Prepared for:

सड़क परिवहन और राजमार्ग मंत्रालय
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
Government of India

Karnataka
Public Works, Ports &
Inland Water Transport Department

Project:

Consultancy Services for "Feasibility-Cum-Geo Technical Study for the bypass to Shiradi Ghat from Km 238.000 to 261.450 on NH-48 in the State of Karnataka"

Subject:

KD-6- Draft Detailed Project Report for Final Approved Alignment for Bypass

Volume - I : Main Report

Prepared by:

GEOCONSULT
INDIA Pvt. Ltd.
A company of the
GEOCONSULT group

GEOCONSULT

473 Udyog Vihar
Industrial Estate, Phase V
Gurgaon 122016
Tel: +91-124-45 69 700
Fax: +91-124-45 69 710
Email: office@geoconsult.co.in

00	17.12.2015	First Issue	SGa	AKg	FKr
Rev.	Date	Description	Originator	Checked	Approved

Document No:	**I6060-REP-09-KD6-DDPR-Vol I-Main Rep**	Revision: **00**
GCI File Path	W:\PROJECTS\I6000\60\REPORTS\R09-KD-6-Reports\I6060-REP-09-KD6-DDPR-Vol I_MainRep\I6060 REP-09-KD6-DDPR-Vol I_MainRep.docx	

Disclaimer

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of GEOCONSULT being obtained. GEOCONSULT accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify GEOCONSULT for all loss or damage resulting there from. GEOCONSULT accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

Revision History

Rev.	Date	Long Description

TABLE OF CONTENTS

INTRODUCTION

This report is prepared under Contract Agreement clause 2.8; "Key Date No: KD 6: Draft Detailed Project Report for Final Approved Alignment for Bypass (DDPR)" after incorporation of Client's observations on earlier submitted "KD5: Kucha Draft Detailed Project Report (KDDPR)" vide letter no. NH/PIU-Tunnel/NH-48/KD-3/2015-16/383-386 dated 14.12.2015.

The present submission (10 Hard Bound Sets and 5 Soft Copies of each) is as detailed below:

(i) Volume-I Main Report:

- *Executive summary*
- *Project Description*
- *Socio Economic Profile*
- *Materials Surveys and Investigation*
- *Traffic Surveys and Analysis*
- *Design Standards and Specifications*
- *Alignment Proposals*
- *Summary of EIA/IEE and Action Plan*
- *Summary of Resettlement Plan*
- *Preliminary Cost Estimates*
- *Preliminary Economic Analysis*
- *Preliminary Financial Analysis*
- *Suggested Methods of procurement and packaging*
- *Conclusions and Recommendations*
- *Acknowledgement*
- *Compliance of the Observations*

(ii) Volume – II : Design Report

Part- I Traffic Study, Analysis and Forecast :

- *Description of Existing Road in Ghat Section*
- *Road and Bridge Inventory*
- *Traffic Surveys, analysis and forecast*
- *Proposed Pavement Design*

Part-II Design of Tunnels :

- *Proposed Tunnel Design, Standards*
- *Technical Note on Tunnel Section and System*
- *Structural Analysis- Primary Lining*
- *Structural analysis of Inner lining and Design*

Part-III Design of Bridges and Cross-Drainage Structures :

- *Proposed Bridges and Structures Design Basis and*
- *Bridges Dimensioning*

Part-IV Geological Design and Geotechnical Report :

- *Geological Survey and Analysis*
- *Geotechnical Investigations Report*

(iii) Volume-III Materials Report :

(iv) Volume - IV(a) Environmental Assessment Report including Environmental Management Plan (EMP) &

(v) Volume - IV(b) Resettlement Action Plan (RAP) :

(vi) Volume - V Technical Specifications :

(vii) Volume - VI Rate Analysis :

(viii) Volume - VII Cost Estimates :

(ix) Volume - VIII Bill of Quantities :

(x) Volume - IX Drawings (A3 Size) :

a. *Location map*
b. *Layout plans*
c. *General Drawings*
d. *Plan and Profile of Refined Alignment "A"*
e. *Typical Cross Sections showing Pavement details of Cut & Fill Section*
f. *Typical Cross Sections of Tunnel*
g. *Typical Cross Sections of Bridges*
h. *Tunnels- General Arrangement Plan and L-Sections (L&R)*
i. *Viaducts – General Arrangement Plan and L-Section*
j. *Cut & Fill and Viaducts – General Arrangement Plan and L-Section*
k. *GAD for proposed RoB at Railway km 54+650*
l. *Standard Drawings*
m. *Miscellaneous Drawings*
n. *Indicative Land Acquisition Plans*
o. *Detailed Cross Sections @ 100m interval*

(xi) Volume - X Civil Work Contract Agreement,

(xii) Volume-XI Project Clearances

VOLUME – I: MAIN REPORT

A. General

This Volume - I: Main Report, a part of "KD 6: Draft Detailed Project Report for Final Approved Alignment for Bypass (DDPR)" is submitted in accordance with the Contract Agreement and as per requirement specified in Terms of Reference (ToR) for preparation of Main Report of "Feasibility-Cum-Geo Technical Study for the bypass to Shiradi Ghat from Km 238.00 to 261.45 on NH-48 in the State of Karnataka".

0 Executive Summary

0.1 General

The project highway from Maranhally (Km 238+000) to Gundya (Km 261+450), is a section of NH-48 (new NH 75). NH-48 connects the capital of Karnataka, Bangalore to the Mangalore, a fast developing port city of Karnataka State. The project highway passes through two districts of Karnataka, namely, Hassan and Mangalore. The total length of the project highway is about 23km. The Location Map given in **Figure 0.1** refers to the location of the Project stretch along the NH-75/48.

Figure 0.1. Location of Project Stretch: Key Plan

0.2 Necessity of Bypass

There is a critical need for the improvement of the alignment in Shiradi Ghat Section to have a better connectivity to Newly Developing Mangalore Ports through Bangalore. The Government of Karnataka plans to enhance the connectivity and wants to avoid frequent lane closures during a monsoon season in this stretch of existing NH-48. Any improvement/ widening along existing road alignment, land acquisition and the cut of forest pose major concerns to implement any projects in Shiradi Ghat. To resolve these issues MoRTH has a strong view that a new alignment with a combination of tunnels and highpier bridges are required. A Team of international experts has found that there are no technical difficulties in building long tunnels in Shiradi Ghat even when considering the geotechnical stability of sites and the expected vertical gradients of tunnels and high level bridges. A four lane Greenfield bypass with long tunnels; long and high-pier bridges/viaducts; and road approaches for about 23 km length between Heggade/ Maranhally – Gundya/ Adda hole in Shiradi Ghat can be constructed in an economically & environmentally viable manner

0.3 Project Objectives

The main objectives of the Consultancy services are reproduced from ToR:

- To undertake preparation of Feasibility study of the proposed, road/ High pier arch Bridges / Tunnel Road including technical, economical, financial viability and land acquisition proposals.
- To prepare a report of three alternative alignments options study of proposed Bypass to Shiradi Ghat from Maranhally (km 238.000) to Gundya (km 261.450) section of NH-48 and recommend the best alignment based on their comparative statements.
- Soil investigation, Geotechnical studies & testing, detail survey & design of tunnel road.
- Cost Estimates with detailed drawing in the form of hard copies and soft copies.

0.4 Geology

A site visit has been conducted between 6th to 11th July '2015 for appreciation of alignments, different project components, topographic survey and general understanding of geotechnical and subsurface geological conditions for planning of geotechnical investigations and geophysical survey. Traversing has been made along the existing railway track between km 54/650 to km 61/000 & km 66/750 to km 68/750 which includes Kadagravelli and Yedakumari Railway stations and drive away survey along existing highway between Maranhally and Gundya .

The project area is mainly comprised of granite, granitic gneiss, amphibolites with local mafic bodies and garnitiferous siliminite gneiss/schist belonging to Peninsular Gneissic Complex. Being the oldest rock of the earth, it has undergone several phases of deformation which have been manifested at site by presence of at least three generation of folding, fault and shear zone. Numerous pegmatitic dyke/ quartz vein have cut across the parent rock.

0.5 Traffic Demand

Traffic analyses for the Project Road – present and future; have been worked out by different vehicle types and presented in Chapter 4. For ready reference, the traffic relating to the base year, year of commencement (i.e. open to traffic) and the terminal year of the Project appraisal period are presented below:

S. No.	TVC Location	Year	Total Traffic volume in numbers	Total Traffic In PCUs	Capacity Criteria			
					Capacity for divided carriageway (PCUs/day)	V/C ratio	LOS	Recommendation based on V/C ratio
Most likely scenario								
1	Km. 229.000	2015	8420	14859	30000	0.50	B	2L+Pav Shoulder
		2020	13574	23264	80000	0.29	A	4 Lane Divided
		2025	17954	35170	80000	0.44	B	4 Lane Divided
		2032	36842	59108	120000	0.49	B	6 Lane Divided
		2038	55983	87150	160000	0.54	C	8 Lane Divided
		2045	92116	137399	-	-	-	-
2	Km. 261.450	2015	6993	13066	30000	0.44	B	2L+Pav Shoulder
		2020	11373	20559	30000	0.69	C	2L+Pav Shoulder
		2025	17823	31212	80000	0.39	B	4 Lane Divided
		2033	33941	56675	120000	0.47	B	6 Lane Divided
		2040	55245	88816	160000	0.56	C	8 Lane Divided
		2045	78697	123436	-	-	-	-

0.6 Proposed Alignment "A"

Recommended and Approved Alignment Option "A" proposed on the Southern side of existing NH-48 has been further refined for better geometry and uniformity. The alignment starts near Heggade Village (km 236.400) traverses through Greenfields, bypassing Heggade, Maranhally Kadagaravalli, Yedakumari and Gundya, villages and ends at Adda Hole (km 263.400) of NH-48. The total length of alignment under this option is 23.579 Km, and the route consists of 6 tunnels (length 12.631km varying from 1660 to 2960 m), 6 bridges, One RoB and One Viaduct (length 6.327km, varying from 50 to 3217m), and 4.621km long cut & fill sections.

The route has low gradient (roads & bridges: 0 to 3.5%, tunnels: 3.0 to 3.5%) and gentle curves (R=500m to 2000m). The height of bridge piers in the deep valleys is restricted to 120m that makes the early implementation of the project possible. Also, tunnel lengths are limited to 3.0km that makes the scale of ventilation/emergency facilities ordinary in size. Only 4.621km out of total length of 23.579km is planned as "cut and fill" that requires deforestation of the construction area. Plan and Profile Drawing is given in Volume IX: Drawings.

0.7 Abstract Cost

Abstract of resultant estimated civil construction costs of proposed tunnels, bridges, viaduct, road approaches including road furniture, and cross drainage structures etc. is Rs 9416.8 Crores.

Sl	Description	Length (km)	Cost (Cr. Rs)
1	Tunnels	12.631	4409
2	Bridges, ROB, Viaduct etc	6.327	4013
3	Cut & Fill Section	4.621	580
	Total Length (km)	**23.579**	
	Access Road with maintenance during Construction period (60 months)		415
	Total Civil Construction Cost (Rs in Cr.)		**9416.8**
a.	Environmental Mitigation Cost during construction		1.2
b.	R& R and Land Acquisition Cost		15.5
c.	Establishment Charges (2.5%)		235.4
d.	Sub Total		9668.9
e.	Service Tax 14.5%		1015.2
	Total Project Cost (TPC), Rs in Crores		**1015.2**

0.8 Economic and Financial Analysis

As per the ToR, the Economic and Sensitivity analysis should include a switching value analysis for construction costs and traffic levels. While carrying out the above sensitivity analysis, these two parameters, viz. construction cost and traffic level have been incorporated to evaluate the impact of changes in the net present value by increase the total project cost (not only construction cost) by 20%, and also decrease in traffic level (by reducing the total project benefits) by 20%. This exercise is fairly wide as well as robust to take care of any investment decisions.

The Project Viability Gap Funding (VGF) comes to 97% (during construction) i.e. Rs. 11118 Cr. The project is unviable for BOT/ DBFO pattern as per financial analysis, hence, it is recommended that this option is not to be considered.

The project is recommended under EPC with 100% government funding.

1 Project Description

1.1 General

The State of Karnataka is located in southwest part of India, surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The existing NH 48 (new NH 75) runs in the state of Karanataka through Bangalore Rural, Tumkur, Hassan and Dakshin Kannada districts and passing through important cities like Nelamangala, Kunigal, Yediyur, Channarayapatna, Hassan, Sakleshpur, Shiradi Ghat, Uppinangadi, Bantwala Crossing, and ending at Mangalore.

The Government of India has sought financial assistance towards improvement of roadway segment between Maranhally (km 238.000) and Gundya (km 261.450) on NH-48 Hassan-BC Road section, under "National Highway Development Program (NHDP)". The Executive Engineer, NH-48, Project Implementation Unit (WB) Shiradi Ghat Tunnel Construction Division, Sakaleshapura, Karnataka, as 'Authority', intends to apply a portion of the financial assistance for providing consultancy services to prepare feasibility-cum-geotechnical study for the bypass to Shiradi Ghat.

In pursuance of the above, GEOCONSULT India Pvt. Ltd (GCI), India have been appointed as Consultants to provide Consultancy Services for Feasibility - Cum - Geo Technical Study for the bypass to Shiradi Ghat from Km: 238.000 to 261.450 on NH-48 in the State of Karnataka. The consultancy agreement for the services was signed on 24th June 2015. It was informed vide Authority letter no NH/PIU-Tunnel/NH-48/Tender/2015-16/43-52 dated 24-06-2015 to proceed the said work within 7 days from receipt of letter i.e. latest by 6th July 2015.The consultant vide letter no. I6060-2015-L-06/003: dated 24th June 2015 agreed to commence consultancy services accordingly.

1.2 Scope of Services

In developing the Work Plan for completing the assignment, the activities have been categorized under stages as follows:

- ✓ *Quality Assurance Plan and Inception Report*
- ✓ *Project Preliminary Report*
- ✓ *Feasibility Report*
- ✓ Detailed Project Report
- ✓ *Documents of Project Clearances*
- ✓ *Land Plan Schedule and RAP*
- ✓ *Bid Documents & Technical Schedules*

These stages will generally follow a sequence, though each stage is inter-related and inter-dependent on each other. The related reports for each stage will be submitted to the Executive Engineer Shiradi Ghat PIU (WB) Sakleshapur, the Authority.

1.3 Existing Road Description

The terrain on this Ghat section of 23km can be termed as hilly and mountainous. The abutting land use pattern varies from residential to agricultural and forest area. Sparingly industrial land also is observed along with barren lands. Almost throughout the ghat section of the Project Highway, very few human settlements were observed along the road. They were as semi built-up and completely built-up areas. The settlements are mainly residential, commercial, religious places viz temple, masjid/mosque, church and petrol stations. The river Kempuhole runs almost parallel to the road on left side along the entire Ghat section. Important crops grown are coffee, Black Pepper, Potato, Paddy and Sugarcane. There are four running mini hydel power stations located at the Ghat section,

out of which three are on Left side and One on Right side of the highway.

Important places and villages are Heggade, Maranhally, Kempuhole, Gundiya, and Addahole along the Project stretch. The existing road is having two lane undivided carriageway width of 7.0 m of flexible & newly laid rigid pavement and predominantly gravel/earthen shoulder of 1.0m to 2.0m width.

The existing road is having two lane undivided carriageway width of 7.0 m of flexible pavement with predominantly earthen shoulder and paved shoulder at few locations of width varying from 1.0m to 1.5m. The horizontal geometry of the Project road doesn't meet IRC standards with respect of design speed, pavement surface condition, riding quality etc. It has many sharp and substandard curves; the stretches passing through ghat sections have sharp curves with design speed of less than 30kmph. All major utility providers have cables running throughout the project road on both sides.

The State PWD took up the work of improvement and reconstruction of the badly damaged bituminous pavement with providing cement concrete pavement from km 238 to km 250.

Sakaleshpura Bypass: The Bypass alignment has been fixed and required land for the bypass has already been acquired by competent authorities on the Left hand side. The bypass alignment starts at km 219.800 [Existing Chainage] of NH-75/48 and passes along the agricultural land and behind the periphery of Planters Club, KEB sub station before Sakleshpura out skirts crossing Hemavathi River. Finally bypass alignment joins the NH-75/48 at km 225.400 [Existing Chainage]. A new bridge for 4-lane highway has to be constructed across Hemavathi River. This bypass will be well connected with four laning of national highway from km 225.400 to km 236.400; the take off point of Shiradi Ghat Bypass. Considering rapid urbanization and future development in the out skirts of Sakleshpura, Shiradi Ghat bypass may be directly connected to Sakleshpura bypass.

2 Socio Economic Profile

2.1 Introduction

The socio economic profile helps in making project implementation decisions. A survey of historical, economic and demographic activity can help to explain current social status distribution among the society, the living standards, the quality of life, general awareness, maturity levels, in turn the reflection on the growth of traffic, etc.

This chapter endeavours to provide socio-economic profile at two levels i) Region or State level and ii) Project Influence Area. Socio-economic and demographic data of the project area – population & density, employment, poverty levels, industry, agriculture, literacy, health, transport, tourism potential and related aspects. Socio- economic profile has been prepared to provide a quantitative framework against which qualitative socio and economic impacts of any of the development initiative can be assessed and evaluated.

The socio-economic profile is discussed in terms of a few selected indicators, which are broadly categorized in to the following and hence together are termed as Socio Economic Indicators.

2.2 Project Influence Area

A project Influence Area is the zone that fall in the near vicinity of the project corridor, to which the project investments induce a catalytic development resulting in additional generation of traffic other than normal. The project corridor passes through two districts – Dakshina Kannada and Hassan in Karnataka state. Therefore, the influence area of the project corridor, for the purpose of the study, is defined as broad PIA at the State or region level, and as immediate PIA at district level. Thus the limits of this zone for this project are assumed to be 0 to 20km on the northern side and 0 to 5 km on the southern side of the project corridor.

The Project roads stretches starts from Km 238.000 (Hassan) to Km 261.450, total length is 23 km. The Project Road mainly passes through Addahole, Maranhally, Shiradi, Gundya and Heggade joining Bangalore – Mangalore Road.

Index Map given in Figure 2.1 refers to the location of the Project stretch along the NH-75/48.

Figure 2.1: Location of Project Stretch

A detailed accounting of the socio-economic profile of the Project Influence Area (PIA) has been prepared which traces the PIA's economic performance of the past and establishes the likely growth prospects of the future. The output of this Chapter is the economic growth prospects of the PIA with respect to certain selected economic variables and serves as the

basis for arriving at a realistic traffic growth rate, for different vehicle categories.

2.3 Profile of the project state

The project section traverse through Karnataka state fall on south-western part of India. Karnataka, was called as Karunadu (elevated land) in ancient times. The course of Karnataka's history and culture takes us back to pre-historic times. The earliest find of the Stone Age period in India was a hand axe at Lingasugur in Raichur district. The Ashoka's rock edicts found in the state indicate that major parts of Northern Karnataka were under the Mauryas. Chandragupta Maurya, the great Indian emperor abdicated the throne and embraced Jainism at Shravanabelagola. Adding new dimensions to the cultural and spiritual ethos of the land, many great dynasties left their imprint upon the aesthetic development of Karnataka's art forms. Prominent among them were the Chalukyas, the Hoysalas and the mighty Vijayanagara Empire. The Chalukyan's built some of the very early Hindu temples in India. Aihole turned up as an experimental base for the dynamic creations of architects. The Hoysala's who ruled from the 11th to the 13th century chiselled their way into the pages of glory by building more than 150 temples, each one is a masterpiece in its own way. The amazing dexterity and fluidity of expressions at Somnathpur, Halebid and Belur open themselves to the wide-eyed wonder in one's eyes. Vijayanagara, the greatest of all medieval Hindu empires and one of the greatest the world over, fostered the development of intellectual pursuits and fine arts. "The eye of the pupil has never seen a place like it and the ear of intelligence has never been informed that there existed anything to equal it in the world" is what Abdur Razaaq the Persian ambassador had to say about Krishnadevaraya's time.

The Vijayanagara Empire with its capital at Hampi fell victim to the marauding army of the Deccan Sultan in 1565 A.D. As a consequence of this, Bijapur became the most important city of the region. This city is a land of monuments and perhaps no other city except Delhi has as many monuments as Bijapur. The Bahmani, Shahis and the Adilshahis of Bijapur have played a notable part in the history of Karnataka by their contribution to the field of art and architecture and also by their propagation of Islam in the state.

Hyder Ali and his valiant son Tipu Sultan are notable figures in the history of the land. They expanded the Mysore kingdom on an unprecedented scale and by their resistance against the British, became personages of world fame.

Tipu was a great scholar and lover of literature. His artistic pursuits were also many and he made rich gifts to the Hindu temples. Tipu Sultan "Tiger of Karnataka" was killed in 1799 A.D., and the Mysore throne was handed over to the Wodeyar's. The whole of Karnataka came under the control of the British in the beginning of the 19th century. The new state was named as new Mysore and the Maharaja of Mysore was appointed Governor by Independent India. This unified state was renamed as Karnataka on November 1, 1973. Karnataka is popularly known for Carnatic Music, which has given to the World a unique form of Classical Music patronized by many across the continents. Karnataka is also known as the Capital of Agarbathi (Incense Sticks), Areca nut, Silk, Coffee and Sandal Wood. All this is apart from the fact that it has been the Cultural Center for hundreds of years and its testimony stands spread across the State, pulling millions of Tourists from all parts of the World to Karnataka, whose richness and hospitality can only be felt and never explained better.

Bangalore, the much known as “Silicon City of India” is the Capital of this beautiful state. Today it has become an Industrial Metropolis. It is also called India’s science city. Sophisticated industries in the public sector employ thousands and thousands of workers. It is also called the Electronics city because most of the country’s basic electronic industries are based here. It is the fastest growing city in Asia. Aircraft building, telecommunication, aeronautics, machine manufacture, etc., are a few unique areas of specialization the city possesses and is proud of. The overall weather throughout the year is pleasant and the average temperature is not more than 28 degrees. Bangalore was known for its salubrious climate which however is now being debated because of the accelerated progress of modern industry. It was called an air-conditioned city and a pensioner’s paradise but with these advances it is to be seen how long it could retain these epithets.

2.3.1 Topography, Location & Boundaries

Karnataka has representatives of all types of variations in topography - high mountains, plateaus, residual hills and coastal plains. It is situated on a tableland where the Western and Eastern Ghat ranges converge into the Nilgiri hill complex, the State of Karnataka is confined roughly within 11.5 degree North and 18.5 degree North latitudes and 74 degree East and 78.5 degree East longitude. 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 Tamilnadu 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. It accounts for 5.83 percent of the total area of the country (3.288millionsq.km) and ranks eighth among major States in terms of size. The State is enclosed by chains of mountains to its west, east and south. It consists mainly of plateau which has higher elevation of 600 to 900 metres above mean sea level. The entire landscape is undulating, broken up by mountains and deep ravines. Plain land of elevation less than 300 metres above mean sea level is to be found only in the narrow coastal belt, facing the Arabian Sea. There are quite a few high peaks both in Western and Eastern Ghat systems with altitudes more than 1,500 metres. A series of cross-sections drawn from west to east across the Western Ghat generally exhibit, a narrow coastal plain followed to the east by small and short plateaus at different altitudes, then suddenly rising upto great heights. Then follows the gentle east and east-north-west sloping plateau. Among the tallest peaks of Karnataka are the Mullayyana Giri (1,925 m), Bababudangiri (Chandradrona Parvata 1,894 m) and the Kudremukh (1,895 m) all in Chikmagalur Dt. and the Pushpagiri (1,908 m) in Kodagu Dt. There are a dozen peaks which rise above the height of 1,500 metres.

The project stretch passes through two districts viz. Hassan and Dakshina Kannada. The details about each district are as below:

2.3.2 Hassan District

Hassan occupies larger geographical area (among the two districts of Hassan and Dakshina Kannada) of the State with 3.56 per cent and Dakshina Kannad District occupies 2.54 per cent. Hassan district has a total area of 6826.15 Sq. Kms and it is divided into 8 Taluks & 2369 Villages. The Geography is mixed with the Malanad or mountainous region to the west and south west called Bisle Ghat and the Maidan or plains regions in the north, south and east. There are some areas of reserved forest ranges in central portion of the district. The Dakshina Kannada district can be divided into two agro-climatic regions as coastal region and Malnad region. The coastal region consists of Mangalore and the Malnad region consists of Belthangady, Puttur, Sullia and Buntwal taluks.

Hassan district is strategically sited 180 km from the Bangalore metropolis. The District is surrounded by Chikmangalur District to the northwest, Chitradurga district to the north, Tumkur district to the east, Mandya District to the south east, Mysore district to the south, kodagu District to the south west, and Dakshin kannad District to the west.

The district lies between 12° 13´ and 13° 33´ North latitudes and 75° 33´ and 76 º 38´ East longitudes.

The general level of Hassan district is; it slopes with the course of Hemavathi River from the western ghat ranges towards the bed of Cauvery River near Hampapura in the south east. Its chief tributary is Yagachi River from Belur taluk which joins it near Gorur. Hemavathi passes through Holenarsipur taluk in a southerly direction and joins with Cavery River near Hampapura close to the border of Hassan district. Hassan and Belur stands around 3084 and 3150 feet above the sea level respectively.

Tourism and coffee are the two main sources of income of Hassan district. Coffee is grown in the Malnad areas of Sakleshpura. Other than this, farmers grow black pepper.

Hassan is a historical place situated in Karnataka. From here one can visit Belur, Halebid and Sravanabelagola. Hassan is a landmark as it is the oldest town of Hoysala Empire of 11th to 13th Century A.D. It has gained importance in the tourism industry for its architectural masterpieces. Belur in Karnataka is located at a distance of 38 kilometers from Hassan. It is popular for its **Chinnakeshava Temple**, one of the three major Hoysala sites. The Temple was constructed to memorialize the victory of Hoysala over Chola kingdom at Talakad. Till date the temple is remained unfinished despite of 86 years of hard labour. The temple stands as a testimony to the amazing Hoysaleswara style of art and architecture. Temple walls are decorated with awesome images of variety of gods and goddesses, animals, birds and dancing girls. Kedareswara and Jain temple are other attractions in Halebid.


HASSAN
DISTRICT
N
CHITRADURGA
Kanakatte
Rampur
CHIKMAGALUR
Manakattur
TUMKUR
Sankahalli
Arsikere
Kodihalli
Halebidu
Kodihalli
Kammaraghatta
Belur
Nagenahalli
Hagare
Santesivara
Hemavati
Koravangala
Nugglihalli
Hosahalli
Mugli
HASSAN
Agalhalli
NH-48
Gaudagere
NH-48
Sakleshpur
Alur
Ambuga
To Bangalore
Kadagarvalli
Kadalu
Channarayapatna
Shravanabelagola
Kerodi
Hole
Attihalli
Arkalgud
MANDYA
DAKSHINA KANNADA
Konanuru
Bidarakka
KODAGU
MYSORE
LEGEND
National Highway
Major Road
Railway
District Boundary
State Boundary
River
District HQ
Other Town
Major Town
Map not to Scale
Copyright © 2013 www.mapsofindia.com
(Updated on 19th February 2013)

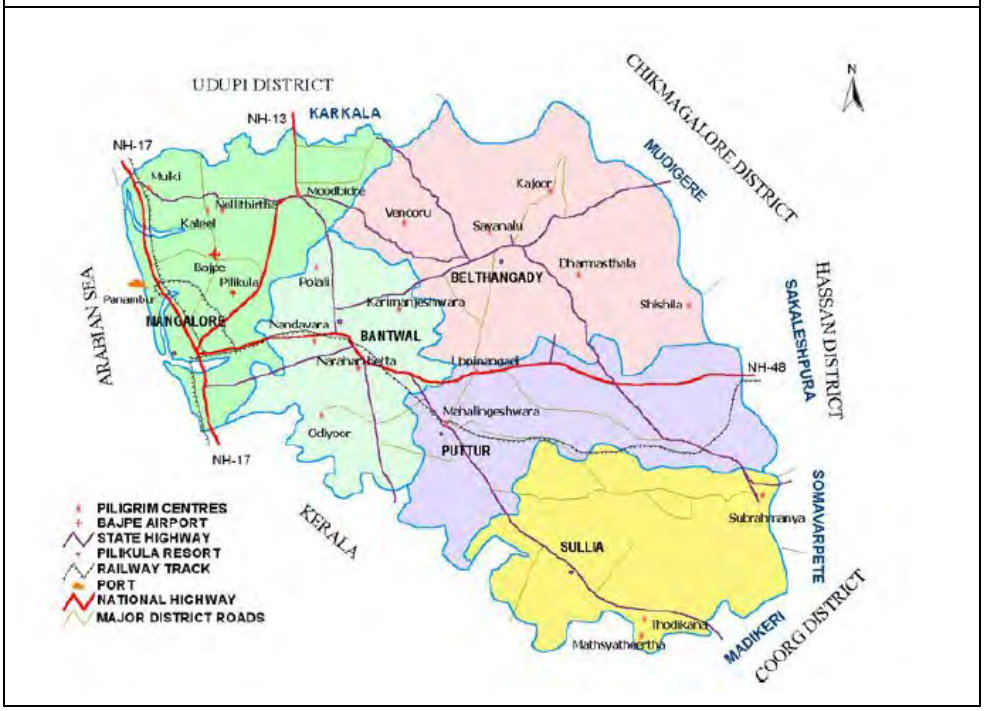
2.3.3 Dakshin Kannada District

Dakshina Kannda is the southern coastal district of Karnataka in the state of Karnataka in India. It is bordered by Udupi district to the North, Chickmagalur District to the Northeast, Hassan District to the east, Kodugu District to the south east, and Kasaragod district in Kerala to the south, the Arabian sea bounds it on the west. Mangalore is the head quarter and chief city of the district. Dakshin Kannada has 4866 Sq. Kms and it is divided into 5 Taluks.The district lies between 12° 57' and 13° 50’ North Latitude and 74° and 75° 50’ East Longitude.

The important rivers of Dakshina Kannada District are Suvarnanadi, Shambavi (Mulki), Gurpur River, Nethravathi, Pavanje, Nandini. Besides these, there are many other rivers with perennial flow of water and a number of streams, all running from east to west.

The valleys are fertile and boast of several gardens of areca nut and coconut, and paddy

fields, which are the main crops of the district. The Western Ghats form the eastern boundary of the district consisting of evergreen forests with patches of paddy fields and areca nut gardens scattered here and there surrounded by forests.



2.4 Economic Situation

The broad social and economic profile of the project state during the past decade has undergone tremendous change. State Domestic Product (SDP), popularly known as 'State Income', is an important and reliable indicator to measure the growth of the economy as well as level of development in various socio-economic sectors of a state. The per capita Net State Domestic Product is used to determine the absolute as well as the relative per-

formance of the State Economy. In other words State Domestic product (SDP) and Per Capita Income (PCI) reflect overall performance of economy of the State and also the well being of the people during a given period of time. The economic growth of all the project Karnataka for the last three years is summarized as under:

2.4.1 State Domestic Product (SDP)

The State Domestic Product (SDP) represents the total monetary value of all the goods produced and services rendered during a given period of time, generally a year, within the geographical boundaries of the State. Gross State Domestic Product (GSDP), Net State Domestic Product (NSDP) and Per Capita Net State Domestic Product or Per Capita Income (PCI) are evaluated both at current and constant prices. The SDP estimates at current prices are obtained by evaluating the goods and services at prices prevailing in the market during the year and the estimates at constant prices are prepared by evaluating the goods and services of current year with base year prices.

2.4.2 Gross State Domestic Product (GSDP)

The Gross State Domestic product (GSDP) is the total monetary value of all the goods produced and services rendered by an economy during a given period of time, generally, a year before making any provision for Consumption of Fixed Capital. The GSDP at current prices for Karnataka state for the year 20010-11 is estimated to be Rs. 34867369 lakhs as compared to Rs. 20585245 lakhs for the year 2006-07. The composition of Gross State Domestic Product by broad sectors of economy for the last three years, in the project state at current prices, is given below **Table**

Table 2.1: Gross State Domestic Product at Factor Cost by Industry of Origin (At Current Prices Rs.in Lacs.)

Sl. No.	Sector	Karnataka				
		2006-07	2007-08	2008-09	2009-10	2010-11
1	Agri. & Allied Sector	3298452	4029734	4144200	4270113	4406098
2	Mining & Quarrying	276870	329340	345493	363261	382451
3	Manufacturing	3649879	3983772	4595060	5267477	5993687
4	Construction	2009059	2353329	2823753	3341219	3900083
5	Electricity & Water Supply	418588	473941	490622	508971	528788
6	Services	10932397	12664711	14791095	17130117	19656262
State Domestic Product		20585245	23834827	27190223	30881159	34867369

Source: -Central Statistical Organisation (CSO)

The Gross State Domestic Product at factor cost by Industry of Origin (1999-2000) prices for the project state for the year 2010-11 is estimated to be Rs. 20139322 lakhs as compared to Rs. 15283218 lakhs in the year of 06-07.

The composition of Gross State Domestic Product by broad sectors of economy for the last years at 1999-2000 prices is given below **in Table 2.2.**

Table 2.2: Gross State Domestic Product at Factor Cost by Industry of Origin (At 1999-00 Prices) (Rs. in Lacs.)

Sl.	Sector	2006-07	2007-08	2008-09	2009-10	2010-11
1	Agri. & Allied Sector	2624261	3036337	2861351	2668866	2460983
2	Mining & Quarrying	137718	156670	162649	169226	176329
3	Manufacturing	2641285	3017442	3150284	3296410	3454226
4	Construction	1465922	1634930	1769175	1916845	2076328
5	Electricity & Water Supply	307359	339100	323960	307306	289320
6	Services	8106673	9072809	9866400	10739350	11682136
State Domestic Product		15283218	17257288	18133819	19098003	20139322

Source: -Central Statistical Organisation (CSO)

2.4.3 Net State Domestic Product (NSDP)

The Net State Domestic product is arrived at after deducting the value of Consumption of Fixed Capital (CFC) or depreciation from the Gross State Domestic Product.

Situated in South West India, Karnataka is one of the leading States in the country in terms of economic development. It is the eighth largest State in terms of both economy and development. The State's GDP at constant prices (2002-03) at Rs.72,399 crore accounts for 5.5 per cent of the national GDP. The State has witnessed a healthy 6.5 per cent CARG in the GSDP for the ten year period 1994-2003, being the highest among the leading States in the country. Karnataka has witnessed the trend of high economic growth during 05-06 fiscal 8.7% at constant prices. The primary sector is expected to grow at 6.3%, secondary sector at 5.7% and the tertiary sector at 11.2 %. Historically, the inflation prevalent in the State has been less than the national inflation rate. The State is largely service oriented and income from the sector contributes to half the State's GDP with the agricultural and the industrial sector contributing to nearly 25 per cent each. The major manufacturing oriented industries in the State include – Sugar, Paper, and Cement industries. The Net State Domestic Product (NSDP) at current prices for the year 2010-11 in the project state viz. Karnataka is estimated to be Rs. 30547299 lakhs as compared to Rs**.** 17964533 lakhs in the year 2006-07.

The year-wise estimates and composition of Net State Domestic Product (NSDP) by broad sectors of economy for the last 5 yrs, at current prices, is given in **Table 2.3.**

Table 2.3: Net State Domestic Product at Factor Cost by Industry of Origin (At Current Prices) (Rs. In Lacs.)

Sl.	Sector	2006-07	2007-08	2008-09	2009-10	2010-11
1	Agricultural and Allied	3014970	3715362	3795551	3883759	3979023
2	Mining & quarrying	235064	282777	293631	305570	318465
3	Manufacturing	2705703	2863295	3265357	3707625	4185275
4	Construction	1952694	2256181	2743759	3280095	3859337
5	Electricity, gas & Water supply	182430	212364	200890	188269	174637
6	Services	9873672	11447367	13449555	15651962	18030561
State domestic product		17964533	20777346	23748743	27017280	30547299
Population		56647000	57292000	57927000	58625500	59379880
State Per Capita Income (Rs.)		31713	36266	40998	46203	51825

Source: -Central Statistical Organisation (CSO)

The Net State Domestic product at factor cost by origin (1999-2000) prices in the project state is estimated to be Rs. 17528860 lakhs in the year 2010-11 as against Rs. 13364779 lakhs during 2006-07.

The year-wise estimates and composition of Net State Domestic Product (NSDP) by broad sectors of economy for the last 5 yrs.at constant prices, is given in **Table 2.4.**

Table 2.4: Net State Domestic Product at Factor Cost by Industry of Origin (At 1999-00 Prices) (Rs. In Lacs.)

Sl	Sector	2006-07	2007-08	2008-09	2009-10	2010-11
1	Agricultural and Allied	2406872	2806520	2618333	2411327	2187761
2	Mining & quarrying	107431	124178	127791	131765	136058
3	Manufacturing	1961393	2246593	2276308	2308995	2344296
4	Construction	1423933	1587128	1714756	1855147	2006769
5	Electricity, gas & Water supply	126138	147245	120846	91807	60445
6	Services	7339012	8223479	9005125	9864936	10793531
State domestic product		13364779	15135143	15863159	16663977	17528860
Population		56647000	57292000	57927000	58625500	59379880
State Per Capita Income (Rs.)		23593	26418	27385	28449	29597

Source: -Central Statistical Organisation (CSO)

2.4.4 Per Capita Income (PCI)

Dividing the Net State Domestic product by the total population of the State derives Per Capita Income. As per available data the per capita income for the year 2011-12 at current prices for the project state is estimated at Rs. 44670 as compared to Rs. 31713 for the previous year 2006-07. As per estimate at constant (1999-00) prices, the per capita income in the project state for the year 2011-12 is estimated to be Rs. 30175 as compared to Rs. 23593 for the year 2006-07. Net State Domestic Product (NSDP) and corresponding Per Capita Income have been depicted in **Table 2.5** from 1999-00 to 2011-12 for the project state.

Table 2.5 : Net State Domestic Product (NSDP) and Per Capita Income

Year	Karnataka			
	At Current Prices		**At Constant Prices**	
	NSDP	**PCI**	**NSDP**	**PCI**
	(Lakhs Rs.)	**(Rs.)**	**(Lakhs Rs.)**	**(Rs.)**
1999-00	9053192	17502	9053192	17502
2000-01	9634777	18344	9113592	17352
2001-02	9889675	18547	9278843	17402
2002-03	10589474	19621	9776504	18115
2003-04	11423011	20901	9966856	18236
2004-05	13669655	24707	10976803	19840
2005-06	16118218	28787	12498807	22322
2006-07	17964533	31713	13364779	23593
2007-08	20777346	36266	15135143	26418
2008-09	21674470	39408	16166148	28450
2010-11	23428686	42596	17289998	29225
2011-12	26698540	44670	181133321	30175

Source: -Central Statistical Organisation (CSO)

The above table reveals that both NSDP and PCI have been showing an upward trend (both at current and constant prices) over the years.

2.4.5 Agriculture

Karnataka state are predominantly agricultural and about 80% of the population depends on agriculture for its livelihood. Rice, wheat, soybean, rapeseed and mustard are among the principal crops of these state. From the below table we can see that is the highest producer of Rice compare to other project state. Likewise, Karnataka is the highest producer of wheat.

According to 2003-04 data, Karnataka state has 19050 hectares ('000) of geographical area, out of which a 16% is under forest. About 20% (3791 hectares ('000) of land is not available for cultivation at all. The rest of the area is under cultivation. 11450 hectares ('000; 63%) of area is sown. 744 hectares ('000) area is irrigated by Canals, 147 hectares ('000) by tanks and a 391 hectares ('000) is by wells. 2384 hectares ('000) is irrigated by bore-wells; lift irrigation and other sources available. 1074 hectares ('000) area is under Paddy crop, 998 hectares ('000) is under Ragi, 17 Ha ('000) is under Jowar, and Bajra is cultivated in 319 Ha ('000). An 8259 ('000) Ha area is under other major crops. The state wise production of these food grains and Non Food grains is presented in below **Table 2.6.**

Table 2.6: State wise Production of Foodgrains & Major Non-Foodgrain Crops

Sl. No	Major Crops	Production (Thousand Tonnes)
1	Rice	2551
2	Ragi	1125
3	Jowar	781
4	Bajra	192
5	Total Cereals & Minor Millets	1210
6	Total Pulses	569
7	Groundnut	434
8	Sugarcane	16015
9	Cotton	264 (bales)

The state has 132 Ha ('000) under Sericulture.

2.4.6 Livestock and Poultry Production

In the Indian socio-economic context, apart from finding a sacred place, the livestock has a major role to play in subsistence rural agricultural economy. Cattle/ Livestock means everything. It is the only major source of energy available for Indian agriculture. It is a source of nutritional value in terms of milk products and meat. The manorial value of cattle dung/urine has been well documented. Dung/urine is also renewable sources of bio-energy and is the vital ingredient of biogas plants. The livestock, unfortunately, is dismally low in their productive capacities owing to several reasons. Karnataka is rich in livestock resources of 16082 thousands as per 2003 livestock census.

Table 2.7: Livestock and Poultry Population in the Project State

Type of Livestock's	Karnataka
Crossbred Cattle	1602
Indigenous Cattle	7936
Total Cattle	9539
Buffaloes	3991
Total Sheep	7256
Total Goats	4484
Total Pigs	312
Total Horses and Ponies	14
Total Mules	0
Total Donkeys	25

Type of Livestock's	Karnataka
Total Livestock	16082
Total Poultry	25593

Source: 17th Livestock Census 2003, Department of Animal Husbandry & Dairying, Ministry of Agriculture, Govt. of India.

2.4.7 Forestry

Forests are the pivot of the ecological and environmental balance and play a significant role in the prosperity of poor masses and enrichment of land.
It can be seen from the below table that, with 23.2 percent of the total geographical area has the highest forest cover compare to Karnataka which have 20.19 percent of the total geographical area covered by the forests. The State wise and district wise forest cover is given in **Table 2.8**.

Table 2.8: State and District-wise forest cover in the project area

State/District	Geographical Area (Sq. Kms)	Forest Area (Sq. Kms)	% of Forest Area to Geographical Area
Karnataka	191791	38724	20.19
Hassan	6826	1825	26.8%
Dakshina Kannada	4866	1440	29.6%

Source: Ministry of Environment and Forest

2.5 State's Population and Growth Rates

2.5.1 Demographic Profile of the Project State

The existing project road passes through Karnataka state. The demographic profile of state and the districts of these state are studied with respect to the influence area.
Demographic profile has an important bearing on the development process. According to the 2001 census, the total population of Karnataka state is around 5.28 crores. The proportion of urban population is 34% in Karnataka. The numbers of households in state of Karnataka is 1,38,30,096. Out of the above no. of households 95.1% of households are in good and livable condition and a small 4.9% are in dilapidated condition. 54.9% are permanent households, 35.6% are semi-permanent and the rest 9.5% are of temporary condition. The density of population per square kilometre for the district is 251. The density of population as per 2001 Census was 275 persons / sq.km, which was lower than the all-India density of 313.The average household size in Karnataka around 5.0 persons per household. The Sex-Ratio for Karnataka is 965 females per 1000 males. The proportion of SC and ST population in Karnataka is around 23%. The state wise demographic details are presented in below **Table 2.9**.

Table 2.9: Demographic Profile of Karnataka State

Description		Karnataka	Hassan District	Dakshina Kannada
No. of Households		1,38,30,096		
Population	Total	5,28,50,562	17,21,669	18,97,730
	Rural	3,48,89,033	14,17,106	11,68,432
	Urban	1,79,61,529	3,04,563	7,29,298
Sex ratio (Females per 1000 Males)		965		
Proportion of SC & ST Population (%)		23		
Proportion of Urban Population (%)		34.0	17.7%	38.4%

2.5.2 Literacy

As per the 2001 census the total literacy rate of Karnataka is 67.04 % (national average: 64.8%). Naturally the urban literacy is far better than the rural almost one and half times than the rural. Urban - 81.05 % to 74.20 % and Rural - 47.69 % to 59.68 %. The state has 53461 Primary schools and 9462 High Schools, 2485 Universities and 179 Polytechnic colleges, 120 Engineering colleges, 23 Medical Colleges, 64 Indian Medicine colleges and 40 Dental colleges.

Hassan has two medical colleges, one dental college and 3 engineering & polytechnic colleges each.

Dakshina Kannada (Mangalore) has 49 Govt. and Private Colleges. There is one educational institute per every 802 persons.

A variation across the state in literacy for the project state is presented in the following **Table 2.10**.

Table 2.10: Literacy of Karnataka State

Name of the State	No. of Literates	Literacy rate (%)
Karnataka	3,04,34,962	67.0

2.5.3 Work Participation

The occupational classification as per 2001 Census shows that the total workers account for 2.35 crores population of Karnataka state account for total workers constituting 45 percent of the total population. Out of the total population, main workers accounted for 37% in Karnataka state. It can be seen from the below table that more than half of the total population is non-workers. The details across the state are presented in the following **Table 2.11**.

Table 2.11: Proportion of Workers & Non workers in Karnataka state

Description	Karnataka
Work Participation Rate (%)	45.0
Proportion of Main Workers (%)	37.0
Proportion of Marginal Workers (%)	8.0
Proportion of Non Workers (%)	55.0

2.6 Infrastructure Facilities

2.6.1 Infrastructures facilities available in the Project Districts

Infrastructure facilities like Drinking water and Safe Drinking water are available in all the inhabited villages of Hassan and Dakshina Kannada around 99.5 percent of the inhabited villages gave these facilities. Education facility (upto primary level) is available in around 99 percent of villages in all the project districts.

Medical facility is available in Hassan sharing of 15%; at 1512 Primary Health Centers and 438 Primary Health Units. Similarly Dakshina Kannada has its share at 18%; 1698 Primary Health Centers and 581 Primary Health Units. In addition there are 846 dispensaries, a few of them with preliminary patient admitting facilities.only around 50 percent of the villages in all the project districts. Post office/telegraph/telephone are available in almost 79 percent of the villages in Hassan and Dakshina Kannada having these facilities. Nearly, 80 percent of the total inhabited villages in all the project districts have bus facility.

2.6.2 Industry

Karnataka is one of the most industrialised states in India (Industrial growth rate 7.7%). Its capital, Bangalore (well known as Silicon Valley of India) has become a major worldwide

hub of the Information Technology industry and is the IT capital of India, contributing approximately 35% of national revenue through IT. Over 90% of India's gold production comes from south Karnataka. Karnataka is the largest producer of coffee, raw silk and sandalwood based products like perfumes and 75% of Indian floriculture industry is located here. The state accounts for 59% of the country's coffee production and 47% of the country's ragi production. The state holds the fifth rank in national level in oilseed production.

The state is on the verge of industrialization since a few recent years. In 2005 here are 6020 numbers of factories. Major share is of Engineering with 2472 nos followed by 1091 nos of Textiles and 445 nos are Chemical factories. 157 nos of Industrial estates and 5743 nos of Industrial sheds, which employ 970994 nos of workers, all over the state indicate a commendable industrial presence. 35 nos of Sugar factories crush 8889000 MT of sugar cane to produce 929000MT of Sugar. In addition to this a 321676 nos of small-scale industrial units employ 1828978 nos of workers. Among the service-oriented sectors, Karnataka leads the Indian biotechnology industry.

2.6.3 Transportation

Karnataka state has 5445616 registered vehicles. The state has 3171 Km of total length of railway line spread through 354 nos of Railway Stations. The total length of roads is 51804 Km. 3967 Km is National Highways, 9590 Km is State Highways and a 38247 Km form Major District roads. Almost entire length i.e. 99.87% of roads is surfaced. The total length of rural roads is 115574 Km. Out of which more than 50% of roads are surfaced. The communication statistics are as follows: 9884 nos of post offices, 2708 nos of telephone exchanges and 2785781 nos of phones are registered.

The State prides in having a strong infrastructure. There are 20 ports across Karnataka, the two major ones being the Mangalore port and the Karwar port. A number of national and State highways make inter-city and town communication easily accessible. Karnataka also has a strong railway and airport network. Karnataka is a preferred destination for investments. The Karnataka Udyog Mitra is a single contact point for all investors who wish to invest in the State.

2.6.4 Air transport

Mangalore and Bangalore are the only two cities in the state that have International flights operating from their airports. While the international flights from Mangalore International Airport are only to countries located in the Middle East, Bangalore has good international connectivity with flights from different nations landing here. The airport at Bangalore is termed as Bengaluru International Airport and Lufthansa, British Airways, Air France, Singapore Airlines and Malaysia Airlines are some of the important airlines that operate out of this airport.Bangalore airport handled 10 million passenger traffic in 2009, with about 300-315 air traffic movements (ATMs) a day.BIAL is host to 9 domestic airlines and 19 international airlines, connecting the city to almost 50 destinations across India and the world. With Bangalore being the 'IT capital' of India, the air traffic to this city has increased manifold.

2.6.5Rail transport

The total length of rail track in Karnataka is 3089 km. For a long time after independence, the railway network in the state was under the Southern and Western railway zones which were headquartered at Chennai and Mumbai respectively. The South Western Zone, headquartered at Hubli was created in 2003 thus fulfilling a long-standing demand of the state. Several parts of the state now come under this zone with the remaining being under Southern Railways. Coastal Karnataka is covered under the Konkan railway network, a

project that is regarded as one of the feats of Indian engineering and included the construction of a bridge of length 2,023 metres (6,637 ft) across the river Sharavathi at Honnavar and a tunnel of length 2,960 metres (9,711 ft) at Karwar. Bangalore, the capital city, is extensively connected with inter-state destinations while other important cities and towns in the state are not so well-connected. Karnataka does not have a good internal rail network though the South Western Railway's headquarters are located here in the city of Hubli. Only Bangalore is connected well by trains to other cities in India. The following reasons indicate the poor rail network in the state:

- Mangalore, one of the major towns in Karnataka has now a train to other major cities like Bangalore, Mysore started on 8 December 2007, but not directly to Hubli.
- Metre gauge tracks from Shimoga to Talguppa and Mysore to Chamarajanagar have no or very few trains running on them.
- District capitals like Chikkamagaluru and Madikeri are not connected by a rail network
- The district of Kodagu has no railway track within it.
- Doubling of the track between Bangalore and Mysore (a line that receives very good patronage) is yet to be completed.
- Though the state has Konkan Railway within it; it has remained isolated with no trains running from other parts of the state to places that exist on the Konkan Railway.

The superfast Shatabdi Express trains run from Bangalore to Chennai and Mysore. A Jan Shatabdi express runs from Bangalore to Hubli and this is the first train in India that has been fitted with a GPS (Global Position System) based Location Announcement System. Using this system, the passengers are announced apriori the arrival of a station. Konkan Railway is an engineering marvel; the construction of which included the bridge across the river Sharavathi at Honnavar of length 2023 mts and a tunnel at Karwar of length 2960 mts. Karnataka has 1 major port; the New Mangalore Port and 10 minor ports; Karwar, Belekeri, Tadri, Honnavar, Bhatkal, Kundapur, Hangarkatta, Malpe, Padubidri and Old Mangalore.[5] The construction of the New Mangalore Port was started in 1962 and completed in 1974. It was incorporated as the 9th major port in India on 4 May 1974. This port handled 32.04 million tonnes of traffic in the fiscal year 2006-07 with 17.92 million tonnes of imports and 14.12 million tonnes of exports. This was actually a slowdown in traffic at this port compared to the previous fiscal year mainly due to the reduction in iron ore exports from the Kudremukh Iron Ore Company limited. The port also handled 1015 vessels including 18 cruise vessels during the year 2006-07. The sector of Inland water transport within the rivers of Karnataka is not well-developed.

2.6.6 Road transport

Among the network of roads in Karnataka, 3973 km. of roads are National Highways. Karnataka also has state highways of length 9829 km. The road from Bangalore to Mysore (State Highway 17) is also well maintained and equal to the standard of a National Highway.

The public bus transport in Karnataka is managed by the Karnataka State Road Transport Corporation (KSRTC). It was set up in the year 1961 with the objective of providing adequate, efficient, economic and properly coordinated road transport services.[8] It operates 5100 schedules using 5400 vehicles covering 1.95 million kilometres and an average of 2.2 million passengers daily. About 25000 people are employed in KSRTC. [8] For better management of public transport, KSRTC was bifurcated into three Corporations viz., Bangalore Metropolitan Transport Corporation, Bangalore on 15th Aug 1997, North-west Karnataka Road Transport Corporation, Hubli on 1st Nov 1997 and North-East Karnataka Road Transport Corporation, Gulbarga on 1st Oct 2000. The reservation system is networked and computerised and tickets can be availed at designated kiosks in towns and cities. An online reservation system called AWATAR has also been devised by KSRTC using which travellers can reserve tickets online. KSRTC plies various categories of buses viz. Airavata (high-end luxury Volvo AC buses), Mayura (luxury AC buses), Rajahamsa (deluxe buses),

Semi-deluxe and normal buses. Grameena Sarige is another initiative by KSRTC to provide bus service to the rural populace of the state.

Buses run by private persons are allowed to operate in few districts of Karnataka.Inter district transportation are run by private operators, connecting capital Bangalore and main cities like Mangalore and Dharwad to district head-quarters. Intra district transportation by private operators is currently allowed in Dakshina Kannada and Udupi districts.

3 Materials Surveys and Geotechnical Investigations

3.1 General

The material investigation for road construction will be carried out to identify the potential sources of construction materials and to assess their general availability, mechanical properties and quantities. This is one of the most important factors for stable, economic and successful implementation of the road program within the stipulated time. For new carriageway / bypass the list of materials includes the following:

- Granular material for lower sub-base works
- Crushed stone aggregates for upper sub-base,
- Base of dry lean concrete, surfacing by PQC and cement concrete works
- Sand for filter material and cement, concrete works, sub-base and filling material
- Borrow material for embankment, subgrade and filling
- Manufactured material like cement, steel, bitumen, geo-textiles etc. for other related works

3.2 Objectives and Information Sources

The information on material sources will be carried out with the following basic objectives.

- Source location, indicating places, kilometerage, availability and the status whether in operation or new source.
- Access to source, indicating the direction and nature of the access road i.e. left / right of project road, approximate lead distance from the gravity centre and type of access road.
- Ownership of land / quarries, either government or private.
- Test results, indicating the quality of materials along with their classification in details.
- Probable uses indicating the likely use of materials at various stages of construction work i.e. fill materials, sub-grade, sub-base, base and wearing course and cross drainage structures.
- During the process of investigation, due consideration will be given to the locally available materials for reducing the cost of construction. The samples from various identified sources will be collected for laboratory testing as per IRC / MoSRT&H / BIS standards.

3.2.1 Material for Embankment and Sub-grade

Potential sources of earth for the construction of embankment and sub-grade for New Carriageway will be identified as the excavated materials obtained from tunnels and cut & fill sections. The details of all the borrow areas investigated with their respective locations, corresponding chainage, description of material are tabulated in **Table 3.1.**

Table 3.1 Details of Borrow area along the Existing Road Section of NH-48

Sl. No.	Chainage	Distance From Road	Side	Adequacy
Borrow Soil				
1	196+500	0.2 Km	LHS	Identified borrow soil are suitable for construction of embankment, subgrade and filling
2	210+000	12 km	LHS	
3	293+000	0.2 Km	LHS	
4	301+000	20 Km	LHS	
5	325+000	20 Km	LHS	

Sl. No.	Chainage	Distance From Road	Side	Adequacy
6	325+000	28 Km	LHS	

The following tests will be conducted to check the suitability of the fine-grained materials:

- Grain size analysis
- Atterberg limits
- Maximum laboratory dry unit weight (Heavy Compaction)
- Optimum moisture content
- CBR (4 days soaked) at three energy levels.

3.2.2 Stone Aggregates

The availability and quality of material as coarse and fine aggregate will be explored and samples collection from the nearest quarry where large quantities of stone aggregates available.

Representative samples from the above stone quarries will be collected for testing in the laboratory for following tests on the samples collected.

- Los Angeles Abrasion Test : As per IS: 2386 (Part-4)
- Aggregate Impact value : As per IS: 2386 (Part-6)
- Combined flakiness and elongation indices : As per IS: 2386 (Part-7)
- Soundness : As per IS: 2386 (Part-5)
- Water absorption : As per IS: 2386 (Part-3)

MoRT&H requirement of stone aggregates for their use in base / surfacing courses of pavement are as follows:

- Los Angeles Abrasion Value < 40%
- Aggregate Impact Value < 30%
- Flakiness and Elongation indices (combined) < 30%
- Water absorption < 2%

Table 3.2 Details of Aggregate Quarry along the Existing Road of NH-48

Sl. No.	Chainage	Distance From Road	Side	Adequacy
Aggregate Quarry				
1	175+000	9.0 Km	LHS	Identified aggregate quarries are suitable for construction of upper sub-base, base, surfacing and cement concrete works
2	211+000	8.0 Km	LHS	
3	280+000	25.0 Km	RHS	
4	300+000	11.0 Km	RHS	

3.2.3 Fine Aggregates

The bed of the following river flowing in the vicinity of the project road is the only potential source for good quality coarse sand in sufficient quantities. The details of quarry and Properties will be given in **Table 3.3**.

Table 3.3 Details of Natural Sand Quarries

Sl. No.	Chainage	Distance From Road	Side	Adequacy
Sand Quarry				
1	218+000	10.0 Km	LHS	Identified sand quarries are suitable for filter material and concrete works
2	300+500	0.20 Km	LHS	
3	327+000	0.20 Km	LHS	

However, it is recommended that aggregates and sand (stone dust) will be used using excavated muck materials of tunnelling works to the maximum extent. Accordingly, crushers and batching plants will be established near the project site in consultation with the concerned forest & other department officials.

3.2.4 Availability of Bitumen, Steel and Cement

Bitumen (IS 73- 1961) is available at MRPL in Mangalore, which is around 100 km from the proposed bypass alignment. The steel to be used as reinforcement for cross drainage structures shall be Deformed Steel Bars conforming to IS 1786 from Mangalore/ Bangalore.

The cement of various types like Ordinary Portland Cement **-** 43 Grade, 53 Grade and Pozzolana Cement is required for the construction. The steel and Cement are available in Mangalore.

Table 3.4 Availability of Bitumen, Steel and Cement

Sl. No.	Chainage	Distance From Road	Side	Adequacy
Bitumen				
1	Available at MRPL in Mangalore, 125 km away from Project road			Required grades in sufficient quantity are available at MRPL
Steel				
2	Available at Mangalore city, 38 km away from End of the Project road			Required grades in sufficient quantity are available at Mangalore City
Cement				
3	Available at Mangalore city, 38 km away from End of the Project road			Required grades in sufficient quantity are available at Mangalore City

3.3 Geotechnical Field Investigations

3.3.1 Drilling of Boreholes

Boreholes shall be drilled at specified locations to obtain information about the sub-surface soil, and to collect soil and rock samples for strata identification and laboratory testing. The minimum diameter of borehole shall be 150 mm in soil and NX size (75 mm dia) in rock and the boring shall be carried out in accordance with the provisions of IS 1892. Rotary drilling rigs shall be used for advancing the boreholes. Bore holes shall be advanced using water or bentonite. Temporary casing may be necessary to maintain the sides of the boreholes in a stable condition. Rock boring shall be carried out using a double core barrel / triple tube having a diamond bit to get higher / proper core recovery.

Temporary casing shall be used in boreholes to support its sides, if required. When temporary casing is used it shall be ensured that its bottom is at all times less that 150mm above the bottom of borehole. In case of cohesion less soil, the advancement of the temporary casing shall be such that it does not disturb the soil to be tested or sampled. The temporary casing shall be advanced by slowly turning the temporary casing pipe and not by driving.

In-situ tests shall be conducted and undisturbed samples shall be obtained at specified intervals in the boreholes. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water level shall be determined in the boreholes and shall be carefully recorded on the drilling log.

All bore holes shall be referenced to the survey control points in plan and elevation.

All daily field observations shall be recorded on formats in accordance with IRC: 78 or relevant IS codes.

3.3.2 Scope of Work

Bore holes shall be carried out as per the schedules given below. All schedules are indicative only, and shall be finalized in consultation with the Client. List of probable structures is given hereunder.

Table 3.5 Guidelines of Tests

Item	*Objective*	*Contents*	*Quantity*
(i) Geo-technical Survey for Bridge Design	*Preliminary design of bridges/structure*	• *Depth assumed to be 15-25m.* • *SPT.* • *Laboratory tests.*	*As required (spacing as per IRC standards)**
(ii)Geo-technical surveyfor Roads	*Confirmation of bearing capacity of road ground and existence of unsuitable materials*	• *Test pit, 1km to 3km interval as per site suitability.* • *Auger Boring, 1km to 3km interval (to be done for embankment section.*	*As required (spacing as per IRC standards and ground conditions)**
(iii)Geo-technical Survey for Tunnel Profile and Design	*Determining geological and geotechnical conditions in tunnel. Determining geotechnical parameters for tunnel design.*	• *Drilling depth 3m to 5m below invert level if same hard rock strata continues and maximum up to 1.5 times tunnel diameter below tunnel invert;* • *In-Situ Testing* • *Laboratory Testing*	*As per AASHTO, Guidelines **

*****

The spacing of boreholes shall be determined based on assessment of site conditions, difficulty of access and time frame required for conducting these, as well as fulfilling the ToR.

- Sub-soil investigations will be done as per IRC 78-2000 / IS 1892.
- The scheme for the boring locations and the depth of boring shall be prepared by the Consultant and submitted to Client for approval. These may be finalized in consultation with Client.
- The scheme for laboratory testing shall be prepared by Consultants and submitted to Client for approval. These may be finalized in consultation with Client.

3.3.3 Standard Penetration Test and Disturbed Soil Samples

SPT tests shall be conducted in all types of deposits at 1.5 to 3 m or at change of strata intervals or as per I.S. Code of practice. The tests shall be carried out by driving a standard split spoon by means of 63.5 kg (140 lbs) hammer having a free fall of 76 cms (30 inches). Detailed procedure for testing as specified in IS 2131 shall be followed. The samples obtained in this split spoon shall be placed in an airtight jar or equivalent, labelled and preserved for identification tests in the laboratory.

3.3.4 In-Situ Field Tests

Other In-Situ Field tests that are shall be conducted during geotechnical investigation works shall be permeability tests in soil /rock. Pressuremeter tests in rock. The codes for these tests are described below.

IN-SITU TESTING

- Permeability Test in Soil (IS 5529 Part 1)
- Packer Test (single / double) in Rock (IS 5529 part 2)
- Pressure meter test in Rock (IS 12955)

3.3.5 Undisturbed Soil Samples

In each borehole, undisturbed soil samples shall be collected at a regular interval of 3 m or at every change of strata subject to a minimum of two samples in each borehole. Un-Disturbed Samples shall be of 100 mm dia and 450 mm length. Samples shall be collected in such a manner that the structure of the soil and the moisture content do not get altered. The collection of Undisturbed Samples may be stopped if SPT N > 60. The specifications for the accessories required for sampling and the sampling procedure shall conform to IS: 1892 and IS: 2132. The Un-Disturbed Sample shall be immediately followed by SPT test, after the borehole has been cleaned.

3.3.6 Rock Core Samples

Drilling in rock shall be carried out using a diamond-coring bit. The core shall be of NX size. The cores shall be collected using Double tube/ triple tube core barrel depending upon the condition of the rock.

The rock cores shall be examined for geological features such as joints and bedding, weathering, hardness, cores recovery and RQD as per IRC: 78 (latest revision). The rock cores shall be placed lengthwise in a wooden box of suitable size with compartments for 1.5m core runs. Wooden spacer cores shall be used where there are gaps in core-runs due to core losses. The samples and the cores shall be labeled and shall identify the borehole number, sampling depth, soil/rock type etc. samples of only one borehole shall be stored in one core box.

3.3.7 Measurement of Static Water Level and Collection of Water Samples

Water level in each borehole shall be measured and recorded during drilling and 24 hours after completion of the boreholes.

Before taking water samples, the borehole must be cleaned from the drilling fluid by flushing the hole and then allowing the groundwater level to stabilize. Ground water samples shall be collected using down-the-hole bailer or other suitable technique. The water samples shall be kept in transparent containers and their lid tightened. Appropriate labels shall be pasted for identification.

3.3.8 Laboratory Testing

Unless otherwise specified, all laboratory testing shall be carried out in accordance with the relevant IS Codes.

The soil/rock/ & water samples collected during the investigation program shall be transported to an approved laboratory for testing. The Firm shall furnish in their tender the details of credentials of the laboratory facilities they intend to use with full address.

The following tests shall be performed on these samples:

Tests on Soil Samples:

- Visual and Engineering Classifications-IS:1498
- Natural moisture contents (IS 2720, Part II)
- density (2720-Parts XXVIII, and XXIX. check)
- Specific gravity (IS 2720 Part III)
- Atterberg limits. IS-2720, Part V
- Sieve Analysis and Hydrometer Analysis IS:2720, Part IV
- Unconfined compression IS 2720, Part X
- Direct shear IS : 2720, Part XIII
- Tri axial shear tests
  - Unconsolidated Undrained (UU) Test – IS:2720, Part XI
  - Consolidated Undrained (CU) Test – IS:2720, Part XII
- Consolidation Tests IS:2720, Part XV
- Determine of free swell index of soils – IS:2720, PART 40
- Silt factor Determination
- Chemical tests on soil as per relevant Indian Standards (IS 2720 Part 26, 27, etc)

Tests on Rock Cores:

- Moisture Content (IS 13030)
- Tensile strength (Brazilian) IS 10082
- Density IS 13030 / IS 1124
- Porosity IS: 13030 / IS 1124
- Durability-IS: 10050
- Specific gravity IS 13030 / IS 1124
- Water absorption IS:1124
- Abrasivity Test
- Unconfined compression IS: 9143
- Point load tests IS: 8764
- Triaxial compressive strength
- Youngs Modulus and Poisson ratio (IS 9221)
- Petrographic Study (Including Thin Sections)

Tests on Water Samples:

Chemical Analysis of water shall be carried out for each structure to evaluate effects of sub-soil water on concrete and steel. Recommendations in this respect shall be clearly mentioned in the report. The tests will be essentially include pH value, sulphate and chloride contents (percentages).

- pH (IS 3025)
- Sulphate (IS 3025)
- Chloride (IS 3025)
- Carbonate content

The soil samples in plastic zip lock bags and rock samples in the form of cores in wooden boxes with locking arrangement shall be finally submitted to the Client after completion of all types of tests as specified above.

4 Traffic Surveys and Analysis

4.1 General

Traffic surveys and analyses will be carried out for addressing various objectives and issues pertaining to lane configuration of the project stretch. The surveys will be conducted include seven days volume counts, 12 hrs intersection, 24 hrs origin – destination& willingness to pay toll surveys and 24 hrs axle load survey at two locations during dry season. The study aims at obtaining the existing traffic and travel characteristics on the project corridor and forecasting for project horizon year considering various constituent streams and for various scenarios.

This chapter gives details about traffic surveys planned, past traffic data, secondary data collection, and analysis of the data, toll traffic forecast and estimates of revenue.

The Project Road Bypass to Shiradi Ghat is part of National Highway–48. NH-48 starts at Bangalore and ends at Mangalore. The proposed bypass takes off at and then traverses through Maranhalley, Gundya, and meets again on NH-48 at Heggade. The project corridor passes through 2 districts viz. Hassan & Dakshina Kannada (Mangalore) in Karnataka state.

4.2 Homogeneous Sections

Detailed reconnaissance survey was done to understand the travel pattern on the project road. Based on the reconnaissance survey, the project road is divided into one homogeneous section.

Considering the network, the project road is divided in to only one homogeneous section from km 225.000 to km 265.000.

4.3 Traffic Surveys

The feasibility and design of any highway facility (or a corridor) basically depends on the volume and intensity of traffic likely to flow on it in the design year. The estimation of the likely traffic scenario in the design year on the highway/corridor proposed for improvement, with an optimal lane configuration as in the present case, requires basic information regarding the current level of traffic and its characteristics on it. Thus, the collection of basic data on the nature and extent at present of different traffic parameters assumes greater significance.

The traffic on the Project corridor is characterized by a high degree of motorized vehicles which consist of passenger vehicles such as cars, two wheelers, LCVs, Trucks. The non-motorized vehicles comprise mostly of bicycles.

Traffic studies detail mode wise traffic estimates, travel pattern of passenger and freight (goods) vehicles, speed and delay (travel time) characteristics and axle load characteristics. Traffic surveys will be conducted as per the guidelines given in IRC:SP-19 2001. The locations and type of various traffic surveys have been carefully finalized on the basis of a reconnaissance survey as well as requirements of the RFP.

The traffic surveys have been undertaken for the project include:

- ✓ Classified 7-day, 24 hours continuous traffic volume counts. (2 locations)
- ✓ 1 day 12 hour Intersection turning movement surveys (2 locations)
- ✓ 1 day 24 hour Origin-Destination surveys with willingness to pay toll (2 locations)
- ✓ 1 day 24 hour Axle load surveys (2 locations)

4.3.1 Classified Volume Counts

As per discussions held with the Authority and past traffic survey data, Classified Traffic Volume Count (CTVC) (7 days 24 hour continuous) surveys have been conducted at 2 already identified &

fixed count stations along the existing road section. The location, type of surveys and dates are given in **Table 4.1**.

Table 4.1: Type, Locations & schedule of Traffic Surveys

S. No.	Type of Survey	Location	Date of Survey	Duration of Survey
1	Classified Traffic Volume Count	Km. 229.000	21.09.15 to 28.09.15	7 Days
		Km. 261.450	21.09.15 to 28.09.15	7 Days
2	Axle Load Survey	Km. 232.000	23.09.15	1 Day
		Km. 263.500	25.09.15	1 Day
3	Origin-Destination Survey	Km. 232.000	23.09.15	1 Day
		Km. 263.500	25.09.15	1 Day
4	Turning movement Survey	Donigal Chowk	28.09.15	12 hours
		Km. 261.500	28.09.15	5 ours

4.3.2 Turning Movement Surveys

On the basis of the reconnaissance survey, there is only two intersections along the project road for conducting detailed turning movement surveys. Classified traffic surveys were carried out for a period of 12 hours at these intersections to capture morning and evening patterns. These intersections are near to Donigal chowk and Km 261+450, junction with SH 114.

4.3.3 O-D and Willingness to Pay Survey

An Origin-Destination (O-D) and Willingness to Pay Survey will be carried out adopting Road Side Interviews (RSI) method at both of the classified count stations for a continuous period of 24 hours along with the classified counts. The random sampling method was adopted for this survey. The local police assistance was available to stop the vehicles for interviewing the road users. The RSI was carried out through pre-planned and structured questionnaires suitable for computer analysis.

The information to be collected during these surveys for passenger vehicles will include the origin and destination; purpose, occupancy and frequency of the trip. In the case of freight vehicles the information sought included type and quantity of commodity being transported, in addition to origin and destination, and frequency of travel on the route.

Information sought on willingness to pay toll included the amount of toll (in rupees) likely to be paid by the road users due to savings in travel time and acceptability level of different toll rates.

4.4 Traffic Analysis

4.4.1 Classified Traffic Volume Counts

Classified Traffic Volume counts were conducted manually for 7 continuous days for 24 hours at four locations. The analysis of the same will be done as below:

- Average Daily Traffic (ADT)

- Temporal Variation
  - Daily Variation
  - Hourly Variation
  - Peak Hour factor
- Directional Distribution
- Traffic composition
- Average Annual Daily Traffic (AADT)
  - Seasonal Correction Factor
  - Average Annual Daily Traffic (AADT)

4.4.2 PCU Factors

The traffic volumes counted in 15 minute intervals will be aggregated to one-hour volumes. The hourly volumes will be aggregated into daily volumes for the entire survey period (7-days). The daily volumes will then be averaged for ADT. To express the classified vehicular count in terms of PCUs, the PCU factors as given in IRC-64: 1990 have been considered. For ready reference, the PCU Factors considered in the analysis are given in **Table 4.2**.

Table 4.2: PCU Factors Adopted for Study

Vehicle Type	PCU factor
Car	1.0
Taxi	1.0
Three Wheelers	0.5
Two Wheelers	1.0
Mini Bus	1.5
Bus	3.0
LCV (3T)	1.0
LCV (4T)	1.5
2 Axle	3.0
3 Axle	3.0
MAV (4 to 6 Axle)	4.5
MAV (< 6 Axle)	4.5
Tractor	1.5
Tractor with trailer	4.5
Cycle	0.5
Cycle Rickshaw	2.0
Hand Cart	3.0
Animal Drawn	6.0

Source: IRC: 64-1990

4.4.3 Past Traffic Data

Past traffic data have been collected from the previous studies carried out by M/s Feedback Infrastructure Pvt Ltd & METI in 2012 & 2014 respectively. The details of ADT and AADT are summarised in the following Tables respectively.

Table 4.3: Average Daily Traffic (ADT)

Survey location chainage		km 261.500	km 261.500	METI (km 261.500)
Year		***Mar 2012***	***May 2012***	***Nov 2014***
Tollable traffic	Car / Jeep / Van	1362	2193	2413
	Mini Bus	111	179	1045
	Std Bus	661	768	
	LCV	465	592	532
	2 Axle	399	517	958
	3 Axle	421	373	
	MAV (4 - 6 Axles)	430	403	411
	MAV (7++ Axles)	0	0	
	Total nos.	**3849**	**5025**	**5568**
	Total PCUs	**8609**	**10142**	
Non-tollable traffic	2 Wheeler	180	149	188
	3 Wheeler	45	28	21
	Agri. Tractor	0	2	
	Tractor trailer	0	0	
	Cycle	0	0	
	Cycle rick.	0	0	
	Animal Drawn	1	0	
	Toll Exempted vehicles	6	12	
	Total nos.	**232**	**191**	
	Total PCUs	**153**	**128**	
Total Vehicles		**4081**	**5216**	**5777**
Total PCUs		**8757**	**10264**	**11184**

Past Data "Average Annual Daily Traffic (AADT)"

The seasonal correction factors for petrol and diesel driven vehicles, have been applied to ADT to derive AADT. The AADT is presented at **Table 4.4**.

Table 4.4: Average Annual Daily Traffic (AADT)

Survey location		km 261.500	km 261.500	km 261.500
Year		***2008***	***Mar 2012***	***May 2012***
Tollable traffic	Car / Jeep / Van	3409	1397	2250
	Mini Bus	526	119	192
	Std Bus	496	708	823
	LCV	782	498	634
	2 Axle	1205	427	554
	3 Axle	508	451	399
	MAV (4 - 6 Axles)	99	461	432
	MAV (7++ Axles)	0	0	0
	Total nos.	**7025**	**4061**	**5283**
	Total PCUs	**12444**	**9154**	**10758**

Survey location		**km 261.500**	**km 261.500**	**km 261.500**
Year		***2008***	***Mar 2012***	***May 2012***
Non-tollable traffic	3 Wheeler	133	46	29
	2 Wheeler	486	185	153
	Agri. Tractor	3	0	2
	Tractor trailer	4	0	0
	Cycle	42	0	0
	Cycle rick.	3	0	0
	Animal Drawn	0	1	0
	Total nos.	**671**	**238**	**196**
	Total PCUs	**426**	**151**	**124**
Total Vehicles		**7696**	**4299**	**5479**
Total PCUs		**12870**	**9305**	**10882**

4.4.4 Past trend of traffic flow

The available past data of traffic census recorded by National Highway department on project road have been studied. The traffic data corresponding to traffic count station of the past study on the project stretch are reproduced in **Table 4.5**.

Table 4.5 Past Traffic data along the project road (in PCUs)

Sl. No.	**Count station**	**1998-99**	**1999-00**	**2000-01**	**2001-02**	**2002-03**
1	km 261.400	10850	11597	13731	14508	15213
Year	2009	2010	2011	2012	2013	2014
PCU	14249	14179	17192	17250	20211	20438

4.5 Present Traffic Data

4.5.1 Average Daily Traffic (ADT)

- The ADT along different sections of the project Highway varies between a mini mum of total 6861 vehicles (12567 PCUs) at Km. 261.450 to a maximum of total 8115 vehicles (13746 PCUs) at Km. 229.000.
- The share of non-motorized vehicles along the project highway is negligible.
- The share of tollable traffic as a percentage of ADT along project Highway varies between a minimum of 82% at Km. 229.000 to a maximum of 94% at Km. 261.450.
- PCU ratio on the project corridor came out to be 1:1.69, thereby signifying a ma jor share of two-wheelers and cars in the total traffic flow.
- The hourly variation in the total traffic (vehicles and PCUs) at the TVC locations along project Highway is presented in Figure 3.2, reveals that there is not much variation in passenger and commercial traffic intensity over the day. At each lo cation, reduced traffic levels have been observed during night hours for passen ger vehicles.

as observed on the Project Road, in terms of vehicles and PCUs at different survey locations is given in **Table 4.6**.

Table 4.6: Average Daily Traffic (ADT) 2015

Vehicle Type	Km. 229.000	Km. 261.450
Car	3298	3272
Taxi	418	438
Three Wheelers	293	20
Two Wheelers	1136	358
Mini Bus	123	149
Bus	670	644
LCV (3T)	12	7
LCV (4T)	322	236
2 Axle	855	820
3 Axle	352	290
MAV (4 to 6 Axle)	624	624
MAV (< 6 Axle)	0	0
Tractor without trailer	0	0
Tractor with trailer	10	0
Cycle	1	0
Cycle Rickshaw	0	0
Hand Cart	0	0
Animal Drawn	0	0
Others	1	3
Tollable Traffic (vehicles)	6662	6473
Tollable Traffic (PCUs)	12825	12358
Total Traffic (vehicles)	8115	6861
Total Traffic (PCUs)	13746	12567

4.5.2 Seasonal variation factor

Traffic fluctuates by the hour, by the day and by the month. Hence, it is essential to estimate a factor which provides a relationship between Annual Average Daily Traffic (AADT) and Average Daily Traffic (ADT) for the month corresponding to the traffic surveys. While hourly and daily fluctuations have been accounted for by conducting surveys for continuous 168 hours (7 days), the Seasonal Correction Factor (SCF) will be required to estimate AADT from this ADT data.

The traffic surveys are conducted in the month of September, year 2015. From the analyzed fuel sales data, the seasonal variation factors are taken as shown in Table 4.7, for AADT calculations.

Table 4.7: Seasonal Variation Factors for AADT

S. No.	TVC Location	Petrol vehicles	Diesel vehicles
1	Km. 229.000	0.88	1.12
2	Km. 261.450	0.92	1.06

4.5.3 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT in no of vehicles) at the survey locations is obtained by multiplying the Average Daily Traffic (ADT) with the seasonal correction factor.

The AADT of vehicles for the year 2015 at the survey locations along the Project Highway is presented in Table 4.8.

Table 4.8: Annual Average Daily Traffic (AADT)

Vehicle Type	Km. 229.000	Km. 261.450
Car	3298	3239
Taxi	468	464
Three Wheelers	328	21
Two Wheelers	1000	329
Mini Bus	138	158
Bus	750	683
LCV (3T)	13	7
LCV (4T)	361	250
2 Axle	958	869
3 Axle	394	307
MAV (4 to 6 Axle)	699	661
MAV (< 6 Axle)	0	0
Tractor without trailer	0	0
Tractor with trailer	11	0
Cycle	1	0
Cycle Rickshaw	0	0
Hand Cart	0	0
Animal Drawn	0	0
Others	1	3
Tollable Traffic (vehicles)	7066	6632
Tollable Traffic (PCUs)	13965	12870
Total Traffic (vehicles)	8420	6993
Total Traffic (PCUs)	14859	13066

4.5.4 Traffic Growth Rates

The growth rates for most likely (realistic) scenario of different vehicle types as per elasticity analysis were recommended for traffic projection, as given in **Table 4.9**

Table 4.9 Proposed Traffic Growth Rates

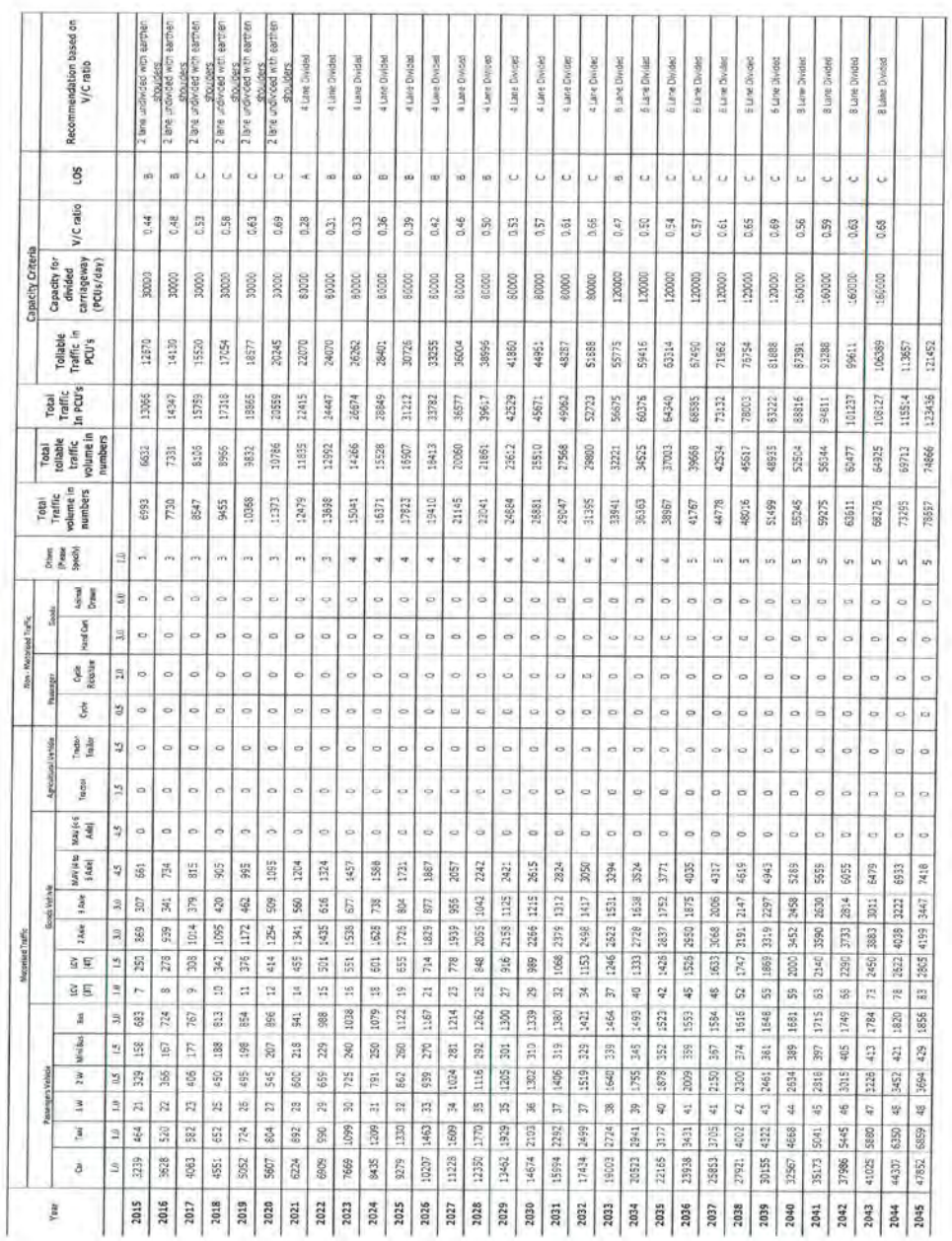
S. no.	Period	2 Wheeler	Car / jeep	Bus	3 Wheeler	Truck			
						2 Axle	3 Axle	M Axle	LCV & Mini LCV
Most likely or realistic scenario									
1	Up to 2018	11.0	12.0	6.0	5.0	8.0	11.0	11.0	11.0
2	2019 -2023	10.0	11.0	5.0	4.0	7.0	10.0	10.0	10.0
3	2024 – 2028	9.0	10.0	4.0	3.0	6.0	9.0	9.0	9.0
4	2029 – 2033	8.0	9.0	3.0	2.0	5.0	8.0	8.0	8.0

S. no.	Period	2 Wheeler	Car / jeep	Bus	3 Wheeler	Truck			
						2 Axle	3 Axle	M Axle	LCV & Mini LCV
5	Beyond 2033	7.0	8.0	2.0	2.0	4.0	7.0	7.0	7.0

4.5.5 Traffic Forecast

The traffic estimated for future years 2015 to 2045 are given in the Table below.

Table 4.10 Year wise Proposed Traffic Forecast



Year	Motorised Traffic												Non - Motorised Traffic			Others (Please Specify)	Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Capacity Criteria			Recommendation based on V/C ratio
	Passengers Vehicle				Goods Vehicle				Agricultural Vehicle		Passenger		Goods							Tollable Traffic in PCU's	Capacity for divided carriageway (PCUs/day)	V/C ratio	LOS	
	Car	Taxi	3 W	M/Bikes	Bus	LCV (P)	LCV (T)	2 Axle	3 Axle	MAV (4 to 6 Axle)	Tractor	Trailer	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn								
	1.0	1.0	1.0	0.5	1.0	1.5	1.0	3.0	4.5	4.5	1.5	4.5	0.5	2.0	3.0	6.0	1.0							
2015	3239	464	21	329	158	683	7	293	869	307	661	0	0	0	0	0	1	6993	6633	13066	12870	30000	0.44	B	2 lane undivided with earthen shoulders
2016	3628	520	22	365	167	724	8	278	939	341	734	0	0	0	0	0	3	7730	7331	14347	14130	30000	0.48	B	2 lane undivided with earthen shoulders
2017	4083	582	23	406	177	767	9	308	1014	379	815	0	0	0	0	0	3	8547	8155	15759	15520	30000	0.53	C	2 lane undivided with earthen shoulders
2018	4551	652	25	450	188	813	10	342	1095	420	905	0	0	0	0	0	3	9455	8966	17318	17054	30000	0.58	C	2 lane undivided with earthen shoulders
2019	5052	724	26	495	198	854	11	376	1172	462	993	0	0	0	0	0	3	10368	9832	18865	18577	30000	0.63	C	2 lane undivided with earthen shoulders
2020	5607	804	27	545	207	896	12	414	1254	509	1085	0	0	0	0	0	3	11373	10786	20559	20245	30000	0.69	C	2 lane undivided with earthen shoulders
2021	6224	892	28	600	218	941	14	455	1341	560	1204	0	0	0	0	0	3	12479	11835	22415	22070	80000	0.28	A	4 Lane Divided
2022	6909	990	29	659	229	988	15	501	1435	616	1324	0	0	0	0	0	3	13698	12992	24447	24070	80000	0.31	B	4 Lane Divided
2023	7669	1099	30	725	240	1038	16	551	1536	677	1457	0	0	0	0	0	4	15041	14266	26674	26262	80000	0.33	B	4 Lane Divided
2024	8435	1209	31	791	250	1079	18	601	1625	738	1588	0	0	0	0	0	4	16371	15528	28849	28401	80000	0.36	B	4 Lane Divided
2025	9279	1330	32	862	250	1122	19	655	1726	804	1731	0	0	0	0	0	4	17823	16907	31212	30726	80000	0.39	B	4 Lane Divided
2026	10207	1463	33	939	270	1187	21	714	1829	877	1887	0	0	0	0	0	4	19410	18413	33782	33258	80000	0.42	B	4 Lane Divided
2027	11228	1609	34	1024	281	1214	23	778	1939	955	2057	0	0	0	0	0	4	21145	20060	36577	36004	80000	0.46	B	4 Lane Divided
2028	12350	1770	35	1116	292	1262	25	848	2055	1042	2242	0	0	0	0	0	4	22041	21861	39617	38996	80000	0.50	B	4 Lane Divided
2029	13462	1929	35	1205	301	1300	27	916	2158	1125	2422	0	0	0	0	0	4	24084	23612	42529	41860	80000	0.53	C	4 Lane Divided
2030	14674	2103	36	1302	310	1339	28	989	2266	1215	2615	0	0	0	0	0	4	26881	25510	45671	44951	80000	0.57	C	4 Lane Divided
2031	15994	2292	37	1406	319	1380	32	1068	2376	1312	2824	0	0	0	0	0	4	29247	27568	49362	48287	80000	0.61	C	4 Lane Divided
2032	17434	2499	37	1519	329	1421	34	1153	2498	1417	3050	0	0	0	0	0	4	31985	29800	53723	51688	80000	0.65	C	4 Lane Divided
2033	19003	2724	38	1640	339	1464	37	1246	2622	1531	3294	0	0	0	0	0	4	33941	32221	56075	55775	120000	0.47	B	6 Lane Divided
2034	20523	2941	39	1755	345	1493	40	1333	2728	1638	3524	0	0	0	0	0	4	36163	34525	60376	59416	120000	0.50	C	6 Lane Divided
2035	22165	3177	40	1878	352	1523	42	1428	2837	1752	3771	0	0	0	0	0	4	38967	37003	64340	63314	120000	0.54	C	6 Lane Divided
2036	23938	3431	41	2009	359	1593	45	1529	2950	1875	4035	0	0	0	0	0	5	41767	39668	68595	67490	120000	0.57	C	6 Lane Divided
2037	25863	3705	41	2150	367	1584	48	1633	3068	2006	4317	0	0	0	0	0	5	44778	42524	73532	71062	120000	0.61	C	6 Lane Divided
2038	27921	4002	42	2300	374	1616	52	1747	3191	2147	4516	0	0	0	0	0	5	48016	45617	78803	75754	120000	0.65	C	6 Lane Divided
2039	30155	4322	43	2461	381	1648	55	1869	3319	2297	4943	0	0	0	0	0	5	51499	48915	63222	81088	120000	0.69	C	6 Lane Divided
2040	32567	4668	44	2634	389	1681	59	2000	3452	2458	5283	0	0	0	0	0	5	55245	52504	88816	87391	160000	0.56	C	8 Lane Divided
2041	35173	5041	45	2818	397	1715	63	2140	3590	2630	5659	0	0	0	0	0	5	59275	56344	94811	93288	160000	0.59	C	8 Lane Divided
2042	37986	5445	46	3015	405	1749	68	2290	3733	2814	6055	0	0	0	0	0	5	63611	60477	101237	99611	160000	0.63	C	8 Lane Divided
2043	41025	5880	47	3226	413	1784	73	2450	3883	3011	6479	0	0	0	0	0	5	68276	64926	108127	106389	160000	0.68	C	8 Lane Divided
2044	44337	6350	48	3452	421	1820	78	2622	4038	3222	6933	0	0	0	0	0	5	73295	69713	115514	113657				
2045	47852	6859	48	3694	429	1856	83	2805	4199	3447	7418	0	0	0	0	0	5	78597	74866	123436	121452				

Table 4.7 Five Year Projection and Lane Configuration (PCU)

S. No.	TVC Location	Year	Total Traffic volume in numbers	Total Traffic In PCUs	Capacity Criteria			
					Capacity for divided carriageway (PCUs/day)	V/C ratio	LOS	Recommendation based on V/C ratio
Most likely scenario								
1	Km. 229.000	2015	8420	14859	30000	0.50	B	2L+Pav Shoulder
		2020	13574	23264	80000	0.29	A	4 Lane Divided
		2025	17954	35170	80000	0.44	B	4 Lane Divided
		2032	36842	59108	120000	0.49	B	6 Lane Divided
		2038	55983	87150	160000	0.54	C	8 Lane Divided
		2045	92116	137399	-	-	-	-
2	Km. 261.450	2015	6993	13066	30000	0.44	B	2L+Pav Shoulder
		2020	11373	20559	30000	0.69	C	2L+Pav Shoulder
		2025	17823	31212	80000	0.39	B	4 Lane Divided
		2033	33941	56675	120000	0.47	B	6 Lane Divided
		2040	55245	88816	160000	0.56	C	8 Lane Divided
		2045	78697	123436	-	-	-	-

Note: Considering exponential growth of industrial and petroleum products on Bangalore-Mangalore as a high priority road after construction of tunnels and bridges, traffic density will be multiplied tremendously.

Table 4.8 Comparison of Projected Sectional Traffic in PCUs

Study by	2012	2017	2020	2022	2025	2027	2030	2032	2035	2037	2040	2044
Feedback	10264	12423	13485	15079	16734	19216	21327	24493	27185	31224	36285	43877
METI			25111	26787	29300	31297	34293	35162	36467	37400	38800	46392
Geoconsult		16822	20963	26141	33191	38865	48472	55916	68172	77442	93970	122081

It is assumed that pre-construction activities shall be done by 2016 and construction of works will start in 2017. Construction time is considered as 5 years (2017-2021). The traffic will open in 2022. Traffic projection will be done for 30 years including construction period i.e. 2015-2045.

It is proposed that existing road will remain in under operation for local traffic movements, desirable up to year 2035 and mandatory after wards to decongest the proposed bypass alignment.

5 Design Standards and Specifications

5.1 General

Design standards for this project will in general conform with "Manual of Specification and Standards" for two laning (IRC SP: 73, 2007) with attention on special requirements for hill road and manual of specifications & standards for four laning IRC:SP:84-2014 for geometrics, IRC SP: 91, 2001 for tunnel design and various relevant standards published by Indian Road Congress. Standards used for this project is summarised below.

5.1.1 General considerations

a) This section lays down the standards for geometric design and general features for new 4-lane road green alignment standard with bridges and tunnels proposals.

b) The Bridges shall normally be provided as per IRC: SP 84: 2014 and IRC: SP: 48: 1998, Hill Road Manual.

c) The Tunnels shall normally be provided as per IRC: SP 84: 2014 and IRC: SP: 48: 1998, Hill Road Manual.

d) The Geometric Design of the Project Road shall conform to the standards set out in this chapter as a minimum.

e) Existing Horizontal Curves, which are found deficient in radius, layout, transition lengths or super-elevation shall be corrected to the specified standards as far as feasible. Similarly deficiencies in the vertical alignment shall also be addressed.

Table 5.1: Design Standards

Sl. No.	Design Specification	Unit	Proposed Design Standards			
1a.	Design Speed	Km/hr	Plain	Rolling	Hilly	Steep
	Desirable		100	80	50	40
	Minimum		80	65	40	30
2.	ROW	M	Plain/Rolling			Hilly
	a) Rural (open areas)		45			24
	b) Urban (built-up)		30			20
	c) New Bypasses		45/60			-
3.	Carriageway width for two lane	M	7.0			
	Carriageway width for four lane (including shyness)	M	2x7.25			
4.	Shoulder width	M	Plain/Rolling		Hilly	
					Hill side	Valley side
			2.5		1.0	2.0
5.	Camber	%				
	Carriageway		2.5			
	Paved Shoulders		2.5			

Sl. No.	Design Specification	Unit	Proposed Design Standards	
	Earthen Shoulders		3.0	
6.	Gradients	%	Ruling	Limiting
	a) Plain and Rolling		3.3	5.0
	b) Mountainous		5.0	6.0
	c) Steep		6.0	7.0
7.	Super elevation Maximum in normal situation	%	5.0	
8.	Minimum Horizontal Curve Radius Desirable Absolute	M	 150 80	
9.	Sight Distance Stopping Sight Distance Intermediate Sight Distance Overtaking Sight Distance	M	 180 360 640	
10.	Minimum Vertical Curve Length (SSD case) Crest Sag		 73.6A 41.5A	
11.	Widening at curve locations	M		
	Up to 40 m		1.5	
	41-60 m		1.2	
	61-100 m		0.9	
	101-300 m		0.6	

Note: 1. A in the above table is the algebraic difference in grades expressed as percentage.

2. This project is being designed for 100 km/hr design speed treating as plain & rolling sections due to provision of flatter gradient for tunnels and bridges to the maximum extent.

5.1.2 Horizontal alignment

The essential elements of the horizontal alignment are as under:

a) Radius of the Horizontal Curve

b) Super elevation

c) Transition Length

d) Sight Distance

The basic considerations for the horizontal alignment shall be as under:

1) The curves shall be designed to have the largest possible radius and in no case less than the ruling value corresponding to the design speed.

2) Sharp curves shall not be introduced at the end of the long tangent.

3) Long Curves with Suitable Transitions shall generally be provided.

4) Reverse Curves shall be avoided as far as possible.

5) Horizontal Alignment shall be coordinated well the vertical alignment.

5.1.3 Transition curves

The minimum length of transition curve shall be determined from the following two considerations and the larger of the two values shall be adopted for design:

i) Rate of Change of Centrifugal Acceleration

Ls =0.0215 V^3 /CR

Where:

Ls = Length of Transition Curve in meters

V = Speed in Km/hr

R = Radius of Circular Curve in meters

C=80/ (75+V) (Subject to a maximum of 0.80 and minimum of 0.50)

ii) Rate of Change of Super elevation should not be steeper than 1 in 150 for roads in Plain/Rolling Terrain, and 1 in 60 in Mountainous/Steep Terrain.

The minimum length of Transition Curve based on this consideration is given by the equation:

Ls=2.7 V^2 /R.

The minimum values of Transition lengths for different Speeds and Curve Radii are given in **Table 5.2.**

Table 5.2: Minimum Values of Transitions

Plain and Rolling Terrain							*Mountainous and Steep Terrain*					
Curve Radius	Design Speed (Km/hr)						Curve Radius	Design Speed (Km/hr)				
(m)	100	80	65	50	40	35	(m)	50	40	30	25	20
	Transition Length in Metres							*Transition Length in Metres*				
45	-	-	-	-	NA	70	14	-	-	-	NA	30
60	-	-	-	NA	75	55	20	-	-	-	35	20
90	-	-	-	75	50	40	25	-	-	NA	25	20
100	-	-	NA	70	45	35	30	-	-	30	25	15
150	-	-	80	45	30	25	40	-	NA	25	20	15
170	-	-	70	40	25	20	50	-	40	20	15	15
200	-	NA	60	35	25	20	55	-	40	20	15	15
240	-	90	50	30	20	NR	70	NA	30	15	15	15
300	NA	75	40	25	NR	-	80	55	25	15	15	NR
360	130	60	35	20	-	-	90	45	25	15	15	
400	115	55	30	20	-	-	100	45	20	15	15	
500	95	45	25	NR	-	-	125	35	15	15	NR	
600	80	35	20	-	-	-	150	30	15	15		
700	70	35	20	-	-	-	170	25	15	NR		
800	60	30	NR	-	-	-	200	20	15	-		
900	55	30	-	-	-	-	250	15	15	-		
1000	50	30	-	-	-	-	300	15	NR	-		
1200	40	NR	-	-	-	-	400	15	-	-		
1500	35	-	-	-	-	-	500	NR	-	-		
1800	30	-	-	-	-	-	-	-	-	-		
2000	NR	-	-	-	-	-	-	-	-	-		

Note:

NA - Not Applicable

5.1.4 Vertical alignment

a) The vertical alignment shall be designed so as to provide a smooth longitudinal profile.

b) Gradients corresponding to the ruling gradients shall be followed in the vertical alignment design.

c) Long Vertical Curves shall be provided at all grade changes.

d) For Design of Vertical Curves, IRC SP 23, and Plates no.3, 4, 5 & 6 of IRC: 73-1980 shall be followed.

5.1.5 Typical cross sections for road

The Proposed typical cross section applicable for the Project Road Sections shall be as under:

a) Typical Cross-Section for 2 x 2-lane road at different contour (half cut/ fill).

b) Typical Cross-Section for 4-lane road in Hill section.

The above typical Cross Sections are shown in Annexure

5.1.6 At-grade intersections

a) The At Grade Intersections shall be provided at merging and de-merging with existing NH-48 road crossing locations.

b) The type of intersections to be provided shall be as under:

- Three Leg Intersection
- Four Leg Intersection

c) The Design of different elements of intersection shall be done as per IRC: SP: 41 and as per MoRT&H-Type Designs for Intersections on National Highways, 1992.

d) Traffic Control Devices (such as Road Markings, Signs, Reflectors, etc) shall be provided as per the provisions of IRC: SP: 41, IRC: 35 and also IRC: 67. 2014

5.1.7 Road embankment

a) Where the bottom of existing sub grade is 0.60 m above the HFL, the existing height of the embankment shall be retained.

b) For the new four lane road, the bottom of sub grade shall be 1.0 m above the high flood level (HFL)/ Ponded water level to ensure proper drainage.

c) High embankments (height 6 m or more) in all soils shall be designed from stability considerations and for design of high embankments IRC: 75 shall be referred.

d) On High embankments, the protection measures shall consist of the following:

- Vegetative Cover
- Kerb Channels
- Chute
- Stone Pitching/Cement Concrete Block Pitching
- In case of cut section slope stability measures such as Pitching, breast walls, etc shall be provided.

e) The Side Slopes of the cuttings shall be provided as per the nature of soil encountered.

f) Side slopes should not be steeper than 2:1 unless soil is retained by suitable soil retaining structures.

5.1.8 Road safety devices

The Road Safety Devices shall consist of the following:

a) Road Markings

b) Traffic Signs

c) Roadside Safety Barriers including Pedestrian Railings.

5.1.9 Road Markings

a) Road Markings shall comprise of carriageway markings such as longitudinal markings and object markings such as raised pavement markers (Cat's Eyes or Road Studs).

b) All markings shall conform to IRC: 35:2015

5.1.10 Road Signs

Three types of Road signs shall generally be provided (such as Mandatory/ Regulatory, Cautionary / Warnings, and informatory signs.

Locations of Signs shall conform to IRC: 67: 2014 and Section 800 of MoRT&H Specifications.

5.1.11 Roadside Safety Barriers

The following types of Road Safety Barriers shall be provided on the Project Road:

a) Semi-rigid type such as "W" Beam Type Steel Barriers shall be provided on the high Embankment Section (where the height of embankment is more than 3.0 m)

b) Rigid Type such as Concrete Crash Barriers shall be provided on the bridges.

5.1.12 Road Drainage

The general design guidelines for the Road Drainage shall be as under:

a) The Design of Drains shall be carried out in accordance with IRC:SP:42:1994 and IRC:SP:50:1999

b) For Surface Drainage, the estimation of Design Discharge and the design of Drain Sections shall be as per the procedure given in IRC:SP:42:1994.

c) The longitudinal slope of the drain shall not be less than 0.5 % for lined drains and 1.0 % for unlined drains.

d) The Side slopes of the unlined drains shall not be steeper than 2H:1V.

e) The Drains on the paved areas shall be provided with CC linings.

f) The Drainage of High Embankment shall be provided with the provision of kerb channel and CC lined chutes.

g) The chute drains and drains at toe of the embankment shall be of Plain Cement Concrete (M15 Grade).

h) Necessary Sub-Surface Drains shall be provided as required.

5.2 Tunnel design criteria and specification

5.2.1 Tunnel Design Standard and Cross Sections

Tunnel design criteria and standards are detailed in Volume II: Design Report, Part- II. Tunnel Layout Plans and L-sections, Typical Cross Sections are shown in Volume IX: Drawings.

5.3 Bridge design criteria and specification

5.3.1 Design standards for bridges

For planning and design of the new four lane bridges, following codes of practices and specifications will be followed:-

5.3.2 Standards and Codes of Practice

Design of all components of structures will be carried out in accordance with the provisions of the following Standards / Codes of Practices:-

- IRC:5-1998 - Section I, General Features
- IRC:6-2000,2014 - Section II, Loads and Stresses
- IRC:18-2000 - Design Criteria for Prestressed Concrete Road Bridges(Post-Tensioned Concrete)
- IRC:21-2000 - Standard Specification & Code of Practice for Road Bridges: Section III Cement Concrete (Plain & Reinforced)
- IRC:22-2008 - Section VI, Composite construction for road bridges (I^{st} Revision)
- IRC:24-2001,2010 - Standard Specification & Code of Practice for Road Bridges: Section V, Steel Road Bridges
- IRC:78-2014 - Section VII, Foundations and Substructure
- IRC:83 (Part II) 1999 - Section IX (Part II), Elastomeric Bearings
- IRC:83 (Part III) 2002 - Section IX (Part III), POT, Pot cum PTFE, Pin and Metallic Guide Bearings
- IRC:89 – 1997 - Guide lines for design and construction of River Training and Control Works for Road Bridges

(I[st] Revision)

- IRC:112-2011 - Code of Practice for Concrete Road Bridges.
- IRC:SP:65-2005 - Guideline for design & construction of Segmental Bridges
- IRC:SP:66-2005 - Guideline for design of Continuous Bridges
- IRC:SP:67-2005 - Guideline for use of External and un-bonded Prestressing Tendons in Bridge Structures
- IRC:SP:69-2005 - Guidelines and Specifications for Expansion Joints.
- IRC:SP:71-2006 Guideline for design & construction of Pre-tensioned Girder of Bridges
- IRC:SP:84-2014 - Manual of Standards & Specification for Four-Laning of Highways through Public Private Partnership.

5.3.3 Carriageway Width / Deck Width

The carriageway width and overall deck width shall be kept on the basis of provisions of IRC:SP:84-2014.

5.3.4 Design Loading

Each new bridge shall be designed for combination of live load specified in Table 2 under Clause 204.3 of IRC:6 depending upon carriageway width. The bridge shall also be checked for 3 lanes of Class-A or one lane of Class-70R + one lane of Class-A.

5.3.5 Seismic Analysis

As per the seismic map given in IRC: 6: 2000; 2014, the project road passes through Seismic Zone–II. The bridges will be designed for seismic force as per provisions of IRC: 6.

5.3.6 Soil Parameters

Soil parameters proposed to be taken for the backfill material behind abutments are:

$\phi = 30^0$, $\delta = 22.5^0$, γ_d =18 kN/m^3, Υ_{sub} = 10 kN/m^3

For the design of foundations for the bridges, rock/soil characteristics will be reviewed on a case to case basis, following the results obtained from actual borings to be carried out at each bridge site.

5.3.7 Design Mixes

Grade of concrete for various components of the bridges shall be adopted as follows:-

PSC Superstructure	-	M45, M50
RCC Superstructure	-	M35
Substructure	-	M30,M35
Pile Foundations	-	M35
Open Foundations	-	M30, M35
RCC Crash Barriers	-	M40

5.3.8 Type of Structures

a) Foundations

Depending upon hydrology of channel, and type of founding strata available, open or pile foundations will be proposed.

b) Substructure

Abutments : Hollow rectangular Wall or Wall type.

Piers : Hollow rectangular Wall type or circular column type depending upon the site requirement.

c) Superstructure

Appropriate type of superstructure will be proposed for each location, bearing in mind the span, width, appearance matching with deep valley and construction scheme associated. In general, proposal will be as follows:

Spans upto 10m length	:	Reinforced concrete solid slab/Integral portal struccture.
Spans ranging from 10m to 20m	:	RC beam & slab / RCC voided slab
Spans ranging from 20m to 30m	:	PSC voided slab / PSC girder with RCC slab / Composite type i.e. steel plate girder and RC slab
Spans ranging from 30 to 45m	:	PSC beam and slab / Composite type steel girder and RC slab
Span ranging from 30m to 60m	:	PSC Box cast in situ / segmental type, steel superstructure
Spans above 60m	:	PSC box cantilever construction, steel truss.

In general due the presence of deep valley massive tall piers nearly 100m high are envisaged. in order to achieve an economically viable option span length close to 150m long will be proposed.

All above structures shall be appropriately detailed to achieve continuity in span arrangement and they shall be integral in nature as per requirement given in clauses 7.4 of IRC SP 84.

d) Bearings

Bearings will be designed depending upon the loads, forces and type of superstructure. POT-PTFE, Elastomeric or Tar paper bearings shall be proposed.

e) Crash Barriers

Crash barriers shall be provided over all the bridges in accordance with IRC: 5-1998.

f) Expansion Joints

Strip seal type elastomeric expansion joints or filler type joints will be proposed depending upon the anticipated expansion / contraction and shall be provided as per provisions of IRC: SP-69.

g) Wearing Coat

Asphaltic concrete wearing coat, 65 mm thick as per MoRT&H standards, will be provided.

h) Approach Slab

Reinforced concrete approach slabs, 3.5m (minimum) long and 300mm thick, in M30 grade concrete at either end of the bridge, will be proposed, with one end supported on the reinforced concrete bracket projecting out from the dirt wall and the other end resting over the soil, in accordance with the guidelines issued by MoRT&H. A leveling course, 15 cm thick, in M 15 grade concrete will be provided under the approach slab.

i) Drainage Spouts

Drainage spouts will be proposed in accordance with MoRT&H standard plans.

j) Protection Works

Details of protection works provided for the existing bridges will be studied and new proposals framed as per provision of IRC: 89 - 1997 taking into account the behavior of the existing protection works.

5.3.9 Reinforcement

TMT Deformed bars Grade designation Fe500, conforming to IS: 1786 will be used.

5.3.10 Pre-stressing Steel

Cables:19 T 13/19 K 15 cables consisting of uncoated, stress relieved, low relaxation strands, conforming to IS:14268, will be provided. It will avoid grouping of cables and also reduce the number of cables.

Pre-stressing Stages: The number of stages of pre-stressing will be kept to the minimum, preferably not more than 2.

5.3 Typical Cross-Section of Bridges

Salient features of Typical Cross-Section for Four Lane Road Bridges is given below:
Option 1: Considering 4-Lane Configuration as per IRC SP 84: 2014

- Number of lanes: 2 (inbound lane) +2 (outbound lane) = 4

Note: Structures are designed as 4 lanes in preparation for 4-laning. Effective width:

- W= 0.30+1.5+0.45+9.6+0.45 = 12.30m

Option 2: Considering 6-Lane Configuration as per IRC SP 87: 2013

- Number of lanes: 3 (inbound lane) +3 (outbound lane) = 6

Note: Structures are designed as 6 lanes in preparation for future 6-laning. Effective width:

- W = 0.30+1.5+0.45+11.5+0.45m+0.3m = 14.50m
- Gradient: Max 3.0% (consideration for traffic safety)
- Max height of piers: 100~ 120m at most;
- Bridge type: - application of concrete bridges to medium-span bridges whose span length up to 100m for its cost-effectiveness study on application of steel bridges for long span bridges in order to minimize pier heights in deep valleys (depth of more than 90m at the deepest points from the bridge surfaces).

- Abutment type: - application of inverted-T type to abutment heights up to 12m. Application of box-type abutment to abutment heights more than 12m.

  Max abutment heights: 20m for structural stability

- Pier type: - application of single circular/rectangular column for reduction of deforestation

  Application of hollow SRC (steel-framed reinforced concrete) sections to pier heights over 30m.

- Foundation type: - application of CCP (Cast-in-place Concrete Pile) to abutments for better stability application of caisson type foundation to piers for reduction of deforestation

6 Alignment Proposals

6.1 Improved alignment "A"

Alignment Option "A" proposed on the Southern side of existing NH-48 has been further refined minutely for better road geometry, structures connectivity, aesthetics, site suitability and construction methods. The alignment starts at Heggade (km. 236.400) traverses through Greenfields, bypassing Maranhally Kadagaravalli, Yedakumari, Gundya villages and ends at Adda Hole (km 263.400) of NH-48. The total length of alignment under this option is 23.579 Km, and the route consists of 6 tunnels (length 12.631km varying from 1660 to 2960 m), 7 bridges, 1 RoB and 1 Viaduct (total length 6.327 km, varying from 50 to 3216m), and 4.621km long cut & fill sections. The route has low gradient (roads & bridges: 0 to 3.5%, tunnels: 3.0 to 3.5%) and gentle curves (R=500m to 2000m). The height of bridge piers in the deep valleys is restricted to 120m that makes the early implementation of the project possible. Also, tunnel lengths are limited up to 3.0km that makes the scale of ventilation/emergency facilities ordinary in size. Only 4.621km out of total length of 23.579km is planned as "cut and fill" that requires deforestation of the construction area. Plan and Profile Drawing is given in Volume IX : Drawings.

Terrain

In general, the terrain can be classified as Rolling and Hilly terrain. The general ground elevation varies along the proposed alignment from 860 to 150 m above sea level.

Carriageway & Shoulder

The typical cross section for the proposed bypass comprises of Four (2x Two) Lane carriageway with each lane of 3.5m widths separated by varied median/ gap 2.5m to 30m. Apart from this, paved shoulder of 1.5m and Gravel shoulder of 1.0m wide is proposed. The proposed roadway is 12m for each road. High Level Bridges The typical cross section for the proposed bridges comprises of two separate bridges of 2 lanes each. The total width of each bridge is 12.3m. The individual bridges are separated by varied gap between two crash barriers from 2.5m to 30m depending on the overall horizontal alignment and topography. Walk way of 1.5m wide separated by crash barrier is proposed on left side. Clear width of paved road is 9.6m for single bridge. Typical cross sections are shown in the Volume IX Drawings. 7 nos. of bridges, 1 RoB and 1 Viaduct are proposed now in refined Option A alignment. For "Tunnels" typical cross section comprises of twin tube of 3 lanes each including one emergency lane of 3.5m wide. The lateral distance between two tubes shall depend on the geotechnical condition and other functional requirements. Apart from this, foot path and drain of 1.5m wide (cumulative) is proposed on each side. The excavated width of single tube is 16.5m. There are 6 tunnels proposed in this option. Typical cross section of tunnel is given in Volume II Design Report and Volume IX: Drawings.

Land use

"Option – A" alignment passes predominately through reserve forest areas on both sides. There are little areas of coffee plantation & agricultural land at start and end of the project. A few locations alignment crosses existing Bangalore- Mangalore railway line from below through tunnel and in one location above railway line through ROB. Built up Areas Option - A alignment generally avoids built-up areas.

Horizontal Alignment

Option - A takes off at Km. 236.400 near Heggade village on the southern side of existing NH-48. The alignment proceeds in the west-south direction, avoiding built-up areas, and crosses the SH-114 at Gundya. The alignment then passes west north of Shiradi Ghat and joins the existing NH-48 at 263.400

near Adda Hole village, thus the length of the proposed alignment is 23.579 km. Overall the Horizontal alignment can be designed for fairly good geometry at design speed of 100 km/hr predominately. The minimum speed for the multi-axle freight vehicles will be 70km/hr. Roadway of Tunnel, Bridges and Cut & Fill sections will be matched properly by tapering as per IRC guidelines. Vertical Profile In general, the terrain can be classified as Rolling at starts & end of the bypass, and Hilly & Mountainous all along the proposed bypass alignment, vertical Geometry can be designed fairly as per the standards of Indian Road Congress (IRC). The alignment is designed in such a way that the maximum longitudinal gradient is kept 3.5% for tunnels, 0% to 3.5% for High Level Bridges and 3.5% for road approaches. However, the vertical profile will be further refined and re-designed for maximum 3.3% gradient at tunnels & bridges and 5% at road approaches during detailed design stage.

Forest Area

There is reserve forest area for almost full length along the proposed alignment.

River Crossing

Yerevatti River is crossing the proposed alignment near railway line crossing. Hence, RoB and River Bridge will be proposed together at their crossings. Kempu hole River is running parallel to existing road NH-48 & Railway line. One Bridge is proposed on this river after proposed flyover on SH-114 crossing, near to Gundya, and before the end of the bypass. The proposed alignment is also crossing Yathina hole River where a suitable bridge has been proposed. There are many other (approximate 16 nos) minor streams and nalla crossings along the alignment where cross drainage structures shall be provided as per topography and site applicability.

Submergence Area

There are no submergence areas along the proposed bypass alignment. Bridges are proposed over the existing rivers, valley and nalla.

Major and Minor junctions

The proposed alignment crosses one State Highway SH-114 about 800m distance from T- Junction with NH-48. Flyover In order to provide safe and efficient access from the project highway to other cross roads and vice versa, a Flyover is proposed with slip roads on SH-114 crossing.

Rail Over Bridges

One ROB' is required in this option at km 54.650 of the existing railway line, hence proposed. GAD's for RoB will be submitted on-line to concerned rail officials after validation of rail levels from topographical surveys and in consultation with the Authority.

Bus Bays

It is a proposed bypass, no existing bus bays are envisaged due to no human settlement exist along the proposed alignment. However Bus Bays have been proposed to facilitate road & rail users at Kadagaravalli, Yedakumari and Arebetta Railway stations.

Access Roads

Access Roads are planned for carrying out the equipment and machineries at the proposed alignment site during construction. In Option A, four numbers of access roads are envisaged with a total length of

approximate 7km (varying from 0.5km to 2.5km). Tentative layouts of access roads are shown in plan & profile drawings and given in Volume IX: Drawings.

Right of Way (ROW)

It is proposed to have 60m ROW, 30m on either side of the proposed centre line of the alignment. At Tunnel and bridges locations the right of way will be needed only during construction period of five (5) years.

Effect on Existing Railway Line

This alignment is running near the existing railway track. Some where it is laterally as well as vertically 40-50m away/down from the existing track. The alignment near railway track have been designed in such a way that at least a safe distance is maintained at such locations. Hence, no RoB shall be required at these locations due to level differences. Instrumentation & Monitoring of railway tracks and the construction activities shall be proposed during tunnel construction below existing railway line.

Utilities along the Project Highway

Utilities such as overhead/ underground electrical, telephone cables and OFC may be required for tunnels and other locations along the project highway. These will be aligned suitably either side of the ROW.

Religious Structure & Private Property Buildings

There is no religious structure along the proposed alignment. The alignment is designed in such a way to minimum effect of private property buildings at start and end of the project.

Road Safety

Project Bypass being a high speed facility, Road safety is of paramount importance. Hence, road safety will be incorporated in the design stage itself. Necessary signage, pavement markings, crash barriers, blinkers etc will be incorporated at appropriate locations.

A summary of alignment features of **Option "A"** has tabulated below:

Table 6.1 Alignment Features of Improved Alignment "Option A"

Design Chainage		Length (m)	Type of Structure	Horizontal Geometry	Gradient (%)
From	To				
0	1800	1800	Cut & Fill	St/Curve	3.5
1800	2100	300	Bridge(B0)	St/Curve	3.5
2100	2320.4	220.4	Cut & Fill	St/Curve	3.5
2320.4	2620.4	300	ROB & CD	St/Curve	3.5
2620.4	5578.14	2957.74	Tunnel -1	St/Curve	3.0
5578.14	5666.38	88.24	Cut & Fill	St/Curve	3.5
5666.38	5716.38	50	Bridge(B1)	Straight	3.5
5716.38	5799.87	83.49	Cut & Fill	Straight	3.5
5799.87	7929.29	2129.42	Tunnel -2	St/Curve	3.0
7929.29	8011.48	82.19	Cut & Fill	St/Curve	3.0
8011.48	9101.48	1090	Bridge(B2)	Straight	0.0
9101.48	9190.1	88.62	Cut & Fill	Straight	3.5

Design Chainage		Length (m)	Type of Structure	Horizontal	Gradient (%)
9190.1	11302.28	2112.18	Tunnel -3	St/Curve	3.0
11302.28	11417.28	115	Cut & Fill	Straight	3.0
11417.28	11467.28	50	Bridge(B3)	Straight	0.0
11467.28	11596.08	128.8	Cut & Fill	St/Curve	3.5
11596.08	13467.65	1871.57	Tunnel -4	St/Curve	3.5
13467.65	13652.65	185	Cut & Fill	St/Curve	3.5
13652.65	14672.65	1020	Bridge(B4)	Straight	3.5
14672.65	14770	97.35	Cut & Fill	Straight	3.5
14770	16429.86	1659.86	Tunnel -5	Straight	3.5
16429.86	16930.31	500.45	Cut & Fill	Straight	3.5
16930.31	17030.31	100	Bridge(B5)	Straight	3.5
17030.31	17501.44	471.13	Cut & Fill	Straight	3.5
17501.44	17701.44	200	Bridge(B6)	Straight	3.5
17701.44	17755.7	54.26	Cut & Fill	St/Curve	3.5
17755.7	19656.37	1900.67	Tunnel -6	St/Curve	3.5
19656.37	20362.44	706.07	Cut & Fill	Straight	3.5
20362.44	23579.21	3216.77	C/F/VIADUCT	St/Curve	3.5

Plan and Profile Drawings are given in Volume IX : Drawings

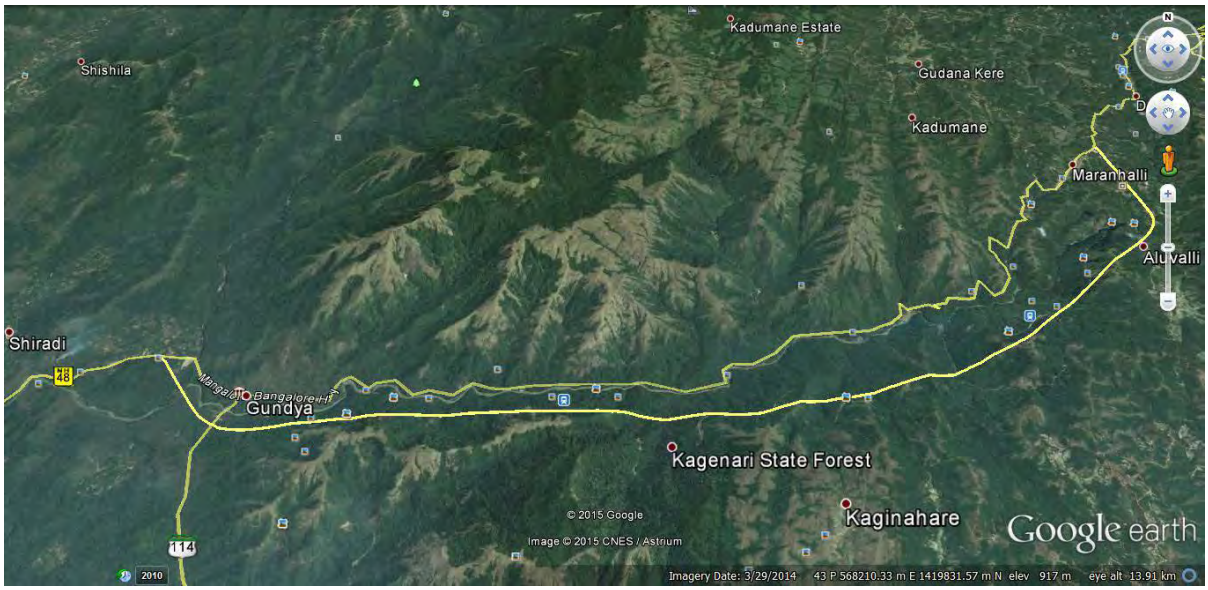


Figure 6.1 Proposed Alternative Alignment Option A

6.2 Pavement Design

The proposed bypass is a green field alignment of design speed 100-80km/hr, comprise of mainly tunnels, bridges sections and small part of cut & fill only. Considering high speed heavy commercial & freight vehicles round the clock and low operation & maintenance cost, concrete pavement has been proposed. Design of rigid pavement is based on latest version of IRC: 58-2015: Guidelines for the Design of Plain and Jointed Rigid Pavements for High-ways.

6.2.1 Vehicle Damage Factor

Due to the very bad pavement condition the Shiradi ghat of NH-75/48 section was closed for commercial vehicles and improvements works were taken up by PWD-NH wing, Govt of Karnataka. Axle load survey had been conducted with traffic surveys and analysis/results have been detailed in Volume II: Design Report. Analysed VDF values are given below in **Table 6.2**

From the perusal of Table, VDF values are

- Very high for Multi axle, Two-axle and three axle vehicles for both Bangalore-Mangalore and Mangalore- Bangalore directions.
- Moderate LCV and Bus for both Bangalore- Mangalore and Mangalore- Bangalore directions.

Table 6.2 : VDF values Observed on Bangalore – Mangalore NH-48

Vehicle Type	Km. 232.000		Km. 263.500	
	Towards Sakleshpur	Towards Mangalore	Towards Sakleshpur	Towards Mangalore
2 Axle	1.912	1.781	2.355	1.995
3 Axle	4.658	3.149	5.479	2.828
4 Axle	9.627	3.658	10.767	3.345
5 Axle	9.462	5.751	-	-
6 Axle	-	1.113	-	-
LCV	0.815	0.203	0.743	0.190
Bus	0.563	0.369	0.361	0.552
Mini Bus	0.126	0.151	0.108	0.117

As per IRC guidelines and above results, following VDF values has been adopted.

- LCV – 1.0
- Two-Axle – 3.0
- Three – Axle – 6.0
- Multi- Axle – 9.0

6.2.2 Design of Subgrade and Subbase

600 mm thickness sub grade/ embankment fill (if required) of CBR 8% and 150 mm Granular Sub base of min 30% CBR has been provided for the design. This sub base layer will act as drainage layer as well.

6.2.3 Dry Lean Concrete

Dry lean concrete of M-10 grade and 150 mm thickness has been provided as base for better load distribution and less erodibility of Pavement Quality Concrete (PQC).

6.2.4 Design of Continuously Reinforced Concrete Pavement (CRCP)

In order to obviate the need for expansion and contraction joints, Continuously Reinforced Concrete Pavement (CRCP) has been proposed. CRCP permits long slab lengths with improved riding comfort. The routine maintenance cost is less in case of CRCP when compared to plain concrete pavements. Conventional CRCP requires relatively high percentage of steel in the order of 0.7 to 1.0 percent of concrete cross section. The technique of CRCP construction with elastic joints (CRCP – EJ) enables significant reduction in quantity of steel (0.4 to 0.5 percent) and also eliminates the random cracks, which occur in conventional CRCP.

The elastic joints consist of dummy contraction joints with the reinforcement continuous through them. The reinforcement is painted with a bond-breaking medium over a specified design length on either side of the joint groove to provide adequate gauge length for limiting the steel strains due to joint movement. The usual spacing of these joints is about 4 to 5 m.

6.2.5 Pavement Quality Concrete (PQC)

Pavement Quality Concrete (PQC) of M-40 grade has been designed based on IRC:58-2015.

The salient features of the recommended pavement design are as below:

- The pavement is designed for 100 Msa and design period of 15 years.
- Panel size of 4.25mx4.50m uniform on both sides has been proposed.
- Dowel bars are proposed at every 4.50 m.
- Silica fumes at the rate of 3% of cement for PQC will be added to increase the strength.
- Non oven Geo textile of 200 GSM to be provided below GSB drainage layer to avoid pumping and intermixing of layers provided and also it will act as drainage layer beside separation function.
- Geo cell of 75mm depth shall be provided in the zone of shoulders at curved portion to avoid surface erosion of shoulders to support pavement edges.
- Provide recron 3Ss fibre can overcome the shrinkage cracks in Rigid Pavement. It compliments structural steel enhancing concretes resistance to shrinkage cracking and impose mechanical properties.
- Extra width in curves as per Hill road manual is proposed.
- Provide gabions in the zone of cut & fill sections having retaining wall and stability of slopes protection works.

The configuration of pavement has been presented as per **Table 6.3.**

- **Table 6.3 Rigid Pavement Composition**

GSB (mm)	DLC (mm)	PQC (mm)
150	150	320

6.2.6 Paved Shoulders

The pavement composition of paved shoulders has been kept with the same specifications as those of the main carriageway.

7 Summary of Environment Impact Assessment/ IEE

7.1 General

Karnataka state is very rich of endangered flora and fauna. There are many reserved forests, wild life sanctuaries and national parks in Karnataka state. According to the secondary data the project road passes through reserve forest areas and un-notified wild life sanctuaries as shown below:

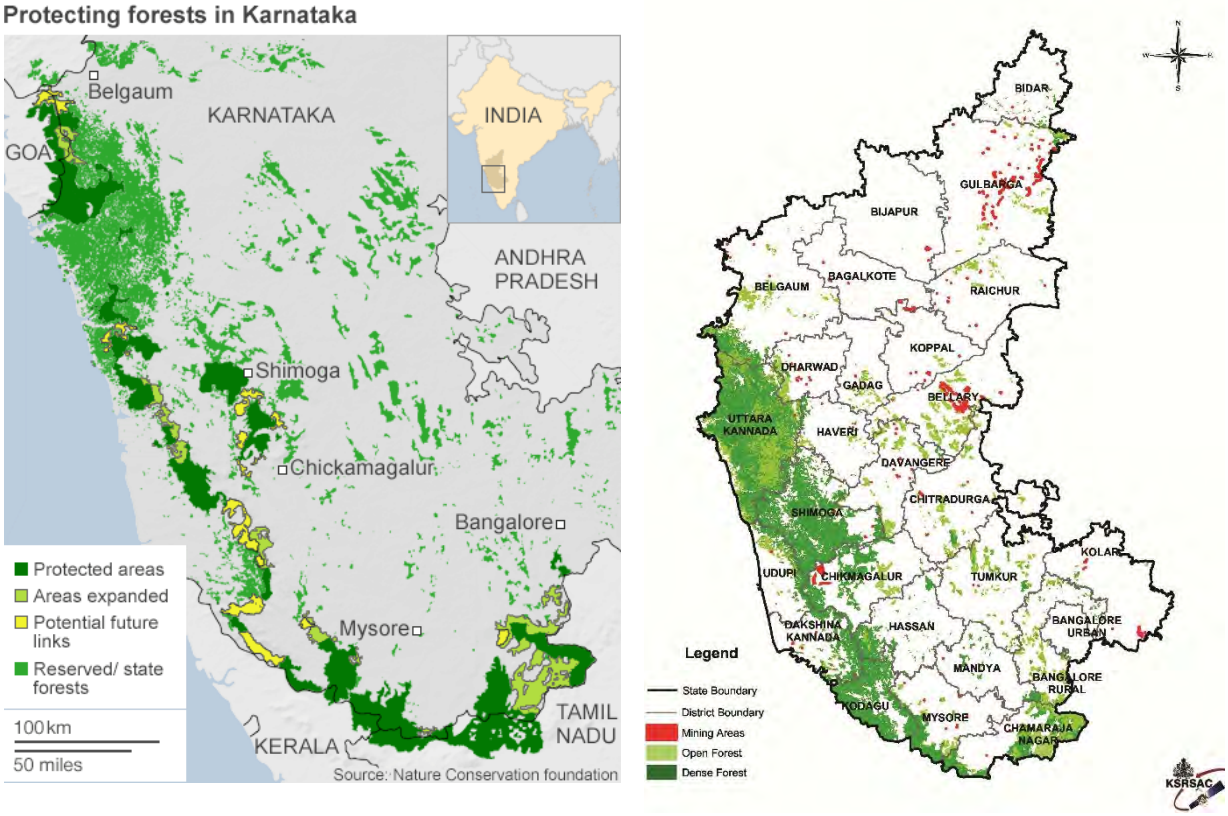


Fig.7.1 Forest Maps and Sanctuaries of Karnataka

However present status of Wildlife Life Sanctuary and Reserve Forest area shall be verified from the concerned department.

The project road takeoff from Maranhally (km 238.000), and merges at Gundya (km 261.450) on existing road section of NH-48.

The State of Karnataka is located in South-West part of India. Karnataka is surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The entire stretch of NH-48, length 328km passes through important towns of Nelamangala, Kunigal, Channarayapatna, Hassan, Sakleshpura, Uppinaangadi and reaches Mangalore city as per secondary data.

7.2 Environmental profile of Project

Lying between 12° 13´ and 13° 33´ North latitudes and 75° 33´ and 76°38´ East longitude, Hassan district has a total area of 6826.15 km². The geography is mixed with the malnad or

mountainous region to the west and south west called Bisle Ghat and the maidan or planis regions in the north, south and east. There are some areas of degraded forest ranges in central portion of the district.

The general level of Hassan district is it slopes with the course of Hemavathi river from the western ghat ranges towards the bed of the Kaveri river near Hampapura in the south east. Its chief tributary is the Yagachi River, from Belur taluka, which joins it near Gorur. Hemavathi passes through Holenarsipur taluq in a southerly direction and joins with the Kaveri near Hampapura close to the border of Hassan district. Hassan and Belur stands around 3,084 and 3,150 feet (960 m) above the sea level respectively.

The district is surrounded by Chikmagalur District to the north west, Chitradurga District to the north, Tumkur District to the east, Mandya Districtto the south east, Mysore to the south, Kodagu District to the south west and Dakshina Kannada district to the west.

7.2.1 Climate

In Hassan District, highest day temperature is in between 27 °C to 38 °C in summers. Average temperatures of January is 23 ° C , February is 23 ° C , March is 26 °C , April is 27 °C , May is 27 °C.

7.2.2 Water Hydrology and Drainage

Weathered and fractured gneiss is the predominant aquifer found in the project districts followed by schistose and granitic aquifers, which occur as isolated patches in a few taluks. As per CGWB, part of 2 project blocks in each Project District fall under overexploited category. Those are 50% of Hassan Block in Hassan district & 40% of Bantawal in Dakshin Kannada. Whereas, part of Belthangadi (10%) and Puttur (10%) Block fall under semi critical category. Water table as per CGWB is 1.39 - 8.32 mbgl (post monsoon in Hassan district) & 0.75 - 8.65 mbgl (post monsoon in Dakshin Kannada district). The major rivers of the project area are Nethravathi, Kumaradhara, Hemavathi, Yagachi etc.

7.2.3 Forest Resources

The alignment of the proposed project road passes through the jurisdiction of 2 forest divisions i.e. Hassan (Hassan District) and Mangalore (Dakshin Kannada District). The forest land acquisition will be required at the portals.

7.2.4 National Park, Sanctuary, Biosphere Reserve

The project road section doesn't fall within 10 Km radius of any National Park, Wild life Sanctuary, or Biosphere reserve. No notified animal corridor/migration route exists along the road as per secondary information obtained from Wildlife Trust of India.

7.2.5 Flora & Fauna

These forests of the project area include unique flora and fauna with rich biological diversity and genetic resources, apart from many medicinal herbs and shrubs.

7.2.6 Biodiversity Hot Spot

A biodiversity hotspot is a biogeographic region in the world with a significant reservoir of biodiversity that is under threat from humans. It is a method to identify those regions of the world where attention is needed to address biodiversity loss and to guide investments in conservation. Around the world, 25 areas are identified so far with another nine possible candidates. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species. India has two such major

biodiversity hotspots and they belong to the Eastern Himalayas and the Western Ghats, through which the project road section passes.

7.3 Objective and Scope of the EIA report

The scope of the EIA includes the following:

- To carry out assessment considering World Bank safeguard policies, 1999.
- Considering the MoEFCC guidelines on Highway project in EIA notification, 2006 and amendments.
- To carry out the preliminary environmental screening to assess the direct and induced impacts due to the project works;
- To assess and document baseline conditions relevant to the project with the objective to establish the benchmarks;
- To assess the potential positive and negative significant impacts due to the project and identify the cost effective mitigation measures to address these impacts adequately in the Environmental Monitoring and Management Plan (EMMP);
- To do the analysis of alternatives incorporating environmental concerns and the associated costs in the economic analysis.
- To give special attention to the environmental enhancement measures in the projects for the following:
  - Provision of protection work in land slide prone zones;
  - Tree plantation along the project road;
  - Cultural property enhancement along the project roads;
  - Bus bays including a review of their location;
  - Traffic safety provisions like Guard post, Road Delineators, Metal Beam Crash Barrier along the Project roads, depending upon the site requirements, and
  - Re-development of the borrow, quarry areas located on public land.
  - Propose an effective muck management plan
- To prepare EIA report adequate public consultation and the recommendations arising thereon.
- To identify all mitigation measures in the EIA and EMMP.
- To prepare the bill-of-quantities (BOQ) and technical specifications for all items of work on account of environmental enhancement measures in such a way that these may be readily integrated to the construction contracts.
- To provide additional inputs in the areas of performance indicators and monitoring mechanisms for environmental components during construction and operational phase of the project.

To provide the cost of mitigation measures and to ensure that environmental related staffing, training and institutional requirements are budgeted in project cost.

7.4 Legal Requirements

NOC and Consents under Air, Water, EP Acts & Noise rules of SPCB for establishing and operating plants from SPCB. The NOC shall be made available after the SPCB completes the process of

conducting Public Hearing of the project (which shall be carried out as per the Prior Environmental Clearance process)

- NOC under Hazardous Waste (Management and Handling) Rules, 1989 from SPCB
- PUC certificate for use of vehicles for construction from Department of Transport
- Quarry lease deeds and license and Explosive license from Dept. of Geology and Mines & Chief controller of explosives
- NOC for ground water extraction for construction and allied works from Ground Water Authority

Apart from the above clearances, the concessionaire also has to comply with the following:

- Clearance of Engineer for location and layout of Worker's Camp, Equipment yard and Storage yard.
- Clearance of Engineer for Traffic Management Plan for each section of the route after it has been handed over for construction.
- An Emergency Action Plan should be prepared by the contractor and approved by the Engineer for accidents responding to involving fuel & lubricants before the construction starts.
- Submit a Quarry Management Plan to the Engineer along with the Quarry lease deeds
- Submit a muck management plan to the Engineer along with the quantity and disposal

Various environmental regulations and policies of Government of India, state Government as well as World Bank's safeguard policies have been reviewed with respect to the proposed project activities. Based on the study, the requirements of various clearances and permits for different activities have been identified for the project as listed below.

Table 7.1 Acts and its objective

National Act	Year	Objective	Authority
Environment (Protection) Act and amendments	1986	To protect and improve the overall environment	MoEFCC, CPCB
Notification on Environment Impact Assessment of Development projects (and amendments) (referred to as the Notification on Environmental Clearance)	2006	To provide environmental clearance to new development activities following environmental impact assessment.	MoEFCC, CPCB, KSPCB, and State Environmental Impact Appraisal committee
Forest (Conservation) Act	1980	To protect and manage forests	MoEFCC, and State Forest Dept
Water (Prevention and Control of Pollution) Act (and subsequent amendments)	1974	To provide for the prevention and control of water pollution and the maintaining or restoring	CPCB, and KSPCB

National Act	Year	Objective	Authority
		of wholesomeness of water.	
Air (Prevention and Control of Pollution) Act (and subsequent amendments)	1981	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes.	CPCB, KSPCB, and Transport Department
The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,	2009	The rule provides prevention for mishandling of Hazardous Wastes and gives a process to control and transport the same.	MoEFCC, CPCB, and KSPCB
The Municipal Solid Wastes (Management and Handling) Rules,	2000	The rule facilitates and provides methods to manage the Municipal Solid Wastes in an efficient and reusable manner.	MoEFCC, CPCB, and KSPCB
The Bio-Medical Waste (Management and Handling) Rules, and amendments	1998	Due to its contamination and hazardous nature the Bio-Medical Wastes to be handled and treated in compliance to the rules.	MoEFCC, CPCB, and KSPCB
E-waste (Management and Handling) Rules,	2011	Due to widespread use of electronic gadgets and equipments for industries and office complexes	MoEFCC, CPCB, and KSPCB
The Noise Pollution (Regulation and Control) Rules, and amendments	2000	Work place noise is covered under Indian factories Act, 1948 but this rule provides safety against noise in ambient condition with generation of noise by certain point and area source.	MoEFCC, CPCB, and KSPCB
Fly Ash notification	2007	Fly ash in construction activities, Responsibilities of Thermal Power Plants and Specifications for use of ash-based products/ responsibility of other agencies,	MoEFCC, CPCB, and KSPCB

National Act	Year	Objective	Authority
Public Liability Insurance Act	1991	The main objective of the Public Liability Insurance Act 1991 is to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.	MoEFCC, CPCB, and KSPCB
The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules,	1996	This rule ensures the preparedness for the emergencies caused by chemical hazards.	MoEFCC, CPCB, and KSPCB
Building and Other Construction Workers (Regulation of Employment and conditions of Service) Act.,	1996	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measure and for other matter connected therewith or incidental	Ministry of Labour and Employment
The Land Acquisition Act	2013	Set out procedures for acquisition of land by government	Land and Land Revenue Department
Central Motor Vehicle Act Central Motor Vehicle Rules	1988 1989	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution.	Motor Vehicle Department
Ancient Monuments and Archaeological sites and Remains Act	1958	Conservation of Cultural and historical remains found in India.	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).

7.5 Triggered Safeguard Policies of the world bank

Table 7.2 Safeguard Policies

Safeguard Policies Triggered by The Project	YES	NO
OP 4.01 / BP 4.01 – Environment Assessment	[X]	[]
Natural Habitats (OP/BP 4.04)	[X]	[]]
Pest Management (OP 4.09)	[]	[X]
Indigenous Peoples (OP/BP 4.10)	[X]	[]
Cultural Property (OPN 11.03, being revised as OP 4.11)	[X]	[]
Involuntary Resettlement (OP/BP 4.12)	[X]	[]
Forests (OP/BP 4.36)	[X]	[]
OP/BP 7.5 – Projects on International Waterways	[]	[X]
Projects in Disputed Areas (OP/BP 7.60)	[]	[X]

7.6 Methodology

The methodology used for this study is based on the procedures described in World Bank Environmental Assessment Guidelines of 1999, and MoEFCC's Environmental Impact Assessment Notification dated 14th September 2006 and amendments therein.

The Environmental Impact Assessment has been carried out using current ADB and Government of India guidelines, specifically:

- Project Terms of Reference (TOR) by MoRTH ;
- Environmental Impact Assessment Notification dated 14thSeptember 2006, Ministry of Environment and Forest (MoEFCC) and amendment, Government of India;
- The Environmental (Protection) Act, 1986 of Government of India;
- Environmental guidelines for Road/Rail/Highway Projects, 1989, Government of India;
- Handbook of environmental procedures and guidelines, 1994, Government of India; and
- Guidelines for Environmental Impact Assessment of Highway Projects (IRC: 104-1988).

The methodology adopted includes the following work plan:

Activity 1: Submission of Inception Report with methodology

Technical Consultant including Environmental Specialist had a field visit, in July 2015, in order to get the team members appraised of the project background, present status, approach and methodology to be followed and sources of secondary data / reports.

Activity 2: Collection and Review of Relevant Documents

The environmental team will collect and review project parameters, including technical information, and design specification provided by engineering team.

Activity 3: Field Investigation

The environmental team will undertake a field environmental survey. Various environmental features of the project corridors will be observed and studied.

Activity 4: Ecological Investigation

The environmental team will undertake a field ecological survey. Various ecological features of the project corridors will be observed and studied.

Activity 5: Stake holders and Public Consultation

During field environmental survey, public consultations will be conducted to obtain the views of local people, project affected persons and local administrative representatives. Focused Group Discussion will be adopted as tool for the public consultation along with social team. The formats for the same is given in Volume IV (a).

Based on collected data and information, potential adverse environmental impacts will be identified and examined using standard “Checklist Method”. Thereafter possible mitigation measures will be identified and on the basis of findings of impact appraisal comprising the key elements embodied in this EIA, an Environmental Management Plan (EMP) has been developed. Continued discussions undertaken with the executive agency and technical team of the consultant for integrating environmental management measures into the project.

7.7 Summary of EIA/IEE

7.7.1 Environmental Issues related to the project

- Construction Materials
- Stone chips
- Arrangement for Construction Water
- Labour Requirements
- Construction Camp Locations- Selection, Design & Layout
- Hot Mix Plants and Batching Plant Locations
- Arrangements for Temporary Land Requirement
- Construction Wastes Disposal including Fly Ash
- Stripping, Stocking and Preservation of Top Soils
- Accessibility
- Raw Materials
- Transporting Construction Materials and Haul Road Management
- Construction Water
- Drainage and Flood Control
- Water Pollution from Construction Wastewater
- Siltation of Water Bodies and Degradation of Water Quality
- Slope Protection and Control of Soil Erosion
- Water Pollution from Fuel and Lubricants
- Dust Pollution from Batching Plants
- Emission from Construction Vehicles, Equipment and Machineries

Noise

- Noise from Vehicles, Plants and Equipments

Safety

- Personal Safety Measures for Labours
- Traffic and Safety
- Precautionary/Safety Measures during Construction
- Risk from Electrical Equipment (s)
- Risk Force Measure
- Health issues
- First Aid
- Project area Plantation
- Flora/ Fauna
- Archaeological Property
- Provision of Potable Water
- Sanitation and Sewage System
- Waste Disposal
- Monitoring of Environmental Conditions
- Continuous Community Participation
- Cleaning of Construction Premises and Restoration
- Plantation
- Monitoring Operation Performance
- Pollution Monitoring
- Atmospheric Pollution
- Ground and Surface Water Analysis
- Noise Pollution
- Waste water management
- Municipal Solid waste management
- Hazardous waste management
- Changes in Land Use Pattern
- Orientation of Implementing Agency and Contractors

7.7.2 Checklist of Impacts due to the Proposed Project

Table 7.3 Checklist of Impact

	Project Phase / Environmental Impact	Impact		No Change	Short Term	Long Term
		+ve	- ve			
A.	**Impacts due to Project Location**					
1	Loss of Land and Trees				*	*
2	Loss of Infrastructure				*	
3	Public Utilities			*		
4	Cultural Properties			*		
5	Risk Due to Earthquake			*		
B.	**Impacts due to Construction**					
6	Change of land use		*		*	*
7	Soil erosion at construction sites		*		*	

	Project Phase / Environmental Impact	Impact		No Change	Short Term	Long Term
		+ve	- ve			
8	Pollution by construction spills			*		
9	Health risks & Cultural Hazards			*		
10	Dust Problem		*		*	
11	Noise Pollution		*		*	
12	Disturbance to traffic		*		*	
13	Effect on Economic Activities		*		*	
C.	**Impacts due to Project Operation**					
14	Noise Pollution			*		
15	Traffic Disturbance	*				*
16	Odour Problem			*		
17	Release of Treated Effluent			*		
D.	**Positive Impacts**					
18	Health Benefits	*				*
19	Improved Aesthetics	*				*
20	Better infrastructure facilities	*				*
21	Improved Air Quality	*				*
22	Increased Socio-economics	*				*
23	Increased Agricultural activity	*				*
24	Employment Opportunity	*				*

7.8 Environmental Management Plan

7.8.1 Introduction

The Environmental management Plan (EMP) consists of set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation stages of the project to eliminate adverse environmental impacts, to offset them, or to reduce them to acceptable levels. The plan will also include the action needed for the implementation of these measures.

The major components of the Environmental Management plan are:

- Mitigation of potentially adverse impacts;
- Monitoring during project implementation and operation;
- Institutional capacity building and training;
- Implementation schedule and Environmental cost estimates; and
- Integration of EMP with Project planning, design, construction and operation.

7.8.2 Objectives of the EMP

The main aim of the Environmental Management Plan is to ensure that the various adverse impacts are mitigated and the positive impacts are enhanced. The objectives of the EMP at various stages of the project planning and implementation are as follows:

7.8.3 Design Stage

- To have minimum impact on road side tree, forestation and ground cover;
- To keep land acquisition and building demolition at a minimum;
- To provide maximum safety to the road users and road side communities;
- To develop a design that incorporates environmental safeguards; and
- To provide mitigation measures to all expected environmental degradation due to the project activity.

7.8.4 Constructions Stage

- To prevent and reduce the adverse environmental impacts of the project by implementing mitigation measures; and
- To ensure that the provisions of the EMP are strictly followed and implemented by strengthening implementation arrangements.

7.8.5 Operation Stage

- To prevent deterioration of environment components of air, water, soil, noise etc.;
- To improve the safety of the road users and road side communities.

7.9 Environmental Budget

Environmental Management Plan will be prepared as part of detailed EIA study and is intended to become a part of the contract documents so that implementation of all the environmental measures can be ensured. The implementation actions, responsibilities and timeframes will be specified for each component and adverse impact anticipated. The cost of implementing above mitigation measures during the construction stage works out to Rs. 1.12 Crores. The operational cost of the same is estimated at Rs. 4.85 lakhs during the first two years. The cost estimates are presented in **Table** below:

Table 7.4 Estimation of Environmental Management Plan Cost

Description	Unit	Quantity	Rate(Rs.)	Amount(Rs.)
A. Annual Cost During Construction Phase during Five Years				
1.Compensatory avenue plantation of twice the number of trees to be cut and their fencing and maintenance for five years	No.	15,000	400	60,00,000
2.Shrub plantation@500 saplings (single row) per Km for the cut and fill section and their fencing and maintenance for five years	No.	100	15000	15,00,000
3. Environmental Monitoring				
3.1. Air Quality Monitoring at 15 sensitive locations for three seasons for 5 consecutive years	No.	70	12,000	8,40,000
3.2. Water Quality Monitoring at 5 locations for two seasons for 5 consecutive years	No.	50	3,000	1,50,000
3.3. Noise Monitoring at 15 sensitive locations for three seasons for 5 consecutive years	No.	75	1000	75,000

Description	Unit	Quantity	Rate(Rs.)	Amount(Rs.)
3.4. Soil Quality Monitoring at 9 sensitive locations for two seasons for 5 consecutive years	No.	45	3,000	1,35,000
3.5. Mobilisation Charges for 3 seasons for 5 years	No.	15	75,000	11,25,000
4. Dust Suppression at Site(6 trips/day for 365 days for 5 years)	No.	150	1000	1,50,000
5. Severances & Others (including training, work-shops, awareness campaigning etc.)		Lump sum		50,000
6. Two Rainwater Harvesting Structures per 5 Kilometer for 24km	No.	5	40,000	2,00,000
Total cost during construction phase				1,02,25,000
B. Annual Cost During Operational Phase during First Two Years				
1. Environmental Monitoring				
1.1. Air Pollution Monitoring at 15 sensitive locations for 3 seasons for first two years	No.	37.25	12,000	4,47,000
1.2. Noise Monitoring at 15 sensitive locations for 3 seasons for first two years	No.	37.5	1000	37,500
Total cost during Operation phase				4,84,500
Total Cost (A+B)				**1,07,09,500**
Contingency (10%)				**10,70,950**
Total				**1,17,80,450**

8 Summary of Resettlement Plan

8.1 Social Impact Assessment

'Social Impact Assessment (SIA) includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment.

Social Impact Assessment of the project is an important component of project preparation. The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act, 2013; project specific R&R Policy as approved by GoUP and World Bank policy require social impact assessment during the design stage to avoid, reduce and mitigate potential negative impacts of project action and enhance positive impacts, sustainability and development benefits.

Assessment results are considered with technical and economic feasibility findings in the final selection of roads to be rehabilitated. The assessments also contribute to engineering design and result in the preparation of social action plans governing project implementation and the resettlement and rehabilitation of those who may be displaced by road improvements.

The main goals of social analysis is to put forward a sustainable and socially relevant design for highway improvement, whereby the displacement is minimized and wherever done, affected persons are suitably rehabilitated. In order to fulfill this goal, the main objectives of the social screening are:

8.2 Encroachment

To undertake a preliminary evaluation of the highway with the objective of identifying and assessing the area specific issues related to anticipated residential, commercial, cultural and industrial encroachments within ROW and also to explore alternative project designs so that the displacement because of the project is minimized.

8.3 Loss Estimation

To estimate various kinds of losses (Land and other movable and immovable assets), deprivation of social facilities, cultural conflicts and identify vulnerable groups who may be displaced resulting from highway widening and strengthening; identify the most critical/problematic locations of the project that may cause displacement and resettlement of the people.

8.4 Framework Development for the Preparation of Land Acquisition Plan and Resettlement Plan

The proposed road intervention is being carried by NHAI. Land free from all encumbrances to contractors will be given for the construction and maintenance of road. For this purpose following activities are required to be carried out:

(a) Land acquisition as National Highway Act 1956

(b) R&R Framework as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013

(c) Institutional arrangement for R&R implementation.

8.4.1 Identification of Impact

In this project most of the alignment passes through forest land but only few location land acquisition will be require for approach road. These impacts are analyzed in detail in social assessment report.

8.5 Resettlement Policies and Legal Framework

8.5.1 Key Social Laws and Regulations

This section presents the legal framework for the land acquisition process and the Resettlement and Rehabilitation Policy which also includes the entitlements for affected eligible families. Project has developed Resettlement and Rehabilitation Policy based on the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013; World Bank's OP 4.12 and various government orders issued by state government for issues related to R&R. The policy recognizes the need to support restoration of livelihoods of adversely affected people and lays down norms for rehabilitating the affected people and broadly outlines an approach and institutional framework to achieve its objectives. The key Social regulations and legislations that will govern then preparation and implementation of the project is presented below.

Table 8.1: Relevant Social Legislations

Acts/Rule/Policy	Year	Objective	Responsible Agency
Ancient Monuments and Archaeological Sites and Remains Act	1958	Conservation of cultural and historical remains found in India.	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).
Right to fair compensation and transparency in land acquisition, rehabilitation and Resettlement Act	2013	Fair compensation for acquisition of immovable assets; Resettlement of displaced population due to LA and economic rehabilitation of all those who are affected due to land acquisition.	Revenue Department. Govt. of Karnataka
The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act	2006	Grants legal recognition to the rights of traditional forest dwelling communities, partially correcting the injustice caused by the forest laws. Makes a beginning towards giving communities and the public a voice in forest and wildlife conservation	Ministry of Tribal Affaires, GOI and Department of Tribal Welfare,

8.6 World Bank Safeguard Policies

Projects financed with IDA resources need to comply with World Bank Operational Policies. The World Bank has Environmental and Social Safeguard Policies to reduce or eliminate the adverse effects of development projects. The safeguard policies of World Bank are provided in the table below.

Table 8.2: Safeguard Policies of World Bank

World Bank Safe Guard Policies	Objective
OP/BP 4.12	Involuntary Resettlement-The objective of this policy is to avoid or minimize involuntary resettlement where feasible, exploring all viable alternative project designs. Furthermore, it intends to assist displaced person in improving their former living standards; community participation in planning and implementing resettlement; and to provide assistance to affected people, regardless of the legality of title of land
OP 4.10	Indigenous People -This policy aims to protect the dignity, right and cultural uniqueness of indigenous people; to ensure that they do not suffer due to development; that they receive social and economic benefits
OP/BP 4.11	Cultural Property –This policy aims at assisting in the preservation of cultural property, historical, religious and unique natural value-this includes remains left by previous human inhabitants and unique environment features, as well as in the protection and enhancement of cultural properties encountered in Bank financed project.

8.7 National Highways Act 1956

Land for construction of a new highway or upgradation /widening is acquired using the NH Act 1956. Key provisions relating to acquisition are as follows:

3A. Power to Acquire Land, etc.

(1) Where the Central Government is satisfied that for a public purpose any land is required for the building, maintenance, management or operation of a national highway or part thereof, it may, by notification in the Official Gazette, declare its intention to acquire such land.

(2) Every notification under sub-section (1) shall give a brief description of the land.

(3) The competent authority shall cause the substance of the notification to be published in two local newspapers, one of which will be in a vernacular language.

3B. Declaration of Acquisition.

(I) Where no objection under sub-section (1) of section 3C has been made to the competent authority within the period specified therein or where the competent authority has disallowed the objection under sub-section (2) of that section, the competent authority shall, as soon as may be, submit a report accordingly to the Central Government and on receipt of such report, the Central

Government shall declare, by notification in the Official Gazette, that the land should be acquired for the purpose or purposes mentioned in sub-section (1) of section 3A.

(2) On the publication of the declaration under sub-section (1), the land shall vest absolutely in the Central Government free from all encumbrances.

(3) Where in respect of any land, a notification has been published under subsection (1) of section 3A for its acquisition but no declaration under sub-section (1) has been published within a period of one year from the date of publication of that notification, the said notification shall cease to have any effect: Provided that in computing the said period of one year, the period or periods during which any action or proceedings to be taken in pursuance of the notification issued under sub-section (1) of section 3A is stayed by an order of a court shall be excluded.

(4) A declaration made by the Central Government under sub-section (1) shall not be called in question in any court or by any other authority.

3C. Power to take Possession.

(I) Where any land has vested in the Central Government under sub-section (2) of section 3D, and the amount determined by the competent authority under section 3G with respect to such land has been deposited under sub-section (1) of section 3H, with the competent authority by the Central Government, the competent authority may by notice in writing direct the owner as well as any other person who may be in possession of such land to surrender or deliver possession thereof to the competent authority or any person duly authorised by it in this behalf within sixty days of the service of the notice.

(2) If any person refuses or fails to comply with any direction made under subsection (1), the competent authority shall apply—

(a) in the case of any land situated in any area falling within the metropolitan area, to the Commissioner of Police;

(b) in case of any land situated in any area other than the area referred to in clause (a), to the Collector of a District, and such Commissioner or Collector, as the case may be, shall enforce the surrender of the land, to the competent authority or to the person duly authorised by it.

3E. Determination of amount payable as compensation

(I) Where any land is acquired under this Act, there shall be paid an amount which shall be determined by an order of the competent authority.

(2) Where the right of user or any right in the nature of an easement on, any land is acquired under this Act, there shall be paid an amount to the owner and any other person whose right of enjoyment in that land has been affected in any manner whatsoever by reason of such acquisition an amount calculated at ten per cent. of the amount determined under sub-section (1), for that land.

(3) Before proceeding to determine the amount under sub-section (1) or sub-section (2), tbe competent authority shall give a public notice published in two local newspaper, one of which will be in a vernacular language inviting claims from all persons interested in the land to be acquired.

(4) Such notice shall state the particulars of the land and shall require all persons interested in such land to appear in person or by an agent or by a legal practitioner referred to in sub-section (2) of section 3C, before the competent authority, at a time and place and to state the nature of their respective interest in such land.

(5) If the amount determined by the competent authority under sub-section (1) or sub-section (2) is not acceptable to either of the parties, the amount shall, on an application by either of the parties, be determined by the arbitrator to be appointed by the Central Government.

(6) Subject to the provisions of this Act, the provisions of the Arbitration and Conciliation Act, 1996 (26 of 1996) shall apply to every arbitration under this Act.

(7) The competent authority or the arbitrator while determining the amount under sub-section (1) or sub-section (5), as the case may be, shall take into consideration

(a) the market va]ue of the land on the date of publication of the notification under section 3A;

(b) the damage, if any, sustained by the person interested at the time of taking possession of the land, by reason of the severing of such land from other land;

(c) the damage, if any, sustained by the person interested at the time of taking possession of the land, by reason of the acquisition injuriously affecting his other immovable property in any manner, or his earnings;

(d) if, in consequences of the acquisition of the land, the person interested is compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change.

8.8 Summary of Resettlement Plan

8.8.1 The Project Area

The project road passes to Dakshin Kannada and Hassan District. In this project road Heggaddle, Masanhalli, Aluvalli, Yadekumari, Kagenari State forest and Gundya village are coming along the proposed road and Tunnel

8.8.2 Social Impact Assessment

'Social Impact Assessment (SIA) includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment.

Social Impact Assessment of the project is an important component of project preparation. The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act, 2013; project specific R&R Policy as approved by GoUP and World Bank policy require social impact assessment during the design stage to avoid, reduce and mitigate potential negative impacts of project action and enhance positive impacts, sustainability and development benefits.

Assessment results are considered with technical and economic feasibility findings in the final selection of roads to be rehabilitated. The assessments also contribute to engineering design

and result in the preparation of social action plans governing project implementation and the resettlement and rehabilitation of those who may be displaced by road improvements.

8.8.3 Framework Development for the Preparation of LAP and Resettlement Plan

The proposed road intervention is being carried by MoRTH. Land free from all encumbrances to contractors will be given for the construction and maintenance of road. For this purpose following activities are required to be carried out:

(a) Land acquisition as National Highway Act 1956

(b) R&R Framework as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013

(c) Institutional arrangement for R&R implementation.

8.8.4 Identification of Impact

In this project most of the alignment passes through forest land but only few location land acquisition will be require for approach road. These impacts are analyzed in detail in social assessment report.

8.8.5 Key Social Laws and Regulations

This section presents the legal framework for the land acquisition process and the Resettlement and Rehabilitation Policy which also includes the entitlements for affected eligible families. Project has developed Resettlement and Rehabilitation Policy based on the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013; World Bank's OP 4.12 and various government orders issued by state government for issues related to R&R. The policy recognizes the need to support restoration of livelihoods of adversely affected people and lays down norms for rehabilitating the affected people and broadly outlines an approach and institutional framework to achieve its objectives. The key Social regulations and legislations that will govern then preparation and implementation of the project is presented below.

Table 8.3: Relevant Social Legislations

Acts/Rule/Policy	Year	Objective	Responsible Agency
Ancient Monuments and Archaeological Sites and Remains Act	1958	Conservation of cultural and historical remains found in India.	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).
Right to fair compensation and transparency in land acquisition, rehabilitation and Resettlement Act	2013	Fair compensation for acquisition of immovable assets; Resettlement of displaced population due to LA and economic rehabilitation of all those who are affected due to land acquisition.	Revenue Department. Govt. of Karnataka
The Scheduled Tribes and other Traditional Forest Dwellers (Recog-	2006	Grants legal recognition to the rights of traditional forest dwelling communities, partially correcting the injustice	Ministry of Tribal Affaires, GOI and Department of Tribal Welfare,

Acts/Rule/Policy	Year	Objective	Responsible Agency
nition of Forest Rights) Act		caused by the forest laws. Makes a beginning towards giving communities and the public a voice in forest and wildlife conservation	

8.9 National Highways Act 1956

Land for construction of a new highway or upgradation /widening is acquired using the NH Act 1956. Key provisions relating to acquisition are as follows:

3A. Power to Acquire Land, etc

3B. Declaration of Acquisition

3C. Power to take Possession

3E. Determination of amount payable as compensation

8.10 Public Consultation

Public information and consultation is an important method of involving various stakeholders particularly, local community with reference to the proposed development initiatives. It provides a platform to participants to express their views, concerns and apprehensions that might affect them positively or negatively. Through participation and consultation stakeholders influence development initiatives, and decision making process. The effectiveness of participation and consultation is directly related to the degree of involvement by the likely project affected persons and the local community and integration of outcome of consultations wherever feasible in the proposed development initiatives. Detailed planning is required to ensure that likely project affected persons, local community, interested groups, non-governmental organizations, civil society organizations; local government, line departments, etc are consulted regularly, frequently and purposefully during different stages of the project including project preparation.

The purpose of consultation will be to inform people about the project, take note of their issues, concerns and preferences, and allow them to make meaningful choices. As mentioned earlier public information and consultation will be held during screening stage and census and socio economic survey stages. The outcomes of consultations will be shared with design team to integrate their concerns and suggestions wherever possible.

8.10.1 Role and Responsibilities Identified during Consultation

Table 8.4 envisaged responsibilities of officials and expected benefits from the consultation. From the consultation, it was established that implementation of the project could be better done with the help of regular MORT&H engineers.

Table 8.4: Role and Responsibilities Identified after Consultation under the Project

Stakeholders	Roles and Responsibility	Expected Benefit for the Project
Potential Project Affected Persons, Project affected groups, Project Affected Communities, Host population	• Participate in formal and informal public meeting, • Raise critical issues relevant to the project, • Suggest alternative alignments, • Options of widening, • Methodologies for agreement on compensation and assistance • Suggest methodologies for continued participation in project cycle	• Easing implementation. • Incorporation of good practices (From long term memories of the people) of the past in project design. • Planning for road safety issues. • Community Capacity building and sense of ownership of the project.
Engineers supervision consultant and MORT&H Division	• Land Acquisition • Participate in Public meetings • Participate in Block and District Level Meeting	• Ease implementation • People oriented planning • Ensured public cooperation • Determination of market value
Forest Official	• Enumeration of trees • Identification of eco sensitive hot spots • Salvaging/Auctioning of trees	• Faster permission for tree felling
Land Acquisition Officials	• Authentication of existing land • Ensure availability of land for road improvement • Timely evacuation of Corridor	• Speedy and timely land acquisition

8.11 Structure of RAP report and Format

In this section we are presented the Structure of RAP report which we will be submit in Final report.

Chapter 1- Introduction

Chapter 2- Study Methodology

Chapter 3- Resettlement Policies and Legal Framework

Chapter 4- Minimizing Negative Social Impact

Chapter 5 -Profile of State and Project Affected Persons

Chapter 6- Community Participation

Chapter 7- Gender Analysis

Chapter 8- Income Restoration

Chapter 9 -Institutional Arrangements

Chapter 10 - Grievance Redress Mechanism

Chapter 11- Monitoring and Evaluation

Chapter 12- Implementation Schedule

Chapter 13- Costs and Budget

8.12 Maintenance, Land Acquisition, Rehabilitation & Resettlement Cost

Provision has been included for maintenance of the existing 2-lane road during construc-

tion at Rs. 5,00,000 /= per Km per month for 60 months. This covers repair of pot holes and renewal coat by 25mm Mastic Asphalt/ Wearing Coat. Cost of Rehabilitation & Resettlement has been provided for as per initial social impact assessment. Provision for cost of land acquisition and compensation for permanent/temporary buildings and other structures has been made there in. The cost of environmental mitigation has been provided for, as per initial assessment. For specific items that have been used for mitigation of impacts in construction or operation stages including environmental monitoring, training of personnel for implementation of the Environmental Management Plan, logistical support for the implementing agency. General components like RCC, PCC, steel ISMB sections or angle sections etc., required for various mitigation measures have been included in the overall rate for the item. The costs of Resettlement and Rehabilitation were worked out based on the prevailing market rates in Heggade, Maranhally, Shiradi and Gundya, Adda hole villages of Hassan and Mangalore Districts respectively. The land acquisition costs for the properties to be acquired for this project has been worked out based on a market value assessment survey conducted at various locations along the proposed bypass alignments. The property dealers, locals and the government agencies as the revenue department etc. were contacted for this purpose.

It has already been stated that the list of affected properties is yet to be firmed up. However, a tentative estimate of cost for Rehabilitation & Resettlement has been worked out to **Rs. 15 Crores**, which covers all components of compensation, assistance and entitlements. The detailed cost estimate for resettlement will be provided in the Preliminary Project Report. The broad break up of tentative R & R budget is given below:

Table 8.5 : Tentative budget for R&R Activities

Sl. No	Particulars	Amount (Rs.)
1	Compensation for structure	1,00,00,000
2	Construction cost	5,00,00,000
3	Compensation for land (including 30% as solatium)	5,00,00,000
4	Assistance @ Rs.20000 per PAF as per National Policy on Resettlement & Rehabilitation	4,00,00,000
5	Support for implementation of RAP (lump sum)	50,00,000
6	M & E consultant (lump sum)	50,00,000
Total		15,00,00,000

9 Preliminary Cost Estimate

9.1 General

Cost estimation is important for the feasibility study as it provides vital input to the economic and financial evaluation of the project. The cost estimates have been prepared the project corridor separately for New Four Lane Green Alignment comprising of Tunnels with 2 x 3 lane configuration; High Level Bridges of 2 x 12.3m width and Cut & Fill sections of 12m roadway. Cross drainage structures, longitudinal drains, junction improvements, road furniture, bus bays, toll plaza, etc. Over and above these construction costs, provision has been made for social and environment costs.

9.2 Cost Methodology

Estimation of Preliminary cost, a primary pre-requisite for Economic and Financial evaluation, has been carried out. The process involved in the preliminary cost estimation has been described under the following sections.

9.2.1 Unit Rates

The rates of various items of construction work have been analysed as per procedure laid down in the "MORT&H Standard Data Book"-2003 (Fourth Revision, Reprint 2006) and guidelines set there in. Market studies were made to ascertain the rates of various items of construction materials. The market rates of major BoQ items like earthworks and pavement layers collected from similar adjacent packages and the rates worked out from the standard data book are compared with these market rates.

The rates of natural materials like river sand, moorum, gravel and stone aggregate etc. have been collected from the available quarry sources, in the vicinity of the road, by local enquiry and from government departments. Aggregate quarries are used from the excavated muck disposal, nearest quarries available are within one to two km from the construction place. In case if number of local aggregate crushers are not sufficient to meet the requirement, the rates of crushed aggregate, and crusher dust are adopted in the rate analysis by considering own cone crusher by the contractors. Sand is available at the Kempuhole river and nalla beds all along Hassan, Sakleshpur, Heggade, Maranhally, and Gundya., Rates of manufactured / proprietary items have been ascertained from the trade. Unit cost of transportation to site, based on the average lead, has been added to the basic cost.

Cartage rates have been considered as per MORT&H Data Book and guide lines laid there in. Hourly cost of owning and operating various machineries and equipment has been considered as per the Standard Data Book and local market enquiry. Local prevailing hire charges and diesel charges were also considered in arriving at Machinery & Equipment hiring charges. For machinery and equipment not covered by the Data Book, prevailing market rates were considered. Rates of different categories of skilled and unskilled manpower, labor have been taken from the rates as provided in the latest NH-SSR of Karnataka 2014-15.

An escalation as per RBI indices has been taken into account wherever applicable for determining current year 2015-2016 rates. Machinery hire charges have been taken from Standard data book with 60% enhancement (5% per year from year 2003 onwards) MoRTH and Karnataka SOR. A conscious effort has been made to arrive at reasonable and logical rates for various items of work. Unit rates have been checked against rates of similar ongoing project under MoRTH near the project road vicinity and were found reasonable.

9.2.2 Detailed Rate Analysis

This software of Rate Analysis is based on "Standard Data book for analysis of Rates for Road and Bridge Works" prepared and published by MoRT&H. This Software runs on Microsoft Excel with Automatic updation & calculation of Item Rate. The Overhead charges (8% for road works and 10% for bridges/ tunnel works) and Contractor profits (10%) are fixed by MoRT&H; and the same is adopted. Items which are not covered in standard data book but used & required for tunneling (including E&M) have been analyzed and/or adopted from similar international projects and practice.

9.2.3 Adopted Rates

The basic rates for tunnels have been adopted from similar project "Peer Panjal Tunnel Project, J&K" executed successfully. Their dpr rates were of 2008 which have been escalated @ 5% per year for 2015-16 year. Bridges and Cut & Fill Sections rates have been considered from detailed analysis of rates. Some of the items rates were adopted as per previous experience of the consultants / Market rates.

a) Cut & Fill Sections : Four Lane, Rigid Concrete Pavement , Slope Protection, Retaining Wall, Road Safety measures, Traffic Signage, Road Furniture, Drainage etc Rs 220000/ sqm.
b) Bridges : Up to 200m Length = Rs 75000/- sqm
c) Bridges : >200m Length = Rs 150,000/sqm
d) Viaduct : 3.8km Length, Rs 120000/ sqm
e) Access Roads : 7m wide motorable hill road with temporary bridges etc Rs 85000/- sqm

9.2.4 Bill of Quantities

The construction items covered in cost estimates are: site clearance; earthwork in new embankment, Subgrade, Pavement in carriageways and shoulders; culverts; Bridges; Junction improvement; Drainage and Protective works; Access Roads; Resettlements; Land Acquisition; Environmental Protection, flyovers, ROB's, Viaduct, electrification, toll plaza and Miscellaneous items which includes Pavement markings, Signages, Guard Rails, etc.

9.2.5 Earthwork and Major Items

The quantities of earth work in cut and fill were computed after designing horizontal and vertical alignment using Civil3/MX software. Digital Terrain Modeling (DTM) has been developed using high resolution satellite imaginaries, cartosat1 and preliminary topographic survey data. A number of typical cross sections have been developed for tunnel, bridges, viaducts and road approaches as per site requirements and optimum alignment. Detailed Cross Sections @ 100m interval are generated using MX and TCS adopted in the respective chainages. Provisions are made for the soft and hard rock excavation based on the road inventory and the site investigation. Quantities of all other items like subgrade (SG), granular sub-base (GSB), dry lean concrete (DLC), pavement quality concrete (PQC) for project road and wet mix macadam, dense bituminous macadam & bituminous concrete for junctions development, bus bays, rest areas and other minor items, (if required) have been worked out using the typical cross sections adopted in the respective locations. The quantities for cross drainage structures, culverts, bridges, viaducts and tunnels have been calculated from typical GAD's on sqm basis for required construction. Road signage, toll plaza, lighting, avenue plantation etc all items are calculated as per Design Plan and IRC standard

9.2.6 Shifting of Utilities & Tree Cutting

Shifting of Utilities like Electrical installations, transformers, H.T/L.T line shifting, High tension towers, Telephone poles, OFC lines, Water pipe lines etc., the required estimates for shifting of these utilities from the concerned Departments will be obtained in detail during Draft DPR stage. Presently, tentative quantities from the road inventory and topography survey data are taken into consideration against shifting of utilities & tree cutting in the costing.

Age old trees with different girths exist on both sides of the existing highway. On an average for all types of Girths, nearly 150 to 200 trees per km are available. Average Tree cutting Cost per tree shall be taken as @ Rs. 700. Average cost of Cutting of trees per Km comes to be Rs. 1.20 Lakhs for the widening portions of existing NH road. In the bypass/new alignment areas this cost shall be less. Salvage value as per the Forest Department norms shall be deducted from the tree cutting cost.

9.2.7 Maintenance, Land Acquisition, Rehabilitation & Resettlement Cost

Provision has been included for maintenance of the existing 2-lane road during construction at Rs. 5,00,000 /= per Km per month for 60 months. This covers repair of pot holes and renewal coat by 25mm Mastic Asphalt/ Wearing Coat. Cost of Rehabilitation & Resettlement has been provided for as per initial social impact assessment. Provision for cost of land acquisition and compensation for permanent/temporary buildings and other structures has been made there in. The cost of environmental mitigation has been provided for, as per initial assessment. For specific items that have been used for mitigation of impacts in construction or operation stages including environmental monitoring, training of personnel for implementation of the Environmental Management Plan, logistical support for the implementing agency. General components like RCC, PCC, steel ISMB sections or angle sections etc., required for various mitigation measures have been included in the overall rate for the item. The costs of Resettlement and Rehabilitation were worked out based on the prevailing market rates in Heggade, Maranhally, Shiradi and Gundya, Adda hole villages of Hassan and Mangalore Districts respectively. The land acquisition costs for the properties to be acquired for this project has been worked out based on a market value assessment survey conducted at various locations along the proposed bypass alignments. The property dealers, locals and the government agencies as the revenue department etc. were contacted for this purpose.

It has already been stated that the list of affected properties is yet to be firmed up. However, a tentative estimate of cost for Rehabilitation & Resettlement has been worked out to **Rs. 15 Crores**, which covers all components of compensation, assistance and entitlements. The detailed cost estimate for resettlement will be provided in the Preliminary Project Report. The broad break up of tentative R & R budget is given below:

Table 9.1: Tentative budget for R&R Activities

Sl. No	Particulars	Amount (Rs.)
1	Compensation for structure	1,00,00,000
2	Construction cost	5,00,00,000
3	Compensation for land (including 30% as solatium)	5,00,00,000
4	Assistance @ Rs.20000 per PAF as per National Policy on Resettlement & Rehabilitation	4,00,00,000
5	Support for implementation of RAP (lump sum)	50,00,000
6	M & E consultant (lump sum)	50,00,000
Total		15,00,00,000

9.2.8 Environmental Budget

Environmental Management Plan will be prepared as part of detailed EIA study and is intended to become a part of the contract documents so that implementation of all the environmental measures can be ensured. The implementation actions, responsibilities and timeframes will be specified for each component and adverse impact anticipated. The cost of implementing above mitigation measures during the construction stage works out to Rs. 1.25 Crores. The operational cost of the same is estimated at Rs. 4.85 lakhs during the first two years. The cost estimates are presented in **Table 9.2.**

Table 9.1: Estimation of Environmental Management Plan Cost

Description	Unit	Quantity	Rate(Rs.)	Amount(Rs.)
A. Annual Cost During Construction Phase during Five Years				
1.Compensatory avenue plantation of twice the number of trees to be cut and their fencing and maintenance for five years	No.	15,000	400	60,00,000
2.Shrub plantation@500 saplings (single row) per Km for the cut and fill section and their fencing and maintenance for five years	No.	100	15000	15,00,000
3. Environmental Monitoring				
3.1. Air Quality Monitoring at 15 sensitive locations for three seasons for 5 consecutive years	No.	70	12,000	8,40,000
3.2. Water Quality Monitoring at 5 locations for two seasons for 5 consecutive years	No.	50	3,000	1,50,000
3.3. Noise Monitoring at 15 sensitive locations for three seasons for 5 consecutive years	No.	75	1000	75,000
3.4. Soil Quality Monitoring at 9 sensitive locations for two seasons for 5 consecutive years	No.	45	3,000	1,35,000
3.5. Mobilisation Charges for 3 seasons for 5 years	No.	15	75,000	11,25,000
4. Dust Suppression at Site(6 trips/day for 365 days for 5 years)	No.	150	1000	1,50,000
5. Severances & Others (including training, workshops, awareness campaigning etc.)		Lump sum		50,000
6. Two Rainwater Harvesting Structures per 5 Kilometer for 24km	No.	5	40,000	2,00,000
Total cost during construction phase				1,02,25,000
B. Annual Cost During Operational Phase during First Two Years				
1. Environmental Monitoring				
1.1. Air Pollution Monitoring at 15 sensitive loca-	No.	37.25	12,000	4,47,000

Description	Unit	Quantity	Rate(Rs.)	Amount(Rs.)
tions for 3 seasons for first two years				
1.2. Noise Monitoring at 15 sensitive locations for 3 seasons for first two years	No.	37.5	1000	37,500
Total cost during Operation phase				4,84,500
Total Cost (A+B)				**1,07,09,500**
Contingency (10%)				**10,70,950**
Total				**1,17,80,450**

9.2.9 Centages

Besides the cost estimates, the following percentages have been added.

- Establishment Charges - 2.5%
- Utility Shifting - 2.5%.

9.3 Abstract Cost

9.3.1 Items & Rate Based Cost Estimate :

Various item of works have been estimated for cut & fill sections, bridges & structures and tunnels & its components based on the drawings prepared so far. The cost estimate is prepared by adopting rates from the similar nature of projects considering construction difficulties, site constraints, terrain, accessibility, climate & weather conditions etc. Bill of Quantities and Abstract of Cost have been presented in Volume VII and VIII respectively. General Abstract of Cost is given in Table 9.3 as below:

Table 9.3 : General Abstract of Cost

S No.	Description	Amount (Rs)
1	Site Clearance and Dismantling	142,56,246
2	Earthwork	9142,84,714
3	Granular Base Course and Sub - Base	1239,52,451
4(A)	Cement Concrete Pavement	19178,61,987
4(B)	Bituminous Course	90,61,329
5	Culverts and Cross Drainage Works	1672,13,336
6	Bridges	401288,62,916
7	Drainage Works and Protection Works	21681,39,209
8	Traffic Signs, Markings and Other Appurtenances.	743,78,824
9	Miscellaneous	3980,27,321

S No.	Description	Amount (Rs)
10	Horticulture	81,49,534
11	Access / Approach Roads	41500,00,000
12	Tunnels (6 Nos, Total Length 12.631 km)	440938,27,424
	Total Civil Cost	**941680,15,290**
	Civil Cost in Crores	**9,416.80**
	Civil Cost per Km (Length = 23.579 Km.) in Crores	**399.37**

9.4 Total Project Costs as per Cost Methodology

Details of various costs for this project road are given separately as below:

a) Civil Construction Cost

As given above in Table 9.3 is reproduced.

b) Total Project Cost

(i) Interest on Debt Component (IDC)
(ii) Contingencies
(iii) Escalation during construction
(iv) Financing charges
(v) IC/IE cost borne by the Concessionaire

c) Project Capita Cost

Project Capital Cost including Total Project Cost and the costs of Land Acquisition, Environmental mitigation measures and Utilities relocation are given in Table 9.4.

Table 9.4: Project Capital Cost

Part A) Civil Construction Cost

S No.	Description	Amount (Rs)
1	Site Clearance and Dismantling	142,56,246
2	Earthwork	9142,84,714
3	Granular Base Course and Sub - Base	1239,52,451
4(A)	Cement Concrete Pavement	19178,61,987
4(B)	Bituminous Course	90,61,329
5	Culverts and Cross Drainage Works	1672,13,336
6	Bridges	401288,62,916
7	Drainage Works and Protection Works	21681,39,209
8	Traffic Signs, Markings and Other Appurtenances.	743,78,824
9	Miscellaneous	3980,27,321
10	Horticulture	81,49,534
11	Access / Approach Roads	41500,00,000
12	Tunnels (6 Nos, Total Length 12.631 km)	440938,27,424
	Total Civil Cost	**941680,15,290**
	Civil Cost in Crores	**9,416.80**
A	**Civil Cost per Km (Length = 23.579 Km.) in Crores**	**399.37**

Part B) Other Costs:

S No.	Description	Amount (Rs)
	Interest on Debt Component (IDC)	Considered 1.75% of Civil Construc-tion Cost
	Contingencies	
	Escalation during construction – 60 months (on 90% debt)	
	Financing charges	
	IC/IE cost borne by the Concessionaire	
B	**Total Project Cost (101.75% of Civil Cost)**	958159,55,558
	Land Acquisition and R&R cost	1500,00,000
	Environmental mitigation measures cost	117,80,450
	Shifting of utilities cost (LS)	5000000
C	**Project Capital Cost**	959827,36,008
	Amount (Rs in Crores)	9,598.3
	Per km cost (Rs Crore/km)	**407.07**
	Add Service Tax @ 14.5%	13917496721
	Project Cost With Service Tax	1099002,32,729
	SAY	**11000 Cr.**

9.5 Alternate Check of Cost Estimate

Cost Estimate prepared per Sqm rate basis under KD4: Preliminary Project Report has been further refined for KD5 alignment also to Compare and Re-check with the Item Rate cost estimate.

Abstract of resultant estimated costs of improvement of roads, bridges, culverts, etc. (including environmental, social and land acquisition cost) are presented in **Table 9.5.**

Table 9.4 : Abstract of Cost (Sqm Basis)

Design Chainage		Length (m)	Type of Structure	W/D (m)/ Nos	Area (Sqm)	Unit Rate (Rs)	Amount (Rs)	Amount (Cr. Rs)
From	To							
0.000	1800.000	1800.000	Cut & Fill	24	43200	220000	9504000000	950.400
1800.000	2100.000	300.000	Bridge(B0)	24.6	7380.000	125000	922500000	92.250
2100.000	2320.400	220.400	Cut & Fill	24	5289.600	220000	1163712000	116.371
2320.400	2620.400	300.000	ROB & CD	24.6	7380.000	125000	922500000	92.250
2620.400	5578.140	2957.740	Tunnel -1	30	88732.200	115000	10204203000	1020.420
5578.140	5666.380	88.240	Cut & Fill	24	2117.760	220000	465907200	46.591
5666.380	5716.380	50.000	Bridge(B1)	24.6	1230.000	75000	92250000	9.225
5716.380	5799.870	83.490	Cut & Fill	24	2003.760	220000	440827200	44.083
5799.870	7929.290	2129.420	Tunnel -2	30	63882.600	115000	7346499000	734.650
7929.290	8011.480	82.190	Cut & Fill	24	1972.560	220000	433963200	43.396
8011.480	9101.480	1090.000	Bridge(B2)	24.6	26814.000	175000	4692450000	469.245
9101.480	9190.100	88.620	Cut & Fill	24	2126.880	220000	467913600	46.791
9190.100	11302.280	2112.180	Tunnel -3	30	63365.400	115000	7287021000	728.702
11302.280	11417.280	115.000	Cut & Fill	24	2400.000	220000	528000000	52.800
11417.280	11467.280	50.000	Bridge(B3)	24.6	1230.000	75000	92250000	9.225
11467.280	11596.080	128.800	Cut & Fill	24	3451.200	220000	759264000	75.926

Design Chainage		Length (m)	Type of Structure	W/D (m)/ Nos	Area (Sqm)	Unit Rate (Rs)	Amount (Rs)	Amount (Cr. Rs)
From	To							
11596.080	13467.650	1871.570	Tunnel -4	30	56147.100	115000	6456916500	645.692
13467.650	13652.650	185.000	Cut & Fill	24	4440.000	220000	976800000	97.680
13652.650	14672.650	1020.000	Bridge(B4)	24.6	25092.000	175000	4391100000	439.110
14672.650	14770.000	97.350	Cut & Fill	24	2336.400	220000	514008000	51.401
14770.000	16429.860	1659.860	Tunnel -5	30	49795.800	115000	5726517000	572.652
16429.860	16930.310	500.450	Cut & Fill	24	12010.800	220000	2642376000	264.238
16930.310	17030.310	100.000	Bridge(B5)	24.6	2460.000	120000	295200000	29.520
17030.310	17501.440	471.130	Cut & Fill	24	11307.120	220000	2487566400	248.757
17501.440	17701.440	200.000	Bridge(B6)	24.6	4920.000	120000	590400000	59.040
17701.440	17755.700	54.260	Cut & Fill	24	1302.240	220000	286492800	28.649
17755.700	19656.370	1900.670	Tunnel -6	30	57020.100	115000	6557311500	655.731
19656.370	20362.440	706.070	Cut & Fill	24	16945.680	220000	3728049600	372.805
20362.440	23579.210	3216.770	C/F/VIADUCT	24.6	79132.542	150000	11869881300	1186.988
		7050.000	Access Road	7	49350.000	85000	4194750000	419.475
			Civil Construction Cost - Sub total (A)					9604.063
			Environmental, Land Acquisition & Utility Shifting Cost (LS= 0.3%)					28.812
			Establishment Charges (2.5%)					240.102
			Sub Total					9872.977
				Service Tax 14.5%				1431.582
				Grand Total				**11304.558**

Say Rs. 11300 Crores

On comparison It is found that the project cost in both of the cost estimates are almost similar. Hence, Item Rate Cost Estimate has been considered for Economic and Financial Analysis.

10 Preliminary Economic Analysis

10.1 Approach & Methodology

The economic analysis is mainly based on comparing the "project costs and project benefits". The project costs include the life cycle cost comprising capital expenditure on the improvement of the sections (Table 9.1). This exercise has been carried out by using the latest version of Economic Model developed by IRC for optimizing the improvement options and working out the economic internal rates of return (EIRRs) and the net present values (NPVs) at the cut-off rate.

The Project costs also comprise the required routine and periodic maintenance costs to offer quality service to the road users, and environmental and social mitigation costs on account of the improvement to take care of the proposed interventions, whereas the project benefits mainly focus on the savings in the vehicle operating costs (VOCs), motorized and non-motorized (NMT); the value of time to the road(s) users; net producers' surplus on major agricultural products; and improved health services to the beneficiaries of the PIA. The traffic generated on the above account has been duly considered in the traffic estimates and projection under "with the project" situation (Chapter 4: Traffic Surveys & Analysis) and in turn contributes to the project benefits in the economic analysis.

The economic analysis has been carried out with a view of sustaining the envisaged benefits on account of quality road transport infrastructure throughout the appraisal period. The Economic Model incorporates all these parameters and also provides default values based on earlier investigations with similar conditions. The Consultants have suitably configured and calibrated the Model with proper input data to incorporate the local condition for economic appraisal of the investment in the Project Road.

The improvement option of the Project Road, corresponding costs of improvement, viz. capital and maintenance, and related details are worked out and presented in respective chapters on the Project Road description; traffic analysis and forecast, and also vehicle-wise traffic projection, preliminary design and costs, and involved environmental and social mitigation measures. For the benefit estimations, as stated earlier, the Economic Model has been used for calculating the savings due to the upgrading of Project Road using the concept of "with and without project situations".

The Project costs and benefits for the Project Road have been developed on a yearly basis throughout the economic appraisal period, i.e. 36 years including the project implementation period of six years from now (2015), and the remaining 30 years for benefits estimations. The results of economic analysis have been obtained in terms of the economic internal rates of return (EIRRs), and the net present values (NPVs) by using the discounted cash flow (DCF) technique. All the inputs related to the costs and benefits for undertaking the economic analysis have been converted into the economic terms by using appropriate conversion factors to capture resource costs to the economy.

10.2 Project Benefits Rationale

The benefits of the proposed intervention of the Proposed Bypass Road have been grouped into: (i) tangible, i.e. quantifiable benefits; and (ii) non-tangible, i.e. non-quantifiable benefits. For undertaking the Feasibility Study, conventionally only the tangible benefits are incorporated in the economic analysis. The tangible benefits are savings in the vehicle operating costs (motorized and non-motorized); savings in travel and transit time; reduction in accidents; and benefits attributable to the improved accessibility in the PIA.

Although the benefits due to improved accessibility and mobility are apparent and highly realized by the beneficiaries, due to several reasons, viz. availability of proper data, re-

source constraints, conceptual clarity avoiding subjectivity in estimation methods and selection of parameters, etc., the quantification of qualitative benefits with fair level of confidence is a difficult task. However, the Study has considered reasonably acceptable assumptions in the economic appraisal to address such issues. A brief description on the tangible and intangible benefits of the Bypass to Shiradi Ghat Road to all weather standard is presented in the following sections.

10.2.1 Tangible Benefits

10.2.1.1 Savings in Vehicle Operating Cost

Road improvement activities bring out several benefits to its users, but savings in vehicle operating costs (VOCs) alone accounts for a higher share in the total benefits. It may also be noted that improvement and widening of much worse road requiring higher investment, may yield much higher benefits to the road users in terms of higher savings in the VOCs. Argument behind this phenomenon is the incremental benefits of an improved 4-lane green alignment tunnel road that would be higher compared to its current bad state, if not improved, it will cause more damage to vehicles besides consuming more fuel and leading to frequent break down, higher wear and tear of tyres, reduced level of vehicle and crew utilization, higher probability of road accidents, etc. This general logic also stands valid in case of the construction of the new tunnel road, and the reduced VOCs has been considered as one of the most important components of the economic analysis for undertaking this Study.

10.2.1.2 Intangible / Qualitative Benefits

The intangible benefits of the new road improvement are: enhancing road safety; reduction in road accidents and related safety concerns (usually intangible, but this is considered and quantified in the study); development in tourism; general poverty alleviation; increased mobility of rural population for suitable employment and effective utilization of socio-economic facilities (education, administrative, recreational, etc.) located in the PIAs; conservation of nature and protection of environment; benefits to the neighboring areas, positive impact on rural-urban disparities, etc.

Project Road Description illustrates the general socio-economic features of the PIAs, and also highlights the need for all weather tunnel road. In addition, the study brings out certain facts and figures, though by and large qualitative and intangible benefits would support the feasibility of the investment proposition in the Project Bypass Road.

The above-mentioned notes on the socio-economic development potential of the PIA highlight that the improved road transport infrastructure would facilitate to realize these benefits effectively and, in turn, overall area development; and most of these benefits are qualitative and intangible. However, these areas of benefit are further discussed with supportive arguments in the following paragraphs. The intangible benefits would be in addition to the tangible benefits, which support the economic appraisal and broadening the base for the project study and decision-making

(i) Proper Transport Infrastructure & Rural Accessibility

Availability of reliable transport infrastructure and efficient transport services for achieving goals of any development plans is an essential requirement, particularly for rural areas. It is a pre-condition for initiation of any economic development process. Therefore, the new 4-lane bypass construction in the National Highways network of the country becomes more important. The PIA has good potential for industrial development, ports connectivity, freight movement and related activities, which could further grow with improved transport infrastructure, as presently the industrial and commercial activities are generally not carried out smoothly, mainly due to lack of efficient and economic road transport system.

Presently, the accessibility condition in the project areas, due to the poor road surface and geometry of the existing road, is not good, causing higher vehicle operating cost, unreliable transport system, more transit time, avoiding travel on the existing road, and road safety concerns due to en-route spoilage of oil & petroleum commodities and frequent vehicle break down causing unsafe driving conditions, etc.

In order to cater to the current and future demand for transport services, the existing facilities of road transport infrastructure in the existing road section not adequate or very poor, which result in the villages around this section becoming almost inaccessible and during rainy condition become impassable due to landslides. This situation restricts movement of MAV goods and services for proper and timely marketing of oil & petroleum, automobiles, equipment & machineries, agricultural products (especially perishable commodities), and procurement of agricultural inputs with competitive transport cost; labor mobility for better employment; level of socio-economic facilities utilization, particularly for rural population.

In order to improve the level of activities listed above, there is a need for well-engineered roads with proper provision of cross drainage surface for all-weather accessibility with road safety concerns by providing 4-lane new bypass road comprising of tunnels, bridges and cut & fill combinations. .

Improved accessibility in the PIAs and efficient connectivity to the main road network will also enhance the road transport infrastructure, which would attract public and private investments in several areas of trading, industry and commerce farming (agriculture, livestock, etc.), accelerating economic development, diversification of the economy, self-sufficiency in food products, etc.

(ii) Rural Development & Producers' Surplus Concept

Bad accessibility or poor transport infrastructure adversely affects its users either in transporting inputs for any production purposes or even for carrying out agricultural activities in terms of procuring inputs, such as, oil & petroleum, industrial & automobile products, high yielding varieties (HYV) seeds, fertilizers, agricultural implements and equipment along with repair and maintenance backup on one hand, and cost of transportation for marketing the industrial and agricultural products or other purposes on another, e.g. storing in warehouses located at distant places.

Besides, poor accessibility hinders the labor mobility for search of better employment opportunities, and also utilization of several socio-economic facilities. Under the bad road or poor transport facilities, in brief, either procuring the inputs or marketing the products, the transport costs would be higher, resulting in higher costs of the products, which may affect the entire production process or even closure or shift of the ongoing activities in general, and agriculture sector in particular.

And contrary to this, improvement of the existing bad road transport system would reduce the transportation cost for both procurement of inputs and marketing of the produces, which would generate "surplus to the producers" and also facilitate the residents for their general socio-economic development. Based on the logic mentioned above, the improvement of Project Road would play positive role in overall rural development and also generate considerable surplus to the producers, i.e. population engaged in undertaking agricultural, fishing and allied activities in the PIA.

(iii) Changes in Cropping Pattern & Allied Activities – Cash Economy

Poor road condition has been identified as one of the basic constraints for agricultural development, which has adversely affected the overall socio-economic development of the PIA, and the agriculture sector, particularly to the cash crops and perishable products. During the field visits and series of the consultative meetings with relevant stake-

holders in the PRAs, the Study observed and realized several problems in agricultural activities, but the need for proper transport system for marketing of their products was on the top. Poor accessibility has affected severally the above phenomenon for many years and likely to create more problems in future if remain neglected, particularly in view of changes in cropping pattern, e.g. cash crops.

Unless a fairly reliable and economical transport system exists, the businessmen, farmers engaged in oil & petroleum, automobile, industrial, agricultural, fishing activities, would either keep observing the poor road situation or with the improved road condition, they would make efforts to optimize their cropping pattern in most suitable manner; taking full advantage of the agricultural and industrial potential areas.

Whereas with an improved road condition, production of cash crops and other perishable commodities, such as poultry, meat, and dairy products would also get proper boost and encouragement. Proper infrastructure would enable the residents of the PIA to produce cash crops and other items, and market them properly without getting spoilt en-route or damaged in shape, color, and quality, and also the produces can be sent to the storage/warehouses located at distant places or nearby. All these would, in turn, enhance their overall income of the inhabitants.

In brief, the improvement of the Shiradi Ghat Tunnel Road would certainly create conducive road transport infrastructure for bringing changes in favorable cropping pattern on much more area of agricultural land, changes in occupational structure in several agro-based industries and creation of more livelihood opportunities, etc.

(iv) Creation of More Job Opportunities

Road construction and maintenance activities provide employment opportunities–directly and indirectly–to skilled as well as unskilled manpower primarily to local manpower. The employment opportunities may vary on the deployment of technological choices while undertaking the road construction and maintenance activities, i.e. with different combinations of capital–labor options. Improvement and construction of the mega millions project road followed by yearly routine and periodic maintenance activities during the appraisal period would generate direct employment to skilled and unskilled workforce including women. The investments in the Project Road would create additional employment, particularly for unemployed work force, during the improvement and construction phase, and also during the yearly routine as well as periodic maintenance activities. The income, thus, enhanced of the local skilled and unskilled work force would also bring out a multiplier effect to other sectors of the economy.

(v) Road Accidents & Safety Concerns

It is often argued that an improved road offers a higher vehicle speed, which may cause more accidents, particularly where the presence of mixed traffic is observed, and users normally do not follow traffic rules, etc. But, it is established that there would be relatively low probability of minor or major accidents on a well-engineered road as compared to poorly maintained needs.

The statistics on accidents on the existing road section, and also highlights the suitable measures to reduce the level of accident after the proposed tunnel bypass. The proposed measures would be part of the road design and subject to the road safety audit. With the above broad framework, the study assumes considerable reduction in the accident on the existing road, and that would be part of the benefit of the upgrading of the Shiradi Ghat Tunnel Road. It may be noted that probability of occurring accidents, either on the existing condition of the Project Road or with the improved condition is not established to a fair level of confidence. Hence, in present economic analysis, the benefits on account of probable reduction in accidents are based on the assumptions considered on the basis of available literature; and value of life estimated for the purpose of accident costing.

(vi) Tourism

The Project Road, i.e. Shiradi Ghat Bypass provides link to several places of tourist interest as the PIA is passing through dense reserve forest, environment eco sensitive zone, green covered western ghat, perennial Kempuhole River. The domestic and international tourists coming from Kerala, Goa, Mangalore etc for visiting the Bangalore, Mysore, Chennai, particularly around western ghat, the Project Road would provide with efficient and economic road transport infrastructure, and tourism industry would grow at higher rate. It is rather difficult to make estimation for the arrivals of tourists in future in the present analysis, as the level of tourism would depend on the overall development and plans for the tourism sub-sector and related infrastructure. However, the proposed improvement on the Project Road would provide economical, reliable and convenient transport infrastructure for any domestic and foreign tourists in the PIA, which would, in turn, give boost to tourism industry in general, and establish additional hotels and resorts and other facilities of tourist attraction in particular. The Project Road, among others, would also play positive role in development of tourism in its catchment areas, also preserving the ecosystem of sensitive region of Western Ghat diverting the traffic from the existing road to high speed tunnels & bridges road corridor passing through the Western Ghat. All these would increase the transport demand for passenger and freight traffic on the Project Road.

(vii) Health & Education

As mentioned earlier, the utilization of health and education facilities located in the PIA's or nearby urban centers or so is highly dependent on the quality and reliability of transport system. During the field visits and consultations, it has been reported that the road users take more time to reach health facilities; schools are also located at distant places, particularly higher-level education centers. Upgraded roads would certainly enhance the level of existing facilities utilization and also facilitate for establishing new and higher level of facilities. Better health and education services could be considered as key economic benefits to residents of the PIA. For the present economic analysis, the benefits expected on account of the above, is considered as qualitative or intangible benefits.

(viii) Poverty Alleviation

Development of roads, particularly those connecting rural areas for agricultural development, and towns and cities with higher level of economic activities would be instrumental in the poverty alleviation strategy in developing countries, which is also true for the Project Road. The distribution analysis of the project benefits in terms of, poor and non-poor, is not a part of the study, however, based on several research findings and also the Consultants' experience of undertaking similar exercises and viewing the nature of the Project, though trunk road, also passing through of rural areas enhancing accessibility in the PIA, would be facilitating and enhancing the agricultural and agro-based allied activities mostly in rural areas. The Project Road, among others, would play positive role in the poverty alleviation in the PIA, as the Project benefits would be going to poor population, particularly to unemployed population including women.

(ix) Mobility of Rural Population

For uplifting the socio-economic conditions of rural households, the role of accessibility (transport infrastructure), and mobility (transport means, particularly intermediate means of transport[1]) is very important in view of poverty reduction and addressing gender is-

[1] *IMTs refer to those transport technologies that fall between walking and four-wheeled motorized transport, viz. cars and trucks. They include pack animals, animal carts, bicycles, rickshaws, motorcycles, three-wheeled scooters, etc.*

sues. The present study does not aim at developing a comprehensive transport plan for the PIA optimizing the locations of socio-economic facilities to rationalize the need based rural mobility.

However, considering the settlement pattern in the PIA, and concentration of several socio-economic facilities at urban centers, it is apparent that by improving the Project Road linking the urban centers, and the national road network, would certainly lead to much higher mobility of rural population with increased number and frequency of mechanized and motorized traffic coupled with the introduction and higher use of intermediate means of transport, particularly for short distances and small freight loads. The residents have, among others, reported the expected phenomenon of higher utilization of NMTs and gradual change towards motorized traffic from NMTs with the upgrading option of the Project Road.

On improved accessibility condition, movement of women in particular could be observed much more, leaving them with some free time to get involved in economic and other gainful activities. The benefits due to other socio-economic development plans, including establishment of several facilities in the PIA to take place on account of improved road infrastructure are not yet known. So, the realization of the benefits on that account should be considered as an addition benefit to the economic appraisal.

(x) Other Issues

- **Conservation of Nature and Protection of Environment:** During the consultations with the stakeholders, inter alia, it was particularly mentioned that due to bad road condition, and also observed by the Study Team visiting the Project Road that a lot of dust pollution was responsible for damaging the quality of crops and fruits and vegetables. Whereas, on improved road situation by providing tunnels, the vehicles' fuel consumption would be more rational and less polluting the nearby areas, and also there would be substantial reduction in dust pollution, particularly to the food items under transportation, i.e. food safety concerns.

Hence, the investments in the Project Road would be helping in conserving nature and protection of environment and also quality of food. In the economic analysis, rationalized fuel consumptions in the estimates of the VOCs are reflected, and other benefits, e.g. food safety and environment concerns remain intangible benefits.

- **Benefits to the Neighboring Areas:** Areas adjoining to the Project Road "Shiradi Ghat Bypass" in all the directions would be benefitted by the proposed investments. Benefits to the PIA due to the improvement of the road would, directly or indirectly, also get spread among the neighboring villages probably in terms of any improved agricultural practices including animal husbandry, dairy, poultry, etc. due to the improved transport infrastructure, hence, there would be demonstration effects of those improved practices, particularly changes in cropping pattern, increase in agricultural productivity, storage and transportation of perishable commodities to market centers, etc. These benefits to the neighboring areas would also take place in due course, which would be benefitting the overall economy.

- **Availability of Consumer Goods:** It has been generally observed that the prices of day-to-day consumable items are comparatively high in those habitations & villages having poor accessibility as compared to the villages with proper accessibility. It may also be observed that a number of consumable items, medicines, other accessories, etc. are frequently not available in the villages with bad accessibility, besides limited choices. The obvious reason for the same is mainly non-availability of proper transport system eventually resulting in higher transport cost. Hence, with the improved road condition, availability of such consumable and other items could be ensured on regular basis and expected at lower or competitive prices, benefitting the local residents

As illustrated above that improvement of the Project Road serving different districts of the regions would also play positive roles in several activities, such as, enhancing the utilization of existing social infrastructure facilities, and improved transport infrastructure attracts provision of such facilities, helping environmental protection, spreading benefits to the neighboring areas of the Project Road, etc. Most of the benefits areas mentioned above are qualitative or intangible unless a special study is conducted with quasi parameters and variables representing particular functions.

However, many studies conducted in several developed and developing countries have produced convincing arguments and evidences to prove that improved transport infrastructure in general plays a significant role in the above-mentioned areas. The intangible benefits obtained on account of the Project Road improvement, would be in addition to those of the tangible benefits incorporated in the economic appraisal of the investment in the proposed intervention. Hence, the qualitative benefits would further support the investment proposal in the Project Road.

10.2.1.3 Exogenous Benefits

(i) Farm Production: As it has been argued and illustrated earlier that with the improvement of the Project Road, among others, the agricultural, horticulture & fishing activities will be substantially increased in the PIA.

However, it is difficult to estimate the extent of increase in several agricultural and agro-based activities in the project influence areas, and also the estimation of the share of the improvement of the road transport sector alone in the agricultural development, is another complicated tasks, moreover, that is out of scope of the present Study. In order to appreciate such benefits, the Study has worked out the likely agricultural benefits due to the up-gradation of the Project Road based on reasonable assumptions. For the purpose, the Study attempted to analyze the agricultural potential of the districts falling in the catchment areas of the Project Road, and expected agricultural outputs generating the truckloads have been worked out and incorporated in the traffic forecast model.

(ii) General Agricultural Benefits: The Study has highlighted about the general agricultural, horticulture and industrial potential of the project influence area covering Karnataka, Tamil Nadu, Goa, Kerala states of the country. The exact estimation of various agricultural produces and increase in dairy, poultry and livestock keeping activities, particularly on account of the improved road transport infrastructure in the PIA, is a difficult task. However, based on the argument supported in favor of positive impact on the above-mentioned activities, there would be considerable improvement in agro-based economy, resulting in quantum increase transport demand. The benefits of these activities under the improved road infrastructure, has been considered as exogenous benefits in lieu of that are being taken as 10% of VOC/VOTT savings in the area for economic analysis.

Further, the area has good potential for future development an additional 20% benefits over 20% socio-economic benefits due to above mentioned induced development in the area have been considered for economic analysis.

10.2.1.4 Savings in Travel Time

A reliable, convenient and efficient transport system created due to improvement option, would save the travel time to its users, mainly on account of increased speed, timely delivery of the commodities under transportation, probably reduced waiting time for getting the transport for freight and passenger movement, higher utilization of vehicle and crew, etc.

The results of field surveys reveal that average travel speeds on the existing national highway section of Project Road observed are 10 to 40 km/hr and post-upgrading the

average speed would go up to 80-100 km/hr based on axle load and terrain, hence there would be considerable time savings while travelling on the Project Road.

Savings in travel time have been considered as tangible benefits for both passenger and freight movement. The concept is considered valid for undertaking the Feasibility Study of the improvement of the Project Road, and hence the savings in travel time for freight and passenger traffic have been worked out and incorporated in the economic analysis.

10.3 Investment appraisal

Existing NH-48 road section between Heggade (Marenhally) (km 236.400) – Addahole (Gundya) (km 263.400) is divided into one homogenous section based on the homogeneity in pavement condition, traffic volume and geometric features like curvature and rise & fall. Two alternatives have been considered for the economic analysis in each section. The first is “without Project” (do minimum) where the Existing Project Road (concrete pavement road section) is considered without improvement proposals. In this case, the future traffic volume will continue to follow the existing two-lane road. In the economic analysis, this ‘Do Minimum’ alternative (without project) will form the base strategy against which all other strategies will be compared. The second is ‘With Project’ alternative. This corresponds to the formation of new 4-lane green alignment of bypass to Shiradi Ghat. In order to arrive at the net benefits associated with the second strategy, it is compared to the ‘Do Minimum Alternative’. By comparing the above alternatives, the net agency costs and net user costs and finally net project benefits, associated with the project during its analysis period of 30 years, are calculated, for the improvement option in order to arrive at the Economic Internal Rate of Return (EIRR) and Economic Net Present Value (ENPV).

In brief, the following two Strategies have been considered and evaluated in this study:

10.3.1 "Without Project" alternative

Strategy 1: This is the “Do Minimum Scenario”. In this scenario, the agency performs routine maintenance and pothole/ cracks patching (if any for concrete pavement) every year from the starting year. It will receive functional overlay of 25mm mastic asphalt coat whenever IRI reaches 10. This would have effect of reducing the surface roughness to IRI 6.0 m/km.

This strategy has been termed “Do Minimum Scenario” where the existing road network is maintained at current levels and no improvements are envisaged. In this situation, the projected future traffic is assumed to use the existing road in a congested traffic flow condition.

Agency costs (maintenance cost), distance and time related vehicle operation costs together with travel time costs and accident costs pertaining to this alternative will form the base on which net project cost and benefit streams during the analysis period are calculated for each ‘with project’ alternative.

10.3.2 "With Project" alternative

Strategy 2: This is the scenario with the new 4-lane green alignment facility by year 2021 with rigid pavement. Once the construction is complete, the agency will perform routine maintenance every year. Also road section will receive a 25mm mastic asphalt whenever IRI reaches 6, which would reduce surface roughness to 2.5 m/km.

This strategy forms ‘With Project’ alternative and is compared to ‘Without Project’ alternative.

10.3.3 Input data

10.3.3.1 General

The following general input values have been considered for the Economic Model.

Table 10.1 General Inputs for Economic Model

Description:	
Run Date	05-12-2015
Discount Rate (%)	12%
Analysis Period (years)	30
Calendar Year of Initial Year	2021
Output Currency Name	Rupees
Input Currency Name	Rupees

10.3.3.2 Capacity of the road

IRC 64-1990 provides daily design service volumes, which are based on Level of Service-B (Volume to capacity ratio of 0.5) and a peak hour share of 10%. It is also suggested that the capacity will increase by 15% with 1.5m paved shoulders. Maximum Capacities as per IRC 64 are considered as indicated in **Table 10.2**.

Table 10.2: Suggested capacities for plain/rolling terrain (PCU/Hr)

Width / Lane Configuration	**Shoulders (Width & Type)**	**Maximum Capacities**
		IRC-64
2-Lane (7m)	Nil	1500
2-Lane (7m)	2 x 1.5m – Paved	1725
4-Lane Dual	Nil	6400
4-Lane Dual	2 x 1.5m - Paved	7360

As per IRC:SP:84: 2014, 4-lane Manual, design capacity of 4-lane road is 20000 PCU

per day for Hilly & Mountainous terrain of the proposed Shiradi Ghat road section.

10.3.3.3 Growth rate

Traffic growth rates necessary to estimate the traffic levels in future on the project road are product of economic factor of the influence area and elasticity of traffic demand. Most likely growth scenario has been considered for Economic Analysis.

Base year traffic as given in the Chapter 4: Traffic Surveys and Analysis for year 2015, is considered in the economic analysis.

10.3.4 Project costs

10.3.4.1 Capital costs

The capital costs of the Construction / Upgradation of the project road including the phasing of investment during the construction period have been calculated. The total capital costs (including tunnel, culverts, bridges and road works, and utilities, land acquisition, EMP, R&R, Quality and Project development charges) at current prices with contingency costs for road works and structures has been considered.

The capital costs (financial) of the project road have been converted into economic costs by using a standard conversion factor of 0.9, to construction costs (road works and structures). The economic cost of acquisition, R & R, Quality and Project Development cost has been taken as same as financial cost, without resorting to shadow pricing or assessing opportunity cost in any other alternative. The project costs, over the construction period, are shown in **Table 10.3**

below:

Table 10.3 : The breakup of total project cost in the analysis

Sl.no	Description of Item	Project Cost in Rs.
1	Civil Cost	14538148168
2	Pre Construction Cost	3634537042
	Total Project Cost in Rs	18172685210

Percentage distribution of cost

Year I (2017)	Year II (2018)	Year III (2019)	Year IV (2020)	Year V (2021)
15	25	25	20	15

10.3.4.2 Road user costs

The economic cost inputs that are required for estimating road user costs are:

- Price of selected (popular) models, by vehicle type
- Tyre prices
- Fuel cost including oil
- Crew cost (wages of Drivers / Assistants)
- Time costs for :
  - Passengers
  - Freight (holding cost)

The cost of vehicles and tyres were collected from the manufacturers, and dealers located in Karnataka. All the transfer payments such as sales tax, excise duty and octroi are deducted from the financial cost to arrive at the resource cost.

A pilot survey was conducted to estimate the wages of drivers and their assistants. The crew cost is estimated with 2400 hours of work time per annum. With respect to maintenance and labour costs, local workshops have been contacted to assess the annual wage bill and assuming 2400 hrs of work per annum, the labour costs have been calculated per hour.

The value of passenger time was calculated based on the average annual income of passenger collected with the assumption of 2400 hours of work time per annum. About 30 percent of the trips were assumed to be made during non-work hours. Finally, a weighted average of time value per hour was calculated. Time saving values applicable to the year 1990 (IRC: SP-30) were adopted and projected to year 2015.

Based on the above considerations, The basic characteristics of the vehicle fleet is given in Table 10.4,10.5 & 10.6

Table 10.4 Basic Characteristics of Vehicle Fleet

Vehicle Type	No. of Wheels	No. of Axles	Tyre Type	Tyres Base Recaps	Tyres Retread Cost (%)
Car	4	2	Radial ply	1.30	15.00
Bus	6	2	Bias ply	1.30	15.00
Truck-2 axle	6	2	Bias ply	1.30	15.00
LCV	4	2	Bias ply	1.30	15.00
3 - axle truck	10	3	Bias ply	1.30	15.00
MAV	14	4	Bias ply	1.30	15.00
Two Wheeler	2	2	Bias ply	1.30	15.00
Auto	3	2	Bias ply	1.30	15.00
Minibus	6	2	Radial ply	1.30	15.00

Vehicle Type	No. of Wheels	No. of Axles	Tyre Type	Tyres Base Recaps	Tyres Retread Cost (%)
Agri.Tractor	4	2	Bias ply	1.30	15.00
Agri.Tractor with Trailor	6	3	Bias-Ply	1.30	15.00

Table 10.5 Basic Characteristics of Vehicle Fleet

Vehicle Type	Annual Km	Annual Work Hours	Average Life (Years)	Private Use (%)	Passengers	Works Related Trips (%)	Operating Weight(T)	Life Model
Car	32,000	1,950	10	40	4	20.00	1.20	Optimal
Bus	66,000	2,000	10	0	40	20.00	15.00	Optimal
Truck-2 axle	85,000	2,100	10	0	0	0.00	12.00	Optimal
LCV	60,000	1,500	12	0	0	0.00	6.20	Optimal
3 - axle truck	85,000	2,100	10	0	0	0.00	18.00	Optimal
MAV	12,000	2,400	12	0	0	0.00	22.00	Optimal
Two Wheeler	16,000	1,300	10	100	2	20.00	0.20	Optimal
Auto	23,000	500	8	0	3	20.00	0.50	Optimal
Minibus	60,000	1500	8	0	20	20.00	3.50	Optimal
Tractor	4,000	350	10	75	0	20.00	3.00	Optimal
Tractor with Trailor	4,000	350	10	75	0	20.00	3.00	Optimal

Table 10.6 Economic Characteristics of Vehicle Fleet

Vehicle Type	New Vehicle	Replacement Tyre	Fuel	Lubricating Oil	Maint. Labour	Crew Wages	Annual Overhead	Annual Interest
Car	395978	1700	66.5	202.5	90	100	41428	12
Bus	2492460	15792.5	46	202.5	120	300	2808543	12
2 Axle	2248720	15792.5	46	202.5	105	287.5	277330	12
LCV	786126	7490	46	202.5	105	125	267710	12
3 Axle	2605940	15792.5	46	202.5	105	287.5	286683	12
MAV	2715540	15792.5	46	202.5	150	287.5	292273	12
Two Wheeler	43826	1825	66.5	202.5	73.5	0	1043	12
Auto	264966	1907.5	36.34	202.5	73.5	0	4603	12
Minibus	1111446	5980	46	202.5	120	300	64655	12
Tractor	706254	5217.5	46	202.5	150	37.5	267710	12
Tractor with Trailor	706254	5217.5	46	202.5	150	37.5	267710	12

10.4 Economic Costing

In order to convert the financial costs (i.e. based on the market prices) into the economic costs, so that it could take care of the market imperfection and present the resource cost to the economy, particularly by elimination of taxes, duties, etc., i.e. referred to as shadow pricing, the Study has used the Standard Conversion Factor (SCF) applicable in the country for similar road improvement project. In India, SCF for similar road projects as

0.85, which has been considered in the economic analysis. The above SCF has been used to convert financial cost into the economic cost of the preliminary cost estimates of Shiradi Ghat tunnel project for different Options: Option 1: Without Project (Existing 2-lane Road as it is with periodic & routine maintenances; and Option 2: "With Project "New 4-Lane Green Alignment with Tunnels, Bridges and Cut & Fill sections, and the same is incorporated in the Economic Model for the economic analysis.

10.4.1 Project Costs

The upgrading costs of the Project Road for two options have been worked out in Chapter 9: Preliminary Cost Estimate, and summarized in **Table 10.7** The Project costs include civil works, social and environment mitigation, resettlement and rehabilitation, contingency (excluding price Contingency), and supervision.

Table 10.7: Total Up-gradation Cost of the Project Road (INR Cr.)

Sl.	Section (Existing km)	Length (km)	Fin. Cost /km (Rs in Cr.)	Eco. Cost /km 85% of Fin Cost (Rs in Cr.)
Option I: Without Project Road				
1	km 236.400 –263.400	27.0	2.50	2.13
Option II: With Project Road				
2	Ch 0+000 –23+579	23.579	399.37	339.47

Fin.=Financial; Eco.=Economic

Phasing of the investments in the Options is assumed as 15% during 2017; 25% & 25% during 2018 & 2019; and 20% & 15% during 2020 & 20121 of the total cost respectively.

10.4.2 Maintenance Strategy

In order to preserve the road networks in the country, i.e. a national asset, a proper maintenance mechanism supported with adequate fund and capable institutional support is highly desirable; otherwise the road asset will be deteriorated to considerable extent, resulting in heavy losses to the economy in long run. In general, it is considered that the roads in the country do not receive adequate maintenance due to lack of funds, which needs proper consideration.

It is important to note that in situation of inadequate maintenance fund and timely maintenance intervention, the entire economic appraisal exercise would be unreliable, as the proposed benefits to the users would not occur in the appraisal period, which would pose a kind of unsustainable proposition in the Project Road.

For the purpose of the economic analysis, a minimum routine maintenance strategy in case of without project or do-nothing option in the Economic Model, has been considered once in a year for covering the items like vegetation clearance, light grading to remove the ruts and pot holes, filling up of depressions, repairing longitudinal and transverse gullies and removal of other obstructions in earthen and gravel surface.

Whereas under with project option, the following expenditures on routine and periodic maintenance have been considered in the economic analysis:

- **Routine Maintenance:** For paved roads, routine maintenance includes patch repairs, crack sealing, edge repair, cleaning of road side drains/cross drainage structures, repairing of shoulders, painting of highway signs and km stones, slope protec-

tion, turfing, road markings, removal of litter, debris, replacement of damaged signs and maintenance of culverts, etc.

- Rs. 250,000 per km per year (with Project case)
- Rs. 600,000/-per km per year (without Project case)

- **Periodic Maintenance:** For long-term benefits of the substantial capital investments in the Project Road, to offer quality roads to the users, and also to protect the national assets, appropriate periodic maintenance has been proposed. It may be noted that the periodic maintenance costs are applicable only for upgrading options or with the project; Periodic maintenance costs will be incurred once in every Ten years for Rigid Concrete Pavement during **the** appraisal period, i.e. in the year 2030, 2040, and 2050 assuming the Project Road become operational in 2022.

  - 65mm Bearing Coat for four lanes @ 10 years interval: Rs. 80 Lakhs/km

  Other maintenance*:* additional operational expenses associated with project such as traffic signposts, lighting etc., are considered as annual charges and included in routine maintenance costs. For annual supervision & administration charges, it has been assumed that the arrangement under 'without project' will continue for the 'with project' situation

  The residual value: 10% residual value has been taken for the Project road.

10.4.3 Environment & Social Mitigation Costs

Any road improvement and rehabilitation works are also termed as "interventions" on the existing physical situation of the specific affected area, i.e. the Reserve Forest Area of Shiradi Ghat. These interventions of proposed bypass construction and the en-route bridges, cross drainage construction activities, affect nearby inhabitants, physical and biological environment. And if required mitigating measures required are not carried out well on time, it would leave behind several direct and/or indirect social and environment problems. This is one of the "externalities" of the proposed investments on the Project Road in the project influence area. These problems may not necessarily be apparent and immediately realized, and also mostly typical for specific region(s) where the interventions are proposed. It is important to note that some of the areas are relatively more sensitive to such interventions.

So there is a need to be careful on this account, as if the proper mitigating measures are not taken within the specified timeframe, the social costs would be much more than the costs of the rectification of such problems. In view of the above, the Study has identified and evaluated such social and environment problems and its concomitant costs.

Chapters 7 and 8 of this report deal with the environmental, social, and resettlement issues and concerns respectively, and also the cost implications for undertaking the mitigation measures required to take care of the proposed interventions in upgrading of the Project Road. The mitigating costs worked out for all the selected sections are also included in the total Project Costs in the economic analysis for the Project Road.

The costs for environment and social mitigation including resettlement and rehabilitation, etc. have been estimated in detail for all the Project Road in Chapter 9, and the same has been incorporated in the economic analysis after having adjusted for the economic costing. Summary of the above costs for the Project Road is presented as follows (INR Cr.):

- Rs. 0.95 Cr/ per km per year (with Project case)
- Rs. 1.70 Cr. /-per km per year (without Project case)

10.4.4 Project Benefits

For undertaking the economic appraisal exercise on the investments in the Project Road, i.e. Shiradi Ghat, Economic Model has been used. The Model incorporates several data inputs relating to the "with and without project situations", followed by comparing the total project costs under two above situations, it estimates the net benefits of the proposed interventions, and compares with the expected benefits. The exercise aims at establishing the feasibility of the investment in upgrading of the Project Road. The economic analysis also incorporates the exogenous benefits as described here.

10.4.5 Basic Parameters & Assumptions

As stated earlier, the economic analysis has been carried out by using the Economic Model. The Model conducts the economic analysis primarily based on the life cycle cost analysis of the proposed intervention, e.g. upgrading options in present case. The merit of this analysis is to establish the good value for money by way of selecting the upgrading options **(Option I: without bypasses, and Option II: with bypasses)**. The Model makes a comparison between the total transport costs–VOC and other costs–on the existing road condition and the improved road condition on a yearly basis for the entire appraisal period.

The concept behind this approach is that if the Project Road is improved to the recommended standards, the benefits would be the reduced transport costs when compared with the cost of opportunity foregone, i.e. the "base case," or "without project situation". Basic parameters and assumptions used while undertaking the economic analysis of the improvement of the Project Road are listed in **Table 10.8**

Table 10.8: Basic Parameters & Assumptions

Parameter	Assumption
Project Construction Period	5 years*
Project Benefit Period Considered	20 years
Project Commencement Year	2017
Project Completion Year	2021
Project Opening Year	2022
Project Terminal/End Year	2042
Discount Rate for Net Present Value	12%
Standard Conversion Factor	0.85

**Including initial preparation and award of the work.*

10.4.6 Traffic Demand

Traffic analyses for the Project Road – present and future; have been worked out by different vehicle types and presented in Chapter 4. For ready reference, the traffic relating to the base year, year of commencement (i.e. open to traffic) and the terminal year of the Project appraisal period are presented in **Table 10.9.**

Table 10.9: Projected Traffic at Homogenous Sections

Homogenous section	*Year*	*Total Traffic volume in numbers*	*Total Traffic In PCUs*	*Capacity Criteria*		
				V/C ratio	*LOS*	*Recommendation based on V/C ratio*

Homogenous section	*Year*	*Total Traffic volume in num-bers*	*Total Traffic In PCUs*	*Capacity Criteria*		
				V/C ratio	*LOS*	*Recommendation based on V/C ratio*
Km. 236.400 to km 263.400	*2015*	*7707*	*13963*	0.47	*B*	*2L+Pav Shoulder*
	2020	*12474*	*21912*	0.49	*B*	*4 Lane Divided*
	2025	*17889*	*33191*	0.42	*B*	*4 Lane Divided*
	2032	*35392*	*57892*	0.48	*B*	*6 Lane Divided*
	2038	*55614*	*87983*	0.55	*C*	*8 Lane Divided*
	2045	*85407*	*130418*	-	-	-

10.5 Economic Analysis

10.5.1 Computation of EIRR & NPV

All the costs and the benefits of the upgrading of Project Road for the options **(Option I: without project, and Option II: with Project)**, as described in the paragraphs mentioned above, and the corresponding figures, thus, obtained have been incorporated in the economic analysis for establishing the justifications of the proposed investments. Summary of the results of the economic analysis has been given in **Table 10.10.**

Table 10.10: Results of Economic Analysis of the Project Road By Option

Project Road Section	Length (km)	Option I		Option II	
		EIRR*	NPV**	EIRR*	NPV**
Project Road	**23.579**	**2.48**	**45.0**	**14.80**	**175.0**

**Economic Rate of Return in %; and **Net Present Value in Rs in Cr. at 12% of discount rate.*

The values obtained in terms of the economic internal rate of return (EIRR) and the net present value (NPV) show that the investment proposals in the Project Road are viable for Option 2 “With Project”, as the values of EIRR are well above the bench-mark rate, i.e. cutoff point of 12%, and also the values of NPV are positive at 12% of the discount rate. The economic appraisal exercise showing the Project Road together as one Project also yields the acceptable results of the EIRR and the NPV obtained for the two Options.

The values of benefits/costs ratios (BCR) are worked out at the discount rate of 12%. The BCR refers to the present value of the economic benefits stream to the present value of the economic costs stream, each discounted at the economic opportunity cost of capital, i.e. 12% in the present analysis. The ratio should be greater than 1.0 for a project to be acceptable. The values of the BCR of the Project Road and all the Project Road together as total are presented in **Table 10.11**

Table 10.11: Value of BCR & FYRR

Option	B-C Ratio	FYRR
Option-I	- 0.65	- 6.24
Option-II	1.45	5.20

The economic analysis has also carried out the First Year Rate of Return (FYRR) at discount rate of 12%. The FYRR illustrates the strength of the investment in the project, which is helpful in making decisions. The values, thus, obtained for the Project Road and Total are given in **Table 10.11**

10.5.2 Sensitivity & Risk Analysis

Investment in road projects, like any other investments, involves risks and uncertainties, such as, cost overrun, time overrun, traffic development, level of benefit realization, etc.

The effect of these uncertainties has been evaluated under the sensitivity analysis, which involves recalculating the economic appraisal results for different values of the major variables for the Project Road under the Study.

The level of traffic (directly related to the benefits) and the upgrading costs of the Project Road are the two basic parameters, influencing the viability of the investments in the Project. Following the requirements of the ToR, the sensitivity analysis has been carried out for varying traffic level and upgrading cost, and reworking out the costs and benefits analysis exercise under the following scenarios for the Options (**Table 10.12**).

Table 10.12: Scenarios of Sensitivity Analysis

Scenario	Level of Risk & Uncertainty
Scenario-I	Increase in Project Costs by 20%
Scenario-II	Decrease in Project Benefits/Traffic by 20%
Scenario-III	Worst: Decrease Project Benefit by 20%; Increase Cost by 20%

Results of the Sensitivity Analysis for both the options are summarized in **Tables 10.13** incorporating the varying costs, benefits, etc. for the investment in upgrading of the project road.

The EIRR values, obtained under different scenarios of the sensitivity analysis examine the vulnerability of the investment in the Project Road against the aforesaid risk and uncertain conditions illustrated in terms of varied traffic levels and different project costs. The most adverse condition under the sensitivity analysis has been worked out, i.e. decrease in benefit (Scenario I), increase in cost (Scenario II), and both put together, i.e. decrease in benefit and increase in cost (Scenario III). The sensitivity analysis under the above-mentioned scenarios covers a wide range as well as most adverse condition to evaluate risks and uncertainties components in the project investments for making decisions.

Table 10.13: Results of Sensitivity Analysis

Project Road Section	Values of EIRR Under Different Scenarios (%)			
	Base	I	II	III
(Option I: Without Bypasses)				
Project Road (Total)	**2.48**	**0.36**	**0.24**	**-0.8**
(Option II: With Bypasses)				
Project Road (Total)	**14.8**	**13.4**	**12.6**	**11.7**

Results of the sensitivity analysis, shows that the values of the EIRR under all the scenarios of the sensitivity analysis considered for the analysis, including the most adverse case, more than the given benchmark rate of 12% for the Project Road.

Similarly, the values of NPV also establish the investment viability of all the Project Road, as all the values are positive at the discount rate of 12%. Hence, the investment proposal of upgrading of the Shiradi Ghat Bypass, i.e. the Project Road totaling 23.579 km passes the criteria set for the sensitivity analysis, by section, hence recommended for implementation.

As per the ToR, the sensitivity analysis should include a switching value analysis for construction costs and traffic levels. While carrying out the above sensitivity analysis, these two parameters, viz. construction cost and traffic level have been incorporated to evaluate the impact of changes in the net present value by increase the total project cost (not only construction cost) by 20%, and also decrease in traffic level (by reducing the total project benefits) by 20%. This exercise is fairly wide as well as robust to take care of any investment decisions.

It is important to note that the Project Road is also connected with rural/feeder roads serving villages located in the project influence area, and the residents living in the PIA, who are engaged mainly in agricultural and allied activities, and also provides direct link between several pairs of points, i.e. avoiding longer detour.

As far as anticipated risks and uncertainties in the investments in the upgrading of the Project Road, beyond those addressed under the sensitivity analysis, viz. decrease in benefits due to not realization of projected traffic; and/or increase in project costs mainly on account of inflationary impact, delays in project implementation, etc., are concerned, these two major parameters adequately cover the issue, particularly the “worst case”, i.e. Scenario-III under the sensitivity analysis.

10.6 Summary & Conclusions of Economic Analysis

Results of economic analysis incorporating the benefits consisting of savings in the vehicle operating costs, value of travel and transit time and benefit on account of the improved agricultural activities in the project influence areas, and also supported with the sensitivity analysis to address risk and uncertainty mainly on account of reduction in benefits and increase in costs, the Project Road as whole, justify the investments on their upgrading as per the proposed tunnel and bridges, pavement design, cut & fill sections, cross drainage structures, etc.; along with the proposed environment and social mitigative measures.

Besides the savings in VOCs and travel time, and benefits on account of improved industrial, commercial, agricultural activities, etc., improvement of the project road, among others, would benefit in several areas, such as, changes in land use / pattern and allied activities in commercial, agriculture sector; creation of more job opportunities for unemployed and poor people, particularly in road construction and routine and periodic maintenance activities; expected reduction in accidents due to improved road geometrics and road signage; boost in tourism due to reliable, convenient and comfortable road accessibility to different places located nearby the project road; reduction in poverty on account of improved accessibility and mobility for better livelihood opportunities, and higher utilization of existing social infrastructure facilities nearby or at distant places, particularly for women, which would enable them to save time for undertaking other domestic obligations or additional gainful activities; etc.

In addition to the above benefits, the upgraded project road would also facilitate the environment protection monitoring in the PIA efficiently and effectively, and also reduced fuel consumption in vehicles operation on the Project Road will be more rational, and less polluting the nearby areas; and also substantial reduction in dust pollution, protecting the quality of food items with the food safety concerns.

The project road would also benefit the neighboring areas by many ways, i.e. likely improved agricultural practices due to better connectivity in the PIA, and there would be spread and demonstration effects of those improved practices, particularly changes in cropping pattern, increase in industrial and agricultural productivity, storage and transportation of perishable commodities, much better farm-gate price of the agricultural produces, etc. in long run.

In terms of the “Options” considered, **Option 2: Project Road Improvement with Tunnels** is recommended on the following criteria and justification:

Traffic Survey Results as presented in Chapter 4 indicate that present traffic and projected traffic for future years is phenomenal and it may require 6-laning (2038) in future.

There are many tangible benefits for improvement of existing road with proposed bypasses; some of these are stated as below:

- Road Geometry as per IRC 73: 1980 for uniform design speed 100 km/h in tunnels & bridges; and 100-80 km/hr in bridges and cut & fill sections.
- As per discussion with concerned officials, mostly land belongs to reserve forest under government, hence Land is available for bypass without any land acquisition & resettlement costs.
- Civil Construction cost of bypass and widening of existing road to four lane is not much due to poor condition and bridges and culverts are not fulfilling the widening to 4-lane standards. So almost new construction is involved.
- There is very low environment and social mitigation expanses for bypasses as mostly are passing through reserve forest, underground tunnels, high level bridges, open and barren lands.
- Existing road geometry is substandard, very sharp curves up to 30m radius are provided in Urban and Junction locations. Sight distances and visibility is poor / insufficient at these locations. Its improvement causes many re-alignments, rehabilitation/resettlement of local road users.
- The present road is poor and failed road sections for carrying out heavy commercial traffic, as now being observed with much higher potential of growing more and more in the near future. There is a high probability that the some of the present bridge might collapse or be declared not safe for heavy commercial traffic. That situation would adversely affect the national transport system significantly, mainly between Bangalore and Mangalore part of the country, besides the international transport movement.
- There is longer alternate route which can connect all town and villages along this project road. It is also noted that during the rainy season, it is difficult to use even this road along the detour.

The improved connectivity of the districts served by the Project Road, i.e. Hassan and Mangalore and further to the entire road network of the country, and also serving different districts and states, would yield higher economic returns and accelerate the development in general, and in project influence are in particular.

- The investments in the Project Road would also impact positively on the overall socio-economic development process of the country in general, besides the PIA. All these factors put together would further increase the Project benefits in several ways. Hence, the bypass to Shiradi Ghat is highly recommended without any delays, so that the expected benefits could be realized as soon as possible.

11 Preliminary Financial Analysis

11.1 Background

The basic objective of the Financial Analysis is to determine whether the build, operate, transfer (BOT) model is workable for the stretch, and if so, under what conditions, and if not than may be workable on annuity basis as decided by the Competent Authority.

Basic Structure

- Length: 23.579 Km
- Lane: 4
- Tollable Additional Structure: Nil
- Tollable Additional Bypass: Nil
- Number of Toll Plaza: 1

Scenarios

The Financial Analysis is carried out under the following scenarios, considering concession period up to 30 years;

- Without MORTH Equity Support
- With MORTH Equity Support (40% during construction and Nil during O&M)
- Viability Gap Funding
- Annuity while maintaining 15% Equity IRR
- Annuity while maintaining 18% Equity IRR

Capital Cost

The Civil Cost of Construction is estimated as Rs. 9416.8 Cr (2015-16).

11.2 Assumptions

Basic Assumption of Financial Model

The financial analysis is prepared on the following parameters/assumptions:

Construction Schedule & Total Project Cost

- Construction Starts : January 2017
- Construction period: 60 months
- Construction allocation: 15%, 25%, 25%, 20% and 15% in respective years
- Opening of Traffic: January 2022
- Contingencies/ QC on Civil Cost: 1%
- Estimated Escalation in Toll Rate: CAGR: 5%
- Independent Consultant (IC) & Pre-Operative: 1%
- Financing Cost: 2%
- Interest: 12%

Other Assumptions/ Basis

- Estimated Escalation in Toll Rate (%) 5.00 CAGR
- Tax Rate: As per the applicable provisions
- Tax Holiday 80 I A (In 20 years block period of Concession Period): 10 years
- Depreciation Rate SLM: During the life
- Depreciation Rate WDV: 10%
- Loan Repayment (during operation, quarterly): 10 years
- Rate of Interest: 12.00% p.a.
- Moratorium (after construction): 6 months
- Discounting Factor: 12%

11.3 Operation And Maintenance Cost

The estimated cost of Operation and Maintenance is as below:

Table 11.1 : O & M Cost

Sl. No.	Particulars	4 Lane
1	Routine Maintenance Rs in Cr./ Km/ year (2016-17)	0.025
2	Periodic Maintenance Rs in Cr./ Km/10th year (2016-17)	0.80
3	Electricity & Patrolling Expenses (Rs in Cr./ Km/ year) (2016-17)	0.01
4	Other Office Expenses(Rs in Cr./ Km/ year) (2016-17)	0.25
5	Toll Plaza and O&M Expenses (Rs in Cr./ toll plaza/ year) (2016-17)	Nil
6	Insurance (of TPC / year)	0.15%
7	Inflation (p.a.)	5%

11.4 Toll Plaza Location

Tollable Traffic at Toll Plaza - Km.21.800 to 22.280, in between Viaduct/Cut & Fill Section.

Tollable Traffic

Tollable Traffic is taken as follows (Base Year 2022):

Table 11.2 : Tollable Traffic

Vehicle Type	Car Jeeps/ Vans	LCV/LGV	Mini Bus	Truck	Bus	MAV
Single pass	3615	337	89	1421	652	1049
Daily Pass	1606	150	40	474	218	140
Monthly Pass	803	75	20	237	108	140
Local	2009	187	50	237	108	71
Total	8032	749	199	2370	1086	1399

Leakage factor

(Assumption as decided by MoRTH)

Traffic Discount

- Car/Jeep/Van: 10%
- Other Vehicles: 5%

Exempted / Leakage

- Car/Jeep/Van: 3%
- Others: Nil

11.5 Results

Financial Analysis

Total Project Cost: The Total Project Cost Structure is as under

Table 11.2 : Tollable Traffic

Sl. No	Description	Total (Rs/Cr)
1	Civil cost of construction (2015-16)	9416.80
2	Escalated (Before Construction)	470.84
3	Total Civil Construction Cost	9887.64
4	Contingencies/QC on Civil Cost	94.17
5	**Total EPC Cost**	9981.81

Sl. No	Description	Total (Rs/Cr)
6	Independent Consultant (IC) & Pre-Operative	99.82
7	**Total Cost**	10081.63
8	Escalated (During Construction)	504.08
9	**Total Cost (with escalation)**	10585.71
10	Financing Cost	211.72
11	Interest during Construction (IDC)	166.99
12	**Total Project Cost**	10964.42
13	MORTH Equity Support (Maximum 40%)	
14	Concessionaire Equity (30%)	3289.33
15	Debt (70%)	7675.09

Toll Rates

The toll rates (in Rs.) are as follows as on 2015-16 (Without MoRTH Support)

Table 11.3 : Total- Toll Rate in Rs.

Total	Car/ Jeep/ Van/ LMV	LCV/ LGV	Mini Bus	Bus	2 Axle Trucks	3 Axle Trucks	MAV (4-6 Axle)
	45.00	75.00	75.00	155.00	155.00	170.00	245.00

The summary of the financial results are given below:

Without MORTH Equity Support & with MORTH Equity Support (40% during construction and Nil during O&M)

Table 11.4 : Results of Financial analysis

Options	Equity Support (%)	Concession Period	Project IRR (%)	Project IRR with-out tax (%)	Equity IRR (%)	NPV (Rs, Cr.)	Average DSCR
Base case	0	30	0.38%	-0.07%	N/A	-657.1	2.25
Option 1	25	30	1.35%	0.90%	N/A	-484.3	2.27
Option 2	30	30	1.59%	1.14%	N/A	-449.6	2.26
Option 3	40	30	**2.12%**	1.61%	N/A	-380	2.26
Option 4	95	30	**12.35%**	11.90%	1.43%	2.32	2.46
Option 5	**97**	**30**	**15.44%**	**15.01%**	**9.20%**	**16.2**	**2.6**
Expected IRR as per GOI Circular*			12		12		
Desirable IRR			14		15		

**The required criteria of Project IRR and Equity IRR are 12% and 14% respectively*

Finding

- **Without MORTH Equity Support**

  The Project is not viable without MORTH equity support. The NPV comes to ***Negative*** by Rs.657.1 Cr. with 0.38% Positive return on Project IRR, and ***Negative*** returns on Equity IRR.

- **With MORTH Equity Support**

  The Project is not viable even with MORTH equity support (40% during construction). The NPV comes to ***Negative*** by Rs. 380 Cr. with 2.12% Positive return on Project IRR, and ***Negative*** returns on Equity IRR.

Table 11.5 : Viability Gap Funding

Particulars	Outcome
MORTH support (during construction)	97%
NPV (Rs./Cr.)	16.2
Project IRR*	15.44%
Equity IRR*	9.20%

**The required criteria of Project IRR and Equity IRR are 12% and 14% respectively*

Finding

- The Project Viability Gap Funding (VGF) comes to 97% (during construction) i.e. Rs. 11118 Cr. Therefore, it is recommended that this option is **not** to be considered.
- The project is recommended under EPC with 100% government funding.

12 Suggested Method of Procurement and Packaging

The total project length of proposed bypass is 23.579 km with limited access to the project site since the project is located primarily in reserve forest area. It is a Greenfield alignment and no motorable road (except one village road and State high way 114 which are cutting the proposed alignment at two locations near two ends) exists to access different project components.

The project components shall be accessed mainly through existing Mangalore- Bangalore railway line. There are three railway stations namely Kadagravelli, Yedakumari and Arbetta which are having lay by (siding) along the proposed bypass alignment. It is planned to construct temporary non-bituminous access roads from these railway stations up to where all machinery, material and manpower shall be transported, to have a least impact on the environment.

Temporary forest lands close to access roads shall be acquired for the dumping yards for excavated muck, which cannot be used as construction material. Afforestation and conversion to forest land shall be made for this dumping yards and temporary access roads after construction of proposed bypass.

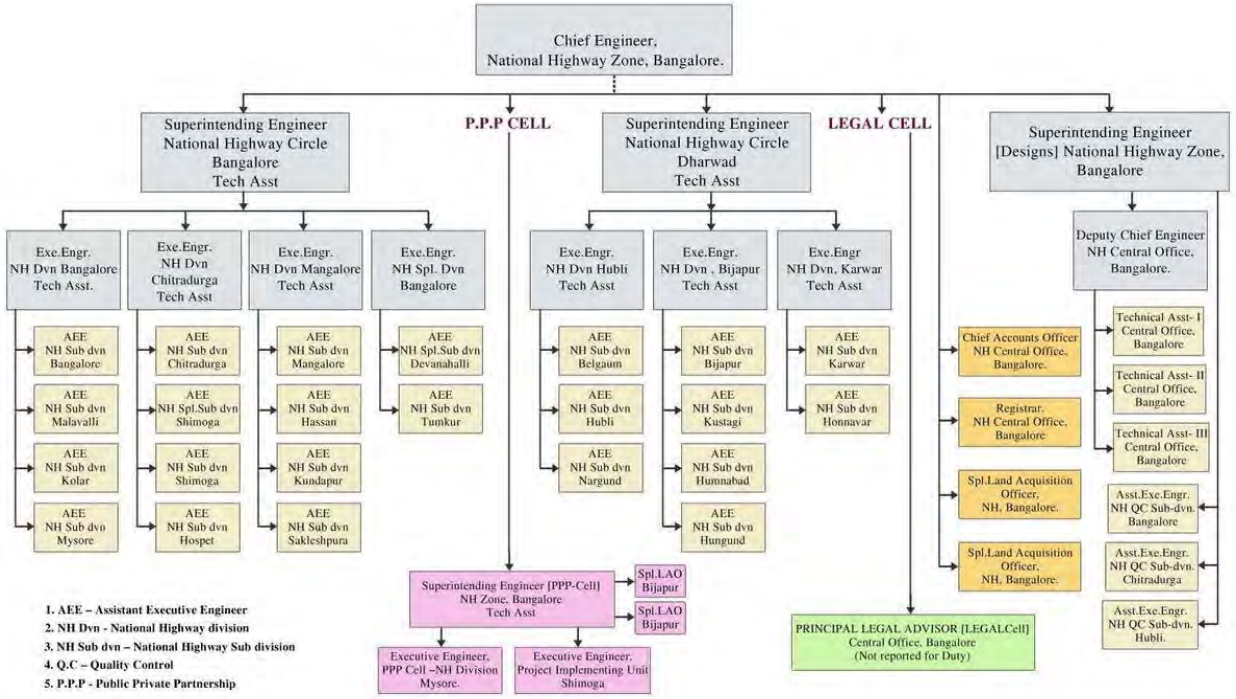
The proposed bypass is having six tunnels, two major bridges with length more than 1km and one viaduct at the end of bypass with bridge over kempu hole river. Considering the complexity of the project, requirement of international expertise, logistic, financial capabilities of EPC contractors, and time requirement for completion of the bypass It is recommended to execute the project under three contract packages. The details of the proposed packages are given in the table below:

Contract Package	Approximate Chainages (m) and length (km)	No. of Tunnels with maximum tunnel length (m)	No. of Bridges/ viaducts with max length (m)	Approximate Cost (in Cr.)
Package 1	0- 9100 / 9.1 km	2 Nos. with max. length of 2.96km	4 no. / 1.24km	3618
Package 2	9100- 16400/ 7.3 km	3 Nos. with max, length 2.11 km	2 no. / 1.02 km	2719
Package 3	16400- 23579/ 7.34 km	1 Nos. / 1.90 km	3 No. / 3.28 km	2846

The construction methodology of tunnels and bridges are described in respective chapters of Volume III: Design Report. Construction Methodology of individual structures and tunnels will be detailed further during DPR stage. Some specific guidelines are stated below:

- This construction of the project has been planned as EPC (Engineering, Procurement and Construction) model from the early planning stage.
- Land acquisition for the access road construction in the project section with compensation completes the land acquisition by December 2016.
- The procurement of the consultant shall be completed in a short period of time with the use of the scheme of the Special Assistance for ODA Loan Project Implementation.
- The process for the procurement of a contractor shall begin in July 2016 after detailed designs and tender documents, bidding process.
- The process for the procurement of the contractor for the construction of the bypass with ICB (international competitive bidding) shall begin in July, 2016.
- The construction of the project shall begin in January 2017, with the construction period of 60 months (five years).
- After the completion of the construction, the operation and maintenance of the constructed road shall be handed over to O&M Company to be selected in a specific tender for the operation of the road.
- The facilities for the toll collection and road operation shall be constructed in the last 18 months of the construction period.
- The use of the bypass shall begin in January 2022.

- The consultant to the government will responsible of acquiring permission for the implementation of the EPC contract and concluding an agreement on the EPC contract project with the contractor without delay, at appropriate stages of the procurement.
- NHZ, the department supervising the construction of national highways, shall take the responsibility of facilitating the implementation of the project. Figure below shows the organizational chart of NHZ. It is composed of five superintending departments, three Circles and two Cells, under the supervision of the Chief Engineer. Each Circle has its local office in each district and is responsible for constructing and maintaining highways in the state systematically. NHZ has an office called “NH 48 Project Implementation Unit Shiradi Ghat” in Sakleshpur for the implementation of the Shiradi Ghat Project. It is a new local office established in 2013 under the Superintending Engineer of the PPP Cell.
- The expected risk factors associated with this project include acquisition of the environmental certification and permits and approval for development including land expropriation, project scale, extension of the construction period and geological risk in the tunnel construction.



Tentative Organization Structure

13 Conclusions and Recommendations

The project is recommended for implementation as the project is likely to leave considerable impact on the economy of the region, which is necessary to put India as a whole in the high growth inclusive trajectory; as evident from the Chapter 10: Economic Analysis. The project is economically viable with ensured EIRR of 12.0%. The project can be financially sustainable if funding is undertaken by the government which ensures 12% equity IRR, hence an economic-financial equilibrium can be achieved. Hence, the project is recommended for implementation under EPC on two stages selection of the contractors. The project road have access to construction from both start & end points, so construction may be started from both ends by two agencies individually. Due to requirement of quantum amount of investment, the Government of India may seek funding for the project through international agencies viz, World Bank, JICA, Kuwait Fund etc.

14 Acknowledgement

The consultants gratefully acknowledge the co-operation, assistance and guidance extended to them by MoRT&H officials, Principal Secretary (PWP), PWD, Forest and other departments of Govt. of Karnataka and South-West Railways at this stage of study.

The consultant's thanks are also due to various Authorities like Geological Survey of India, Directorate of Mines, Economics and Statistics, Transport Dept. and other concerned officials of Govt. of Karnataka for furnishing us the valuable reports and data for preparation of this study.

15 Compliance of the Observations

We the consultant has received the observations from the Client vide letter no NH/PIU-Tunnel/NH-48/KD-3/2015-16/383-386 dated 14.12.2015 on KD 5: Kucha Draft Detailed Project Report (KDDPR) and we give below our point wise clarifications as follow:

Table 15.1: Compliance of the Observations

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
	1. **Following subjects as per Additional Condition of Contract are not covered in the Kucha draft report;**			
	Vol I. Main Report:			
	i. Economic and Commercial analysis and its conclusion.	Economic and Financial (Commercial) Analysis with Conclusions & Recommendations have been given in Chapters 10 and 11 respectively.	Refer Page 88 to 110 of Volume –I: Main Report.	
	ii. Give Bus bays near kadagaravalli, yadakumari, arebrtta and Shiribagilu Railway station.	Bus Bays have been provided at Kadagaravalli and Yadakumari railway stations. Alignment near Arebetta Station is passing through Tunnel. Shribagilu Railway station is not lying with proposed alignment, hence no bus bays at these stations are proposed.	Additional Bus Bays near Design Ch 20+000 is proposed to facilitate road users to connect 'Arebetta' railway station.	Volume-I Main Report Page 55 has been modified.
	Vol IX Drawing			
	i. No include Toll plaza, office cum residential complex for PIU	As the project is NON-VIABLE under BOT as per Financial Analysis. The Pro-	Decision on Toll Plaza, Truck Lay Bye and Rest Areas is requested from	No change in KD 5 Reports and Draw-

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
		ject Implementation will be based on EPC. A decision and consent is required from the Client about Toll Plaza. However Standard 5+5 lane Toll Plaza Drawing will be enclosed.	the Authority. Reports & Drawings will be modified accordingly during KD 7 submission.	ings.
	ii. Widening Scheme	The project alignment is GREEN Alignment, hence WIDENING SCHEME of proposed bypass alignment is not Applicable.	Please refer clarification.	There is no change in Drawings and Reports
	iii. Location of Median openings, Under passes, Over passes	Median Opening is not recommended due to high speed corridor. There is no Underpass and Overpass proposal as no road and/or habitation exists. Flyover over SH-114 is a part of Viaduct, hence no additional Overpass is required.	Median Opening will be provided at cut & fill sections of >300m lengths. There are two locations (Ch 0+000 to 1+800 and Ch 16+500 to 17+500) where Median opening may be provided.	Two Median openings are provided. Volume - I Main Report will be modified. Detailed drawing will be prepared under KD 7 submission.
	iv. Location of service roads	There is no urban area along proposed bypass alignment, hence, Service Road are not required as per IRC guidelines.	Please refer clarification.	

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
	v. Location of toll plaza, parking area, weighing stations bus bays rest areas etc,	Presently, provision of One Toll Plaza, One Truck Lay bye, One Rest Area is taken into costing. The project is nonviable as per financial analysis. Provision of Will be decided in consultation with the Client.	Same provisions are kept at this stage as clarified.	
	vi. The drawing shall also include the locations of all traffic signals, signs, marking, crass barriers, Delineators and rest areas etc,	Provisions of traffic signage, road markings, barriers and delineators have been taken in estimation & costing. Standard drawing for traffic signage, road markings etc are given.	Same provisions are kept at this stage.	Detailed Traffic Signage Plan will be prepared and submitted under KD 7 submission.
	2. **Following are the observations on this report:**			
	Vol II. Design Report: Part I Traffic study, Analysis and Forecast			
	i. In 1.1.4 pavement Condition, existing PQC is 300mm and DLC is 150mm	This Para describes the pavement crust of EXISTING ROAD (NH-48) constructed recently.	Please refer clarification.	
	ii. Main Report 1.3 page no's 11 and VOL-II 1.1.2 page 16 difference in Hydel power station *These 2 are contradicting each other, the same needs to be rectified*	Noted,	Page 11 of Volume -I: Main Report has been modified.	

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
	iii. Detail pavement Design Required @ **8.PAVEMENT DESIGN**	Rigid Pavement Design has been carried out as per IRC 58 : 2015 assuming SBC & CBR.	Pavement design will be finalized based on actual bearing capacity & CBR after getting field investigations results.	
	Part II A) Proposed Tunnel design, standard i. 2.6.1 Distance between two cross passage to be rectified.	Cross Passage distances have been stated as 300m & 500m as mentioned in the IRC and European Standard respectively. However, we have considered 300m spacing as stated in the report (2.6.1 & 2.10.15) and the same is considered in BOQ	Pl refer clarification. Drawings have been updated with 300m spacing as stated in the report	
	Vol IX Drawing These drawings to be rectified			
	i. Dwg-1531 Bridge -3 plan and section to be rectified *which need correction/revision.*	Noted,	Proposed Bridge Location has been modified based on Nala crossing and Longitudinal profile.	Drawing No 1531 has been updated. Table 6.1 & 9.4 of Volume I: Main Report is updated.
	ii. Dwg-1010, Starting point of Tunne-5 RL and railway RL to be checked which need correction.	Rail Track Levels are based on Carto Sat Imaginary. These will be vetted again after topographical survey. Which is in progress now a days.	A note has been written in the drawings stating that Rail Levels will be vetted after carrying out Topographic Survey.	

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
	iii. Dwg-**1011,** Exit point of Tunne-5 RL and railway RL to be checked *which need correction.*	Rail Track Levels will be vetted after topographical survey.	- Same as above-	
	iv. Dwg-1061, section @1+000.00 how much is the height of the retaining wall.	Noted, One square shown in the drawings represents 10m x 10m .	RE Walls have been proposed and height is approx. 17m.	Dimensions are marked in the drawing
	v. Dwg-1073, section @7+900.00 how much is the height of the excavation depth @ centre of the carriage way which needs correction.	Noted,	Height of Excavation @ centre of carriage way is approx. 30m	- do -
	vi. Dwg-**1079,** section @11+600.00 how much is the height of the excavation depth @ centre of the carriage way which needs correction.	Noted,	Height of Excavation @ centre of carriage way is approx. 29m	- do -
	vii. Dwg-**1084,** section @13+500.00 how much is the height of the excavation depth @ centre of the carriage way ,both tubes to be rectified	Noted, Tunnel Lengths (left & Right) are varying as portals have been decided based on ground profile and other technical aspects.	Height of Excavation @ centre of carriage way is approx. 38m. Tunnel (T4) Left & Right ends at Ch 13+505.30 & 13+467.65 respectively.	- do -
	viii. Dwg-**1085,** Dwg-1061, section @14+700.00 how much is the height of the retaining wall. And section @14+800.00 how much is the height of the excavation depth @ centre of the carriage way	Noted, Reinforced Earth (RE) walls have been proposed.	Height of RE Wall is 19m and Excavation Depth @ centre of the carriage way is approx. 34m	- do -
	ix. Dwg-**1078,** section @11+300.00 how much is the height of the	Noted,	Height of Excavation @ centre of carriage way is	- do -

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
	excavation depth @ centre of the carriage way ,both tubes to be rectified		approx. 17m	
	x. Dwg-**1069,** section @5+900.00 Tunnel RL and railway RL to be checked *which need correction.2D Distance to be rectified.*	Rail Track Levels will be vetted after topographical survey. 2 D distance between rail & tunnel is not mandatory.	Distance between rail & tunnel will be determined based on geotechnical investigation report test results (SBC & CBR).	
	xi. Dwg-**1063, Why not propose excavation** section @2+900 *which need correction/ revision.*	Tunnel alignment T-1 (L&R) have been fixed based on design standard and parameters from design ch 2+686.59 to 5+581.47 and 2+715.56 & 5+553.19 respectively. Portals have been fixed accordingly.	As per carto sat1 generated contour plan, shallow depth is found at a small portion (50m – 100m only). Ground Levels will be vetted after detailed topographic survey. Cross sections drawings will be modified at later stage.	
	xii. Dwg-**1089,** section @16+800.00 how much is the height of the excavation depth @ centre of the carriage way which needs correction.	Noted,	Height of excavation @ centre of carriage way is 37m and 20m on Left and Right side respectively.	Dimensions have been marked in the drawing.
	xiii. Dwg-1521, Exit point of the Bridge-2 there is a railway tunnel give necessary support system.	Noted,	Detailed drawing at each portals will be prepared after validation of topographical survey.	
	xiv. Dwg-1591 please rectified existing railway RL and bottom level of the super structure of ROB.	Railway RLs are tentative. Future Track shown on R/s is	Cross Section at Railway track is corrected.	

Sl	Observations	Consultant's Clarifications	Action taken	Remarks
		incorrect.		
	Vol X Bidding Document Address of the Executive Engineer is, Office of the Executive Engineer, NH-48 Project Implementation Unit (World Bank), Shiradighat Tunnel Construction Division, Sakaleshapur-573134	Noted ,	Address will be modified in Volume X.	Volume X is updated.

-------- End of Main Document --------

16. Table of Annexures

Sl. No.	Topic	Pages
1	Annexures	11

Annexures

Km. 229.000 Km - 229.000

Optimintic.

Year	Motorised Traffic														Non - Motorised Traffic				Others (Please Specify)	Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Capacity Criteria			LOS	Recommendation based on V/C ratio
	Passengers Vehicle						Goods Vehivle						Agricultural Vehicle		Passenger		Goods						Tollable Traffic in PCU's	Capacity for divided carriageway (PCU/day)	V/C ratio		
	Car	Taxi	3 W	2 W	Mini Bus	Bus	LCV (3T)	LCV (4T)	2 Axle	3 Axle	MAV (4 to 6 Axle)	MAV (< 6 Axle)	Tractor	Tractor Trailor	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn									
	1.0	1.0	1.0	0.5	1.5	3.0	1.0	1.5	3.0	3.0	4.5	4.5	1.5	4.5	0.5	2.0	3.0	6.0	1.0								
2015	3298	468	328	1000	138	750	13	361	958	394	699	0	0	11	1	0	0	0	1	8420	7066	14859	13965	30000	0.50	B	2 lane undivided with earthen shoulders
2016	3760	534	354	1140	149	810	15	404	1044	442	783	0	0	11	1	0	0	0	1	9447	7925	16524	15532	30000	0.55	C	2 lane undivided with earthen shoulders
2017	4286	608	383	1299	161	875	17	452	1138	495	877	0	0	12	1	0	0	0	1	10604	8892	18385	17282	30000	0.61	C	2 lane undivided with earthen shoulders
2018	4886	694	413	1481	174	945	19	507	1240	554	982	0	0	12	1	0	0	0	1	11908	9981	20464	19236	30000	0.68	C	2 lane undivided with earthen shoulders
2019	5521	784	442	1674	186	1011	21	562	1339	615	1090	0	0	12	1	0	0	0	1	13260	11109	22585	21228	80000	0.28	A	4 Lane Divided
2020	6239	886	473	1891	199	1082	23	624	1446	682	1210	0	0	12	1	0	0	0	1	14771	12369	24936	23437	80000	0.31	B	4 Lane Divided
2021	7050	1001	506	2137	213	1158	26	693	1562	758	1343	0	0	13	1	0	0	0	1	16461	13777	27544	25885	80000	0.34	B	4 Lane Divided
2022	7967	1131	542	2415	227	1239	29	769	1687	841	1491	0	0	13	1	0	0	0	1	18352	15352	30439	28601	80000	0.38	B	4 Lane Divided
2023	9002	1278	580	2729	243	1326	32	854	1822	933	1655	0	0	13	1	0	0	0	1	20469	17113	33652	31615	80000	0.42	B	4 Lane Divided
2024	10083	1431	615	3056	258	1405	35	939	1950	1027	1820	0	0	13	1	0	0	0	1	22634	18913	36884	34645	80000	0.46	B	4 Lane Divided
2025	11293	1603	651	3423	273	1490	38	1033	2086	1129	2002	0	0	14	1	0	0	0	1	25038	20909	40445	37980	80000	0.51	C	4 Lane Divided
2026	12648	1795	691	3834	290	1579	42	1136	2232	1242	2202	0	0	14	1	0	0	0	1	27708	23125	44367	41653	80000	0.55	C	4 Lane Divided
2027	14165	2011	732	4294	307	1674	47	1250	2388	1366	2422	0	0	14	1	0	0	0	1	30674	25585	48690	45699	80000	0.61	C	4 Lane Divided
2028	15865	2252	776	4809	326	1774	51	1375	2556	1503	2665	0	0	14	1	0	0	0	1	33969	28316	53457	50158	80000	0.67	C	4 Lane Divided
2029	17610	2500	815	5338	342	1863	56	1499	2709	1638	2904	0	0	15	1	0	0	0	1	37292	31066	58180	54572	120000	0.48	B	6 Lane Divided
2030	19548	2775	855	5925	359	1956	61	1634	2872	1786	3166	0	0	15	1	0	0	0	1	40954	34095	63347	59398	120000	0.53	C	6 Lane Divided
2031	21698	3080	898	6577	377	2054	66	1781	3044	1947	3451	0	0	15	1	0	0	0	1	44990	37431	69000	64676	120000	0.58	C	6 Lane Divided
2032	24085	3419	943	7300	396	2157	72	1941	3226	2122	3761	0	0	16	1	0	0	0	1	49441	41106	75188	70449	120000	0.63	C	6 Lane Divided
2033	26734	3795	990	8104	416	2264	79	2116	3420	2313	4100	0	0	16	1	0	0	0	1	54349	45157	81962	76767	120000	0.68	C	6 Lane Divided
2034	29407	4174	1030	8914	432	2355	85	2285	3591	2498	4428	0	0	16	1	0	0	0	1	59219	49171	88562	82914	160000	0.55	C	8 Lane Divided
2035	32348	4592	1071	9805	450	2449	92	2468	3771	2698	4782	0	0	17	1	0	0	0	1	64545	53557	95730	89587	160000	0.60	C	8 Lane Divided
2036	35583	5051	1114	10786	468	2547	99	2665	3959	2913	5165	0	0	17	2	0	0	0	2	70370	58351	103518	96833	160000	0.65	C	8 Lane Divided
2037	39141	5556	1158	11864	486	2649	107	2878	4157	3146	5578	0	0	17	2	0	0	0	2	76743	63592	111980	104702	160000	0.70	C	8 Lane Divided
2038	43055	6112	1205	13051	506	2755	116	3109	4365	3398	6024	0	0	18	2	0	0	0	2	83716	69323	121179	113251				
2039	47361	6723	1253	14356	526	2865	125	3357	4583	3670	6506	0	0	18	2	0	0	0	2	91347	75591	131180	122541				
2040	52097	7395	1303	15791	547	2980	135	3626	4812	3964	7026	0	0	18	2	0	0	0	2	99698	82447	142057	132638				
2041	57307	8135	1355	17371	569	3099	146	3916	5053	4281	7589	0	0	19	2	0	0	0	2	108841	89947	153888	143615				
2042	63037	8948	1409	19108	592	3223	158	4229	5306	4623	8196	0	0	19	2	0	0	0	2	118851	98154	166762	155552				
2043	69341	9843	1466	21018	615	3352	170	4567	5571	4993	8851	0	0	19	2	0	0	0	2	129811	107134	180772	168536				
2044	76275	###	1524	23120	640	3486	184	4933	5849	5392	9559	0	0	20	2	0	0	0	2	141814	116962	196023	182662				
2045	83902	###	1585	25432	666	3625	199	5328	6142	5824	10324	0	0	20	2	0	0	0	2	154961	127721	212628	198034				

Km-261.450 Optimistic

Km 261.450

Year	Motorised Traffic														Non - Motorised Traffic				Others (Please Specify)	Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Capacity Criteria				
	Passengers Vehicle						Goods Vehivle						Agricultural Vehicle		Passenger		Goods						Tollable Traffic in PCU's	Capacity for divided carriageway (PCUs/day)	V/C ratio	LOS	Recommendation based on V/C ratio
	Car	Taxi	3 W	2 W	Mini Bus	Bus	LCV (3T)	LCV (4T)	2 Axle	3 Axle	MAV (4 to 6 Axle)	MAV (< 6 Axle)	Tractor	Tractor Trailor	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn									
	1.0	1.0	1.0	0.5	1.5	3.0	1.0	1.5	3.0	3.0	4.5	4.5	1.5	4.5	0.5	2.0	3.0	6.0	1.0								
2015	3239	464	21	329	158	683	7	250	869	307	661	0	0	0	0	0	0	0	3	6993	6632	13066	12870	30000	0.44	B	2 lane undivided with earthen shoulders
2016	3693	529	23	375	171	737	8	280	947	344	741	0	0	0	0	0	0	0	3	7852	7443	14541	14319	30000	0.48	B	2 lane undivided with earthen shoulders
2017	4210	603	25	428	184	796	9	314	1033	386	830	0	0	0	0	0	0	0	3	8821	8355	16189	15937	30000	0.54	C	2 lane undivided with earthen shoulders
2018	4799	688	27	488	199	860	10	351	1126	432	929	0	0	0	0	0	0	0	3	9912	9384	18031	17747	30000	0.60	C	2 lane undivided with earthen shoulders
2019	5423	777	29	551	213	920	12	390	1216	479	1031	0	0	0	0	0	0	0	3	11045	10450	19911	19592	30000	0.66	C	2 lane undivided with earthen shoulders
2020	6128	878	31	623	228	985	13	433	1313	532	1145	0	0	0	0	0	0	0	3	12312	11642	21997	21639	80000	0.27	A	4 Lane Divided
2021	6925	992	33	704	244	1053	14	481	1418	591	1271	0	0	0	0	0	0	0	3	13729	12975	24311	23909	80000	0.30	B	4 Lane Divided
2022	7825	1122	35	796	261	1127	16	534	1531	656	1411	0	0	0	0	0	0	0	3	15316	14466	26881	26429	80000	0.34	B	4 Lane Divided
2023	8842	1267	37	899	279	1206	18	592	1654	728	1566	0	0	0	0	0	0	0	4	17092	16134	29734	29226	80000	0.37	B	4 Lane Divided
2024	9903	1419	40	1007	296	1278	19	651	1770	801	1722	0	0	0	0	0	0	0	4	18910	17841	32607	32041	80000	0.41	B	4 Lane Divided
2025	11092	1590	42	1128	314	1355	21	717	1894	881	1895	0	0	0	0	0	0	0	4	20930	19735	35772	35141	80000	0.45	B	4 Lane Divided
2026	12423	1780	45	1263	332	1436	23	788	2026	969	2084	0	0	0	0	0	0	0	4	23174	21839	39260	38556	80000	0.49	B	4 Lane Divided
2027	13913	1994	47	1415	352	1523	26	867	2168	1065	2293	0	0	0	0	0	0	0	4	25667	24175	43106	42322	80000	0.54	C	4 Lane Divided
2028	15583	2233	50	1584	373	1614	28	954	2320	1172	2522	0	0	0	0	0	0	0	4	28438	26771	47347	46473	80000	0.59	C	4 Lane Divided
2029	17297	2479	53	1759	392	1695	31	1040	2459	1278	2749	0	0	0	0	0	0	0	4	31234	29388	51554	50587	80000	0.64	C	4 Lane Divided
2030	19200	2752	55	1952	412	1779	34	1133	2606	1392	2996	0	0	0	0	0	0	0	4	34316	32271	56156	55087	120000	0.47	B	6 Lane Divided
2031	21312	3055	58	2167	432	1868	37	1235	2763	1518	3266	0	0	0	0	0	0	0	4	37714	35448	61193	60011	120000	0.51	C	6 Lane Divided
2032	23656	3391	61	2405	454	1962	40	1346	2929	1654	3560	0	0	0	0	0	0	0	4	41462	38951	66708	65401	120000	0.56	C	6 Lane Divided
2033	26258	3763	64	2670	477	2060	44	1468	3104	1803	3880	0	0	0	0	0	0	0	4	45595	42813	72748	71301	120000	0.61	C	6 Lane Divided
2034	28884	4140	67	2937	496	2142	47	1585	3260	1948	4191	0	0	0	0	0	0	0	4	49699	46644	78637	77051	120000	0.66	C	6 Lane Divided
2035	31772	4554	69	3230	515	2228	51	1712	3423	2103	4526	0	0	0	0	0	0	0	4	54188	50833	85035	83295	160000	0.53	C	8 Lane Divided
2036	34949	5009	72	3554	536	2317	55	1849	3594	2272	4888	0	0	0	0	0	0	0	5	59099	55414	91987	90079	160000	0.57	C	8 Lane Divided
2037	38444	5510	75	3909	558	2410	59	1997	3773	2453	5279	0	0	0	0	0	0	0	5	64472	60424	99544	97451	160000	0.62	C	8 Lane Divided
2038	42289	6061	78	4300	580	2506	64	2156	3962	2650	5701	0	0	0	0	0	0	0	5	70351	65905	107760	105463	160000	0.67	C	8 Lane Divided
2039	46518	6667	81	4730	603	2607	69	2329	4160	2862	6157	0	0	0	0	0	0	0	5	76787	71902	116695	114175				
2040	51169	7334	84	5203	627	2711	75	2515	4368	3091	6650	0	0	0	0	0	0	0	5	83831	78465	126415	123650				
2041	56286	8067	88	5723	652	2819	81	2716	4586	3338	7182	0	0	0	0	0	0	0	5	91544	85648	136990	133956				
2042	61915	8874	91	6295	678	2932	87	2934	4816	3605	7757	0	0	0	0	0	0	0	5	99988	93510	148500	145169				
2043	68106	9762	95	6925	705	3049	94	3168	5057	3893	8377	0	0	0	0	0	0	0	5	109236	102118	161029	157372				
2044	74917	###	98	7617	734	3171	101	3422	5309	4205	9047	0	0	0	0	0	0	0	5	119365	111543	174670	170656				
2045	82409	###	102	8379	763	3298	110	3695	5575	4541	9771	0	0	0	0	0	0	0	5	130460	121864	189526	185119				

Km - 229,000
Most like Senario

Year	Motorised Traffic														Non - Motorised Traffic				Others (Please Specify)	Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Capacity Criteria			LOS	Recommendation based on V/C ratio
	Passengers Vehicle						Goods Vehivle						Agricultural Vehicle		Passenger		Goods						Tollable Traffic in PCU's	Capacity for divided carriageway (PCUs/day)	V/C ratio		
	Car	Taxi	3 W	2 W	Mini Bus	Bus	LCV (3T)	LCV (4T)	2 Axle	3 Axle	MAV (4 to 6 Axle)	MAV (< 6 Axle)	Tractor	Tractor Trailor	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn									
	1.0	1.0	1.0	0.5	1.5	3.0	1.0	1.5	3.0	3.0	4.5	4.5	1.5	4.5	0.5	2.0	3.0	6.0	1.0								
2015	3298	468	328	1000	138	750	13	361	958	394	699	0	0	11	1	0	0	0	1	8420	7066	14859	13965	30000	0.50	B	2 lane undivided with earthen shoulders
2016	3694	524	345	1110	146	795	15	400	1034	438	776	0	0	11	1	0	0	0	1	9290	7807	16297	15330	30000	0.54	C	2 lane undivided with earthen shoulders
2017	4137	587	362	1232	155	843	17	444	1117	486	861	0	0	12	1	0	0	0	1	10254	8630	17884	16835	30000	0.60	C	2 lane undivided with earthen shoulders
2018	4633	658	380	1367	164	894	18	493	1206	539	956	0	0	12	1	0	0	0	1	11323	9544	19633	18496	30000	0.65	C	2 lane undivided with earthen shoulders
2019	5143	730	395	1504	172	938	20	543	1291	593	1051	0	0	12	1	0	0	0	1	12395	10462	21367	20143	80000	0.27	A	4 Lane Divided
2020	5709	810	411	1654	181	985	22	597	1381	652	1157	0	0	12	1	0	0	0	1	13574	11472	23264	21947	80000	0.29	A	4 Lane Divided
2021	6337	900	427	1820	190	1035	24	656	1478	718	1272	0	0	13	1	0	0	0	1	14871	12585	25341	23921	80000	0.32	B	4 Lane Divided
2022	7034	998	444	2002	199	1086	27	722	1581	789	1399	0	0	13	1	0	0	0	1	16299	13810	27615	26083	80000	0.35	B	4 Lane Divided
2023	7808	1108	462	2202	209	1141	30	794	1692	868	1539	0	0	13	1	0	0	0	1	17869	15160	30105	28451	80000	0.38	B	4 Lane Divided
2024	8588	1219	476	2400	218	1186	32	866	1793	946	1678	0	0	13	1	0	0	0	1	19419	16495	32532	30762	80000	0.41	B	4 Lane Divided
2025	9447	1341	490	2616	226	1234	35	944	1901	1032	1829	0	0	14	1	0	0	0	1	21112	17954	35170	33273	80000	0.44	B	4 Lane Divided
2026	10392	1475	505	2851	236	1283	38	1029	2015	1125	1993	0	0	14	1	0	0	0	1	22959	19548	38036	36002	80000	0.48	B	4 Lane Divided
2027	11431	1623	520	3108	245	1334	42	1121	2136	1226	2173	0	0	14	1	0	0	0	1	24976	21289	41152	38970	80000	0.51	C	4 Lane Divided
2028	12574	1785	536	3388	255	1388	46	1222	2264	1336	2368	0	0	14	1	0	0	0	1	27179	23193	44539	42197	80000	0.56	C	4 Lane Divided
2029	13706	1946	547	3659	262	1429	49	1320	2377	1443	2558	0	0	15	1	0	0	0	1	29314	25042	47779	45285	80000	0.60	C	4 Lane Divided
2030	14939	2121	557	3952	270	1472	53	1426	2496	1558	2763	0	0	15	1	0	0	0	1	31625	27046	51273	48616	80000	0.64	C	4 Lane Divided
2031	16284	2312	569	4268	278	1516	57	1540	2621	1683	2984	0	0	15	1	0	0	0	1	34130	29218	55042	52210	80000	0.69	C	4 Lane Divided
2032	17750	2520	580	4609	287	1562	62	1663	2752	1818	3222	0	0	16	1	0	0	0	1	36842	31573	59108	56089	120000	0.49	B	6 Lane Divided
2033	19347	2746	592	4978	295	1609	67	1796	2890	1963	3480	0	0	16	1	0	0	0	1	39782	34126	63497	60275	120000	0.53	C	6 Lane Divided
2034	20895	2966	603	5326	301	1641	72	1922	3005	2101	3724	0	0	16	1	0	0	0	1	42575	36554	67606	64192	120000	0.56	C	6 Lane Divided
2035	22566	3203	615	5699	307	1674	77	2056	3125	2248	3984	0	0	17	1	0	0	0	1	45575	39164	72004	68385	120000	0.60	C	6 Lane Divided
2036	24372	3460	628	6098	313	1707	82	2200	3250	2405	4263	0	0	17	2	0	0	0	2	48799	41971	76711	72874	120000	0.64	C	6 Lane Divided
2037	26321	3736	640	6525	320	1741	88	2354	3381	2573	4562	0	0	17	2	0	0	0	2	52262	44988	81752	77681	120000	0.68	C	6 Lane Divided
2038	28427	4035	653	6982	326	1776	94	2519	3516	2753	4881	0	0	18	2	0	0	0	2	55983	48234	87150	82830	160000	0.54	C	8 Lane Divided
2039	30701	4358	666	7470	333	1812	100	2695	3656	2946	5223	0	0	18	2	0	0	0	2	59982	51724	92931	88346	160000	0.58	C	8 Lane Divided
2040	33158	4707	680	7993	339	1848	107	2884	3803	3152	5588	0	0	18	2	0	0	0	2	64280	55478	99123	94255	160000	0.62	C	8 Lane Divided
2041	35810	5083	693	8553	346	1885	115	3086	3955	3373	5979	0	0	19	2	0	0	0	2	68900	59517	105758	100586	160000	0.66	C	8 Lane Divided
2042	38675	5490	707	9152	353	1923	123	3302	4113	3609	6398	0	0	19	2	0	0	0	2	73866	63862	112866	107372				
2043	41769	5929	721	9792	360	1961	132	3533	4277	3862	6846	0	0	19	2	0	0	0	2	79205	68537	120483	114644				
2044	45110	6404	736	10478	367	2000	141	3780	4449	4132	7325	0	0	20	2	0	0	0	2	84945	73567	128647	122440				
2045	48719	6916	750	11211	375	2040	151	4044	4626	4421	7838	0	0	20	2	0	0	0	2	91116	78980	137399	130798				

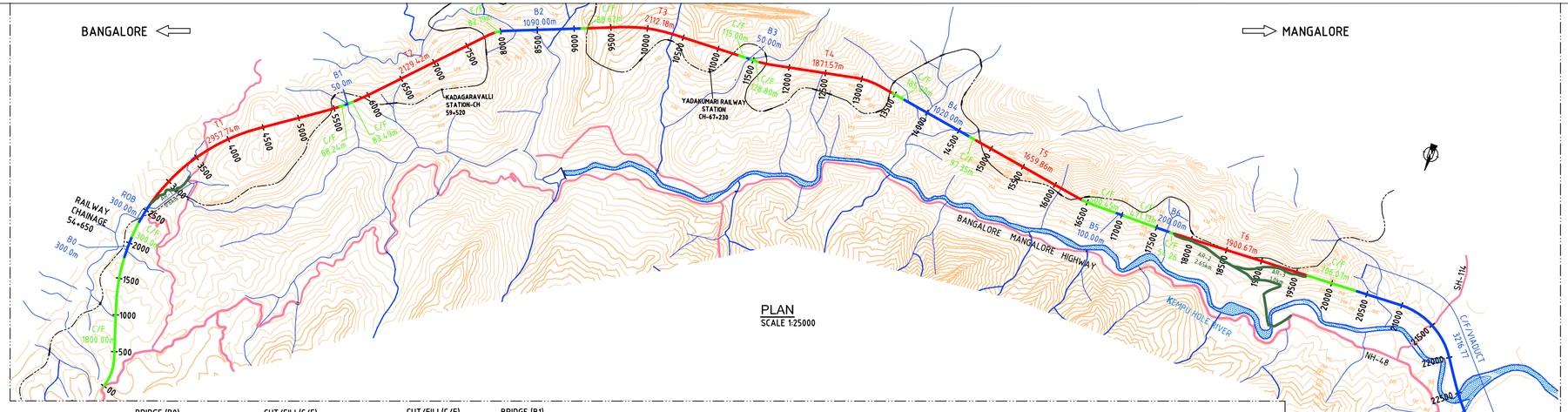
Km. 261.450

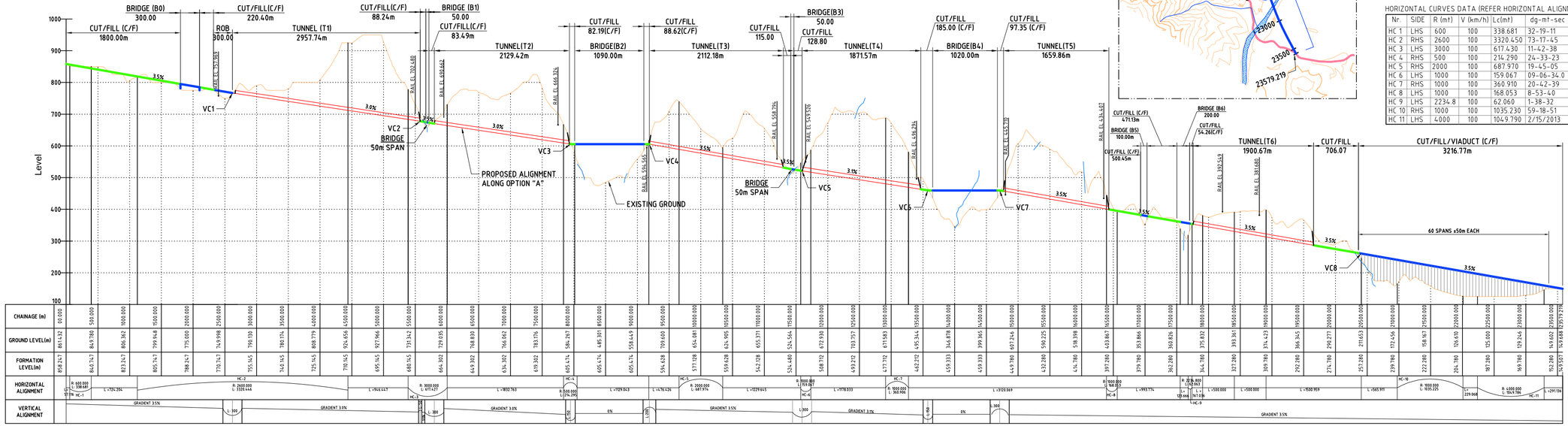
Km 261.450

Most like Scenario

Year	Motorised Traffic														Non - Motorised Traffic				Others (Please Specify)	Total Traffic volume in numbers	Total tollable traffic volume in numbers	Total Traffic In PCU's	Capacity Criteria				
	Passengers Vehicle						Goods Vehivle						Agricultural Vehicle		Passenger		Goods						Tollable Traffic in PCU's	Capacity for divided carriageway (PCUs/day)	V/C ratio	LOS	Recommendation based on V/C ratio
	Car	Taxi	3 W	2 W	Mini Bus	Bus	LCV (3T)	LCV (4T)	2 Axle	3 Axle	MAV (4 to 6 Axle)	MAV (< 6 Axle)	Tractor	Tractor Trailor	Cycle	Cycle Rickshaw	Hand Cart	Animal Drawn									
	1.0	1.0	1.0	0.5	1.5	3.0	1.0	1.5	3.0	3.0	4.5	4.5	1.5	4.5	0.5	2.0	3.0	6.0	1.0								
2015	3239	464	21	329	158	683	7	250	869	307	661	0	0	0	0	0	0	0	3	6993	6632	13066	12870	30000	0.44	B	2 lane undivided with earthen shoulders
2016	3628	520	22	366	167	724	8	278	939	341	734	0	0	0	0	0	0	0	3	7730	7331	14347	14130	30000	0.48	B	2 lane undivided with earthen shoulders
2017	4063	582	23	406	177	767	9	308	1014	379	815	0	0	0	0	0	0	0	3	8547	8106	15759	15520	30000	0.53	C	2 lane undivided with earthen shoulders
2018	4551	652	25	450	188	813	10	342	1095	420	905	0	0	0	0	0	0	0	3	9455	8966	17318	17054	30000	0.58	C	2 lane undivided with earthen shoulders
2019	5052	724	26	495	198	854	11	376	1172	462	995	0	0	0	0	0	0	0	3	10368	9832	18865	18577	30000	0.63	C	2 lane undivided with earthen shoulders
2020	5607	804	27	545	207	896	12	414	1254	509	1095	0	0	0	0	0	0	0	3	11373	10786	20559	20245	30000	0.69	C	2 lane undivided with earthen shoulders
2021	6224	892	28	600	218	941	14	455	1341	560	1204	0	0	0	0	0	0	0	3	12479	11835	22415	22070	80000	0.28	A	4 Lane Divided
2022	6909	990	29	659	229	988	15	501	1435	616	1324	0	0	0	0	0	0	0	3	13698	12992	24447	24070	80000	0.31	B	4 Lane Divided
2023	7669	1099	30	725	240	1038	16	551	1536	677	1457	0	0	0	0	0	0	0	4	15041	14266	26674	26262	80000	0.33	B	4 Lane Divided
2024	8435	1209	31	791	250	1079	18	601	1628	738	1588	0	0	0	0	0	0	0	4	16371	15528	28849	28401	80000	0.36	B	4 Lane Divided
2025	9279	1330	32	862	260	1122	19	655	1726	804	1731	0	0	0	0	0	0	0	4	17823	16907	31212	30726	80000	0.39	B	4 Lane Divided
2026	10207	1463	33	939	270	1167	21	714	1829	877	1887	0	0	0	0	0	0	0	4	19410	18413	33782	33255	80000	0.42	B	4 Lane Divided
2027	11228	1609	34	1024	281	1214	23	778	1939	956	2057	0	0	0	0	0	0	0	4	21145	20060	36577	36004	80000	0.46	B	4 Lane Divided
2028	12350	1770	35	1116	292	1262	25	848	2055	1042	2242	0	0	0	0	0	0	0	4	23041	21861	39617	38996	80000	0.50	B	4 Lane Divided
2029	13462	1929	35	1205	301	1300	27	916	2158	1125	2421	0	0	0	0	0	0	0	4	24884	23612	42529	41860	80000	0.53	C	4 Lane Divided
2030	14674	2103	36	1302	310	1339	29	989	2266	1215	2615	0	0	0	0	0	0	0	4	26881	25510	45671	44951	80000	0.57	C	4 Lane Divided
2031	15994	2292	37	1406	319	1380	32	1068	2379	1312	2824	0	0	0	0	0	0	0	4	29047	27568	49062	48287	80000	0.61	C	4 Lane Divided
2032	17434	2499	37	1519	329	1421	34	1153	2498	1417	3050	0	0	0	0	0	0	0	4	31395	29800	52723	51888	80000	0.66	C	4 Lane Divided
2033	19003	2724	38	1640	339	1464	37	1246	2623	1531	3294	0	0	0	0	0	0	0	4	33941	32221	56675	55775	120000	0.47	B	6 Lane Divided
2034	20523	2941	39	1755	345	1493	40	1333	2728	1638	3524	0	0	0	0	0	0	0	4	36363	34525	60376	59416	120000	0.50	C	6 Lane Divided
2035	22165	3177	40	1878	352	1523	42	1426	2837	1752	3771	0	0	0	0	0	0	0	4	38967	37003	64340	63314	120000	0.54	C	6 Lane Divided
2036	23938	3431	41	2009	359	1553	45	1526	2950	1875	4035	0	0	0	0	0	0	0	5	41767	39668	68585	67490	120000	0.57	C	6 Lane Divided
2037	25853	3705	41	2150	367	1584	48	1633	3068	2006	4317	0	0	0	0	0	0	0	5	44778	42534	73132	71962	120000	0.61	C	6 Lane Divided
2038	27921	4002	42	2300	374	1616	52	1747	3191	2147	4619	0	0	0	0	0	0	0	5	48016	45617	78003	76754	120000	0.65	C	6 Lane Divided
2039	30155	4322	43	2461	381	1648	55	1869	3319	2297	4943	0	0	0	0	0	0	0	5	51499	48935	83222	81888	120000	0.69	C	6 Lane Divided
2040	32567	4668	44	2634	389	1681	59	2000	3452	2458	5289	0	0	0	0	0	0	0	5	55245	52504	88816	87391	160000	0.56	C	8 Lane Divided
2041	35173	5041	45	2818	397	1715	63	2140	3590	2630	5659	0	0	0	0	0	0	0	5	59275	56344	94811	93288	160000	0.59	C	8 Lane Divided
2042	37986	5445	46	3015	405	1749	68	2290	3733	2814	6055	0	0	0	0	0	0	0	5	63611	60477	101237	99611	160000	0.63	C	8 Lane Divided
2043	41025	5880	47	3226	413	1784	73	2450	3883	3011	6479	0	0	0	0	0	0	0	5	68276	64925	108127	106389	160000	0.68	C	8 Lane Divided
2044	44307	6350	48	3452	421	1820	78	2622	4038	3222	6933	0	0	0	0	0	0	0	5	73295	69713	115514	113657				
2045	47852	6859	48	3694	429	1856	83	2805	4199	3447	7418	0	0	0	0	0	0	0	5	78697	74866	123436	121452				

Original Drawing Size 1200x600mm





CONSTRUCTION TYPE DETAILS

S Nr.	CONSTRUCTION TYPE	CHAINAGE (m) FROM	CHAINAGE (m) TO	LENGTH 'Ls' (m)
1	CUT/FILL (C/F)	0.00	1800.00	1800.00
2	BRIDGE (B0)	1800.00	2100.00	300.00
3	CUT/FILL (C/F)	2100.00	2320.40	220.40
4	ROB	2320.40	2620.40	300.00
5	TUNNEL (T1)	2620.40	5578.14	2957.74
6	CUT/FILL (C/F)	5578.14	5666.38	88.24
7	BRIDGE (B1)	5666.38	5716.38	50.00
8	CUT/FILL (C/F)	5716.38	5799.87	83.49
9	TUNNEL (T2)	5799.87	7929.29	2129.42
10	CUT/FILL (C/F)	7929.29	8011.48	82.19
11	BRIDGE (B2)	8011.48	9101.48	1090.00
12	CUT/FILL (C/F)	9101.48	9190.10	88.62
13	TUNNEL (T3)	9190.10	11302.28	2112.18
14	CUT/FILL (C/F)	11302.28	11417.28	115.00
15	BRIDGE (B3)	11417.28	11467.28	50.00
16	CUT/FILL (C/F)	11467.28	11596.08	128.80
17	TUNNEL (T4)	11596.08	13467.65	1871.57
18	CUT/FILL (C/F)	13467.65	13652.65	185.00
19	BRIDGE (B4)	13652.65	14672.65	1020.00
20	CUT/FILL (C/F)	14672.65	14770.00	97.35
21	TUNNEL (T5)	14770.00	16429.86	1659.86
22	CUT/FILL (C/F)	16429.86	16930.31	500.45
23	BRIDGE (B5)	16930.31	17030.31	100.00
24	CUT/FILL (C/F)	17030.31	17501.44	471.13
25	BRIDGE (B6)	17501.44	17701.44	200.00
26	CUT/FILL (C/F)	17701.44	17755.70	54.26
27	TUNNEL (T6)	17755.70	19656.37	1900.67
28	CUT/FILL (C/F)	19656.37	20362.44	706.07
29	C/F/VIADUCT	20362.44	23579.21	3216.77

VERTICAL CURVES DATA (REFER VERTICAL ALIGNMENT TABLE)

Nr.	TYPE OF CURVE	CHAINAGE (mt) FROM	CHAINAGE (mt) TO	LENGTH OF CURVE (MT)	VALUE OF K	PVI CH & RL PVI NO.	PVI CH & RL CHAINAGE	PVI CH & RL RL	VALUE OF A	DESIGN SPEED (KM)
VC 1	SUMMIT	14560	14860	300	85.714	1	14710	459.333	3.5	100
VC 2	VALLEY	13503	13653	150	48.387	2	13578	459.805	3.1	100
VC 3	VALLEY	11446	11746	300	45.455	3	11596	521.117	6.6	100
VC 4	SUMMIT	9090	9290	200	57.143	4	9190	605.474	3.5	100
VC 5	VALLEY	7871	8021	150	50	5	7946	605.474	3	100
VC 6	VALLEY	5650	5950	300	46.154	6	5800	670.305	6.5	100
VC 7	SUMMIT	5553	5603	50	100.000	7	5578	677.8	0.5	100
VC 8	VALLEY	2470	2770	300	46.154	8	2620	766.533	6.5	100

HORIZONTAL CURVES DATA (REFER HORIZONTAL ALIGNMENT TABLE)

Nr.	SIDE	R (mt)	V (km/h)	Lc(mt)	dg-mt-sec	Ls(mt)	e(%)	
HC 1	LHS	600	100	338.681	32-19-11	80	5.000	5.000
HC 2	RHS	2600	100	3320.450	73-17-45	NR	1.709	2.500
HC 3	LHS	3000	100	617.430	11-42-38	NR	2.500	1.481
HC 4	RHS	500	100	214.290	24-33-23	95	5.000	5.000
HC 5	RHS	2000	100	687.970	19-45-05	NR	2.222	2.500
HC 6	LHS	1000	100	159.067	09-06-34.0	50	4.444	4.444
HC 7	RHS	1000	100	360.910	20-42-39	50	4.444	4.444
HC 8	LHS	1000	100	168.053	8-53-40	50	4.444	4.444
HC 9	LHS	2234.8	100	62.060	1-38-32	NR	2.500	1.989
HC 10	RHS	1000	100	1035.230	59-18-51	50	4.444	4.444
HC 11	LHS	4000	100	1049.790	2/15/2013	NR	2.500	1.111

NOTES:-

1. ALL DIMENSIONS AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSIONS TO BE MEASURED FROM DRAWING. WRITTEN DIMENSIONS TO BE FOLLOWED.
3. ALIGNMENT DESIGN AND STRUCTURES, RAIL INTERFERENCES SHOWN IN THE DRAWING ARE BASED ON PRELIMINARY DATA ONLY AND MAY CHANGE AFTER GETTING DETAILED SURVEY DONE.
4. THIS DRAWING SHALL BE READ ALONG WITH RELATED REFERENCE DRAWINGS.

LONGITUDINAL SECTION
SCALE HOR. 1:25000, VERT. 1:5000

SCALE 1 : 5000 (VERTICAL)
100m 0 100m 500m

SCALE 1 : 25000 (HORIZONTAL)
1000m 0 1000m 2000m 2500m

PRELIMINARY

REFERENCE DRAWINGS:
SHGA-FS-LAY-1001 TO 1016 (16 SHEETS)
SHGA-FS-LAY-1061 TO 1098 (38 SHEETS)

LEGEND:
- EXISTING ROAD
- RIVER
- NALA
- RAILWAY LINE
- CUT/FILL (C/F)
- BRIDGES (B)
- TUNNELS (T)
- ACCESS ROAD

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
F	DEC 2015	BRIDGE 'B3' LOCATION MODIFIED AND RELATED MODIFICATIONS (KD-6)	PRa	RMe	AKg
E	DEC 2015	ALIGNMENT IMPROVEMENT AND RELATED MODIFICATIONS	PRa/RMe	RMe	AKg
D	SEP 2015	ALIGNMENT IMPROVEMENT AND RELATED MODIFICATIONS	PRa/RMe	RMe	AKg
C	AUG 2015	ROW AND OTHER DETAILS ADDED AND DRAWING RESUBMITTED	PRa	RMe	AKg
B	AUG 2015	MINOR MODIFICATIONS AND RESUBMISSION	PRa	RMe	AKg
A	JULY 2015	FIRST DRAFT (INCEPTION STAGE)	PRa/ABa	RMe	AKg

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	22.07.15	22.07.15	22.07.15	22.07.15	22.07.15
Name	PRa/RMe	RMe	ADh/RMe	AKg	AKg
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

W:\GEOCONSULT_PRa_K\1600 Projects\1650-Shiradi Ghat\CURRENT\KD-6\SHGA-FS-LAY_1000_F.dwg, 2015-12-18

DESIGN CONSULTANTS :
GEOCONSULT India Pvt. Ltd.
Plot No, 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE
CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

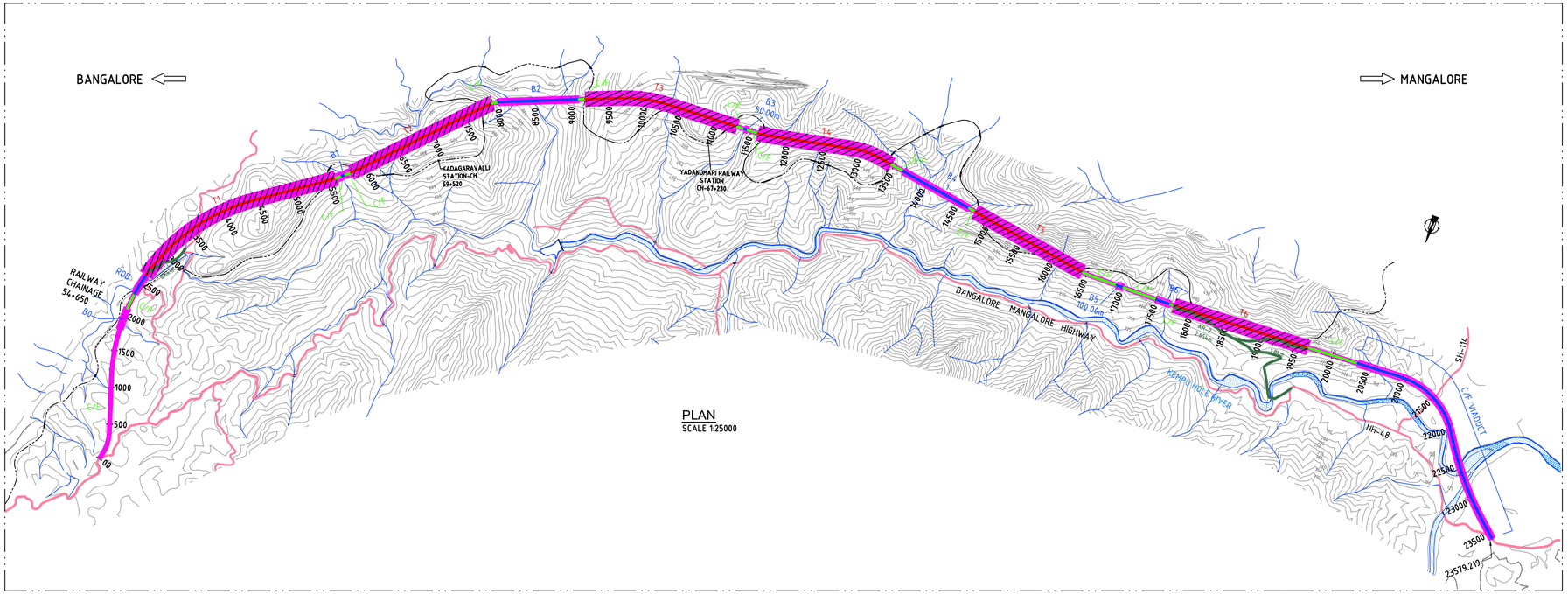
CLIENT
GOVERNMENT OF KARNATAKA

DRAWING TITLE
ALIGNMENT OPTION "A"
PLAN AND PROFILE
CHAINAGE 0+000 TO 23+579.22Km

DRAWING NUMBER
SHGA-FS-LAY-1000
REV F

SCALE AS SHOWN
MONTH (Earliest Issue) DEC 2015

Original Drawing Size 1200x600mm



TOTAL LAND ACQUISITION AREA = 344.64 Hectares	
TEMPORARY LAND AQUISITION AREA =252.58 Hectares (TUNNELS)	
PERMANENT LAND AQUISITION AREA (344.64-252.58)= 92.06 Hectare	
LAND AQUISITION - BRIDGES	= 68 Hectare
LAND AQUISITION - CUT/FILL (92.06-68)	= 24.06 Hectare
CONSTRUCTION ROADS AND APPROACH	= 5 Hectares

NOTES:-

1. ALL DIMENSIONS ARE SHOWN IN mm AND LEVELS ARE SHOWN IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSIONS TO BE MEASURED FROM DRAWING. WRITTEN DIMENSIONS TO BE FOLLOWED.
3. LAND AREA SHOWN IS BASED ON PRELIMINARY ALIGNMENT DESIGN AND MAY CHANGE IF ANY MODIFICATION IS DONE IN THE ALIGNMENT AT A LATER STAGE.

SCALE 1 : 25000 (HORIZONTAL)

1000m 0 1000m 2000m 2500m

PRELIMINARY

REFERENCE DRAWINGS:

SHGA-FS-LAY-1000

LEGEND:

- EXISTING ROAD
- RIVER
- NALA
- RAILWAY LINE
- CUT/FILL (C/F)
- BRIDGES (B)
- TUNNELS (T)
- ACCESS ROAD

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
B	DEC 2015	SECOND DRAFT (KD-6)	RMe	RMe	AKg
A	DEC 2015	FIRST DRAFT (KD-5)	RMe	RMe	AKg

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	DEC 15	DEC 15	DEC 15	DEC 15	22.07.15
Name	RMe	RMe	AKg	AKg	AKg
	Drawn	Draffting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :

GEOCONSULT India Pvt. Ltd.
Plot No, 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE

CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

CLIENT

GOVERNMENT OF KARNATAKA

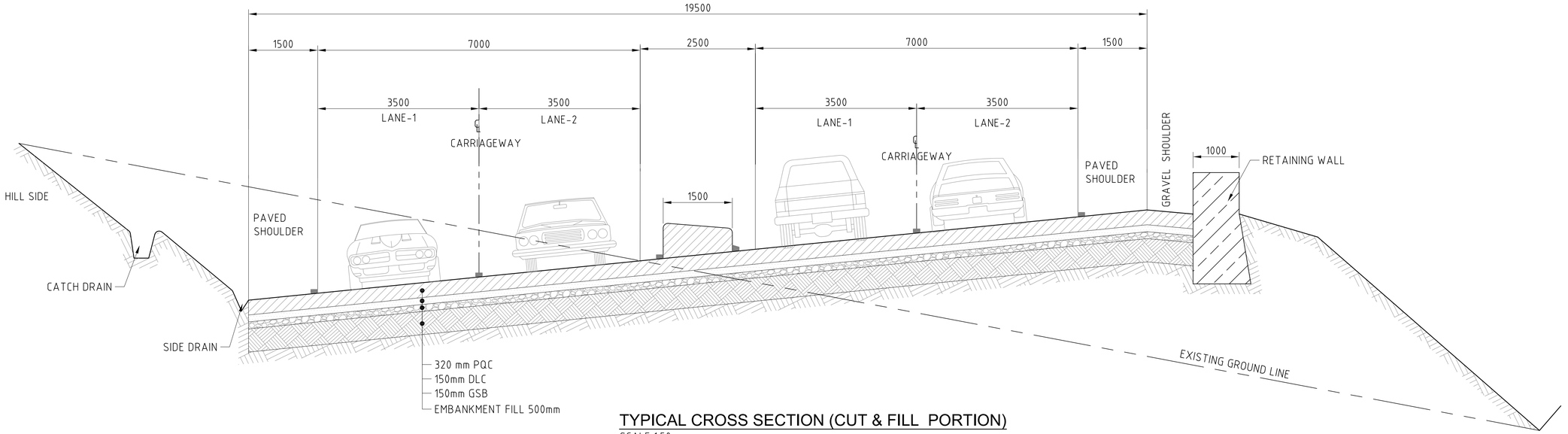
DRAWING TITLE

ALIGNMENT OPTION "A"
LAND AQUISITION AREA
PLAN

DRAWING NUMBER: SHGA-FS-LAQ-2011 | REV: B

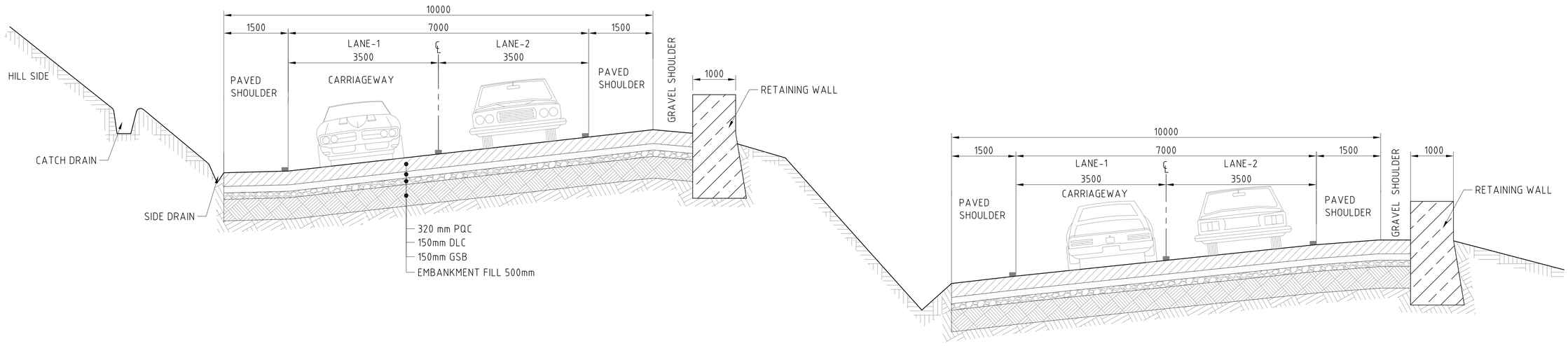
SCALE: AS SHOWN | MONTH (Earliest Issue): DEC 2015

Original Drawing Size A1



TYPICAL CROSS SECTION (CUT & FILL PORTION)

SCALE 1:50



TYPICAL CROSS SECTION ON HILLY TERRAIN

SCALE 1:50

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.

SCALE 1 : 50

1m 0 1m 5m

PRELIMINARY

REFERENCE DRAWINGS:

SHGA-FS-LAY-1001 TO 1016 (16 SHEETS)

SHGA-FS-LAY-1061 TO 1098 (38 SHEETS)

LEGEND:

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
E	DEC 2015	RESUBMITTED (KD-6)	ABa	RMe	FKr
D	DEC 2015	PQC REVISED TO 320 mm	ABa	RMe	FKr
C	SEP 2015	RESUBMITTED (KD-4)	ABa	RMe	FKr
B	AUG 2015	RESUBMITTED (KD-3)	ABa	RMe	FKr
A	JULY 2015	FIRST DRAFT (INCEPTION STAGE)	ABa	RMe	FKr

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	22.07.2015	22.07.2015	22.07.2015	22.07.2015	22.07.2015
Name	ABa	RMe	AKg	BRs	AKg
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :

GEOCONSULT India Pvt. Ltd.
Plot No. 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE

CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

G:\GEOCONSULT\ PRs\ R:\16000 Projects\16066-Shiradi Ghat\CURRENT\KD-6\SHGA-FS-GEN-011_E.dwg, 2015-12-18

CLIENT

GOVERNMENT OF KARNATAKA

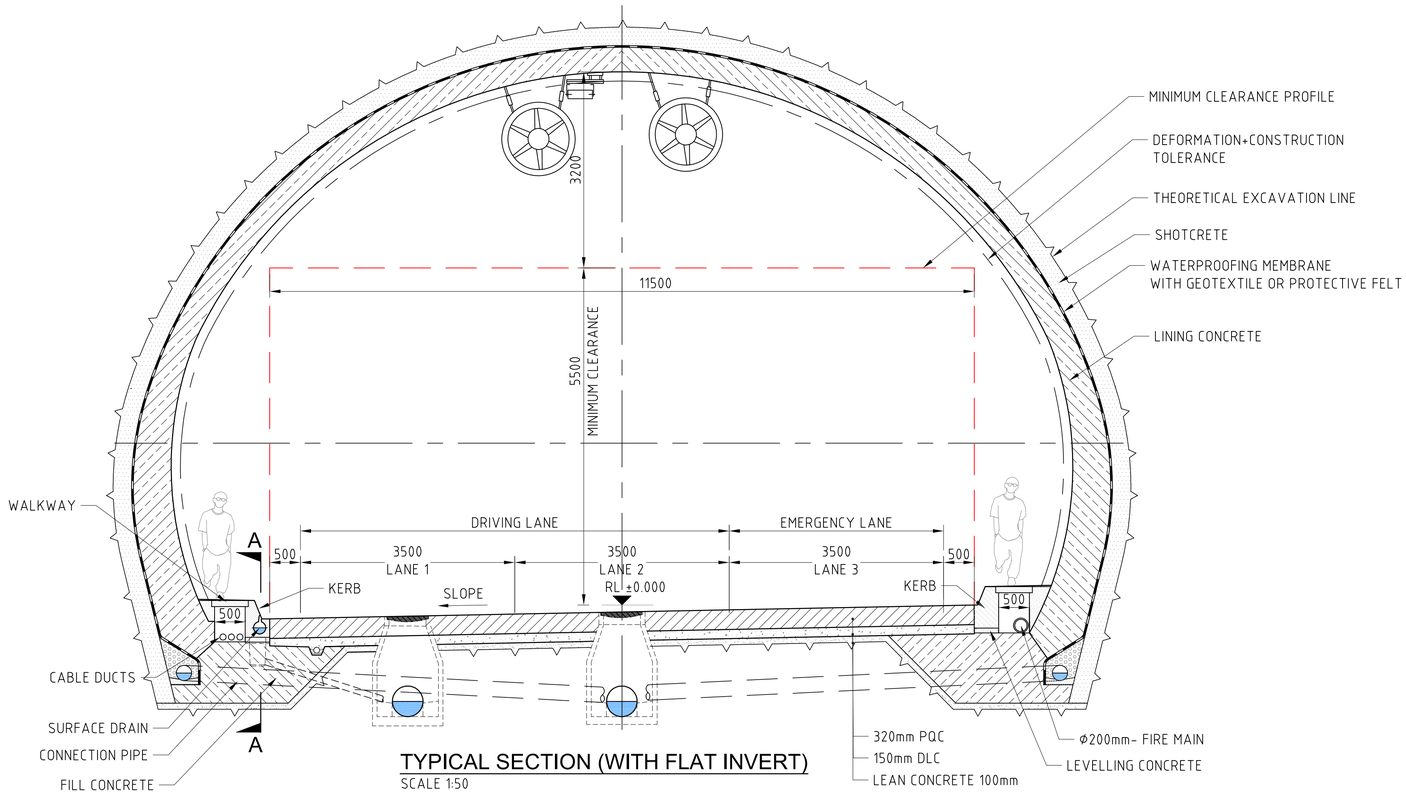
DRAWING TITLE

4 LANE ROAD
TYPICAL CROSS SECTION AND PAVEMENT DETAILS

DRAWING NUMBER: SHGA-FS-GEN-011 | REV: E

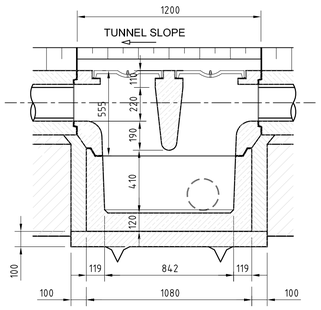
SCALE: 1:50 | MONTH (Current Issue): DEC 2015

Original Drawing Size A1



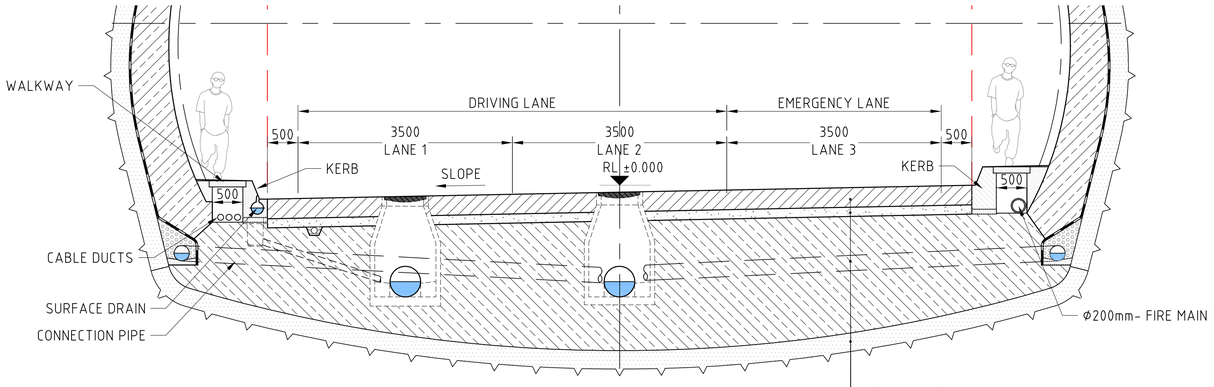
TYPICAL SECTION (WITH FLAT INVERT)

SCALE 1:50



SECTION A-A

NTS



TYPICAL SECTION (WITH ARCH INVERT)

SCALE 1:50

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.

SCALE 1 : 50

1m 0 1m 5m

PRELIMINARY

REFERENCE DRAWINGS:

SHGA-FS-LAY-1001 TO 1016 (16 SHEETS)

SHGA-FS-LAY-1061 TO 1098 (38 SHEETS)

LEGEND:

- LINING / INVERT CONCRETE
- PAVEMENT QUALITY CONCRETE (PQC)
- DRY LEAN CONCRETE (DLC)

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
E	DEC 15	MINOR CORRECTIONS / RESUBMITTED (KD-6)	RMe	BRs	FKr
D	DEC 15	SECTION WITH ARCH INVERT ADDED (KD-5)	RMe	BRs	FKr
C	SEP 15	CP HEIGHT MODIFICATION & RESUBMISSION (KD-4)	PRa	BRs	FKr
B	AUG 15	MINOR MODIFICATION	PRa	BRs	FKr
A	JULY 15	FIRST DRAFT (INCEPTION STAGE)	RMe	BRs	FKr

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	22.07.15	22.07.15	22.07.15	22.07.15	22.07.15
Name	RMe	RMe	BRs	FKr	FKr
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :
GEOCONSULT India Pvt. Ltd.
Plot No. 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE

CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

©GEOCONSULT; P:\Ra, R:\6000 Projects\6060-Shiradi Ghat\CURRENT\KD-6\SHGA-FS-GEN-012_E.dwg, 2015-12-18

CLIENT: GOVERNMENT OF KARNATAKA

DRAWING TITLE: MAIN TUNNEL
REGULAR CROSS SECTION
2 DRIVING LANES+ 1 EMERGENCY LANE

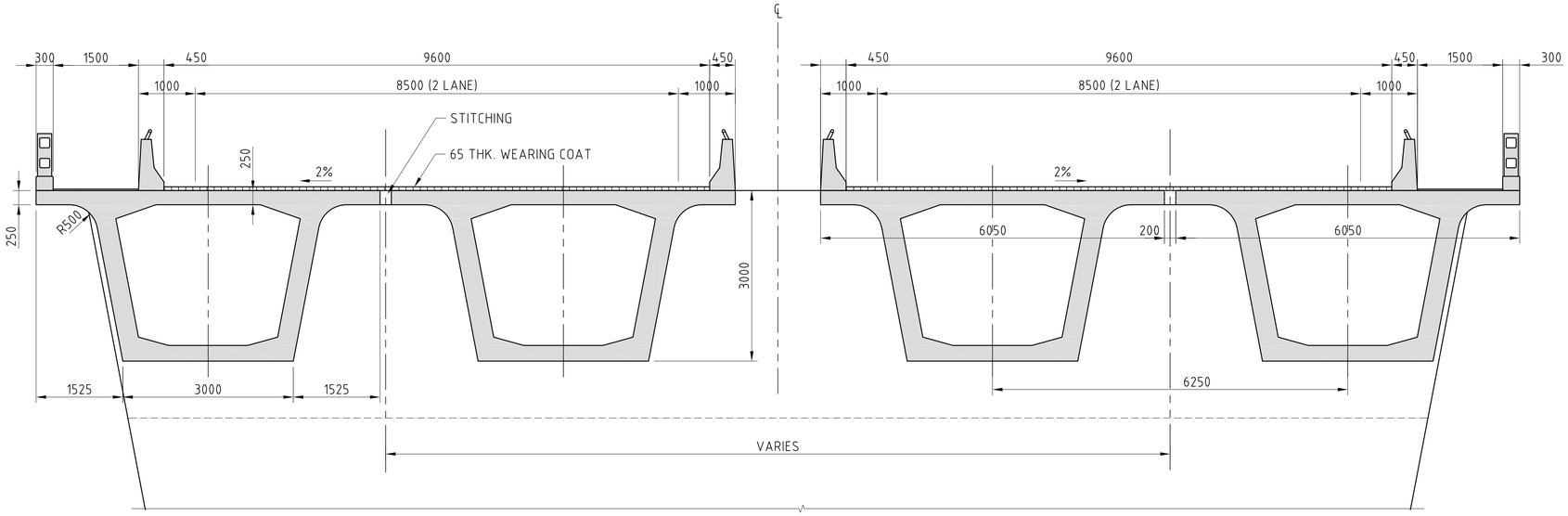
DRAWING NUMBER: SHGA-FS-GEN-012

REV: E

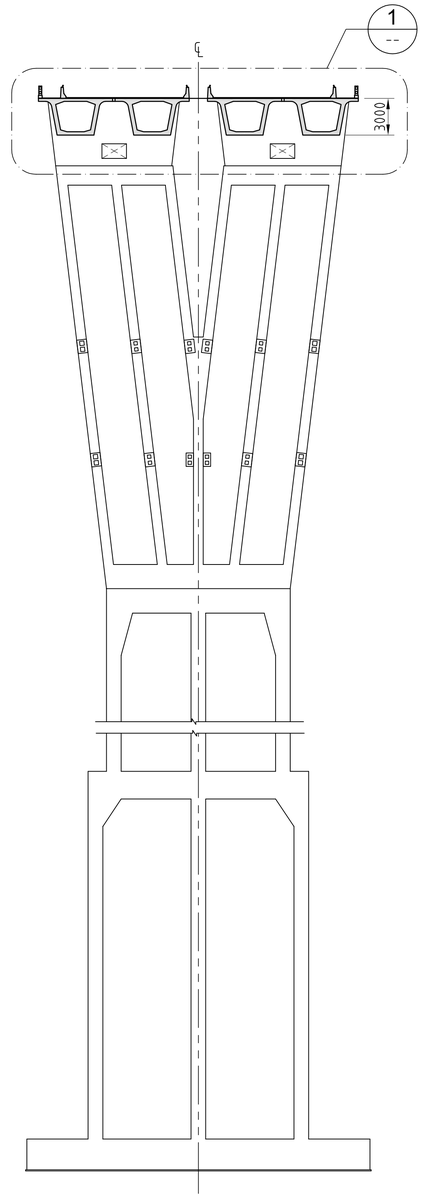
SCALE: 1:50

MONTH (Current Issue): DEC 15

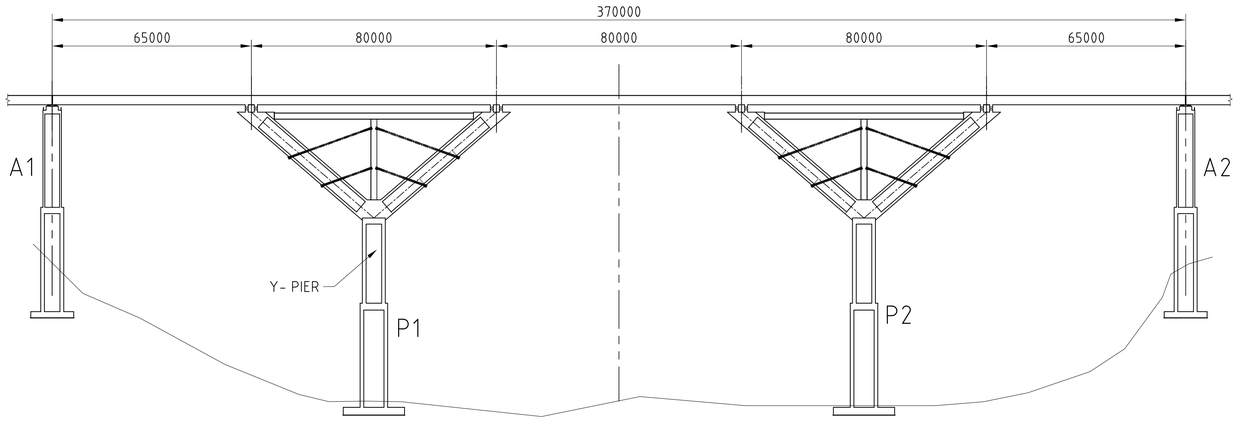
Original Drawing Size A1



DETAIL 1
SCALE 1:50



4 LANE -Y- PIER OPTION - TWIN BOX STRUCTURE
SCALE 1:250



LONGITUDINAL SECTION -Y PIER OPTION- TWIN BOX STRUCTURE
SCALE 1:1000

APPLICABLE AT Y-PIERS IN LONG SPAN BRIDGES.

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.

SCALE 1 : 50
1m 0 1m 5m

SCALE 1 : 250
10m 0 10m 20m 25m

SCALE 1 : 1000
50m 0 50m 100m

PRELIMINARY

REFERENCE DRAWINGS:

LEGEND:

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
E	DEC 2015	PIER SHAPE MODIFIED (KD-6)	ABa	RMe	FKr
D	DEC 2015	BOX GIRDER & PIER SHAPE MODIFIED (KD-5)	PRa	RMe/ADh	FKr
C	SEP 2015	PIER ELEVATION MODIFIED AND RESUBMITTED (KD-4)	ABa	RMe	FKr
B	SEP 2015	RESUBMITTED INTERIM PROGRESS (KD-3)	ABa	RMe	FKr
A	JULY 2015	FIRST DRAFT (INCEPTION STAGE)	ABa	RMe	FKr

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date [FIRST ISSUE]	22.07.15	22.07.15	22.07.15	22.07.15	22.07.15
Name	ABa/RMe	RMe	DSu	ADh	FKr
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :
GEOCONSULT India Pvt. Ltd.
Plot No. 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE
CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

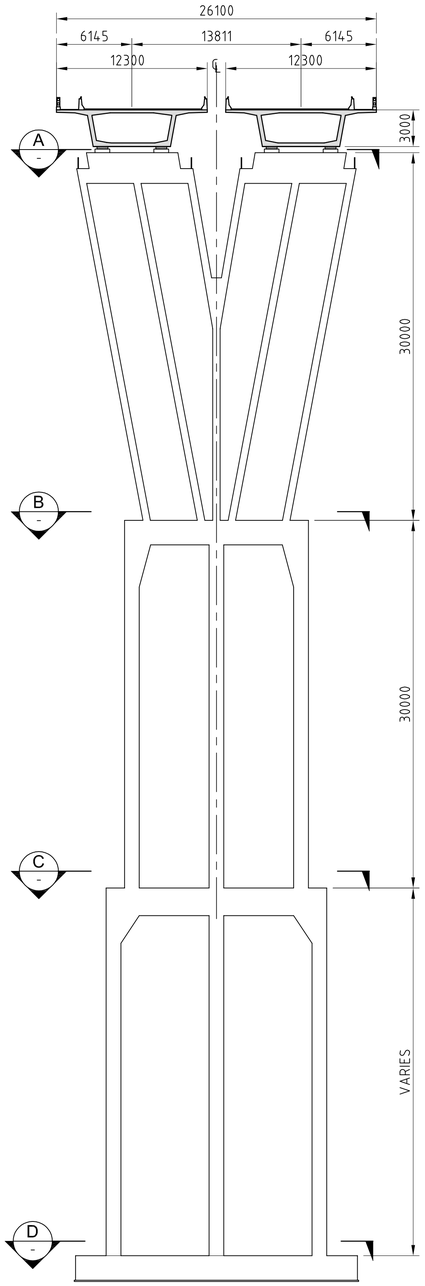
CLIENT
GOVERNMENT OF KARNATAKA

DRAWING TITLE
4 LANE MAJOR BRIDGE
GENERAL SECTIONS
PSC BOX GIRDER WITH Y-PIERS

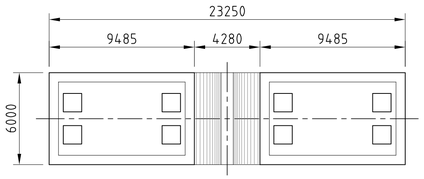
DRAWING NUMBER: SHGA-FS-GEN-013
REV: E

SCALE: AS SHOWN
MONTH (Current Issue): DEC 15

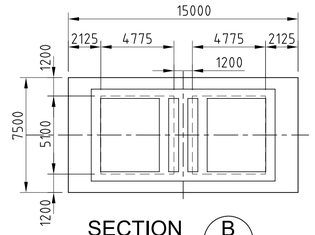
Original Drawing Size A1



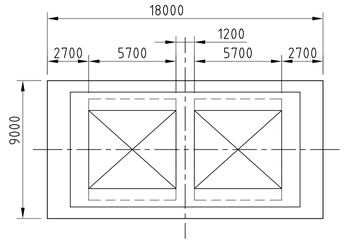
TYPICAL SECTION OF PIER (HIGHEST VARIANT)
SCALE 1:250



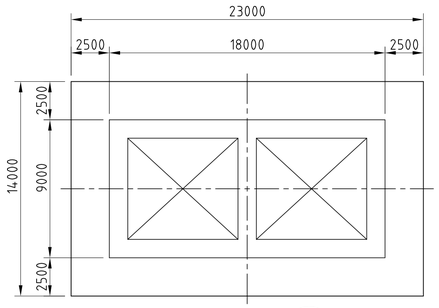
SECTION A
SCALE 1:200



SECTION B
SCALE 1:200



SECTION C
SCALE 1:200



SECTION D
SCALE 1:200

VALID FOR VIADUCTS LOCATION

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.

SCALE 1 : 250
10m 0 10m 20m 25m

SCALE 1 : 200
5m 0 10m 20m

PRELIMINARY

REFERENCE DRAWINGS:
.
.

LEGEND:

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
D	DEC 2015	FOURTH DRAFT (KD-6)	ABa	ADh/RMe	AKg
C	DEC 2015	THIRD DRAFT (KD-5)	PRa	ADh/RMe	AKg
B	SEP 2015	SECOND DRAFT (KD-4)	PRa	ADh/RMe	AKg
A	AUG 2015	FIRST DRAFT (KD-3)	ABa	ADh/RMe	AKg

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	AUG 15	AUG 15	AUG 15	AUG 15	AUG 15
Name	ABa/PRa	RMe	ADh	ADh/AKg	AKg
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :
GEOCONSULT India Pvt. Ltd.
Plot No. 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE
CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

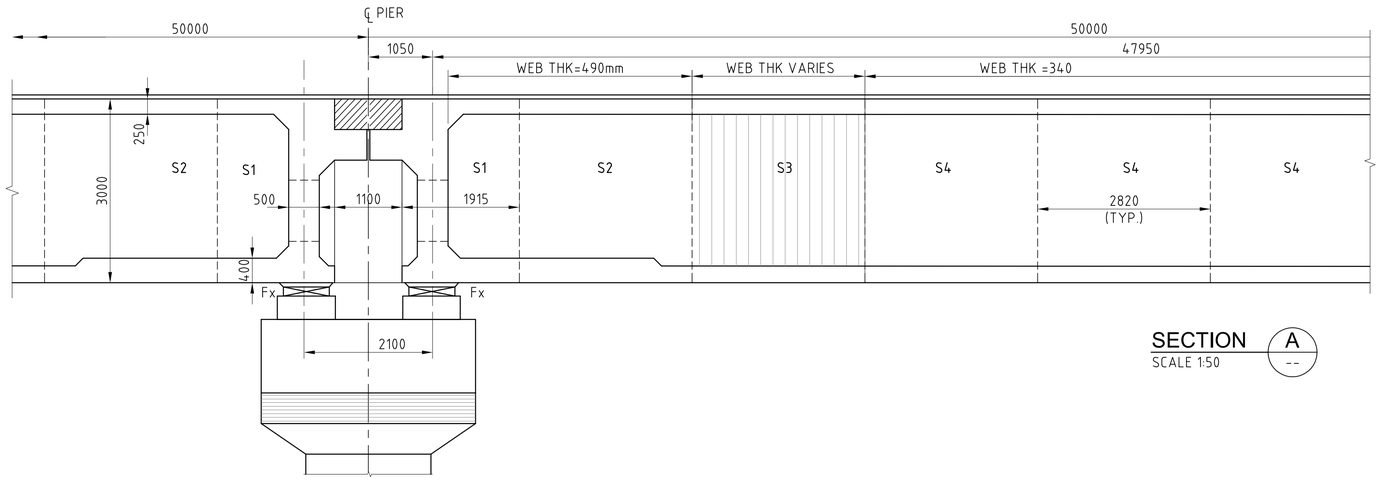
CLIENT
GOVERNMENT OF KARNATAKA

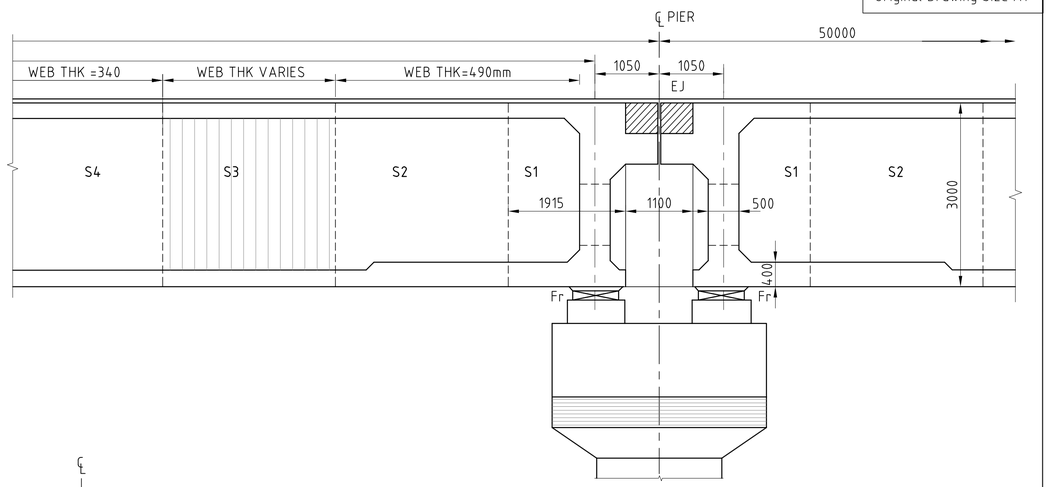
DRAWING TITLE
4 LANE MAJOR BRIDGE- GENERAL SECTIONS
PIERS UP TO 90M HIGH
PILE FOUNDATION AND OPEN FOUNDATION

DRAWING NUMBER: SHGA-FS-GEN-014
REV: D

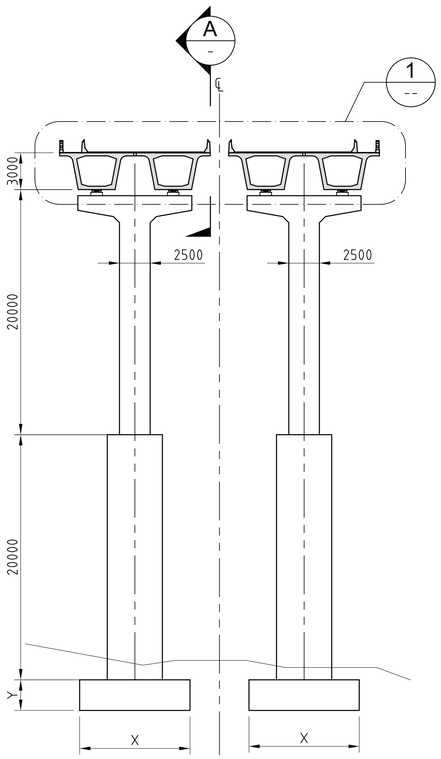
SCALE: AS SHOWN
MONTH (Current Issue): DEC 2015

Original Drawing Size A1



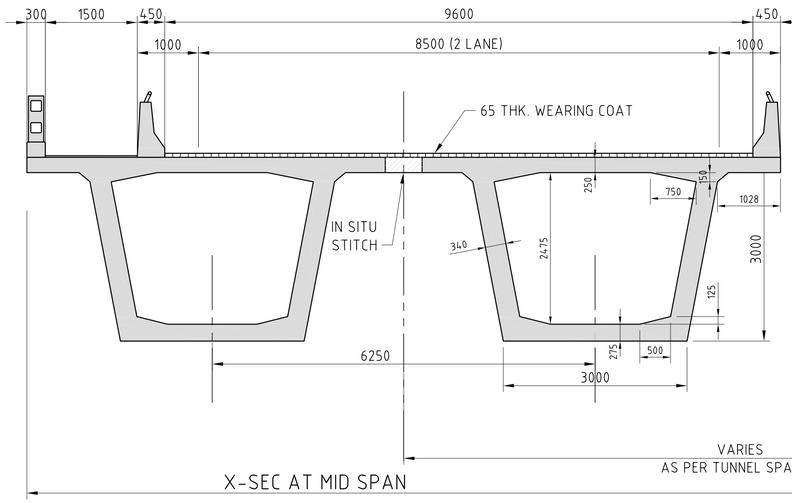


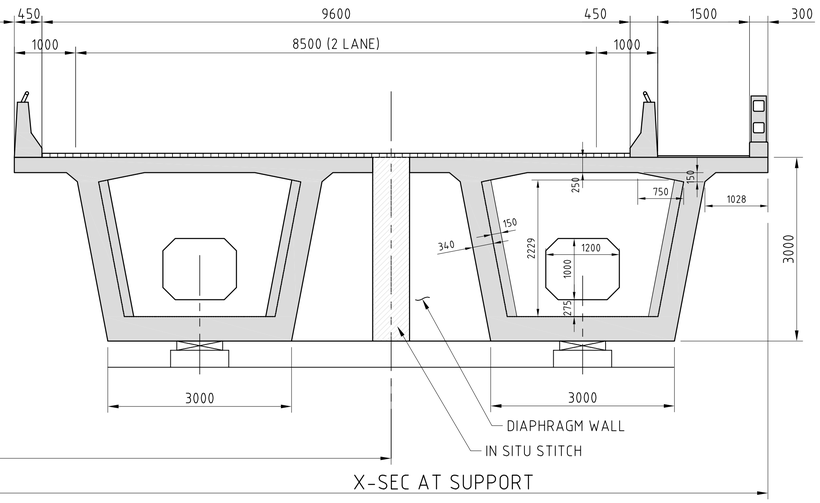
SECTION A
SCALE 1:50



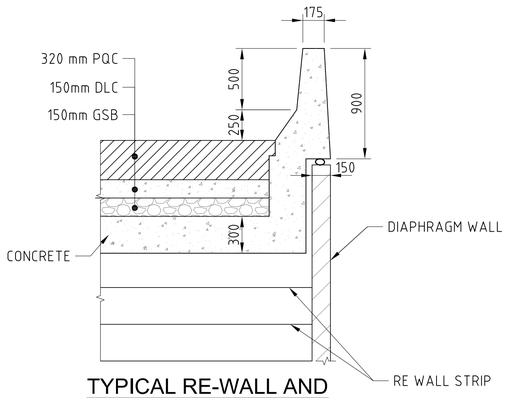
4 LANE - TWIN BOX STRUCTURE - MINOR BRIDGES
SCALE 1:250

DIMENSIONS AND SIZES SHOWN ARE PRELIMINARY AND SHALL BE FINALIZED AFTER DETAILED GEOLOGICAL/ GEOTECHNICAL INVESTIGATION

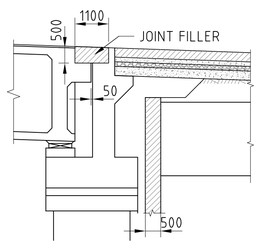




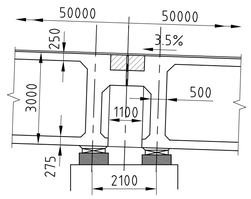
DETAIL 1
SCALE 1:50



TYPICAL RE-WALL AND CRASH BARRIER ARRANGEMENT
SCALE 1:25



TYPICAL DETAIL AT ABUTMENT JUNCTION
SCALE 1:100



TYPICAL DETAIL AT PIER TO PIER JUNCTION
SCALE 1:100

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.
2. THIS DRAWING SHALL BE READ ALONG WITH RELATED GENERAL ARRANGEMENT DRAWINGS.

SCALE 1 : 50
1m 0 1m 5m

SCALE 1 : 25
1m 0 1m 2m 2.5m

SCALE 1 : 100
5m 0 5m 10m

SCALE 1 : 250
10m 0 10m 20m 25m

PRELIMINARY

REFERENCE DRAWINGS:
.
.

LEGEND:

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
C	DEC 2015	MINOR CORRECTIONS/RESUBMITTED (KD-6)	PRa/RMe	RMe	FKr
B	DEC 2015	GEOMETRY REVISED/DETAILS ADDED (KD-5)	PRa/RMe	RMe	FKr
A	SEP 2015	FIRST DRAFT	ABa	RMe	FKr

QUALITY ASSURANCE

The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.

Date (FIRST ISSUE)	19.09.15	19.09.15	19.09.15	19.09.15	19.09.15
Name	ABa/RMe	RMe	DSu	ADh	AKg
	Drawn	Drafting Chk	Designed	Design Chk	Approved

Originators

DESIGN CONSULTANTS :
GEOCONSULT India Pvt. Ltd.
Plot No. 473, Industrial Estate,
Udyog Vihar, Phase V
Gurgaon-122016, (India)

PROJECT TITLE
CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

•GEOCONSULT; PRa; R:\16000 Projects\16060-Shiradi Ghat\CURRENT\KD-6\SHGA-FS-GEN-015_C.dwg, 2015-12-18

CLIENT
GOVERNMENT OF KARNATAKA

DRAWING TITLE
4 LANE MINOR BRIDGES
GENERAL SECTIONS
PSC BOX GIRDER WITH PIERS UP TO 40m HIGH

DRAWING NUMBER: SHGA-FS-GEN-015
REV: C

SCALE: AS SHOWN
MONTH (Current Issue): DEC 2015

Prepared for:

सड़क परिवहन और राजमार्ग मंत्रालय
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
Government of India

Karnataka
Public Works, Ports & Inland Water Transport Department

Project:

Consultancy Services for "Feasibility-Cum-Geo Technical Study for the bypass to Shiradi Ghat from Km 238.000 to 261.450 on NH-48 in the State of Karnataka"

Subject:

KD-6 - Draft Detailed Project Report for Final Approved Alignment for Bypass

Volume - II : Design Report
Part I: Traffic Study, Analysis and Forecast

Prepared by:

GEOCONSULT INDIA Pvt. Ltd.
A company of the GEOCONSULT group

GEOCONSULT

473 Udyog Vihar
Industrial Estate, Phase V
Gurgaon 122016
Tel: +91-124-45 69 700
Fax: +91-124-45 69 710
Email: office@geoconsult.co.in

00	17.12.2015	First Issue	PJs	AKg	FKr
Rev.	Date	Description	Originator	Checked	Approved

Document No:	**I6060-REP-09-KD6-DDPR-Vol II-DR-Part I**	Revision **00**
GCI File Path	**W:\PROJECTS\I6000\60\REPORTS\R09-KD-6-Reports\I6060-REP-09-KD6-DDPR-Vol II_DR_Part-I\I6060-REP-09-KD6-DDPR-Vol II_DR_Part-I.docx**	

Disclaimer

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of GEOCONSULT being obtained. GEOCONSULT accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify GEOCONSULT for all loss or damage resulting there from. GEOCONSULT accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

Revision History

Rev.	Date	Long Description

Table of Contents

INTRODUCTION

This report is prepared under Contract Agreement clause 2.8; "Key Date No: KD6: Draft Detailed Project Report for Final Approved Alignment for Bypass (DDPR)" after incorporation of Client's observations on earlier submitted "KD5: Kucha Draft Detailed Project Report (KDDPR)" vide letter no. NH/PIU-Tunnel/NH-48/KD-3/2015-16/383-386 dated 14.12.2015.

The present submission (10 Hard Bound Sets and 5 Soft Copies of each) is as detailed below:

(i) Volume- I Main Report :

- *Executive summary*
- *Project Description*
- *Socio Economic Profile*
- *Materials Surveys and Investigation*
- *Traffic Surveys and Analysis*
- *Design Standards and Specifications*
- *Alignment Proposals*
- *Summary of EIA/IEE and Action Plan*
- *Summary of Resettlement Plan*
- *Preliminary Cost Estimates*
- *Preliminary Economic Analysis*
- *Preliminary Financial Analysis*
- *Suggested Methods of procurement and packaging*
- *Conclusions and Recommendations*
- *Acknowledgement*
- *Compliance of the Observations*

The basic data obtained from the field studies and investigations and input data used for the detailed engineering design (if any) shall be submitted in a separate volume as an Appendix to Main Report.

(ii) Volume- II Design Report :

Part -I: Traffic Study, Analysis and Forecast

- *Description of Existing Road in Ghat Section*
- *Road and Bridge Inventory*
- *Traffic Surveys, analysis and forecast*
- *Proposed Pavement Design*

Part-II Design of Tunnels

- *Proposed Tunnel Design, Standards*
- *Structural Analysis- Primary Lining*

Part- III Design of Bridges and Cross-Drainage Structures

- *Proposed Bridges and Structures Design Basis and*
- *Bridges Dimensioning*

Part - IV Geological Design and Geotechnical Report

- *Geological Survey and Analysis*
- *Geotechnical Investigations Report*

(iii) Volume - III Materials Report :

(iv) Volume - IV (a) Environmental Assessment Report including Environmental Management Plan (EMP) :

(v) Volume - IV (b) Resettlement Action Plan (RAP) :

(vi) Volume - V Technical Specifications :

(vii) Volume - VI Rate Analysis :

(viii) Volume - VII Cost Estimates :

(ix) Volume - VIII Bill of Quantities :

(x) Volume - IX Drawings (A3 Size) :

a. *Location map*
b. *Layout plans*
c. *General Drawings*
d. *Plan and Profile of Refined Alignment "A"*
e. *Typical Cross Sections showing Pavement details of Cut & Fill Section*
f. *Typical Cross Sections of Tunnel*
g. *Typical Cross Sections of Bridges*
h. *Tunnels- General Arrangement Plan and L-Sections (L&R)*
i. *Viaducts – General Arrangement Plan and L-Section*
j. *Cut & Fill and Viaducts – General Arrangement Plan and L-Section*
k. *GAD for proposed RoB at Railway km 54+650*
l. *Standard Drawings*
m. *Miscellaneous Drawings*
n. *Indicative Land Acquisition Plans*
o. *Detailed Cross Sections @ 100m interval*

(xi) Volume - X Civil Work Contract Agreement :
(xii) Volume - XI Project Clearances :

Volume - II: Design Report

Part - I: Traffic Study, Analysis and Forecast

A. General

This Volume - II: Design Report-Part I: Traffic Study, Analysis and Forecast, a part of "KD 6: Draft Detailed Project Report for Final Approved Alignment for Bypass (DDPR)" is submitted in accordance with the Contract Agreement and as per requirement specified in Terms of Reference (ToR) for preparation of Design Report - Part I: Traffic Study, Analysis and Forecast, of "Feasibility-Cum-Geo Technical Study for the bypass to Shiradi Ghat from Km 238.00 to 261.45 on NH-48 in the State of Karnataka".

1 DESCRIPTION OF EXISTING ROAD IN GHAT SECTION

1.1 Project Area

1.1.1. Location

Roads form the spine of any emerging economy – India is no exception. The economic benefits of a newly constructed/ improved road, both in terms of direct and indirect benefits, are immense. An accurate estimate of the traffic that is likely to use the Project road is very important as it forms the basic input in planning, design, operation and financing. A thorough knowledge of the travel characteristics of the traffic likely to use the Project road as well as other major roads in the influence area of the study corridor is essential for future traffic estimation. The estimation of revenue through toll collection is important to assess the financial viability of the project and to finalize the financial covenants for the concession agreement. Thus accurate assessment of the existing traffic and forecasting attains utmost importance in the projects taken up under PPP/ EPC mode.

The State of Karnataka is located in southwest part of India. Karnataka is surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The entire stretch of National Highway 48 passes through Bangalore Rural, Tumkur, Hassan and Dakshin Kannada districts of Karnataka, passing through important cities like Nelamangala, Kunigal, Yediyur, Channarayapatna, Hassan, Sakleshpur, Shiradi Ghat, Uppinangadi, Bantwala Crossing, and ending at Mangalore.

The project under consideration aims at conducting feasibility study for developing, up grading / improving bypass to Shiradi Ghat from Km 238.000 to 261.450 on NH- 48 in the State of Karnataka, totalling to a length of approximately 23.450 Km. The ghat section of Western ghats through which NH-48 passes is called Shiradi Ghat. The project road is connecting Mangalore with Hassan and passing through Gundya, Maranhally and Donigal in Dakshin Kannad and Hassan districts respectively of the state of

Karnataka. The project highway from Maranhally (Km 238+000) to Gundya (Km 261+450), is a section of NH-48 (new NH 75). NH-48 connects the capital of Karnataka, Bangalore to the Mangalore, a fast developing port city of Karnataka State. The project highway passes through two districts of Karnataka, namely, Hassan and Mangalore. The total length of the project highway is about 23km. The Location Map given in Figure 1 refers to the location of the Project stretch along the NH-75/48.

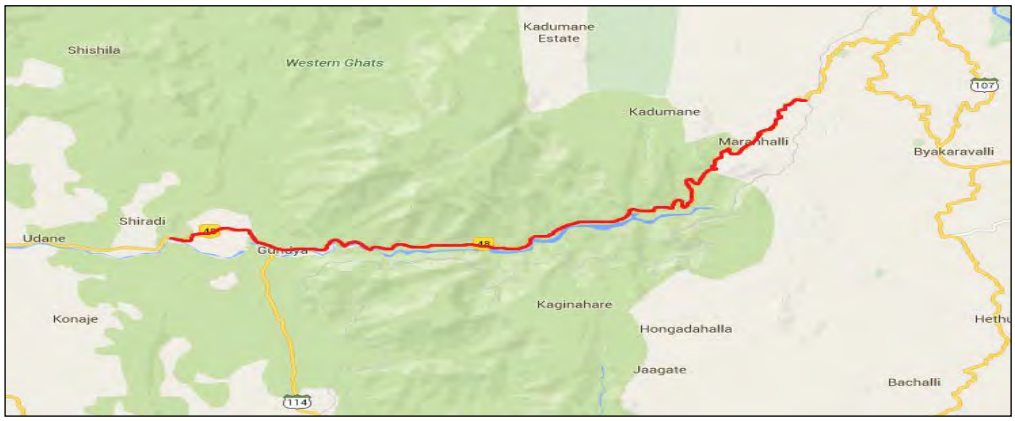


Figure 1. Location of Project Stretch: Key Plan

1.1.2. Terrain and Land Use

The terrain on this Ghat stretch can be termed as hilly, mountainous and rolling. The abutting land use pattern varies from residential to agricultural and forest area. Sparingly industrial area is also observed along with barren lands. Almost throughout the stretch, barring the ghat section of the project highway, sparsely populated human settlements were observed. They were as semi built-up and completely built-up areas along the existing road. The river Kempu Hole runs almost parallel to the road along the entire ghat section. In the initial reach the river is on the right side of the road and later on the river runs parallel to the road on its left. The important crops grown are coffee, Black Pepper, Potato, Paddy and Sugarcane. In the hilly terrain cutting sections were observed along the highway. Three mini hydel power stations are located at the Ghat section to the left of the highway.

The alignment of project road passes through a number of built up sections. These urban/village stretches act as bottlenecks to the free flow of traffic due to mixed local and through traffic, presence of ribbon development on either side and uncontrolled access from side road/cross roads, lack of traffic segregation and pedestrian facilities. A lot of important places and towns / villages are there along the ghat stretch. They are mainly Heggade, Maranhally, Gundiya and Addahole. The list of built-up towns, villages and their locations are shown in Table 1.1 below.

Table 1.1: List of Villages/Towns

Sl No	Chainage, km		Name of Village/Town
	From	To	
1	236.250	236.350	Heggade
2	238.100	238.400	Maranhally
3	249.950	250.100	Kempuhole
4	261.100	261.350	Gundya
5	263.200	263.400	Addahole

1.1.3. Existing Road Width

The existing road is generally having two lane undivided carriageway width, with a few stretches varying from 7.50 m to 15.0 m width. Brief details of carriageway width are shown in Table 1.2 below

Table 1.2: Details of Carriageway width

Sl. No	Chainage Km		Length, km	Road Width, m
	From	To		
1	235.000	239.800	4.80	8.00
2	239.800	240.600	0.80	15.00
3	240.600	265.600	25.00	7.50

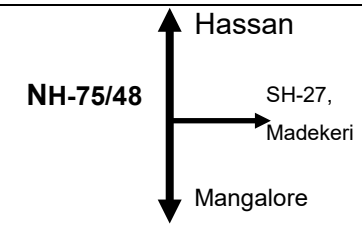
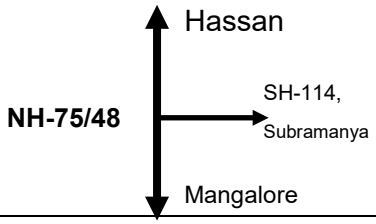
1.1.4. Pavement Condition

The existing road section is recently laid newly constructed concrete (rigid) pavement from km 238 to km 250 comprise of 320mm PQC over 150mm DLC and 250mm GSB. Bituminous (flexible) pavement exists in rest stretch (km 228 to 238 & km 250 to 260).

1.1.5. Major Intersection

There are 2 major intersections present near and along the project stretch. 2 Nos of SHs (SH-27, and SH-114) cross the project road. The details of Major junctions are shown in Table 1.3 below.

Table 1.3: Major Intersections

Sl No	Location	No of Arms	Description of Intersection	Sketch
1	Donigal, Sakaleshpura, km 229.100	3	NH-75/48 and SH-27, Madekeri Road	
2	Gundya, km 261.300	3	NH-75/48 and SH-114 , To Subramanya	

1.1.6. Horizontal Alignment

The existing alignment is a hill road hence having many sharp curves from 14m to 200m radius as detailed below:

Sl. No	Chainage, Km	Radius, m	Direction
1	228+111	128	RHS
2	228+159	69	LHS
3	228+356	20	LHS
4	228+456	65	RHS
5	228+637	109	RHS
6	228+727	30	LHS
7	228+831	50	RHS
8	229+000	78	RHS
9	229+114	91	RHS
10	229+211	78	LHS
11	229+435	107	LHS
12	229+520	38	LHS
13	229+641	105	RHS
14	229+721	68	LHS
15	229+823	20	LHS
16	229+900	23	RHS
17	229+940	43	LHS
18	230+000	51	RHS
19	230+023	86	LHS
20	230+118	22	RHS
21	230+280	126	LHS
22	230+358	138	RHS
23	230+546	217	LHS
24	230+746	115	LHS
25	230+799	49	RHS
26	230+836	44	LHS
27	230+91	33	RHS
28	231+000	18	LHS
29	231+080	131	LHS
30	231+162	26	RHS
31	231+276	31	LHS
32	231+376	41	RHS
33	231+399	50	RHS
34	231+461	14	LHS
35	231+557	42	RHS
36	231+629	16	LHS
37	232+000	101	LHS
38	232+147	44	RHS
39	232+289	44	LHS
40	232+436	112	RHS
41	232+541	49	LHS
42	232+615	60	RHS
43	232+687	29	LHS
44	232+761	42	LHS
45	232+809	47	RHS
46	232+859	34	RHS
47	232+917	49	LHS
48	232+972	181	RHS
49	233+000	39	LHS
50	233+092	27	RHS
51	233+228	55	LHS
52	233+364	27	RHS
53	233+476	34	LHS
54	233+584	86	LHS
55	233+719	29	RHS
56	233+802	41	LHS
57	233+851	45	RHS
58	234+000	81	LHS
59	234+134	53	RHS
60	234+205	83	LHS
61	234+426	179	LHS
62	234+750	201	RHS
63	234+859	126	LHS
64	234+956	107	RHS
65	235+000	60	LHS
66	235+052	112	RHS
67	235+110	27	LHS
68	235+154	93	RHS
69	235+289	79	RHS
70	235+367	65	LHS
71	235+500	37	RHS
72	235+636	29	LHS
73	235+699	119	RHS
74	235+752	25	LHS
75	235+804	104	RHS
76	235+877	160	LHS
77	235+939	85	RHS
78	235+996	43	LHS
79	236+032	178	LHS
80	236+078	34	LHS
81	236+194	47	RHS
82	236+253	53	LHS
83	236+294	19	RHS
84	236+331	19	LHS
85	236+381	51	RHS
86	236+514	28	LHS
87	236+590	53	LHS
88	236+660	105	RHS
89	236+778	227	RHS
90	237+024	36	RHS

Sl. No	Chainage, Km	Radius, m	Direction
91	237+098	19	LHS
92	237+238	79	LHS
93	237+557	138	RHS
94	237+691	73	RHS
95	237+741	35	LHS
96	237+838	46	LHS
97	237+889	28	RHS
98	237+971	62	RHS
99	238+000	107	RHS
100	238+090	27	LHS
101	238+151	56	RHS
102	238+218	105	RHS
103	238+273	63	LHS
104	238+385	38	RHS
105	238+517	82	LHS
106	238+587	17	RHS
107	238+664	59	LHS
108	238+726	62	RHS
109	238+776	105	LHS
110	238+883	50	RHS
111	238+986	28	LHS
112	239+066	71	RHS
113	239+149	45	LHS
114	239+227	47	RHS
115	239+405	101	LHS
116	239+601	124	RHS
117	239+730	39	LHS
118	239+791	41	RHS
119	240+044	86	RHS
120	240+119	73	LHS
121	240+429	48	RHS
122	240+587	93	LHS
123	240+676	36	RHS
124	240+738	40	LHS
125	240+839	187	RHS
126	240+972	16	LHS
127	241+033	56	LHS
128	241+084	66	RHS
129	241+110	76	LHS
130	241+207	51	RHS
131	241+355	25	LHS
132	241+415	130	RHS
133	241+581	79	RHS
134	241+728	17	LHS
135	241+896	179	RHS
136	242+054	184	LHS
137	242+110	84	RHS
138	242+230	29	LHS
139	242+315	52	RHS
140	242+426	32	RHS
141	242+532	92	RHS
142	242+578	44	RHS
143	242+622	20	LHS
144	242+699	36	RHS
145	242+811	34	LHS
146	243+000	143	RHS
147	243+045	86	LHS
148	243+119	34	RHS
149	243+174	37	LHS
150	243+274	105	LHS
151	243+327	65	RHS
152	243+409	75	LHS
153	243+499	24	RHS
154	243+585	24	LHS
155	243+694	25	RHS
156	243+729	23	LHS
157	243+821	201	RHS
158	243+888	31	LHS
159	243+922	65	RHS
160	244+000	29	LHS
161	244+065	41	LHS
162	244+118	32	RHS
163	244+233	158	RHS
164	244+358	46	LHS
165	244+520	22	RHS
166	244+599	37	LHS
167	244+671	41	LHS
168	244+728	76	RHS
169	244+769	106	LHS
170	244+800	40	RHS
171	244+861	24	LHS
172	244+918	25	RHS
173	244+971	99	LHS
174	245+039	92	RHS
175	245+075	57	LHS
176	245+155	59	RHS
177	245+319	107	RHS
178	245+476	78	LHS
179	245+531	37	RHS
180	245+632	42	LHS

Sl. No	Chainage, Km	Radius, m	Direction
181	245+742	34	RHS
182	245+835	43	RHS
183	245+897	37	LHS
184	246+000	126	RHS
185	246+080	36	LHS
186	246+185	91	RHS
187	246+254	21	LHS
188	246+428	125	LHS
189	246+563	83	RHS
190	246+663	200	LHS
191	246+704	41	RHS
192	246+821	29	RHS
193	246+869	21	LHS
194	246+931	89	RHS
195	246+993	45	LHS
196	246+1089	85	RHS
197	246+1159	26	LHS
198	246+1255	26	LHS
199	246+1359	31	RHS
200	246+1439	18	LHS
201	246+1529	37	RHS
202	246+1616	8	LHS
203	246+1755	17	RHS
204	246+1843	105	LHS
205	247+000	71	RHS
206	247+091	44	LHS
207	247+201	100	RHS
208	247+254	60	LHS
209	247+302	41	RHS
210	247+365	29	LHS
211	247+419	121	LHS
212	247+468	48	RHS
213	247+529	38	RHS
214	247+640	41	LHS
215	247+699	20	LHS
216	247+802	104	LHS
217	247+881	106	RHS
218	248+034	84	RHS
219	248+161	97	LHS
220	248+305	65	RHS
221	248+391	51	RHS
222	248+437	60	LHS
223	248+511	182	RHS
224	248+576	71	LHS
225	248+758	128	RHS
226	248+882	77	RHS
227	248+983	39	LHS
228	249+107	70	RHS
229	249+202	52	RHS
230	249+239	38	LHS
231	249+289	45	RHS
232	249+320	27	LHS
233	249+360	45	RHS
234	249+401	55	LHS
235	249+543	130	LHS
236	249+612	118	RHS
237	249+680	77	LHS
238	249+749	86	RHS
239	249+842	80	RHS
240	249+918	168	LHS
241	250+096	200	LHS
242	250+403	214	LHS
243	250+559	109	RHS
244	250+652	74	LHS
245	250+747	89	RHS
246	250+849	171	LHS
247	251+000	91	RHS
248	251+093	76	LHS
249	251+175	212	RHS
250	251+334	64	RHS
251	251+399	197	LHS
252	251+464	152	RHS
253	251+500	144	LHS
254	251+570	82	LHS
255	251+732	94	LHS
256	251+877	59	LHS
257	252+155	44	RHS
258	252+808	128	RHS
259	253+218	79	LHS
260	253+263	148	RHS
261	253+593	171	LHS
262	253+727	90	LHS
263	253+917	125	RHS
264	253+976	173	LHS
265	254+050	215	LHS
266	254+121	201	RHS
267	254+178	47	LHS
268	254+350	94	RHS
269	254+467	61	LHS
270	254+522	79	RHS

Sl. No	Chainage, Km	Radius, m	Direction
271	254+595	76	LHS
272	254+800	124	RHS
273	254+858	198	LHS
274	254+946	115	LHS
275	254+975	79	RHS
276	255+000	176	RHS
277	255+088	44	LHS
278	255+200	56	RHS
279	255+264	49	LHS
280	255+323	58	RHS
281	255+437	57	RHS
282	255+473	155	LHS
283	255+531	109	LHS
284	255+657	117	LHS
285	255+718	115	RHS
286	255+881	228	LHS
287	256+000	184	RHS
288	256+222	72	RHS
289	256+333	48	LHS
290	256+450	54	RHS
291	256+525	127	LHS
292	256+600	217	RHS
293	256+700	134	LHS
294	256+784	79	RHS
295	256+820	75	LHS
296	256+888	67	RHS
297	256+945	44	LHS
298	256+977	44	RHS
299	257+061	62	RHS
300	257+120	29	RHS
301	257+160	16	LHS
302	257+188	55	LHS
303	257+400	113	RHS
304	257+507	30	LHS
305	257+800	80	RHS
306	258+074	110	LHS
307	258+120	148	RHS
308	258+250	81	LHS
309	258+388	39	RHS
310	258+421	21	LHS
311	258+475	42	RHS
312	258+567	68	RHS
313	258+650	40	LHS
314	258+778	47	RHS
315	258+850	82	RHS
316	258+928	49	LHS
317	259+000	51	RHS
318	259+050	98	RHS
319	259+075	22	LHS
320	259+200	50	LHS
321	259+321	110	LHS
322	259+400	96	LHS
323	259+520	151	RHS
324	259+585	89	RHS
325	259+700	38	LHS
326	259+800	92	RHS
327	259+900	44	RHS
328	260+200	94	RHS
329	260+274	141	LHS
330	260+550	192	RHS
331	260+600	151	LHS
332	260+800	77	RHS
333	260+850	57	LHS

Table 1.4: Details of Sharp Curves for Ghat section of Existing Road NH-48 (From km 228.000 to km 261.000)

1.1.7. Right of Way

Right of Way (RoW) in ghat section from km 228.000 to Km 261.000 the existing RoW varies from 10 m to 12 m. The RoW stones are not available along the project stretch.

1.1.8. Cross Drainage Structures

There are 12 minor bridges and many culverts along the existing road section. The following Table 1.5 gives the minor bridges details along the project road stretch.

Table 1.5: Details of Existing Bridges on Project Stretch

SI.NO	STR.NO	CHAINAGE	TYPE	SPAN CFG.
1	239/4	238+900	MNB	1x6
2	244/1	243+110	MNB	1x12.5
3	248/9	247+650	MNB	3x10
4	250/5	249+410	MNB	1x6
5	251/5	250+680	MNB	3x10.9
6	254/1	253+025	MNB	1x12
7	254/9	253+990	MNB	1x6
8	257/1	256+030	MNB	1x7.65
9	258/1	257+180	MNB	1x6
10	259/6	258+400	MNB	1x10.5
11	260/5	259+620	MNB	2x11
12	263/4	262+720	MNB	3x20

Note: MJB: Major Bridge, MNB: Minor Bridge

1.1.9. ROBs

The project road crosses the railway line at 1 location as tabulated in Table 1.6.

Table 1.6: Details of ROB and Vehicular Under Pass

Sl. No.	Chainage (km/m)	Type of structure	Span Arrangement
1	234+650	ROB	1x5.5

1.1.10. Religious Structures

There are 6 religious places located along the project road. List of religious structures and their locations is given in Table 1.7 below.

Table 1.7: Details of Religious Structure along existing Ghat section of NH-48

Sl	Location (km)	Type	Side
1	233.150	Temple	RHS
2	238.200	Mosque	RHS
3	238.800	Temple	RHS
4	255.500	Temple	LHS
5	263.300	Church	RHS
6	263.700	Church	RHS

1.1.11. HT Lines

HT lines are present parallel to the existing alignment at a distance of about 10m to 40m at Kempuhole The existing HT lines govern the widening option near Kempuhole Hydel power station.

1.1.12. Hydel Power Station

There are four running mini hydel power station on left hand side between National Highway and Kempuhole River.

Table 1.8: Hydel Power Generation Stations on NH-48 (Shiradi Ghat)

Sl No	Chainage	Name of company	Generation Capacity	Year of commission	Remarks
1	Km:234.00 (L/S)	Mysore Mercantile Company Limited Kundapura	3.00MW	2011	
2	Km:247.00 (L/S)	Maruthi Hydel Power Corporation Bangalore	(24x2) 48MW	-	Work stopped in the middle.
3	Km:247.50 (L/S)	Paschim Hydel Power corporation Hyderabad	(4.50x2) 9.00MW	2007	
4	Km:249.00 (L/S)	Indian power corporation Hyderabad	(6.0x3) 18.00MW	2004	
5	Km:250.300 (R/S)	Nagarjuna Hydel Power Corporation Hyderabad	(7.5x2) 15.00MW	2010	

1.1.13. OFC

BSNL, Airtel and Reliance OFCs are present and the cables are running parallel to the project road on both sides.

1.1.14. Petrol Pumps

There is no petrol pumps located along the project road section. One Petrol Pump on LHS has been recently constructed near km 226, Durga International Hotel. The nearest petrol pumps are stated in Table 1.9 below

Table 1.9: Locations of Petrol Pumps along the Stretch

Sl No	Chainage , (Km)	Side
1	221.000	LHS
2	226.100	LHS
3	283.000	LHS

The salient features of PIA are shown in self-explanatory photographs as below:

	
Starting Point of Proposed Bypass (km 236.400)	*End Point of Proposed Bypass (km 263.400)*
	
Railway Time Schedule- Sakleshpur Rly station	*Existing ROB at km 234.650*
	
Road Accident near km 265	*Temple – Boundary of Hassan/Mangalore District*
	
Rock Strata along the Existing Road.	*Utilities along the Existing Bridge*

	
T- Junction of NH-48 & SH-114 at Gundya.	*Major Junction at Gundya.*
	
Traffic Closed due to Road Construction	*Traffic Diversion due to Road Construction*
	
Hydropower Genereration on Kempu Hole river	*Rigid Pavement under Construction*
	
Wild Life Sanctuary along Road	*Wild Life Sanctuary along Road*

Coffee Plantation along Road

Coffee Plantation along Road

Dr Florian Krenn Int Tunnel Expert's Visit to Shiradi Ghat for Review Alignment

Dr Florian Krenn Int Tunnel Expert's Visit to Shiradi Ghat for Review Alignment

Private Land and Junction at Start of Project

Existing Road : Minor Bridge at Sharp Curve

2 SOCIO- ECONOMIC PROFILE OF THE PROJECT AREA

2.1 General Features

Socio-economic characteristics of the project influence region would normally have a bearing on the present traffic and would further influence the traffic levels in the future. Given this, the socio-economic profile of the project influence area has been studied and presented in brief in the ensuing sections. The Project stretch passes through the state of Karnataka, located in south-west India is the country's eighth largest state, situated on a table land where the western and eastern ghat ranges converge into the Nilgiri Hill complex, covering total geographical area of 1,91,791 sq km. The state is bounded by Maharashtra and Goa states in the north and northwest; 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. It is the 6th largest state in India, in terms of geographical area comprising 30 districts, 176 Taluks, 29340 inhabited villages and 347 Census Towns.

The growth of GSDP at constant prices slightly decreased from 7.2% in 2013-14 to 7.0% in 2014-15, mainly attributable to the decline in the growth of agriculture from 9.4% in 2013-14 to 4.5% in 2014-15. However, the growth of industry and services slightly increased from 4.2% and 8.0% in 2013-14 to 4.4% and 8.9% during 2014-15 respectively. The State economy showed reviving trends with anticipated growth rate of 6.1% in 2012-13, 7.2% in 2013-14 and 7.0% during 2014-15. Nearly 56% of the workforce in Karnataka is engaged in agriculture and related activities. A total of 12.31 million hectares of land, or 64.6% of the state's total area, is cultivated. Much of the agricultural output is dependent on the southwest monsoon as only 26.5% of the sown area is irrigated.

Karnataka is the manufacturing hub for some of the largest public sector industries in India, including Hindustan Aeronautics Limited, National Aerospace Laboratories, Bharat Heavy Electricals Limited, Indian Telephone Industries, Bharat Earth Movers Limited and HMT, which are based in Bangalore. Many of India's premier science and technology research centers, such as Indian Space Research Organization, Central Power Research Institute, Bharat Electronics Limited and the Central Food Technological Research Institute, are also headquartered in Karnataka.

2.2 Demographic and Socio Economic Characteristics

The State of Karnataka has a total population of 64 millions for the year 2014. Out of this, 60% is rural and 40% is urban population. It shows that the level of urbanization in the state is greater than that of the national average level of urbanization of 31%. The population density of 319 persons per sq. Km in the state is less than the national average of 324 person per sq. Km of area.

The literacy rate of the state is 76% which is higher than that of India. The sex ratio of the state is 968, which is higher than that of India. The demographic and socio - economic characteristics of the project influenced districts are presented in Table 2.1, as shown below.

Table 2.1: Demographic and Socio Economic Details of Project Influence Districts

S.No.	Item	Unit	Dakshin Kannada	Hassan
1	Area	Sq. Km	4559	6826
2	Population (2011 census)	000's	2083625	1776221
3	Urban Pop. To Total Population	%	47.67	21.21
4	Population density	Person/sq. Km	457	261
5	Per Capita Income at 2012-13 constant prices	Rs	98572	53000
6	Sex ratio (Females per 1000 males	No.	1018	1005
7	Literacy rate	%	88.62	75.89
8	Gross District Income at 2004-05 constant prices	Rs. In lakhs	1429004	661228

3 TRAFFIC SURVEYS PLANNING AND SCHEDULE

3.1 Scope of Traffic Survey

The consultant has carried out the following traffic studies, investigations and forecast:

- Determination of Average Daily Traffic (ADT) and Annual Average Daily Traffic (AADT)
- Identification of zone of influence for the project stretch and extent of influence based on O-D survey
- Determination of traffic growth rates
- Capacity and Level of Service (LOS) analysis; and
- Determination of Vehicle Damage Factor (VDF) as an aid to pavement design

Accordingly, the Consultants have carried out the necessary surveys to arrive at the details requested as above.

3.2 Traffic surveys and collection of data

Traffic forms a key element of project preparation studies of road projects proposed to be implemented under the PPP implementation format. It has a direct bearing on several aspects, including carriageway configuration and width requirements, pavement thickness, structural design, other design features and elements, wayside facilities as well as revenues and project viability, both economic and financial. All these signify the importance of traffic data and analyses, and are a major determinant of improvement costs. Given this, decisions on the type of traffic surveys, locations and duration have therefore been taken judiciously to arrive at representative traffic flows on the various sections, traffic desire patterns and characteristics.

An extensive analysis of the traffic database developed by conducting various surveys has been made not only to appreciate present traffic and travel characteristics but also to arrive at realistic traffic scenarios for future years on the project highway. The road network has been thoroughly studied during the reconnaissance stage. In order to assess the traffic volume and modal split, the Consultants have carried out Classified Traffic Volume Count (TVC) surveys at 2 strategic points .e., at Km. 229.000 and at Km. 261.450 named as TVC 1 and TVC 2 starting from Donigal to Gundya by trained personnel, round the clock for 7 days.

On the basis of the reconnaissance survey, 2 intersections along project highway were identified for conducting detailed turning movement surveys. Classified turning movement traffic surveys were carried out for a period of 12 hours at all these intersections. The traffic flow through these intersections is likely to experience increased conflicting movements in future. Axle Load surveys have been conducted at 2 locations named as AL 1 and AL2 at chainages Km. 232.000 (Maranhally police station) and at Km. 263.500. This survey was conducted for 1 normal day in both directions of traffic simultaneously with volume count of commercial vehicles. To capture the traffic and travel characteristics of predominant category of vehicles, Origin-Destination surveys by Road side Interview (RSI) method are conducted along the project stretch. Origin-Destination and commodity movement surveys are conducted at 2 locations namely at Km. 232.000 (Maranhally police station) and at Km. 263.500 for a period of 24 hours. Photographs showing the TVC, RSI and Axle load survey in progress are presented in Figure 3.1.

Figure 3.1: Surveys in progress

3.2.1 Schedule of Traffic Surveys

A detailed schedule of TVC, OD and Axle load traffic surveys conducted along the project stretch are listed and presented in Table 3.1, as shown below.

Table 3.1: Traffic Surveys – Schedule

S. No.	Type of Survey	Location	Date of Survey	Duration of Survey
1	Classified Traffic Volume Count	Km. 229.000	21.09.15 to 28.09.15	7 Days
		Km. 261.450	21.09.15 to 28.09.15	7 Days
2	Axle Load Survey	Km. 232.000	23.09.15	1 Day
		Km. 263.500	25.09.15	1 Day
3	Origin-Destination Survey	Km. 232.000	23.09.15	1 Day
		Km. 263.500	25.09.15	1 Day
4	Turning movement Survey	Donigal Chowk	28.09.15	12 hours
		Km. 261.500	28.09.15	ours

3.2.2 Objectives of Traffic surveys

The primary objective of these traffic studies is:

- To determine characteristics of traffic movement and to establish base year traffic demand

- To determine of vehicle damage factor as an aid to pavement design
- To identify the zone of influence for the project stretch and extent of influence based on O-D Survey
- To determine the travel pattern of goods and passenger vehicles
- To determine the percentage of right turning traffic at road intersections as a guide to the intensity of vehicle – vehicle conflict and geometric design; and
- To assess the capacity and LOS of project highways.

3.2.3 Methodology of Traffic Surveys

- Manual counting system was adopted under supervision of qualified Traffic Engineers, to eliminate data collection errors. Two teams are deployed in a station for recording all vehicles passing through that section of the road in both directions. Each team comprised of five enumerators and one reliever. Each station is managed by a supervisor.

- Continuous 24-hour traffic volume count survey was conducted in 3 shifts for 7 days. The survey was conducted in accordance with the guidelines provided by IRC: 9-1972. Enumerators specially trained for this purpose, record the number of vehicles of different categories moving along the road in both directions. The vehicles are broadly classified into motorized passenger vehicles, motorized goods vehicles and non-motorized vehicles. These groupings have further been sub-divided to reflect the present day traffic pattern more realistically.

- The surveyors counting the vehicles are placed at locations, where there was clear visibility of the flow of vehicles in respective direction. Independent checks were carried out by the supervisors, away from survey location, to cross check the count. Every count sheet has was checked for identification information, i.e. date, day, shift, direction, weather conditions etc. and signed by the Supervisor.

- 1 day O-D survey was conducted on normal working day Road Side Interview (RSI) method for 24 continuous hours in 2 shifts on random sample basis. A sample of well above 20% was targeted for Road Side Interview Method, to obtain a fair representative data. Willingness-to-Pay Survey was conducted along with O-D survey with a view to estimate the realistic value of money one is willing to pay in return of the facility provided, mostly with truck drivers and passenger cars.

- In axle load survey, different truck types have been selected on random sampling basis and a few buses also have been weighed to have an idea of loading in buses.

- Turning movement surveys were conducted for 8 hours in 2 shifts. At each entry arm of the intersection, one enumerator for recording each type of turning movement (i.e. left turning, right turning and straight moving) was positioned strategically so that they were able to observe the turning movement of each vehicle and record appropriately. The survey was conducted in accordance with IRC: SP: 41 – 1994.

- Banners indicating “Traffic Volume Count in progress” with name of Consultants is displayed near the survey stations (written in blue on white cloth), so that this is visible at least 200m ahead on both sides. Since, round the clock surveys were carried out, arrangements for lighting and temporary shelters were made to conduct surveys during night.

3.2.4 Traffic Volume Survey and Analysis

The data collected from primary and secondary sources are recorded in Excel sheets, compiled, checked and corrected before further proceeding for analysis. Traffic data analysis has been carried out, to understand traffic characteristics and travel pattern in the study area and to provide basic input for traffic capacity assessment.

3.2.5 Passenger Car Unit (PCU)

The traffic flow is measured in terms of number of vehicles per unit time. Since Indian traffic is heterogeneous in nature, it is common practice to convert the traffic in terms of Passenger car units (PCUs). The traffic data (in vehicles) collected during field surveys have been compiled and converted into equivalent Passenger Car Units (PCU) to determine the Average Daily Traffic (ADT) in vehicles and in PCU. Table 3.2 lists the adopted PCU equivalent for different vehicle type based on IRC: 64-1990.

Table 3.2: Passenger Car Unit (PCU)

Vehicle Type	PCU factor
Car	1.0
Taxi	1.0
Three Wheelers	0.5
Two Wheelers	1.0
Mini Bus	1.5
Bus	3.0
LCV (3T)	1.0
LCV (4T)	1.5
2 Axle	3.0
3 Axle	3.0
MAV (4 to 6 Axle)	4.5
MAV (< 6 Axle)	4.5
Tractor	1.5
Tractor with trailer	4.5
Cycle	0.5
Cycle Rickshaw	2.0
Hand Cart	3.0
Animal Drawn	6.0

3.2.6 Classified Traffic Volume Count

The analysis has been carried out to derive:

- Average Daily Traffic (ADT) for fast and slow moving vehicles
- Average Daily Variation and average Hourly Variation
- Annual Average Daily Traffic (AADT) after seasonal correction
- Traffic composition pattern for passenger, goods and non-motorized vehicles

3.2.7 Average Daily Traffic (ADT)

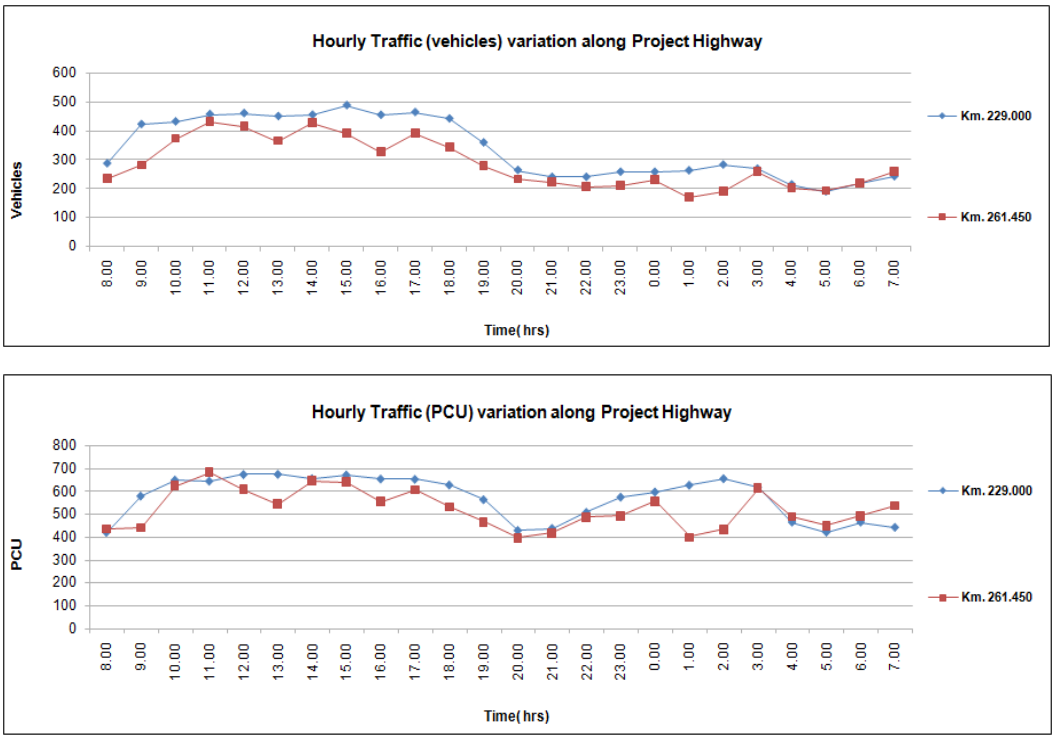
The classified traffic volume count data collected is analyzed to assess the traffic intensity along the project highway. Table 4.3 presents the summary of Average Daily Traffic (ADT in number of vehicles) at the two survey locations with salient findings as shown below. The detailed calculations are presented in **Annexure – 1.**

- The ADT along different sections of the project Highway varies between a mini mum of total 6861 vehicles (12567 PCUs) at Km. 261.450 to a maximum of total 8115 vehicles (13746 PCUs) at Km. 229.000.
- The share of non-motorized vehicles along the project highway is negligible.
- The share of tollable traffic as a percentage of ADT along project Highway varies between a minimum of 82% at Km. 229.000 to a maximum of 94% at Km. 261.450.
- PCU ratio on the project corridor came out to be 1:1.69, thereby signifying a ma jor share of two-wheelers and cars in the total traffic flow.
- The hourly variation in the total traffic (vehicles and PCUs) at the TVC locations along project Highway is presented in Figure 3.2, reveals that there is not much variation in passenger and commercial traffic intensity over the day. At each lo cation, reduced traffic levels have been observed during night hours for passen ger vehicles.

Table 3.3: Average Daily Traffic (ADT)

Vehicle Type	Km. 229.000	Km. 261.450
Car	3298	3272
Taxi	418	438
Three Wheelers	293	20
Two Wheelers	1136	358
Mini Bus	123	149
Bus	670	644
LCV (3T)	12	7
LCV (4T)	322	236
2 Axle	855	820
3 Axle	352	290
MAV (4 to 6 Axle)	624	624
MAV (< 6 Axle)	0	0
Tractor without trailer	0	0
Tractor with trailer	10	0
Cycle	1	0
Cycle Rickshaw	0	0
Hand Cart	0	0
Animal Drawn	0	0
Others	1	3
Tollable Traffic (vehicles)	6662	6473
Tollable Traffic (PCUs)	12825	12358
Total Traffic (vehicles)	8115	6861
Total Traffic (PCUs)	13746	12567

Figure 3.2: Hourly traffic variation



3.2.8 Seasonal variation factor

Traffic fluctuates by the hour, by the day and by the month. Hence, it is essential to estimate a factor which provides a relationship between Annual Average Daily Traffic (AADT) and Average Daily Traffic (ADT) for the month corresponding to the traffic surveys. While hourly and daily fluctuations have been accounted for by conducting surveys for continuous 168 hours (7 days), the Seasonal Correction Factor (SCF) will be required to estimate AADT from this ADT data.

The seasonal variation factor is normally estimated using the past fuel sales data collected from the existing petrol bunks or from existing toll plazas along the project stretch. The petrol (MS) and diesel (HSD) sales data in liters has been collected from petrol bunks along the project stretch near traffic volume count locations for the past one year and analyzed for the monthly variation in the sales of fuel. Table 3.4 and Figure 3.3 presents the analysis to assess the seasonal variation factor.

Figure 3.3: Fuel seasonal variation

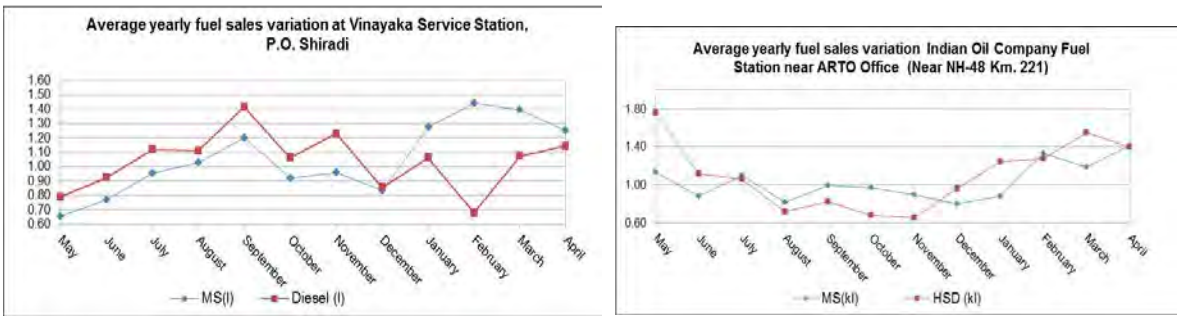


Table 3.4: Seasonal variation for Fuel at petrol bunks near Shiradi and Donigal

Vinayaka Service Station, P.O. Shiradi					Indian Oil Company Fuel Station near ARTO Office (Near NH-48 Km. 221)				
Month of the year	2014-15		2014-15		Month of the year	2014-15		2014-15	
	MS(l)	SF	Diesel (l)	SF		MS(kl)	SF	HSD (kl)	SF
May	18572	0.66	66098	0.79	September	65	1.13	111	1.76
June	15875	0.77	56553	0.92	October	83	0.88	175	1.12
July	12776	0.95	46665	1.12	November	67	1.10	185	1.06
August	11829	1.03	46986	1.11	December	90	0.82	270	0.72
September	10134	1.20	36862	1.42	January	74	0.99	238	0.82
October	13222	0.92	49106	1.06	February	76	0.97	288	0.68
November	12695	0.96	42386	1.23	March	82	0.90	298	0.66
December	14597	0.83	61120	0.85	April	92	0.80	204	0.96
January	9568	1.27	49153	1.06	May	83	0.88	157	1.24
February	8456	1.44	76962	0.68	June	55	1.33	153	1.28
March	8741	1.39	48558	1.07	July	62	1.18	126	1.55
April	9748	1.25	45550	1.15	August	52	1.41	140	1.40
Average factor	12184		52167		Average factor	73		195	

The traffic surveys are conducted in the month of September, year 2015. From the analyzed fuel sales data, the seasonal variation factors are taken as shown in Table 3.5, for AADT calculations.

Table 3.5: Seasonal Variation Factors for AADT

S. No.	TVC Location	Petrol vehicles	Diesel vehicles
1	Km. 229.000	0.88	1.12
2	Km. 261.450	0.92	1.06

3.2.9 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT in no of vehicles) at the survey locations is obtained by multiplying the Average Daily Traffic (ADT) with the seasonal correction factor. The AADT of vehicles for the year 2015 at the survey locations along the Project Highway is presented in Table 3.6.

Table 3.6: Annual Average Daily Traffic (AADT)

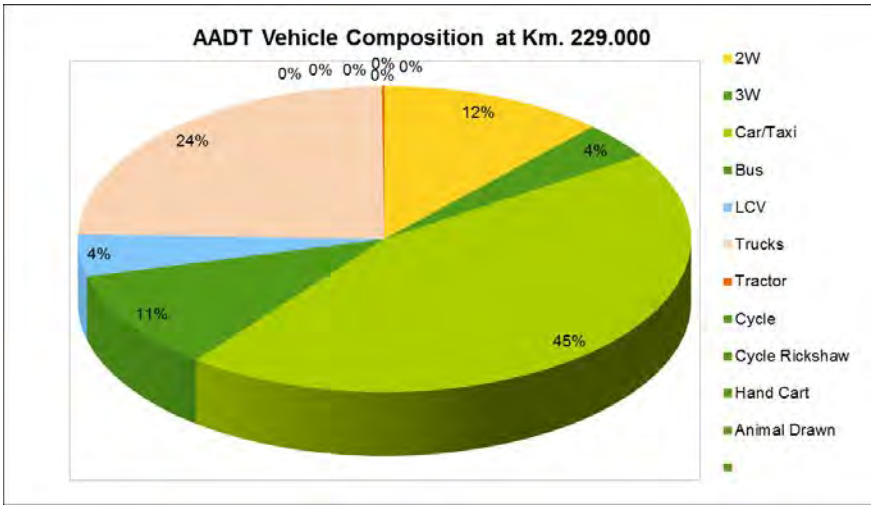
Vehicle Type	Km. 229.000	Km. 261.450
Car	3298	3239
Taxi	468	464
Three Wheelers	328	21
Two Wheelers	1000	329
Mini Bus	138	158
Bus	750	683
LCV (3T)	13	7
LCV (4T)	361	250
2 Axle	958	869
3 Axle	394	307
MAV (4 to 6 Axle)	699	661
MAV (< 6 Axle)	0	0
Tractor without trailer	0	0
Tractor with trailer	11	0
Cycle	1	0
Cycle Rickshaw	0	0
Hand Cart	0	0
Animal Drawn	0	0
Others	1	3
Tollable Traffic (vehicles)	7066	6632
Tollable Traffic (PCUs)	13965	12870
Total Traffic (vehicles)	8420	6993
Total Traffic (PCUs)	14859	13066

3.2.10 AADT Modal Split

a) Km. 229.000

- ✓ Car and 2 Wheeler Traffic is about 45% and 12% respectively in the total traffic along the corridor at this location, as project Highway has a fair proportion of local traffic at some locations due to the presence of hamlets and towns as shown in Figure 3.4.
- ✓ The share of non motorized vehicles is almost negligible.
- ✓ The commercial vehicles contribute 29% and buses constitute only 11% of the total vehicles using the corridor at this location.
- ✓ The share of 3 Wheelers is 4% in the total traffic and almost negligible.

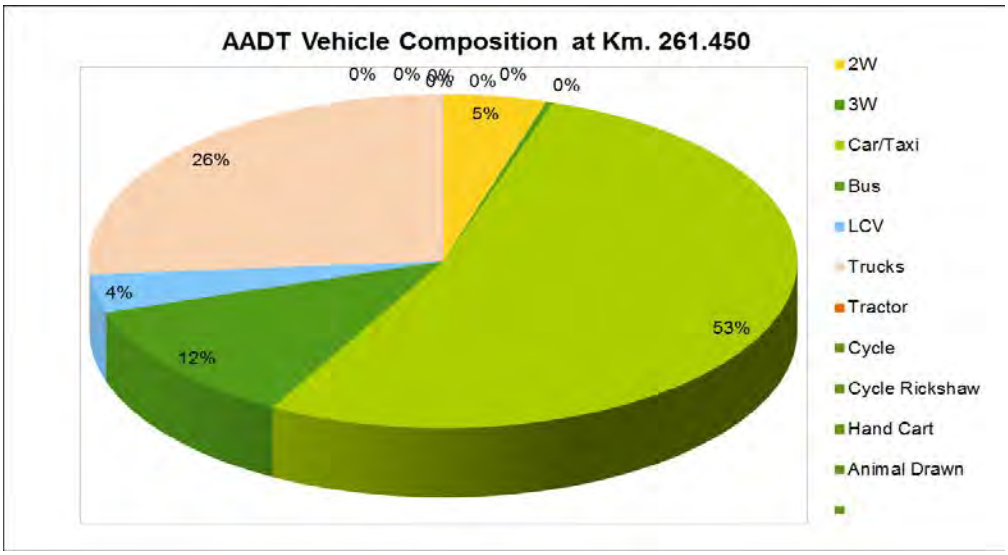
Figure 3.4: AADT vehicle composition at Km. 229.000



b) Km. 261.450

- ✓ Car Traffic is about 53% in the total traffic along the corridor at this location.
- ✓ The share of non motorized vehicles is almost negligible.
- ✓ The commercial vehicles contribute 13% and buses constitute 8.3% of the total vehicles using the corridor.
- ✓ Two wheelers constitute 30% of the total traffic as shown in Figure 3.5.
- ✓ The share of 3 Wheelers is almost negligible.

Figure 3.5: AADT vehicle composition at Km. 261.450



3.2.11 Fast and slow moving traffic – Total and Tollable Traffic

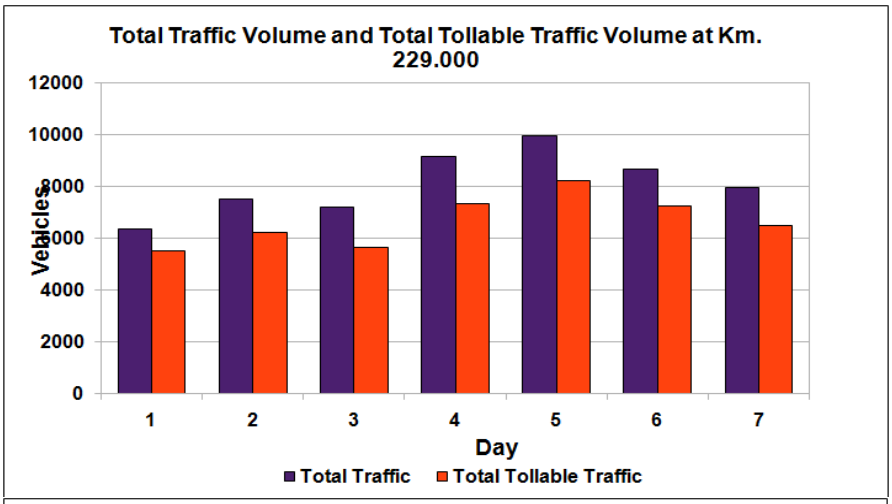
The bifurcation of traffic in terms of fast and slow moving vehicles along the highway at different traffic survey locations is presented in Table 3.7. The variation of tollable traffic with total traffic is presented in Figure 3.6.

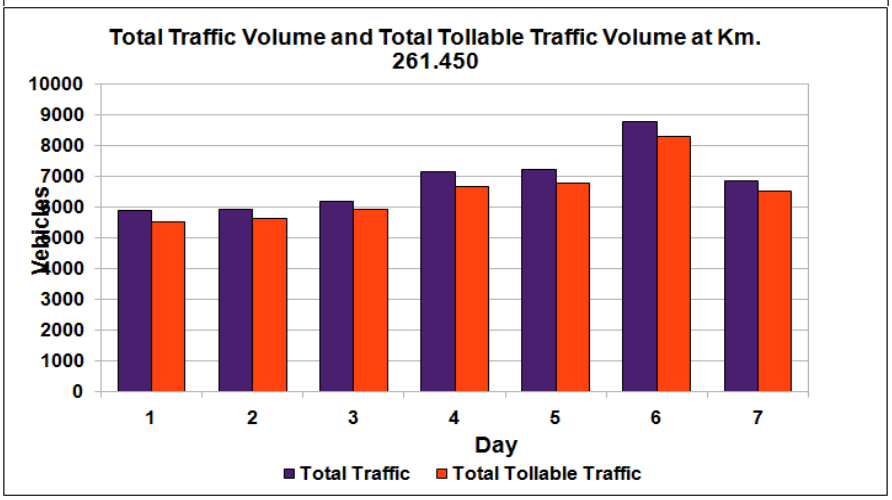
Table 3.7: Fast and slow moving traffic

Vehicle Type	ADT		AADT	
	Km. 229.000	Km. 261.450	Km. 229.000	Km. 261.450
Fast moving Vehicles	8113	6858	8418	6990
Slow moving Vehicles	2	3	2	3
Total Traffic	8115	6861	8420	6993

Figure 3.6: Total and Tollable Traffic

i.





3.2.12 Peak Hour Factor

The peak hour factor is defined as the traffic volume during peak hour expressed as a percentage of AADT. The day (04:00 AM to 16:00 PM) and night time (16:00 PM to 04:00 AM) peak factors are calculated at the traffic count locations as given in Table 4.8, indicate fairly uniform distribution of the traffic volume during the day time and night peak hour factors indicates slightly higher traffic volumes during the peak hour at night time.

Table – 3.8: Peak hour factor

S. No.	TVC Location	Peak Hour	Peak hour volume (PCU)	Peak hour volume (Veh)	AADT (Veh)	Peak Hour Factor (%)
1	Km. 229.000	15.00 to 16.00	674	488	8117	6.0%
2	Km. 261.450	11.00 to 12.00	427	684	6790	6.3%

3.3 Turning Movement Survey and Junction Improvement

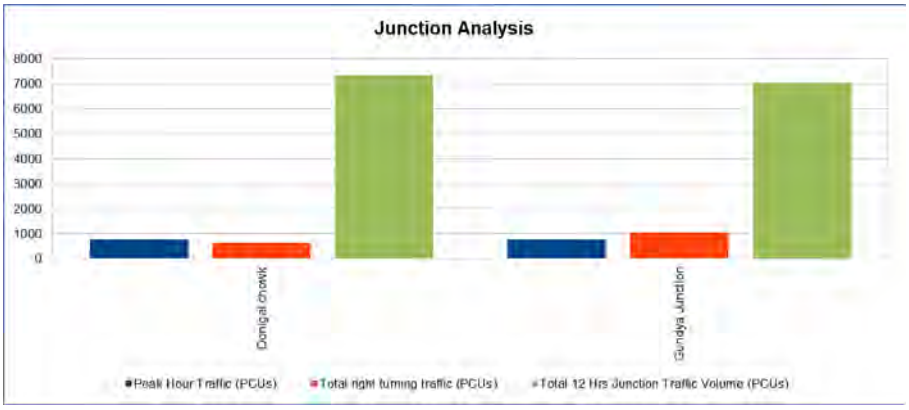
The mid-block traffic volume count stations are located to capture the pattern of the traffic plying on the project stretch. Apart from these traffic volume counts, for the study of the road network around the project corridor, 2 junctions are identified for the turning movement surveys. The traffic pattern is considerably influenced by these junctions, either in case of passenger vehicles or goods or both also. 12 hours mode wise turning movement counts have been taken on all the legs of these junctions. The traffic volume levels and their characteristics at these intersections are presented in Table 3.9. The leg wise classified traffic volume counts are presented in **Annexure – 2**.

Table 3.9: Traffic Volume Characteristics at Intersections

S. No.	Name/ Ch. of the Junction	Type of Junction	Total 12 Hrs Junction Traffic Volume (Veh)	Total 12 Hrs Junction Traffic Volume (PCUs)	Peak Hour	Peak Hour Traffic (Veh)	Peak Hour Traffic (PCUs)	Total right turning traffic (PCUs)	% Total Right turning traffic in total traffic	Total Traffic Entering Project Stretch (PCUs)	Total Traffic Leaving Project Stretch (PCUs)	Total Traffic moving along Project Stretch (PCUs)
1	Donigal chowk	3 Legged	5610	7339	12.00 to 13.00	544	754	640	9%	621	847	5871
2	Gundya Junction	3 Legged	4900	7042	15.45 to 16.45	444	742	1046	15%	902	796	5346

The peak hour flow has been observed to be maximum at Donigal chowk junction (544 PCUs) followed by Gundya junction (444 PCUs. The number of right turning traffic in the total junction flow is the index value, which indicates the intensity of vehicle-vehicle conflict at the intersection. From the above table, it is inferred that, maximum right turning traffic is at Gundya junction (1046 PCUs) followed by Donigal chowk junction with 640 PCUs. The share of right turning traffic is observed to be high at Gundya junction (15%) followed by Donigal chowk junction with 9%. The total junction volume, peak hour volume along with right turning traffic at all the intersections are presented in Figure 3.7.

Figure 3.7: Total junction, peak hour, right turning traffic volume



A road junction is a location where multiple roads intersect, allowing vehicular traffic to change from one road to another. Managing the flow of traffic across the junction became of increasing importance, to minimize junction delays, vehicle operating costs and to improve the safety of the road users. As per IRC: 65 -1976 and IRC: SP: 41 – 1994, the junction improvement along the project stretch suggested based on the peak hour traffic volume is presented in Table 3.10.

Table 3.10: Junction improvement

S. No.	Name/ Ch. of the Junction	Type of Junction	Peak Hour Traffic (Veh)	Peak Hour Traffic (PCUs)	Junction Improvement
1	Donigal chowk	3 Legged	544	754	As per IRC: 65, Rotary intersection is warranted, as the junction peak hour traffic is less than 3000 vehicles.
2	Gundya Junction	3 Legged	444	742	As per IRC: 65, Rotary intersection is warranted, as the junction peak hour traffic is less than 3000 vehicles.

4 AXLE LOAD SURVEY

4.1 Objective and Scope of Axle Load Surveys

The objective of undertaking Axle load surveys at the pre-identified locations along project highway is to estimate the mode wise and direction wise Vehicle Damage Factors (VDFs) at all the surveyed locations to be used in estimation of design traffic loading on Flexible pavement and to obtain axle load spectrum to be used in design of rigid Pavement at Toll Plaza locations.

4.2 Axle Load Survey

Traffic loading has a significant impact on pavement performance and design. This is because the damage that vehicles create to a road depends very strongly on the axle loads of the vehicles. The exact relationship is influenced by the type of road structure and the way the road deteriorates but a `fourth power' damage law gives a good approximation. Axle load studies have been conducted using portable axle load pads. While selecting the location, care has been taken to see that these locations would facilitate capturing of all types of vehicles and loading patterns. The survey has been conducted in both the directions.

4.3 Vehicle Types Captured

Since the damage caused by the light vehicles such as two wheelers, three wheelers and cars etc to the pavement is negligible when compared with that of heavy commercial vehicle, hence only the commercial vehicles like LCV, 2 Axle, 3 Axle, M Axle, Mini Bus and Bus have been aimed to capture during the survey and all other vehicles have been omitted from survey.

4.4 Survey Procedure and sample size

The axle load pads have been placed on either side of the carriageway in a staggered manner to measure the axles in both the directions. These pads have been placed by digging up a pit and filling with sand so that they are at same level with the existing road. The time of measurement, the axle load, and the axle load group has been recorded and the commodity type has been also noted for each vehicle. Traffic count of vehicles has been simultaneously done with axle load survey to know the percentage of sample captured. The following Table 4.1 presents these details.

Table 4.1: Percentage Sample

Vehicle Type	Km. 232.000		Km. 263.500	
	Towards Sakleshpur	Towards Mangalore	Towards Sakleshpur	Towards Mangalore
2Axle	21%	20%	20%	22%
3Axle	22%	19%	21%	19%
M Axle	20%	22%	29%	25%

Vehicle Type	Km. 232.000		Km. 263.500	
	Towards Sakleshpur	Towards Mangalore	Towards Sakleshpur	Towards Mangalore
LCV	19%	20%	20%	23%
BUS	11%	9%	8%	9%
Mini Bus	12%	10%	4%	6%

4.5 Axle Load Data Analysis

The data collected from the Axle Load survey has been compiled and analyzed through "fourth power" pavement damage law to arrive at the vehicle damage factor (VDF) as given below.

The Load Equivalency Factor is derived using the following relationships:

$$\text{Load Equivalency Factor} = \left(\frac{AxleLoad}{Std.AxleLoad}\right)^4$$

$$\text{VDF} = \left(\frac{\Sigma Equivalent\ .load\ no.\ axles\ in\ the\ load\ group}{No.\ of\ Vehicles\ carrying\ the\ Axle\ group}\right)$$

The vehicle damage factors have been calculated using the standard axle loadings given in IRC: 37-2012. The standard axle loadings adopted have been presented in Table 4.2.

Table 4.2: Standard Axle loads

Axle Configuration	Standard Axle load (Tonnes)*	Remarks
Single Wheel, Single Axle	6.50	As per IRC: 37-2012
Dual Wheel, Single Axle	8.00	As per IRC: 37-2012
Dual Wheel, Tandem Axle group	14.80	As per IRC: 37-2012
Dual Wheel, Tridem Axle group	22.40	As per IRC: 37-2012

Direction wise VDF for each mode of commercial traffic has been estimated at each location. Results of axle load surveys have been presented in Table 4.3. At all survey locations, the VDF values are within permissible limits as shown in Table.

Axle load spectrum is defined as a frequency distribution of axle weights, of a given axle type, into weight ranges. Axle types are classified by the spacing between consecutive axles. Axles that are far apart (usually more than 2.44m) are called single axles. Two axles close together are called tandem axles; three axles spaced close together are triple axles; and four axles closely spaced are quadruple axles. Axle load spectrum is also referred to as axle load distribution.

Table 4.3: Vehicle Damage Factor (VDF)

Vehicle Type	Km. 232.000		Km. 263.500	
	Towards Sakleshpur	Towards Mangalore	Towards Sakleshpur	Towards Mangalore
2 Axle	1.912	1.781	2.355	1.995
3 Axle	4.658	3.149	5.479	2.828
4 Axle	9.627	3.658	10.767	3.345
5 Axle	9.462	5.751	-	-
6 Axle	-	1.113	-	-
LCV	0.815	0.203	0.743	0.190
Bus	0.563	0.369	0.361	0.552
Mini Bus	0.126	0.151	0.108	0.117

Normalized axle load spectrum provides proportions of total axle loads that occur within designated load ranges. The combined axle load spectra is used to facilitate comparison of axle load spectra obtained for different truck volumes or sample sizes. Detailed axle load and load spectrum analysis has been presented in **Annexure - 3.**

4.6 State wise contribution

The results obtained from the registered number plate information were used to identify the project influence area. The ratio of the total traffic originated/destined to a particular zone to the total traffic gives the influence factor for the particular zone. The influence zone information has been obtained from the analysis of collected number plate data during axle load survey. A comparative study of the influence factors indicated that the state of Karnataka, where the project stretch lies is the major influence region for passenger vehicles with an influence factor of about 100% and 70 to 80% for commercial vehicles. The states of Tamilnadu and Andhra Pradesh which are very close to the project stretch are found to have limited influence as shown in Table 4.4. As the influence of other states is negligible, only Karnataka state socio economic factors have been accounted in the derivation of traffic growth factors for future year traffic projections.

Table 4.4: State wise vehicle contribution

State	2 Axle	3 Axle	4 Axle	5 Axle	6 Axle	LCV	Bus	Mini Bus
Km. 232.000								
Karnataka	94%	76%	63%	100%	100%	87%	100%	100%
Tamilnadu	2%	13%	33%	0%	0%	10%	0%	0%
Andhra Pradesh	0%	8%	4%	0%	0%	0%	0%	0%

State	2 Axle	3 Axle	4 Axle	5 Axle	6 Axle	LCV	Bus	Mini Bus
Haryana	4%	4%	1%	0%	0%	2%	0%	0%
Km. 263.500								
Karnataka	90%	62%	61%	-	-	98%	100%	100%
Tamilnadu	7%	21%	31%	-	-	2%	0%	0%
Andhra Pradesh	3%	0%	8%	-	-	0%	0%	0%
Haryana	0%	4%	0%	-	-	0%	0%	0%
Rajasthan	0%	13%	0%	-	-	0%	0%	0%

5 ORIGIN-DESTINATION SURVEY AND ANALYSIS

The origin and destination of trips on the existing road is needed to estimate the information regarding travel characteristics of different users on the project road. The origin – destination data is also needed for identifying the major influence zones along the road, as traffic growth in the project road is directly dependent upon the growth in economic activity of the influencing area. These surveys are important in defining the traffic movement and travel desire patterns in the transport network along the study corridor and to derive the traffic growth rates based on the information of trip ends and travel characteristics of the road users of different types. These surveys are carried out for one day in both directions at the survey locations as defined in this report. The location of origin and destination zones is determined in relation to each individual station and possibility of traffic diversion to the project road from/to other routes. Appropriate locations are selected so as to conduct interviews without affecting movement of other vehicles.

5.1 Road Side Interview Method

The vehicles are stopped on random sample basis with the help of a traffic police. Designated trained enumerators have interviewed the traffic and entered the data in the well-designed format. A volume count survey was carried out simultaneously to get the number of vehicles passing in both the directions in order to assess the sample size. This survey is limited to 2W, Standard Bus, Mini Bus and Car in passenger vehicles category, LCV and Trucks (2 Axle / 3 Axle / M Axle) in freight vehicle category. The following pertinent information of travel has been collected during the interview from the commuters. The sample size for goods and passenger vehicles in percentage is presented in Table 5.1.

- Origin and destination of trip
- Trip purpose
- Type of vehicle
- Commodity type
- Occupancy
- Trip length
- Purpose and Tonnage

Table 5.1: O – D Sample size

Vehicle type	Km. 232.000	Km. 263.500
2 W	20%	24%
Car	26%	22%
Mini Bus	24%	29%
Bus	26%	24%
LCV	31%	36%
Truck	22%	30%
M Axle	34%	39%

5.2 Zonal Code

Traffic movement on a particular stretch depends on its zone of influence. The zones of influence can be external and/or internal. The zones within 20 Km around survey locations are considered as internal zones for non-commercial passenger vehicles and the zones with in Hassan and Dakshin Kannada districts are considered as internal zones for commercial vehicles and those outside are considered as external zones. Appropriate zoning system is adopted and coding is done for zones, type of vehicle and its origin and destination. The zonal distribution adopted for analysis is given in Table 5.2.

Table 5.2: Zonal code for O-D analysis

Zone No	DESCRIPTION	DISTRICT	STATE
1	Donigal, Sakleshpur, Achangi, Jambaradi, Agani, Kadumane, Maranhally, Manjarabad, Hasade, Narvey, Devihalli	Hasan	Karnataka
2	Byakarvalli, Kaginahare, Hongadahalla, Jaagate, Kyanahalli, Kesaganahalli, Hullahalli, Hallibailu, Anemahal, Chikkasatigala	Hasan	Karnataka
3	Hasan, Doddagadduvalli, Belur, Dassur, Pura, Gorur, Hagare, Kuppe, Alur, Yadur, Guddenahalli, Uddur	Hasan	Karnataka
4	Kodlipet, Agali, Arkalagoud, Mandira, Marve, Abbana, Bhage, Bellupet, Kadalu	Hasan	Karnataka
5	Chennarayapatna, Hosur, Anekere, Hole narsipur, Kumbhenahalli, Udaypura, Shantigrama, Halekote, Mavinakere	Hasan	Karnataka
6	Arsikere, Haranhalli, Gandasi, Attavara, Dudda, Chikkakadalur, Heragu, Madenur, banavar	Hasan	Karnataka
7	Halebidu, Javagal, Banavara, Salagame, Gangur, Arakere, Handralu, Mosale, Chikkur	Hasan	Karnataka
8	Gundya, Shiradi, Udane, Bhandihole, Kowkradi, Rekhya, Shibaje, Shishilla, Kalanja	Dakshin Kannad	Karnataka
9	Kulkunda, Kombaru, Konaje, Bilinele	Dakshin Kannad	Karnataka
10	Puttur, mani, mura, Narimogru, Sarve, Belandoor, Jalsoor, sulya, Perlampady, Bellare, Savanoor, Devachalla, Guttigaru	Dakshin Kannad	Karnataka
11	Mangalore, Adyar, Vittal, Alike, Ullal, Bantwal, Kolnadu	Dakshin Kannad	Karnataka
12	Belthangady, Maadi, Kuvettu, Charmadi, Ujire, Belalu, Machina	Dakshin Kannad	Karnataka
13	Mulur, Moodbidri, Kuppepadav, Thodar, Hejamadi, Nadsal, Mundkur	Dakshin Kannad	Karnataka
14	Madikeri, Somvarpet, Kodagu, Subrahmanya, Sampaje, Shanivarasanthe	Kodagu	Karnataka
15	Chelavara, Virajpet, Tala kaveri, Napoklu, Pollibetta, Gonikoppal	Kodagu	Karnataka
16	Ponnampet, Kutta, Kurchi, Kanoor, Nagarahole	Kodagu	Karnataka
17	Kalasa, Shringeri, Koppa, Mudigere, Chikmagalore	Chikmagaloore	Karnataka

Zone No	DESCRIPTION	DISTRICT	STATE
18	Kemmangundi, Narasimha rajpura, Tarikere, Vittala	Chikmagaloore	Karnataka
19	Kadur, Birur, Ajjampur, Pattanagere, Tadaga	Chikmagaloore	Karnataka
20	Udpi,suratkal,mudibidri,baltangadi,perudur,kumdapura,malpe,gangolim,kollur,shrirur,baindur,kakundur,karkal	Udupi	Karnataka
21	shimoga,hosangara,mandagadde,tirtahalli,sagar	shimoga	Karnataka
22	shikaripur,sirelkoppa,banvasi,sorab,tunga,bhadravathi,	shimoga	Karnataka
23	my-sore,chamrajnagar,gundlupet,nanjangud,tirumpur,narsipur,hunsur,piryapatna,saligra,somanathpur,kolligad,yelandur	Mysore, chamrajnagar	Karnataka
24	mandya,maddur,bellore,pandavapura,shrirangapatna, Malavalli, Sivasamudram	Mandya	Karnataka
25	benglore,devanahelli,hoskot,anegal,magadi,ramnagaram,chennpatnam,kanakapura,nelamangla,dodbollapur	Banglore Rural	Karnataka
26	Bangalore	Banglore Urban	Karnataka
27	kolar,sidlagatta,banganapet,mallur,mulbagal,rayapadu,chintamani,chikballpur,gouribidunur,gudibanda,sidlagatta	Kolar	Karnataka
28	tunkuru,sira,chiknayakanhalli,gubbi,misandrakaligal,yadiyur	Tumkur	Karnataka
29	koratagiri,madhugiri, Hulikunt, Pavagada, Timmani	Tumkur	Karnataka
30	chitradurg,belaguru,hosedurg,dharmapura,hiliyu,chellakeri,	chitradurg	Karnataka
31	Parasurampurm,tiruvennur,molakalmuru	chitradurg	Karnataka
32	Davangir, Haveri, Uttar Kannad	Districts	Karnataka
33	Ballary, Koppal	Districts	Karnataka
34	Gadag, Dharwad, Belgaum	Districts	Karnataka
35	Bagalkot, Bijapur	Districts	Karnataka
36	Raichur, Kalburji, Bidar	Districts	Karnataka
37	Tamilnadu	States	
38	Kerala	States	
39	Andhra pradesh and Telangana	States	
40	Orissa, chattisgad, jharkand, westbengal, bihar,	States	
41	North east states	States	
42	Maharashtra and Gujarat	States	
43	Madhyapradesh, uttarpradesh	States	

Zone No	DESCRIPTION	DISTRICT	STATE
44	Rajasthan, Haryana, Punjab	States	
45	J & K, Himachal Pradesh, Uttarakhand	States	

5.3 O-D Analysis

A total of 1775 vehicles have been interviewed during the O-D survey at Location Km. 232.000. Number of goods vehicles interviewed (LCV and trucks) is 776, which represents about 43% of the total vehicles. The number of passenger vehicles (cars, buses) interviewed is 999, which represent about 57% of the total vehicles. A total of 1730 vehicles have been interviewed during the O-D survey at Location Km. 263.500. Number of goods vehicles interviewed (LCV and trucks) is 719, which represents about 41% of the total vehicles. The number of passenger vehicles (cars, buses) interviewed is 1011, that represent about 59% of the total vehicles.

The findings for the analysis of O-D survey are shown in Table 5.3. The O – D trip end matrices have been prepared and mode wise distribution of trips between internal and external zones has been derived on origin destination pairs as furnished in **Annexure – 4.**

Table 5.3: Zonal Trip distribution

Vehicle Type	Km. 232.000				Km. 263.500			
	I-I	I-E	E-I	E-E	I-I	I-E	E-I	E-E
2 W	25%	52%	23%	0%	16%	40%	44%	0%
Car	3%	17%	8%	72%	0%	2%	2%	96%
Mini Bus	0%	25%	25%	50%	0%	39%	61%	0%
Bus	1%	18%	11%	70%	0%	54%	36%	10%
LCV	4%	27%	20%	49%	0%	56%	24%	20%
Truck	1%	12%	13%	74%	0%	44%	43%	13%
M Axle	0%	6%	2%	92%	0%	45%	46%	9%

Note: I-I: Internal to Internal, I-E: Internal to External, E-I: External to Internal, E-E: External to External

5.4 Commercial traffic Trip Interaction

The project corridor plays a very important role in meeting the mobility demands of traffic, both goods and passenger, moving among the districts of Dakshin Kannada, Hassan and Bangalore. These findings are based on the trips intercepted on the project corridor during the traffic surveys. From the generated trip end matrices at survey locations, it is observed that most of the Truck and M axle trips are distributed between Mangalore and Bangalore. 5% to 8% of the commercial trips are observed from other states like Kerala, Andhra Pradesh and Tamilnadu to Mangalore.

5.5 Trip Length distribution

The O-D data collected has been analyzed to study the trip length distribution over the entire project stretch. Following are the salient findings from O-D information collected from the survey.

a) Km. 232.000

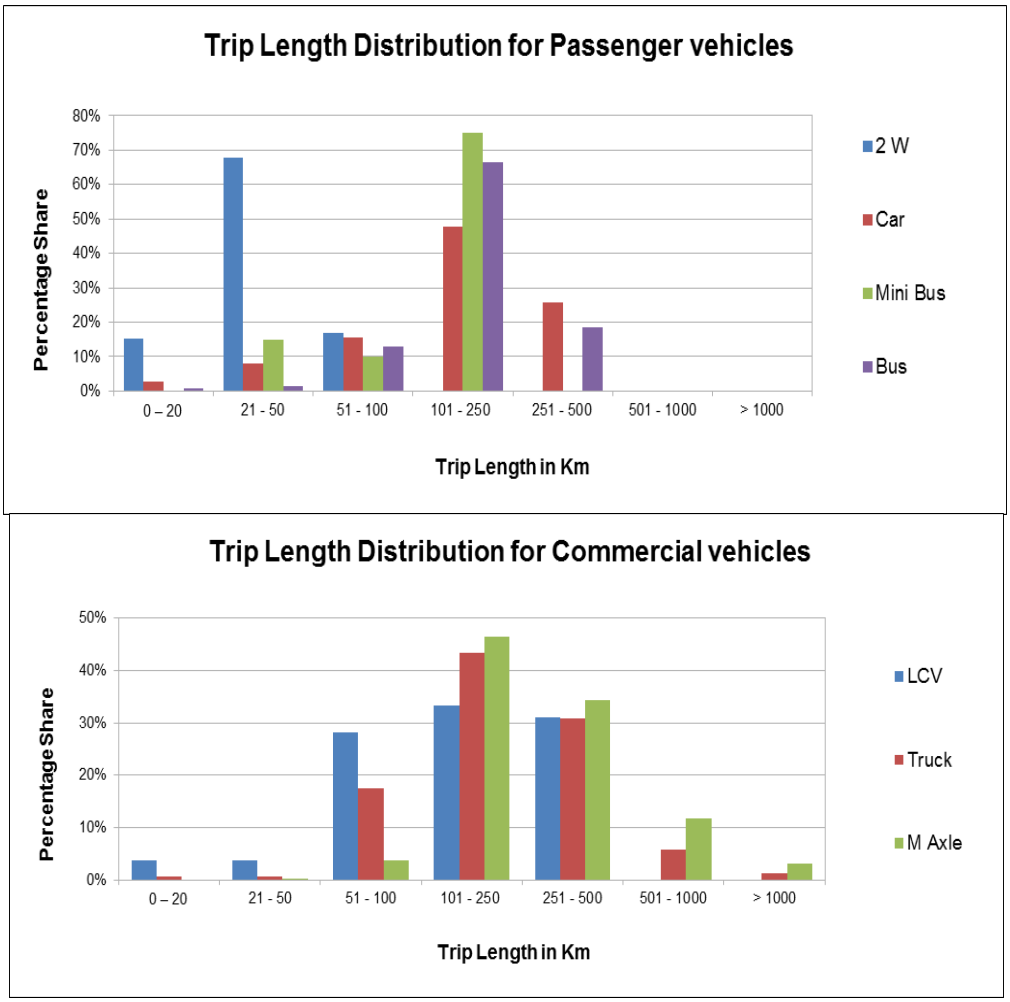
- Nearly 42% of all the vehicles are travelling from 100 to 250 Km.
- 41% of goods vehicles are travelling more than 250 Km.
- 74% cars are travelling less than 250 Km.
- 14% vehicles are travelling less than 50 Km.

The mode wise average trip length is presented in Table 5.4 and the trip length distribution of all vehicles is presented in Figure 5.1.

Table 5.4: Average Trip length in Km at Km. 232.000

Vehicle Type	Total Vehicles	0 – 20	21 - 50	51- 100	101- 250	251 - 500	501 - 1000	> 1000	Average Trip Length (Km)
2 W	202	15%	68%	17%	0%	0%	0%	0%	41
Car	637	3%	8%	16%	48%	26%	0%	0%	178
Mini Bus	20	0%	15%	10%	75%	0%	0%	0%	127
Bus	140	1%	1%	13%	66%	19%	0%	0%	196
LCV	135	4%	4%	28%	33%	31%	0%	0%	191
Truck	327	1%	1%	17%	43%	31%	6%	1%	260
M Axle	314	0%	0%	4%	46%	34%	12%	3%	331

Figure 5.1: Trip length distribution



b) Km. 263.500

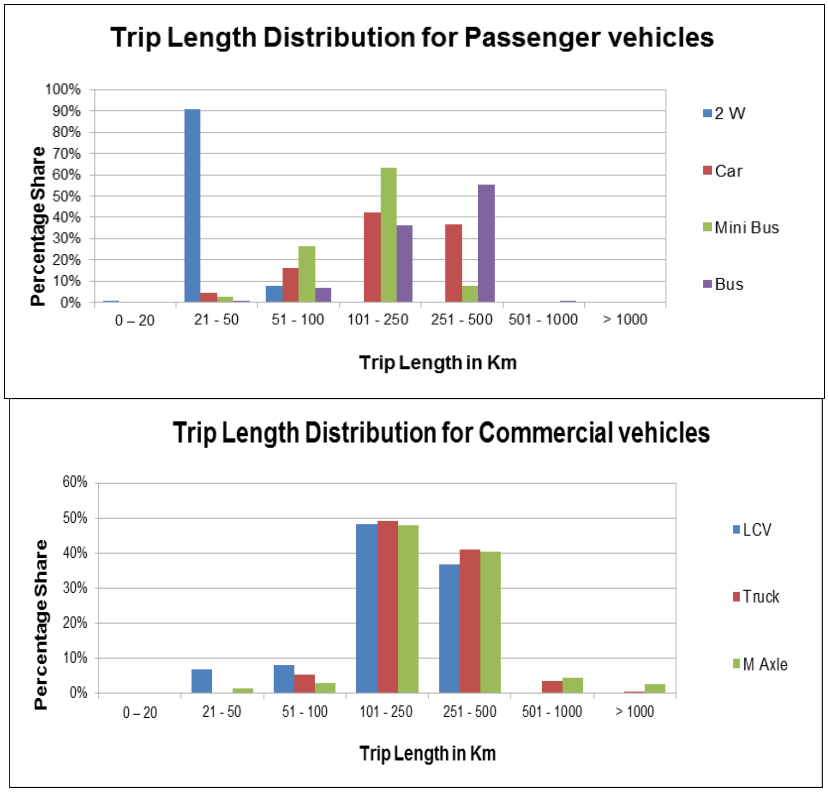
- Nearly 42% of all the vehicles are travelling between 100 to 250 Km.
- 48% of goods vehicles are travelling between 100 to 250 Km.
- 20% of cars are travelling less than 100 Km.
- 8% of the all vehicles are travelling less than 50 Km.

The mode wise average trip length is presented in Table 5.5 and the trip length distribution of all vehicles is presented in Figure 5.2.

Table 5.5: Average Trip length in Km at Km. 263.500

Vehicle Type	Total Vehicles	0 – 20	21 - 50	51 - 100	101 - 250	251 - 500	501 - 1000	> 1000	Average Trip Length (Km)
2 W	100	1%	91%	8%	0%	0%	0%	0%	43
Car	738	0%	4%	16%	42%	37%	0%	0%	214
Mini Bus	38	0%	3%	26%	63%	8%	0%	0%	140
Bus	135	0%	1%	7%	36%	56%	1%	0%	259
LCV	87	0%	7%	8%	48%	37%	0%	0%	218
Truck	365	0%	0%	5%	49%	41%	4%	1%	258
M Axle	267	0%	1%	3%	48%	40%	4%	3%	289

Figure 5.2: Trip length distribution



5.6 Commodity Distribution

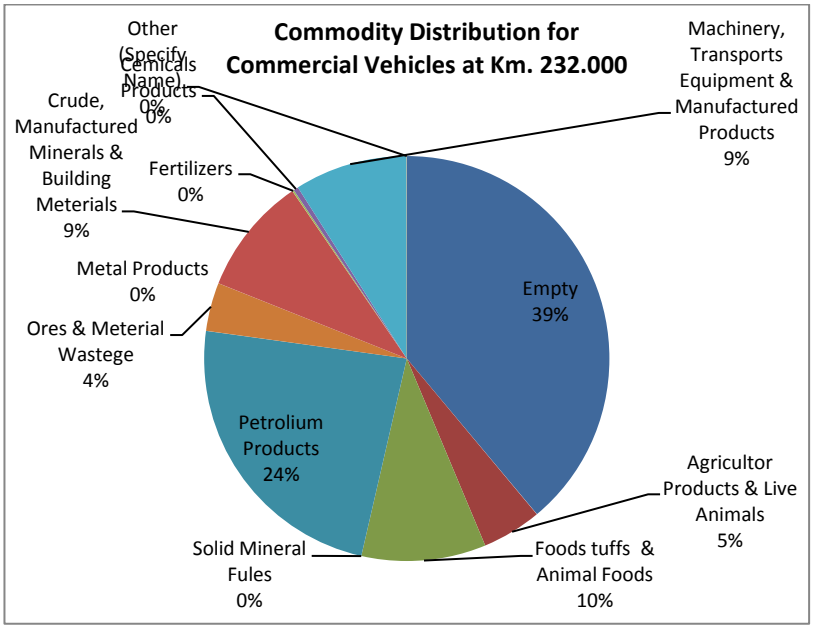
The O-D data collected has been analyzed to study the type of commodities carried by the commercial vehicles along the entire project stretch. The percentage of each type of commodity carried by each mode of commercial vehicle along the project stretch at different survey locations is presented in Table 5.6 and in Figure 5.3. From the analyses it can be concluded that the use of LCVs are transporting all types of Agriculture Products, Live Animals and Foods tuffs & Animal Foods. Crude, Manufactured Minerals, Building Materials and Petroleum Products are transported primarily by Trucks and M Axle vehicles. Trucks are the preferred mode for transporting Machinery, Transport Equipment & Manufactured Products along the project stretch. At all the survey locations, 30 to 60% of the empty vehicles are reported. Trip end commodity distribution matrices are prepared as furnished in **Annexure – 4**.

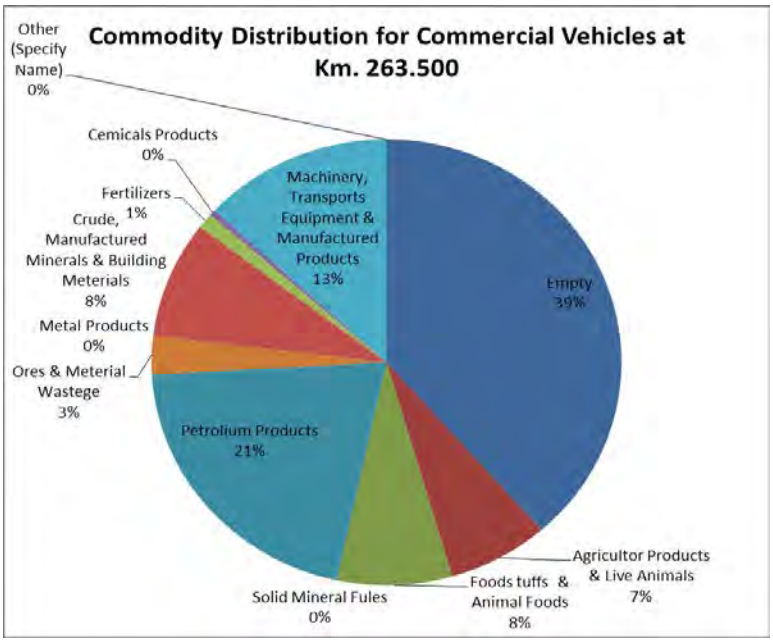
Table 5.6: Percentage (%) of commodity distribution

Code	Commodity	Km. 232.000			Km. 263.500		
		LCV	Truck	M Axle	LCV	Truck	M Axle
0	Empty	66%	39%	27%	40%	39%	38%
1	Agriculture Products & Live Animals	11%	3%	4%	21%	6%	3%
2	Foods tuffs & Animal Foods	13%	12%	6%	17%	10%	2%

Code	Commodity	Km. 232.000			Km. 263.500		
		LCV	Truck	M Axle	LCV	Truck	M Axle
3	Solid Mineral Fuels	0%	0%	0%	0%	0%	0%
4	Petroleum Products	5%	18%	38%	17%	15%	30%
5	Ores & Material Wastage	0%	6%	4%	2%	1%	6%
6	Metal Products	0%	0%	0%	0%	0%	0%
7	Crude, Manufactured Minerals & Building Materials	5%	8%	12%	2%	9%	9%
8	Fertilizers	0%	0%	0%	0%	1%	1%
9	Chemical Products	0%	0%	1%	0%	1%	0%
10	Machinery, Transports Equipment & Manufactured Products	0%	13%	9%	0%	19%	10%
11	Others	0%	0%	0%	0%	0%	0%

Figure 5.3: Commodity distribution





5.7 Distribution of trips by trip purpose

From the Table 5.7, it can be inferred that approximately 40 to 50% trips are performed for work and business purpose, followed by social and home return purpose. For work purpose, cars are the preferred vehicle type.

Table 5.7: Trip Purpose

Vehicle Type	Total Vehicles	Work	Business	Education	Social	Shopping	To Home	Others
Km. 232.000								
2 W	202	56%	3%	2%	14%	0%	20%	3%
Car	637	23%	5%	3%	28%	0%	27%	14%
Mini Bus	20	40%	30%	0%	30%	0%	0%	0%
Km. 263.500								
2 W	100	26%	2%	2%	12%	2%	34%	22%
Car	738	22%	3%	3%	26%	4%	23%	19%
Mini Bus	38	95%	5%	0%	0%	0%	0%	0%

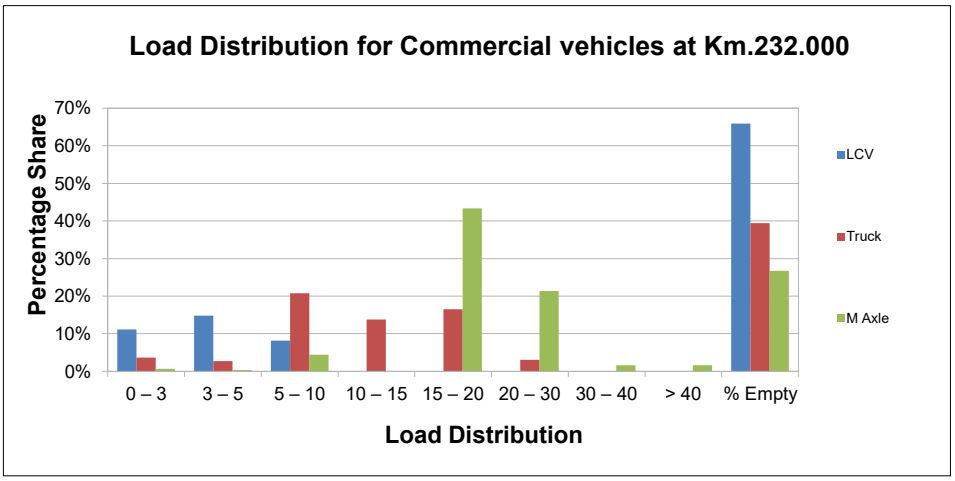
5.8 Pay Load and Load distribution

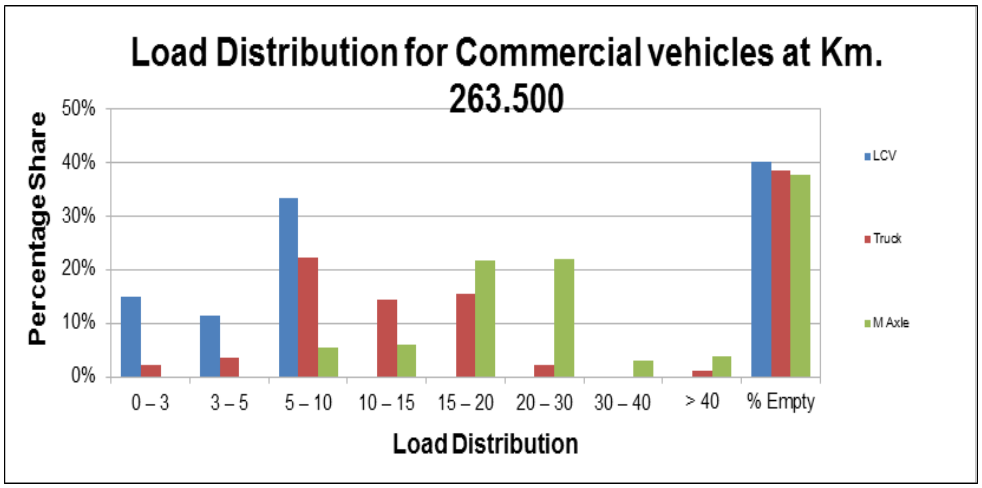
The pay load and load distribution analysis has been done as these influences the vehicle damage factor in the pavement design, based on the RSI survey data for the two survey locations and the findings are presented in Table 5.8 and in Figure 5.4. It is observed that, M axle trucks are carrying an average load from 19T to 21T and LCVs are carrying in the range of 3 to 6 Tonnes.

Table 5.8: Average Pay load in Tonnes

Vehicle Type	Total Vehicles	Load in Tonnes (T)								
		0 – 3	3 – 5	5 – 10	10 – 15	15 – 20	20 – 30	30 – 40	> 40	% Empty
Km. 232.000										
LCV	135	11%	15%	8%	0%	0%	0%	0%	0%	66%
Truck	327	4%	3%	21%	14%	17%	3%	0%	0%	39%
M Axle	314	1%	0%	4%	0%	43%	21%	2%	2%	27%
Km. 263.500										
LCV	87	15%	11%	33%	0%	0%	0%	0%	0%	40%
Truck	365	2%	4%	22%	15%	16%	2%	0%	1%	39%
M Axle	267	0%	0%	6%	6%	22%	22%	3%	4%	38%

Figure 5.4: Load distribution





5.9 Vehicle Occupancy

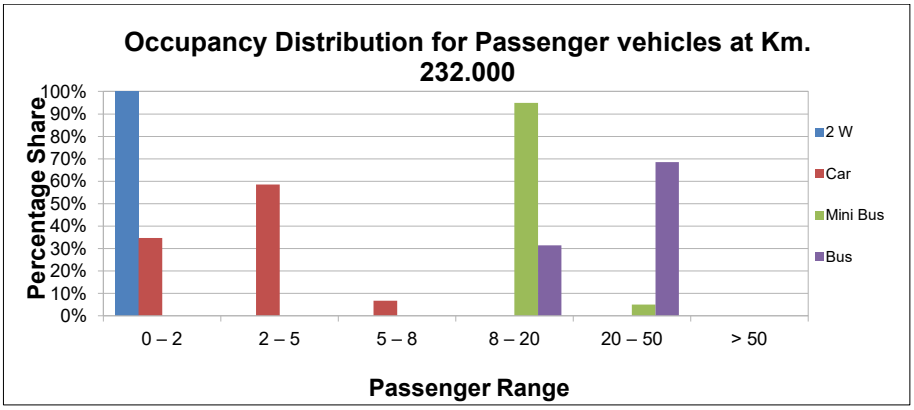
Average occupancy and occupancy range of passenger vehicles is given in Table 5.9 and in Figure 5.5. It is observed that, the average occupancy of passengers for Bus and Mini Bus is more at survey location Km. 232.000. 2 Wheeler occupancy rate is almost same at both locations.

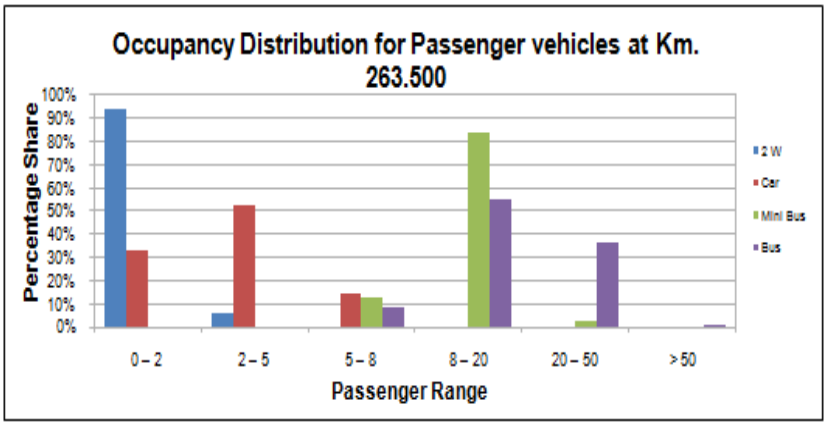
Table 5.9: Average Occupancy

Vehicle Type	Total Vehicles	No. of Passengers						
		0 – 2	2 – 5	5 – 8	8 – 20	20 – 50	> 50	Average occupancy
Km. 232.000								
2 W	202	100%	0%	0%	0%	0%	0%	1.3
Car	637	35%	59%	7%	0%	0%	0%	3.2
Mini Bus	20	0%	0%	0%	95%	5%	0%	18.0

Vehicle Type	Total Vehicles	No. of Passengers						
		0 – 2	2 – 5	5 – 8	8 – 20	20 – 50	> 50	Average occupancy
Bus	140	0%	0%	0%	31%	69%	0%	30.2
Km. 263.500								
2 W	100	94%	6%	0%	0%	0%	0%	1.5
Car	738	33%	52%	14%	0%	0%	0%	3.5
Mini Bus	38	0%	0%	13%	84%	3%	0%	14.4
Bus	135	0%	0%	8%	55%	36%	1%	21.8

Figure 5.5: Occupancy distribution





5.10 Willingness to pay survey

Along with the O-D survey, the drivers of both commercial and passenger vehicles were questioned about the amount of toll they will be willing to pay on provision of an improved road facility. They have given options in terms of some factors ranging from 0.5 to 2 times the toll rates. In case of Goods Vehicles, nearly 66 to 85 % were willing to pay toll amount at both the locations, majority with 0.5 and 1 time for toll rate, while 60 to 80% of passenger vehicles are ready to pay toll but majority with a factor of 0.5 times the toll rate as indi-

cated in Table 5.10. At location Km. 263.500, almost no driver is interested to pay 2 times the prescribed toll rate.

Table 5.10: Willingness to Pay Toll by Vehicle Type

Vehicle Type	Toll Amount (INR)	% No. of vehicles willing to pay toll	% factor payment				% No. of vehicles willing to pay toll	% factor payment			
			< = 0.5	1	1.5	2		< = 0.5	1	1.5	2
		Km. 232.000					Km. 263.500				
Car	50	83%	48%	9%	41%	1%	85%	48%	34%	16%	1%
Mini Bus		70%	57%	14%	7%	21%	58%	36%	18%	41%	5%
Bus	150	68%	32%	11%	26%	32%	81%	25%	33%	42%	0%
LCV	50	66%	35%	33%	25%	8%	59%	59%	31%	10%	0%
Truck	150 & 300	83%	23%	38%	23%	16%	63%	27%	42%	29%	3%
M Axle	450	91%	21%	21%	34%	23%	85%	26%	44%	20%	10%

6 TRAFFIC FORECAST

6.1 Methodology

The past motor vehicle registration data at the state and district level provides a valuable indication regarding the trends in the traffic growth and presents a dependable tool for estimating future growth rates in different categories of vehicles. A more rational method will be to establish a relationship between the socio-economic variables such as Population, Net State Domestic Product (NSDP) and Per-Capita Income (PCI) on the one hand and the past registration data of different categories of vehicles on the other to determine the elasticity of transport demand with respect to different categories of vehicles. According to IRC: 108 - 1996, an econometric model could be derived in the form

$$\text{Log}_e P = A_0 + A_1 \text{Log}_e (E.I)$$

Where:

P = number of vehicles of any particular category;

E.I= Economic Indicator such as NSDP, Per-capita income or Population;

A_0 = Constant;

A_1 = Regression coefficient (Elasticity value).

Based on future economic growth prospects in terms of income growth, per-capita growth and population growth of the project influenced districts and states, the future traffic growth rate by vehicle type are estimated by suitably adjusting the elasticity values.

6.2 Secondary Data Collection

The analyzed traffic data from the primary surveys and processed data from secondary sources pertaining to the project stretch together provide basic input for design, future projection of traffic. As project highway is located in the State of Karnataka, following secondary information like statistical data, economic indicators (2004-2005 constant prices) are collected from Directorate of Economics & Statistics, Karnataka and vehicle registration data from Road transport year books (2006-2012) issued by Transport research wing, Ministry of shipping, Road transport & Highways, Government of India has been collected as shown in Table 6.1.

Table 6.1: Vehicle registration & Economic Indicators of Karnataka

S. No	Year	Vehicle Registration statistics					Economic Indicators			
		Cars / Jeeps	Trucks	2W	Bus	3W	GSDP (Rs in Crs)	PCI (Rs)	Pop (in 000's)	NSDP (Rs in Crs)
1	2004-05	583322	221913	3957762	27584	202298	166747	26882	55327	148729
2	2005-06	677194	276013	4512910	30223	213721	184277	29295	55993	164031
3	2006-07	730991	268994	3755719	24042	214574	202660	31967	56648	181086
4	2007-08	829333	310214	4230864	25865	243034	228202	35574	57292	203810

S. No	Year	Vehicle Registration statistics					Economic Indicators			
		Cars / Jeeps	Trucks	2W	Bus	3W	GSDP (Rs in Crs)	PCI (Rs)	Pop (in 000's)	NSDP (Rs in Crs)
5	2008-09	931829	340957	4796587	26677	247077	244421	37687	57927	218309
6	2009-10	1045516	377495	6404905	28941	237295	247590	37294	58552	218363
7	2010-11	1172430	415491	7033045	30773	259429	272721	40699	59170	240817
8	2011-12	1311609	454582	7737366	32548	285408	282784	41492	59780	248040
9	2012-13	1464030	506340	8575104	36148	285895	299991	43266	60382	261250
10	2013-14	1616808	555254	9534792	50101	312565	321455	46012	60975	280561
Average Yearly Growth Rate %		**12.01**	**10.92**	**10.96**	**7.79**	**5.09**	**7.62**	**6.22**	**1.09**	**7.37**

Note: GSDP – Gross State Domestic Product, NSDP – Net State Domestic Product, PCI- Per Capita Income, Pop - Population

6.3 Traffic Growth rate

The most important parameter, on which the future forecast of traffic depends, is the Growth rate. However, for a small stretch where most of the traffic neither originates nor ends within the stretch, growth potential of the origin and destination (Zone of Influence) need to be assessed to arrive at the growth potential of the stretch. It is ideal to identify future growth potential of each zone for goods and passenger movements and for each category of vehicles separately.

6.4 Transport demand elasticity

To arrive at a realistic and rational assessment of growth factor, efforts have been made to collect various secondary data and statistical information. The growth factor derived from past traffic data on the stretch supplemented by registration trend and the statistical parameters would have been the ideal method. However, due to irregular, erratic and insufficient past traffic data available, the derivation of elasticity and growth factors was based on registration data of vehicles and the economic parameters.

The growth trend has been derived for the following categories of vehicles:

Pv = Passenger Vehicles (Car, jeep, Taxi, Van, etc.)

T = Trucks (LCV, 2 Axle, 3 Axle and M Axle)

B = Bus, Mini Bus

The following steps have been adopted to derive the elasticity and growth factors

- Growth rate of registered vehicles in zone of influence is found out.
- Growth rates of NSDP/GSDP, Per Capita Income and population are obtained.
- For passenger vehicles and buses, number of registered vehicles has been re gressed with population data of the state.

- For trucks, number of registered trucks has been regressed with NSDP.

- Mean value of average growth rate of registered vehicles and the growth rate ob tained by regression analysis for all categories have been found out at stat level.

The relationship between various economic indicators and different modes over the past is presented in Figure 6.1. The elasticity analysis in terms of econometric models is presented in Table 6.2 and the detailed calculations are given in **Annexure - 5**.

Figure 6.1: Economic Indicators and Traffic mode

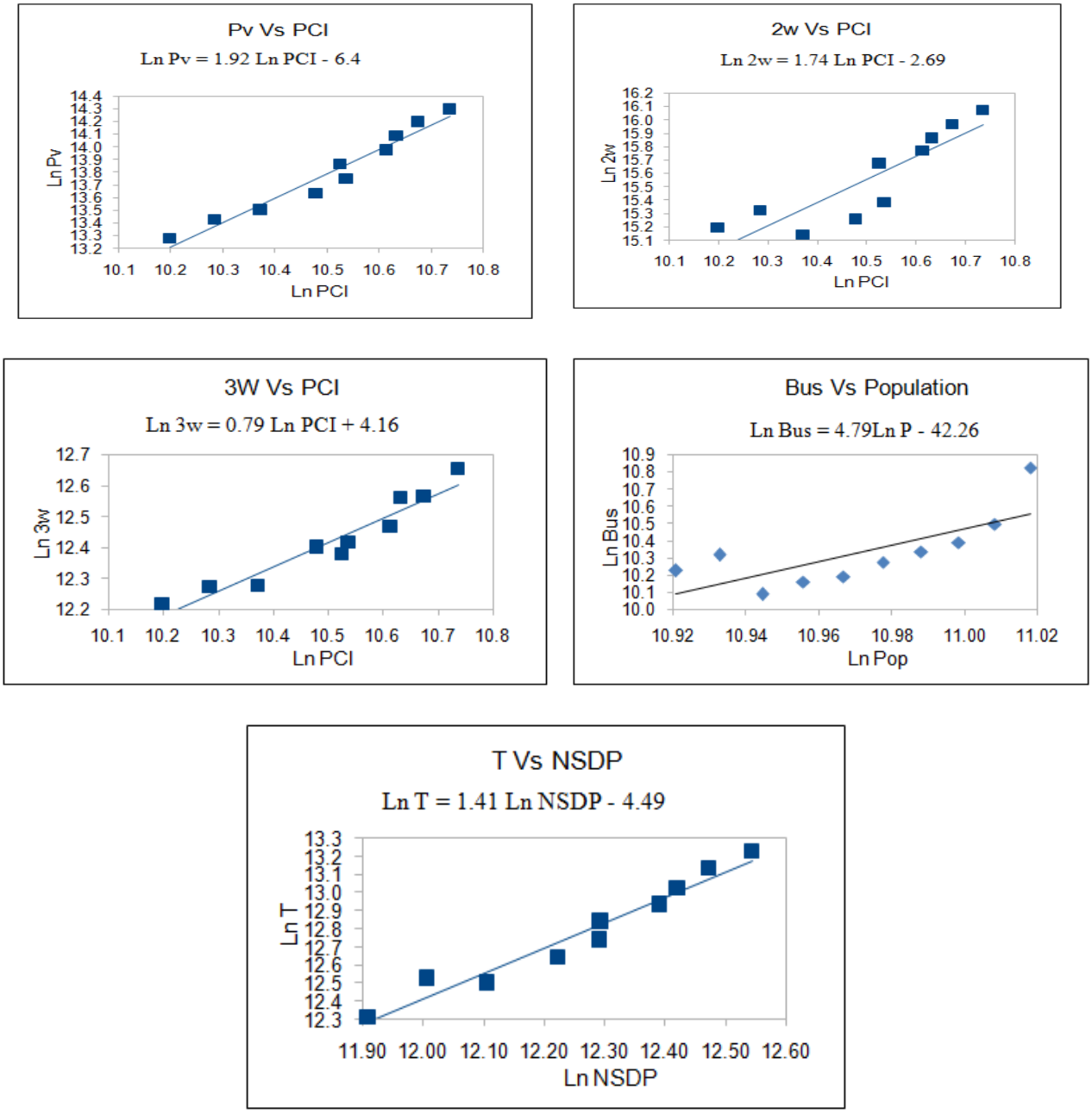


Table 6.2: Elasticity Analysis

S. No.	Vehicle Type	Economic Indicator	Elasticity Value	R^2 Value
1	Car/Jeep	PCI	1.92	0.955
2	Truck	NSDP	1.41	0.954
3	2 Wheeler	PCI	1.74	0.774
4	3 Wheeler	PCI	0.79	0.924
5	Bus	Population	4.79	0.560

6.5 Elasticity of Transport Demand Values (Road Development Plan, Vision 2021)

Experience reveals that the growth rates of passenger and goods vehicles grow at different rates. This phenomenon is primarily because of varying levels of relationships between economy and/ or socio-economic and traffic growth rates, and therefore, the elasticity values need to be graded differently by modes such as cars, buses, trucks etc.

In this regard, MoSRTH, GoI in its document "Road Development Plan, Vision 2021" recommends elasticity values shown in Table 6.3 for forecasting traffic on rural highways. The declining rate of elasticity value is commonly used as this reduces the impact of future uncertainties on prediction.

Table 6.3: Elasticity Values

Vehicle Type	2001-06	2006-11	2011-16	2016-21	2021-26	2026-31	2031-36	2036-41
Car	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1
Bus	1.4	1.3	1.2	1.1	1.1	1.1	1	1
Truck	1.5	1.4	1.2	1.1	1.1	1.1	1	1

It is envisaged in 'Road Development Plan Vision: 2021' published in 2001 by IRC that the growth rate of India GDP will be in the range of 6 to 8% in the coming years. Indian economy is expected to grow every year and would be a developed country by the year 2020. This is due to fast development of Indian infrastructure, industrialisation and exports. In conformity with the development, PCI, GSDP and annual growth rate in terms of GDP is likely to grow up to 8 to 10%. Thereafter, it is assumed that there would be likely fall in GDP growth and elasticity values tend to decrease with economic development in future years. The calculation of realistic or most likely growth rates is based on this concept. In optimistic scenario, abnormal and negative yearly growth rates are neglected for the calculation of average yearly growth rates.

The calculated growth rates for different category of vehicles in optimistic, pessimistic and most likely or realistic scenario for the project stretch are presented in Table 6.4. By considering the decreasing production rates of 2 Axle trucks, their growth rates have been declined for the future years when compared to other truck categories. For other vehicle types, a nominal growth rate of 2% per annum has been assumed for the study.

Table 6.4: Traffic growth rates

S. no.	Period	2 Wheeler	Car / jeep	Bus	3 Wheeler	Truck			
						2 Axle	3 Axle	M Axle	LCV & Mini LCV
Optimistic scenario									
1	Up to 2018	14.0	14.0	8.0	8.0	9.0	12.0	12.0	12.0
2	2019 -2023	13.0	13.0	7.0	7.0	8.0	11.0	11.0	11.0
3	2024 – 2028	12.0	12.0	6.0	6.0	7.0	10.0	10.0	10.0
4	2029 – 2033	11.0	11.0	5.0	5.0	6.0	9.0	9.0	9.0
5	Beyond 2033	10.0	10.0	4.0	4.0	5.0	8.0	8.0	8.0
Most likely or realistic scenario									
1	Up to 2018	11.0	12.0	6.0	5.0	8.0	11.0	11.0	11.0
2	2019 -2023	10.0	11.0	5.0	4.0	7.0	10.0	10.0	10.0
3	2024 – 2028	9.0	10.0	4.0	3.0	6.0	9.0	9.0	9.0
4	2029 – 2033	8.0	9.0	3.0	2.0	5.0	8.0	8.0	8.0
5	Beyond 2033	7.0	8.0	2.0	2.0	4.0	7.0	7.0	7.0
Pessimistic scenario									
1	Up to 2018	8.0	8.0	6.0	5.0	5.0	7.0	7.0	7.0
2	2019 -2023	7.0	7.0	5.0	4.0	4.0	6.0	6.0	6.0
3	2024 – 2028	6.0	6.0	4.0	3.0	3.0	5.0	5.0	5.0
4	2029 – 2033	5.0	5.0	3.0	2.0	2.0	4.0	4.0	4.0
5	Beyond 2033	4.0	4.0	2.0	2.0	2.0	3.0	3.0	3.0