# 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 Ministry of Road Transport and Highways (MORTH) plays a key role. MORTH has been entrusted to implement the development of some of the stretches of National Highways under National Highway Development Programme (NHDP) 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 Maharashtra/Goa Border - Goa/Karnataka Border of NH-17 from Km 475/040 to 611/000 in the state of Goa on BOT (Toll) basis under NHDP-III (Patradevi to Pollem 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.

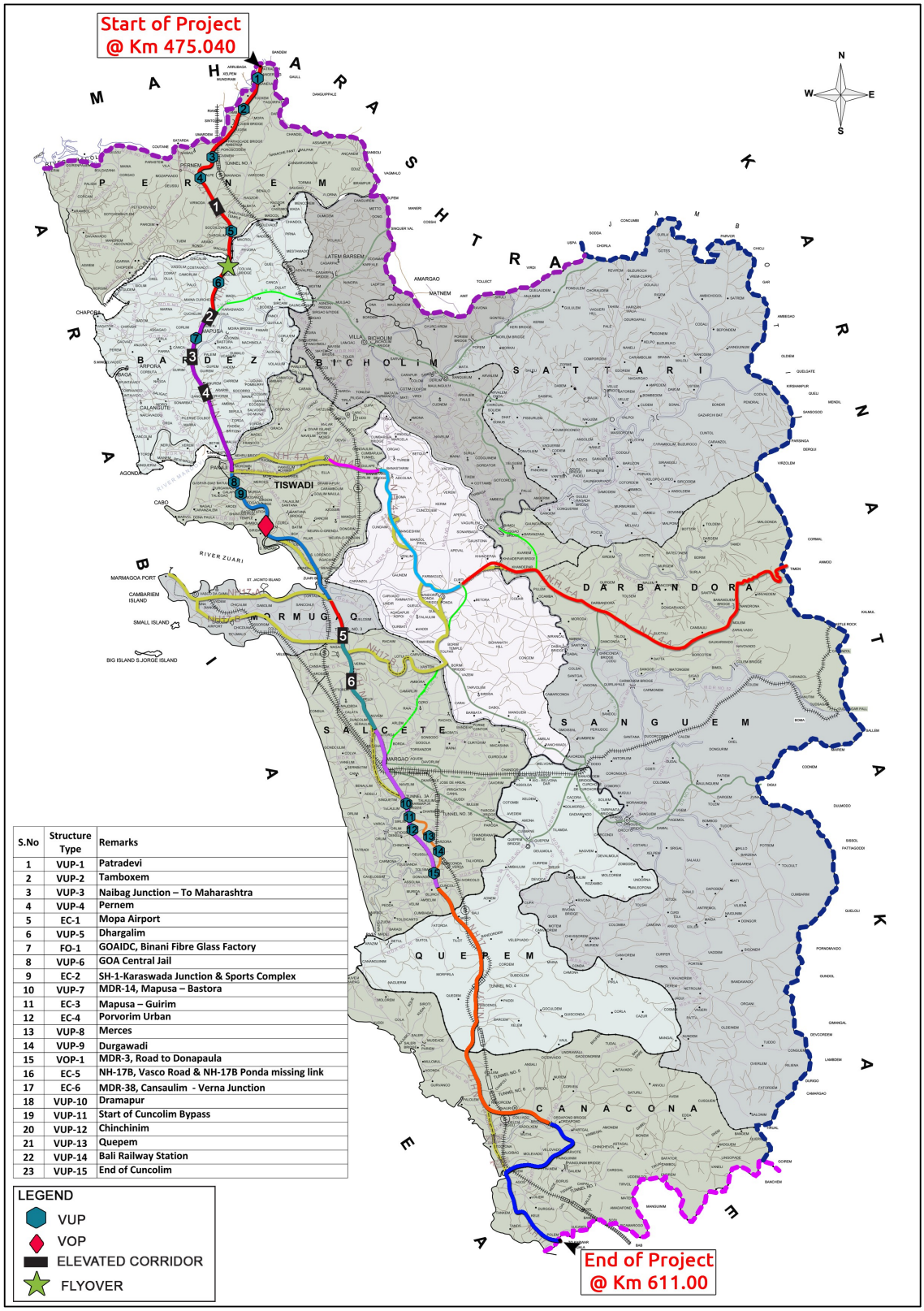
The project stretch excludes following reaches:

1. From Km 515.000 to Km 518.000 (Mandovi Bridge Reach)
2. From Km 523.000 to Km 535.000 (Zuari Bridge Reach)
3. From Km 545.000 to Km 554.000 (Margaon Bypass Reach)
4. From Km 586.000 to Km 603.000 (Canacona Bypass reach)

## E.2 Project Description

The Project Highway is a section of NH-17 between Patradevi and Pollem, passing through villages Torxem, Tamboxem, Uguem, Poroscodem, Casnem, Pernem, Virnoda, Dargalim, Colvale, Acola, Mapusa, Bastora, Guirim, Porvorim, Panaji, Santa Cruz Bambolim, Siridao, Palem, Cortalim, Nagoa, Verna, Nuvem, Fatorda, Margao, Navelim, Sirlim, Chinchinim, Panzarconi, Cuncolim, Tiloi, Canacona, Macem, Kalmath, Pollem. It connects Panvel (South of Mumbai city) to Kochi in Kerala, passing through the states of Maharashtra, Goa, Karnataka, and Kerala. The Project stretch is an important link connecting the states of Maharashtra, Goa and Karnataka starts at Patradevi Maharashtra-Goa border to Pollem, Goa-Karnataka border with length of 135.96 km. It has a great potential of growth in the passenger as well as freight

movement in future due to tourism, agriculture and industrial growth in the project influence area. From Km 475.040 to Km 545.000, the right of way ranges from 8 m to 45m, from Km 555.000 to 585.000 the ROW ranges from 8m to 10m and Km 603.000 to Km 611.000 it is 10m to 30m. From Km 570.000 to Km 585.000 the alignment passes through Ghat Section. The entire alignment passes through hilly and rolling terrain except few reaches in plain terrain. The Index Map of the project stretch is given as Figure E-1.




| S.No | Structure Type | Remarks |
|---|---|---|
| 1 | VUP-1 | Patradevi |
| 2 | VUP-2 | Tamboxem |
| 3 | VUP-3 | Naibag Junction – To Maharashtra |
| 4 | VUP-4 | Pernem |
| 5 | EC-1 | Mopa Airport |
| 6 | VUP-5 | Dhargalim |
| 7 | FO-1 | GOAIDC, Binani Fibre Glass Factory |
| 8 | VUP-6 | GOA Central Jail |
| 9 | EC-2 | SH-1-Karaswada Junction & Sports Complex |
| 10 | VUP-7 | MDR-14, Mapusa – Bastora |
| 11 | EC-3 | Mapusa – Guirim |
| 12 | EC-4 | Porvorim Urban |
| 13 | VUP-8 | Merces |
| 14 | VUP-9 | Durgawadi |
| 15 | VOP-1 | MDR-3, Road to Donapaula |
| 16 | EC-5 | NH-17B, Vasco Road & NH-17B Ponda missing link |
| 17 | EC-6 | MDR-38, Cansaulim - Verna Junction |
| 18 | VUP-10 | Dramapur |
| 19 | VUP-11 | Start of Cuncolim Bypass |
| 20 | VUP-12 | Chinchinim |
| 21 | VUP-13 | Quepem |
| 22 | VUP-14 | Bali Railway Station |
| 23 | VUP-15 | End of Cuncolim |

***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 the improvement scheme of the options are mentioned below.

The Project road has 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: From Km 475.040 to Km 514.800 (Rolling/Plain terrain).**

The Project Highway starts with a mix of rolling/plain terrain from Km 475+040 at Goa/Maharashtra border. Existing alignment has substandard horizontal geometry. The existing speed on the highway is about 50 to 60 kmph. Minor realignments are proposed to meet the minimum design speed of 80KMPH at following locations.

1. From Km 477.500 to Km 478.000
2. From Km 485.000 to Km 490.000

The existing alignment in Naibag location has substandard horizontal & vertical curves in particularly from Km 486.500 to Km 490.500.

**Section II: From Km 514.800 to Km 518.400 – Mandovi Bridge**

Four Lane bridge construction is under progress on the River Mandovi from Km 514.800 to Km 518.400.

**Section III: From Km 518.400 to Km 523.500 - Bambolim**

The project highway passes through plain to rolling terrain in the urban area of Panaji. Vehicular Overpass is proposed in this project stretch.

**Section IV: From Km 523.500 to Km 535.500 – Zuari Bridge**

The Project stretch constitutes a major bridge Zuari which is in the initial stage of construction taken up by the Public works department.

**Section V: From Km 535.500 to Km 545.000**

The Project stretch passes through Verna Industrial area. The Proposed alignment follows the existing alignment with minor curve improvements within the available

ROW. Elevated Corridor is proposed in this location to segregate the Airport traffic and Verna Industrial Estate traffic plying on NH-17B.

**Section VI: From Km 545.000 to Km 555.000**

The Project stretch constitutes Margao bypass which is under construction taken up by Public works department to bypass the heavily congested Margao City traffic.

**Section VII: From Km 555.000 to Km 586.000**

In this stretch the project highway passing through the congested villages namely Chinchinim, Panzorconi, Cuncolim and Bali from Km 557.800 to Km 567.700. Thereafter it is passing through the dense forest area of Kharmal Ghat from Km 572.000 to Km 582.000. The existing alignment in Kharmal Ghat stretch has substandard horizontal & vertical curves in particularly from Km 579 to Km 582.

There are some minor realignments has been proposed to improve the geometry or make use of existing 4 Lane RUBs at following locations.

1. From Km 569.200 to Km 570.600: existing 4 lane RUB in skew.
2. From Km 573.700 to Km 574.000: Substandard existing curves.
3. From Km 574.300 to Km 574.700: Substandard existing curve.
4. From Km 575.500 to Km 576.000: Substandard existing curves.
5. From Km 577.100 to Km 578.100: Substandard existing curves.
6. From Km 578.600 to Km 579.000: Substandard existing curves.
7. From Km 582.200 to Km 583.700: Substandard existing curves.

**Section VIII: From Km 587.000 to Km 603.000**

The Project Stretch from Km 587.000 to Km 603.000 is awarded and is under construction.

**Section IX: From Km 603.000 to Km 611.000**

In this stretch the project highway passes through rolling terrain. The consultants have proposed realignment from Km 606.100 to Km 607.000 to improve the existing horizontal curves.

## 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-17 is having two lane and four lane configuration. Carriageway width was measured at every 100m interval. Width of shoulders on either side was measured separately 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 0.4 to 5.0m width on either side 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 | 475.000 | 489.100 | 14100 | 2 lane carriageway | Good |
| 2 | 489.100 | 490.100 | 1000 | 4 lane carriageway | Good |
| 3 | 490.100 | 507.100 | 17000 | 2 lane carriageway | Good |
| 4 | 507.100 | 510.800 | 3700 | 4 lane carriageway | Good |
| 5 | 510.800 | 513.000 | 2100 | 2 lane carriageway | Good |
| 6 | 513.000 | 515.000 | 2000 | 4 lane carriageway | Good |
| 7 | 515.000 | 521.500 | 6500 | 2 lane carriageway | Good |
| 8 | 521.500 | 522.800 | 1300 | 4 lane carriageway | Good |
| 9 | 535.000 | 537.000 | 2000 | 2 lane carriageway | Good |

| S. No. | Existing Chainage (Km) | | Length (m) | Lane Configuration | Condition of the Road |
|---|---|---|---|---|---|
| | From | To | | | |
| 10 | 537.000 | 538.400 | 1400 | 4 lane carriageway | Good |
| 11 | 538.400 | 542.800 | 4400 | 2 lane carriageway | Good |
| 12 | 555.000 | 557.200 | 2200 | 2 lane carriageway | Good |
| 13 | 570.000 | 585.000 | 15000 | 2 lane carriageway | Good |
| 14 | 603.000 | 611.000 | 8000 | 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 - 1nos.
RUBs - 3nos.
c) Total number of Minor Bridges - 18nos.
d) Total number of Slab/Box Culverts - 88nos.
e) Total number of Pipe Culverts - 235nos.
f) Total number of Grade Separators - Nil
g) Total number of Vehicular and Non Vehicular Underpasses - 1 (2 Lane)

## 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, Willing-ness to Pay, etc., including collection of secondary data for traffic projections were carried out in the month of June in 2015. Secondary data was collected for the pur-pose 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 eight survey locations of traffic volume count survey along the Project corridor is presented below.

***Table E.2: Average Annual Daily Traffic***

| Mode | | Km 493.0 | Km 511.0 | Km 522.0 | Km 537.0 | Km 544.0 | Km 556.0 | Km 588.0 | Km 610.0 |
|---|---|---|---|---|---|---|---|---|---|
| Two Wheelers | | 6132 | 17062 | 12232 | 9385 | 11411 | 10243 | 5777 | 3390 |
| Three Wheelers | | 12 | 154 | 68 | 37 | 54 | 108 | 196 | 4 |
| Car / Jeep / Van | | 5231 | 16337 | 14586 | 10892 | 13092 | 9386 | 4754 | 2166 |
| Car Yellow board | | 176 | 2026 | 4647 | 2169 | 2026 | 527 | 808 | 148 |
| Tata Magic | | 19 | 9 | 3 | 59 | 2 | 4 | 54 | 11 |
| RTC Bus | | 155 | 474 | 767 | 461 | 595 | 189 | 257 | 91 |
| Private Bus | | 237 | 655 | 330 | 406 | 455 | 487 | 402 | 45 |
| School/College bus | | 3 | 15 | 8 | 9 | 7 | 14 | 25 | 9 |
| Mini Bus | | 80 | 148 | 272 | 270 | 171 | 109 | 146 | 18 |
| 2 Axle | | 706 | 738 | 110 | 143 | 1660 | 310 | 255 | 146 |
| 3 Axle | | 149 | 293 | 29 | 21 | 488 | 171 | 179 | 82 |
| M Axle | | 197 | 186 | 2 | 5 | 318 | 66 | 150 | 83 |
| HEM | | 15 | 72 | 7 | 5 | 21 | 13 | 56 | 2 |
| LCV/LGV | | 787 | 1539 | 711 | 931 | 1451 | 543 | 486 | 127 |
| Mini LCV | | 466 | 1803 | 1605 | 1591 | 2069 | 750 | 621 | 140 |
| Three Wheeler goods | | 2 | 42 | 39 | 18 | 23 | 46 | 64 | 7 |
| Tractor | | 5 | 2 | 6 | 0 | 2 | 5 | 6 | 1 |
| Tractor with trailer | | 2 | 12 | 5 | 5 | 0 | 1 | 1 | 0 |
| Non-Motorized Vehicles | | 7 | 20 | 11 | 31 | 19 | 56 | 56 | 25 |
| Govt. Exempted Vehicles | | 28 | 193 | 147 | 55 | 47 | 42 | 52 | 8 |
| Tollable Traffic (vehicles) | | 8220 | 24294 | 23079 | 16960 | 22355 | 12567 | 8192 | 3069 |
| Tollable Traffic (PCU's) | | 11894 | 30389 | 26091 | 19672 | 30761 | 15510 | 11463 | 4187 |
| Total Vehi-cles | Motorized | 14400 | 41758 | 35575 | 26459 | 33892 | 23012 | 14288 | 6479 |
| | Non-Motorized | 7 | 20 | 11 | 31 | 19 | 56 | 56 | 25 |
| | Total Traffic | 14407 | 41778 | 35586 | 26490 | 33911 | 23068 | 14344 | 6504 |
| Total PCUs | Motorized | 15024 | 39439 | 32573 | 24522 | 36615 | 20853 | 14687 | 5905 |
| | Non-Motorized | 26 | 20 | 8 | 25 | 10 | 44 | 30 | 12 |
| | Total Traffic | 15050 | 39459 | 32581 | 24547 | 36625 | 20897 | 14717 | 5917 |

## E.6.2 Zuari Bridge Traffic (Heavy Vehicle Traffic)

Zuari Bridge, the main connecting link between North & South Goa is closed for heavy vehicular traffic (above 12 tonnes) since 1997 as it was found structurally not sound to cater to heavy traffic loads prevailing.

As per above context, the Consultants presumed that once Zuari bridge construction gets completed and is thrown open to traffic, the truck traffic which is currently plying on alternative routes is expected to use this bridge again. Considering this, Consultants have collected traffic census data when Zuari Bridge was open to heavy

vehicular traffic and the same has been projected to 2015 the base year, with a growth rate of 5% per annum.

***Table E.3: Heavy Vehicle Traffic along Project Stretch when Zuari Bridge is under Operation***

| S. No. | Vehicles | Traffic when Zuari bridge is under operation | Regular Traffic (Actual) | Total Traffic |
|---|---|---|---|---|
| **Km 493, Malpem** | | | | |
| 1 | Trucks (2 or 3 AT) | 1282 | 857 | 2139 |
| 2 | Multi Axle Trucks | 314 | 212 | 526 |
| 3 | Total | 1596 | 1069 | 2665 |
| **Km 511, Porvorim** | | | | |
| 1 | Trucks (2 or 3 AT) | 1403 | 1042 | 2445 |
| 2 | Multi Axle Trucks | 371 | 258 | 629 |
| 3 | Total | 1774 | 1300 | 3074 |
| **Km 537, Cortalim** | | | | |
| 1 | Trucks (2 or 3 AT) | 1289 | 174 | 1463 |
| 2 | Multi Axle Trucks | 171 | 10 | 181 |
| 3 | Total | 1460 | 184 | 1644 |
| **Km 556, Navelim/Dharmapur** | | | | |
| 1 | Trucks (2 or 3 AT) | 554 | 482 | 1036 |
| 2 | Multi Axle Trucks | 611 | 79 | 690 |
| 3 | Total | 1164 | 561 | 1725 |
| **Km 588, Canacona** | | | | |
| 1 | Trucks (2 or 3 AT) | 560 | 437 | 997 |
| 2 | Multi Axle Trucks | 259 | 206 | 465 |
| 3 | Total | 818 | 643 | 1461 |

### E.6.3 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.4: Vehicle Damage Factor (VDF)***

| S. No. | Mode | Km 475.000 | | | Km 610.000 | | |
|---|---|---|---|---|---|---|---|
| | | To Panaji | To | Adopted | To | To | Adopted |

| | | | Patradevi | | Karwar | Canacona | |
|---|---|---|---|---|---|---|---|
| 1 | 2 Axle | 3.37 | 1.02 | 3.37 | 2.40 | 3.78 | 3.78 |
| 2 | 3 Axle | 3.74 | 3.91 | 3.91 | 3.53 | 4.53 | 4.53 |
| 3 | M axle | 6.28 | 4.92 | 6.28 | 4.58 | 5.19 | 5.19 |
| 4 | LCV | 2.41 | 1.14 | 2.41 | 0.33 | 0.74 | 0.74 |

### E.6.4 Traffic Growth Rates (%)

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

***Table E.5: 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.6.5 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-17: From Patradevi to Pollem | HS-1 | 475.040 | 503.250 | 28.210 | SH-1 to Bicholim |
| 2 | | HS-2 | 503.250 | 517.500 | 14.250 | NH-4A, Old Goa-Belgaum Road |
| 3 | | HS-3 | 517.500 | 533.400 | 15.900 | NH-17A to Vasco |
| 4 | | HS-4 | 533.400 | 537.500 | 4.100 | NH-17B to Vasco |
| 5 | | HS-5 | 537.500 | 546.850 | 9.350 | Arlem Bypass, SH-5 to Borim & Ponda |
| 6 | | HS-6 | 546.850 | 563.500 | 16.650 | Cuncolim |

| S.No. | Sections | HS | From (Km) | To (Km) | Length (Km) | Remarks |
|---|---|---|---|---|---|---|
| 7 | | HS-7 | 563.500 | 592.300 | 28.800 | Canacona, MDR-50 |
| 8 | | HS-8 | 592.300 | 611.000 | 18.700 | End of Project Stretch |

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 Total Traffic***

| S. No. | HS | Chainage | | Present Traffic | | Year Attaining 15,000 PCU's (Capacity of 2 lane With LOS B) | | Year Attaining 40,000 PCU's (Capacity of 4 lane With LOS B) | |
|---|---|---|---|---|---|---|---|---|---|
| | | From Km | To Km. | PCUs | Year | PCUs | Year | PCUs | Year |
| 1 | HS-1 | 475.040 | 503.250 | 20316 | 2015 | - | - | 38713 | 2025 |
| 2 | HS-2 | 503.250 | 517.500 | 45298 | 2015 | - | - | 45298 | 2015 |
| 3 | HS-3 | 517.500 | 533.400 | 38817 | 2015 | - | - | 38817 | 2015 |
| 4 | HS-4 | 533.400 | 537.500 | 29169 | 2015 | - | - | 39192 | 2019 |
| 5 | HS-5 | 537.500 | 546.850 | 36522 | 2015 | - | - | 39323 | 2016 |
| 6 | HS-6 | 546.850 | 563.500 | 25263 | 2015 | - | - | 38855 | 2021 |
| 7 | HS-7 | 563.500 | 592.300 | 17501 | 2015 | - | - | 39551 | 2027 |
| 8 | HS-8 | 592.300 | 611.000 | 8754 | 2015 | 15669 | 2024 | 39379 | 2039 |

By considering 75% of cars, 2W, 3W, Tractors and Slow moving vehicles on service roads from Km 503.250 to Km 546.850 (Urban portion from Karaswada Junction to

Arlem Bypass) where 4 lane with service roads are proposed and the 6 lane requirement shall be after year 2030.

## 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 8 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 | 475.040 | 503.250 | 28.210 | 13 | 30 | 50 | 76 |
| 2 | HS-2 | 503.250 | 517.500 | 14.250 | 18 | 40 | 70 | 105 |
| 3 | HS-3 | 517.500 | 533.400 | 15.900 | 12 | 26 | 45 | 70 |
| 4 | HS-4 | 533.400 | 537.500 | 4.100 | 10 | 23 | 40 | 60 |
| 5 | HS-5 | 537.500 | 546.850 | 9.350 | 16 | 35 | 60 | 95 |
| 6 | HS-6 | 546.850 | 563.500 | 16.650 | 10 | 20 | 35 | 55 |
| 7 | HS-7 | 563.500 | 592.300 | 28.800 | 10 | 20 | 30 | 46 |
| 8 | HS-8 | 592.300 | 611.000 | 18.700 | 6 | 12 | 20 | 31 |

### 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 | 475.04 | 503.25 | 10% | 15 Y | 50 | VG-40 | 40 | 95 | 250 | 200 | 585 |
| HS-2 | 503.25 | 517.50 | 10% | 15 Y | 70 | VG-40 | 40 | 105 | 250 | 200 | 595 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HS-3 | 517.50 | 537.50 | 10% | 15 Y | 45 | VG-40 | 40 | 95 | 250 | 200 | 585 |
| HS-4 | 537.50 | 546.85 | 10% | 15 Y | 60 | VG-40 | 40 | 100 | 250 | 200 | 590 |
| HS-5 | 546.85 | 592.30 | 10% | 15 Y | 35 | VG-40 | 40 | 95 | 250 | 200 | 585 |
| HS-6 | 592.30 | 611.00 | 10% | 15 Y | 20 | VG-30 | 40 | 80 | 250 | 200 | 570 |

### 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 475 to Km 592.3 | Km 592.3 to Km 611.0 |
|---|---|---|---|
| 1 | PQC of M40 grade, mm | 270 | 250 |
| 2 | DLC of M10 grade, mm | 150 | 150 |
| 3 | GSB, mm | 150 | 150 |
| 4 | Dia. of Dowel bar, mm | 36 | 32 |
| 5 | Length of Dowel bar, mm | 450 | 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 | 415 | 445 |

### 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. 746.84 crores. Whereas for rigid pavement the cost comes to Rs. 718.64 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. CBR | MSA | Bitumen Grade | Crust Composition in mm | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 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 65 m for the project stretch. Typical Cross Sections (TCS) have been developed duly considering various aspects. From Km 572.000 to Km 585.000 the alignment passes through Karmal Ghat Section where right of way ranges from 7 m to 10 m and acquiring the land will be difficult as it comes under Reserve Forest/Wild Life Sanctuary. The entire alignment passes through hilly and rolling terrain except few reaches in plain terrain. 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-Symmetrical 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-a | 6 Lane Cross section-Approaches to PUP/ LVUP/VUP/Flyover -0.6m median-Slip roads(7.0m) on both sides-45m PROW in Existing Alignment |
| VI-b | 6 Lane Cross section-Approaches to PUP/ LVUP/VUP/Flyover -0.6m median-Slip roads(7.0m) on both sides-45m PROW in Bypass |
| VII | 6 Lane Cross section-Approaches to VOP-1.5m median-Slip roads(7.0m) on both sides-60m PROW |

| TCS type | Description |
|---|---|
| VIII | 4 Lane Cross section for Mountainous terrain in cut and fill sections-1.5m median-30m PROW |
| 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 in Urban Area-30m PROW |
| XI | 6 Lane Twin Tunnel Cross Section in Ghat Section-65m 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 | 475.000 | 475.800 | 475.000 | 475.800 | 0.800 | Slip Road | VUP (to Patradevi) |
| 2 | 479.900 | 480.510 | 480.100 | 480.710 | 0.610 | Slip Road | VUP (to Mopa village and Tambosa village) |
| 3 | 481.000 | 481.700 | 481.300 | 482.000 | 0.700 | Slip Road | CUP (Uguem village & Temple) |
| 4 | 483.850 | 484.910 | 484.200 | 485.260 | 1.060 | Slip Road | VUP Road to MH border (Naibag junction) |
| 5 | 489.824 | 490.494 | 487.190 | 487.860 | 0.670 | Slip Road | VUP Pernem |
| 6 | 490.494 | 491.934 | 487.860 | 489.300 | 1.440 | Slip Road | LVUP – Govt. College |
| 7 | 494.036 | 494.816 | 491.380 | 492.160 | 0.780 | Slip Road | Fly Over (Road to Mopa New Airport) |
| 8 | 495.420 | 495.950 | 492.720 | 493.250 | 0.530 | Slip Road | PUP (School) |
| 9 | 495.950 | 496.900 | 493.250 | 494.200 | 0.950 | Slip Road | VUP (Road to Industrial Area, Tuem village) |
| 10 | 498.535 | 499.085 | 495.790 | 496.340 | 0.550 | Slip Road | LVUP (Colvale- |

| S. No. | Ex. Chainage (km) | | De. Chainage (km) | | | Slip/ Service Road | Remarks |
|---|---|---|---|---|---|---|---|
| | From | To | From | To | Length | | |
| | | | | | | | Chicali) |
| 11 | 499.085 | 499.915 | 496.340 | 497.170 | 0.830 | Slip Road | 2 Lane PUP |
| 12 | 499.915 | 500.585 | 497.170 | 497.840 | 0.670 | Slip Road | FO/Viaduct (GOAIDC, Binani Fibre Glass Factory) |
| 13 | 500.585 | 502.245 | 497.840 | 499.500 | 1.660 | Slip & Service Road | VUP (Road to Central Jail) |
| 14 | 502.245 | 504.595 | 499.500 | 501.850 | 2.350 | Slip Road | Fly Over (Karaswada Jn.) |
| 15 | 504.595 | 506.315 | 501.850 | 503.570 | 1.720 | Slip Road | VUP (Bastora-Mapusa |
| 16 | 506.315 | 509.465 | 503.570 | 506.720 | 3.150 | Slip Road | Fly Over to Mapusa and LVUP Guirim |
| 17 | 509.465 | 514.920 | 506.720 | 512.120 | 5.400 | Service Road | EC (Urban Porvorim) |
| 18 | 518.400 | 520.250 | 518.400 | 520.250 | 1.850 | Service Road | VUP (Road to Merces) |
| 19 | 520.250 | 520.970 | 520.250 | 520.970 | 0.720 | Slip Road | VUP (Road to Durgawadi) |
| 20 | 520.970 | 522.800 | 520.970 | 522.840 | 1.870 | Slip Road | VOP (Road to Donapaula on RHS) |
| 21 | 535.600 | 538.660 | 535.600 | 538.660 | 3.060 | Service Road | EC (NH-17B, Vasco Road & NH-17B Ponda missing link) |
| 22 | 538.660 | 542.800 | 538.660 | 542.840 | 4.180 | Service Road | EC (Cansaulim Junction, Verna Rly. Station road |
| 23 | 554.801 | 555.131 | 554.900 | 555.230 | 0.330 | Service Road | End of Margao Bypass |
| 24 | 555.760 | 556.580 | 555.900 | 556.720 | 0.820 | Slip Road | VUP (Dramapur) |
| 25 | 556.580 | 557.536 | 556.720 | 557.700 | 0.980 | Slip Road | Start of Cuncolim Bypass |
| 26 | 558.736 | 559.686 | 558.900 | 559.850 | 0.950 | Slip Road | VUP (Chinchinim) |
| 27 | 564.236 | 564.836 | 564.400 | 565.000 | 0.600 | Slip Road | VUP (Quepem) |
| 28 | 567.446 | 567.806 | 567.610 | 568.200 | 0.590 | Slip Road | VUP (Bali) |
| 29 | 567.284 | 567.834 | 568.200 | 568.750 | 0.550 | Slip Road | Cuncolim bypass end |
| 30 | 603.640 | 604.490 | 603.600 | 604.450 | 0.850 | Slip Road | LVUP (Mashem) |
| 31 | 607.350 | 608.100 | 606.950 | 607.700 | 0.750 | Slip Road | LVUP (Loliem) |

### 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 15 no's of VUPs, 4 no's of LVUPs, 4 no's of PUP/CUPs, 1 no's

VOPs, 4 Fly Over and 3 no's Elevated Corridors along the project highway at the following locations as given in below.

***Table E.14: Vehicular Underpasses (VUP)***

| S. No. | Existing Chainage (Km) | Design Chainage (Km) | Span / Opening (m) | Underpass | Remarks |
|---|---|---|---|---|---|
| 1 | 475.400 | 475.400 | 1 x 20.0 x 5.5 | VUP | To Patradevi |
| 2 | 480.829 | 480.526 | 1 x 20.0 x 5.5 | VUP | To Mopa - |
| 3 | 481.800 | 481.600 | 1 x 10.5 x 4.5 | CUP | To Uguem |
| 4 | 486.100 | 485.320 | 1 x 20.0 x 5.5 | VUP | To Shiroda |
| 5 | 490.200 | 488.357 | 1 x 20.0 x 5.5 | VUP | To Pernem |
| 6 | 491.600 | 489.744 | 1 x 10.5 x 4.5 | LVUP | To Govt. College |
| 7 | 495.500 | 493.650 | 1 x 7.0 x 3.0 | PUP | To School |
| 8 | 496.400 | 494.446 | 1 x 20.0 x 5.5 | VUP | To Industrial Area |
| 9 | 497.800 | 495.864 | 1 x 7.0 x 3.0 | CUP | Access for |
| 10 | 498.850 | 496.908 | 1 x 10.5 x 4.5 | LVUP | To Colvale - Colvale |
| 11 | 499.450 | 497.459 | 1 x 7.0 x 3.0 | PUP | Existing 2 Lane PUP |
| 12 | 501.850 | 499.901 | 1 x 40.0 x 5.5 | VUP | To Central Jail |
| 13 | 505.900 | 503.932 | 1 x 20.0 x 5.5 | VUP | To Bastora - Mapusa |
| 14 | 519.800 | 519.811 | 1 x 20.0 x 5.5 | VUP | To Merces |
| 15 | 520.600 | 520.612 | 1 x 20.0 x 5.5 | VUP | To Durgawadi |
| 16 | 556.200 | 556.280 | 1 x 20.0 x 5.5 | VUP | To Dramapur |
| 17 | 557.261 | 557.400 | 1 x 20.0 x 5.5 | VUP | Cuncolim Bypass |
| 18 | - | 559.350 | 1 x 20.0 x 5.5 | VUP | To Chinchinim |
| 19 | - | 564.660 | 1 x 20.0 x 5.5 | VUP | To Quepem |
| 20 | - | 567.800 | 1 x 20.0 x 5.5 | VUP | To Bali |
| 21 | 567.556 | 568.450 | 1 x 20.0 x 5.5 | VUP | Cuncolim Bypass |
| 22 | 604.000 | 603.980 | 1 x 10.50 x 4.5 | LVUP | Mashem |
| 23 | 607.651 | 607.250 | 1 x 10.50 x 4.5 | LVUP | Pollem |

***Table E.15 (a): Vehicular Overpasses (VOP)***

| Sl. No. | Existing Chainage (Km) | Design Chainage (Km) | Span / Opening (m) | Remarks |
|---|---|---|---|---|
| 1 | 521.900 | 521.770 | 1 x 30.00 x 5.5 | To Donapaula – MDR 3 |

***Table E.15 (b): Fly Over***

| Sl. No. | Design Chainage (Km) | Span / Opening (m) | Remarks |
|---|---|---|---|
| 1 | 492.554 | 15 + 30 + 15 | Mopa Airport |
| 2 | 496.209 | 15 + 30 + 15 | Binani – GOA IDC |
| 3 | 501.300 | 15 + 30 + 15 | Karaswada Jn |
| 4 | 505.920 | 15 + 30 + 15 | Mapusa- Green Park |

***Table E.16: Elevated Corridors***

| S. No. | Location | Elevated Corridors (Design Chainages) (km) | | | Proposed Span Arrangement | Total width of Structure |
|---|---|---|---|---|---|---|
| | | From | To | Length | | |
| 1 | Porvorim | 508.644 | 512.344 | 3700 | 30+47x50+40+65 +40+13x50+40+6 5+40+7x50+30 | 29 |
| 2 | Airport Link | 537.540 | 538.390 | 850 | 30+50+40+65+40 +8x50+40+65+40 +50+30 | 29 |
| 3 | Verna | 539.297 | 540.897 | 1600 | 30+12x50+40+65 +40+12x50+40+6 5+40+50+30 | 29 |

## 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 | Proposed structure type | Proposed span arrangement | Total Width of the structure(m) | |
|---|---|---|---|---|---|---|---|
| | | | | | | LHS | RHS |
| 1 | 481+385 | 481+045 | 4 lane width | PSC I-girder | 3x25.0 | 12.5 | 12.5 |

**B) Rehabilitation & Repair of Existing Major Bridges**

| S. No | Ex. Chainage Km | Design chainage km | Proposed structural Configuration | Proposed structure type | Proposed span arrangement | Total Width of the structure(m) | |
|---|---|---|---|---|---|---|---|
| | | | | | | LHS | RHS |
| 1 | 498+253 | 495+600 | 2 lane width | PSC Box girder | 1x51+3x60+1x21 | 12.5 | Existing |

*Note: RR= Repair and Rehabilitation*

### E.9.3 Minor Bridge

**A) New Construction and Reconstruction of New Minor Bridges**

| S. No. | Existing chainage | Design Chainage (Km) | Proposed structural Type | Existing span arrangement (m) | Proposed span arrangement (m) | Total width (m) |
|---|---|---|---|---|---|---|
| 1 | - | 477+665 | Box | - | 1x8 | 12.5+3+12.5 |
| 2 | - | 485+085 | Box | - | 1x10 | 12.5+3+12.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 492+267 | 489+620 | PSC Girder | 2x5.8 | 1x25 | 12.5+3+12.5 |
| 4 | 500+520 | 497+750 | Box | 1x7.5 | 1x7.5 | 12.5+3+12.5 |
| 5 | 505+550 | 502+800 | RCC Girder | 13x1.4 dia | 3x18 | 12.5+3+12.5 |
| 6 | 506+580 | 503+825 | RCC Girder | 13x1.4 dia | 3x18 | 12.5+3+12.5 |
| 7 | 541+045 | 541+075 | Box | 1x6.0 | 1x6.0 | 12.5+3+12.5 |
| 8 | - | 558+600 | Box | - | 1x10 | 12.5+3+12.5 |
| 9 | - | 562+340 | Box | - | 1x6 | 12.5+3+12.5 |
| 10 | - | 562+790 | Box | - | 1x6 | 12.5+3+12.5 |
| 11 | - | 563+950 | PSC Girder | - | 1x25 | 12.5+3+12.5 |
| 12 | - | 564+805 | Box | - | 1x6 | 12.5+3+12.5 |
| 13 | - | 566+550 | Box | - | 1x10 | 12.5+3+12.5 |
| 14 | 570+200 | 571+190 | Box | 1x10.5 | 1x10.5 | 12.5+3+12.5 |
| 15 | 570+830 | 571+780 | Box | 1x6.0 | 1x6.0 | 12.5+3+12.5 |
| 16 | - | 577+200 | PSC Girder | - | 1x25 | 12.5+3+12.5 |
| 17 | - | 578+320 | RCC Girder | - | 1x20 | 12.5+3+12.5 |

**B) Widening, Repairs and Rehabilitation of Existing Minor Bridges:**

| S. No. | Existing chainage | Design Chainage (Km) | structural Type | | Existing span arrangement (m) | Proposed span arrangement (m) | Widening width (m) |
|---|---|---|---|---|---|---|---|
| | | | Existing | Proposed | | | |
| 1 | 540+120 | 540+150 | Box | Box | 1x6.0 | 1x6.0 | 12.5 |
| 2 | 542+575 | 542+625 | Box | Box | 1x6.0 | 1x6.0 | 12.5 |
| 3 | 555+620 | 555+725 | slab | Slab | 5x8.5 | 5x8.5 | 12.5 |
| 4 | 571+560 | 572+500 | slab | Box | 1x10.5 | 1x10.5 | 12.5 |
| 5 | 584+800 | 584+125 | slab | Box | 1x10.0 | 1x10.0 | 12.5 |

*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 ar-rangement (m) | Total Width(m) | |
|---|---|---|---|---|---|---|---|
| | | | | | | LHS | RHS |
| -Nil- | | | | | | | |

## E.10 Project Facilities

The project facilities are summarized below:

***Table E.18: Project Facilities***

| S. No. | Design Chainage (Km) | Location | Side (LHS/RHS) |
|---|---|---|---|
| **Toll Plaza** | | | |
| 1 | 507.050 | Toll Plaza - 1 | |
| 2 | 583.700 | Toll Plaza - 2 | |
| **Truck Lay-bye** | | | |
| 1 | 498.300 | Truck Lay-bye | RHS |
| 2 | 498.450 | Truck Lay-bye | LHS |

| S. No. | Design Chainage (Km) | Location | Side (LHS/RHS) |
|---|---|---|---|
| 3 | 541.400 | Truck Lay-bye | LHS |
| 4 | 541.500 | Truck Lay-bye | RHS |
| 5 | 605.500 | Truck Lay-bye | LHS |

| S. No. | Bus bay(BB) or Bus shelter (BS) | Design Chainage (Km) | Name of Village | Side (LHS/RHS) |
|---|---|---|---|---|
| 1 | BS | 475.250 | Patradevi | LHS |
| 2 | BS | 475.550 | Patradevi | RHS |
| 3 | BS | 480.400 | Tamboxem | LHS |
| 4 | BS | 480.610 | Tamboxem | RHS |
| 5 | BS | 481.470 | Uguem | LHS |
| 6 | BS | 481.770 | Uguem | RHS |
| 7 | BS | 484.440 | Naibag Junction | LHS |
| 8 | BS | 485.500 | Naibag Junction | RHS |
| 9 | BS | 487.350 | Pernem Rural | LHS |
| 10 | BS | 487.670 | Pernem Rural | RHS |
| 11 | BS | 488.802 | Bhutwadi Junction | LHS |
| 12 | BS | 489.135 | Bhutwadi Junction | RHS |
| 13 | BS | 491.600 | Mopa Airport | LHS |
| 14 | BS | 492.000 | Mopa Airport | RHS |
| 15 | BS | 492.780 | Dhargalim | LHS |
| 16 | BS | 493.010 | Dhargalim | RHS |
| 17 | BS | 493.550 | Industrial Area | LHS |
| 18 | BS | 493.850 | Industrial Area | RHS |
| 19 | BS | 495.950 | Colvale | LHS |
| 20 | BS | 496.000 | Colvale | RHS |
| 21 | BS | 496.550 | Colvale | LHS |
| 22 | BS | 496.820 | Colvale | RHS |
| 23 | BS | 497.265 | GOAIDC | LHS |
| 24 | BS | 497.440 | GOAIDC | RHS |
| 25 | BS | 498.958 | Central Jail | LHS |
| 26 | BS | 499.288 | Central Jail | RHS |
| 27 | BS | 500.310 | Karaswada Junction | LHS |
| 28 | BS | 500.700 | Karaswada Junction | RHS |
| 29 | BS | 502.980 | Basthora | LHS |
| 30 | BS | 503.300 | Mapusa | RHS |
| 31 | BS | 505.250 | Mapusa | LHS |
| 32 | BS | 506.055 | Mapusa | RHS |
| 33 | BS | 507.980 | Porvorim | LHS |

| S. No. | Bus bay(BB) or Bus shelter (BS) | Design Chainage (Km) | Name of Village | Side (LHS/RHS) |
|---|---|---|---|---|
| 34 | BS | 511.350 | Porvorim | RHS |
| 35 | BS | 519.663 | Merces Junction | LHS |
| 36 | BS | 519.963 | Merces Junction | RHS |
| 37 | BS | 520.460 | Durgawadi | LHS |
| 38 | BS | 520.760 | Durgawadi | RHS |
| 39 | BS | 521.640 | Bambolim | LHS |
| 40 | BS | 521.900 | Bambolim | RHS |
| 41 | BS | 537.700 | Airport | LHS |
| 42 | BS | 538.240 | Airport | RHS |
| 43 | BS | 539.400 | Cansaulim | LHS |
| 44 | BS | 540.700 | Cansaulim | RHS |
| 45 | BS | 556.130 | Dramapur | LHS |
| 46 | BS | 556.430 | Dramapur | RHS |
| 47 | BS | 559.200 | Chinchinim | LHS |
| 48 | BS | 559.500 | Chinchinim | RHS |
| 49 | BS | 564.510 | Quepem | LHS |
| 50 | BS | 564.850 | Quepem | RHS |
| 51 | BS | 567.700 | Bali | LHS |
| 52 | BS | 567.900 | Bali | RHS |
| 53 | BS | 568.300 | Cuncolim | LHS |
| 54 | BS | 568.620 | Cuncolim | RHS |
| 55 | BS | 603.850 | Mashem | LHS |
| 56 | BS | 604.200 | Mashem | RHS |
| 57 | BS | 607.100 | Loliem | LHS |
| 58 | BS | 607.400 | Loliem | RHS |

## 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 | Pack-1 Km 475 to Km 541 | Pack-2 Km 541 to Km 611 | Total Amount |
|---|---|---|---|
| BILL NO: 1 - SITE CLEARANCE | 4 8,971,353 | 20,295, 461 | 69,266, 815 |
| BILL NO: 2 - EARTHWORKS | 1,21 2,362,550 | 1,185,341, 333 | 2,397,703, 883 |
| BILL NO: 3 - SUB-BASE AND BASE COURSES | 98 6,614,811 | 463,739, 089 | 1,450,353, 900 |
| BILL NO: 4A - BITUMINOUS WORKS FOR FLEXIBLE PAVEMENT | 43 5,619,770 | 162,802, 179 | 598,421, 949 |
| BILL NO: 4B - RIGID PAVEMENT | 3,14 1,263,899 | 3,020,582, 487 | 6,161,846, 387 |
| BILL NO: 5 - CULVERTS | 20 3,839,987 | 194,998, 348 | 398,838, 335 |
| BILL NO: 6 (A) - BRIDGES | 8,28 9,488,753 | 425,817, 511 | 8,715,306, 264 |
| BILL NO: 6 (B) - REPAIR AND RE-HABILITATION OF EXISTING BRIDGES | 7,685,381 | 7,685 ,381 | 15,370, 761 |
| BILL NO: 7 - DRAINAGE AND PROTECTION WORKS | 3,32 8,229,226 | 2,864,147, 269 | 6,192,376, 496 |
| BILL NO: 8 – JUNCTIONS | 10 5,162,761 | 96,056, 058 | 201,218, 819 |
| BILL NO: 9 - TRAFFIC SIGNS, MARKINGS AND APPURTENANCES | 34 7,923,034 | 147,341, 698 | 495,264, 732 |
| BILL NO: 10 – MISCELLANEOUS | 30 1,577,108 | 153,960, 548 | 455,537, 656 |
| BILL NO: 11– MAINTENANCE DURING CONSTRUCTION | 4 1,435,237 | 34,309, 227 | 75,744, 464 |
| BILL NO: 12 | 1,88 6,000,000 | 3,542,000, 000 | 5,428,000, 000 |
| Extra 5% for detail design during Final Feasibility | 40 6,723,477 | 246,381, 532 | 653,105, 009 |
| Total Construction Cost | 20,742 ,897,349 | 12,565,458,1 21 | 33,308,355,4 70 |

## 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***

| Toll Plaza(TP) | Existing Chainages (km) | | | Bypass Length (km) | Structures Length (km) |
|---|---|---|---|---|---|
| | From | To | Length | | |
| TP-1 at Km 509.500 near Ex. TP (Guirim, North Goa) | 475.040 | 541.000 | 66.00 | - | 5.98 |
| TP-2 at Km 584.5 near Chapoli Dam (South Goa) | 541.000 | 611.000 | 70.00 | 11+8+9 =28 Margaon, Cuncolim & Canacona | 0.125 |

### 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 Plazas | Tollable Traffic | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cars | M. Bus | Bus | LCV | 2 AT | 3 AT | M AT | M. LCV | Total |
| TP-1 @ Km 509.5 | 5426 | 80 | 395 | 787 | **1091** | **1047** | **526** | 466 | 9818 |
| TP-2 @ Km 584.5 | 5616 | 146 | 683 | 486 | **426** | **571** | **465** | 621 | 9014 |

### E.12.5 Toll Revenue

A summary of Toll revenues has been presented below.

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

| Years | | TP-1 at Km 509.500 | | TP-2 at Km 584.500 | |
|---|---|---|---|---|---|
| From | To | Rs Crores/ Year | Rs Lakhs / Day | Rs Crores/ Year | Rs Lakhs / Day |
| 2015 | 2016 | 83.32 | 22.83 | 42.25 | 11.58 |
| 2016 | 2017 | 93.53 | 25.62 | 47.96 | 13.14 |
| 2017 | 2018 | 105.29 | 28.85 | 54.10 | 14.82 |
| 2018 | 2019 | 117.58 | 32.21 | 60.08 | 16.46 |
| **2019** | **2020** | **131.23** | **35.95** | **67.81** | **18.58** |
| 2020 | 2021 | 147.56 | 40.43 | 76.34 | 20.92 |
| 2021 | 2022 | 165.90 | 45.45 | 86.03 | 23.57 |
| 2022 | 2023 | 185.00 | 50.68 | 96.87 | 26.54 |
| 2023 | 2024 | 207.73 | 56.91 | 108.98 | 29.86 |
| 2024 | 2025 | 232.91 | 63.81 | 124.14 | 34.01 |

| Years | | TP-1 at Km 509.500 | | TP-2 at Km 584.500 | |
|---|---|---|---|---|---|
| From | To | Rs Crores/ Year | Rs Lakhs / Day | Rs Crores/ Year | Rs Lakhs / Day |
| 2025 | 2026 | 261.29 | 71.59 | 139.45 | 38.20 |
| 2026 | 2027 | 292.81 | 80.22 | 156.21 | 42.80 |
| 2027 | 2028 | 327.96 | 89.85 | 175.27 | 48.02 |
| 2028 | 2029 | 366.49 | 100.41 | 198.82 | 54.47 |
| 2029 | 2030 | 412.17 | 112.92 | 222.16 | 60.86 |
| 2030 | 2031 | 460.59 | 126.19 | 251.29 | 68.85 |
| 2031 | 2032 | 517.38 | 141.75 | 283.89 | 77.78 |
| 2032 | 2033 | 580.76 | 159.11 | 320.07 | 87.69 |
| 2033 | 2034 | 650.75 | 178.29 | 356.16 | 97.58 |
| 2034 | 2035 | 728.44 | 199.57 | 400.36 | 109.69 |
| 2035 | 2036 | 818.99 | 224.38 | 454.49 | 124.52 |
| 2036 | 2037 | 915.19 | 250.74 | 509.99 | 139.72 |
| 2037 | 2038 | 1027.53 | 281.52 | 571.22 | 156.50 |
| 2038 | 2039 | 1152.76 | 315.82 | 646.16 | 177.03 |
| 2039 | 2040 | 1292.93 | 354.23 | 723.22 | 198.14 |
| 2040 | 2041 | 1455.41 | 398.74 | 815.24 | 223.35 |
| 2041 | 2042 | 1635.93 | 448.20 | 919.13 | 251.82 |
| 2042 | 2043 | 1838.60 | 503.73 | 1034.14 | 283.33 |
| 2043 | 2044 | 2064.13 | 565.51 | 1172.00 | 321.10 |
| 2044 | 2045 | 2325.68 | 637.17 | 1317.24 | 360.89 |
| 2045 | 2046 | 2615.73 | 716.64 | 1488.30 | 407.75 |

### 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 | Costing Length in km | Stretches excluded in project cost | Civil Cost (Crores) |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Package-1 | From Km 475.040 to Km 541.000 | 46.96 | Mandovi Bridge (3km)<br>Zuari Bridge (13km) | 2075 |
| Package-2 | From Km 541.000 to Km 611.000 | 39.53 | Margaon Bypass (10km)<br>Canacona Bypass 17km) | 1257 |

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 | TP-1 | TP-2 |
|---|---|---|
| Total Civil Construction cost in 2017 year | 2178.75 | 1319.85 |
| Contingencies/OC @ 1.0% of TPC | 21.79 | 13.20 |
| Total EPC Cost | 2200.54 | 1333.05 |
| IC & Pre-operative expenses @1% of EPC | 22.01 | 13.33 |
| Financing Cost @ 1.0 % on Debt | 11.50 | 7.0 |
| Escalation @ 5% Per Anum | 248.49 | 150.53 |
| Interest During Construction | 181.89 | 110.16 |
| **TOTAL PROJECT COST in crores** | **2664** | **1614** |

## 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) – 20 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 on BOT Toll Basis

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 20 years has been examined and tabulated below.

***Table E.26: Financial Analysis Results***

| Toll Plaza | Tolling Lengths (km) | | | Grant (%) | Concession Period | Project FIRR (%) | Equity FIRR (%) |
|---|---|---|---|---|---|---|---|
| | From | To | Length | | | | |
| TP-1 @ Km 509.5 | 475.040 | 541.000 | 66.00 | 40% | 20Y | 11.55% | 13.20% |
| TP-2 @ Km 584.5 | 541.000 | 611.000 | 70.00 | 40% | 20Y | 5.37% | 11.04% |

The Equity IRR under BOT-Toll model comes lower than the minimum requirement of 15%, hence the Project is not viable under BOT-Toll model.

### E.12.10 Financial Viability on Hybrid Annuity Mode

**1. Bid Project Cost**

The Parties expressly agree that the cost of construction of the Project, as on the Bid Date, which is due and payable by the Authority to the Concessionaire, shall be deemed to be the " Bid Project Cost". The Parties further agree that the Bid Project Cost for payment to the Concessionaire shall be inclusive of the cost of construction, interest during construction, working capital, physical contingencies and all other costs, expenses and charges for and in respect of construction of the Project, save and except any additional costs arising on account of variation in Price Index, Change of Scope, Change in Law, Force Majeure, which costs shall be due and payable to the

Concessionaire in accordance with the provisions of the Agreement.

**2 Adjusted Bid Project Cost**

2.1 The Bid Project Cost specified above shall be revised from time to time in accordance with the variation in Price Index occurring after the Reference Index Date immediately preceding the Bid Date.

2.2 The Bid Project Cost adjusted for variation between the Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date immediately preceding the Appointed Date shall be deemed to be the Bid Project Cost at commencement of construction.

2.3 For every month occurring after the Appointed Date, the Authority shall compute the variation in Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date preceding the date of Invoice, and shall express the latter as a multiple of the former (the "Price Index Multiple"). All Invoices to be submitted by the Concessionaire to the Authority for and in respect of the Construction Period shall be the product of the relevant proportion of the Bid Project Cost and the Price Index Multiple applicable on the date of Invoice.

**3 Payment of Bid Project Cost**

3.1 [40% (forty per cent)] of the Bid Project Cost, adjusted for the Price Index Multiple, shall be due and payable to the Concessionaire in 5 (five) equal installments of [8% (eight per cent)].

3.2 The remaining Bid Project Cost, adjusted for the Price Index Multiple, shall be due and payable in [30 (thirty)] biannual installments commencing from the 180th (one hundred and eightieth) day of COD.

**4 Payment during Construction Period**

Upon receiving a report from the Independent Engineer certifying the achievement of the below mentioned Payment Milestones, the Authority shall disburse, within 15 (fifteen) days of the receipt of each such report, an installment equal to 8% (eight per cent) of the Bid Project Cost, adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of that report.

The Payment Milestone for release of payment during Construction Period shall be as under:

a) I (first) Payment Milestone – On achievement of 20% Physical Progress
b) II (second) Payment Milestone – On achievement of 40% Physical Progress
c) III (third) Payment Milestone – On achievement of 60% Physical Progress

d) IV (fourth) Payment Milestone – On achievement of 75% Physical Progress

e) V (fifth) Payment Milestone – On achievement of 90% Physical Progress

Provided that in case of Change of Scope, the Physical Progress shall be recalculated to account for the changed scope.

**5 Annuity Payments during Operation Period**

The (the "Completion Cost" shall be the summation of A, B, C, D, E, and F below:

A. 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 20% Physical Progress.

B. Another 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 40% Physical Progress.

C. Another 20% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 60% Physical Progress.

D. Another 15% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 75% Physical Progress.

E. Another 15% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of report confirming 90% Physical Progress.

F. Another 10% of the Bid Project Cost adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the COD.

The Parties acknowledge and agree that the Authority has paid a portion of the Completion Cost as payments during Construction Period. The balance Completion Cost remaining shall be due and payable during the Operation Period.

The Completion Cost remaining to be paid in pursuance of the provisions of above shall be due and payable in biannual installments over a period of [15 (fifteen)] years commencing from COD, (the "Annuity Payments"). The 1st (first) installment of Annuity Payments shall be due and payable within 15 (fifteen) days of the 180th(one hundred and eightieth) day of COD and the remaining installments shall be due and payable within 15 (fifteen) days of completion of each of the successive six months ("the Annuity Payment Date"). Each of the Annuity Payments due and payable during the years following the COD shall be as under:

| Annuity following the COD | Percentage of Completion Cost remaining to be paid on COD |
|---|---|
| 1st Annuity | 2.10% |
| 2nd Annuity | 2.17% |
| 3rd Annuity | 2.24% |
| 4th Annuity | 2.31% |
| 5th Annuity | 2.38% |
| 6th Annuity | 2.45% |
| 7th Annuity | 2.52% |
| 8th Annuity | 2.60% |
| 9th Annuity | 2.68% |
| 10th Annuity | 2.76% |
| 11th Annuity | 2.84% |
| 12th Annuity | 2.93% |
| 13th Annuity | 3.02% |
| 14th Annuity | 3.11% |
| 15th Annuity | 3.20% |
| 16thAnnuity | 3.30% |
| 17th Annuity | 3.40% |
| 18th Annuity | 3.50% |
| 19th Annuity | 3.61% |
| 20th Annuity | 3.72% |
| 21st Annuity | 3.83% |
| 22nd Annuity | 3.94% |
| 23rd Annuity | 4.06% |
| 24th Annuity | 4.18% |
| 25th Annuity | 4.25% |
| 26thAnnuity | 4.25% |
| 27th Annuity | 4.44% |
| 28th Annuity | 4.71% |
| 29th Annuity | 4.75% |
| 30th Annuity | 4.75% |

Each of the biannual installments payable hereunder shall be paid along with interest. Interest shall be due and payable on the reducing balance of Completion Cost at an interest rate equal to the applicable Bank Rate [plus 3% (three per cent)]. Such interest shall be due and payable biannually along with each installment.

**6.0 O&M Payments**

All O&M Expenses shall be borne by the Concessionaire and in lieu thereof; a lump sum financial support in the form of biannual payments shall be due and payable by the Authority, which shall be computed on the amount quoted by the selected bidder under its O&M Bid. The Parties further acknowledge and agree that any O&M

Expenses in excess of the O&M Payments shall be borne solely by the Concessionaire, save and except as expressly provided.

The O&M Payments due and payable to the Concessionaire shall be paid in 2 (two) equal biannual installments and disbursed by the Authority together with the corresponding installments of Annuity Payments.

Each installment of O&M Payment shall be the product of the amount determined in accordance with the Price Index Multiple on the Reference Index Date preceding the due date of payment thereof.

***Table E.27: Financial Analysis Results on Hybrid Annuity Mode (HAM)***

| Toll Plaza | Tolling Lengths (km) | | | Const. Support (%) | Concession Period | Bid Parameters | |
|---|---|---|---|---|---|---|---|
| | From | To | Length | | | Bid Project Cost | First Year O&M |
| TP-1 @ Km 509.5 | 475.0 | 541.0 | 66.00 | 13.20% | 15Y | 2800 | 13.58 |
| TP-2 @ Km 584.5 | 541.0 | 611.0 | 70.00 | 11.04% | 15Y | 1700 | 12.35 |

### E.12.11 Conclusion

A minimum return on equity of around 15% could be considered satisfying the requirement of prospective concessionaire. In view of this, it can be concluded that both the Toll Plazas @ Km 509.500 and @ Km 584.500 are financially not viable with a maximum grant of 40% and a general concession period of 20 year.

**Hence, it is proposed to let out this project for development under EPC Mode or Hybrid Annuity Mode.**