E. EXECUTIVE SUMMARY

E.1 Introduction

The Government of India has envisaged to create a world-class infrastructure facility, to boost the economic development in the country, for which National Highways Authority of India (NHAI) plays a key role. NHAI has been entrusted to implement the development of some of the stretches of National Highways under National Highway Development Programme on EPC/BOT basis. As part of this endeavor, the Public Works Department (PWD) of Government of Goa has decided for the development of "Four Laning of Existing Goa/Karnataka Border - Panaji Goa Section of NH-4A from Km 84/000 to 153/075 on BOT (Toll) basis under NHDP-III (Anmod to Panaji section)".

Public Works Department (PWD) of Goa has appointed M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd., Hyderabad to provide consultancy services for detailed engineering study for the above road section.

The project stretch excludes following reaches:

1. From Km 118 (Kandepar) to Km 125 (Safa Maszid)
2. From Km 143.400(Ella) to Km 153.075 (Panaji).

E.2 Project Description

The Project Highway is a section of NH-4A(Belgaum-Anmod-Ponda-Panaji) between Anmod and Panaji, passing through villages Molem, Sangod, Dharbandora, Piliem, Tiska, Candepar, Curti, Ambegal, Veling, Boma, Banastarim, Corlim, Velha goa, Ribandar. The entire stretch of NH-4A lies in the states of Karnataka and Goa, it provides an important link between NH-4 and NH-17. It has a great potential of growth in the passenger as well as freight movement in future due to agriculture and industrial growth in the project influence area. From Km 84 to Km 94, the right of way ranges from 7 m to 10 m where acquiring the land will be a difficult as it comes under Wild Life Sanctuary and from Km 94 to Km 97 comes under Reserve Forest. The entire alignment passes through hilly and rolling terrain except few reaches towards Goa.

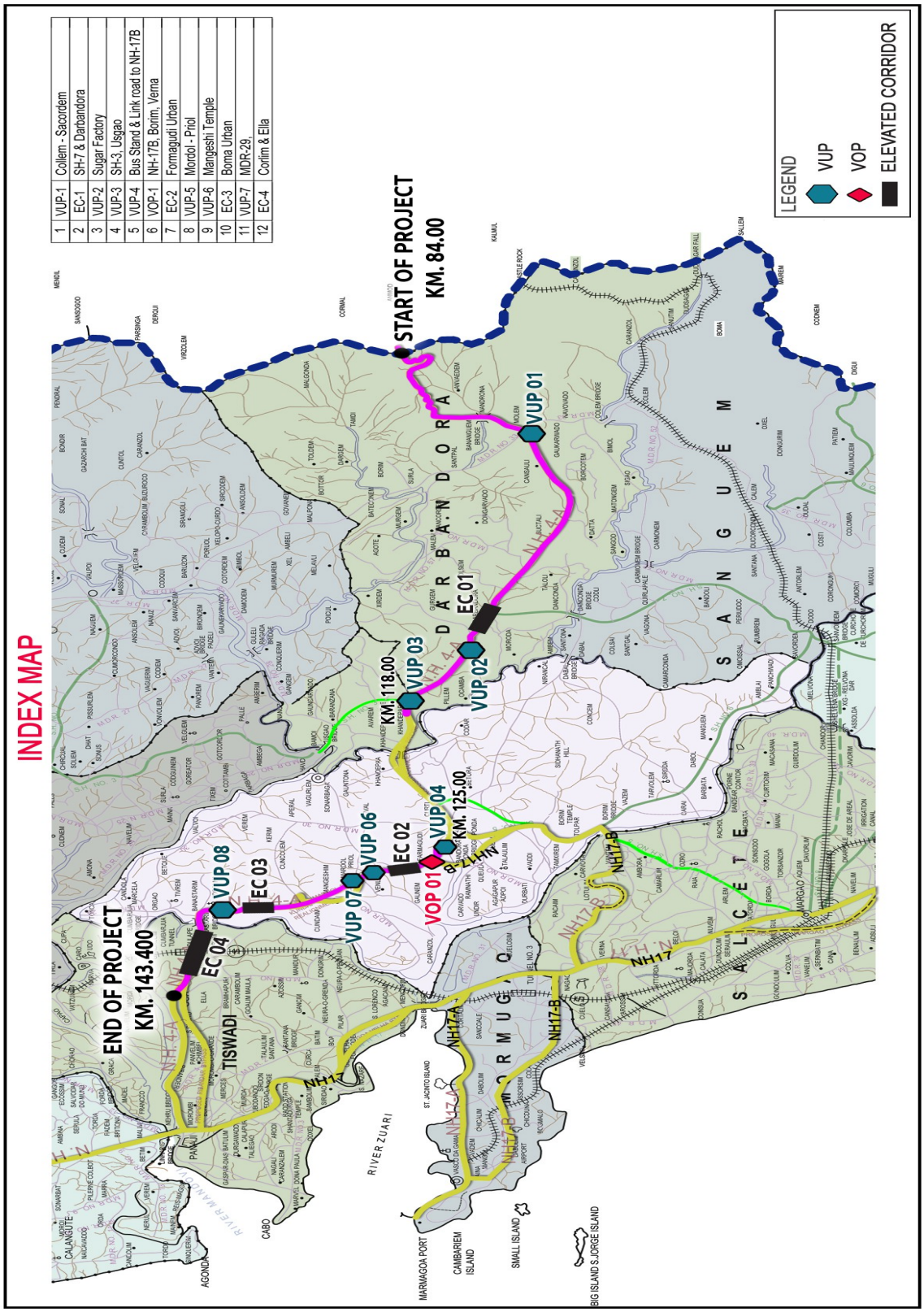

Figure: E.1 Index Map

E.3 Alignment Option Study

Reconnaissance, map studies and detailed investigations of the influence area were carried out for identifying the existing road network, land use pattern and industrial activities along the project corridor. Different alignment options are considered, evaluated and recommendations are presented in the subsequent sections. The improvement scheme of the options are mentioned below.

Project road have inconsistent terrain conditions with a mix of hilly, highly rolling and plain topography. The following standards have been followed for improving the horizontal geometry. For the purpose of horizontal design the project road is divided in to following sections

Section I: Km 84.000 to 96.000 (Mountainous/Steep terrain).

The Project Highway starts with mountainous/steep terrain form Km 84+000 at Goa/Karnataka border. Existing alignment has substandard horizontal as well as vertical geometry due to steep terrain from Km 84.000 to Km 94+000. There are hairpin bends, where the speed about 20 kmph.

The consultants have studied in details for improving the horizontal geometry of existing 2 lane carriageway as well as new 2 lane carriageway in consultation with the PWD. The stretch under consideration is passing through wild life sanctuary. Hence, following options were studied for improvement proposal

Option - 1: Widening on hill side

Hard rock outcrop is visible in this stretch. For widening new carriageway on hill side requires blasting operations and frequent closing of live traffic. Further, blasting may pose sever impact on wild life in surrounding area.

There are locations, where landslides also observed in this stretch. Widening on hill side may result in heavy breast walls.

Option - 2: Widening on Valley side without improving the existing

Widening on valley side do not requires closing live traffic. It will have minimum impact on wild life, since it do not requires any blasting operations.

Widening new carriageway on valley side requires construction of either retaining wall or via-duct to support new carriageway.

To have minimum impact on local environment and ease of construction, the consultants have proposed via-duct for the new carriageway. It be indepen-

dent of existing carriageway (no common median) and will comply with geometric standards stipulated in 4 laning manual.

Option - 3: Widening on Valley side with realignments

Cost of viaduct is directly proportional to the length of via-duct. The consultants have studied in detail for feasibility of shortening the length of via-duct within permissible gradients. After detailed study at site, based on the topographical survey and preliminary design of vertical alignment, it was identified that from Km 89 to Km 92 can be connected with smooth geometry within permissible gradients. Based on above three options, Option 3 is most feasible, even though the construction cost is higher than the options 1&2.

Table E.1: Merits and Demerits

Description	Option-1	Option-2	Option-3
Traffic Management	Road closure during blasting and removal of debris operations	Road closure while forming ramps on the valley side	Road closure while forming ramps on the valley side
Stability issues	It would not be possible to cut hill to the required slope since that would disturb road on the hill side. Thus, adequate slope stabilizing structures are to be provided to prevent landslides.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns
Structures involved	Breast Walls, Soil Nails etc. may be required for ensuring slope.	Viaduct structure; earth retaining structures	Viaduct structure; earth retaining structures
Environmental issues	This option would involve disturbing of hill slopes in the wild life sanctuary.	This option would involve insignificant disturbance to environment during construction time.	This option would involve insignificant disturbance to environment during construction
Description	**Option-1**	**Option-2**	**Option-3**

Description	Option-1	Option-2	Option-3
Extra Forest Land to be acquired	26.4 hectares. This option would involve disturbing of hill as the complete widening on hill side and the entire land will be occupied. In this option revegetation of forest cover will not be possible as additional 2 lanes will land on hills.	26.6 hectares. This option would involve insignificant disturbance of hill as the new 2 lane will come on valley side and the land required is only at pier locations. In this option the above land is utilized for construction project. After the construction the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.	25.4 hectares. This option would involve insignificant disturbance of hill as the new 2 lane and some existing 2 lane realignments will come on valley side and the land required is only at pier locations. In this option the above land is utilized for construction project. After the construction the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.
Geometric alignment	Will follow the existing alignment; Substandard curves will remain.	Will follow the existing alignment; Substandard curves will remain.	Sharp sub-standard curves will be improved.
Construction time	Less compared to other two options	Viaduct formation will be time consuming.	Slightly more time compared to option 2 since substructure height will be higher.

Recommended Option

Since, the project stretch falls in wild life sanctuary, Option-3 which involves minimum acquisition of the forest land falling in wild life sanctuary and improvement of the existing alignment to the proper geometric standards is recommended.

The alignment options were discussed with the competent authority (Ministry) in the presence of PWD officials at Delhi on 02/02/2016. The alignment Option-3 is approved by Authority vide letter no. RW/NH/37015/14/2016/NHDP-IV A, dated 26.02.2016.

Section II: Km 96.000 to 118.000 (Plain to Rolling terrain).

In this stretch, the project highway passing through the partly forest land and built-area. There are some local realignment, those are in progress. The Consultants have collected all ongoing improvement proposals from the PWD. New alignment proposed duly taking in account all ongoing proposals. New underpasses were proposed at all major intersection and service roads proposed in built-up areas.

Section III: Km 118.000 to 126.000– Kandepar Realignment.

Four laning of this stretch is already awarded and construction is in progress.

Section IV: Km 126.000 to 143.000 (Plain to Rolling terrain)

In this stretch, the alignment passing through mainly builtup areas like Formagudi, Boma, Corlim and Old goa and partly forest land. After interacting with PWD officials, the Consultants learnt that the acquiring the ROW higher than 30m is very difficult and it may leads more acquisition of structures too. But required 4 lane carriageway with service road cross section is not fit in 30m ROW. Hence, the consultants have studied all the possible options and proposed elevated corridor with service roads by providing the service roads just below the elevated structure to fit into 30m ROW. Typical cross section for such elevated corridor has been presented in TCS-X and the same is adopted for built-up locations.

One Vehicular Overpass (VOP) is proposed at Km 127(existing chainage) where NH-17B starts from our project road on LHS and moves towards Borim & Verna. As the joining point of NH-17B with NH-4A is on hill top, the consultants proposed VOP by considering the vertical geometry.

Section V: Km 143.000 to 153.000 – Raibander bypass.

Four laning of this stretch is already awarded and construction is in progress.

E.4 Surveys and Investigations

The studies and investigations carried out during the feasibility study comprised mainly of the following:

- Detailed Inventory & Condition Surveys for Road
- Detailed Inventory & Condition Survey for Bridges
- Topographic Surveys along the existing alignment
- Traffic surveys viz., Classified Traffic Volume Count, Turning Movement Count, Axle Load, Origin Destination and Commodity Movement, Willingness to Pay etc., including collection of secondary data for traffic projections
- Investigations of the existing pavement and sub grade involving BBD test
- Collection and laboratory testing of soil samples from pits adjacent to the existing road
- Identification of borrow areas for different types of pavement and bridge construction material, collection of samples and their analysis
- Environmental baseline studies
- Public Consultations

E.5 Existing Condition of Road & Bridges

E.5.1 Inventory & Condition surveys for Existing Road

The existing NH-4A is having two lane configuration. Carriageway width was measured at every 100m interval. Width of shoulders on either side was measured simultaneously along with carriageway measurements. The overall condition of pavement is good and is of flexible type. The existing two lane carriageway width is 7.0m with earthen shoulders of about 0.3 to 2.0m width on either side and paved shoulder exists of around 0.5 to 2.5m and at few parts of the stretch are existing with 4 lane road also.

S. No.	Existing Chainage (Km)		Length (m)	Lane Configuration	Condition of the Road
	From	To			
1	84.000	118.450	34450	2 lane carriageway	Good
2	125.000	133.500	8500	2 lane carriageway	Good
3	133.500	136.300	2800	4 lane carriageway	Good
4	136.500	143.400	6900	2 lane carriageway	Good

E.5.2 Inventory & Condition surveys for Bridges

The detailed inventory and condition survey of structures are discussed in Volume-II Investigation Report. Total numbers of Structures on the Site are noted below:

a) Total number of Major Bridges - 1no
b) Total number of
ROBs - 1no.
RUBs - 0
c) Total number of Minor Bridges - 7nos.
d) Total number of Slab/Box Culverts - 40nos.
e) Total number of Pipe Culverts - 133nos.
f) Total number of Grade Separators - Nil
g) Total number of Vehicular and Non Vehicular Underpasses - Nil

E.6 Traffic Studies

Based on reconnaissance studies, the locations for conducting various traffic surveys were finalized. The traffic surveys viz., Classified Traffic Volume Count, Turning Movement Count, Axle Load, Origin Destination and Commodity Movement, Willingness to Pay, etc., including collection of secondary data for traffic projections were carried out in the month of May in 2015. Secondary data was collected for the purpose of determining the Seasonal Variation Factors and Growth Rates at various count stations for different vehicle categories.

E.6.1 Average Annual Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT in no of vehicles) at the survey locations is obtained by multiplying the Average Daily Traffic (ADT) with the seasonal correction factor. The AADT of vehicles for the year 2015 at the three survey locations of traffic volume count survey along the Project corridor is presented below.

Table E.2: Average Annual Daily Traffic

Mode	Km 96.600	Km 133.000	Km 140.000
Two Wheelers	513	4751	11498
Three Wheelers	1	53	76
Car / Jeep / Van	1244	5516	11798
Car Yellow board	93	639	993
Tata Magic	2	9	13
RTC Bus	191	146	226

Mode		Km 96.600	Km 133.000	Km 140.000
Private Bus		17	84	269
School/College bus		31	82	654
Mini Bus		1	1	1
2 Axle		336	1254	941
3 Axle		328	418	360
M Axle		151	257	267
HEM		0	3	6
LCV/LGV		279	888	938
Mini LCV		82	532	1078
Three Wheeler goods		0	23	31
Tractor		0	1	2
Tractor with trailer		0	0	0
Non-Motorized Vehicles		2	1	2
Govt. Exempted Vehicles		5	5	25
Tollable Traffic (vehicles)		2734	9830	17545
Tollable Traffic (PCU's)		5120	15032	22893
Total Vehicles	Motorized	3251	14663	29098
	Non-Motorized	2	1	2
	Total Traffic	3253	14664	29100
Total PCUs	Motorized	5388	17496	28747
	Non-Motorized	1	2	1
	Total Traffic	5389	17498	28748

E.6.2 Vehicle Damage Factors (VDF)

The VDF calculated for different categories of commercial vehicles are shown below and the detailed analysis is presented in Traffic Report.

Table E.3(a): Vehicle Damage Factor (VDF) without Mine Traffic

S. No.	Mode	Km 96.600			Km 140.000		
		To Anmod	To Panaji	Adopted	To Anmod	To Panaji	Adopted
1	2 Axle	2.01	1.19	2.5	1.90	3.40	3.5
2	3 Axle	2.13	2.62	3.0	1.49	2.31	3.0
3	M axle	1.91	3.72	4.0	0.10	4.35	5.0
4	LCV	1.48	1.00	1.5	0.62	1.40	1.5

Table E.3(b): Vehicle Damage Factor (VDF) with Mine Traffic

S. No.	Mode	Km 96.600		Km 140.000	
		To Anmod	To Panaji	To Anmod	To Panaji
1	2 Axle	2.5	8.8	3.5	3.5
2	3 Axle	3.0	8.8	3.0	3.0
3	M axle	4.0	10.0	5.0	5.0
4	LCV	1.5	1.5	1.5	1.5

The Project Road from Km 84.000 to Km 122.200 predominantly cater to the movement of iron ore from Karnataka & Goa to Vasco Port and return empty.

E.6.3 Traffic Growth Rates (%)

Traffic growth rates are an important parameter for projecting the traffic for the de-sign life of pavement. The projected traffic, in turn, will form the basis for capacity assessment, pavement design, and financial viability analysis.

Table E.4: Traffic Growth Rates (%)

S. No.	Period	2 Wheeler	3 Wheeler	Cars/ Jeeps	Buses	Trucks			
						2 Axle	3 Axle	M Axle	LCV and Mini LCV
1	Up to 2016	7.0	5.0	10.0	8.0	5.0	5.0	5.0	5.0
2	2017 -2021	6.5	5.0	9.5	7.5	5.0	5.0	5.0	5.0
3	2022 – 2026	6.0	5.0	9.0	7.0	5.0	5.0	5.0	5.0
4	2027 – 2031	5.5	5.0	8.5	6.5	5.0	5.0	5.0	5.0
5	Beyond 2031	5.0	5.0	8.0	6.0	5.0	5.0	5.0	5.0

E.6.4 Mine Traffic

The Goa state government had banned mining activities in Goa on September 10, 2012, even before the Supreme Court had imposed ban in October 2012. The Supreme Court had lifted the ban on April 21, 2014. But mining operations has remained suspended pending finalizing new policy.

The state Government on January 15, 2015 issued an order revoking its 2012 order that had halted the over 60 year old mining industries in Goa. The new order will pave the way for the resumption of mining activities in the state, pending the lifting of the ban imposed by the Ministry of Environment and Forests (MoEF).

So, Consultants presumes that the Supreme Court will lift the ban and mining activities will be revoked in couple of months. The Consultants collected traffic censes data when mining operations were in full swing mode and the same data has projected to the base year 2015 with growth rate of 1% per annum.

Table E.5: Mine Traffic

Vehicles	Traffic when mines are open in the 2006 year		Present Traffic (Actual)	Balance Mine Traffic	Total Traffic (Regular + Mine)
	2006	2015	2015	2015	2015
Trucks (2 or 3 Axles)	6722	7352	667	6685	7352
Multi Axle Trucks	1071	1171	151	1020	1171
Total	7793	8523	818	7705	8523

E.6.5 Capacity of the Highway

The project road has been divided into homogeneous road sections on the basis of traffic generation and dispersal nodes located along the project road. Considering the above mentioned traffic generation/ distribution points, total project road are divided into three homogeneous road sections for the purpose of analysis and presentation of traffic and travel characteristics.

Table E.6: Traffic Homogeneous sections (HS)

S.No.	Sections	HS	From (Km)	To (Km)	Length (Km)	Remarks
1	NH-4A: From Anmod to Panaji	HS-1	84.000	122.200	38.200	SH-5, to Borim and link road to NH-17B
2		HS-2	122.200	140.000	17.800	Corlim Goa/Old Goa
3		HS-3	140.000	143.400	3.400	Raibandar Bypass

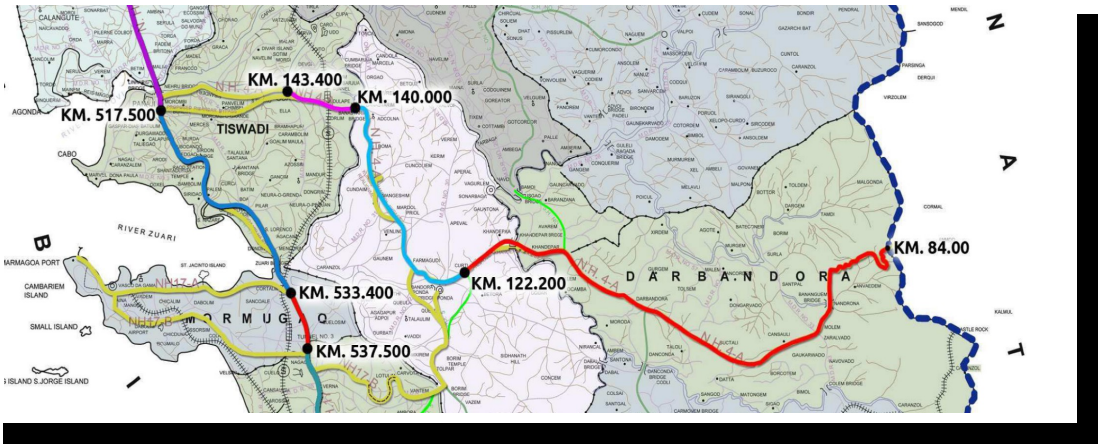

Figure: E.2 Traffic Homogeneous sections (HS)

The Highway Capacity Manual has introduced the concept of "Level of Service" to denote the level of facility one can derive from a road under different operating conditions and traffic volumes. It is defined as a qualitative measure describing the operational conditions with in a traffic stream and their perception by motorists. The

level of service for urban and suburban roads can be related to the flow conditions, average overall travel speed, load factor at intersections, peak hour factor and service volume to capacity ratio. National and State Highways in rural areas are normally designed for LOS B giving a design service volume of 40000 PCUs per day for 4 lane divided carriageway and 57000 PCUs per day for 6 lane divided carriageway based on level of service criteria with a V/C ratio less than 0.5. If we go for V/C ratio criteria, we can go up to LOS C with V/C ratio of less than 0.7. The LOS and capacity analysis for the proposed project stretch is presented.

Table E.7: Capacity analysis with Mine Traffic

S. No.	HS	Chainage		Present Traffic		Year Attaining 40,000 PCU's (Capacity of Four lane With LOS B)		Year Attaining 57,500 PCU's (Capacity of 6 lane With LOS B)	
		From Km	To Km.	PCUs	Year	PCUs	Year	PCUs	Year
1	HS-1	84.000	122.200	30078	2015	40428	2028	57173	2040
2	HS-2	122.200	140.000	17619	2015	39543	2027	54732	2032
3	HS-3	140.000	143.400	18951	2015	40486	2026	56359	2031

E.7 Pavement Design

E.7.1 Introduction

The Preliminary Pavement design is done for both flexible and rigid options. The flexible pavement is designed as per IRC: 37-2012. The rigid pavement is designed using IRC and CMA methods. The Sub grade CBR for the new carriage way is considered 10%. Sub grade thickness of 500 mm is considered for both flexible and rigid pavement options.

E.7.2 Million Standard Axles (MSA)

Design traffic in terms of Million Standard Axles has been determined at 3 locations based on traffic homogeneous sections, where volume count and axle load surveys were conducted.

Table E.8: Million Standard Axles (MSA)

S.No.	Homogeneous Sections	From (Km)	To (Km)	Length (Km)	5 Years MSA	10 Years MSA	15 Years MSA	20 Years MSA

1	HS-1 towards Panaji	84.000	122.200	38.200	75	165	280	425
	HS-1 towards Anmod				25	60	100	150
2	HS-2	122.200	140.000	17.800	10	20	35	55
3	HS-3	140.000	143.400	3.400	10	25	40	60

E.7.3 Flexible Pavement

For the design traffic estimated for a life of 15 years and a sub grade CBR of 10%, the pavement composition with granular base & sub-base option as follows:

Table E.9: Pavement Composition details for Main Carriageway

HS	Reach		Eff. CBR (%)	Design Life in Years	MSA	Bitumen Grade	Crust Composition in mm				
	From	To					BC	DBM	WMM	GSB	Total
HS-1*	84	122.2	10	15	280	VG-40	50	150	250	200	650
HS-1#	84	122.2	10	15	100	VG-40	50	110	250	200	610
HS-2	122.2	140	10	15	35	VG-40	40	95	250	200	585
HS-3	140	143.4	10	15	40	VG-40	40	95	250	200	585

HS-1: Anmod to Panaji direction*
HS-1#: Panaji to Anmod direction

E.7.4 Rigid Pavement

For the design traffic estimated for a life of 30 years and a sub grade CBR of 10%, the pavement composition with granular base & DLC is as follows:

Table E.10: Rigid Pavement Design with Tied Concrete Shoulders

S.No.	Item	Km 84 to Km 122.2	Km 122.2 to Km 143.4
1	PQC of M40 grade, mm	300	250
2	DLC of M10 grade, mm	150	150
3	GSB, mm	150	150
4	Dia. of Dowel bar, mm	38	32
5	Length of Dowel bar, mm	500	450
6	Spacing of Dowel bar, mm	300	300
7	Dia. of Tie bar, mm (Plain bars)	12	12
8	Length of tie bar, mm	580	580
9	Spacing of tie bar, mm	370	450

E.7.5 Recommended Pavement Option

Based on the life cycle cost analysis, Net Present Value (NPV) of rigid pavement is less than the flexible pavement. The life cycle cost for 30 years' period analysed for flexible pavement comes to Rs. 346.04 crores. Whereas for rigid pavement the cost comes to Rs. 330.79 crores.

As per **MoRTH** circular no. RW/NH-33044/53/2013-S&R(R) Pt. dated 20th November, 2013 (Appendix IIA) has advocated the use of environment friendly construction practices for reduction of greenhouse gases and had also iner-alia specified the life cycle cost analysis as an essential component of infrastructure design.

"Considering the issue related to longer service life, fuel consumption, resistance to extreme weather condition, saving of natural resources and maintenance etc. the obvious advantages of rigid pavement cannot be denied."

MoRTH circular no. RW/NH-33044/31/2014-S&R(R) Pt. dated 04th August, 2014 states that "The price of cement vis-à-vis bitumen varies widely in different parts of the country depending upon the lead from the production centers/refineries etc. This variation would be required to be mapped out and unless there is price comparison within an acceptable limit up to 20%, the use of flexible pavements may perhaps require to be continued." It means that rigid pavement could be considered when the cost of construction with rigid pavement doesn't exceed that of flexible pavement by more than 20%.

By considering the life cycle cost analysis, heavy load traffic and as mentioned in Ministry circulars it is recommended to construct Rigid pavement for the entire stretch.

E.7.6 Crust Composition for Service Roads

Design of pavement for service road has been carried out in accordance with clause 5.5.5 of IRC: SP:84-2014 for a design traffic 10 msa and CBR of 10%.

Table E.11: Pavement Composition for Service Roads

HS	Eff.	MSA	Bitumen	Crust Composition in mm

	CBR		Grade					
				BC	DBM	WMM	GSB	Total
Service Roads	10%	10	VG-30	40	50	250	200	540

E.7.7 Design of Shoulders

Paved Shoulder: The shoulder would be useable during all seasons of the year and hence as per Clause 5.10 of IRC:SP:84-2014, the crust composition and specification of paved shoulder shall be same as of the main carriageway.

Earthen Shoulder: Earthen shoulder shall be covered with 150 mm thick layer of granular material confirming to the requirements given in Clause 401 of MORTH specifications.

E.7.8 Crust Composition for Bus bays

Bus bays have been designed for 10 MSA and shall be of a flexible pavement. The crust composition for the bus bay is same as service road crust and given in table above.

E.7.9 Crust Composition for Truck Lay Byes

Pavement Design for Truck Lay byes shall be same as that for main carriageway in the relevant sections.

E.8 Highway Improvement Proposals

E.8.1 General

Primarily, the scope of the project is '4laning' of the existing 2-lane carriageway. The project corridor is to be designed as a 'partially access controlled highway' by providing service roads, grade separated intersections, acceleration and deceleration lanes, vehicular and pedestrian underpasses / overpasses etc. with an objective to segregate the local traffic from the through traffic.

The various upgrades required for enhancing the project road to 4 lane configuration as per the guidelines given in the Four laning manual (IRC-SP:84-2014) are brought out. In congested locations, various alternative upgrade options such as bypasses or elevated highway have been considered before recommending the feasible option.

E.8.2 Typical Cross Sections

It is proposed to widen the existing 2-Lane carriageway to 4-lane carriageway with two lane service road on either side of the project highway where ever required. The existing right of way varies from 8 m to 45 m for the project stretch. Typical Cross Sections (TCS) have been developed duly considering various aspects. From Km 84 to Km 94, the right of way ranges from 7 m to 10 m where acquiring the land will be a difficult as it comes under Wild Life Sanctuary and from Km 94 to Km 97 comes under Reserve Forest. The entire alignment passes through hilly and rolling terrain except few reaches towards Goa. Description of each type of cross section is listed in the Table shown below.

Table E.12: Typical Cross Section (TCS)

TCS type	Description
I	4 Lane Cross section-Concentric widening-4m median-45m PROW
II	4 Lane Cross section-Concentric/Eccentric widening-1.5m median-Service roads on both sides-45m PROW
III	4 Lane Cross section-Eccentric Widening (LHS)-4.0m median-45m PROW
IV	4 Lane Cross section-Eccentric Widening (RHS)-4.0m median-45m PROW
V	4 Lane Cross section-Realignment/Bypass-4.0m median-45m PROW
VI	6 Lane Cross section-Approaches to PUP/ LVUP/VUP/Flyover -0.6m median-Slip roads(7.0m) on both sides-45m PROW
VII	6 Lane Cross section-Approaches to VOP-1.5m median-Slip roads(7.0m) on both sides-45m PROW
VIII(a)	4 Lane Cross section for Mountainous terrain in cut and fill sections-1.5m median-26m PROW
VIII(b)	4 Lane Cross section for Mountainous terrain in cut and fill sections-2 lane Elevated Structure on valley side
VIII(c)	4 Lane Cross section for Mountainous terrain in cut and fill sections-4 lane Elevated Structure on valley side
IX	4 Lane Cross section for Mountainous terrain in cut section(both sides)-1.5m median-30/45m PROW
X	4/6 Lane Cross section with Elevated Corridor-30m PROW
XI	4 Lane Cross section at existing differential Carriageway-4.0m median- Slip roads on both sides-45m PROW

E.8.3 Service Roads/Slip Roads

As per clause 2.1.ii (a) of four lane manual (IRC: SP-84-2014), service roads shall be provided on both sides of the main highway in built-up areas and interconnected through underpasses, overpasses and grade separators. However, keeping the project viability in view, service roads have been proposed at built-up locations and major villages along the project corridor on both sides of the 4 lane carriageway depending on the nature and extent of village/town development. Service roads are designed to carry two-way traffic with turning areas where required and are linked to the main carriageway by one-way deceleration and acceleration lanes with 'taper-

merge' arrangements. Service roads are generally kept at existing ground level to serve the adjacent properties, whereas the main carriageway is constructed as per the requirements of design vertical profile of highway. Service roads are proposed in the following locations as shown in Table below.

Table E.13: Service Roads/Slip Roads

S.No.	Ex.Chainage (km)		De. Chainage (km)			Slip/Service Road	Remarks
	From	To	From	To	Length		
1	96.170	96.970	96.300	97.080	0.780	Slip Road	VUP (Collem-LHS & Sacordem-RHS)
2	102.700	103.300	102.550	103.100	0.550	Slip Road	LVUP (Kajumal-LHS & School-RHS)
3	108.600	110.700	108.400	110.600	2.200	Slip & Service Road	Elevated CW Darbandhora
4	112.250	113.300	112.050	113.080	1.030	Slip Road	VUP (Sugar Factory on LHS & College on RHS)
5	114.000	114.950	113.750	114.750	1.000	Slip Road	VUP (SH-3, RHS, to Usgao)
6	116.000	118.000	115.350	117.350	2.000	Sevice Road	Industries (MRF, Finolex & Nestle)
7	125.000	125.600	125.000	125.600	0.600	Slip Road	VUP (TO Bus Stand)
8	125.600	126.220	125.600	126.220	0.620	Slip Road	VUP (NH-17B, LHS, to Borim, Verna)
9	126.220	127.700	126.220	127.700	1.480	Sevice Road	Elevated CW Formagudi
10	129.980	130.690	130.250	130.960	0.710	Slip Road	VUP (Mardol on LHS & Priol on RHS)
11	130.690	133.000	130.960	131.710	0.750	Sevice Road	Mangeshi Tourisim Traffic
12	133.000	133.890	131.710	132.600	0.890	Slip Road	VUP (to Mangesh Temple on LHS)
13	135.000	136.500	133.865	135.390	1.525	Slip & Service Road	LHS Elevated CW
14	136.700	138.300	135.390	137.100	1.710	Sevice Road	Elevated CW Boma
15	138.700	139.400	137.100	137.725	0.625	Slip Road	VUP (MDR-29, Link to SH-1, to Orgao, RHS)
16	140.300	140.700	139.600	141.070	1.470	Sevice Road	Elevated CW Corlim Ella
17	140.700	141.400	141.070	141.900	0.830	Sevice Road	ROB with Service Roads

E.8.4 Underpass/Overpass/Elevated Corridors

In order to avoid conflict of traffic on project road with the traffic on cross roads, Vehicular underpasses (VUPs) or Vehicular Overpass (VOPs) or Elevated Corridors are proposed at the intersections of major cross roads with the project highway. It is proposed to provide 9 no's of VUPs, 2 no's of LVUPs, 2 no's VOPs and 5 no's Elevated Corridors along the project highway at the following locations as given in below.

Table E.14: Vehicular Underpasses (VUP)

Sl No.	Existing Chainage (Km)	Design Chainage (Km)	Span / Opening (m)	Underpass	Remarks
1	96.612	96.610	1 x 20.0 x 5.5	VUP	MDR-33
2	102.950	102.830	1 x 10.5 x 4.5	LVUP	Local
3	112.630	112.427	1 x 20.0 x 5.5	VUP	Sugar Factory
4	114.380	114.160	1 x 20.0 x 5.5	VUP	SH-3
5	126.375	125.380	1 x 20.0 x 5.5	VUP	Link road to NH-17B
6	131.800	130.630	1 x 12.0 x 5.5	VUP	Mardol-Priol
7	133.410	132.164	1 x 20.0 x 5.5	VUP	Mangesh Temple
8	135.616	134.370	1 x 20.0 x 5.5	VUP	Local
9	138.950	137.750	1 x 20.0 x 5.5	VUP	MDR-29
10	142.650	141.200	1 x 10.5 x 4.5	LVUP	Urban, near ROB
11	144.080	142.600	1 x 40.0 x 5.5	VUP	MDR-1, Railway Station Road

Table E.15: Vehicular Overpasses (VOP)

Sl. No.	Existing Chainage (Km)	Design Chainage (Km)	Span / Opening (m)	Remarks
1	127.000	126.005	1 x 30.00 x 5.5	NH-17B, to Borim
2	134.600	133.500	1 x 20.0 x 5.5	Madkai IDC

Table E.16: Elevated Corridors

S. No.	Location	Starts at proposed Chainage	Ends at Proposed Chainage	Length (km)	Proposed Span Arrangement
1	Darbhandora	108.600	110.400	1800	1X105+16X100+1X105
2	Formagudi	126.430	127.340	910	1X105+7X100+1X105
3	Kundai	134.200	134.560	360	18X20
4	Boma	135.350	137.060	1710	1X105+15X100+1X105
5	Corlim & Ella	139.840	141.320	1480	1X105+13X100+1X105

Table E.17: Proposed Widening at Mollem/Anmod Ghat (Km 84 to Km 96)

Sl. No	Starts at Proposed Chainage (Km)	Ends at Proposed Chainage (Km)	Total Length (m)	Proposed structure	Proposed Span arrangement(m)

1	84/207	84/287	80	New2-lane bridge for MCW on LHS	2 x 40.0
2	84/570	84/730	160	New2-lane bridge for MCW on LHS	4 x 40.0
3	84/752	84/932	180	New2-lane bridge for MCW on LHS	4 x 40.0 + 1 x 20.0
4	85/328	85/388	60	New2-lane bridge for MCW on LHS	1 x 40.0 + 1 x 20.0
5	85/912	91/752	5840	New2-lane bridge for MCW on LHS	2 x 20 + 145 x 40.0
6	84/000	85/520	1520	New2-lane bridge for MCW on RHS	38 x 40.0
7	87/574	88/014	440	New2-lane bridge for MCW on RHS	11 x 40.0
8	88/205	88/325	120	New2-lane bridge for MCW on RHS	3 x 40.0
9	88/431	88/491	60	New2-lane bridge for MCW on RHS	1 x 40.0 + 1 x 20.0
10	88/880	90/900	2020	New2-lane bridge for MCW on RHS	50 x 40.0 + 1 x 20.0

E.9 Structures Improvement Proposals

Recommendation of structure improvements, including widening, repair and reconstruction / new construction of bridges, other cross drainage structures and the proposals are given below. Where Minor bridges are proposed to be widened, it is recommended that the existing railing to be replaced with RCC crash barrier by chipping the edge of deck and exposing the reinforcement and then casting the RCC crash barrier.

Widening of existing pipe culverts smaller than 900 mm shall be replaced with 1200 mm dia Pipe Culverts. Existing 900 mm dia pipe culverts can be widened using 900 mm dia pipes.

E.9.1 Rehabilitation scheme for Existing Structures

Rehabilitation measures for existing bridges & other structures are described briefly below:

The basic measures to be taken into account are:

- Repair of existing scour protection/bed protection or slope protection (wherever necessary).
- Replace existing wearing coat on all structures
- Replace expansion joints in all bridges.
- Replace bearings for bridges.
- Repair corroded reinforcement.

- Repair of cracks by epoxy injection – RCC elements.
- Repair of cracks by PMC mortar – Stone masonry elements.

E.9.2 Major Bridge

A) Construction of New Major Bridge

Sl. No	Ex. Chainage km	Design chainage km	Proposed structural Configuration	Prposed structure type	Proposed span arrangement	Total Width of the structure(m)	
						LHS	RHS
1	139.212	138.003	New2-lane bridge for main carriageway on LHS	PSC Box girder	1 x 51 + 4 x 52 + 1 x 51.0	12.50	Existing bridge

B) Rehabilitation & Repair of Existing Major Bridges

Sl. No	Existing Chainage (Km)	design chainage (Km)	Width of existing structure (m)	Span arrangement	Type of structure			Remarks
					Foundation	Sub structure	super structure	
1	139.212	138.003	11.30	1 x 51.0 + 4 x 52.0 + 1 x 51.0	Well	RCC Pier and abutment	PSC Box girder	RR

Note: RR= Repair and Rehabilitation

E.9.3 Minor Bridge

A) Construction of New Minor Bridge

Sl. No	Ex. Chainage km	Design chainage km	Proposed structural Configuration	Proposed structure type	Proposed span arrangement	Total Width structure(m)	
						LHS	RHS
1	93/873	92/237	New2-lane bridge for LCW	RCC Box	1 x 7.40 (Skew)	12.50	Existing bridge
2	93/913	92/283	New2-lane bridge for LCW	RCC Box	5 x 5.80	12.50	Existing bridge
3	94/471	92/834	New2-lane bridge for LCW	RCC-T-Girder + Deck slab	1 x 18.00	12.50	Existing bridge

Sl. No	Ex. Chainage km	Design chainage km	Proposed structural Configuration	Proposed structure type	Proposed span arrangement	Total Width structure(m)	
						LHS	RHS
4	97/753	97/763	New2-lane bridge for LCW	RCC Box	1 x 6.00	12.50	-
					1 x 4.50	-	12.50
5	115/813	115/615	New2-lane bridge for LCW & New 2-lane bridge for service road on both sides	RCC Box	1 x 12.00	12.50 +10.0	12.50 +10.00
6	131/711	130/442	New4-lane bridge for main carriageway & New 2-lane bridge for service road on both sides	RCC Box	2 x 7.20 (Skew)	12.50 +9.25	12.50 +9.25
7	133/592	132/362	New4-lane bridge for main carriageway & New 2-lane bridge for service road on both sides	RCC Box	1 x 6.60	12.50 +9.25	12.50 +9.25

B) Rehabilitation & Repair of Existing Minor Bridges

Sl. No	Existing Chainage km	Design chainage km	Width of existing structure (m)	Span arrangement	Type of structure			Remarks
					Foundation	Sub structure	super structure	
1	93/873	92/237	7.60	1 x 7.4	Open	PCC Abutment	RCC slab	RR
2	93/913	92/283	7.60	5 x 5.80	Open	PCC Abutment and Pier	RCC slab	RR

Sl. No	Existing Chainage km	Design chainage km	Width of existing structure (m)	Span arrangement	Type of structure			Remarks
					Foundation	Sub structure	super structure	
3	94/471	92/834	8.60	1 x 18.0	Open	PCC Abutment and Pier	RCC-Girder	RR
4	97/753	97/763	15.90	1 x 6.0 & 1 x 4.50	Open	PCC Abutment	RCC Slab	RR
5	115/813	115/615	24.00	1 x 12.0	Open	PCC Abutment	RCC-Girder	RR

Note: 1) RR= Repair and rehabilitation

E.9.4 Road Over Bridge

Sl. No	Existing Chainage (km)	Proposed Chainage (km)	Proposed structure configuration	Proposed structure Type	Proposed Span arrangement (m)	Total Width(m)	
						LHS	RHS
1	142/840	141/372	New2-lane bridge for MCW on LHS +Existing 2-lane structure on RHS and New 2-lane bridge for service road on both sides	*steel composite girder*	5 x 37.20+1 x 14.0 for on LHS 1 x 15.0+1 x 37.20+ 1 x 15.0 for Service road on RHS	23.50	Existing Bridge +10.0 m for Service road

E.10 Project Facilities

The project facilities are summarized below:

Table E.18: Project Facilities

	Chainage (Km)	Location	Side
Toll Plaza			

	Chainage (Km)	Location	Side
1	97.500	Toll Plaza	
Truck Lay-bye			
1	98.300	Truck Lay-bye	RHS
2	98.450	Truck Lay-bye	LHS
3	105.720	Truck Lay-bye	RHS
4	108.050	Truck Lay-bye	RHS
5	116.300	Truck Lay-bye	LHS
6	116.400	Truck Lay-bye	RHS

Sl. No.	Bus bay(BB) or Bus shelter (BS)	Design Chainage (Km)	Name of Village	Side (LHS/RHS)
1	BS	96.450	Mollem	LHS
2	BS	96.750	Mollem	RHS
3	BB	101.270	Dhat Farm	LHS
4	BB	101.550	Dhat Farm	RHS
5	BS	102.750	Suktali	LHS
6	BS	102.910	Suktali	RHS
7	BS	109.300	Dharbandora	LHS
8	BS	109.540	Dharbandora	RHS
9	BS	112.300	Sugar Factory	LHS
10	BS	112.550	Sugar Factory	RHS
11	BB	113.650	Pratapnagar	RHS
12	BS	114.015	Tisk usgao	LHS
13	BS	114.300	Tisk Usgao	RHS
14	BS	115.650	Dhatwada	RHS
15	BS	115.830	Dhatwada	LHS
16	BS	116.640	Kurdas Nagar	RHS
17	BS	116.900	Kurdas Nagar	LHS
18	BS	125.220	Ponda	RHS
19	BS	125.300	Ponda	LHS
20	BS	126.550	Formagudi	LHS
21	BS	126.800	Formagudi	RHS
22	BS	130.500	Mardol	LHS
23	BS	130.700	Mardol	RHS
24	BS	132.050	Mangeshi	LHS
25	BS	132.300	Mangeshi	RHS
26	BB	133.350	Kundaim	LHS
27	BB	133.200	Kundaim	RHS
28	BS	134.250	Kundaim	LHS
29	BS	134.500	Kundaim	RHS
30	BS	135.830	Boma	LHS
31	BS	136.050	Boma	RHS

Sl. No.	Bus bay(BB) or Bus shelter (BS)	Design Chainage (Km)	Name of Village	Side (LHS/RHS)
32	BS	136.800	Muslimwada	LHS
33	BS	136.900	Muslimwada	RHS
34	BB	137.500	Adcolna	RHS
35	BB	137.250	Adcolna	LHS
36	BS	139.650	Corlim	RHS
37	BS	139.700	Corlim	LHS
38	BS	140.820	Ella	RHS
39	BS	140.900	Ella	LHS

E.11 Estimation and Costing

E.11.1 General

Based on the improvement options considered, the quantities are estimated for:

- Rehabilitation of existing carriageway
- Construction of new carriageway
- Road side furniture including safety devices
- Passenger amenities and toll gates
- Project facilities

The pavement quantities are worked out for the adopted Rigid pavement design made based on the traffic data and other design criteria. The analysis of rates has been carried out as per the Standard Data Book of MORT&H.

E.11.2 Unit Rates

The Unit rates of all items of construction work have been analyzed as per the guidelines given in Standard Data Book of MORT&H. The rates of materials are obtained from the SOR of Goa - 2014. Market rates are adopted for items for which the rates are not available in SOR. The location of material quarries like gravel, sand, crushed aggregate are obtained from the material investigations. In respect of hourly hire and operating cost of various road construction machinery and equipment, rates given in MORT&H Standard Data Book and SOR are considered. For machinery and equipment not covered by these two, the prevailing market rates are considered. The labour rates are taken from SOR. Unit rates so arrived have been compared with reference to the rates of similar items in the ongoing projects under NHAI and are found comparable.

E.11.3 Construction Quantities

The quantities of earthwork in cut and fill are calculated based on the highway design. The pavement quantities like Sub grade, GSB, DLC, PQC, WMM, DBM and BC are computed using the Pavement design and the typical cross section adopted. Adequate provision is made for road side furniture including safety devices and miscellaneous items.

The summary of cost is as given below and detailed computations are furnished in Volume-IV Preliminary Costing.

Table E.19: Item wise Costing

Item Description	Total cost in Rs.
BILL NO: 1 - SITE CLEARANCE	4 1,810,666
BILL NO: 2 - EARTHWORKS	1,64 1,106,163
BILL NO: 3 - SUB-BASE AND BASE COURSES	72 3,806,601
BILL NO: 4A - BITUMINOUS WORKS FOR FLEXIBLE PAVE-MENT	22 6,040,600
BILL NO: 4B - RIGID PAVEMENT	3,05 5,756,586
BILL NO: 5 - CULVERTS	20 1,601,764
BILL NO: 6 (A) - BRIDGES	9,58 2,937,158
BILL NO: 6 (B) - REPAIR AND REHABILITATION OF EXISTING BRIDGES	9,149,442
BILL NO: 7 - DRAINAGE AND PROTECTION WORKS	3,75 4,281,605
BILL NO: 8 - JUNCTIONS	10 0,170,633
BILL NO: 9 - TRAFFIC SIGNS, MARKINGS AND APPURTE-NANCES	27 6,182,306
BILL NO: 10 – MISCELLANEOUS	24 7,213,747
BILL NO: 11– MAINTENANCE DURING CONSTRUCTION	5 4,135,210
Extra 7% for transoprtation in hilly terrain and misc. works	1,39 3,993,474
Total Construction Cost	21,308,1 85,956
Project Length in Km	50.900
Construction Cost/ Km	41.863

E.12 Toll Revenue & Financial Analysis

E.12.1 Approach to Financial Evaluation

The main objective of financial analysis is to examine the viability of implementing the project on BOT basis. The analysis attempts to ascertain the extent to which the investment can be recovered through toll revenue and the gap, if any, be funded through Grant / Subsidy. This covers aspects like financing through debt and equity, loan repayment, debt servicing, taxation, depreciation, etc. The viability of the project is evaluated on the basis of Project FIRR (Financial Internal Rate of Return) on total investment). The FIRR is estimated on the basis of cash flow analysis, where both costs and revenue have been indexed to take account of inflation. Financial analysis has been carried out for the entire project road with debt equity ratio of 70:30. The basic indicators for assessing the Financial Viability of the project are as follows.

NPV (Net Present Value): The NPV for the project should be positive when a discount rate representing the opportunity cost along with a risk premium is applied in the financial analysis.

FIRR (Financial Internal Rate of Return): The FIRR should have a value above the discount rate (opportunity cost).

E.12.2 Model Concession Agreement

Financial analysis was carried out based on following Assumptions:

Time Assumptions:

1. Concession Period has been fixed to the year in which the projected traffic would cross the design capacity of the Project Road.
2. Concession Period included the time required for construction also.

Economic Assumptions:

3. Annual Inflation rate of 5% has been considered for determining the Project Cost, Routine Maintenance and Periodic Maintenance.

Project Cost Assumptions*:

1. Contingency cost has been taken as 1% of the civil construction cost.

2. IC&Pre-Operative Expenses cost has been taken as 1% of Estimated Project Cost.

3. Financing Cost has been taken as:

Civil Cost	% on Debt amount
Up to 500 crores	2%
Between 500 crores to 1000 crores	1.5%
More than 1000 crores	1%

4. Interest rate for calculation of Interest during Construction has been taken as 12.5% (Base rate 10%+2.5% as per MoRTH Circular dated 16/06/14)

5. The Construction cost for the up gradation of the Project road does not include the Environmental, Social, Land Acquisition, Utility relocation and Tree cutting cost for the purpose of Financial Analysis.

Reference*: Guidelines/circular – NHAI Policy matter: Technical (70/2010) circulated vide NHAI, HQ letter No. 11041/218/2007-Admin, dated 08/12/2010.

Financing Assumptions:

a) The Debt has been considered as 70% of the Net Project Cost.

b) The Equity has been considered as 30% of the Net Project Cost.

c) Maximum Government/Client Contribution (Grant) is 40% of TPC.

d) Toll rates have been rounded to nearest 5 rupees.

Expenditure Assumptions:

a) Cost of Routine Maintenance and Periodic Maintenance has been taken from NHAI circular (NHAI/11033/CGM(Fin.)/2011 dated 29/04/11)

b) Interest rate on Debt has been considered as 12.50% per annum.

Other Assumptions:

a) Loan Repayment Period- 10 Years.

b) Tax Exemption/Tax Holiday- 10 Years of Concession Period to get maximum advantage of tax exemption. The MAT rate has been made applicable in those years.

c) Income Tax rate- 33.063% & MAT- 20.389%

E.12.3 Location of Toll Plaza

The fee levied and collected for use of a National highway shall be due and payable at the toll plazas. The toll revenue has been calculated considering the proposed toll plazas at the following locations as shown below.

Table E.21: Location of Toll Plazas and their tolling lengths

Package	Toll Plaza Location	Existing Chainages (km)			Bypass Length if any (km)
		From	To	Length	
Total Package	Km 97.500 (Mollem)	84.000	143.400	59.4	-

E.12.4 Tollable Traffic

The classified traffic volume count data collected has been analyzed to assess the traffic intensity at all the proposed toll plaza locations (reaches). The summary of Annual Average Daily Traffic (AADT in number of vehicles) at the proposed toll plaza location is given below.

***Table E.22:* Tollable Traffic**

Location of Toll Plaza at Mollem	Tollable Traffic								
	Cars	M. Bus	Bus	LCV	2 AT	3 AT	M AT	M. LCV	Total
Base/Present Traffic	1337	31	189	279	336	328	151	82	2733

E.12.5 Toll Revenue

A summary of Toll revenues has been presented below.

***Table E.23:* Toll Revenue**

Years		Total Package from Km 84 to Km 143.400	
From	To	Rs Crores per Year	Rs Lakhs / Day
2015	2016	30.51	8.36
2016	2017	34.17	9.36
2017	2018	38.43	10.53
2018	2019	42.76	11.71
2019	**2020**	47.96	13.14
2020	2021	53.69	14.71
2021	2022	60.17	16.48
2022	2023	67.26	18.43
2023	2024	75.15	20.59
2024	2025	84.09	23.04
2025	2026	94.51	25.89
2026	2027	105.51	28.91
2027	2028	118.47	32.46
2028	2029	131.97	36.16
2029	2030	147.79	40.49
2030	2031	165.65	45.38
2031	2032	186.30	51.04
2032	2033	208.10	57.01
2033	2034	233.54	63.98
2034	2035	261.36	71.61
2035	2036	292.27	80.07
2036	2037	327.07	89.61
2037	2038	365.64	100.18
2038	2039	410.14	112.37
2039	2040	459.77	125.96
2040	2041	516.78	141.58
2041	2042	578.26	158.43
2042	2043	649.03	177.82
2043	2044	730.21	200.06
2044	2045	820.52	224.80
2045	2046	921.95	252.59

E.12.6 Tax Calculation Model

According to the scheme under section 80-IA, 100% of the profit is deductible for the continuous period of ten years out of the concession period. However the benefit deduction is available only for ten consecutive assessment years falling within the

concession period. The tax rate adopted for this study is **33.063%** (30% tax + 7% surcharge + 3% education cess) following the deduction of depreciation and amortization. Minimum Alternate Tax (MAT) of **20.389%** (18.5% tax + 7% surcharge + 3% education cess) has been taken into account for the total concession period.

E.12.7 Civil Cost of the Project and Interest during construction (IDC)

The cost of Civil works of the project including the improvement of existing carriageway and cost of toll plaza and details are given below:

Table E.24: Cost Summary

Package	Length in km	Cost/ Km in Cr.	Civil Cost (Crores)
From Km 84.000 to Km 143.400	50.900	42	2131

The interest during construction, which is on the cost of funding incurred on the project, has been calculated on the basis of an interest rate of 12.50% per annum as per the present trends.

The total landed cost for the project at the end of the construction period has been estimated by adding the (capitalizing) interest during construction (IDC). The total landed cost at the time of commissioning is thus estimated and is given below

Table E.25: Summary of Concessionaire cost in Crores

Concessionaire Cost	Crores
Total Civil Construction cost in 2016 year	2131
Contingencies/OC @ 1.0% of TPC	21.31
Total EPC Cost	2152.31
IC & Pre-operative expenses @1% of EPC	21.52
Financing Cost @ 1.5 % on Debt.	11.00
Escalation @ 5% Per Anum	243
Interest During Construction	178
TOTAL PROJECT COST in crores	**2606**

E.12.8 Financial Analysis Considerations

The main objective of undertaking this study is to assess whether the project is financially viable or not. It is important to note that the proposal should be an attractive proposition for private sector participation under Build, Operate and Transfer (BOT) system. The basic methodology followed for estimating the financial

viability of the project is to calculate the FIRR (Financial Internal Rate of Return) on the investment for the project.

Following assumptions are taken into consideration for the financial analysis: -

a) Debt – Equity ratio :- 70:30

b) Subsidy/Grant – 40% (maximum)

c) Concession period (Including construction period) – 30 years.

d) Escalation – 5%

e) Interest on Debt – 12.5%

f) Project Phasing : First year – 20%, Second year – 40% and Third year -40%

g) Loan Repayment period – 10 years

h) Tax rebate–10 years (100% exemption for 10 years out of block of 20 years).

i) Depreciation by Straight line method - 100% for Concession Period

j) Depreciation by Written down value method – 10%

k) Financing cost - 1.0% of TPC.

E.12.9 Financial Viability

Based on the project structure traffic study and toll rate analysis, financial feasibility analysis has been carried out as per the methodology outlined in earlier sections. The objective of the financial analysis is to ascertain the existence of sustainable project returns, which shall successfully meet the expectations of its financial investors. The analysis reveals various FIRR values corresponding to each year of toll operation. FIRR for the Returns on Investment and Returns on Equity for the concession period of 30 years has been examined and tabulated below.

Table E.26: Financial Analysis Results

Tolling Lengths (km)			Grant (%)	Concession Period	Civil Cost in Cr.	Project FIRR (%)	Equity FIRR (%)
From	To	Length					
84	143.4	59.4	40%	30Y	2131	7.61	-

E.12.10 Conclusion

A minimum return on equity of around 15% could be considered satisfying the requirement of prospective concessionaire. The project is not yielding any returns on equity even with 40% grant and 30 years concession period. In view of this, it can be concluded that the option with BOT (Toll) is not viable for taking up the project on BOT -Toll basis.

Keeping in view of poor response for the BOT mode projects due to various Financing/Lending issues, the project may taken up on EPC mode or Hybrid Annuity Mode.