standards for Two-laning of Highways through Public Private Partnership' and IRC-SP: 84-2019 'Manual of Specifications and Standards for Four-

laning of Highways through Public Private Partnership'. The project stretch passes through plain terrain predominantly. The design service volume standards for LoS B and LoS C considered as per guidelines are given in Table 6.10.

Table 6.10
Design service volume standards for LoS B & LoS C

Road	Shoulder Type	Plain terrain	
		LOS B	LOS C
2 lane	Paved shoulders	10000	14000
4 lane	Paved shoulders	40000	60000
6lanes	Paved shoulders	60000	120000

**as per MORTH notification(F.N. RW/NH-33044/37/2015/S&R(R) in light of changing socioeconomic conditions in the country in order to ensure safe and comfortable mobility of road users and reduction in road accidents, widening of road and decongestion of traffic is required. Accordingly, Ministry has revised the traffic at which the up gradations from two lanes to four lane will trigger.*

Based on the present traffic scenario of the project road existing Traffic Warrants for Two Lane with Paved Shoulder.

CHAPTER 7

IMPROVEMENT PROPOSAL

7.1. Introduction

As explained in the previous chapter Project road is located in Karnataka, the third largest state in India. The State bounded by Maharashtra and Goa States in the North and North-West; by the Arabian Sea in the West; by Kerala and Tamil Nadu States in the South and by the State of Andhra Pradesh in the East. The State extends to about 750 km from North to South and about 400 km from East to West, and covers an area of about 1,91,791 sq.km. The Project stretch is part of National Highway NH-167N which starts its junction with NH-167 near Mahabubnagar connecting Kodangal, Tandur in the state of Telangana, Chincholi and terminating at its Junction with NH-65 near Bapur in the state of Karnataka. NH 167N is declared as NH on 07.04.2021. The total length of this highway in the state of Karnataka is about 49.09 km in terms of existing alignment. This chapter deals with Engineering Designs and Alternatives studied for the improvement of the project road.

7.2. Alignment Improvement Proposal

Traffic characteristics based on the traffic data collected and analyses carried out by the consultants are presented in detail in Chapter 6. The traffic analysis related to pavement design has been dealt here.

7.2.1 Horizontal Design

The design made use of the data collected from the surveys and investigations carried out for the study. Geometric design of the project section has been done as per the provisions of IRC: SP: 73-2018. All the horizontal curves are as greater or equal to the minimum radius specified for given terrain type in the manual. Curve radius on the existing alignment is sufficient and the existing alignment followed for horizontal design.

7.2.2 Improvements to Vertical Profile

The vertical alignment of the Project Road has been designed conforming to the design standards for the design speed limit as per IRC-SP73-2018 and also the following:

- a) Sight Distance
- b) Avoid excessive cut and fills along the Project Road
- c) Level of the Existing Project Road
- d) Typical low and high points along the Project Road

- e) Existing and proposed culverts/bridges on the Project Road
- f) The allowable grade for the type of terrain and speed has been adopted except warranted by obvious constraints

The gradients kept below the limiting gradient of 3.3%, as far as possible. The Vertical curve improvement done along at only two locations along the project road.

The vertical alignment design of the project road in built up areas (towns and villages) has followed the existing grade elevations. This is preferred to provide easy road side access to the abutting property and at grade intersections / junctions. While designing the vertical alignment, efforts were made to satisfy the Intermediate Sight Distance.

7.2.3 Right of Way (ROW)

Throughout the length of the project stretch, 45m ROW proposed for construction of Bypass AND 30M AT Forest Area.

7.2.4 Widening Scheme

Based on the appreciation of widening constraints during site reconnaissance, topographic survey data, study of the road inventory data and keeping in view above factors the optimum widening proposal worked out and presented in cross section forms. All typical cross sections given in Drawing Volume.

The details of the different types of cross sections given below and types of widening scheme adopted given in Table 7.2 and Table 7.3 respectively.

Table 7.1
Typical Cross Section Type

Sl No	TCS Type	Description	Length, Km
1	Type 1	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	3.390
2	Type 2	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	7.630
3	Type 2A	New Construction of 4 Lane Carriage way with Paved Shoulder - High Embankment (3m-6m) (open country plain/rolling terrain)	1.010
4	Type 3	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Footpath cum Drain (Built-up plain/rolling terrain)	1.000

5	Type 4	New construction of Approaches to VOP with Service/Slip road (open country plain/rolling terrain)	1.175
6	Type 4A	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	0.425
7	Type 5	New Construction of 4 Lane Carriage way with Paved Shoulder in cutting section (open country plain/rolling terrain)	0.940
8	Type 5A	New Construction of 4 Lane Carriage way with Paved Shoulder in cutting section (more than 4m) (open country plain/rolling terrain)	0.300
Total			15.870

Table 7.2
Details of widening scheme

Sl.No.	Proposed Chainage, Km		Length, Km	Widening Proposal	TCS Proposed
	From	To			
1	0.000	0.120	0.120	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 1
2	0.120	1.500	1.380	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
3	1.500	1.880	0.380	New Construction of 4 Lane Carriage way with Paved Shoulder in cutting section (open country plain/rolling terrain)	Type 5
4	1.880	2.630	0.750	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
5	2.630	2.860	0.230	New Construction of 4 Lane Carriage way with Paved Shoulder - High Embankment (3m-6m) (open country plain/rolling terrain)	Type 2A
6	2.860	3.150	0.290	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
7	3.150	4.000	0.850	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 1
8	4.000	5.000	1.000	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Footpath cum Drain (Builtup plain/rolling terrain)	Type 3
9	5.000	6.875	1.875	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 1
10	6.875	7.000	0.125	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder	Type 1

				(open country plain/rolling terrain)	
11	7.000	8.175	1.175	New construction of Approaches to VOP with Service/Slip road (open country plain/rolling terrain)	Type 4
12	8.175	8.6	0.425	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 4A
13	8.600	8.750	0.150	New Construction of 4 Lane Carriage way with Paved Shoulder - High Embankment (3m-6m) (open country plain/rolling terrain)	Type 2A
14	8.750	10.370	1.620	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
15	10.370	10.670	0.300	New Construction of 4 Lane Carriage way with Paved Shoulder in cutting section (more than 4m) (open country plain/rolling terrain)	Type 5A
16	10.670	11.240	0.570	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
17	11.240	11.740	0.500	New Construction of 4 Lane Carriage way with Paved Shoulder - High Embankment (3m-6m) (open country plain/rolling terrain)	Type 2A
18	11.740	12.430	0.690	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
19	12.430	12.560	0.130	New Construction of 4 Lane Carriage way with Paved Shoulder - High Embankment (3m-6m) (open country plain/rolling terrain)	Type 2A
20	12.560	12.790	0.230	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
21	12.790	13.350	0.560	New Construction of 4 Lane Carriage way with Paved Shoulder in cutting section (open country plain/rolling terrain)	Type 5
22	13.350	15.700	2.350	New Construction of 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 2
23	15.700	15.750	0.050	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 1
24	15.750	15.870	0.120	Reconstruction of 2 Lane Carriageway to 4 Lane Carriage way with Paved Shoulder (open country plain/rolling terrain)	Type 1
Total			15.870		

7.2.5 Intersection Proposals

The geometric design of intersections carried out taking in to account the site conditions, turning movement characteristics, level of services, overall economy and operational safety. There are five major Intersections along project road and are proposed for improvements as per IRC standards. There are Four minor intersection along the road and are detailed in Table 7.3 and Table 7.4.

**Table 7.3
Details of Major Intersection**

SL No.	Deisgn Chainage, Km	At grade/Grade separated	Type	Category of Cross Road			Leads To		Remarks
				NH	SH	MDR	LHS	RHS	
1	0+500	At grade	T	-	-	-	-	Miriyan	Connecting Arm
2	2+650	At grade	T	-	-	-	-	Miriyan	Connecting Arm
3	7+650	Grade Separated	X	SH-122	-	-	Bhaktampalli	Chikkalingadahalli	SH Junction
4	9+450	At grade	T	-	-	-	Chincholi	-	Connecting Arm
5	15+600	At grade	T	-	-	-	Chincholi	-	Connecting Arm

**Table 7.4
Details of Minor Intersection**

Sl. No.	Design Chainage (Km)	Type of Junction	Leads to	
			LHS	RHS
1	6+530	3 legged	Chettinad Cement Factory	-
2	8+445	3 legged	-	Polakpalli Thanda
3	10+315	4 legged	Polakpalli	Mines
4	12+780	4 legged	Chandapur	Kalbhavi

7.3 Pavement Design

The existing pavement along the project is flexible in nature for the entire length. The project envisages Reconstruction to Four lanes with paved shoulder and Four Lane carriageway for augmenting the capacity of the project road from existing two-lane road and significantly extending its service life. Pavement design includes strengthening and widening of existing pavement and reconstruction at few locations as well.

The general procedure for design of the flexible pavement for widened portion as new construction as well as strengthening of existing carriageway has been followed as per the guidelines of IRC: 37-2018 – “Guidelines for the design of flexible pavements”.

The following parameters were considered for the design of Pavement.

- Design CBR
- Design Period
- Vehicle Damage Factor
- Lane Distribution Factor
- Design Traffic (MSA)

i. Design CBR

An effective CBR of 10% is considered in the design of flexible pavement for the project stretches.

ii. Design Period

The design period (15 years) was adopted for the design of Flexible pavements, based on the IRC codes and the lane distribution factor (D) for the corridor was taken as 50 percent.

iii. Vehicle Damage Factors

The Vehicle Damage Factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions. It is defined as equivalent number of standard axles per commercial vehicle.

The Vehicle Damage Factor (VDF) for the corridor was arrived at based on the Axle load and classified volume count surveys.

iv. Design Traffic

The design traffic for the project corridor in terms of cumulative number of standard axles has been computed for a design life of 15 years for the design of initial bituminous layers & for concession / operating period (16.5 years) for the design of base and sub-base layers using the following equation.

$$N = \frac{365 \times [(1 + r)^n - 1]}{r} \times A \times D \times F$$

Where,

N: The cumulative number of standard axles in the design period in terms of msa.

r: Annual Growth Rate of commercial vehicles.

- n: Design Life in years
A: Initial traffic in the year of completion of construction in terms of the number of commercial vehicles/day
D: Lane Distribution Factor
F: Vehicle Damage Factor

As per Clause 5.4.1 (i) of IRC:SP:73-2018, "Flexible pavement shall be designed for a minimum design period of 15 years, subject to a condition that design traffic shall not be less than 27 MSA". Hence a minimum of 27 MSA was considered as Design traffic.

1.1.1. Axle load Survey

Vehicle Damage Factor of 5.0 is adopted as per table 4.2 of IRC 37 - 2018.

Table -7.5: Existing Crust Composition

SL. No.	Location / Chainage	Thickness (mm)					Total Crust Thickness (mm)	Remarks
		BC	DBM	WMM	GSB	Sub grade		
1	0.000	60	70	200	200	500	1030	Miryan
2	3.100	40	70	200	250	500	1060	Miryan
3	4.100	40	70	200	200	500	1010	Chincholi
4	5.100	40	70	200	200	500	1010	Chincholi
5	6.100	40	70	200	200	500	1010	Chincholi
6	7.100	40	80	200	200	500	1020	Chincholi
7	8.000	40	80	250	200	500	1070	Chincholi
8	15.100	70	80	200	250	450	1050	Chincholi

7.4 Pavement composition

Pavement design is carried out in accordance with IRC 37:2018 for Granular base and sub-base. The standard designs given in IRC: 37-2018 specify the minimum thickness and specifications of various component layers for the given traffic in terms of cumulative standard axles and the subgrade CBR. The required pavement composition according to IRC: 37-2018 is as given in table 7.6.

**Table 7.6
Pavement Composition for Main Carriageway**

Design MSA - 27 (15 years)	Crust Composition in mm				
	BC	DBM	WMM	GSB	Total
Thickness	40	80	250	200	570

Pavement Composition for Service Road Carriageway

Design MSA – 27 (15 years)	Crust Composition in mm				
	BC	DBM	WMM	GSB	Total
Thickness	40	50	250	200	540

7.5 Geotechnical Design

7.7.1 General

For most of the structures it is the earth that provides the ultimate support. The behaviour of the supporting ground must therefore affect stability of the structures and approach embankment / retaining structures. The supporting ground is invariably a soil (sound rocky stratum being very rare) which is weaker than the most construction materials and hence a larger area or mass of the in-situ soil is necessarily involved in carrying the structural loads. Structural foundations should transmit the structural loads to the earth in such a manner that the supporting soil is not overstressed and does not undergo deformations that would cause unacceptable settlement of the structure. Hence the engineering characteristics of the supporting soil must be evaluated which affects vitally the choice of the type of structural foundations suitable for a structure.

Consultant have devised a comprehensive Geotechnical and Subsoil exploration program, based on structural condition surveys of the existing bridges / structures where the existing structures require modification or reconstruction from the detailed design consideration. The investigation program also caters to encompass for the proposed new structures bridges / Road over bridges / Viaducts / Interchanges / Underpasses etc. along with the high embankments and any other location necessary for a comprehensive detailed design of the structures and the high embankments.

7.7.2 Stability of Embankment slope

All road embankments where the height exceeds 6m from the surrounding ground level shall be analysed for its slope stability aspects both during the construction as well as in the long term in accordance to recommendations of IRC 75: 1979. The embankment design shall provide maximum utilization of locally available material resources and in compliance to the specifications (MoRTH). Use of fly-ash wherever available within an economical leads shall be suitably considered and recommended in the design. Engineering characteristics of the fly-ash material shall be evaluated to adopt in the design analysis and recommendations where applicable.

Slope stability analysis and assessment of settlement of the high embankment locations along the project highway shall be analysed keeping in view engineering properties of the subsoil strata based on geotechnical report and the material report

available from the borrow areas. The side-slope of the embankment has been recommended with 1(V): 1.5(H) is generally adopted in practice to meet the highway safety requirements and failure against shear or deformation exceeding tolerable limits. However at locations having height of embankment more than 6m, the stability and settlement analysis of the embankment has been assessed.

Stability and settlement analysis are carried out following the IRC 75-2015 "Guidelines for the Design of High Embankment". The Simplified Bishop's method has been used for stability analysis, where applicable. The effective stresses are used for the analysis along with the material parameters Cohesion 'C', angle of internal friction ' ϕ ' and unit weight of the soil ' γ '.

7.6 Design of Bridges and Culverts

7.6.1. Slab & Box Culverts

All above are analysed per meter width of strip for self-weight and superimposed loads. For live load analysis, effective width method recommended by IRC is used for calculating the dispersion. The section design is done for critical values of loads and combinations from the output of the analysis.

7.6.2. Box type structures for Minor Bridges and Vehicular & Pedestrian Underpasses

All above are analysed per meter width of strip for self-weight and superimposed loads. For live load analysis, effective width method recommended by IRC is used for calculating the dispersion. The section design is done for critical values of loads and combinations from the output of the analysis.

7.6.3. Analysis for Superstructures with RCC/PSC Girders for Bridges

Grillage Analysis : Superstructure decks of slab on girder bridges are analysed as a two dimensional grillage for the geometry by applying calculated grillage properties. Analysis is carried out for static as well as moving loads.

The analysis of the slab on girder bridges for longitudinal flexure shall be carried out using Grillage model on STAAD Pro on the following basis:

- Grillage model has been generated with longitudinal members along the C/L of the I-Girder and along the outer edges. Suitable transverse members along the cross beams have also been provided.
- Moment and shear force will be calculated separately for inner & outer girders by keeping the loading with minimum eccentricity to crash barrier.
- For the design of the longitudinal Girders shear and moments shall be determined at End of solid section, End of tapering section, and mid-section at suitable intervals for other locations.
- Transverse members of the grillage other than the Cross-diaphragm shall be modelled as slab elements.

Method of Analysis for Cross Diaphragm : The analysis of the Cross Diaphragm shall be carried out using Grillage model on STAAD Pro on the following basis:

The end cross Diaphragm shall be designed both as a continuous beam supported on the longitudinal girders and for the jack up condition.

Intermediate diaphragm shall be provided for span greater than 30.0m. It needs to be designed at service stage loads for the results of the grillage analysis.

Section properties : The effective flange width calculation for determination of sectional properties for the longitudinal girders and cross diaphragm shall be done in accordance with IRC: 112.

The longitudinal members of bridges shall have torsion carrying capacity. Torsion effect is accounted in bridges by assigning torsional moment of inertia for the members in the grillage model.

Method of analysis for deck slab : The deck slab shall be designed as a continuous one-way slab supported on the longitudinal girders with cantilever overhang beyond the girders. Live load effects shall be taken based on effective width method recommended in IRC: 112.

7.6.4. Pre-stressing details for PSC Superstructure

Maximum pre-stressing force, the losses in pre-stressing force and Partial factors for pre-stressing shall be as per Clause 7.9 of IRC: 112.

Design parameters

- It is proposed to use 12T13/19T13 cables conforming to Class 2 of IS: 14268 (Low relaxation strands) with HDPE Sheathing for pre-stressing.
- Values of friction and wobble coefficient (μ and k) for pre-stressing strands shall be considered as $\mu = 0.17$ and $k = 0.002$. (Ref. Table 7.1 of IRC: 112).
- Relaxation losses shall be computed as per Clause 6.3.6 of IRC: 112.
- Ultimate resistance of the T-Girder in flexure shall be checked against yielding of steel and against crushing of concrete.
- Duct diameter is based on the number of strands in cable. Clear cover protecting cable from the nearest concrete surface is kept as 75mm as per Clause 14.3.2 of IRC: 112.

Proposed Sequence of Pre-stressing

The girder may be pre cast in the bed or in casting yard or in position.

1st stage pre-stressing shall be done after 7 days of casting of girder or after concrete has attained a strength of 70% of f_{ck} whichever is later.

2nd stage pre-stressing shall be done after 21 days of casting of girder or after concrete has attained full strength whichever is later.

- Launch the precast girders to the position in case the girders cast in bed or casting yard. For launching the girders, lifting arrangement will be done only on either ends at end diaphragm location.
- Erect staging and shuttering for slab by suitable supporting arrangement from web / bottom bulb of girders.
- Cast the top RC Slab together with end/Intermediate cross diaphragm.
- Cast the crash barrier and Kerb.
- Lay wearing coat.

7.6.5. Substructure and Retaining Walls

The pier has been designed for the vertical forces transferring from superstructure and for the biaxial moments developed in both longitudinal and transverse directions due to braking, LL eccentricity, seismic and other horizontal forces.

Conventional plate type abutment / counterfort type structure is proposed depending upon the height of the structure.

The abutment and pier is checked for both cracked and un-cracked condition and designed as per section 8 of IRC: 112.

Pedestals are provided under each of the girder. The pier cap is checked for bending and shears arising from vertical forces acting on bearings and torsion due to unbalanced vertical loads on bearings.

The retaining walls shall be provided as per site requirement beyond the return walls of abutments where the height of structure above ground is more.

RE walls / Retaining walls are proposed for the approaches of ROB's and Flyover. Coulomb's theory is applicable for Earth pressure calculations as per IRC: 6 -2010.

7.6.6. Foundation

Type of foundation is based on the properties of sub grade soil strata. Foundation type as per the inventory of existing structures is open foundation. Hence open foundation is proposed. In case of deep foundation if any required as per geo-tech, pile foundation is proposed.

The details of hydrology and hydraulic design parameters (Discharge, HFL, scour and afflux if any) for the bridges are adopted from the relevant sections of Hydrology and Hydraulics report.

Also details of geotechnical design parameters (Founding / Pile tip levels & SBC / Pile capacity) for bridges are adopted from the relevant section containing the geotechnical report.

Open Foundation : Open foundation is proposed where good stratum will be available at shallow depths. Footing is designed as per bending theory.

7.6.7. Bridge Appurtenances

7.6.7.1.Drainage Spouts

Drainage Spouts shall be placed not greater than 5m centre to centre. Down-take pipes will be provided to dispose the water below soffit of the superstructure.

7.6.7.2.Bearings

The elastomeric bearings are designed as per guidelines given in IRC: 83 (Part II). The design loads for POT/PTFE bearings are calculated as per the guidelines of IRC: 83 (Part III).

The horizontal forces due to bearings shall be calculated as per Clause 211 of IRC: 6. For slab culverts tar paper bearing shall be used.

7.6.7.3.Expansion Joints

Strip seal type of expansion joint is proposed.

7.6.7.4. Wearing Course

65mm thick wearing course is proposed consisting of 40mm thick bituminous concrete laid over 25mm thick mastic asphalt.

7.6.7.5. Durability

Durability of structure depends on the materials used, mix proportions, workmanship achieved, design and detailing including minimum cover to steel. From durability consideration for 100 years of service life, the water cement ratio and maximum cement content shall be as per Table 14.2 of IRC: 112. The grade of concrete, steel and cover to reinforcement to be adopted are given below:

7.6.7.6. Materials Used:

Minimum grades of Concrete:

- | | | |
|--|---|-----------|
| • Levelling course | : | M15 |
| • PCC members | : | M15 / M20 |
| • RCC Girder + Deck Slab | : | M35 + M40 |
| • RCC Solid Slab | : | M40 |
| • PSC Girder (Precast) + Slab | : | M40 + M40 |
| • RCC Pier Shaft, Abutment Shaft & Footing | : | M30 / M35 |
| • RCC Abutment cap & Pier cap | : | M35 |

- RCC Retaining wall & Median wall : M30
- RCC Approach Slab : M30
- RCC Box/ Slab Culvert : M30
- RCC Crash Barrier : M40
- Pedestals : M35
- Pile Cap : M35

Reinforcement (un-tensioned Steel as per Code IS: 1786):

Grade of HYSD bars shall be Fe 500D & Modulus of elasticity 2.0 X 105Mpa.

The reinforcement shall be protected with coating in the areas of marine environment areas.

Prestressing Steel: Prestressing steel comprises uncoated stress relieved strands conforming to Cl.2 strands of IS.14268-1995.12T13/19T13 with HDPE Sheathing duct of 75mm / 90mm diameter respectively.

Modulus of elasticity = $1.95 \times 10^5 \text{ N/mm}^2$

Structural Steel : The following type of structural steel considered for the design of steel / composite superstructure. Fe 490 conforming to IS: 2062-1992: The basic permissible stresses for design of steel sections are taken from Table 6.2 of IRC: 24-2001.

Permanent liner shall be provided for piles up to scour level for bridges with pile foundation.

7.6.7.7. Cover

The minimum cover to reinforcement shall be determined from the recommendations of IRC: 112 table 14.2 taking into account the moderate / severe environmental conditions depending upon the location of roads.

Refer to **Part II: Structure Design of Volume II** for details on the bridges and culverts design.

7.7 Summary of Inventory, Condition Survey and Improvement Proposal for Structures.

7.7.1 Inventory, Condition Survey and Proposal for Structures.

Project is a green filed alignment, along the project stretch four culverts; one MNB and one slab MNB observed.

Table 7.7 gives the list of existing structure along the project stretch.

Table 7.7

Existing structures on Project stretch

Sl No.	Type of Structure	No. of Structures
1	Culvert	8
2	Minor Bridge	4
3	Major Bridge	1
	Total	13

7.7.2 Proposal for Structures

Based on detailed condition survey, adequacy of waterway and proposed horizontal geometrics, each structure will be categorized and proposed as reconstruction/retain/widen/new construction as per IRC:SP:73-2018.

The summary of proposed structures listed below in Table 7.8.

Table 7.8

Summary of Proposed Structures on Project Stretch

Sl No.	Type of Structure	Retain with minor maintenance	New Construction	Reconstruction	Widening	Dismantling	Total No's
1	PIPE CULVERT	-	7	1	-	-	8
2	BOX CULVERT	-	6	1	-	-	7
3	SLAB CULVERT	-	2	5	-	-	7
4	MINOR BRIDGE	-	7	-	-	-	7
5	MAJOR BRIDGE	-	-	-	1	-	1
6	VEHICULAR OVER PASS	-	1	-	-	-	1
						TOTAL	31

Minor Bridges

There are three Minor Bridge proposed for new construction along the project road stretch as shown in Table 7.12. And summary of improvements to Minor Bridges is given in table 7.9 below.

Table 7.9
Proposed new construction of Minor Bridge details

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existin g Width (m)	Improveme nt Proposal	Proposed Span Arrangements			Propose d Width (m)	Skew
			No. of cells / No of pipes	Width of opening (B) Dia. of Pipe	Clear Height (H)			No. of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	-	1+880	Minor Bridge of Span 1 x 10 x 4.0 Adjacent to the Proposed Alignment .				New Construction	1	20.00	5.50	24.00	-
2	-	2+745	Pipe Culvert of Span 3 x 0.9 Dia Adjacent to the Proposed Alignment .				New Construction	1	12.0	4.5	24.00	12°
3	-	9+685	Minor Bridge of Span 1 x 10 x 3 Adjacent to the Proposed Alignment .				New Construction	1	12.0	5.5	24.00	-
4	-	11+910	Minor Bridge of Span 1 x 10 x 5 Adjacent to the Proposed Alignment .				New Construction	2	8.0	3.0	24.00	-
5	-	13+350	-	-	-	-	New Construction	1	6.0	1.5	24.00	-
6	-	14+420	Minor Bridge of Span 1 x 12 x 6.5 Adjacent to the Proposed Alignment .				New Construction	2	15.0	2.5	24.00	-
7	-	14+930	-	-	-	-	New Construction	1	6.0	1.5	24.00	-

Table 7.10
Improvement Proposal for Existing Minor Bridges

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existin g Width (m)	Improveme nt Proposal	Proposed Span Arrangements			Propose d Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
NIL												

Culverts

The proposed new pipe Culvert details is shown in Table 7.11 and there are two pipe culverts proposed for widening.

Table 7.11
Proposed Pipe Culverts - New construction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No. of cells / No of pipes	Width of opening (B) Dia. of Pipe	Clear Height (H)			No. of cells / No of pipes	Width of opening (BxH) Dia. of Pipe	Clear Height (H)		
1		1+130	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-
2		3+720	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-

3		5+400	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-
4		5+630	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-
5		5+950	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-
6		10+880	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-
7		15+250	-	-	-	-	New construction	1	1.2 Dia	-	24.00	-

Table 7.12

Proposed Pipe Culverts - Reconstruction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	8+750	9+000	1	0.9 Dia	-	12.6	Reconstruction	1	1.2 Dia	-	24.00	-

The proposed new pipe Culvert details is shown in Table 7.13 and there are two pipe culverts proposed for widening.

Table 7.13

Proposed Box Culverts details - New construction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements (Total ventway x No.of cells/Dia.Of Pipe x Number of pipes)			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements (Total ventway x No.of cells/Dia.Of Pipe x Number of pipes)			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1		0+860	-	-	-	-	New construction	1	2.0	2.0	24.00	-
2		7+000	-	-	-	-	New construction	1	1.5	1.5	42.00	-
3	-	8+175	-	-	-	-	New construction	1	1.5	1.5	42.00	-
4	-	8+460	-	-	-	-	New construction	1	1.5	2.5	31.50	-
5		12+290	-	-	-	-	New Construction	1	2.0	1.5	24.00	-
6		12+781	-	-	-	-	New Construction	1	2.0	1.5	30.50	11°

Table 7.14

Proposed Box Culverts details – Reconstruction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements (Total ventway x No.of cells/Dia.Of Pipe x Number of pipes)			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements (Total ventway x No.of cells/Dia.Of Pipe x Number of pipes)			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	8+450	8+680	1	2.0	2.5	17.0	Reconstruction	1	3.0	3.0	24.00	-

The proposed new pipe Culvert details is shown in Table 7.15 and there are two pipe culverts proposed for widening.

Table 7.15

Proposed Slab Culverts details – New Construction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1		11+1113	Canal Crossing Throughout the stretch				New Construction	1	4.0	1.5	24.00	35°
2		15+054	-	-	-	-	New Construction	1	5.0	1.5	24.00	-

Table 7.16

Proposed Slab Culverts details – Reconstruction

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	2+925	3+145	1	3.0	2.5	9.2	Reconstruction	1	3.0	3.5	24.00	-
2	4+845	5+040	2	0.9 Dia	-	12.5	Reconstruction	1	3.0	2.0	24.00	-
3	5+040	5+240	4	0.9 Dia	-	12.5	Reconstruction	1	4.0	1.5	24.00	-
4	6+530	6+750	2	0.9 Dia	-	12.6	Reconstruction	1	3.0	1.5	28.20	-
5	15+500	15+723	1	5.0	3.5	11.8	Reconstruction	1	5.0	3.5	24.00	-

Major Bridge

The proposed Major Bridge details for the bypass is shown in table 7.17

Table 7.17

Proposed Major Bridge details – Widening

"Widening/Re-Construction to Four Lane from Km 0.000 to Km 15.870 starts near Miriyan Telangana/Karnataka border and ends at Chincholi Section of NH-167N in Kalaburagi District in the State of Karnataka under Annual Plan 2023-24".

Sl No.	Existing Chainage (Km)	Design Chainage (km)	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	4+250	4+460	8	10.0	5.0	15.0	Widening	8	10.0	5.0	9.5	-

VOP

The proposed VOP details for the bypass is shown in table 7.18

Table 7.18
Proposed VOP details

Sl No.	Existing Chainage (Km)	Proposed Type of Structure	Existing Span Arrangements			Existing Width (m)	Improvement Proposal	Proposed Span Arrangements			Proposed Width (m)	Skew
			No.of cells / No of pipes	Width of opening (B) Dia.of Pipe	Clear Height (H)			No.of cells / No of pipes	Width of opening (BxH) Dia.of Pipe	Clear Height (H)		
1	-	VOP	-	-	-	-	New Construction	1	30.0	5.5	24.00	-

7.8 Drainage

Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road in addition to preserving the valuable road assets created. Pavement structure including sub grade must be protected from any ingress of water otherwise over a period of time it may weaken the sub grade by saturating it and cause distress in the pavement structure. Hence, rapid dispersal of water from pavement and sub grade is a basic consideration in road design. Also, quick drainage takes away the water from pavement's surface and reduces chances of skidding of vehicles. New CC drains proposed at Built up locations along the project road, at VOP Locations and Deep Cutting Sections. Design Considerations for Drainage

The requirements of road drainage are essentially based on IRC: SP-42 "Guidelines on Road Drainage". Camber of 2.5% is provided for the carriageway in rural sections and 3% camber for shoulders is considered adequate. For longitudinal drains, a minimum longitudinal gradient of 0.3 percent shall be ensured for satisfactory drainage.

7.8.1 Culverts Across Cross Roads

Hume pipe culverts proposed across all the roads intersecting the project road to achieve continuity of drains in the longitudinal direction. 9m length of culvert considered at each of the road crossing. Culverts proposed at all road crossings.

Full depth granular sub base layer extended over the entire formation width of the project road in order to drain the subsurface water.

7.8.2 Utility Crossings

To avoid frequent cutting of road for laying/ maintaining/ repair of utility services especially near settlements proposed to have two rows of 600 mm diameter NP-4 Pipe along with inspection box/chamber, at every 1 Km intervals shall be provided for crossing underground utilities.

7.9 Utility Shifting

At present there are several underground and over-ground utilities running across and along the roadside close/ within ROW. These have to relocate to the extent possible at the extreme edge of the available ROW. The consultant is in constant follow up with concerned departments for utility details and the final utility shifting given in Schedule A.

7.10 Construction Period

As the project road passes through Green field alignment , 18 month of construction period suggested. Further availability and experience in use of modern construction equipment and plants indigenously and acquaintance with modern construction technologies by most of the contractors justify the construction period suggested.

7.11 Traffic Management and Traffic Diversion

The traffic diversion plan during construction shall be followed as per IRC: SP:55 for the entire project highway.

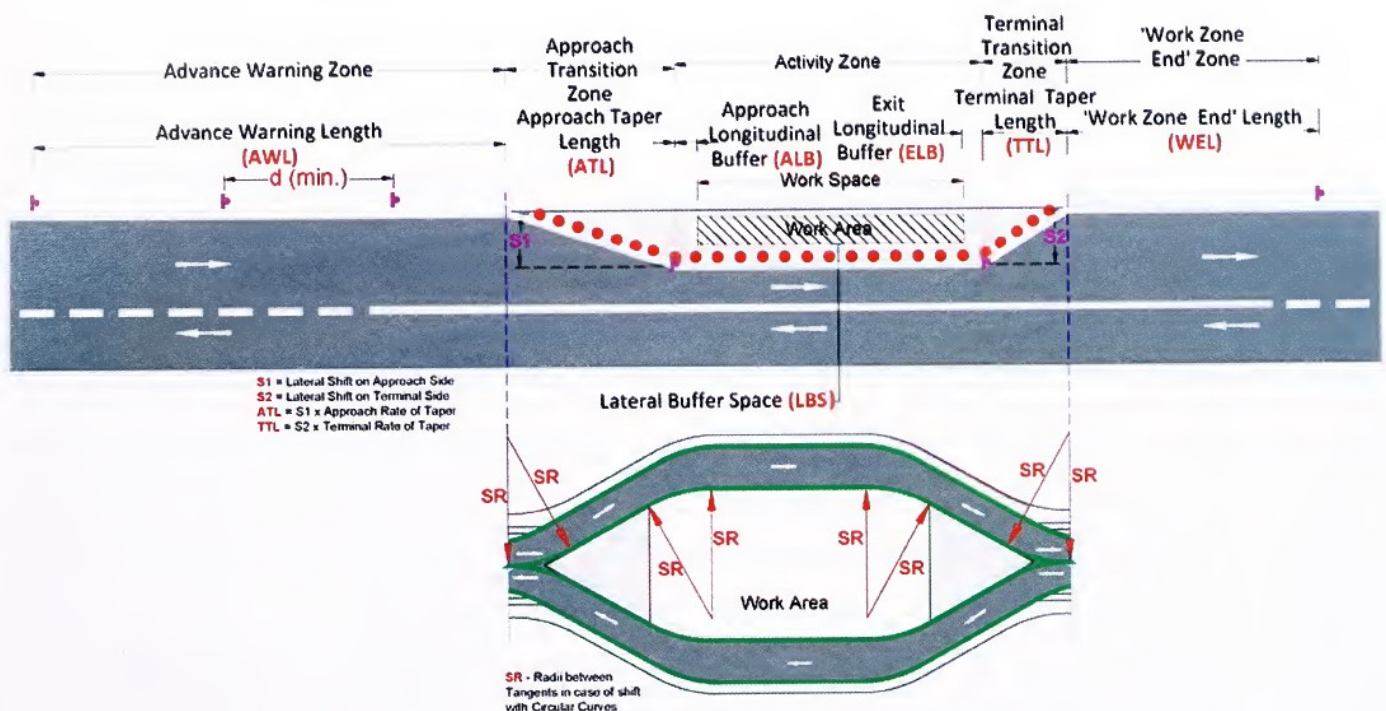
As the project road passes through both plain and rolling terrain, mainly in rural stretches except few settlements, and also it has inconsistent side slopes in few locations (varying abruptly every now and then), an appropriate construction methodology is prerequisite for effective construction and to prevent disturbance to existing traffic. Disturbance to traffic is inevitable during implementation but the same shall be kept as minimum as possible. Roads cannot be closed fully, except during night times /short periods and accordingly the major quantum of construction activities shall be scheduled during night hours. On-site activities shall be kept minimum and products from off-site activities such as footpath slabs, drain, kerb, components of CD structures etc., shall be brought to the site in ready-to-install condition. Safety of workers and public shall be ensured in accordance with IRC: SP-55-2014 "Guidelines for Safety in Construction Zones".

7.11.1 Traffic Control Zone

The construction zone is the area of the road which is affected by the works and which affects the traffic flow and road users. It includes all those areas of carriageway in advance of the actual work site which are required for advanced warning of the hazard as well as safety zones, transition zones and working zones itself. These elements are detailed in Figure 6.1.

Speed at the Start of Traffic Control Zones (kmph)	Advance Warning Zone/Length		Transition Zone/Length										Buffer Space				Work Space	Distance Between Sites in kilometers	
	First Sign from Start of Taper i.e. Advance Warning Length-AWL	Minimum Distance between two successive signs in meters-d (min.)	Approach Taper Length in Meters-ATL				Terminal Taper Length in Meters-TTL				Radius in Case of Circular Curves in meters - SR	'Work Zone End' Length in meters - WEL	Minimum Approach Longitudinal Buffer in meters - ALB	Minimum Exit Longitudinal Buffer in meters - FLB	Minimum Lateral Buffer Space in meters - LBS	Desirable		Exceptional	
			Rate of Taper	Example Width of Hazard (S1) including Buffer Space in meters	Rate of Taper	Examples Lateral Shift Including Buffer Space (S2) *in meters													
Up to 50	180	40	1:12	12	24	48	1:10	10	20	40	30	45	10	5	0.5	Varies**	2	1	
51 to 65	270	55	1:15	15	30	60	1:12	12	24	48	90	60	15	10	0.9		5	2	
66 to 80	350	80	1:18	18	36	72	1:15	15	30	60	165	75	30	15	1.2		10	5	
81 to 100	500	100	1:20	20	40	80	1:18	18	36	72	250	105	60	30	1.2		10	5	
101 to 120	1100	120	1:25	25	50	100	1:20	20	40	80	400	135	100	60	1.5		10	5	

Figure 7.1
Recommended Length of Traffic Control Zones



Note : The measured distance of S1 and S2 shown above is same when the road section is straight and may differ in other cases.

Figure 7.2
Recommended Length of Traffic Control Zones

The distance between two traffic control zones shall be such that the flow of traffic can return to normal stream between them and shall permit fast moving vehicles to overtake slow moving vehicles. The length of traffic control zone varies depending upon the work being undertaken. The length of advance warning and transition zones governed by the speed of approaching vehicle and the location of site. The

recommended lengths for each of the zones for a clearly visible approach given in figure 6.2.

7.11.2 Traffic Control Devices

The primary traffic control devices used in work zones are signs, delineators, barricades, cones, pavement markings and flashlights. These traffic control devices shall be used and placed as per the guidelines of IRC: 67-2012, IRC: 35-1997 and IRC: SP: 55-2014.

7.11.3 Traffic Management

Work Zone Traffic Management Plans (WTMPs) are required to meet the safety needs of regular traffic as well as works traffic, ensuring minimum disruption in access to properties and movement of pedestrians.

The traffic management strategies are to be used at traffic control zones. On the roads with low traffic flows width of 5.5m could be acceptable but two-way working would not be possible. Considering the limited paved width (existing) half the carriageway plus shoulders could be used for the movement of vehicles during the execution of half the road width. On completion of half the width, work on other half could be taken up.

Further, if the available road width is less after blocking the part roadway for construction activities, in such cases one-way traffic operation shall be done with the help of flagmen, positioned on opposite sides, and shall be on duty throughout the blockade period. For regulation of traffic, the flagmen shall be equipped with red/green flags and baton (red/green) lights. If the blockage length (work area length) is long, short range radio communication facility may be used for controlling the traffic.

7.11.4 Diversion Road (for CD works)

In case where the construction zone would close the road completely, the remaining carriageway space would be insufficient for the traffic and create large delays, and when there is no suitable alternative route, it will be necessary to construct a temporary carriageway. The temporary diversion road shall ensure requirements as stipulated in guidelines of IRC: SP: 55-2014. The temporary diversion road shall have all necessary traffic control devices as per IRC: 67-2012 and placed as per IRC: SP: 55-2014 guide lines.

7.11.5 Traffic Management for the Project Road

The traffic management shall be closely coordinated with the sequence of the construction operations. As the proposed improvement is to reconstruct/ widening/ strengthening the existing two-lane road to six lane with service road on either side, accordingly it is proposed to undertake the execution of new carriageway to the left side of the existing alignment and utilize the existing road for the traffic movement. On completion of this portion of the road, work on widening of the existing carriageway on the right side shall be carried out.

The improvement proposals suggested based on the surveys/investigations carried out, data analysis and designs. It is preferable to start the construction activities soon to prevent greater damage to road infrastructure due to continuous use of vehicles, vagaries of weather and traffic overloading. Any delay in project implementation coupled with non-maintenance may endanger the structural capacity of the asset eventually needing reconstruction (based on reengineering and re design), which is very costly and needs further time period.

CHAPTER 8 ROAD FURNITURE

8.1 General

For the safety of traffic, road furniture provided at appropriate locations along the project road as per relevant guidelines/ standards and specifications of IRC and MoRT&H. At the road intersections, the use of traffic control devices and other road furniture has been considered. The common types of street furniture, which are proposed to enhance road safety, reduce accidents and improve flow conditions, are road markings and road signs and traffic control devices at junctions. This chapter deals with the various road furniture proposed for the project road integral to proposals.

Safety of a road is the ability of the road to carry an adequate number of vehicles with minimum delay and inconvenience, which is highly dependent on the orderly movement of stream. Orderly flow of traffic is obtained when motorists were provided with intelligent and reliable regulation and information on the road and at the roadside. Effective traffic signs at the roadside are the basic necessity for maintaining the road safety. Road marking and road sign should be easily recognizable and readable under any condition of light. The visibility of road sign during night greatly depends on the amount of reflected beam against the incident light. High visibility of traffic signs is obtained by using reflective sheets, which possesses high level of reflectivity which can be obtained by glass bead (Spherical), corner-cube prismatic (triangular) and cat's eye (macro-sphere) structure, embedded in the reflecting sheets. The visibility of a road sign depends upon, retro reflective property of sheets used in road signs, intensity of primary light sources at the road, height of driver's eye and luminance caused by the headlight beam of the vehicle on road sign and by reflected beam on driver's eye. To maintain the retro reflectivity, the signs shall be cleared from dust accumulated and oil vapour of vehicle exhaust.

Road Furniture details include:

- *Road Markings*
- *Road Stud or Reflective Pavement Markers (RPM)*
- *Road Signs*
 - ✓ *Cautionary, Mandatory and Informatory signs*
 - ✓ *Direction sign Boards*
 - ✓ *Overhead sign Boards*
- *Guard Posts*
- *Road Delineators (Hazard Markers) and Chevron Signs*
- *Crash Barriers*
- *Kilometre stones*

- 200m stones and boundary stones
- Footpaths
- Bus bays / bus stops
- Landscaping
- Junction improvement
- Utility Crossings
- Lighting
- Guard Rail

8.2 Road Markings

Road markings perform important function of guiding and controlling traffic on a road. The markings serve as psychological barriers and signify the delineation of traffic paths and their lateral clearance from traffic hazards for safe movement of traffic. Road markings are therefore essential to ensure smooth and orderly flow of traffic and to promote road safety. Road markings will be as per IRC: 35-2015 "Code of Practice for Road Markings". Centerline markings, lane markings and edge line markings are proposed for the project road. Thermoplastic road markings with reflective glass beads are proposed for this purpose. Typical road marking is shown in Figure 8.1.



Figure 8.1
Details of Road Marking

8.3 Road Studs or Raised Reflective Pavement Markers (RPM)

Reflective Pavement Marker (RPM) or road stud is a device, which is bonded to or anchored within the road surface for lane marking and delineation for night time visibility. It reflects incident light in directions close to the direction from which it came.



Figure 8.2
Typical Road Stud (RPM)

Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS - (High Impact Polystyrene) or ABS or any other suitable material approved by the Engineer-in-Charge. The markers shall support a load of 13635 Kg tested in accordance with ASTM D4280. Reflective panels shall consist of number of lens containing single or dual prismatic cubes capable of providing total internal reflection of light entering the lens face. Lenses shall be molded of methyl methacrylate conforming to ASTM D788 or equivalent.

In the case of road studs to be placed on carriageway having paved shoulder, it shall

be placed outside edge line and shall be set back by a distance of 50 mm from the edge line. It shall be placed at an interval of 18 m in normal section and 9m on warning sections for both centre line and edge line.

Design details, Optical performance details and details of fixing and placement shall be in-accordance with Ministry's letter No.RW/NH-33023/10/97-DO III dated, 11 June 1997 on 'Technical Specifications for Reflective Pavement Markers (Road Studs)'. Typical details of road studs shown in Figure 8.2.

8.4 Road Signs

Road signs are extremely important tools of communication to guide and direct the driver through conflict points and hazards on the road network. They enable the driver to be given advance warning.

8.4.1 Cautionary, Mandatory and Informatary Signs

Cautionary, mandatory and informatory signs are provided depending on the situation and function, they perform in accordance with the IRC: 67-2022 "Code of Practice of Road Signs".

The signs must be placed at right angles to the line of travel of the approaching traffic. These signposts must be installed at an offset distance of 2m from the edge of the carriageway. The cautionary/warning signs are located at distances of 120m in plain and rolling terrain and 60m in hilly terrain in advance of hazard warnings in rural sections. In the case of urban locations, these are installed at a distance of 50m in advance of hazard warnings. The informatory signs such as advance direction signboards etc. are located at specified distances usually at major intersections on appropriate directions of travel.

The retro reflective sheeting used on the sign shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro-reflection over its entire surface. It shall be weather resistant and show colourfastness. It shall be new, unused, shall have no evidence of cracking, scaling, pitting, blistering, edge lifting or curling, and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed test laboratory.

The colour of the sheeting in case of wide-angle prismatic lens shall conform to the colour requirements determined by instrumental method in accordance with ASTM E-1164 on sheeting applied to aluminum test panels. Computation shall be done in accordance with E-308 for 2-degree observer. In case of Encapsulated lens type-

sheeting specification shall confirm with MOST, ASTM E-810.

A total of 193 Cautionary, 95 Informatory and 17 Mandatory Signboards proposed at appropriate locations along the project road.

8.4.2 Direction Sign Boards

Direction signboards at important locations indicating the important locations along the project road are provided. Overhead gantry sign boards (cantilever/portal type) or Variable message sign board with direction details along the left carriageway and provision for advertisement on the right carriageway will be fixed at right angles to the center line of the carriageway.

8.5 Guard posts

Guard posts proposed on embankments of height more than 1.5m, bridge approaches and horizontal curves of radius less than 170m. The spacing of guard post shall be 2.0m c/c in these areas. Typical Guard post consists of pre-cast (M20) CC post of size 200mm x 200mm and a height of 600mm above ground level. They encased in M15 cement concrete to a depth of 500mm below ground level. Guard posts painted with alternate black and white reflective paint of 150mm wide bands. Reflective markers provided on guard posts to enhance visibility during night and to enhance safety.

8.6 Road Delineators and Chevron Signs

Rigid (concrete) or flexible (rubberized plastic) delineators with reflective panels are proposed depending upon site conditions. These are especially useful at nighttime in guiding a driver through what might otherwise be a potentially dangerous location. They allow drivers more easily and accurately to judge their position on the road and are particularly helpful in conditions of poor visibility such as in rain, fog or darkness.

Hazard markers define obstructions like guard rails and abutments adjacent to the carriageway. The markers should be erected immediately ahead of the line of obstruction i.e, at the point where the bridge/culvert rail starts. The markers should be located immediately behind the guardrail at sufficient height to ensure proper visibility to the oncoming traffic. Hazard markers are also proposed near median openings (if any near the junctions). Reflective markers are provided on hazard markers to enhance

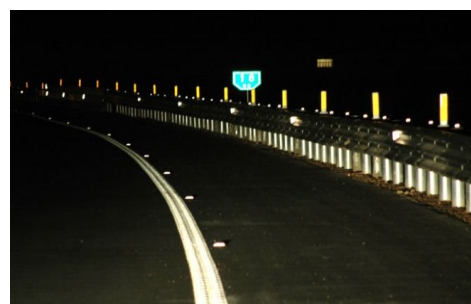


Figure 8.3: Typical Road Delineator

visibility during night and to enhance safety.

Object markers are used to indicate hazards and obstructions within the vehicle flow path, for example, channelizing islands close to the intersections.

Delineators are provided in accordance with the provisions of IRC: 79-1981. They are basically driving aids and should not be regarded as substitutes for warning signs, road markings or barriers. Delineators are generally provided for all curves of radius less than 600m. There is no need to provide object markers at locations where Chevron signboards are provided.

Chevron signs are very useful in showing the location of sharp bends. They should be sited so as to be visible as a vehicle approaches the hazard. If the bend is long, they should be repeated. If a guardrail is present the chevron signs should be sited behind, but not obscured by, the guardrail. The signboard should be retro-reflective signboard with wide-angle micro-prismatic lens.



Figure 8.4 Typical Chevron Signs

Typical delineators and chevron signs are shown in Figure 8.3 and Figure 8.4 respectively. Delineators proposed at appropriate locations along the project road.

8.7 Crash Barriers

Metal Beam Crash Barriers proposed at locations where the embankment height is more than 3.0m, at horizontal curves of radius less than 170m and at major bridge approaches. The beam rails shall be W-profile corrugated sheet steel beams conforming to the following mechanical properties and MoRT&H specifications.

- Tensile strength, Min = 483 MPA
- Elongation in 2 inches, Min = 12%
- Yield, Min = 345 MPA



Figure 8.5: Typical Metal Beam Crash Barriers

The beam elements shall have nominal width as shown in figure. Post consists of formed channel of size 150 x 75 x 5, 769mm long and space consists of formed channel of size 150 x 75 x 5, 330 mm long. All members of the system should be hot dipped galvanised to have a minimum coating of 550g/sqm, each face in compliance to relevant MORT&H Specification (Cl. 810). The spacing of posts should

be 2.0m c/c. Painting is done using Reflective paints on crash barriers to enhance visibility during night and safety. The crash barrier system absorbs impact of vehicle and laterally restrains a vehicle from veering off. This ensures minimum damage to the vehicle and passengers. This further prevents the vehicle from skidding back onto the carriageway and provides gradual vehicle deceleration and effective redirection. The W-beam absorbs maximum energy during collision by flattening out. Crash barriers have been tapered at the edges so as to bring it to the ground level gradually. Typical crash barriers are shown in Figure 8.5. At high embankment and curve less than 400m W beam Barrier proposed. 3660m of Crash Barrier is proposed along project road at various locations.

8.8 Kilometre Stones

The details of Kilometer stones are in accordance with IRC: 8-1980 guidelines. Both ordinary and fifth kilometer stones are provided. Kilometer stones are located on the left-hand side of the road as one proceeds from the station from which the Kilometer count starts. Kilometer stones shall be fixed at right angles to the centre line of the carriageway.

8.9 200m Stones and Boundary Stones

The details of 200m stones and boundary stones conform to IRC: 26-1967 and IRC: 25-1967. The 200m stones are located on the same side of the road as the kilometer stones. The inscription on the stones shall be the numerals 2, 4, 6 and 8 marked in an ascending order in the direction of increasing kilometer away from the starting station.

The numerals shall be 80mm high. The colour of the numerals shall be black on a white background. Boundary stones shall be located on either side of the road opposite every 200m stone and kilometer stone. In addition, these shall be fixed at all angular points of the boundary. Where the boundary is on a curve or the land is of significant value and likely to be encroached upon, the boundary stones, as required, shall be installed at closer intervals.

The letter RB, indicating road boundary, shall be inscribed on each stone and below it the name of the authority in which the road rests i.e., PWD, ZP etc. Boundary stones could be fixed after finalizing/fixing the ROW for the entire road length. In the project road boundary stones were observed at few locations.

8.10 Footpaths

For footpath, precast concrete blocks using controlled concrete of M20 grade with checkered tiles proposed at all built up locations. Kerbs are of semi-barrier type

and mountable type (near approaches to road side properties) and are proposed for painting.

8.11 Bus bays / Bus Shelter

Bus bays (minimum 1m wide) are proposed (as per the guidelines given in IRC: 80 - 1981) at locations where the right of way is adequate so as to ensure smooth entry/exit of buses without hampering the free flow of vehicles on the carriageway. At locations of existing bus stops where the provision of bus bay is impossible from space considerations provision will be made for bus stops with bus shelters with markings to delineate the bus stop location with necessary signboards and markings.

Construction of 8 Bus Bay and shelters with extra widening of paved shoulders (Bus Bay), shall to be provided at the following locations.

SI. No.	Chainage	Remarks
1	4+000	RHS
2	4+160	LHS
3	4+900	RHS
4	5+100	LHS
5	10+170	LHS
6	10+460	RHS
7	12+610	LHS
8	12+690	RHS

8.12 Landscaping

The landscaping will take into account the overall functional and aesthetic aspect and at the same time they will be in harmony with the surrounding and shall add to the beauty of road-scape.

Where possible, plantation will be made within the right of way at appropriate selected locations such as medians, islands near junctions, extra widths of footpaths, near bus bays / bus stops etc. Strip of grassing near the edges of road boundary induces aesthetic appearance in addition to delineating the road boundary. Small shrubs or grassing on the medians and islands near the junctions will have a soothing effect to the road. Also tree plantation will have bearing in reducing noise and air pollution like other environmental enhancement/mitigating measures. This item is proposed for private sponsorship.

8.13 Utility Crossings

To avoid frequent cutting of road for laying/maintaining/repair of utility services especially near settlements it is proposed to have Two metre wide strip of land at the extreme edge of ROW for accommodating utilities, both over as well as underground. Provisions contained in IRC: 98 shall be followed to accommodate utility services in built-up areas of Project Highway. Utility ducts in the form of 600 mm diameter NP-4 Pipe across the Project Highway along with inspection box/chamber at a spacing of 1 km shall be provided for crossing of underground utilities in built up areas.

8.14 Lighting

An assessment made regarding the adequacy/inadequacy of the existing illumination levels along the project corridor and near the junctions. An optimal proposal has been recommended including efficient lighting fixtures with reflective arrangements, capacitors and automatic sensor (with off/on) to improve illumination and at the same time consuming minimum power. The electrical poles proposed for mounting on tubular pole. The existing transformers, which are at ground level and located on footpath and partially on carriageway (in some cases), are proposed to be replaced with single pole mounted transformers.

CHAPTER 9 COST ESTIMATES

9.1 General

As a part of Detailed Project Report preparation for the project road, cost estimates have been prepared based on the improvement proposals. This takes into account reconstruction/ widening of the existing flexible pavement, strengthening and geometric improvements, strengthening/ rehabilitation/ reconstruction of bridges and CD structures in the entire length of the existing road. Cost estimate covers Widening/Re-Construction to Four Lane from Km 0.000 to Km 15.870 starts near Miriyan Telangana/Karnataka border and ends at Chincholi Section of NH-167N in Kalaburagi District in the State of Karnataka on EPC mode under Annual Plan 2023-24.

9.2 Components

The costs of various components of the improvement proposal include:

- ◇ *Site Clearance*
- ◇ *Earth Work*
- ◇ *Sub Base and Base Works*
- ◇ *Flexible Pavement*
- ◇ *Drain Works*
- ◇ *Footpath, Median and Kerb Works*
- ◇ *Road Furniture's*
- ◇ *Junction Improvement*
- ◇ *Miscellaneous Works*
- ◇ *Traffic Signs, Road Marking, and Other Appurtenances*
- ◇ *Bus Bay and Bus shelter*
- ◇ *Bridges and Culverts*
- ◇ *Lighting*
- ◇ *Utility Shifting*
- ◇ *Land Acquisition*
- ◇ *Contingencies*

The earthwork quantity computations for the proposed improvement proposal were based on existing cross-sections and proposed cross-sections for established standards in various sections along the project road. This quantity has been estimated directly from the software. In the estimate, utilisation of the existing subgrade with CBR of 10% is considered and provision of new subgrade material is

made at locations where CBR is less than 10% for reconstruction sections, however during execution tests on existing subgrade shall be carried out at closer intervals as per MORT&H specifications and if found suitable same shall be used by loosening, watering and re-compacting the existing subgrade. The provisions made towards subgrade quantity may be deducted as appropriate. The quantities for pavement work has been computed for proposed pavement components, shoulders, drains and related items for strengthening/ widening of existing structures and reconstruction of pavement. The provisions for these works for flexible pavement include Bituminous Concrete (BC), Dense Bituminous Macadam (DBM), and Wet Mix Macadam (WMM), sub-base, drains and all other related items.

The earthwork, pavement and shoulder at bridge approaches have been included as appropriate in road work items.

Provisions for road safety measures like pick up bus stops (bus bays), road signs, markings, Zebra range, and road appurtenances have been made. Turfing on embankment, earthen shoulder and low height flowering trees/plantation in median, roadside plantation and landscaping have been proposed. Approximate cost for shifting of utilities and land acquisition cost has been included separately on lump sum basis.

Provisions have been kept for improvement of important road junctions and all cross roads for proper integration between project road and cross road to achieve overall improvements from traffic point of view and safety.

9.3 Costing Data

The project cost is estimated mainly based on the rates derived after rate analysis using NHSR 2022-23, National Highways Circle, Bengaluru. For the few items of road works and CD structures not covered in NHSR, rates have been analyzed based on respective KPW, P&IWT department SR. The item wise rate analysis for various items of road works and CD works have been made by incorporating the actual lead distances. Items not covered in NHSR/ KPW, P&IWT department SR have been based on market rate.

Non-plastic material i.e., crushed stone aggregates have been considered for the construction of granular sub base layer and Bitumen with 60/70 grade is used for strengthening and wearing course layers. VG 40 is considered for main carriageway.

9.4 Material Rates

As discussed with the client, the latest issue rates of materials issued by concerned NHSR/ KPW, P&IWT circle for that particular quarter are adopted for the rate analysis. Adopted issue rates are given in Table 9.1.

Table 9.1
Material Rates

Material	Unit	Rate, Rs.
Bitumen 40 grade VG 40	MT	47650
RS Emulsion packed (Bulk)	MT	42192
SS Emulsion packed (Bulk)	MT	77059
Cement	MT	5800
TMT Steel	MT	59050

**Issue rates January 2023*

For raw materials such as, aggregates, sand etc., the lead distances are not considered as it is absorbed in the basic rates. However, for earthwork for embankment and mixed materials, appropriate lead based on actual location from the quarry/hot mix plant/pug mill/batching plant/RMC with respect to the project road has been considered.

9.5 Estimated Project Cost

Quantities of each of the item have been estimated based on the improvement proposals suggested and by making use of the typical cross sections/standard drawings developed.

Therefore, the estimated civil Cost is 242.34 crores excluding GST and the Total Project cost of balance work is Rs 392.96 crores.

Table 11.2
Abstract of Cost Estimates

Bill No.	Item	Amount (in Rs.)	Total Amount (in Cr.)	Total Amount in %
1	Site Clearance and Dismantling	4832555.00	0.48	0.20%
2	Earthwork and Subgrade	481185586.00	48.12	19.86%
3	Granular Sub-Base and Base Courses	487616899.00	48.76	20.12%
4	Bituminous Pavement Works	425591432.00	42.56	17.56%
5	Drain Works	72112714.00	7.21	2.98%
6	Road Furniture (Traffic Signs, Road Marking Street Light, High Mast Light & Others)	105940559.00	10.59	4.37%
7	Protection Works (Pitching, Turfing, Toe Wall/Guard Wall, RE wall, Retaining Wall & River Training)	429505961.00	42.95	17.72%

8	CROSS ROAD PIPE CULVERTS	9208059.00	0.92	0.38%
9	PIPE CULVERT	7335283.00	0.73	0.30%
10	BOX CULVERT	51345098.00	5.13	2.12%
11	SLAB CULVERT	74907521.00	7.49	3.09%
12	MINOR BRIDGE	189606177.00	18.96	7.82%
13	MAJOR BRIDGE	42680541.00	4.27	1.76%
14	VEHICULAR OVER PASS (VOP)	35166026.00	3.52	1.45%
15	Project Facilities (Bus Bay,Bus shelter, Rain Water Harvesting,etc)	6349056.00	0.63	0.26%
A	Civil Construction Cost	2423383467.00	242.34	
B	Utility Shifting Cost Excl GST	68141349.00	6.81	
1	IC/Pre-operative expenses @1% of (A+B) above	24200000.00	2.42	
2	Financing Cost (2% of debt amount)	19600000.00	1.96	
3	Interest during Construction	87300000.00	8.73	
C	Estimated Project Cost	2622624816.00	262.26	
D	GST @ 18% on C	472072467.00	47.21	
E	Centages			
1	Contingencies @ 1% on (A)	24233835.00	2.42	
2	Supervision Charges @ 1.5% on (A)	36350752.00	3.64	
3	Agency charges @ 3% on (A)	72701504.00	7.27	
4	Maintenance charges @ 2.50% on (A)	60584587.00	6.06	
5	Price Escalation charges @ 5% on (C)	131131241.00	13.11	
	Sum of E	325001919.00	32.50	
F	Pre-construction Activities			
6	Land Acquisition cost	503991153.00	50.40	
7	Afforestation (291 x 411.27 x 10) + 15.87 x 300000	5957795.70	0.60	
	Sum of F	509948948.70	50.99	
	Total Project Cost	3929648150.70	392.96	

The item wise cost estimate, BoQ of road works and CD works are given in Volume II-Cost Estimate.