# 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 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 359.100 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.

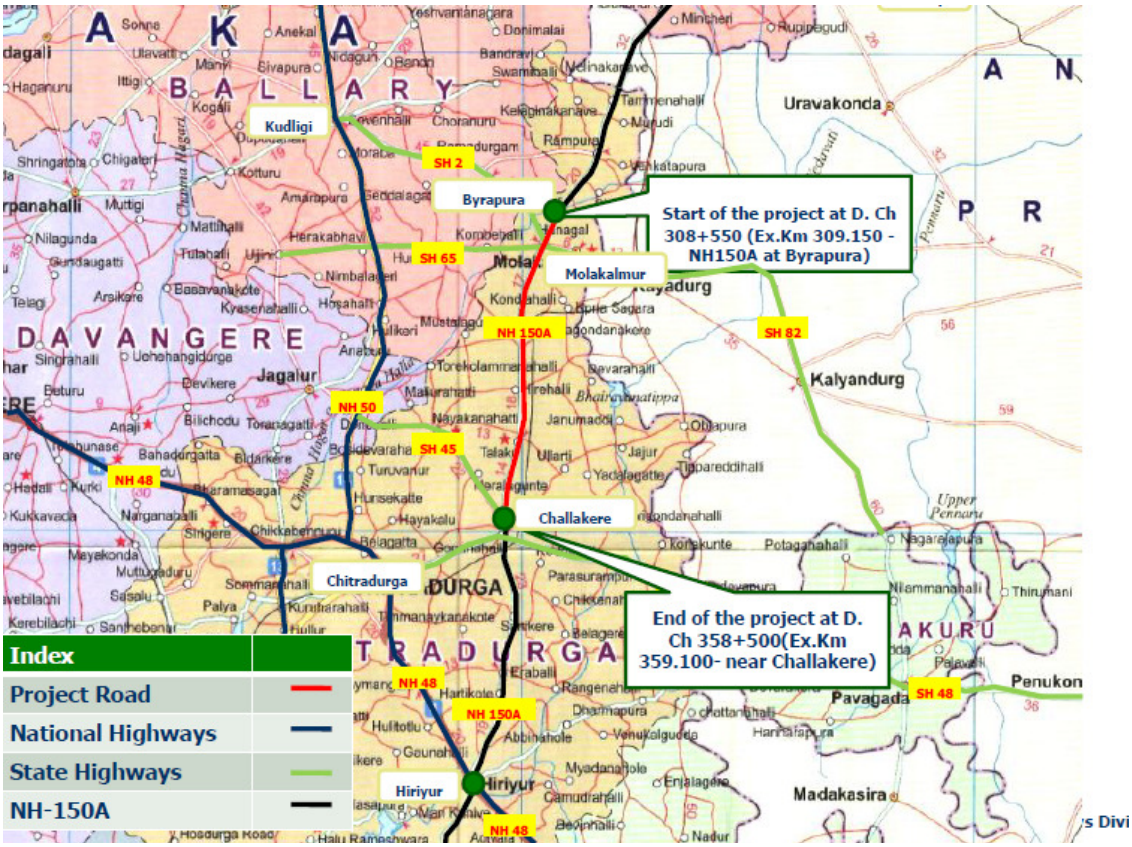


**Figure 0-1: Location of Project Stretch**

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**

| Sl. No. | Location | | Vehicles | PCUs |
|---|---|---|---|---|
| | Chainage | Location | AADT | AADT |
| 1 | km 311.400 | Hanagal | **6122** | **13023** |
| 2 | km 327.750 | B.G Kere | **6669** | **13687** |
| 3 | km 350.300 | Thalaku | **7203** | **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 4 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 | 311.955 | 3 legged | Katanaikanahalli | | T |
| 3 | 313.207 | 3 legged | Pujarihatti | | T |
| 4 | 314.220 | 3 legged | | Village Road | Y |
| 5 | 314.780 | 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 |
| 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 | 314.220 | 3 Legged | | Kudligi | SH-2 |
| 2 | 314.780 | 4 Legged | Mulakalamuru road | Village Road | |
| 3 | 317.765 | 4 Legged | Rayapura | Yerenahalli | SH-65 |
| 4 | 347.165 | 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 |
| 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 | 6.410 |
| 2 | Eccentric | 22.050 |
| 3 | Realignments | 15.170 |
| 4 | Reconstruction | 6.320 |
| **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** |
| **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 |

| Element | Width (m) | Total Width (m) |
|---|---|---|
| Footpath cum drain | 2 x 1.5 | 3 |
| **Total** | | **60** |
| **VOP Approach Cross Section in Urban (C/S Type 4)** | | |
| 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 |
| Footpath cum Drain | 2 x 1.0 | 2 |
| Crash Barrier | 2 x 0.5 | 1 |
| Slip road on both sides | 2 x 7.0 | 14 |
| Earthen shoulders | 2 x 1.5 | 3 |
| Utility Corridor | 2 x 2.0 | 4 |
| Drain & Slope | 2 x 3.0 | 6 |
| **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** |

**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 |
| 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 | 341.550 | 341+300 | Near Hirehalli | 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, 5 no.'s Flyovers, 1 no. VOP, 6 no's LVUP along with many other cross drainage works are proposed along the project stretch. Nos. 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 | Minor bridges | 30 |
| 2 | Flyover | 05 |
| 3 | VOP | 01 |
| 4 | LVUP | 06 |
| 5 | Culverts | 78 |

## 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 Byrapura to Hiriyur section of NH-150A**

## Case I: Flexible Pavement cost

**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 | | 2,68,57,601 | 2.69 | 0.48% |
| 2 | Earth Work | | 36,11,44,334 | 36.11 | 6.46% |
| 3 | Granular Sub-Base and Base Courses | | 99,18,37,377 | 99.18 | 17.75% |
| 4 | Bituminious Works | | - | - | |
| 4A | Flexible Pavement | | 1,06,06,02,244 | 106.06 | 18.99% |
| 5 | CULVERTS | | - | - | |
| 5A | Box Culvert | | 17,52,34,465 | 17.52 | 3.14% |
| 5B | Pipe Culvert | | 4,42,82,909 | 4.43 | 0.79% |
| 6 | BRIDGES | | - | - | |
| 6A | Repair & Rehabilitation of Structures | | 8,86,918 | 0.09 | 0.02% |
| 6C | Minor Bridges | | 96,23,80,158 | 96.24 | 17.23% |
| 6E | PUP/LVUP | | 33,99,20,468 | 33.99 | 6.08% |
| 6H | Flyover and Overpass | | 55,25,95,786 | 55.26 | 9.89% |
| 7 | Drainage, Protective Works & Other Services | | 39,64,27,093 | 39.64 | 7.10% |
| 8 | Junctions | | 9,12,99,157 | 9.13 | 1.63% |
| 9 | Traffic Signs, Road Marking and Other Appurtenances | | 26,95,97,371 | 26.96 | 4.83% |
| 10 | Miscellaneous | | 20,10,07,675 | 20.10 | 3.60% |
| 11 | Toll Plaza Construction @ Ch.341+300 | | 11,22,07,651 | 11.22 | 2.01% |
| A | Total Civil Cost (YR: 2016-2017) = | | 5,58,62,81,207 | 558.63 | |
| | Civil Cost per Km (Length of Project Highway-49.950 km) | | 11.18 | | |
| II | Escalation @ 5% of Civil Cost (I) | | 27,93,14,060 | 27.93 | |
| III | Contingencies @ 1% of Civil Cost (I+II) | 1% | 5,86,55,953 | 5.87 | |
| IV | ESTIMATED PROJECT COST (I+II+III) | | 5,92,42,51,220 | 592.43 | |
| V | IC/Pre-operative expenses @ 1% of Total EPC Cost (IV) | 1% | 5,92,42,512 | 5.92 | |
| VIII | Centages over EPC cost (V+VI+VIII) | | 5,92,42,512 | 5.92 | |
| IX | TOTAL PROJECT COST (IV+VIII) | | 5,98,34,93,732 | 598.35 | |
| | Total Project Cost per Km | | 11.98 | | |
| X | PRE CONSTRUCTION ACTIVITY | | | | |
| | LA, R&R and Social | | 1,39,49,02,850 | 139.49 | |
| | Environment Cost and Utility shifting and other preconstrucion activities | | 1,15,60,000 | 1.16 | |
| | Shifting of Electrical Poles/Lines (1% of Civil Cost) = | | 5,58,62,812 | 5.59 | |
| | Shifting of Water Supply Pipe Lines (1% of Civil Cost) = | | 5,58,62,812 | 5.59 | |
| | Total cost of preconstruction activities D=(a+b+c+d+e) = | | 1,51,81,88,474 | 151.82 | |
| XI | Total Capital Cost (C+D) = | | 7,50,16,82,207 | 750.17 | |
| | Total Capital Cost Per Km in Crores = | | 15.02 | | |

## Case II: Rigid Pavement cost

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 | 86,76,309 | 0.87 | 0.12% |
| 2 | Earth Work | 38,35,62,003 | 38.36 | 5.45% |
| 3 | Granular Sub-Base and Base Courses | 52,03,92,790 | 52.04 | 7.39% |
| 4 | Bituminious Works | - | - | |
| 4A | Flexible Pavement | 10,83,15,714 | 10.83 | 1.54% |
| 4B | Rigid Pavement | 2,87,72,67,631 | 287.73 | 40.85% |
| 5 | CULVERTS | - | - | |
| 5A | Box Culvert | 17,52,34,465 | 17.52 | 2.49% |
| 5B | Pipe Culvert | 4,42,82,909 | 4.43 | 0.63% |
| 6 | BRIDGES | - | - | |
| 6A | Repair & Rehabilitation of Structures | 8,86,918 | 0.09 | 0.01% |
| 6C | Minor Bridges | 96,23,80,158 | 96.24 | 13.66% |
| 6E | PUP/LVUP | 33,99,20,468 | 33.99 | 4.83% |
| 6H | Flyover and Overpass | 55,25,95,786 | 55.26 | 7.84% |
| 7 | Drainage, Protective Works & Other Services | 39,64,27,093 | 39.64 | 5.63% |
| 8 | Junctions | 9,12,99,157 | 9.13 | 1.30% |
| 9 | Traffic Signs, Road Marking and Other Appurtenances | 26,95,97,371 | 26.96 | 3.83% |
| 10 | Miscellaneous | 20,10,07,675 | 20.10 | 2.85% |
| 11 | Toll Plaza Construction @ Ch.341+300 | 11,22,07,651 | 11.22 | 1.59% |
| A | Total Civil Cost (YR: 2016-2017) = | 7,04,40,54,098 | 704.41 | |
| | Civil Cost per Km (Length of Project Highway-49.950 km) | 14.10 | | |
| B | Centages over Civil Cost of 25% | 1,76,10,13,525 | 176.10 | |
| C | TOTAL PROJECT COST (A+B) | 8,80,50,67,623 | 880.51 | |
| | Total Project Cost per Km | 17.63 | | |
| D | PRE CONSTRUCTION ACTIVITY | | | |
| | LA, R&R and Social | 1,39,49,02,850 | 139.49 | |
| | Environment Cost and Utility shifting and other preconstrucion activities | 1,15,60,000 | 1.16 | |
| | Shifting of Electrical Poles/Lines (1% of Civil Cost) = | 7,04,40,541 | 7.04 | |
| | Shifting of Water Supply Pipe Lines (1% of Civil Cost) = | 7,04,40,541 | 7.04 | |
| | Total cost of preconstruction activities = | 1,54,73,43,932 | 154.73 | |
| E | Total Capital Cost (C+D) = | 10,35,24,11,555 | 1,035.24 | |
| | Total Capital Cost Per Km in Crores = | 20.73 | | |

## 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 provide sufficient returns to equity on commercial BOT (Toll) format with 21 % & 36% grant for concession period of 20 years of Flexible and Rigid Pavement.

However as per Policy Matter: Technical (161/2014) Lt No.11041/218/2007-Admn Dated: 24.07.2014 (attached) the project has been recommended on Hybrid Annuity mode /EPC mode.