0. EXECUTIVE SUMMARY

0.1 INTRODUCTION

The Highway starting from Jeevargi connecting Maski, Siruguppa, Bellary, Challakere, Hiriyur, Turuvekere, Shrirangapattana, Mysore, and Chamarajanagar, which previously comprised of SH was recently upgraded and declared as NH-150A by Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI).

The Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI), (Public Works, Ports And Inland Water Transport Department), Office of The Executive Engineer, National Highways, Chitradurga division has appointed M/s. Feedback Infra Pvt. Ltd. for providing the consultancy services for preparation of Feasibility Study, Detailed Project Report, Survey, Preparation of Land Plan for widening to Two lane Paved shoulder from Bellary to Hiriyur section in the state of Karnataka.

The Contract Agreement for the assignment was signed on 7th May 2015; the Consultancy services were commenced with effect from 7th May 2015.

The Consultant has studied the feasibility of the project and submitted the Detailed Project Report along with EPC Schedules Executive Engineer, National Highways, Chitradurga division vide letter no FIPL/Highways/DPR/NH-PWD/CTR/2016-17/485 and FIPL/Highways/DPR/NH-PWD/CTR/2016-17/486A

From the Traffic surveys and analysis, it was concluded that the project road requires four lane with paved shoulders (PCUs are more than 10000), hence the Project is transferred from Ministry of Road Transport & Highways to National highways authority of India vide Gazette notification S.O. 1096 (E) dated 23.11.2016. The Tripartite agreement for the Consultancy services was signed on 04 May 2017 and the project preparation activities commenced subsequently.

As per the Tripartite agreement Project road has been divided into three packages and Package wise Details given in below table

Sl. no	Package	Project Section	Existing km		Design Chainage		Design Length in km
			From	To	From	To	
1	I	Bellary to Byrapura (include Bellary Bypass)	253.600	309.150	253+600	308+550	54.95
2	II	Byrapura to Challakere	309.150	359.100	308+550	358+500	49.95
3	III	Challakere to Hiriyur (Including Challakere and Hiriyur Bypass)	359.100	413.500	358+500	414+215	55.71

Current report depicts Final Feasibility report of first package i.e. to **Bellary to Byrapura Including Bellary Bypass.**

DESCRIPTION OF PROJECT

The State of Karnataka is located in southwest part of India. Karnataka is surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The NH 150A starts at Jevargi and ends at Chamarajanagar in Karnataka. The entire stretch of NH 150A passes through Gulbarga, Raichur, Bellary, Ananthpur, Chitradurga, Tumkur, Mandya, Mysore and Chamarajanagar districts and passing through important cities/towns like Jevargi, Shorapur, Lingsugur, Sindhanur, Siruguppa, Ballari, Hanagal, Challakere, Hiriyur, Huliyar, Turuvekere, Nagamangala, Pandavapura, Shrirangapattana, Mysore, Nanjanagudu and Chamarajanagar. The Total length of NH 150A is 618.62kms. The Project Road Starts at km 253.600 near Bellary and ends at km 309.150 near Byrapura. The Total Length of the project stretch is 55.55 kms. **Figure 0-1** Refers to the location of the Project stretch NH 150A.

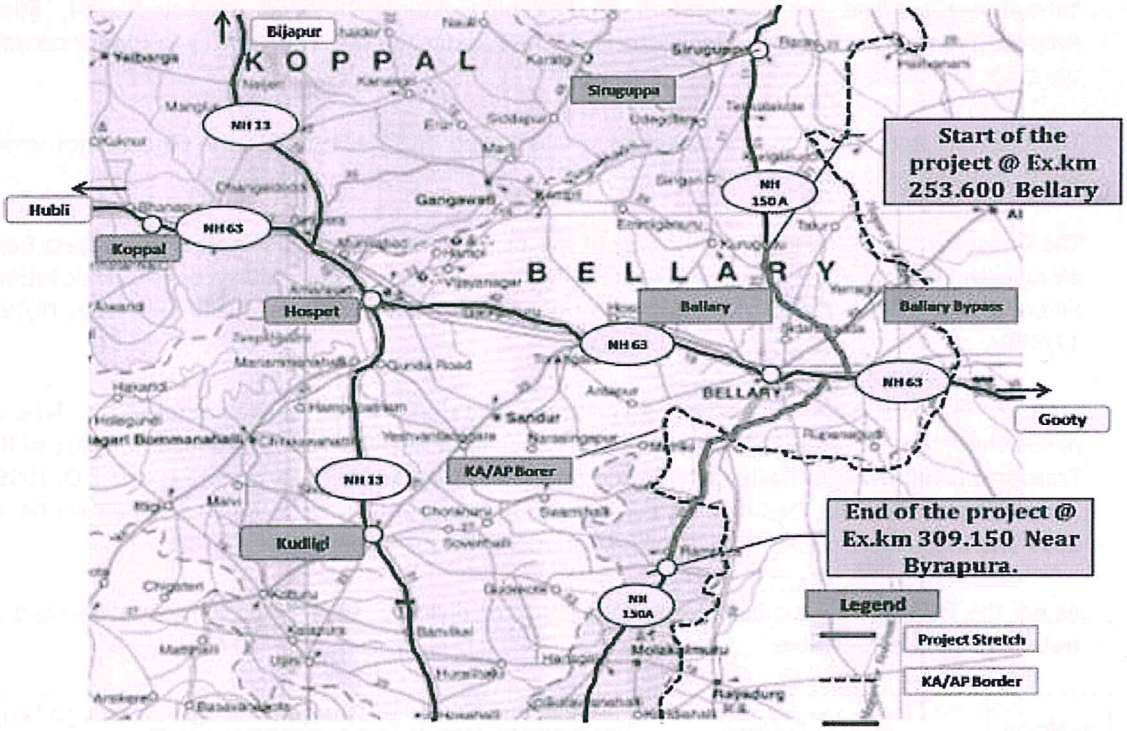

Figure 0-1: Location of Project Stretch

The project road alignment generally runs in plain terrain and passes through settlements like Bellary, Halikundhi, Obulapuram, D.Hirehal, Bommakkanahalli,Rampura, and Byrapura.

The existing alignment comprises of many sharp horizontal curves which require geometric corrections. Few among these are observed to have insufficient sight distance.

The existing road has two lane carriageways with 1 m to 1.5m paved shoulder. The condition of existing pavement varies from Good to fair.

There are 118 structures present in 55.55 km length of stretch. These include 1 Major bridge, 42 minor bridges, 1 ROB, 1 Causeway and 73 culverts. One level crossing is also present along the project stretch.

Right of Way (RoW) available varies from 15m to 30 m in rural stretches and 15 m to 20 m in urban and Semi-urban stretches.

The traffic on this stretch of NH 150A is of mixed type, with of passenger traffic, up to 55% and that of freight traffic up to 45%. Daily traffic ranges from 22261 PCUs to 15101 PCUs, equally distributed in both direction.

The predominant land use is agricultural (53.74% on LHS and 51.40 % on RHS) built up (34.74% on LHS and 35.10% on RHS) and barren land (11.52% on LHS and 13.50% on RHS)

There are 26 numbers of minor intersections & 9 numbers of major intersections along the project corridor with various categories of roads.

Large number of utility lines viz. electric / telephone lines, gas pipe lines & OFCs run parallel and across the route, which needs to be relocated for facilitating the widening.

0.2 Traffic Survey and Analysis

Traffic surveys and analyses were carried out in two phases for addressing various objectives and issues pertaining to widening of the project stretch. The surveys conducted include seven day volume counts, intersection, pedestrian/ cattle crossing, axle load and Origin Destination survey. The study aims at understanding existing traffic and travel characteristics on the project corridor and forecasting for project horizon year considering various constituent streams and for various scenarios. The results of analysis would form inputs for designing the pavement, developing capacity augmentation proposals, carrying out financial analysis, decisions regarding grade separators, pedestrian facilities, planning the tolling strategy, designing the toll plaza, wayside amenities along with design of intersections on the widened project road.

The volume count surveys were conducted at two locations, i.e., in July month of 2015. The annual average daily traffic at these locations is shown in table below.

Table 0-1 Annual Average Daily Traffic along project corridor

Chainage	Location	Vehicles		PCU	
		ADT	AADT	ADT	AADT
km 269.290	Halakundi	12070	12070	22261	22261
km 287.350	Tammenahalli	6520	6520	15101	15101

The investment priorities are governed by traffic demand, assessed benefits and cost of project. Demand plays the important role that governs which type of facility / infrastructure to be created. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out near accurately. For the design of pavement and to plan for the future maintenance programme as well as capacity augmentation and for financial evaluation, it is necessary to have realistic estimate of the size of traffic in horizon year.

Traffic forecasting is done in two ways, one with CAGR of 5 % as proposed in the ToR and the other with growth rates established by using elasticity method. This forecasting is made by determining the past trend of traffic flow along the corridor and by use of economic models developed to co-relate past vehicle registration data and economic indices such as per capita income (PCI), net state domestic product (NSDP) and gross domestic product (GDP). By using the elasticity values obtained from the econometric models and the likely rate of growth of indices, population and regional influences, the mode wise growth rates are established.

Classified direction wise turning movement survey has been conducted at 2 major junctions shown in Table below along the project stretch. Type of existing intersection and structures proposed based on the turning movement survey are also shown in Table below.

Table 0-2 Turning movement survey locations

S No.	Chainage	Location	Total Volume (PCU-12 hrs)	Peak Hour Volume (PCU)	Peak Hour
1	km 269.290	Bellary	22158	2199	18.00 – 19.00
2	km 287.350	Bellary	19913	1959	17.00 – 18.00

0.3 Axle load survey

Axle load survey has been conducted at 1locations using portable electronic weigh pads in order to plot actual loading spectrum of commercial vehicles, which create potential damage to pavement.

This damage to pavement normally qualified by a factor termed as vehicle Damage Factor (VDF). The VDF for project stretch is worked out using equivalency factors and damaging power of different axle, IRC: 37-2012. The VDF values adopted for MSA calculation are shown in Table below.

The Axle load surveys were conducted at one location, i.e., in December month of 2015. The annual average daily traffic at these locations is shown in table below.

Table 0-3 VDF values, observed and recommended

Location	Existing NH 150A km 287.350	
Mode	Bellary – Byrapura	Byrapura - Bellary
LCV	0.79	0.15
2-axle	3.75	2.86
3-axle	4.86	2.31
MAV	8.52	2.38
Bus	1.22	1.28

The cumulative million standard axles at count locations have been calculated for various horizon years and shown in Table below. These values are used in new pavement design.

0.4 Intersections

There are 9 major & 26 minor intersections along the project stretch. These include 9 four legged Intersections and rest are three legged Intersections. The minor & major intersections, with state highways and district roads are given in below table.

Table 0-4 List of Minor Junctions

Sl. No	Existing km	Type of intersection	Leads	
			LHS	RHS
1	258.350	3 Legged	Ashok Nagar	
2	258.665	4 Legged	Gayatri Nagar	To Shanti Nagar
3	260.340	3 Legged		To Shivalinga Nagar
4	260.720	3 Legged		Devi Nagar Circle
5	262.960	3 Legged	To Bangalore Road	
6	264.020	3 Legged		To Cowl Bazar
7	264.750	4 Legged	To Phase I	To Guggrahatti
8	268.820	3 Legged	Halakundhi	
9	273.820	3 Legged	Hiredahalu	
10	275.800	3 Legged		Obulapuram

Sl. No	Existing km	Type of intersection	Leads	
			LHS	RHS
11	278.724	3 Legged		D HireHal
12	278.960	3 Legged		D.Hirehal
13	281.060	3 Legged		Madenahalli
14	281.600	3 Legged	Jajarakal	
15	282.725	3 Legged		To Lingamanahalli
16	284.930	4 Legged	To Kanakuppe	To Bommaghatta
17	286.584	4 Legged	To Tammenahalli	Bommaghatta
18	287.955	3 Legged		To Rajapura
19	289.172	4 Legged	Sirekola	Konapura
20	293.865	3 Legged		Rampura Village
21	294.160	3 Legged		Rampura Village
22	294.420	3 Legged		To Pakkurthy
23	300.590	3 Legged	To Siddapura	
24	301.830	4 Legged	Gowrasamudra	Chikkanahalli
25	303.840	3 Legged	To Nagasamudra	
26	308.495	3 Legged	To Nagasamudra	

Table 0-5 List of Major Junctions

Sl. No	Existing km	Type of Intersection	Leads To		Remarks
			Left	Right	
1	260.020	4 Legged	Moka	Hospet Road	NH-63
2	261.000	3 Legged		Fort Main Road	
3	261.235	3 Legged		Hospet Road	Matha Road
4	261.240	3 Legged	Anantapur		Bellary Moti circle
5	261.520	3 Legged		Old Trunk Road	SH-132
6	266.140	3 Legged	Kakkabevinahalli		NH-63
7	266.840	4 Legged	Burrayanakanahal	Kudatini	NH-63
8	294.420	3 Legged		Melinakannave	SH-131
9	296.415	4 Legged	Devasamudra	Mahadevarapura	SH-131

0.5 Engineering Surveys and Investigations

The general engineering studies conducted along the project stretch include topographic survey, Pavement composition, pavement condition surveys and pavement structural strength.

Topographic Survey

The Topographic Survey for improvement of project road was carried out by GPS, electronic Total Station and Auto level equipments. The detailed survey methodology and specifications followed are as described below.

Initially control points and traverse stations were established using GPS and Total Station equipments. Then using Auto level equipment, Double Tertiary (DT) levelling was carried out to fix temporary benchmarks with respect to GTS Benchmarks available in the area to establish the

vertical control to all TBMs and traverse stations. The detailed survey was then carried out and the data was processed for engineering design.

The following specifications were adopted for carrying out the topographic surveys. Traverse points positioning was with accuracy of 1:10,000. All traverse points were marked on ground by punching nails in to surface. TBMs are fixed on BM reference pillars fixed 250 m apart, at top of the kilometre stones, parapets of culverts and on plinth top of the buildings. Double tertiary methods have been used in levelling, taking the sum and average of three wire readings to determine reduced levels.

Cross-sections of roads are taken at an interval of 50 m. Levels were taken at the centre and edges of carriageway, edge of shoulders and levels up to property lines on both sides. Details of drain widths and depths also collected. For all the existing culverts, top levels / road levels and bed levels / sill levels were collected.

Road Inventory

The existing pavement for the entire stretch is of bituminous surface except at major bridge locations. The pavement width is predominantly two lane carriageway with 1.0 m Paved shoulders on either side and 4 lane divided carriageway exists at some built up stretches of the highway and is varies from fair to poor condition.

Pavement Condition

The survey on general pavement condition was primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements wherever necessary. Visual assessment was carried out at suitable intervals at 200 m and wherever necessary, depending on variations in pavement conditions.

The existing pavement condition based on visual observation varies from good to poor. It has been observed that in most of the stretches heaving / settlements / distress were observed. This may be due to weak subgrade, improper compaction or movement of heavy loaded trucks. Summary of pavement condition is given in Table below.

Table 0-6 Summary of Pavement Condition

Sl. No.	Summary	Length (km)	%
1	Good	29.35	58.00
2	Fair	23.80	47.04
3	Poor	2.40	4.74
Total		**55.55**	**100**

Pavement Structural Strength

Benkelman Beam deflection studies were carried out for evaluating the residual strength of the existing pavement and assessing the strengthening requirements for the existing pavement.

BBD tests have been conducted for every 3 km interval. The pavement deflection has been observed for homogeneous sections based on pavement condition survey.

The summary of Characteristic deflection is given in Table below.

Table 0-7 Summary of Characteristic Deflection

Sr. No	Existing Km		Length Km	Characteristic Deflection Value
	From	To		
1	272.400	275.400	3	0.901
2	275.400	281.400	6	1.132
3	281.400	284.400	3	1.502
4	284.400	287.400	3	1.500
5	287.400	290.400	3	1.327
6	290.400	293.400	3	1.398
7	293.400	296.400	3	0.915
8	296.400	303.400	7	0.856
9	303.400	308.400	5	1.371

Subgrade Investigation

The laboratory investigations of sub-grade indicate that the existing subgrade varies from location to location along the road. The 4 days soaked CBR values for 65 blows of existing sub-grade varies from 7% to 11%.

Material Investigation

Potential sources of soil for construction of embankment and subgrade (for reconstruction / new carriageway) were identified on either side of project stretch.

Borrow area quarries located in 7 locations with average CBR of 11% which is found suitable for construction.

Aggregate quarries were identified in 5 locations which are found suitable for construction.

Hydrological investigations

Hydrological investigations have been carried out for the entire project road. It has been verified that majority of the cross drainage structures are hydrologically adequate to carry the discharges of the river / streams. It has been ascertained from local enquiry and from the National Highways.

0.6 PRELIMINARY DESIGN

Geometric design

The existing alignment largely runs is in plain terrain and the design speed of 80 to 100 kmph has been adopted as per IRC: SP: 84- 2014. Geometric design viz. horizontal and vertical curves are designed as per IRC 38-1988 & IRC: SP: 23 - 1983.

Alignment proposal

After carrying out field investigations and reconnaissance survey of existing alignment, the consultants have been arrived at alignment proposals.

Widening proposals have been prepared based on availability of additional land / existing RoW, horizontal geometrics, study of existing bridges and considering road safety parameter measures. The lengths of adopted type of widening details (as per proposed chainage) are given in Table below.

Table 0-8 Length of adopted type of widening scheme

Sl. No	Type of widening	Design Length Km
1	Concentric	0.800
2	Eccentric left/Right	15.030
3	Realignments	21.134
4	Bypass	17.986
Total Length, Km		**54.950**

Proposed Lane widths

The width of basic traffic lane is taken to be 3.5 m. For proposed 4-lane the carriageway width will be 14m width with paved shoulders on both sides. In divided cross-section, the median will be of 5.0 m width in rural areas and of 2.5 m width in urban areas including 0.5 m shy off on both sides. The proposed carriageway details are presented in table below.

Table 0-9 Proposed Lane widths

Sl. No	Design Chainage		Length, m	Lane Width	Remarks
	From	To			
1	253+600	290+760	37160	4 Lane with Paved Shoulders	
2	290+760	291+060	300	4 Lane with Paved Shoulders + Service Road	Built Up Bommakkanahalli Village
3	291+060	308+550	17490	4 Lane with Paved Shoulders	

Typical Cross Sections

Based on the traffic considerations, geometric standards and existing site conditions, the following typical cross sectional elements are framed for project road.

Table 0-10 Details of Proposed Cross Section

Element	Width (m)	Total Width (m)
4-lane Divided Carriage way Cross Section in Rural (C/S Type 1,1A,1B,& 1D)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Utility corridor	2 x2.00	4
Drain, Future widening etc	2x15.0	30
Total		**60**
4-lane Divided Carriage way with Service Cross Section in Rural (C/S Type 1C)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4

Element	Width (m)	Total Width (m)
Utility corridor	2 x2.00	4
Service Road	2 X 7.0	14
Earthen Shoulders on either side of Service road	4 X 1.50	6
Drain, Future widening etc	2 X 5.0	10
Total		**60**
4-lane Divided Carriage way Cross Section in Urban (C/S Type 2, 2A & 2B)		
Main Carriageway	2 X 7.00	14
Median	1 X 1.50	1.5
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Earthen Shoulders	2 X 2.00	4
Earthen Shoulders for service roads	2 X1.50	3
Service Road	2 X 7.5	15
Drain cum Foot Path	2 X 1.5	3
Utility Corridor/Footpath	2 x 2.00	4
Space left for future widening / Drain	2 X 5.25	10.5
Total		**60**
VUP approach Cross Section in rural (C/S Type 3)		
Main Carriageway	2 x 10.5	21
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Crash barrier with shyness	2 x 1.0	2
Slip road on both sides	2 x 7.0	14
Earthen shoulders	2 x 1.5	3
Divider between slip Road and VUP Approach	2 x 0.5	1
Utility Corridor	2 x 2.0	4
Drain & Slope	2 x 3.0	6
Total		**60**
VUP/Flyover approach Cross Section in Urban (C/S Type 3A)		
Main Carriageway	2 x 10.5	21
Median	1 X 1.50	1.5
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Crash barrier with shyness	2 x 1.0	2
Divider between slip Road and Fly Over Approach	2 x 4.250	8.5
Service road on both sides	2 x 7.5	15
Utility corridor	2 x 2	4
Footpath cum drain	2 x 1.5	3
Total		**60**
VOP Approach Cross Section in Urban (C/S Type 4)		
Main Carriageway	2 x 14.00	28
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1

Element	Width (m)	Total Width (m)
Paved shoulder	2 X 1.5	3
Footpath cum Drain	2 x 1.5	3
Crash Barrier	2 x 0.5	1
Divider between slip Road and VOP Approach	2 x 0.5	1
Divider Shy Off	2 x 0.5	1
Slip road on both sides	2 x 5.5	11
Kerb Shyness	2 x 0.5	1
Footpath cum Drain	2 x 1	2
Utility Corridor	2 x 2.0	4
Total		**60**
4-lane Divided Carriage way Cross Section in Hilly Area (C/S Type 5)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Utility corridor	2 x2.00	4
Drain, Breast Wall, Catch water Drain and Future widening etc	2x15.0	30
Total		**60**
ROB Approach with Slip road Cross Section (C/S Type 6)		
Main Carriageway	2 x 12.0	24
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Main Carriage way Shy off	2 x 0.5	1
Footpath	2 X 1.5	3
Divider	2 x 0.5	1
Crash Barrier	4 x 0.5	2
Slip road on both sides	2 x 5.5	11
Earthen shoulders	2 x 1.5	3
Utility Corridor	2 x 2.0	4
Drain & Slope	2 x 3.0	6
Total		**60**

Pavement Design

New Flexible pavement has been proposed for additional 2-lane & flexible overlay over existing 2-lane road. Rigid pavement is proposed only at toll plaza location.

New Flexible/Rigid Pavement Design

The pavement design basically aims at determining the total thickness of the pavement structure as well as thickness of individual structural components. The following assumptions are considered for the preliminary pavement design. The basic assumptions considered while designing are as follows.

As per IRC: SP: 84-2014 (for 4-Lane)

As per IRC: SP: 84-2014 flexible pavements shall be designed for a minimum design period of 15 years or operation period whichever is more. Stage construction will be permitted subject to the thicknesses of sub-base & base coarses are designed for 15 years & bituminous surface for a minimum of 10 years. Strengthening for the future traffic can be carried out by means of Bituminous Overlay. Rigid pavement shall be designed for a minimum design period of 30 years; stage construction shall not be permitted.

Flexible Pavement

The project road has been divided into two homogeneous sections, design for which are furnished below.

Table 0-11 Cumulative MSA at sections

Description	Section-I (from D. Ch 253+600 to 284+400)		Section-II (from D. Ch 284+400 to 308+550)	
	LHS	RHS	LHS	RHS
Design life of Base and Sub Base (in years) - **For Stage Const.**	15	15	15	15
Design life of BT layer (in years) - **For Stage Const.**	10	10	10	10
MSA for Base and Sub Base - **For Stage Const.**	96.67	40.62	75.14	32.63
MSA for BT layer - **For Stage Const.**	55.97	23.58	43.46	18.92
Design CBR	10%	10%	10%	10%

Table 0-12 Flexible pavement composition (in mm) recommended for Main Carriageway

Sections	Section-I (from D. Ch 253+600 to 284+400)		Section-II (from D. Ch 284+400 to 308+550)	
Description	**Bellary-Byrapura**	**Byrapura - Bellary**	**Bellary-Byrapura**	**Byrapura - Bellary**
BC	45	40	40	40
DBM	100	90	95	80
WMM	250	250	250	250
GSB	200	200	200	200
Subgrade Material	500	500	500	500
Total	**1095**	1080	1085	1070

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

Table 0-13: Flexible Pavement Compositions for Service road

Service/Slip Road			
Composition	**MSA**	**Design CBR (%)**	**Thickness, mm**
BC	10	10	40
DBM			50
WMM			250
GSB			200
Subgrade			500
Total			**1040**

Table 0-14 Overlay Thickness (in mm) recommended

S. No	NH-150A Existing Km		Design Chainage		Average Characteristic Deflection	MSA	BM (mm)	Overlay (mm)	Design Thickness	
	From	To	From	To					BC (mm)	DBM (mm)
1	253.600	284.800	253600	284400	1.32	74.63	165	115.5	40	80
2	284.800	309.150	284400	308550	1.23	57.89	161.05	112.74	40	75

Rigid Pavement

The Rigid pavement is proposed at toll plaza location. The design as per the IRC: 58 – 2015 leads to the crust thickness of pavement as given in following table.

Table 0-15 Rigid Pavement Compositions (As per IRC: 58-2015)

Pavement Composition	Thickness in mm
Design Life (Yrs)	30
Design CBR (%)	10
PQC (mm)	280
DLC (mm)	150
GSB (mm)	150
Sub-grade	500
Total	**1080**

Truck lay-byes

Truck lay-byes are proposed at following locations and new Flexible pavements is proposed at these locations.

Sl. No.	Existing Km	Design Chainage	Side	Name / Location
1	Bellary Bypass	255+200	Both	Bellary Bypass
2	290.625	290+180	Both	Near Bommakkanahalli

Rest Area

The location of the Rest area is given below

S. No	Existing km	Design Chainage	Side	Location	Area
1	Halakundhi Realignment	269+100	LHS	Halakundhi Realignment	2.5 Ha
2	301.000	300+800	RHS	Near Gowrasamudra	2.5 Ha

Bus Bay with Bus Shelters

There are 12 nos Bus Bay with Bus Shelters and 34 bus shelters are proposed along the project stretch.

Toll Plaza

Rigid Pavement is proposed for the toll plaza location, as it has longer life and can resist the wear and tear caused by the braking forces exerted by heavy vehicles.

One toll plaza is proposed with additional right-of-way, service lanes, toll booths, lighting, weigh-in-motion Weigh Bridge, automatic, semi automatic and manual toll booths, separate lanes for wide bodied vehicles etc. The detail of the proposed toll plaza is given below.

Table 0-16 Proposed Toll Plaza Location

Sl. No.	Toll Plaza Location			No of Toll Lanes*	
	Existing Chainage	Design Chainage	Location	LHS	RHS
1	280.710	280+350	Near D. Hirehal	7+1	7+1

*As per DO No. NHAI/Chairman/Misc./2016 dated 26.12.2016

Proposal for Structures

There are 2 major bridges, 44 Minor bridges, 7 Flyovers, 4 VUP, 4 VUP grade-II (LVUP) , 2 ROB and 2 Trumpet Interchange along with many other cross drainage works are proposed along the project stretch. Nos. of each type of structure along the project stretch is given in below Table. These structures are proposed for widening, rehabilitation or construction of new structure.

Table 0-17: Proposed Structures on Project Stretch

Sl. No.	Type of structure	No's.
1	Major bridges	02
2	Minor bridges	44
3	Flyover	07
4	VUP	04
5	VUP Grade II-(LVUP)	04
6	Trumpet Interchange	02
7	ROB	02
8	Culverts	118

0.7 Cost Estimation

The cost estimation for the project is extremely important as the viability and implementation of a project depends on the project cost. Therefore, cost estimates have been carried out with due care. Estimation of preliminary cost, a primary pre-requisite for economic and financial evaluation, has been carried out for widening the existing NH stretches to 4-lane carriageway with paved shoulders on both sides including Reconstruction of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, road furniture, bus bays, truck bays, way side amenities, toll plazas, etc. and is presented in below Table.

Table 0-18 Summary of Cost Estimate for Bellary to Byrapura section of NH-150A

ABSTRACT OF COST - Bellary to Byrapura Section of NH-150A (Ds.Ch: 253+600 to Ds.Ch: 308+550)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	2,44,15,461	2.44	0.25%
2	Earth Work	1,18,14,53,438	118.15	12.17%
3	Granular Sub-Base and Base Courses	1,53,38,42,169	153.38	15.80%
4	Bituminious Works	-	-	
4A	Flexible Pavement	1,44,77,63,809	144.78	14.91%
4B	Rigid Pavement	-	-	
5	CULVERTS	-	-	
5A	Box Culvert	44,75,68,840	44.76	4.61%
5B	Pipe Culvert	7,60,41,655	7.60	0.78%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	38,37,085	0.38	0.04%
6B	Major Bridges	19,76,76,138	19.77	2.04%
6C	Minor Bridges	1,26,88,83,425	126.89	13.07%
6D	VUP	35,18,67,519	35.19	3.62%
6E	PUP/LVUP	29,20,59,095	29.21	3.01%
6F	CUP	10,04,34,959	10.04	1.03%
6G	ROB	80,00,98,317	80.01	8.24%
6H	Flyover and Overpass	1,11,75,72,102	111.76	11.51%
7	Drainage, Protective Works & Other Services	20,54,34,089	20.54	2.12%
8	Junctions	10,10,58,103	10.11	1.04%
9	Traffic Signs, Road Marking and Other Appurtenances	19,05,73,423	19.06	1.96%
10	Miscellaneous	25,70,73,325	25.71	2.65%
11	Toll Plaza Construction @ Ch280+300	10,98,07,651	10.98	1.13%
A	**Total Civil Cost (YR: 2016-2017) =**	**9,70,74,60,603**	**970.75**	
	Civil Cost per Km (Length of Project Highway-54.950 km)	**17.67**		
VIII	**Centage (As per ministry circular dated 10th Aug 2016, for HAM project 15%**	**1,45,61,19,090**	**145.61**	
IX	**TOTAL PROJECT COST (IV+VIII)**	**11,16,35,79,694**	**1,116.36**	
	Total Project Cost per Km	**20.32**		
X	**PRE CONSTRUCTION ACTIVITY**			
	LA, R&R and Social	2,32,15,90,100	232.16	
	Environment Cost	2,62,99,369	2.63	
	Shifting of Electrical Poles/Lines (1% of Civil Cost) =	9,70,74,606	9.71	
	Shifting of Water Supply Pipe Lines (1% of Civil Cost) =	9,70,74,606	9.71	
	Total cost of preconstruction activities D=(a+b+c+d+e) =	**2,54,20,38,681**	**254.20**	
XI	**Total Capital Cost (C+D) =**	**13,70,56,18,375**	**1,370.56**	
	Total Capital Cost Per Km in Crores =	**24.94**		

CONCLUSIONS AND RECOMENDATION

ECONOMIC ANALYSIS

The economic internal rate obtained was return of 14.8% for development of the project road with flexible pavement, which is more than the presented 12% of discounted rate and larger positive value of NPV of net benefits indicate the firm viability of project for the proposed improvement of four laning with paved shoulders and hence recommended for implementation.

FINANCIAL ANALYSIS

It is concluded that the project is not viable on commercial BOT (Toll) format with 40 % grant for concession period of 10 and 15 years. At concession period of 20 Years, equity IRR achieves benchmark of 15% at 33.10% grant but project IRR stands much below the benchmark of 12%. However, as concession period is increased to 25 years, the equity IRR benchmark is met at 22.20% grant while project IRR is marginally short of achieving the benchmark of 12% at this level of grant. However as per Policy Matter: Technical (161/2014) Lt No.11041/218/2007-Admn Dated: 24.07.2014 (Given in Appendix 12) the project has been recommended both on EPC mode or HAM Mode.

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0. EXECUTIVE SUMMARY

0.1 Introduction

The Highway starting from Jeevargi connecting Maski, Siruguppa, Bellary, Challakere, Hiriyur, Turuvekere, Shrirangapattana, Mysore, and Chamarajanagar, which previously comprised of SH was recently upgraded and declared as NH-150A by Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI).

The Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI), (Public Works, Ports And Inland Water Transport Department), Office of The Executive Engineer, National Highways, Chitradurga division has appointed M/s. Feedback Infra Pvt. Ltd. for providing the consultancy services for preparation of Feasibility Study, Detailed Project Report, Survey, Preparation of Land Plan for widening to Two lane Paved shoulder from Bellary to Hiriyur section in the state of Karnataka.

The Contract Agreement for the assignment was signed on 7th May 2015; the Consultancy services were commenced with effect from 7th May 2015.

The Consultant has studied the feasibility of the project and submitted the Detailed Project Report along with EPC Schedules Executive Engineer, National Highways, Chitradurga division vide letter no FIPL/Highways/DPR/NH-PWD/CTR/2016-17/485 and FIPL/Highways/DPR/NH-PWD/CTR/2016-17/486A

From the Traffic surveys and analysis, it was concluded that the project road requires four lane with paved shoulders (PCUs are more than 10000), hence the Project is transferred from Ministry of Road Transport & Highways to National highways authority of India vide Gazette notification S.O. 1096 (E) dated 23.11.2016. The Tripartite agreement for the Consultancy services was signed on 04 May 2017 and the project preparation activities commenced subsequently.

As per the Tripartite agreement Project road has been divided into three packages and Package wise Details given in below table

Sl. no	Package	Project Section	Existing km		Design Chainage		Design Length in km
			From	To	From	To	
1	I	Bellary to Byrapura (include Bellary Bypass)	253.600	309.150	253+600	308+550	54.95
2	II	Byrapura to Challakere	309.150	359.120	308+550	358+500	49.95
3	III	Challakere to Hiriyur (Including Challakere and Hiriyur Bypass)	359.120	411.560	358+500	414+205	55.705

Current report depicts Draft feasibility report of Second package i.e. to **Byrapura to Challakere**.

Description of project

The State of Karnataka is located in southwest part of India. Karnataka is surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The NH 150A starts at Jevargi and ends at Chamarajanagar in Karnataka. The entire stretch of NH 150A passes through Gulbarga, Raichur, Bellary, Ananthpur, Chitradurga, Tumkur, Mandya, Mysore and Chamarajanagar districts and passing through important cities/towns like Jevargi, Shorapur, Lingsugur, Sindhanur, Siruguppa, Ballari, Hanagal, Challakere, Hiriyur, Huliyar, Turuvekere, Nagamangala, Pandavapura, Shrirangapattana, Mysore, Nanjanagudu and Chamarajanagar. The Total length of NH 150A is 618.62kms. The Project Road Starts at km 309.150 near Byrapura and ends at km 359.120 near Challakere. The Total Length of the project stretch is 49.95 kms. **Figure 0-1** Refers to the location of the Project stretch NH 150A.

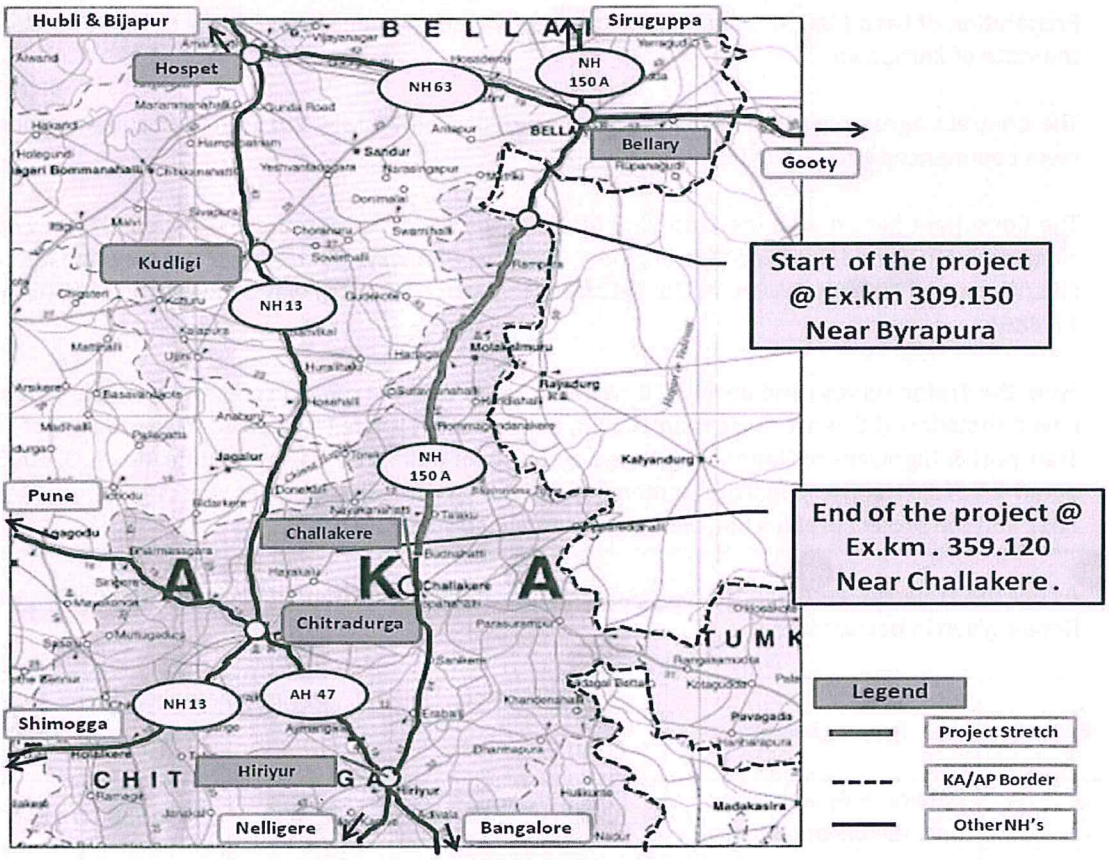

Figure 0-1: Location of Project Stretch

The project road alignment generally runs in plain terrain and passes through settlements like Byrapura, Hanagal, Mysarahatti, Rayapura, Bommagondaakere, Hirehalli Thalaku and Budnahatti

The existing alignment comprises of many sharp horizontal curves which require geometric corrections. few among these are observed to have insufficient sight distance.

The existing road has two lane carriageways with 1 m to 1.5m paved shoulder. The condition of existing pavement varies from Good to fair.

There are 98 structures present in 50.550 km length of stretch. These include 26 minor bridges, and 72 culverts.

Right of Way (RoW) available varies from 15m to 30 m in rural stretches and 15 m to 20 m in urban and Semi-urban stretches.

The traffic on this stretch of NH 150A is of mixed type, with of passenger traffic, up to 55% and that of freight traffic up to 45%. Daily traffic ranges from 12264 PCUs to 14159 PCUs, equally distributed in both direction.

The predominant land use is agricultural (73.97 % on LHS and 73.37 % on RHS) followed by Forest (16.22% on LHS and 15.02% on RHS), built up (7.61% on LHS and 7.01% on RHS) and barren land (2.20% on LHS and 4.60% on RHS)

There are 22 numbers of minor intersections & 4 numbers of major intersections along the project corridor with various categories of roads.

Large number of utility lines viz. electric / telephone lines, gas pipe lines & OFCs run parallel and across the route, which needs to be relocated for facilitating the widening.

0.2 Traffic Survey and Analysis

Traffic surveys and analyses were carried out in two phases for addressing various objectives and issues pertaining to widening of the project stretch. The surveys conducted include seven day volume counts, intersection, pedestrian/ cattle crossing, axle load and Origin Destination survey. The study aims at understanding existing traffic and travel characteristics on the project corridor and forecasting for project horizon year considering various constituent streams and for various scenarios. The results of analysis would form inputs for designing the pavement, developing capacity augmentation proposals, carrying out financial analysis, decisions regarding grade separators, pedestrian facilities, planning the tolling strategy, designing the toll plaza, wayside amenities along with design of intersections on the widened project road.

The volume count surveys were conducted at three locations, i.e., in july month of 2015 & May month of 2016. The annual average daily traffic at these locations is shown in table below.

Table 0-1 Annual Average Daily Traffic along project corridor

Mode of Vehicle	km 311.400	km 327.750	km 350.300
	Hanagal	B.G Kere	Thalaku
Car / Jeep / Van (Private)	1064	1273	1281
Car / Jeep / Van (Taxi)	194	294	330
Local/Shared Car	13	19	105
Mini Bus	28	40	38
School Bus	2	4	2
Govt. Bus	280	312	345
Pvt. Bus	243	274	273
LMV	199	311	349
LCV (4 Wheels)	142	72	67
LCV (6 Wheels)	188	135	194
2 Axle	286	368	347
3 Axle	684	670	720
MAV (4 - 6 Axles)	1158	1144	1212
MAV (7++ Axles)	0	0	0

Mode of Vehicle	km 311.400	km 327.750	km 350.300
	Hanagal	B.G Kere	Thalaku
2 Wheeler	1258	1395	1601
3 wheeler/Auto	247	199	161
Tractor	10	22	15
Tractor with trailer	81	76	115
Cycle	10	27	6
Cycle rickshaw	0	0	0
Animal drawn	2	10	1
Toll exempted Vehicles	33	24	41
Motorised	**6110**	**6632**	**7196**
Non motorised	**12**	**37**	**7**
Tollable Vehicles	**4481**	**4916**	**5263**
Non-Tollable Vehicles	**1641**	**1753**	**1940**
Total Vehicles	**6122**	**6669**	**7203**
Total PCU	**13023**	**13687**	**14590**

The investment priorities are governed by traffic demand, assessed benefits and cost of project. Demand plays the important role that governs which type of facility / infrastructure to be created. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out near accurately. For the design of pavement and to plan for the future maintenance programme as well as capacity augmentation and for financial evaluation, it is necessary to have realistic estimate of the size of traffic in horizon year.

Traffic forecasting is done in two ways, one with CAGR of 5 % as proposed in the ToR and the other with growth rates established by using elasticity method. This forecasting is made by determining the past trend of traffic flow along the corridor and by use of economic models developed to co-relate past vehicle registration data and economic indices such as per capita income (PCI), net state domestic product (NSDP) and gross domestic product (GDP). By using the elasticity values obtained from the econometric models and the likely rate of growth of indices, population and regional influences, the mode wise growth rates are established.

Classified direction wise turning movement survey has been conducted at 4 major junctions shown in Table below along the project stretch. Type of existing intersection and structures proposed based on the turning movement survey are also shown in Table below.

Table 0-2 Turning movement survey locations

S No.	Chainage	Location	Total Volume PCU	Peak Hour Volume PCU	Peak Hour
1	314.220	Near Hanagal	10256	1233	18.00-19.00
2	314.770	Hanagal Cross	7936	884	20.00-21.00
3	317.760	Rayapura Cross	6883	10236	18.00-19.00
4	347.170	Garani Cross	7082	11414	18.00-19.00

0.3 Axle load survey

Axle load survey has been conducted at 1locations using portable electronic weigh pads in order to plot actual loading spectrum of commercial vehicles, which create potential damage to pavement.

This damage to pavement normally qualified by a factor termed as vehicle Damage Factor (VDF). The VDF for project stretch is worked out using equivalency factors and damaging power of different axle, IRC: 37-2012. The VDF values adopted for MSA calculation are shown in Table below.

The Axle load surveys were conducted at one location, i.e., in may month of 2016. The annual average daily traffic at these locations is shown in table below.

Table 0-3 VDF values, observed and recommended

Location	Existing NH 150A km 350.300		
Mode	Byrapura – Hiriyur	Hiriyur - Byrapura	Recommended
LCV	1.02	0.41	1.02
2-axle	2.96	1.69	2.96
3-axle	3.16	3.70	3.70
MAV	5.85	3.25	5.85
Bus	1.45	1.25	1.45

The cumulative million standard axles at count locations have been calculated for various horizon years and shown in Table below. These values are used in new pavement design.

0.4 Intersections

There are about 26 intersections along the project stretch includes 3 major Intersections and 22 minor Intersections. The minor & major intersections with state highways and district roads are given in below table

Table 0-4 List of Minor Junctions

Sl. No	Existing km	Type of Junction	Leads To		Type of Intersection
			LHS	RHS	
1	311.060	3 legged	Katanaikanahalli		T
2	311.970	3 legged	Katanaikanahalli		T
3	313.207	3 legged	Pujarihatti		T
4	314.250	3 legged		Bommalinganahalli	Y
5	314.660	3 legged		Village road	T
6	316.445	3 legged		Iyanahalli	T
7	317.150	3 legged	Rayapura		T
8	320.530	4 legged	Nerlahalli	Tumkurlahalli	Staggered, +
9	324.890	3 legged	Marammanahalli		T
10	331.010	4 legged	Mogalahalli	Surammanahalli	Staggered, X
11	331.755	3 Legged	Village Road		Y
12	331.940	3 legged		Bommagondanakere	T
13	338.305	3 legged	Village road		T
14	339.030	4 legged	Village road	Hirehalli	Staggered, +
15	339.850	4 legged	Chikkahalli	Hirehalli	Staggered, +
16	345.160	4 legged	Byadareddyhalli	Kereyagalahalli	Staggered, X
17	345.850	3 legged	Mannekote		T

Sl. No	Existing km	Type of Junction	Leads To		Type of Intersection
			LHS	RHS	
18	346.490	3 legged	Village road		T
19	348.260	3 legged	Thalaku		T
20	351.320	4 legged	Village road	Devarhalli	+
21	354.145	3 legged		Varavoo	T
22	358.100	3 legged		Labanehatti	Y

Table 0-5 List of Major Junctions

Sl. No	Existing km	Type of Junction	Leads To		Remarks
			LHS	RHS	
1	314.860	4 Legged	Mulakalamuru road	Village road	
2	317.870	4 Legged	Rayapura	Yerenahalli	SH-65
3	347.170	3 Legged		Nayakanhatti	SH-65

0.5 Engineering Surveys and Investigations

The general engineering studies conducted along the project stretch include topographic survey, Pavement composition, pavement condition surveys and pavement structural strength.

Topographic Survey

The Topographic Survey for improvement of project road was carried out by GPS, electronic Total Station and Auto level equipments. The detailed survey methodology and specifications followed are as described below.

Initially control points and traverse stations were established using GPS and Total Station equipments. Then using Auto level equipment, Double Tertiary (DT) levelling was carried out to fix temporary benchmarks with respect to GTS Benchmarks available in the area to establish the vertical control to all TBMs and traverse stations. The detailed survey was then carried out and the data was processed for engineering design.

The following specifications were adopted for carrying out the topographic surveys. Traverse points positioning was with accuracy of 1:10,000. All traverse points were marked on ground by punching nails in to surface. TBMs are fixed on BM reference pillars fixed 250 m apart, at top of the kilometre stones, parapets of culverts and on plinth top of the buildings. Double tertiary methods have been used in levelling, taking the sum and average of three wire readings to determine reduced levels.

Cross-sections of roads are taken at an interval of 50 m. Levels were taken at the centre and edges of carriageway, edge of shoulders and levels up to property lines on both sides. Details of drain widths and depths also collected. For all the existing culverts, top levels / road levels and bed levels / sill levels were collected.

Road Inventory

The existing pavement for the entire stretch is of bituminous surface except at major bridge locations. The pavement width is predominantly two lane carriageway with 1.0 m Paved shoulders on either side and 4 lane divided carriageway exists at some built up stretches of the highway and is varies from fair to poor condition.

Pavement Condition

The survey on general pavement condition was primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements wherever necessary. Visual assessment was carried out at suitable intervals at 200 m and wherever necessary, depending on variations in pavement conditions.

The existing pavement condition based on visual observation varies from good to poor. It has been observed that in most of the stretches heaving / settlements / distress were observed. This may be due to weak subgrade, improper compaction or movement of heavy loaded trucks. Summary of pavement condition is given in Table below.

Table 0-6 Summary of Pavement Condition

Sl. No.	Summary	Length, (km)	%
1	Good	28.85	57.76
2	Fair	21.10	42.24
Total		**49.95**	**100.00**

Pavement Structural Strength

Benkelman Beam deflection studies were carried out for evaluating the residual strength of the existing pavement and assessing the strengthening requirements for the existing pavement.

BBD tests have been conducted for every 3 km interval. The pavement deflection has been observed for homogeneous sections based on pavement condition survey.

The summary of Characteristic deflection is given in Table below

Table 0-7 Summary of Characteristic Deflection

Sl. No	Existing Km NH-150A		Characteristic Deflection (mm)
	From	To	
1	308.500	308.725	1.66
2	311.400	311.625	0.99
3	316.750	316.975	1.13
4	320.750	320.975	2.47
5	322.750	322.975	1.26
6	326.750	326.975	2.06
7	329.750	329.975	1.76
8	332.750	332.975	1.60
9	336.750	336.975	2.22
10	339.700	339.925	0.83
11	342.750	342.975	1.80
12	345.770	345.995	1.58
13	351.000	351.225	1.94
14	353.800	354.025	1.02

Sl. No	Existing Km NH-150A		Characteristic Deflection (mm)
	From	To	
15	358.200	358.425	2.12

Subgrade Investigation

The laboratory investigations of sub-grade indicate that the existing subgrade varies from location to location along the road. The 4 days soaked CBR values for 65 blows of existing sub-grade varies from 9% to 11%.

Material Investigation

Potential sources of soil for construction of embankment and subgrade (for reconstruction / new carriageway) were identified on either side of project stretch.

Borrow area quarries located in 6 locations with average CBR of 10% which is found suitable for construction.

Aggregate quarries were identified in 5 locations out of these 4 locations found suitable for construction.

Hydrological investigations

Hydrological investigations have been carried out for the entire project road. It has been verified that majority of the cross drainage structures are hydrologically adequate to carry the discharges of the river / streams. It has been ascertained from local enquiry and from the National Highways.

0.6 PRELIMINARY DESIGN

Geometric design

The existing alignment largely runs is in plain terrain and the design speed of 80 to 100 kmph has been adopted as per IRC: SP: 84- 2014. Geometric design viz. horizontal and vertical curves are designed as per IRC 38-1988 & IRC: SP: 23 - 1983.

Alignment proposal

After carrying out field investigations and reconnaissance survey of existing alignment, the consultants have been arrived at alignment proposals.

Widening proposals have been prepared based on availability of additional land / existing RoW, horizontal geometrics, study of existing bridges and considering road safety parameter measures. The lengths of adopted type of widening details (as per proposed chainage) are given in Table below.

Table 0-8 Length of adopted type of widening scheme

Sl. No	Type of widening	Design Length km
1	Concentric	8.070
2	Eccentric	24.800
3	Realignments	16.270
4	Toll plaza	0.810
Total Length, Km		**49.950**

Proposed Lane widths

The width of basic traffic lane is taken to be 3.5 m. For proposed 4-lane the carriageway width will be 14m width with paved shoulders on both sides. In divided cross-section, the median will be of 5.0 m width in rural areas and of 2.5 m width in urban areas including 0.5 m shy off on both sides. The proposed carriageway details are presented in table below.

Table 0-9 Proposed Lane widths

S. No	Design Chainage		Length, m	Lane Width	Remarks
	From	To			
1	308+550	312+460	3910	4 Lane	
2	312+460	313+000	540	4 Lane with service road	Pujarihatti
3	313+000	316+950	3950	4 Lane	
4	316+950	317+250	300	4 Lane with service road	Mysavahatti
5	317+250	331+320	14070	4 Lane	
6	331+320	332+000	680	4 Lane with service road	Bommagondanakere
7	332+000	358+500	26500	4 Lane	

Typical Cross Sections

Based on the traffic considerations, geometric standards and existing site conditions, the following typical cross sectional elements are framed for project road.

Table 0-10 Details of Proposed Cross Section

Element	Width (m)	Total Width (m)
4-lane Divided Carriage way Cross Section in Rural (C/S Type 1,1A,1B,& 1D)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Utility corridor	2 x2.00	4
Drain, Future widening etc	2x15.0	30
Total		**60**
4-lane Divided Carriage way Cross Section in Urban (C/S Type 2, 2A & 2B)		
Main Carriageway	2 X 7.00	14
Median	1 X 1.50	1.5
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Earthen Shoulders	2 X 2.00	4
Earthen Shoulders for service roads	2 X1.50	3
Service Road	2 X 7.5	15
Drain cum Foot Path	2 X 1.5	3
Utility Corridor/Footpath	2 x 2.00	4
Space left for future widening / Drain	2 X 5.25	10.5
Total		**60**

Element	Width (m)	Total Width (m)
VUP approach Cross Section in rural (C/S Type 3)		
Main Carriageway	2 x 10.5	21
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Crash barrier with shyness	2 x 1.0	2
Slip road on both sides	2 x 7.0	14
Earthen shoulders	2 x 1.5	3
Divider between slip Road and VUP Approach	2 x 0.5	1
Utility Corridor	2 x 2.0	4
Drain & Slope	2 x 3.0	6
Total		**60**
VUP/Flyover approach Cross Section in Urban (C/S Type 3A)		
Main Carriageway	2 x 10.5	21
Median	1 X 1.50	1.5
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Crash barrier with shyness	2 x 1.0	2
Divider between slip Road and Fly Over Approach	2 x 4.250	8.5
Service road on both sides	2 x 7.5	15
Utility corridor	2 x 2	4
Footpath cum drain	2 x 1.5	3
Total		**60**
VOP Approach Cross Section in Urban (C/S Type 4)		
Main Carriageway	2 x 14.00	28
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 1.5	3
Footpath cum Drain	2 x 1.5	3
Crash Barrier	2 x 0.5	1
Divider between slip Road and VOP Approach	2 x 0.5	1
Divider Shy Off	2 x 0.5	1
Slip road on both sides	2 x 5.5	11
Kerb Shyness	2 x 0.5	1
Footpath cum Drain	2 x 1	2
Utility Corridor	2 x 2.0	4
Total		**60**
4-lane Divided Carriage way Cross Section in Hilly Area (C/S Type 5)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4

Element	Width (m)	Total Width (m)
Utility corridor	2 x2.00	4
Drain, Breast Wall, Catch water Drain and Future widening etc	2x15.0	30
Total		**60**

Pavement Design

New Flexible pavement has been proposed for additional 2-lane & flexible overlay over existing 2-lane road. Rigid pavement is proposed only at Major realignments and toll plaza location.

New Flexible/Rigid Pavement Design

The pavement design basically aims at determining the total thickness of the pavement structure as well as thickness of individual structural components. The following assumptions are considered for the preliminary pavement design. The basic assumptions considered while designing are as follows.

As per IRC: SP: 84-2014 (for 4-Lane)

As per IRC: SP: 84-2014 flexible pavements shall be designed for a minimum design period of 15 years or operation period whichever is more. Stage construction will be permitted subject to the thicknesses of sub-base & base coarses are designed for 15 years & bituminous surface for a minimum of 10 years. Strengthening for the future traffic can be carried out by means of Bituminous Overlay. Rigid pavement shall be designed for a minimum design period of 30 years; stage construction shall not be permitted.

Flexible Pavement

The project road has been divided into three homogeneous sections, design for which are furnished below.

Table 0-11 Cumulative MSA at sections

Description	Section-I		Section-II		Section-III	
	LHS	RHS	LHS	RHS	LHS	RHS
Design life of Base and Sub Base (in years) - **For Stage Const.**	15	15	15	15	15	15
Design life of BT layer (in years) - **For Stage Const.**	10	10	10	10	10	10
MSA for Base and Sub Base - **For Stage Const.**	42.49	50.98	45.01	48.9	47.18	51.9
MSA for BT layer - **For Stage Const.**	25.26	30.29	26.77	29.07	28.05	30.84
Design CBR %	9	9	9	9	9	9

Table 0-12 Flexible pavement composition (in mm) recommended for Main Carriageway

Description	Pavement Thickness, mm	
	Byrapura-Challakere	Challakere to Byrapura
Bituminous Concrete (BC), mm	40	40
Dense Bituminous Macadam , mm	95	85
Wet Mix Macadam , mm	250	250
Granular Sub Base, mm	200	200

Description	Pavement Thickness, mm	
	Byrapura-Challakere	Challakere to Byrapura
Subgrade of CBR 9% material, mm	500	500
Total	**1085**	**1075**

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

Table 0-13: Flexible Pavement Compositions for Service road

Service/Slip Road			
Composition	**MSA**	**Design CBR (%)**	**Thickness, mm**
BC	10	9	40
DBM			50
WMM			250
GSB			200
Subgrade			500
Total			**1040**

Table 0-14 Overlay Thickness (in mm) recommended

S. No	NH-150A Existing Km		Design Chainage		Average Characteristic Deflection	MSA	BM (mm)	Overlay (mm)	Design Thickness	
	From	To	From	To					BC (mm)	DBM (mm)
1	309.150	316.950	308+550	316+850	1.02	37	89.84	63	40	50
2	316.950	326.950	316+850	326+930	1.75	35.53	176.44	124	40	85
3	326.950	346.950	326+930	346+600	1.44	35.53	149.48	105	40	65
4	350.200	359.100	349+700	358+500	1.63	38.16	169.05	118	40	80

Rigid Pavement

The Rigid pavement is proposed at Built up locations and toll plaza location. The design as per the IRC: 58 – 2015 leads to the crust thickness of pavement as given in following table.

Table 0-15 Rigid Pavement Compositions (As per IRC: 58-2015)

For CBR = 9%

Pavement Composition	Thickness in mm
Design Life (Yrs)	30
Design CBR (%)	10
PQC (mm)	280
DLC (mm)	150
GSB (mm)	150
Sub-grade with material having effective CBR of 9%	500
Total	**1080**

Truck lay-byes

Truck lay-byes are proposed at following locations and new Flexible pavements is proposed at these locations.

Sl. No.	Existing Km	Design Chainage	Side	Name / Location
1	316.600	316+500	Both	Near Mysarahatti
2	354.370	354+800	Both	Near Chikkammanahalli

Rest Area

The location of the Rest area is given below

S. No	Existing km	Design Chainage	Side	Location	Area
1	332.725	332+600	LHS	Near Bommagondanakere	3 Ha
2	332.980	332+850	RHS	Near Bommagondanakere	3 Ha

Bus Bay with Bus Shelters

There are 12 nos Bus Bay with Bus Shelters and 22 bus shelters are proposed along the project stretch.

Toll Plaza

Rigid Pavement is proposed for the toll plaza location, as it has longer life and can resist the wear and tear caused by the braking forces exerted by heavy vehicles.

One toll plaza is proposed with additional right-of-way, service lanes, toll booths, lighting, weigh-in-motion Weigh Bridge, automatic, semi automatic and manual toll booths, separate lanes for wide bodied vehicles etc. The detail of the proposed toll plaza is given below.

Table 0-16 Proposed Toll Plaza Location

Sl. No.	Toll Plaza Location			No of Toll Lanes*	
	Existing Chainage	Design Chainage	Location	LHS	RHS
1	341.560	341+300	Near Chikkamanahalli	7+1	7+1

*As per DO No. NHAI/Chairman/Misc./2016 dated 26.12.2016

Proposal for Structures

There are 30 no's. Minor bridges, 4 no.'s Flyovers, 1 no. VOP, 6 no's LVUP's along with many other cross drainage works are proposed along the project stretch. Nos. of each type of structure along the project stretch is given in below Table. These structures are proposed for widening, rehabilitation or construction of new structure.

Table 0-17: Proposed Structures on Project Stretch

Sl. No.	Type of structure	No's.
1	Minor bridges	30
2	Flyover	04
3	VOP	01
4	LVUP's	06
5	Culverts	78
6	Cross Road Culverts	31

0.7 Cost Estimation

The cost estimation for the project is extremely important as the viability and implementation of a project depends on the project cost. Therefore, cost estimates have been carried out with due care. Estimation of preliminary cost, a primary pre-requisite for economic and financial evaluation, has been carried out for widening the existing NH stretches to 4-lane carriageway with paved shoulders on both sides including Reconstruction of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, road furniture, bus bays, truck bays, way side amenities, toll plazas, etc. and is presented in below Table.

0. EXECUTIVE SUMMARY

0.1 Introduction

The Highway starting from Jeevargi connecting Maski, Siruguppa, Bellary, Challakere, Hiriyur, Turuvekere, Shrirangapattana, Mysore, and Chamarajanagar, which previously comprised of SH was recently upgraded and declared as NH-150A by Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI).

The Ministry of Road Transport & Highways (MoRT&H), Government of India (GOI), (Public Works, Ports And Inland Water Transport Department), Office of The Executive Engineer, National Highways, Chitradurga division has appointed M/s. Feedback Infra Pvt. Ltd. for providing the consultancy services for preparation of Feasibility Study, Detailed Project Report, Survey, Preparation of Land Plan for widening to Two lane Paved shoulder from Bellary to Hiriyur section in the state of Karnataka.

The Contract Agreement for the assignment was signed on 7th May 2015; the Consultancy services were commenced with effect from 7th May 2015.

The Consultant has studied the feasibility of the project and submitted the Detailed Project Report along with EPC Schedules Executive Engineer, National Highways, Chitradurga division vide letter no FIPL/Highways/DPR/NH-PWD/CTR/2016-17/485 and FIPL/Highways/DPR/NH-PWD/CTR/2016-17/486A

From the Traffic surveys and analysis, it was concluded that the project road requires four lane with paved shoulders (PCUs are more than 10000), hence the Project is transferred from Ministry of Road Transport & Highways to National highways authority of India vide Gazette notification S.O. 1096 (E) dated 23.11.2016. The Tripartite agreement for the Consultancy services was signed on 04 May 2017 and the project preparation activities commenced subsequently.

As per the Tripartite agreement Project road has been divided into three packages and Package wise Details given in below table

Sl. no	Package	Project Section	Existing km		Design Chainage		Design Length in km
			From	To	From	To	
1	I	Bellary to Byrapura (Include Bellary Bypass)	253.600	309.150	253+600	308+550	54.95
2	II	Byrapura to Challakere	309.150	359.120	308+550	358+500	49.95
3	III	Challakere to Hiriyur (Including Challakere and Hiriyur Bypass)	359.120	411.560	358+500	414+205	55.705

Current report depicts Draft feasibility report of Package-III i.e. to Challakere to Hiryur (Including Challakere and Hiriyur Bypass).

Table 0-18 Summary of Cost Estimate for Byrapura to Hiriyur section of NH-150A

ABSTRACT OF COST - Byrapura - Challakere Section of NH-150A (Ds.Ch: 308+550 to Ds.Ch: 358+500)

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	2,14,04,901	2.14	0.35%
2	Earth Work	69,18,31,848	69.18	11.40%
3	Granular Sub-Base and Base Courses	1,10,72,27,125	110.72	18.25%
4	Bituminious Works	-	-	
4A	Flexible Pavement	1,17,04,29,993	117.04	19.29%
5	CULVERTS	-	-	
5A	Box Culvert	17,40,13,010	17.40	2.87%
5B	Pipe Culvert	6,45,66,468	6.46	1.06%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	7,98,856	0.08	0.01%
6C	Minor Bridges	90,69,32,746	90.69	14.94%
6E	PUP/LVUP	44,42,32,332	44.42	7.32%
6F	CUP	9,79,14,064	9.79	1.61%
6H	Flyover and Overpass	62,08,34,286	62.08	10.23%
7	Drainage, Protective Works & Other Services	17,52,04,392	17.52	2.89%
8	Junctions	8,52,89,890	8.53	1.41%
9	Traffic Signs, Road Marking and Other Appurtenances	19,59,91,350	19.60	3.23%
10	Miscellaneous	20,20,87,150	20.21	3.33%
11	Toll Plaza Construction @ Ch.341+300	10,98,07,651	10.98	1.81%
A	**Total Civil Cost (YR: 2017-2018) =**	**6,06,85,66,062**	**606.86**	
	Civil Cost per Km (Length of Project Highway-50.05 km)	**12.13**		
II	**Centage (As per ministry circular dated 10th Aug 2016, for HAM project**	**91,02,84,909**	**91.03**	
III	**TOTAL PROJECT COST (IV+VIII)**	**6,97,88,50,972**	**697.89**	
	Total Project Cost per Km	**13.94**		
IV	**PRE CONSTRUCTION ACTIVITY**			
	LA, R&R and Social	1,39,49,02,850	139.49	
	Environment Cost and Utility shifting and other preconstrucion activities	1,15,55,710	1.16	
	Shifting of Electrical Poles/Lines (1% of Civil Cost) =	6,06,85,661	6.07	
	Shifting of Water Supply Pipe Lines (1% of Civil Cost) =	6,06,85,661	6.07	
	Total cost of preconstruction activities D=(a+b+c+d+e) =	**1,52,78,29,881**	**152.78**	
V	**Total Capital Cost (C+D) =**	**8,50,66,80,853**	**850.67**	
	Total Capital Cost Per Km in Crores =	**17.00**		

CONCLUSIONS AND RECOMENDATION

ECONOMIC ANALYSIS

The economic internal rate obtained was return of 25.7% for development of the project road with flexible pavement, which is more than the presented 12% of discounted rate and larger positive value of NPV of net benefits indicate the firm viability of project for the proposed improvement of four laning with paved shoulders and hence recommended for implementation.

FINANCIAL ANALYSIS

It is concluded that the project doesn't provide sufficient returns to equity on commercial BOT (Toll) format with 40 % grant for concession period of 10 years & 15 years. However, if the concession period is increased to 20 years, the project provides sufficient returns to equity at 7.5% Grant. For a concession period of 25 Years, the project doesn't require any grant and provides 16.38% return on equity.

However, the consultants recommend the project on HAM with concession period of 15 years and on EPC mode, as per Policy Matter: Technical ((161/2014) Lt No.11041/218/2007-Admn dated 24.07.2014.

K.N. Ajay Mohan Kumar
National Highways Authority of India
Project Director
National Highways Authority of India
PIU, Hospet

Description of project

The State of Karnataka is located in southwest part of India. Karnataka is surrounded by Maharashtra, Goa, Andhra Pradesh, Kerala and Tamil Nadu. The NH 150A starts at Jevargi and ends at Chamarajanagar in Karnataka. The entire stretch of NH 150A passes through Gulbarga, Raichur, Bellary, Ananthpur, Chitradurga, Tumkur, Mandya, Mysore and Chamarajanagar districts and passing through important cities/towns like Jevargi, Shorapur, Lingsugur, Sindhanur, Siruguppa, Ballari, Hanagal, Challakere, Hiriyur, Huliyar, Turuvekere, Nagamangala, Pandavapura, Shrirangapattana, Mysore, Nanjanagudu and Chamarajanagar. The Road was declared as National Highways No. 150A. The Total length of NH 150A is 618.62 Kms. The Project Road Starts at Km 359.120 of NH-150A near Challakere and ends at Km 411.560 of NH-150A Hiriyur. The total existing length of the project stretch is 52.44 km and mainly passes through Challakere, Sanikere, Hirehal and Hiriyur**. Figure 0-1** Refers to the location of the Project stretch of NH 150A.

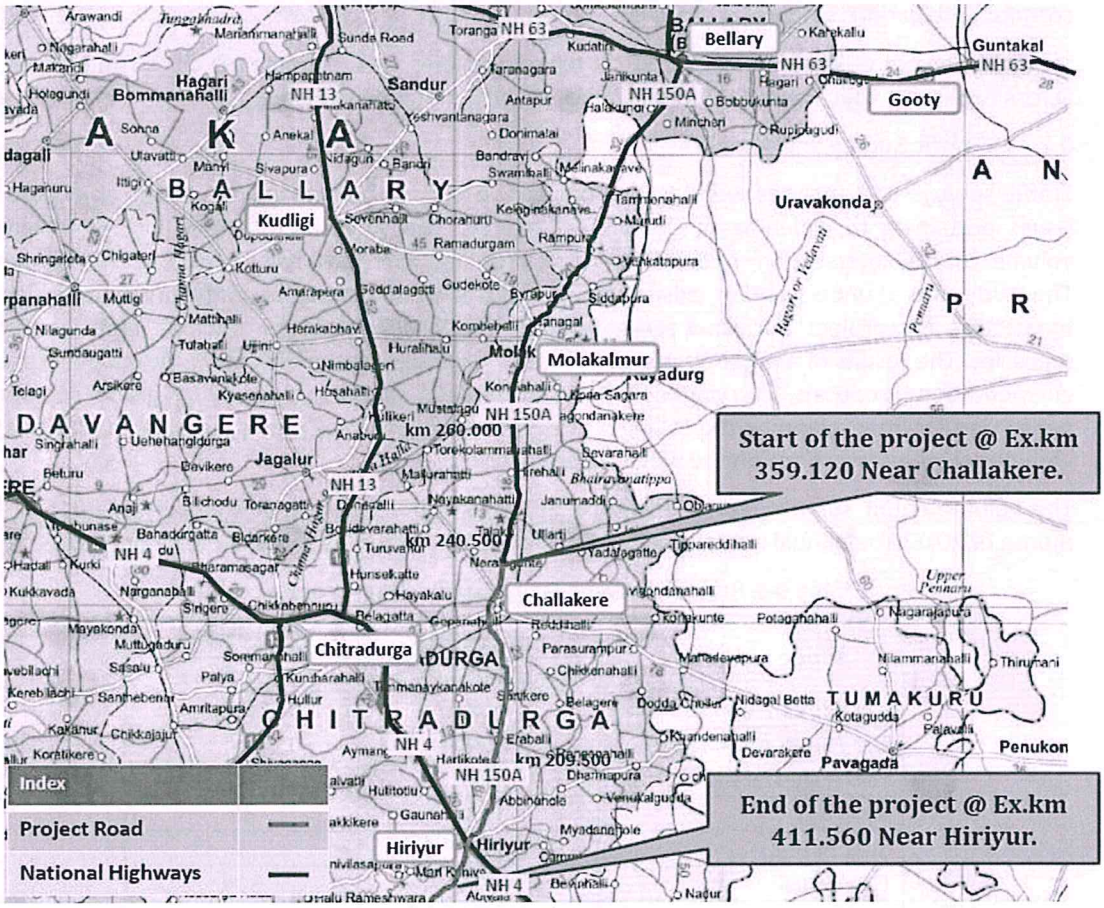

Figure 0-1: Location of Project Stretch

The project road alignment generally runs in plain terrain and passes through settlements like Challakere, Samikere, Hirehal, Hiriyur.

The existing alignment comprises of many sharp horizontal curves which require geometric corrections. Few among these are observed to have insufficient sight distance.

The existing road has two lane carriageways with 0.5m to 1.5m earthen shoulder. The condition of existing pavement mainly varies from Good to fair.

There are 81 structures present in 52.44 km length of stretch. These include 1 major bridge, 24 minor bridges, 1 VOP, 1 RUB and 54 culverts.

Right of Way (RoW) varies from 10 m to 30 m in the project stretch.

The traffic on this stretch of NH 150A is of mixed type, with of passenger traffic is varying from 51.7 % to 56.4 % and that of freight traffic range from 43.6 % to 47.9 %. Share of slow moving vehicles range from 0.0 to 0.4 %.

The predominant land use is agricultural (77.30 % on LHS and 73.50 % on RHS) followed by built up (22.20 % on LHS and 25.50 % on RHS) and Industrial (0.50 % on LHS and 1.00 % on RHS)

There are 51 numbers of minor intersections & 4 numbers of major intersections along the project corridor with various categories of roads.

Large number of utility lines viz. electric / telephone lines, gas pipe lines & OFCs run parallel and across the route, which needs to be relocated for facilitating the widening.

0.2 Traffic Survey and Analysis

Traffic surveys and analyses were carried out in two phases for addressing various objectives and issues pertaining to widening of the project stretch. The surveys conducted include seven day volume counts, intersection, pedestrian/ cattle crossing, axle load and Origin Destination survey. The study aims at understanding existing traffic and travel characteristics on the project corridor and forecasting for project horizon year considering various constituent streams and for various scenarios. The results of analysis would form inputs for designing the pavement, developing capacity augmentation proposals, carrying out financial analysis, decisions regarding grade separators, pedestrian facilities, planning the tolling strategy, designing the toll plaza, wayside amenities along with design of intersections on the widened project road.

The volume count surveys were conducted at two locations, i.e., in July month of 2015 & May month of 2016. The annual average daily traffic at these locations is shown in table below.

Table 0-1 Annual Average Daily Traffic along project corridor

Mode of Vehicle	Km 376.220	Km 391.285
	Mummadisagara B	Harthikote
Car / Jeep / Van (Private)	1082	1069
Car / Jeep / Van (Taxi)	378	381
Local/Shared Car	54	38
Mini Bus	43	38
School Bus	2	1
Govt. Bus	304	314
Pvt. Bus	253	262
LMV	256	420
LCV (4 Wheels)	96	101
LCV (6 Wheels)	178	167
2 Axle	416	472
3 Axle	682	727
MAV (4 - 6 Axles)	1063	1115

Mode of Vehicle	Km 376.220	Km 391.285
	Mummadisagara B	Harthikote
MAV (7++ Axles)	0	0
2 Wheeler	1360	1158
3 wheeler/Auto	115	91
Tractor	7	20
Tractor with trailer	35	48
Cycle	0	22
Cycle rickshaw	0	0
Animal drawn	2	3
Toll exempted Vehicles	21	7
Motorised	**6345**	**6429**
Non motorised	**2**	**25**
Tollable Vehicles	**4807**	**5104**
Non-Tollable Vehicles	**1540**	**1349**
Total Vehicles	**6347**	**6454**
Total PCU	**13003**	**13668**

The investment priorities are governed by traffic demand, assessed benefits and cost of project. Demand plays the important role that governs which type of facility / infrastructure to be created. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out near accurately. For the design of pavement and to plan for the future maintenance programme as well as capacity augmentation and for financial evaluation, it is necessary to have realistic estimate of the size of traffic in horizon year.

Traffic forecasting is done in two ways, one with CAGR of 5 % as proposed in the ToR and the other with growth rates established by using elasticity method. This forecasting is made by determining the past trend of traffic flow along the corridor and by use of economic models developed to co-relate past vehicle registration data and economic indices such as per capita income (PCI), net state domestic product (NSDP) and gross domestic product (GDP). By using the elasticity values obtained from the econometric models and the likely rate of growth of indices, population and regional influences, the mode wise growth rates are established.

Classified direction wise turning movement survey has been conducted at 3 major junctions shown in Table below along the project stretch. Type of existing intersection and structures proposed based on the turning movement survey are also shown in Table below.

Table 0-2 Turning movement survey locations

Location	Chainage (NH 150A)	Survey Location	Type of Junction	Legs leading to	Date
TMC 1	km 361.650	Near Challakere	3 Leg	Kalyanadurgam	17-07-2015
TMC 2	km 363.485	Challakere Junction	4 Leg	Pavagada, Chitradurga	18-07-2015
TMC 3	km 404.250	Hiriyur T.B Circle	4 Leg	Chitradurga, Bangalore	20-07-2015

0.3 Axle load survey

Axle load survey has been conducted at 1locations using portable electronic weigh pads in order to plot actual loading spectrum of commercial vehicles, which create potential damage to pavement.

This damage to pavement normally qualified by a factor termed as vehicle Damage Factor (VDF). The VDF for project stretch is worked out using equivalency factors and damaging power of different axle, IRC: 37-2012. The VDF values adopted for MSA calculation are shown in Table below.

The Axle load surveys were conducted at one location, i.e., in May month of 2016. The annual average daily traffic at these locations is shown in table below.

Table 0-3 VDF values, observed and recommended

Location	km 376.220		
Mode	Ballari – Hiriyur	Hiriyur - Ballari	Recommended
LCV	1.11	0.63	1.11
2-axle	3.14	1.76	3.14
3-axle	3.73	1.73	3.73
MAV	6.16	2.81	6.16
Bus	1.30	1.29	1.30

The cumulative million standard axles at count locations have been calculated for various horizon years and shown in Table below. These values are used in new pavement design.

0.4 Intersections

There are about 55 intersections along the project stretch includes 4 major Intersections and 51 minor Intersections. The minor & major intersections with state highways and district roads are given in below table

Table 0-4 List of Minor Junctions

Sl. No	Existing km	Type of Intersection	Leads To	
			Left	Right
1	362.100	Staggered	To Durgavara	To Sujimalleswara Nagar
2	362.315	3 Legged	-	To Sujimalleswara Nagar
3	362.820	Staggedred	To Katappana hatti	To Chitrayyanna hatti
4	363.075	3 Legged	To Challakere Old Town	-
5	363.240	3 Legged	To Challakere Old Town	-
6	363.300	3 Legged	To Challakere Old Town	-
7	363.700	3 Legged	To Railway Station Road	-
8	363.860	3 Legged	-	To Gandhi Nagar
9	363.975	3 Legged	To Challakere Town	-
10	364.220	Staggered	To Challakere Town	To Gandhi Nagar
11	364.300	3 Legged	To Challakere Town	-
12	364.385	3 Legged	To Challakere Town	-
13	364.465	3 Legged	-	To Gandhi Nagar
14	364.560	3 Legged	To Challakere Town	-
15	364.685	3 Legged	-	To Gandhi Nagar
16	365.490	3 Legged	To Nagaramgere	-

Sl. No	Existing km	Type of Intersection	Leads To	
			Left	Right
17	366.755	3 Legged	-	To Village
18	366.605	4 Legged	To SR Layout	To Radhaswamy Nagar
19	368.350	4 Legged	To Siddapur	To Laxmipur
20	370.255	3 Legged	-	To Hotteppanahalli
21	373.125	3 Legged	To Gopanahalli	-
22	374.465	3 Legged	-	To Ganugutta
23	376.260	4 Legged	To Golarahatti	To Sanikare
24	377.610	3 Legged	To Chikkanahalli	-
25	377.705	3 Legged	To Sondekere	-
26	379.540	3 Legged	-	To Heggere
27	385.375	3 Legged	-	To Maddanakunte
28	386.550	3 Legged	To Kandikere	-
29	387.370	3 Legged	-	To Vaddikere
30	388.810	3 Legged	To Gudunurhalli	-
31	389.095	3 Legged	-	To Kalavibagi
32	390.280	3 Legged	To Rangenahalli	-
33	391.335	4 Legged	To Harthikotta	To Salavammana Halli
34	396.430	3 Legged	To Balenahalli	-
35	397.270	3 Legged	To Balenahalli	-
36	399.000	3 Legged	-	To Gannaanakamhalli
37	399.340	3 Legged	To Hamadala Village	-
38	400.045	3 Legged	-	To Chinanaikanhatti
39	400.950	3 Legged	-	To Chinanaikanhatti
40	401.940	3 Legged	-	To Chinanaikanhatti
41	403.445	3 Legged	To Babbur	-
42	403.700	3 Legged	To City	-
43	403.800	3 Legged	-	To City
44	403.850	3 Legged	To City	-
45	404.665	3 Legged	To Avdani Nagar	-
46	405.315	3 Legged	-	Akshay Food Park Road
47	405.725	3 Legged	To Hiriyur City	-
48	406.195	4 Legged	To Hiriyur City	To Vishveshwarayya Road
49	407.505	3 Legged	-	To Kottige Village
50	408.640	3 Legged	To Somerahalli	-
51	411.180	4 Legged	To Somerahalli	To Doddaghatta

Table 0-5 List of Major Junctions

Sl. No	Existing km	Type of Intersection	Leads To		Remarks
			Left	Right	
1	361.730	3 Legged	-	To Nayakanahatti (NH-45)	NH-45
2	363.500	4 Legged	Anantapur (SH-48)	To Chitradurga (SH-48)	SH-48
3	404.330	4 Legged	To Bangalore (NH-4)	To Chitradurga	NH-4

Sl. No	Existing km	Type of Intersection	Leads To		Remarks
			Left	Right	
4	405.850	3 Legged	To Bangalore	-	

0.5 Engineering Surveys and Investigations

The general engineering studies conducted along the project stretch include topographic survey, Pavement composition, pavement condition surveys and pavement structural strength.

Topographic Survey

The Topographic Survey for improvement of project road was carried out by GPS, electronic Total Station and Auto level equipments. The detailed survey methodology and specifications followed are as described below.

Initially control points and traverse stations were established using GPS and Total Station equipments. Then using Auto level equipment, Double Tertiary (DT) levelling was carried out to fix temporary benchmarks with respect to GTS Benchmarks available in the area to establish the vertical control to all TBMs and traverse stations. The detailed survey was then carried out and the data was processed for engineering design.

The following specifications were adopted for carrying out the topographic surveys. Traverse points positioning was with accuracy of 1:10,000. All traverse points were marked on ground by punching nails in to surface. TBMs are fixed on BM reference pillars fixed 250 m apart, at top of the kilometre stones, parapets of culverts and on plinth top of the buildings. Double tertiary methods have been used in levelling, taking the sum and average of three wire readings to determine reduced levels.

Cross-sections of roads are taken at an interval of 50 m. Levels were taken at the centre and edges of carriageway, edge of shoulders and levels up to property lines on both sides. Details of drain widths and depths also collected. For all the existing culverts, top levels / road levels and bed levels / sill levels were collected.

Road Inventory

The existing pavement for the entire stretch is of bituminous surface except at major bridge locations. The pavement width is predominantly two lane carriageway with 1.0 to 1.5 m earthen shoulders on either side and 4 lane divided carriageway exists at some built up stretches of the highway and is varies from fair to poor condition.

Pavement Condition

The survey on general pavement condition was primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements wherever necessary. Visual assessment was carried out at suitable intervals at 200 m and wherever necessary, depending on variations in pavement conditions.

The existing pavement condition based on visual observation varies from good to poor. It has been observed that in most of the stretches heaving / settlements / distress were observed. This may be due to weak subgrade, improper compaction or movement of heavy loaded trucks. Summary of pavement condition is given in Table below.

Table 0-6 Summary of Pavement Condition

Sl. No.	Summary	Length (km)	Percentage (%)
1	Good	21.04	40.12
2	Fair	23.75	45.28
3	Poor	7.15	13.63
4	V. Poor	0.50	0.97
Total		**52.44**	**100**

Pavement Structural Strength

Benkelman Beam deflection studies were carried out for evaluating the residual strength of the existing pavement and assessing the strengthening requirements for the existing pavement.

BBD tests have been conducted for every 3 km interval. The pavement deflection has been observed for homogeneous sections based on pavement condition survey.

The summary of Characteristic deflection is given in Table below

Table 0-7 Summary of Characteristic Deflection

Sl. No	Chainage (Km) NH-150A		Characteristic Deflection (mm)
	From	To	
1	368.920	369.145	0.93
2	371.960	372.185	1.45
3	374.895	375.120	1.51
4	377.885	378.110	1.47
5	380.860	381.085	1.37
6	382.870	383.095	1.43
7	385.860	386.085	1.69
8	388.840	389.065	1.31
9	391.875	392.100	1.70
10	394.875	395.100	0.61
11	397.875	398.100	0.79
12	400.875	404.355	1.18

Subgrade Investigation

The laboratory investigations of sub-grade indicate that the existing subgrade varies from location to location along the road. The 4 days soaked CBR values for 65 blows of existing sub-grade varies from 9% to 12%.

Material Investigation

Potential sources of soil for construction of embankment and subgrade (for reconstruction / new carriageway) were identified on either side of project stretch.

Borrow area quarries located in 6 locations with average CBR of 10% which is found suitable for construction.

Aggregate quarries were identified in 5 locations out of these 4 locations found suitable for construction.

Hydrological investigations

Hydrological investigations have been carried out for the entire project road. It has been verified that majority of the cross drainage structures are hydrologically adequate to carry the discharges of the river / streams. It has been ascertained from local enquiry and from the National Highways.

0.6 PRELIMINARY DESIGN

Geometric design

The existing alignment largely runs is in plain terrain and the design speed of 80 to 100 kmph has been adopted as per IRC: SP: 84- 2014. Geometric design viz. horizontal and vertical curves are designed as per IRC 38-1988 & IRC: SP: 23 - 1983.

Alignment proposal

After carrying out field investigations and reconnaissance survey of existing alignment, the consultants have been arrived at alignment proposals.

Widening proposals have been prepared based on availability of additional land / existing RoW, horizontal geometrics, study of existing bridges and considering road safety parameter measures. The lengths of adopted type of widening details (as per proposed chainage) are given in Table below.

Table 0-8 Length of adopted type of widening scheme

Sl. No	Type of widening	Design Length km
1	Eccentric	29.540
2	Bypass	22.660
3	Concentric	1.905
4	Realignment	0.600
5	Toll Plaza	1.000
Total Length, Km		**55.705**

Proposed Lane widths

The width of basic traffic lane is taken to be 3.5 m. For proposed 4-lane the carriageway width will be 14m width with paved shoulders on both sides. In divided cross-section, the median will be of 5.0 m width in rural areas and of 2.5 m width in urban areas including 0.5 m shy off on both sides. The proposed carriageway details are presented in table below.

Table 0-9 Proposed Lane widths

S. No	Design Chainage		Length, Km	Lane Width	Remarks
	From	To			
1	358+500	389+100	30.600	4 Lane Divided Carriageway	
2	389+100	389+800	0.700	4 Lane Divided Carriageway with Service Road	Yarraballi Built up
3	389+800	414+205	24.405	4 Lane Divided Carriageway	

Typical Cross Sections

Based on the traffic considerations, geometric standards and existing site conditions, the following typical cross sectional elements are framed for project road.

Table 0-10 Details of Proposed Cross Section

Element	Width (m)	Total Width (m)
4-lane Divided Carriage way Cross Section in Rural (C/S Type 1,1A,1B,& 1D)		
Main Carriageway	2 X 7.00	14
Median	1 x 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Space left for Future widening, Earthen drain, Slope Varies	2 x 15.00	30
Space for Services	2 x 2.00	4
Total		**60**
4-lane Divided Carriage way New Construction for Bypass With Service Road (C/S Type 1C)		
Main Carriageway	2 X 7.00	14
Median	1 X 4.00	4
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Earthen Shoulders	2 X 2.00	4
Earthen Shoulders for service roads	2 X 3.00	6
Service Road	2 X 7.00	14
Variable, Space for Services	2 X 7.00	14
Total		**60**
4-lane Divided Carriage way Cross Section in Urban (C/S Type 2, 2A & 2B)		
Main Carriageway	2 X 7.00	14
Median	1 X 1.50	1.5
Kerb Shyness	2 x 0.5	1
Paved shoulder	2 X 2.00	4
Earthen Shoulders	2 X 2.00	4
Drain/Future Widening	2 x 5.25	10.5
Earthen Shoulders for service roads	2 X1.50	3
Service Road	2 X 7.5	15
Drain	2 X 1.5	3
Space for services	2 x 2.00	4
Total		**60**
Flyover approach Cross Section with Slip Road in Rural Areas (C/S Type 3)		
Main Carriageway	2 x 10.50	21
Median	1 x 4.00	4
Median Shy off	2 x 0.50	1
Paved shoulder	2 X 2.00	4
Crash barrier with shyness	2 x 1.00	2
Slip road on both sides	2 x 7.00	14

Element	Width (m)	Total Width (m)
Earthen shoulders	2 x 1.50	3
Divider between slip Road and RE wall	2 x 0.50	1
Slope Varies, Drain / Space for Services	2 x 5.00	10
Total		**60**
VUP/Flyover approach Cross Section with Slip Roads in Built Up Area (C/S Type 3A)		
Main Carriageway	2 x 10.5	21
Median	1 X 1.50	1.5
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 2.0	4
Crash barrier with shyness	2 x 1.0	2
Divider between slip Road and Fly Over Approach	2 x 4.250	8.5
Service road on both sides	2 x 7.50	15
Utility corridor	2 x 2.00	4
Footpath cum drain	2 x 1.50	3
Total		**60**
VOP Approach Cross Section with Slip Road (C/S Type 4)		
Main Carriageway	2 x 14.00	28
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Paved shoulder	2 X 1.50	3
Footpath cum Drain	2 x 1.5	3
Crash Barrier	2 x 1.0	2
Slip road on both sides	2 x 5.5	11
Shy off in Slip Road	2 x 1.0	2
Footpath/Drain in Slip Road	2 x 1.0	2
Space for Services	2 x 2.0	4
Total		**60**
4-lane Divided Carriage way with Retaining Wall at Hilly Area (C/S Type 5)		
Main Carriageway	2 x 7.00	14
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Paved shoulder	2 x 1.50	3
Earthen Shoulders	2 x 2.00	4
Drain, Breast Wall, Catch water Drain and Future widening, Utility corridor etc	2 x 17.00	34
Total		**60**
Approach of ROB with Slip Road (C/S Type 6)		
Main Carriageway	2 x 12.00	24
Median	1 x 4.00	4
Median Shy off	2 x 0.5	1
Footpath Shy off	2 x 0.5	1
Footpath	2 x 1.5	3
Footpath Crash barrier	2 x 0.5	1

Element	Width (m)	Total Width (m)
Slip road on both sides	2 x 5.5	11
Divider	2 x 0.5	1
Earthen Shoulder	2 x 1.5	3
Utility Corridor and Drain	2 x 2.0	4
Varies	2 x 3.5	7
Total		**60**

Pavement Design

New Flexible pavement has been proposed for additional 2-lane & flexible overlay over existing 2-lane road. Rigid pavement is proposed only at toll plaza location.

New Flexible/Rigid Pavement Design

The pavement design basically aims at determining the total thickness of the pavement structure as well as thickness of individual structural components. The following assumptions are considered for the preliminary pavement design. The basic assumptions considered while designing are as follows.

As per IRC: SP: 84-2014 (for 4-Lane)

As per IRC: SP: 84-2014 flexible pavements shall be designed for a minimum design period of 15 years or operation period whichever is more. Stage construction will be permitted subject to the thicknesses of sub-base & base coarses are designed for 15 years & bituminous surface for a minimum of 10 years. Strengthening for the future traffic can be carried out by means of Bituminous Overlay. Rigid pavement shall be designed for a minimum design period of 30 years; stage construction shall not be permitted.

Flexible Pavement

The project road has been divided into three homogeneous sections, design for which are furnished below.

Table 0-11 Cumulative MSA at sections

Description	From D. Ch 358+500 to 389+150		From D. Ch 389+150 to 414+205	
	Challakere-Hiriyur	Hiriyur-Challakere	Challakere-Hiriyur	Hiriyur-Challakere
Design life of Base and Sub Base (in years) - **For Stage Const.**	15	15	15	15
Design life of BT layer (in years) - **For Stage Const.**	10	10	10	10
MSA for Base and Sub Base - **For Stage Const.**	47.92	22.96	48.90	25.26
MSA for BT layer - **For Stage Const.**	27.69	13.27	28.26	14.60
Design CBR %	9%	9%	9%	9%

Table 0-12 Flexible pavement composition (in mm) recommended for Main Carriageway

Description	From D. Ch 358+500 to 389+150		From D. Ch 389+150 to 414+205	
	Challakere-Hiriyur	Hiriyur-Challakere	Challakere-Hiriyur	Hiriyur-Challakere
Bituminous Concrete (BC)	40	40	40	40
Dense Bituminous Macadam	95	70	95	70
Wet Mix Macadam	250	250	250	250
Granular Sub Base	200	200	200	200
Sub Total	**585**	**560**	**585**	**560**
Subgrade of CBR 9% material	500	500	500	500
Total	**1085**	**1060**	**1085**	**1060**

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

Table 0-13: Flexible Pavement Compositions for Service road

Service/Slip Road			
Composition	**MSA**	**Design CBR (%)**	**Thickness, mm**
BC	10	9	40
DBM			50
WMM			250
GSB			200
Subgrade			500
Total			**1040**

Sub grade of 500 mm thickness of CBR value not less 9 % and sub base material of CBR not less than 30 % shall be used

Table 0-14 Overlay Thickness (in mm) recommended

NH-150A Existing Km		Design Chainage		Dc	MSA	BM (mm)	Overlay (mm)	Design Thickness	
From	To	From	To					BC (mm)	DBM (mm)
368.160	387.410	369+900	389+150	1.404	34.58	145.41	101.787	40	65
387.410	399.560	389+150	401+300	1.12	35.36	107.99	75.593	40	50

Rigid Pavement

The Rigid pavement is proposed at toll plaza location. The design as per the IRC: 58 – 2015 leads to the crust thickness of pavement as given in following table.

Table 0-15 Rigid Pavement Compositions (As per IRC: 58-2015)

For CBR = 9%

Pavement Composition	Thickness in mm
Design Life (Yrs)	30
Design CBR (%)	9
PQC (mm)	280
DLC (mm)	150
GSB (mm)	150
Total	**580**

Truck lay-byes

Truck lay-byes are proposed at following locations and new Flexible pavements is proposed at these locations.

Sl. No.	Existing km	Design Chainage	Side	Name / Location
1	Bypass	361+200	Both	Challakere Bypass
2	384.435	386+200	Both	Near Golahalli

Rest Area

The location of the Rest area is given below

Sl. no	Existing km	Design Chainage	Side	Location Name
1	376.800	378+550	LHS	Near Sanekere
2	Bypass	407+150	RHS	Hiriyur Bypass

Bus Bay with Bus Shelters

There are 18 nos Bus Bay with Bus Shelters and 22 bus shelters are proposed along the project stretch.

Toll Plaza

Rigid Pavement is proposed for the toll plaza location, as it has longer life and can resist the wear and tear caused by the braking forces exerted by heavy vehicles.

One toll plaza is proposed with additional right-of-way, service lanes, toll booths, lighting, weigh-in-motion Weigh Bridge, automatic, semi automatic and manual toll booths, separate lanes for wide bodied vehicles etc. The detail of the proposed toll plaza is given below.

Table 0-16 Proposed Toll Plaza Location

Sl. No.	Toll Plaza Location			No of Toll Lanes*	
	Existing Chainage	Design Chainage	Location	LHS	RHS
1	km 395.620	397+400	Near Balenahalli	7+1	7+1

*As per DO No. NHAI/Chairman/Misc./2016 dated 26.12.2016

Proposal for Structures

There is 1 Major bridge, 23 No's, Minor Bridges, 1 No's Minor bridge Cum VUP, 1 No's MNB Cum Flyover, 6 No's Flyovers, 1 No's. Interchange, 5 No's VUP's, 2 No's LVUP's and 1 ROB along with many other cross drainage works are proposed along the project stretch. No's of each type of structure along the project stretch are given in below Table. These structures are proposed for widening, rehabilitation or construction of new structure.

Table 0-17: Proposed Structures on Project Stretch

Sl. No.	Type of structure	No's.
1	Major Bridge	01
2	Minor bridges	23
3	MNB Cum VUP	01
4	MNB Cum Flyover	01
5	Flyover	06
6	Interchange	01
7	VUP	05
8	LVUP	02
9	ROB	01
10	Culverts	72
11	Cross Road Pipe Culverts	52
12	Cross Road MNB	1

0.7 Cost Estimation

The cost estimation for the project is extremely important as the viability and implementation of a project depends on the project cost. Therefore, cost estimates have been carried out with due care. Estimation of preliminary cost, a primary pre-requisite for economic and financial evaluation, has been carried out for widening the existing NH stretches to 4-lane carriageway with paved shoulders on both sides including Reconstruction of the existing pavement, strengthening / widening of existing bridge structures, construction of new bridges, rehabilitation and reconstruction / widening of cross drainage structures, longitudinal drains, junction improvements, road furniture, bus bays, truck bays, way side amenities, toll plazas, etc. and is presented in below Table.

Table 0-18 Summary of Cost Estimate for Challakere to Hiriyur section of NH-150A

BILL NO.	BILL NAME	Total Amount in Rs	Total Amount in Crores	Total Amount in %
	CIVIL CONSTRUCTION COST			
1	Site Clearance and Dismantling	63,95,439	0.64	0.07%
2	Earth Work	1,00,96,17,720	100.96	11.74%
3	Granular Sub-Base and Base Courses	1,47,69,27,290	147.69	17.17%
4A	Flexible Pavement	1,35,21,39,938	135.21	15.72%
4B	Rigid Pavement	-	-	
5	CULVERTS	-	-	
5A	Box Culvert	28,11,71,246	28.12	3.27%
5B	Pipe Culvert	9,21,73,672	9.22	1.07%
6	BRIDGES	-	-	
6A	Repair & Rehabilitation of Structures	40,14,660	0.40	0.05%
6B	Major Bridges	12,02,44,825	12.02	1.40%
6C	Minor Bridges	85,46,91,352	85.47	9.94%
6D	VUP	71,80,69,153	71.81	8.35%
6E	LVUP	15,33,94,187	15.34	1.78%
6F	CUP	9,97,89,921	9.98	1.16%
6G	ROB	39,46,99,009	39.47	4.59%
6H	Flyover	1,08,53,59,962	108.54	12.62%
7	Drainage, Protective Works & Other Services	6,91,52,012	6.92	0.80%
8	Junctions	9,74,53,864	9.75	1.13%
9	Traffic Signs, Road Marking and Other Appurtenances	25,95,95,287	25.96	3.02%
10	Miscellaneous	41,80,04,850	41.80	4.86%
11	Toll Plaza Construction @ Ch.397+400	10,98,07,651	10.98	1.28%
A	**Total Civil Cost (YR: 2016-2017) =**	**8,60,27,02,038**	**860.27**	
	Civil Cost per Km (Length of Project Highway-55.705 km)	**15.44**		
B	**Centages over CIVIL cost (15%)**	**1,29,04,05,306**	**129.04**	
C	**TOTAL PROJECT COST (A+B)**	**9,89,31,07,344**	**989.31**	
	Total Project Cost per Km	**17.76**		
D	**PRE CONSTRUCTION ACTIVITY**			
	LA, R&R and Social	2,37,65,88,850	237.66	
	Environment Cost and Utility shifting and other preconstrucion activities	1,81,03,594	1.81	
	Shifting of Electrical Poles/Lines (1% of Civil Cost) =	8,60,27,020	8.60	
	Shifting of Water Supply Pipe Lines (1% of Civil Cost) =	8,60,27,020	8.60	
	Total cost of preconstruction activities D=(a+b+c+d+e) =	**2,56,67,46,485**	**256.67**	
E	**Total Capital Cost (C+D) =**	**12,45,98,53,829**	**1,245.99**	
	Total Capital Cost Per Km in Crores =	**22.37**		

CONCLUSIONS AND RECOMENDATION

ECONOMIC ANALYSIS

The economic internal rate obtained was return of 18.9% for development of the project road with flexible pavement, which is more than the presented 12% of discounted rate and larger positive value of NPV of net benefits indicate the firm viability of project for the proposed improvement of four laning with paved shoulders and hence recommended for implementation.

FINANCIAL ANALYSIS

It is concluded that the project doesn't provide sufficient returns to equity on commercial BOT (Toll) format with 40 % grant for concession period of 10 years & 15 years. However, if the concession period is increased to 20 years, the project provides sufficient returns to equity at 7.5% Grant. For a concession period of 25 Years, the project doesn't require any grant and provides 16.38% return on equity.

However, the consultants recommend the project on HAM with concession period of 15 years and on EPC mode, as per Policy Matter: Technical ((161/2014) Lt No.11041/218/2007-Admn dated 24.07.2014.

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