Ministry of Road Transport and Highways
**(GOVERNMENT OF INDIA)**

**NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.**


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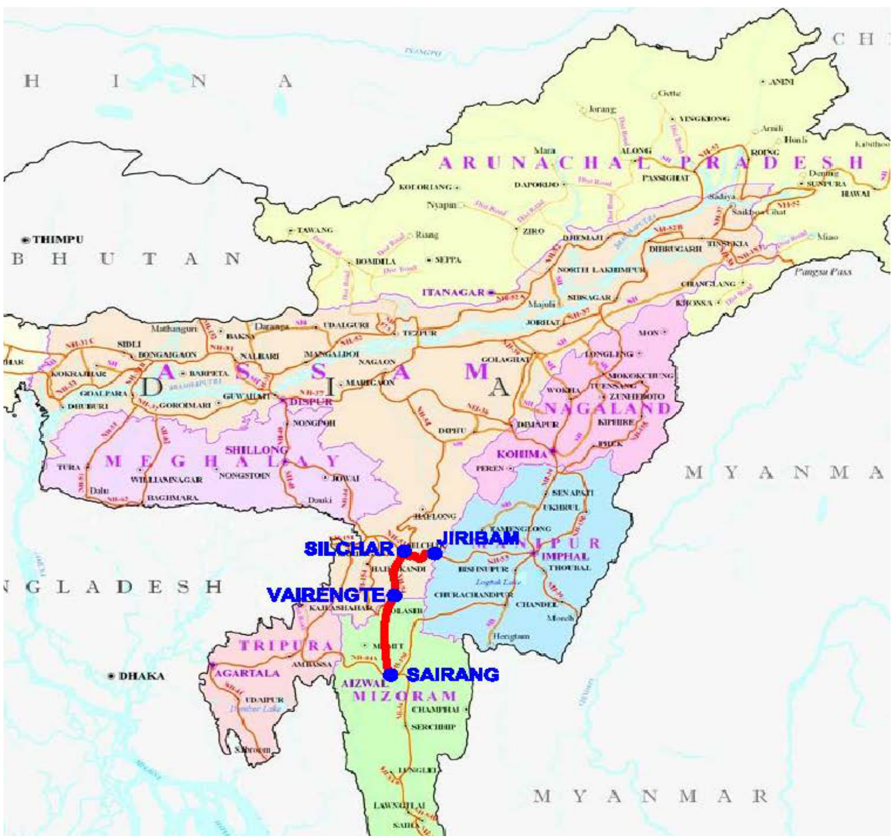
# Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).




## Final Detailed Project Report - R1 (Silchar-Jiribam)
## Package: SJ-1 (From D. Km 4+560 to D. Km 24+560)
### Volume-I (MAIN REPORT)

**August 2023**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**Section: Silchar to Jiribam (Package: SJ-1, D. Km 4+560 to D. Km 24+560)**

# FINAL DETAILED PROJECT REPORT - R1

| | | |
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# Vol-I

## Main Report

**Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte(49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km))**

**Section: Silchar to Jiribam (Package: SJ-1, D. Km 4+560 to D. Km 24+560)**

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# Chapter 0 - Executive Summary

**Section: Silchar to Jiribam, Package: SJ-1 (From D. Km 4+560 to D. Km 24+560)**

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# 0 Chapter 0 - Executive Summary

## 0.1 The Consultancy Services

The Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte(49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)) for a total length of 215.9 km was awarded to M/s. Transys Consulting Pvt. Ltd., by the National Highways Infrastructure Development Coorporation Ltd.

The Letter of Acceptance was issued on 22nd March 2018 vide letter ref no NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package-III/2017/66 and the letter regarding commencement of services was issued on 02nd July 2018 vide letter ref no. NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package-III/2017/107. The contract agreement was signed on 19.06.2018.

## 0.2 Project Background and Objectives

Recognising the need for improvement of capacity of road network in tune with intensity of traffic, the Ministry of Road Transport and Highways (MoRT&H) acting through the National Highways Infrastructure Development Corporation Ltd. (NHIDCL) has decided to take up the development of various National Highways stretches/Corridors of 10,000 kms out of 50,000 kms under proposed Bharatmala Pariyojna.

The project roads under Lot-1/ Package-3 comprise of following three stretches which are part of four Economic Corridors.

1) Silchar to Vairengte (Part of Silchar-Aizawl Economic Corridor NER) in the state of Assam and Mizoram.
2) Vairengte to Sairang (Part of Silchar-Aizawl Economic Corridor NER) in the state of Mizoram.
3) Silchar to Jiribam (Part of Silchar-Imphal Economic Corridor NER) in the state of Assam and Manipur.

The main objectives of the Consultancy Services are to establish the technical, economical, and financial viability of the project and prepare detailed project reports for development of economic corridors, Inter-corridors and feeder routes, as the case may be. These corridors are proposed for development to at least 4-lane access controlled (fully access control for Economic Corridors), however, DPR for access controlled 6-laning/8-laning may be required, in certain stretches, depending upon traffic.

## 0.3 Project Road (Silchar to Jiribam)

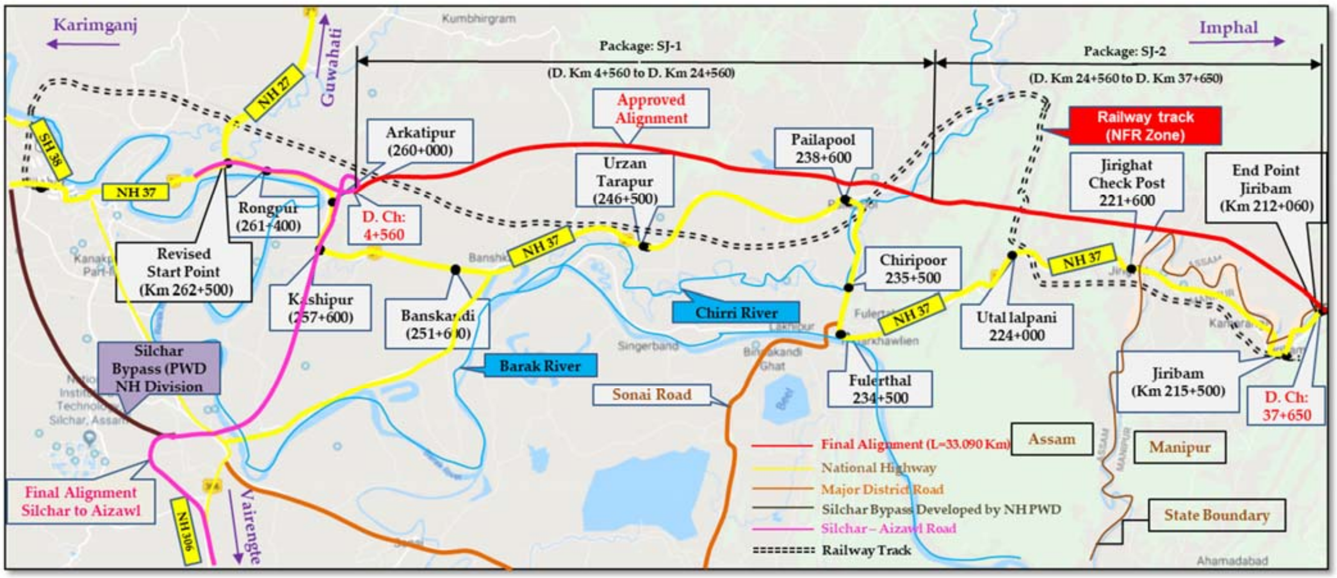


**Fig 0.1 Section (Silchar - Jiribam)**

a) As per the CA the project road from Silchar to Jiribam starts at Km 268+500 junction of NH-37 & SH-38 (kalian Jn.) in Silchar and end at Km 213+500 Jiribam in the state of Manipur. The project road is part of NH-37 (old NH-53) (Sutarakandi-Bhali NH road), connecting Sutarakandi, silchar and Jirighat) having a total length of 55.00km from Silchar to Jiribam.

b) After reconnaissance survey and further discussion held with NHICL, the DPR consultant has revised the start point of the project road for Silchar to Jiribam section from existing km 268+500 to km 263+500 near junction of NH-37 & NH-27 (towards Guwhathi) at Rongpur village due to already 4-lane developed under NH-PWD.

Further, new 4-lane development between km 263+500 and km 260+000 stretch has been included under Package-1 in Silchar-Vairengte DPR section of Silchar-Vairengte-Sairang-Aizawl Economic Corridor due to prioritising of NHs development specially section of Guwahati-Silchar-Aizawal and Shilong/Dawki/Karimganj to Silchar.

Hence, start point of Silchar – Jiribam has been fixed at Km 260+000 of NH-37 and End point at Km 212+060. Accordingly, the total existing length of the project road comes to 47.940Km.

**Therefore, Start Chainage shall be read with existing Km 260+000 (D. Ch. 4+560) and End with exiting km 212+060 (D. Ch. 37+650). Total Design length of the proposed 4-lane road turn into 33.09km.**

However, after successful submission of Draft DPR vide through letter Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40386, it was conveyed by NHIDCL that pkg. pertaining to Silchar – Jiribam (SJ) section shall be on hold as the project stretch has not been included in the priority list due to uncertainty of 4-lane development of said stretch.

However, in the month of May 2023 the said project has been reopened under the direction of MD & D(T) during VC meeting and DPR had been asked to accelerate the remaining pending assignment pertaining to said project as the project stretch was included under current year development plan.

Final DPR was submitted vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2022-23/404037 dated but collectively decision was taken to bifurcate the project corridor in to two (02) packages due to tunnel proposal & its cost constraints and several other limitations.

Hence, project corridor is as below.

1. Package: SJ-1 (Existing km 260+000=D. Ch. 4+560 at Silchar/ Nutan Dayapur to existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam State).
2. Package: SJ-2 (Existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam state to Existing km 212+060=D. Ch 37+650 at Jiribam in Manipur State).

Major built up areas along existing are Rongpur Pt 1, Rongpur Pt2, Kashipur, Lakhipur, Banskhandi, Pailapool, Fulerthal and Jiribam. The condition of existing pavement varies from good to fair. The detailed discussion about the project road is given in Chapter 2: Project Description.

## 0.4 Terrain

Terrain is classified by the general slope of the country across the highway alignment as per IRC: 73 and with these criteria the project Highway Road passes through mostly rolling and mountainous terrain.

The proposed green filed alignment falling 61 % under rolling terrain and 39% under mountainous / hill terrain. The details of the same is given below.

**Table 0.1 Summary of Terrain along Project Road**

| Sl. No. | Proposed Chainage | | Length (m) | Terrain |
|---|---|---|---|---|
| | From | To | | |
| 1 | 4+560 | 7+400 | 2840 | Rolling |
| 2 | 7+400 | 17+400 | 10000 | Mountainous |
| 3 | 17+400 | 18+600 | 1200 | Rolling |

| Sl. No. | Proposed Chainage | | Length (m) | Terrain |
|---|---|---|---|---|
| | From | To | | |
| 4 | 18+600 | 21+100 | 2500 | Mountainous |
| 5 | 21+100 | 23+150 | 2050 | Rolling |
| 6 | 23+150 | 23+550 | 400 | Mountainous |
| 7 | 23+550 | 37+650 | 14100 | Rolling |
| | | **Total Length (Km)** | **33.090** | |

## 0.5 Land use pattern

Project existing road passes through mainly plain and hilly terrain at certain location. The alignment mostly passes through agricultural area, semi built-up, built-up areas and few stretches lying on hill cum forest area. The land use pattern along the existing project road is as tabulated below;

**Table 0.2 Summary of Land use along Project Road**

| Sl. No. | Land use Description | Existing Length (m) | % of Length |
|---|---|---|---|
| 1 | Built up Area | 29.650 | 64.00 |
| 2 | Semi Built up Area | 7.500 | 15.00 |
| 3 | Agricultural Land | 3.350 | 7.00 |
| 5 | Hill Cum Forest Area | 4.500 | 9.00 |
| 6 | Hilly Area | 2.940 | 5.00 |

Detailed land use pattern is presented in Chapter 2: Project Description.

## 0.6 Road Geometry and Configuration

In order to arrive at a feasible option, alternatives were decided based on both horizontal design and additional LA. Environmental, social perspective and safety parameters have also been considered while proposing the alignment. As far as geometric improvement is concerned, it includes the curve improvements, realignment at villages where ribbon development with substandard curves and inadequate land availability and bypass proposal in case of town advancement and based on future traffic demand.

Existing road is passing through congested built-up areas at some locations. The existing project has also significantly encountered with number of substandard/acute horizontal curves hence, bypass options were studied. The proposed bypasses were critically examined / studied for individual built-up vs option of Green-field single alignment for entire stretch.

**Study were classified in to 02 options as below,**

**Option A**: Improvement of existing road with individual bypass options at Major built up

**Option B**: Green filed alignment.

The detail of the same is given below. The most economical with minimum disturbance has been considered, which details of these improvements are given in subsequent sections and summary is presented below.

**Table 0.3 List of Bypass Proposals.**

| Sl. No | Location | Exist. Chainage (Km) | | Exist. Length (Km) | Prop. Chainage (Km) | | Prop Length (Km) |
|---|---|---|---|---|---|---|---|
| | | Start | End | | Start | End | |
| **A.** | **Improvement of existing road with bypass options at Major Built up** | | | | | | |
| 1 | Kashipur Bypass (under Pkg-1) | 259+600 | 254+600 | 5.000 | These bypasses sections studied but ultimately merged / added with Approved green field alignment. | | 3.500 |
| 2 | Banskhandi Bypass (under Pkg-1) | 254+135 | 249+500 | 4.240 | | | 4.100 |
| 4 | Ujan Tarapur, Pailapool, Fulerthal Bypass (under Pkg-1) | 246+000 | 231+800 | 14.000 | | | 8.300 |
| 5 | Jiribam Bypass (under Pkg-2) | 225+000 | 215+750 | 9.250 | | | 8.100 |
| | | **Total Length (m)** | | **32.490** | | | **24.000** |
| **B** | **Green Field Alignment** | | | | | | |
| 1 | Green Field Alignment (under Pkg-1) | 260+000 | 233+000 | 27.000 | 4+560 | 24+560 | 20.000 |
| | Green Field Alignment (under Pkg-2) | 233+000 | 212+060 | 20.940 | 24+560 | 37+650 | 13.090 |
| | | **Total Length (m)** | | **47.940** | | | **33.090** |
| | **Total Approval Length (m) along bypasses / Green Field Alignment** | | | **47940** | | | **33.090** |

** The detailed discussion of the Green Field Alignment is given below, which is approved alignment however, the details of the other bypasses options are given in chapter-7.*

**Green Field Alignment**

From Km 262+500 to Km 212+060 the existing road passes through many built-up locations such as Kashipur, Banskandi, Ujain Tarapur, Pailapool, Fulertal and Jiribam. As discussed above options have been studied for improving the existing road along with the bypasses at built up locations. In this segment effort has been made to study the green filed alignment, which passes through green filed/agriculture land. The alignment of green filed vs. improving of existing alignment with bypass options are shown below.

The Green field alignment takes-off on LHS from Km 260+000 of NH-37 and passes through agricultural filed and Tea plantation at few locations and terminates / joins at NH-37 near Jiribam at km 212+060. The approximate length along green filed alignment comes to is 33.090 Kms as compared to existing road length of 47.700 Kms causing drastic reduction in length however, 01 tunnel (aapx.800m) being proposed to avoid extensive route via permissible contour gradient. The chosen green alignment also mitigates the effects on residential and commercial buildings. However, the proposed green filed alignment crosses existing railway line at Km 5+190, Km 22+535 and Km 26+385 that need to propose ROBs at these locations. In this option a green filed alignment is proposed to be bypassing all above built up areas through single alignment navigating through open / green field and fulfils all the requirement of developing 4-lane economic corridor.

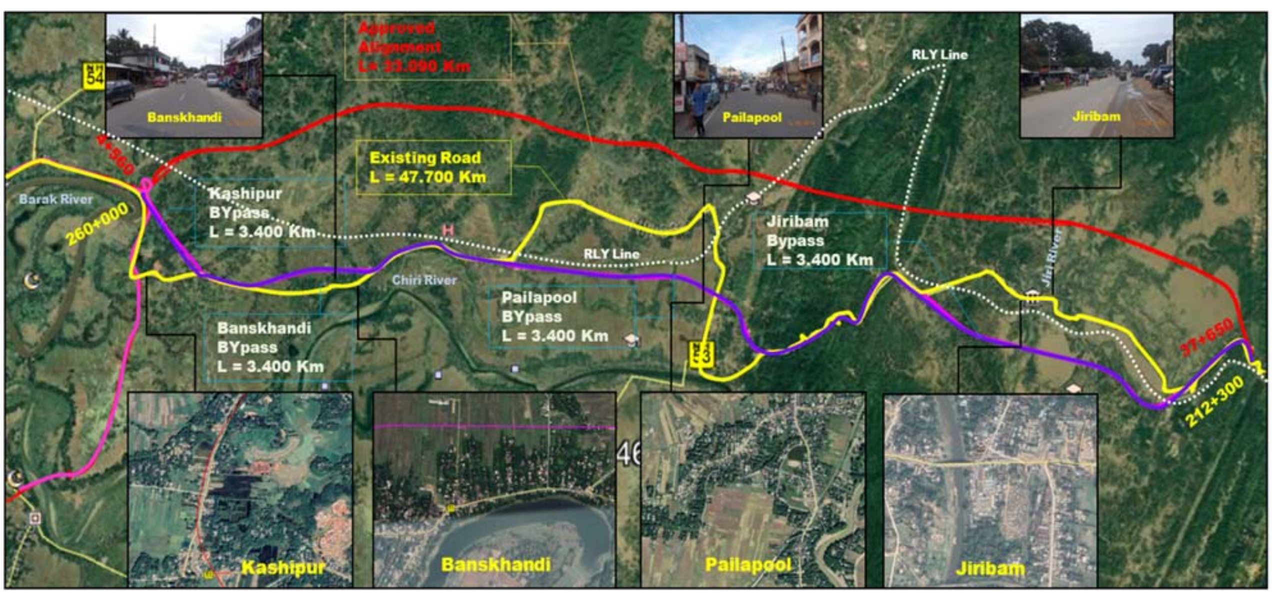


**Fig 0.2 Approved Green Field Alignment**

Eventually, all the above options were discussed during the presentation furnished on 15th January 2019 and 14th August 2019 at NHIDCL HQ, Delhi and green filed alignment (Option-V) were agreed by all the delegates during the presentation followed by letter no NHIDCL/Bharatmla/V-S/ DPR/ Mizoram/2019-20//353 on 23rd October 2019.

However, after superimposing the DPR alignment on "SOI TOPO map" issued by Survey of India (SOI), it has been found that the following chainage.

1) D.Ch. 31+500 to D.Ch. 36+700 = 5.20km

The above sections have been proposed for forest clearance in consultation with DFO and DC-Cachar during stakeholders meeting. However, this section falls under Package: SJ-2.

## 0.7 Pavement Condition and composition of the Project Corridor

The existing pavement type is flexible from Km 260+000 to Km 212+060. The pavement varies from Fair to Good. It is also observed that the road has developed cracks, potholes edge drop etc. for most of stretches. The width of earthen shoulder towards valley side varies from 0.5m to 1.0m.The shoulders, in majority of length, are earthen with fair condition. The side drainage is earthen and lined drains are observed along some habitations.

The soil type along the alignment is generally silty clay. The project road runs mainly in plain/rolling terrain and hilly terrain at some locations.

**Table 0.4 Pavement Condition**

| Sl. No. | Pavement Condition | Potholes (%) | Cracking (%) | Patching (%) | Ravelling (%) | Rut (mm) |
|---|---|---|---|---|---|---|
| 1 | Excellent | Nil | ≤5 | Nil | ≤1.0 | ≤5 |
| 2 | Good | ≤5 | > 5 ≤ 10 | ≤ 0.5 | >1.0 ≤ 2.0 | > 5 ≤10 |
| 3 | Fair | >5 <10 | > 10 ≤ 20 | > 0.5 ≤ 2.0 | 2.0 ≤ 5.0 | > 10 ≤ 20 |
| 4 | Poor | >10 <50 | >20 ≤ 30 | >2 ≤ 6.0 | >5.0 ≤10.0 | >20 |
| 5 | Very poor | >50 | >30 | >6.0 | >10.0 | - |

Total thickness of the existing pavement thickness is varying between 370 mm to 540 mm. The thickness of bituminous layer is varying between 80-140 mm. The detailed discussion is done in Chapter 2: Project Description.

## 0.8 Bridges and Structures

There are total 05 nos. of existing bridges out of which 01 is major bridge, whereas the other 04 nos. are minor bridges along the existing road.

The Major Bridge cross Chiri River near Pailapool at km 236+200, having a span arrangement of 1x63m having a deck width of 11.0m a total length of 63m. Super structure consists of RCC Box girder.

Out of 4 Nos. of Minor Bridges, 1 No RCC Slab Type, 1 No Box type, 1 Nos Box girder type and 1 No. is RCC-I girder type. All the existing major structures are abandoned as the proposed alignment is passing through new green field alignment.

## 0.9 Culverts

The inventory data for the existing cross drainage structures, culverts and bridges, are given with details in Chapter 3: Analysis & Interpretation of Engineering Surveys and Investigations.

**Table 0.5 Summary of Culverts / Bridges / ROB/RUB/VUP/LC**

| Culverts | | | | Bridges | | | Causeway | ROB | RUB | LC |
|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Slab/Arch | Box | Total | Minor | Major | Total | | | | |
| 09 | 03 | 05 | 17 | 04 | 01 | 05 | - | 01 | - | 01 |

There are total 17 nos. of existing culverts along the project corridor, out of which 05nos are Box, 03nos are RCC Slab and 09nos are Pipe culverts. All the culverts are abandoned as the proposed alignment is passing through green filed.

## 0.10 Road Junctions and Intersections

There are 03 nos. existing major road junctions with NH / SH / MDR and 108 no's minor junctions with village/city roads along the existing road. All the junctions are abandoned as the proposed alignment is passing through green filed.

## 0.11 Railway Level Crossings and ROBs

There are 1 no. ROB at Km 245+600 and Level crossing at Km 238+400 along the existing road.

## 0.12 Underpass and Overpass

There are no Underpass and Overpass along existing road in this package.

## 0.13 Right-of-way

As per the records available with PWD NH division, the ROW in town/ built-up areas is presented in Table 2.6 of Chapter - 2.

## 0.14 Traffic Studies

There is mixed traffic plying on the Project Highway comprising of trucks, buses, cars, two wheelers, non-motorised vehicles, etc. 2 homogeneous sections tabulated below have been considered to know the traffic flow conditions as shown in the traffic report. The detailed survey location and traffic analysis is given in Chapter 4: Traffic studies and Demand forecast.

**Table 0.6 Details of Homogeneous Sections**

| Section | Homogenous Section | Chainage | | Length (Km) |
|---|---|---|---|---|
| | | From (Km) | To (Km) | |
| Section - 1 | Silchar (Rongpur) to Pailapool | 263+500 | 240+000 | 23.500 |
| Section – 2 | Pailapool to Jiribam | 240+000 | 212+060 | 27.940 |

The above homogeneous section is considered based on traffic pattern and type of state highways the project road is traversing.

In order to generate the essential inputs, various traffic surveys were organized on the project road. The surveys carried out with their location and period are:

Classified Volume Count (7 days) – 2 Locations

Classified Volume Count (3 days) – 1 Location

O-D Survey (1day) - 2 Locations

Intersection Volume Count (16 hrs) - 1 Locations

Axle Load Survey (2 day) - 2 Locations

* *As per ToR, Classified Volume Count survey shall be conducted for 7 continuous days at minimum 3 locations. However, we have carried out 7 days CVC at 5 locations for the project sections ie Silchar-Vairengte, Vairengte-Sairnage and Silchar-Jiribam. However, the traffic survey that is conducted for Silchar to Jiribam section is represented above.*

**Traffic Volume and Composition**

The Annual Average Daily Traffic at different survey locations are presented below:

**Table 0.7 Details of AADT for different sections (Base year 2020)**

| Section | Homogenous Section | AADT (No's) | AADT (PCUs) |
|---|---|---|---|
| Section – 1 | Silchar (Rongpur) to Pailapool | 11196 | 10985 |
| Section – 2 | Pailapool to Jiribam | 6888 | 7493 |
| - | Along Proposed Green Filed | 5144 | 6259 |

**AADT (PCU) shown above is combined traffic (Trough and local traffic) however, details discussion on same shall be referred in chapter 4 Traffic analysis and Demand forecast**

**Growth Rates**

Using the growth rates relevant to (i) passenger vehicles and (ii) freight vehicles are calculated separately. The formulae and methods for passenger vehicles and freight vehicles are illustrated below:

**Passenger Vehicles**

The growth rates of population, per capita income and elasticity of transport demand in relation to the income have been used to estimate the growth rates, as suggested in the World Bank guidelines using the following formula: -

Passenger Vehicles : Tgr = ((1+Pgr)*(1+PCI gr)-1)*100*E

Where,
Tgr = Traffic Growth Rate
Pgr = Population Growth Rate
PCI gr = Per Capita Income Growth Rate
E = Elasticity value

**Freight Vehicles**

The forecast growth rates for trucks have been made by calculating the average growth rates of the core sectors of economy, viz., Agriculture, Industrial and mining sectors and by multiplying the projected growth rates of these sectors of the following elasticity factors for the different periods:

Freight Vehicles : Tgr = ½ (Agr + NSDPgr) x E x 100

Where,

Agr = Growth rate of agricultural sector

NSDPgr = Growth rates of industrial & mining sectors

The growth rates for different vehicle categories have been estimated as per the methodology outlined above and the adopted growth rate figures are presented in the following table.

**Table 0.8 Proposed Traffic Growth rates for Silchar to Jiribam section**

| Vehicle Type | Upto 2025 | 2026-30 | 2031-35 | 2036-40 | Beyond 2040 |
|---|---|---|---|---|---|
| **Most Likely Scenario** | | | | | |
| Car/Van/Jeep | 5.00% | 9.70% | 8.50% | 5.00% | 5.00% |
| Bus/Minibus | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| LCV | 5.00% | 12.40% | 10.85% | 5.00% | 5.00% |
| 2A Trucks | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| 3A Trucks | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |
| MAV | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |

| Vehicle Type | Upto 2025 | 2026-30 | 2031-35 | 2036-40 | Beyond 2040 |
|---|---|---|---|---|---|
| **Optimistic Scenario** | | | | | |
| Car/Van/Jeep | 6.00% | 10.70% | 9.50% | 6.00% | 6.00% |
| Bus/Mini Bus | 6.00% | 6.00% | 6.00% | 6.00% | 6.00% |
| LCV | 6.00% | 13.40% | 11.85% | 6.00% | 6.00% |
| 2A Trucks | 6.00% | 6.00% | 6.00% | 6.00% | 6.00% |
| 3A Trucks | 6.00% | 8.00% | 7.50% | 7.00% | 6.00% |
| MAV | 6.00% | 8.00% | 7.50% | 7.00% | 6.00% |
| | | | | | |
| **Pessimistic Scenario** | | | | | |
| Car/Van/Jeep | 4.00% | 8.70% | 7.50% | 4.00% | 4.00% |
| Bus/Mini Bus | 4.00% | 4.00% | 4.00% | 4.00% | 4.00% |
| LCV | 4.00% | 11.40% | 9.85% | 4.00% | 4.00% |
| 2A Trucks | 4.00% | 4.00% | 4.00% | 4.00% | 4.00% |
| 3A Trucks | 4.00% | 6.00% | 5.50% | 5.00% | 4.00% |
| MAV | 4.00% | 6.00% | 5.50% | 5.00% | 4.00% |

**Projected Traffic**

The assigned traffic is projected for the different homogeneous section from Silchar to Jiribam based on the above growth rates and the summary of projected traffic in PCUs is presented below;

**Table 0.9 Projected Traffic AADT in PCU**

| Homogeneous Section | Proposed Green filed alignment | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 6259 | 6259 | 6259 |
| 2021 | 6571 | 6634 | 6509 |
| 2022 | 6899 | 7031 | 6768 |
| 2023 | 7242 | 7451 | 7037 |
| 2024 | 7603 | 7897 | 7318 |
| 2025 | 7982 | 8370 | 7609 |
| 2026 | 8380 | 8871 | 7913 |
| 2027 | 9002 | 9618 | 8421 |
| 2028 | 9676 | 10433 | 8967 |
| 2029 | 10405 | 11324 | 9552 |
| 2030 | 11194 | 12296 | 10182 |
| 2031 | 12049 | 13358 | 10858 |
| 2032 | 12895 | 14429 | 11512 |
| 2033 | 13804 | 15591 | 12209 |
| 2034 | 14782 | 16850 | 12952 |
| 2035 | 15834 | 18217 | 13744 |

| Homogeneous Section | Proposed Green filed alignment | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2036 | 16966 | 19701 | 14589 |
| 2037 | 17829 | 20901 | 15186 |
| 2038 | 18737 | 22174 | 15808 |
| 2039 | 19692 | 23526 | 16455 |
| 2040 | 20695 | 24960 | 17129 |
| 2041 | 21750 | 26481 | 17831 |
| 2042 | 22836 | 28068 | 18543 |
| 2043 | 23976 | 29750 | 19283 |
| 2044 | 25173 | 31533 | 20053 |
| 2045 | 26430 | 33423 | 20854 |
| 2046 | 27749 | 35426 | 21686 |
| 2047 | 29135 | 37549 | 22552 |
| 2048 | 30590 | 39799 | 23453 |
| 2049 | 32117 | 42185 | 24390 |
| 2050 | 33721 | 44713 | 25364 |
| 2051 | 35405 | 47393 | 26377 |
| 2052 | 37174 | 50234 | 27430 |
| 2053 | 37192 | 50264 | 27441 |

| Homogeneous Section | Section-1 Silchar to Pailapool (Km 263+500 to Km 240+000) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 10985 | 10985 | 10985 |
| 2021 | 11521 | 11631 | 11411 |
| 2022 | 12084 | 12315 | 11855 |
| 2023 | 12675 | 13041 | 12316 |
| 2024 | 13295 | 13809 | 12795 |
| 2025 | 13945 | 14623 | 13293 |
| 2026 | 14628 | 18582 | 15192 |
| 2027 | 15606 | 19892 | 16056 |
| 2028 | 16658 | 21314 | 16978 |
| 2029 | 17792 | 22857 | 17964 |
| 2030 | 19014 | 24534 | 19018 |
| 2031 | 20331 | 26346 | 20146 |
| 2032 | 21649 | 28202 | 21252 |
| 2033 | 23061 | 30206 | 22426 |
| 2034 | 24574 | 32372 | 23673 |
| 2035 | 26196 | 34714 | 25000 |
| 2036 | 27935 | 37197 | 26411 |
| 2037 | 29330 | 39333 | 27465 |
| 2038 | 30795 | 41599 | 28563 |

| Homogeneous Section | Proposed Green filed alignment | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2039 | 32334 | 44001 | 29705 |
| 2040 | 33951 | 46548 | 30893 |
| 2041 | 35650 | 49246 | 32130 |
| 2042 | 37412 | 52082 | 33398 |
| 2043 | 39263 | 55086 | 34716 |
| 2044 | 41206 | 58270 | 36087 |
| 2045 | 43245 | 61644 | 37512 |
| 2046 | 45386 | 65220 | 38994 |
| 2047 | 47634 | 69009 | 40535 |
| 2048 | 49993 | 73025 | 42138 |
| 2049 | 52470 | 77280 | 43805 |
| 2050 | 55071 | 81790 | 45538 |
| 2051 | 57801 | 86569 | 47340 |
| 2052 | 60667 | 91634 | 49214 |
| 2053 | 60697 | 92163 | 49409 |

| Homogeneous Section | Section-2 Pailapool to Jiribam (Km 240+000 to Km 212+300) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 5713 | 5713 | 5713 |
| 2021 | 5998 | 6056 | 5941 |
| 2022 | 6298 | 6418 | 6179 |
| 2023 | 6612 | 6803 | 6425 |
| 2024 | 6943 | 7211 | 6682 |
| 2025 | 7289 | 7643 | 6949 |
| 2026 | 7653 | 8101 | 7226 |
| 2027 | 8148 | 8705 | 7621 |
| 2028 | 8677 | 9358 | 8039 |
| 2029 | 9243 | 10062 | 8484 |
| 2030 | 9849 | 10823 | 8955 |
| 2031 | 10499 | 11644 | 9457 |
| 2032 | 11147 | 12480 | 9946 |
| 2033 | 11838 | 13378 | 10463 |
| 2034 | 12574 | 14343 | 11009 |
| 2035 | 13358 | 15380 | 11586 |
| 2036 | 14193 | 16496 | 12195 |
| 2037 | 14981 | 17577 | 12750 |
| 2038 | 15814 | 18729 | 13331 |
| 2039 | 16693 | 19958 | 13939 |
| 2040 | 17622 | 21268 | 14575 |

| Homogeneous Section | Section-2 Pailapool to Jiribam (Km 240+000 to Km 212+300) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2041 | 18604 | 22665 | 15242 |
| 2042 | 19533 | 24024 | 15851 |
| 2043 | 20509 | 25465 | 16484 |
| 2044 | 21534 | 26992 | 17143 |
| 2045 | 22610 | 28610 | 17828 |
| 2046 | 23740 | 30326 | 18541 |
| 2047 | 24926 | 32144 | 19282 |
| 2048 | 26172 | 34072 | 20053 |
| 2049 | 27479 | 36115 | 20854 |
| 2050 | 28853 | 38281 | 21688 |
| 2051 | 30294 | 40577 | 22555 |
| 2052 | 31808 | 43011 | 23456 |
| 2053 | 31824 | 43037 | 23466 |

As per IRC SP: 73-2018 and IRC SP: 84-2019, as the project road from Silchar to Jiribam is passing through plain terrain the following capacity values has been adopted.

- For 2-Lane Highway capacity (4-Lane requirement) : 10,000 PCU/day
- 4-Lane Highway capacity (6-Lane requirement) : 60,000 PCU/day

Hence, based on above traffic projection and in line with TOR, DPR consultant has proposed for 4-Lane divided carriageway.

## 0.15 Pavement Design

### Flexible pavement

The Flexible pavement with geogrid provision between WMM layer is designed for Main carriageways, Bus bay, Truck lay bye, Rest area and Flexible pavement is designed for service road.

The crust composition is given below

**Table 0.10 Proposed Flexible pavement detail**

| Pavement Layer | Main Carriageway Thickness | Service Road Thickness |
|---|---|---|
| BC | 40 mm | 30 mm |
| DBM | 65 mm | 60 mm |
| WMM | 250 mm | 250 mm |
| Geogrid | Biaxial | - |
| GSB | 200 mm | 200 mm |
| Subgrade | 500 mm | 500 mm |

*Detailed design of different pavement options is given in Chapter 6: Pavement Design.*

As the proposed alignment is passing through high embankment and falls under submerged area were the CBR value varies from 5 % to 6 %. Hence, an additional geogrid layer has been introduced between natural ground (after clearing and grubbing) and selected earth (Embankment).

A sand blanket has been considered between subgrade and selected earth (embankment) wherever applicable/as per site condition.

## 0.16 Improvement Proposals

The details of the improvement proposals along the proposed road are discussed in chapter 7: Improvement Proposals however, the summary of the same is given in table below.

**Table 0.11 Summary of Improvement Proposals**

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| 1 | **Alignment & Geometrics** | | |
| | Total Length | Km | 20.000 |
| | **Re-alignments** | Km | - |
| | **Green Field Alignment** | | |
| | Green Field Alignment | Km | 20.000 |
| | **Total (Green Field Alignment)** | **Km** | **20.000** |
| 2 | **Cross Section** | | |
| | 4-Lane Road | Km | 20.000 |
| | 6-Lane Road (Tunnel portion along with approaches) | Km | Nil |
| 3 | **Bridges** | | |
| | **Existing** | Nos | 05 |
| | Major | Nos | 01 |
| | Minor | Nos | 04 |
| | **Rehabilitation Proposal of Existing Bridges** | | |
| | **Existing Bridges reconstruction (Major and Minor)** | Nos | - |
| | **Existing Bridges Repair/ Retain MJB** | Nos | - |
| | **Existing Bridges Widening (Major and Minor)** | Nos | - |
| | **Abandoned (not in use)** | Nos | 05 |

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| | **New Bridges** | **Nos** | 22 |
| | a. Major Bridges | Nos | 02 |
| | b. Minor Bridges | Nos | 14 |
| 4 | **Culverts** | | |
| | Existing Culverts | Nos | 17 |
| | Proposed Culverts | Nos | 61 |
| | **Rehabilitation Proposal of Culvert** | | |
| | Existing Culverts reconstruction / widened / Retained | Nos | - |
| | Existing Culverts Abandon | Nos | 17 |
| | New Culvert along project road | Nos | 49 |
| | New Culvert for cross roads | Nos | 12 |
| 5 | **Major & Minor Junctions** | | |
| | Major Junction | Nos | 02 |
| | Minor Junctions | Nos | 13 |
| 6 | **Tunnel** | Nos | Nil |
| 7 | **Toll Plaza** | Nos | Nil |
| 8 | **Service/Slip Road (LHS/RHS)** | Km | 4.050 |
| 9 | **Rest Area** | Nos | - |
| 10 | **Grade Separator** | | |
| | **Overpass** | Nos | 01 |
| | **Vehicular Underpass (VUP)** | Nos | 03 |
| | **Light Vehicular Underpass (LVUP)** | Nos | 02 |
| | **Smaller Vehicular Underpass (SVUP)** | Nos | 09 |
| | **Railway over Bridge (ROB)** | Nos | 02 |
| 11 | **Bus Bay** | Nos | 06 |
| 12 | **Truck Lay bye (Km 6+330, RHS)** | Nos | 01 |

| Sl. No. | Description | | Unit | Total |
|---|---|---|---|---|
| 13 | **Protection Work** | | | |
| | **Retaining Wall** | **LHS** | Mts | 1240 |
| | | **RHS** | Mts | 1240 |
| | **Breast Wall** | **LHS** | Mts | 1000 |
| | | **RHS** | Mts | 1080 |
| | **Crash Barrier** | **LHS** | Mts | 14000 |
| | | **RHS** | Mts | 13870 |
| 14 | **Drain** | | | |
| | **PCC Drain @ Grade Separator** | **LHS** | Mts | 1790 |
| | | **RHS** | Mts | 1850 |
| | **PCC Drain @ Other Location** | **LHS** | Mts | 290 |
| | | **RHS** | Mts | 570 |
| | **PCC Drain at Hill side** | **LHS** | Mts | 5315 |
| | | **RHS** | Mts | 5515 |
| 15 | **Additional Land requirement for the project** | | Km. | 20.000 |
| 16 | **% of Land Requirement for the Project (Length wise)** | | % | 100.00 |
| 17 | **Pavement Design Life** | | | |
| | **Flexible** | | Year | 20 |
| | **Rigid** | | Year | 30 |
| 18 | **Traffic in MSA : Km 4+560 to Km 24+560** | | MSA | 40 |
| 19 | **Pavement Type Proposed**<br>1. **Km 4+560 to Km 24+560** | | Flexible | Flexible –4L |
| | **Existing Type** | | BT | |
| | **Proposed new 4 Lane ( Main Carriageway)** | | **Flexible** | |
| | **BC(PMB/CRMB)** | | **mm** | 40 |
| | **DBM (VG-40)** | | **mm** | 65 |
| | **WMM** | | **mm** | 250 |

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| | **Geogrid** | | Biaxial |
| | **Granular Sub-Base (GSB)** | **mm** | 200 |
| | **Subgrade** | **mm** | 500 |
| | **Service Road** | **Flexible** | |
| | **BC(VG-30)** | mm | 30 |
| | **DBM (VG-30)** | mm | 60 |
| | **WMM** | mm | 250 |
| | **Granular Sub-Base (GSB)** | mm | 200 |
| | **Subgrade** | mm | 500 |

**Geometric Design Standards**

The entire project section passes through plain/rolling terrain. The design speeds as per IRC: SP: 84-2019, have been proposed as under:

| Plain and Rolling Terrain | | Mountainous and steep Terrain | |
|---|---|---|---|
| **Ruling** | **Minimum** | **Ruling** | **Minimum** |
| 100 | 80 | 60 | 40 |

Proposed Cross-sectional elements for the project road have been adopted as follows

**Table 0.12 Typical Cross Section element**

| **Four-lane Road (Built-up area)** | |
|---|---|
| Paved Carriageway | 2 x 7.0 m = 14.00m |
| Paved Shoulders | 2 x 2.5m = 5.00m |
| Kerb shyness | 4 x 0.50m = 2.00m |
| Median | 1 x 2.50m = 2.50m |
| Separator | 2 x 1.75 = 3.5m |
| Service Road | 2 x 7.00 = 14.0m |
| Drain cum Footpath | 2 x 1.50 = 3.0 m |
| Space for Service | 2 x 2.00 = 4.0m |
| Total Roadway Width | 48.00 m |

| Four-lane Road (Rural area) | | |
|---|---|---|
| Paved Carriageway | | 2 x 7.0 m = 14.0m |
| Shoulders | Paved | 2 x 2.5m = 5.0m |
| | Unpaved | 2 x 1.5m = 3.0m |
| Kerb shyness | | 2 x 0.50m = 1.00m |
| Median | | 4.00 m |
| Total Roadway Width | | 27.00 m |

**Grade Separator/Underpass/Overpass**

At all crossing of major road, start and end point of bypass/green filed alignment Flyover/Vehicular underpass is provided. These grade separation facilities are classified and tabulated in following Table.

**Table 0.13 Proposed Grade-Separated Structures for Cross Roads**

| Sl. No. | Type / Location of Structure | Type of Structure | Span arrangement and Vertical clearance |
|---|---|---|---|
| 1 | LVUP | 4+780 | Span = 1 x 12<br>Vertical Clearance = 4.0 |
| 2 | SVUP | 5+860 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 3 | SVUP | 6+820 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 4 | SVUP | 8+110 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 5 | SVUP | 9+597 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 6 | VUP | 11+913 | Span = 1 x 24<br>Vertical Clearance = 5.5 |
| 7 | SVUP | 13+777 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 8 | SVUP | 14+235 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 9 | LVUP | 15+075 | Span = 1 x 12<br>Vertical Clearance = 4.0 |
| 10 | Overpass | 16+796 | Span = 2 x 36<br>Vertical Clearance = 5.5 |
| 11 | SVUP | 17+813 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 12 | SVUP | 19+612 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 13 | VUP | 20+803 | Span = 1 x 24<br>Vertical Clearance = 5.5 |

| Sl. No. | Type / Location of Structure | Type of Structure | Span arrangement and Vertical clearance |
|---|---|---|---|
| 14 | SVUP | 21+718 | Span = 1 x 7<br>Vertical Clearance = 4.0 |
| 15 | VUP | 22+648 | Span = 1 x 24<br>Vertical Clearance = 5.5 |

**Summary of Grade Separated Structures:**

| Type | Nos. |
|---|---|
| VUP | 03 Nos. |
| LVUP | 02 Nos. |
| SVUP | 09 Nos. |
| Overpass | 01 Nos. |
| TOTAL | 15 Nos. |

**Cross drainage Structures:**

There are total 17 nos of existing culverts along the project corridor. All the culverts along existing road is abandoned as the proposed alignment is passing through green field and new 49 no's of box culverts on MCW and 12 nos on Cross Road are proposed along proposed green filed alignment.

**Table 0.14 Summary of Proposed culverts**

| Existing | | | | Proposed | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Slab | Box | Total | New Box On MCW | New Box On CR | Reconstruction | Widening | Retained | Abandoned | |
| 09 | 03 | 05 | 17 | 49 | 12 | - | - | - | 75 | 61 |

**Major and Minor Bridges:**

As the proposed alignment is passing through green filed 2 no's of new Major and 14 no's of Minor bridges are provided where the proposed alignment crossed the river or Nala. The details of the same is given below

**Table 0.15 Summary of Proposed Bridges**

| Existing | | Proposed | | | Retained | Abandoned | Total |
|---|---|---|---|---|---|---|---|
| Type | No. | New | Reconstruction | Widening | | | |
| Major Bridge | 1 | 2 | - | - | - | 1 | 2 |
| Minor Bridge | 4 | 15 | - | - | - | 4 | 15 |

***Note:*** *All existing bridges are abandoned as the proposed alignment is passing through green filed.*

**Rail Over Bridge (ROB):**

The proposed green filed alignment is crossing the existing railway line at 2 Locations. At all the 2 locations ROB has been proposed and the details of the same is given below.

**Table 0.16 Details of Proposed ROB**

| Sl. No. | Location of Structure (Design Chainage) | Type of structure | Type of track | Span arrangement (m) | Total Width of Structure (m) |
|---|---|---|---|---|---|
| 1 | 5+083 | ROB | Silchar-Jiribam BG Railway Line | 3 x 36 | 2x13.5 |
| 2 | 22+452 | ROB | Silchar-Jiribam BG Railway Line | 3 x 36 | 2x13.5 |

*The detailed discussion about the proposed structures along the project road is discussed in Chapter 7: Improvement proposals*

## 0.17 Environment Screening

The main objectives of the study are: i) identify the impacts of the project improvement on environment and ii) alleviate the unsafe condition and congestion of the existing highway on NH 37 by enhancing the capacity and quality of the road to the users in a sustainable and environment friendly manner.

MoEF, GoI, has enforced Environment (Protection) Act 1986 and Notification on Environmental Impact Assessment dated 14th September 2006 and subsequent amendments to avoid, mitigate and prevent the environmental impacts from project activities. The EIA Report is prepared in line with EIA Notification guidelines. The report attempts to identify, predict and communicate information on impacts of the proposed subproject on the environment along with mitigation and management measures for the indicated impacts

**Key Environmental Laws & Policies:**

The Constitutional Provisions like Article 48 and 51-A (g) and 74$^{th}$ Amendment to the Constitution serve as principle guidelines of environmental protection. Further Regulations, Acts, Policies applicable to sustainability and environmental protection are as follows.

- *EIA Notification, September 2006 & subsequent Amendments*
- *The Environment (Protection) Act, 1986*
- *The Water (Prevention and Control) Act, 1974*
- *The Air (Prevention and Control) Act, 1981*

- *The Indian Forest Act, 1927*
- *The Karnataka Forest Act, 1963*
- *The Forest (Conservation) Act, 1980 (as amended in 1988)*
- *The Forest Conservation Rules, 1981*
- *The Wildlife Protection Act, 1972*
- *The Hazardous Waste (Management and Handling) Rules, 1989*
- *Fly ash Notification, 2009*
- *The Ancient Monuments and Archaeological Sites and Remains Act 1958*
- *The Motor Vehicles Act 1988*
- *Public Liability Insurance Act, 1991*
- *Coastal Regulation Zones Act*
- *The Factories Act 1956*

The other guidelines and norms related to road construction by Indian Road Congress that help for environmental protection include, IRC: 104-1988, IRC: 36-1974, IRC: 10-1961, IRC: 36-1970, IRC: 43-1972, IRC: 72-1978, IRC: 33-1982, etc.

**Applicability of EIA Notification, 2006:**

The **project** road from Km 4+560 to Km 37+650 has a length of 33 km but involves additional right of way or land acquisition less than 40 m on the existing alignment and 60m acquisition for bypass/green filed alignment proposal. Hence, the highway does not qualify for environmental clearance.

**Baseline Environment:**

Information on baseline environment is collected from secondary sources of data for the macro environmental parameters like climate, physiography (geology and geomorphology), biological and socio-economic environment of the project influence area. The micro-environmental details within the Corridor of Impact (CoI) have been collected from primary source of data such as base maps prepared by reconnaissance survey, extrapolation of environmental features on the proposed design, tree enumeration, analysis for environmental attributes along the project road.

**Analysis of Alternatives:**

The existing National Highway NH-37 is being up-graded to 4/6 Lane standards. An alignment options were studied by providing realignments for improving the road geometrics and for smoothening the sharp curves and bypasses to avoid narrow and congested stretches of the project road along with green filed alignment option. Hence analysis has been done for provision of bypass and green filed alignment.

**Stakeholder Consultation:**

During the survey, informal and unstructured stakeholder consultations were conducted at DC office Silchar, the purpose of the surveys and salient features of the proposed project were explained to the stakeholders to gather their opinions and concerns regarding the project.

**Anticipated environmental impacts and mitigation measures:**

The key Environmental impacts, both direct and indirect on various environmental attributes during construction and operational phases of proposed NH improvement project are discussed in detail in the report. Significant positive and negative impacts due to project are summarized in the following impact matrix.

| **Environmental Attributes** | **Physical Environment** | | | **Biological Environment** | | **Geology** | | **Topo-graphy** |
|---|---|---|---|---|---|---|---|---|
| | **Air** | **Water** | **Noise** | **Flora** | **Fauna** | **Natural Drainage** | **Soil** | |
| **I. Construction Phase** | | | | | | | | |
| Labour Camp Activities | | -ve/t | | | | | | |
| Quarrying | **-ve/t** | | **-ve/t** | -ve/t | | -ve/t | **-ve/p** | **-ve/p** |
| Material Transport & Storage | -ve/t | -ve/t | -ve/t | -ve/t | | -ve/t | -ve/t | |
| Drilling and Blasting | **-ve/t** | | **-ve/t** | -ve/t | | | | **-ve/p** |
| Pavement works | -ve/t | -ve/t | -ve/t | -ve/t | -ve/t | **-ve/p** | -ve/t | **-ve/p** |
| Use of Construction Equipment | **-ve/t** | **-ve/t** | **-ve/t** | | | | | |
| Cutting of Trees | | | | **-ve/p** | | | | |
| Plantation | +ve/p | | +ve/p | **+ve/p** | | | +ve/p | |
| Culvert and Bridge Construction | | -ve/t | -ve/t | | | **-ve/p** | | |
| Stripping of Topsoil | | | | -ve/t | | -ve/t | **-ve/t** | |
| Debris Generation | -ve/t | -ve/t | | | | -ve/t | -ve/t | |
| Oil and Grease | | -ve/t | | | | | -ve/t | |
| **II. Operational Phase** | | | | | | | | |
| Vehicular Movement | +ve/p | | +ve/t | +ve/t | -ve/p | | | |

***Note: t – Temporary; p- Permanent; Impacts indicated in bold letters are Significant Impacts.***

**Environmental Management Plan:**

Environmental Management Plan (EMP) deals with the implementation procedure of the guidelines and mitigation measures recommended to avoid, minimize and mitigate foreseen environmental impacts of the project. The implementation of environmental management plan needs suitable organization set up and the success of any environmental management plan depends on the efficiency of the group responsible for implementation of the programme. It is proposed to carryout regular environmental monitoring to provide information to the management for periodic review to ensure that environmental protection is optimized at all stages of the project implementation.

**Conclusion:**

The proposed improvement to the existing National Highway section road and it is proposed to be up-graded with new.

The Environmental Assessment study nation report attempts to identify significant potential environmental impacts associated with the construction and operational phases of the proposed road Project. Apart from positive impacts road projects could also generate some adverse direct and indirect environmental impacts. Direct environmental impacts are usually due to construction activities, while indirect environmental impacts are usually related to the operation of improved roads.

Other than the temporary insignificant impacts during construction phase, the two most significant issues involved are cutting of road side trees along the proposed stretch of NH-37 and acquisition of forest land in the forest along the proposed green field alignment.

## 0.18 Social Assessment

Social Assessment details the processes for assessing the project's potential social impacts and defining opportunities to enhance benefits and mitigate adverse social impacts. It contains the modalities for profiling socio-economic conditions, identifying stakeholder groups and analysing their interests and concerns, conducting social screening to assess potential impacts and linking these findings to project design. This will provide input for the Resettlement Action Plan, which will be prepared in due course.

**Expected Socio-Economic Benefits Of the Project**

The project will help to increase new economic and employment opportunities by providing improved linkages to markets, production centres and other areas of economic opportunities. The project is major transportation corridor which connects Silchar and Imphal. The road will increase the connectivity of the project area as well as the state as a whole to the surrounding region.

This project aims at maximizing project benefits while minimizing the negative social impacts. The social development outcome of the project will include:

i) The project road connects Assam and Manipur. The proposed green filed alignment will serve the settlement along existing road with better access to economic activities. Improved connectivity will facilitate travel, will help to have better access to amenities such as health, education, town/market, and improved social networking.

ii) The project will improve the accessibility of the population along the project corridor to education, health, employment, trading and employment opportunities and in the long run help towards poverty alleviation.

iii) The project will help to increase new economic and employment opportunities by providing improved linkages to markets, production centers and other areas of economic opportunities. Better and quicker transportation would help the rural population to transport their produce faster and get more profit margins instead of depending solely on local 'markets' and middlemen. This corridor has abundant tourism potential other places of tourist interests.

iv) Women will benefit, as their mobility will be facilitated both in terms of access to social services, as well as access to higher levels of schooling. Women's access to higher levels of health care outside the village particularly during the time of childbearing will also improve considerably.

v) Targeted assistance will be provided to vulnerable groups including below poverty line families, women headed households, and handicapped persons, through the Resettlement Policy for the Project.

The likely adverse impacts of the project are:

i) Potential adverse impacts associated with land acquisition;

ii) Loss of livelihood and

iii) Social exclusion where the affected non-titleholder and encroachers may not be eligible for assistance and compensation under local laws and procedures

Overall, the proposed Project will bring in economic and social changes, which in turn would bring economic prosperity and would lead to poverty alleviation.

**Methodology**

Collection and Analysis of Secondary Data: Secondary data pertaining to various socioeconomic parameters was collected from government departments like Census of India, Department of Industries, Department of Economics and Statistics, Department of Agriculture, etc.

Screening survey: A preliminary screening survey was conducted within a width of 45 meter to quantify the impact on buildings/structures that likely to be affected by the widening of the road. The number of residences, commercial buildings, common property resources and religious structures were surveyed for RHS and LHS separately. The survey covered: the settlements along the alignment, structures likely to be affected, community structures likely to be affected and communities affected.

Focused Group Discussions (FGD): Focus Group Discussions were conducted at selected places throughout the corridor to understand the people's perception about the project as well as their issues and concerns. The willingness of the people to part with their land for the project and the compensation anticipated also noticed.

**Task of the assignment**

**The tasks of this assignment include:**

a) Carry out a preliminary social screening in coordination with other screening exercise (environment and technical) – desk review and field visit- of the highway to determine the magnitude of actual and potential impact and ensure that social considerations are given adequate weight in the selection and design of proposed highway improvements;

b) Collect information – desk review and field visit – on existing baseline conditions (include all within the proposed width or Right of Way), and undertake a preliminary evaluation of the highway selected for improvement in order to define, the zone of impact of such component or activities, design and management studies;

c) Explore viable alternative project designs and alignments to avoid, where feasible, or minimize displacement and carry out public consultations on alternate bypass alignments.

d) Identify major and minor social impact issues and estimate the economic and social negative impacts on people and land of upgrading the highway and propose cost-effective measures to avoid and/or mitigate negative impacts;

e) Identify case of likely impact on Indigenous communities, to establish the applicability of GOI/State Government regulation;

f) Carry out public consultation with the likely affected groups, NGOs, district administration and other stakeholders and document the outcomes;

g) Provide a preliminary cost estimate for land acquisition, transfer and resettlement and rehabilitation and ensure inclusion in the overall project cost;

h) Assets both within and outside of the right of way such structures and land will be recorded on strip maps; and

## 0.19 Cost Estimates

The project cost has been worked out for civil works for main carriageway, Service road, Truck lay bye, bus bays and junction improvement with Flexible pavement. Project road length is considered as Silcha/ Nutan Dayapurr – Budha Nagar section, Package: SJ-1 from D. Km 4+560 to D. Km 24+560. The details are presented in the Volume VI, VII & VIII: Rate analysis and Cost estimate. The item - wise abstract of cost of Civil Works for this Package are given below.

**Table 0.17 Abstract of Cost Estimate**

| Bill No. | Item of works | Cost (Rs. Crores) | % of Total cost |
|---|---|---|---|
| 1 | Site Clearance | 0.57 | 0.09% |
| 2 | Earthwork | 172.01 | 27.86% |
| 3 | Granular Sub-base & Base Courses | 104.56 | 16.93% |
| 4 | Bituminous Base and Surface Courses | 47.82 | 7.74% |
| 5 | Drain works | 14.76 | 2.39% |
| 6 | Protection Works | | |
| | a) Breast wall | 13.20 | 2.14% |
| | b) Retaining /Toe wall | 9.58 | 1.55% |
| | c) Slope protection work | 5.09 | 0.82% |
| 7 | Traffic Signs, Markings and Other Road Appurtenances | 29.74 | 4.82% |
| 8 | Miscellaneous works | 17.34 | 2.81% |
| 9 | Toll Plaza | 0.00 | 0.00% |
| 10 | Cross Drainage Works - Box Culverts | 38.78 | 6.28% |
| 11 | Bridges | | |
| | a) Minor Bridge | 62.86 | 10.18% |
| | b) Major Bridge | 29.31 | 4.75% |
| 13 | Underpasses | - | - |
| | a) SVUP | 14.31 | 2.32% |
| | b) LVUP | 4.53 | 0.73% |
| | c) VUP/VOP | 18.16 | 2.94% |
| 14 | ROBs | 34.88 | 5.65% |
| **I** | **Cost of Civil Works (in Crores)** | **617.49** | 100.00% |
| II | Utility Shifting Cost with GST | 12.80 | |
| **III** | **Total Civil Cost (I+II+III)** | **630.29** | |

| Bill No. | Item of works | Cost (Rs. Crores) | % of Total cost |
|---|---|---|---|
| IV | Contingencies @ 1% of civil cost (I) as per circular dated Aug 2021 | 6.17 | |
| V | Supervision charges @ 3% of civil cost excluding GST (II) (as per MORTH Letter no.EW-Nh-33044/10/2019-S&B9P&B dated March 7 2019) | 18.52 | |
| VI | Administrative charges @ 3.0% of civil cost (I) | 18.52 | |
| VII | Annual maintenance for 5 years (in total) @ 2.5% of Civil Cost (I) as per EPC Agreement Clause 14.1 (i) (a) - 0%+0.5%+0.5%+0.5%+1.0% | 15.44 | |
| VIII | Price escalation @ 5% per annum for two years i.e. 10% of Civil Cost (I) | 61.75 | |
| **IX** | **Centages over civil cost (IV+V+VI+VII+VIII)** | **120.40** | |
| X | GST @ 18% of civil cost (I) | 111.15 | |
| XI | GST @ 18% of Utility cost | **2.30** | |
| **XII** | **Total Project cost including centages XII =IX+X+XI (in Crores)** | **864.15** | |
| | | | |
| **XIII** | **Non-Civil Cost** | | |
| | Environmental Cost | 3.09 | |
| | AGCL (132 KV) | 14.47 | |
| | PGCIL (400 KV & 132 KV) | 17.91 | |
| | Land Acquisition and Rehabilitation & Resettlement cost | 209.62 | |
| | **Sub-Total (in Crores)** | **245.09** | |
| | | | |
| **XIV** | **Total project completion cost XIV = XII+XIII (Rs. Crores)**<br>Length of the project road (Km) | **1109.24**<br>20.00 | |
| | Civil Cost Rate per km (in Crores) | 30.87 | |
| | Total Project Complation Cost Rate per km (in Crores) | 55.46 | |

# Annexure

## Annexure 1. DPR Checklist – Stage 4 – Final Detailed Project Report (R1)

| General Details | |
|---|---|
| Project Name | **Silchar to Jiribam, Package: SJ-1 (D. Km 4+560 to D. Km 24+560)** |
| Consultant's Name | **Transys Consulting Pvt.Ltd.** |
| Date of Review | |

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| 1 | **Main Report** | Yes ☑ No ☐ NA ☐ | NA | |
| 2 | **Introduction and project background** | Yes ☑ No ☐ NA ☐ | NA | |
| 2.1 | Overview of project location, project objectives etc. | Yes ☑ No ☐ NA ☐ | NA | |
| 2.2 | Overview of report structure, deliverables etc. | Yes ☑ No ☐ NA ☐ | NA | |
| 3 | **Social analysis of the project** | Yes ☑ No ☐ NA ☐ | NA | |
| 3.1 | Project impact on stakeholders such as local people | Yes ☑ No ☐ NA ☐ | NA | |
| 3.2 | Project impact on residential, commercial and public properties | Yes ☑ No ☐ NA ☐ | NA | |
| 3.3 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 4 | **Reconnaissance survey** | Yes ☑ No ☐ NA ☐ | NA | |
| 4.1 | Geometric Features of the Existing Road Design Speed<br>• Sight distance details<br>• Horizontal Alignment Details<br>• Vertical Alignment Details<br>• Height of Embankment | Yes ☑ No ☐ NA ☐ | | |
| 4.2 | Topographical Survey using LiDAR (or equivalent technology) as per IRC:SP:19<br>• Gradient<br>• Terrain | Yes ☑ No ☐ NA ☐ | NA | |
| 4.3 | Pavement composition and condition survey as per IRC:SP:19 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.4 | Pavement roughness survey as per IRC:SP:16 | Yes ☑ No ☐ NA ☐ | Na | |
| 4.5 | Pavement structural strength survey as per IRC:81 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.6 | Geological Survey<br>• Geological Map of the Area<br>• Seismicity | Yes ☑ No ☐ NA ☐ | NA | |
| 4.7 | Climatic Conditions<br>• Temperature<br>• Rainfall<br>• Wind | Yes ☑ No ☐ NA ☐ | NA | |
| 4.8 | Land Use along the existing alignment<br>• Map of the Project Area depicting Agricultural/Habitation/Forest Area | Yes ☑ No ☐ NA ☐ | NA | |

| S.No | SECTION OF THE REPORT | YES/NO/NA | Details/ Specifications | Remarks |
|---|---|---|---|---|
| 4.9 | Details of Existing Structures<br>• Map of the Project Area depicting Hutments/Buildings/Temples/Public Building/Any Other Significant Structure | Yes ☑ No ☐ NA ☐ | NA | |
| 4.10 | Inventory and condition survey of culverts | Yes ☑ No ☐ NA ☐ | NA | |
| 4.11 | Geo-technical and sub-soil explorations as per IRC:78 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.12 | Number of Bore holes dug (holes for every pier and abutment) | Yes ☑ No ☐ NA ☐ | | |
| 4.13 | Field testing, soil sampling, laboratory testing as per IRC: 78 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.14 | Recommendation of Foundation Type and Depth | Yes ☑ No ☐ NA ☐ | | |
| 4.15 | Hydrological investigations as per IRC:5 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.16 | High Flood Level specified | Yes ☑ No ☐ NA ☐ | NA | |
| 4.17 | Depth of Water Table specified | Yes ☑ No ☐ NA ☐ | NA | |
| 4.18 | Ponded Water Level specified | Yes ☑ No ☐ NA ☐ | NA | |
| 4.19 | Materials Survey conducted as per IRC:SP:19 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.20 | Sources of Naturally Occurring Aggregates specified<br>• Details of Borrow Pits with Distance from Project Site<br>• Cost of Material/Transportation | Yes ☑ No ☐ NA ☐ | | |
| 4.20.1 | Sources of environmentally friendly construction materials identified as per MoRT&H circular | Yes ☑ No ☐ NA ☐ | NA | |
| 4.21 | Sources of Manufactured Items specified<br>• Details of Suppliers with Distance from Project Site<br>• Cost of Material/Transportation | Yes ☑ No ☐ NA ☐ | NA | |
| 4.22 | Source of Water for construction specified as per IS:456 | Yes ☑ No ☐ NA ☐ | NA | |
| 4.23 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 5 | **Traffic studies and demand forecast designs** | Yes ☑ No ☐ NA ☐ | NA | |
| 5.1 | Classified traffic volume counts using IHMCL data (7 day data) | Yes ☑ No ☐ NA ☐ | NA | |
| 5.2 | Traffic projection methodology as per IRC:108 | Yes ☑ No ☐ NA ☐ | NA | |
| 5.3 | Projected Traffic data for 20 years | Yes ☑ No ☐ NA ☐ | NA | |
| 5.4 | Current and Projected PCU | Yes ☑ No ☐ NA ☐ | | |
| 5.5 | Current and Projected TVU | Yes ☑ No ☐ NA ☐ | | |
| 5.6 | Origin destination surveys as per IRC: 102 | Yes ☑ No ☐ NA ☐ | NA | |
| 5.7 | Speed and delay studies as per IRC:102 | Yes ☑ No ☐ NA ☐ | NA | |
| 5.8 | Traffic surveys for the design of road junctions as per data in IRC: SP:41 | Yes ☑ No ☐ NA ☐ | NA | |

| | | | | |
|---|---|---|---|---|
| 5.9 | Analysis for replacing railway level crossings with over bridges/ subways | Yes ☑ No ☐ NA ☐ | NA | |
| 5.10 | Axle load survey as per IRC:SP:19 | Yes ☑ No ☐ NA ☐ | NA | |
| 5.11 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 5.12 | Traffic surveys monitored and reviewed by the client | Yes ☑ No ☐ NA ☐ | NA | |
| 6 | **Cost estimates** | Yes ☑ No ☐ NA ☐ | NA | |
| 6.1 | Project costing as per latest SoR | Yes ☑ No ☐ NA ☐ | NA | |
| 7 | **Environmental aspects** | Yes ☑ No ☐ NA ☐ | NA | |
| 7.1 | Environment profile of the project region | Yes ☑ No ☐ NA ☐ | NA | |
| 7.2 | Details of Public consultation at residential and commercial settlements affected | Yes ☑ No ☐ NA ☐ | NA | |
| 7.3 | Impact analysis and mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 8 | **Economic and commercial analysis** | Yes ☑ No ☐ NA ☐ | NA | |
| 8.1 | Estimated cost details | Yes ☑ No ☐ NA ☐ | NA | |
| 8.2 | Projected revenues details | Yes ☑ No ☐ NA ☐ | NA | |
| 8.3 | Assumptions stated | Yes ☑ No ☐ NA ☐ | NA | |
| 8.4 | Analysis and results (IRR, Sensitivity Analysis, Financial Viability) | Yes ☑ No ☐ NA ☐ | NA | |
| 8.5 | Conclusions and recommendations | Yes ☑ No ☐ NA ☐ | NA | |
| 8.6 | Financial model shared with client and reviewed | Yes ☑ No ☐ NA ☐ | NA | |
| 9 | **Conclusions and recommendations** | Yes ☑ No ☐ NA ☐ | NA | |
| 9.1 | Report fulfils project objectives and scope as per RFP | Yes ☑ No ☐ NA ☐ | NA | |
| 9.2 | Report reviewed for errors and omissions | Yes ☑ No ☐ NA ☐ | NA | |
| 9.3 | Compliance report prepared on client observations | Yes ☑ No ☐ NA ☐ | NA | |
| 10 | **Design Report** | Yes ☑ No ☐ NA ☐ | NA | |
| 10.1 | Highway improvement proposals | Yes ☑ No ☐ NA ☐ | NA | |
| 10.2 | Highway geometric designs | Yes ☑ No ☐ NA ☐ | NA | |
| 10.3 | Roadside drainage | Yes ☑ No ☐ NA ☐ | NA | |
| 10.4 | Intersections | Yes ☑ No ☐ NA ☐ | NA | |
| 10.5 | Urban service roads | Yes ☑ No ☐ NA ☐ | NA | |
| 10.6 | Bus-stops | Yes ☑ No ☐ NA ☐ | NA | |
| 10.7 | Toll plazas | Yes ☑ No ☐ NA ☐ | NA | |
| 10.8 | Pedestrian crossings | Yes ☑ No ☐ NA ☐ | NA | |
| 10.9 | Utility relocation | Yes ☑ No ☐ NA ☐ | NA | |
| 10.10 | Pavement | Yes ☑ No ☐ NA ☐ | NA | |
| 10.11 | Structures | Yes ☑ No ☐ NA ☐ | NA | |
| 10.12 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 10.13 | Pavement deflection survey as per IRC 81-1997 | Yes ☑ No ☐ NA ☐ | NA | |
| 10.14 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |

| S.No | SECTION OF THE REPORT | YES/NO/NA | Details/ Specifications | Remarks |
|---|---|---|---|---|
| 11 | **Materials Report** | Yes ☑ No ☐ NA ☐ | NA | |
| 11.1 | Material investigations as per IRC:10 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.2 | Review of material investigations by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.3 | Multiple borrow areas identified | Yes ☑ No ☐ NA ☐ | NA | |
| 11.4 | Material survey as per IRC: SP: 19 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.5 | Review of material survey by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.6 | Geo-technical and sub-soil explorations as per IRC:78 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.7 | Review of geo-technical and sub-soil explorations by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.8 | Field testing, soil sampling, laboratory testing in accordance with BIS/ AASHTO/ BS | Yes ☑ No ☐ NA ☐ | NA | |
| 11.9 | Pavement composition and condition survey as per IRC:SP:19 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.10 | Review of pavement composition and condition survey by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.11 | Pavement roughness survey as per IRC:SP:16 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.12 | Review of pavement roughness survey by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.13 | Pavement structural strength survey as per IRC:81 | Yes ☑ No ☐ NA ☐ | NA | |
| 11.14 | Review of pavement structural strength survey by client | Yes ☑ No ☐ NA ☐ | NA | |
| 11.15 | Water sample tests as per MoRTH specifications | Yes ☑ No ☐ NA ☐ | NA | |
| 11.16 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 12 | **Environmental Assessment Report/ Resettlement and Rehabilitation Plan** | Yes ☑ No ☐ NA ☐ | NA | |
| 12.1 | Option for alignment alternatives considered and conclusions | Yes ☑ No ☐ NA ☐ | NA | |
| 12.2 | Land environment data collection and details/ impact/ mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 12.3 | Air environment data collection and details/ impact/ mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 12.4 | Water resources details/ impact/ mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 12.5 | Noise environment details/ impact/ mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 12.6 | Biological environment details/ impact/ mitigation measures | Yes ☑ No ☐ NA ☐ | NA | |
| 12.7 | Details of public consultation | Yes ☑ No ☐ NA ☐ | NA | |
| 12.8 | Environment monitoring and management plan | Yes ☑ No ☐ NA ☐ | NA | |
| 12.9 | Details of social impact assessment | Yes ☑ No ☐ NA ☐ | NA | |
| 12.10 | Details of resettlement and rehabilitation action plan | Yes ☑ No ☐ NA ☐ | NA | |

| | | | | |
|---|---|---|---|---|
| 12.11 | Measures to minimize resettlement | Yes ☑ No ☐ NA ☐ | NA | |
| 12.12 | Details of public consultation with stakeholders | Yes ☑ No ☐ NA ☐ | NA | |
| 12.13 | Details of implementation arrangement / budget | Yes ☑ No ☐ NA ☐ | NA | |
| 12.14 | Any other details relevant to the project | Yes ☑ No ☐ NA ☐ | NA | |
| 13 | **Technical Specifications** | Yes ☑ No ☐ NA ☐ | NA | |
| 13.1 | MoRTH technical specifications for Roads and Bridge works followed | Yes ☑ No ☐ NA ☐ | NA | |
| 13.2 | Details of technical specifications | Yes ☑ No ☐ NA ☐ | NA | |
| 14 | **Rate Analysis** | Yes ☑ No ☐ NA ☐ | NA | |
| 14.1 | Rate analysis for all relevant items as per latest SoR | Yes ☑ No ☐ NA ☐ | NA | |
| 15 | **Cost Estimates** | Yes ☑ No ☐ NA ☐ | NA | |
| 15.1 | Cost estimates for all relevant items as per latest SoR | Yes ☑ No ☐ NA ☐ | NA | |
| 16 | **Bill of quantities** | Yes ☑ No ☐ NA ☐ | NA | |
| 17 | **Drawing Volume** | Yes ☑ No ☐ NA ☐ | NA | |
| 18 | **Digital drawings of road** | | | |
| 18.1 | Highway cross sections | Yes ☑ No ☐ NA ☐ | | |
| 18.2 | 3D engineered models of:<br>• Road alignment geometry<br>• Proposed highway<br>• Proposed structures | Yes ☑ No ☐ NA ☐ | | |

1

# Chapter 1- Introduction

**Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte(49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km))**

**Section: Silchar to Jiribam, Package: SJ-1 (From D. Km 4+560 to D. Km 24+560)**

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# 1 Chapter 1 – Introduction

## 1.1 General

**Bharatmala Pariyojana** is a mega plan of the government and the second-largest highways project after the NHDP. Many defined highway stretches totalling about 50,000 km are proposed to be developed as "**Economic Corridors, Inter Corridors & Feeder Routes" under "Bharatmala Pariyojna".**

Economic corridors are integrated networks of infrastructure within a geographical area designed to stimulate economic development. These corridors are generally developed to link cities or countries, manufacturing hubs, areas with high supply and demand, and manufacturers of value-added goods, whereas 44nos of corridors are identified. Inter Corridors & Inter-connection between different economic corridors, development of first mile & last mile connectivity. Development of these corridors will help in decongesting 30 top cities in the country by building ring roads and logistics hubs along these corridors. These stretches pass through and connect major hubs of economic activities such as manufacturing clusters, ports etc. Under 'Logistic Efficiency Enhancement Programme', these are proposed to be developed by taking an end-to-end corridor view, rather than stretch-by-stretch road construction view to ensure consistent infrastructure along the corridor.

As a first step towards this task, preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojana is being undertaken by National Highways Authority of India (NHAI). Numbers of consultants have been appointed by National Highway Authority of India (NHAI), to prepare the Detailed Project Report for identified economic corridors, inter corridors & feeder routes under Bharatmala Pariyojana.

The National Highways & Infrastructure Development Corporation Limited **(NHIDCL)** has been constituted through an Act of Parliament for faster, economical and quality Road Construction work throughout India.

National Highways and Infrastructure Development Corporation is a fully owned company of the Ministry of Road Transport & Highways, Government of India. The company promotes surveys, establishes, designs, builds, operates, maintains and upgrades National Highways and Strategic Roads including interconnecting roads in parts of the country which share international boundaries with neighbouring countries. The regional connectivity so enhanced would promote cross border trade and commerce and help safeguard India's international borders. This would lead to the formation of a more integrated and economically consolidated South and South East Asia. In addition, there would be overall economic benefits for the local population and help integrate the peripheral areas with the mainstream in a more robust manner. An approximate aggregate length of 10,000 kms has been identified to begin with for development through this company. The company envisages creating customized and specialized skills in terms of addressing issues like complexities of geographical terrains and addressing extensive coordination requirements with security agencies. The company would also endeavour to undertake infrastructure projects including but not restricted to urban infrastructure and urban or city transport and to act as an agency for development of all types of Infrastructure. The company envisages working towards cross sharing of technical know-how and enhancing opportunities for business development with other nations and their agencies including the multilateral organizations and institutions.

The company also proposes to improve road connectivity and efficiency of the international trade corridor, by expanding about 500 KMs of roads in the North Bengal and Northeastern region of India to enable efficient and safe transport regionally with other South Asia Sub-regional economic Cooperation (SASEC) member countries. These projects are being funded by ADB (Asian Development Bank).

M/s. Transys Consulting Pvt. Ltd., has been appointed as consultants by National Highway Infrastructure Development Corporation Limited (NHIDCL), to prepare the Detailed Project Report for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India (Lot-1) **Package-III** under Bharatmala Pariyojana.

NHIDCL will be the employer and executing agency for the consultancy services and the standards of output required from the appointed consultants are of international level both in terms of quality and adherence to the agreed time schedule. The consultancy firm will solely be responsible for submission of quality work in stipulated period.

The Index Map of Project road and Project Location Map are given in Figure 1.1 and Figure 1.2 respectively.

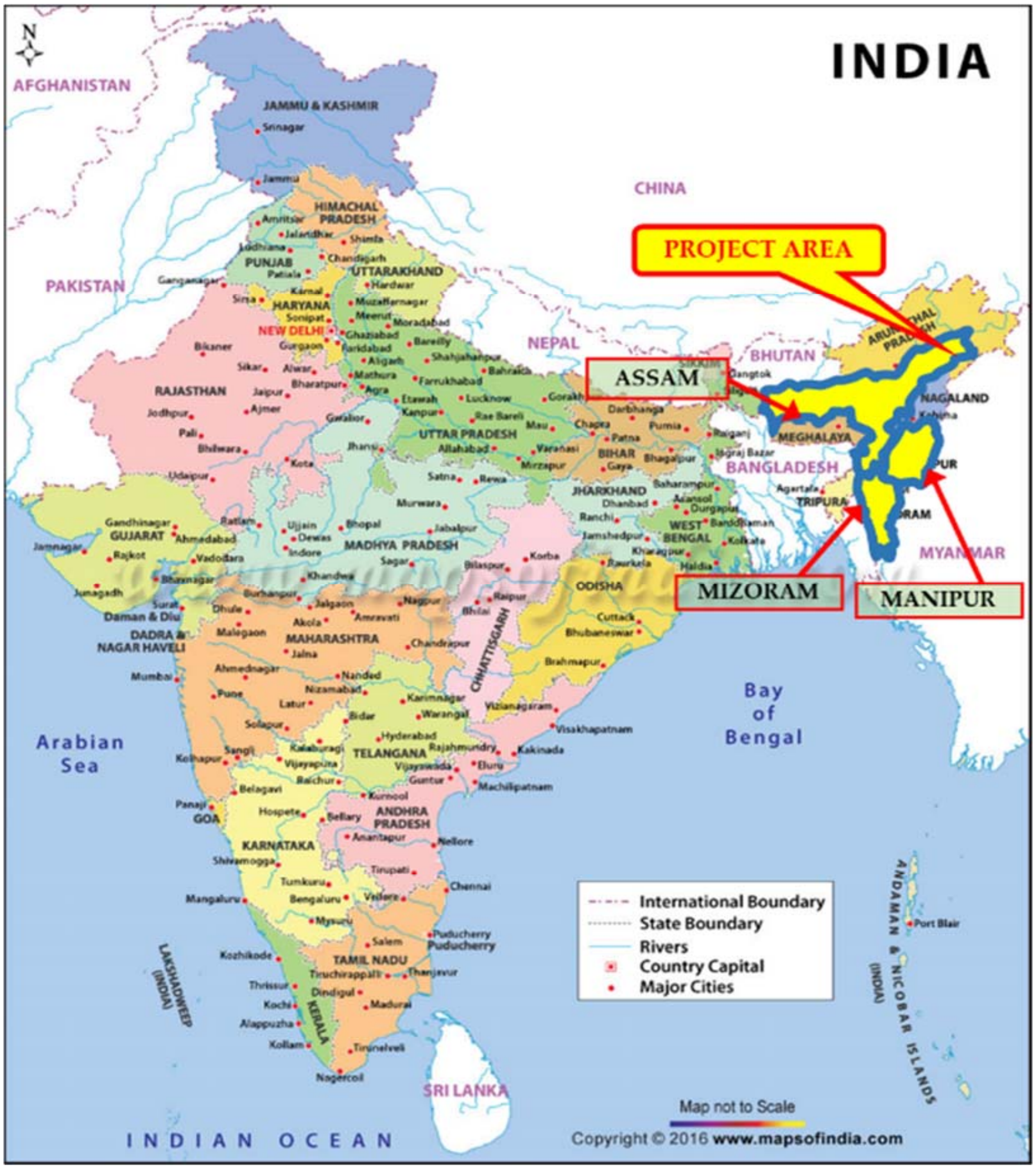
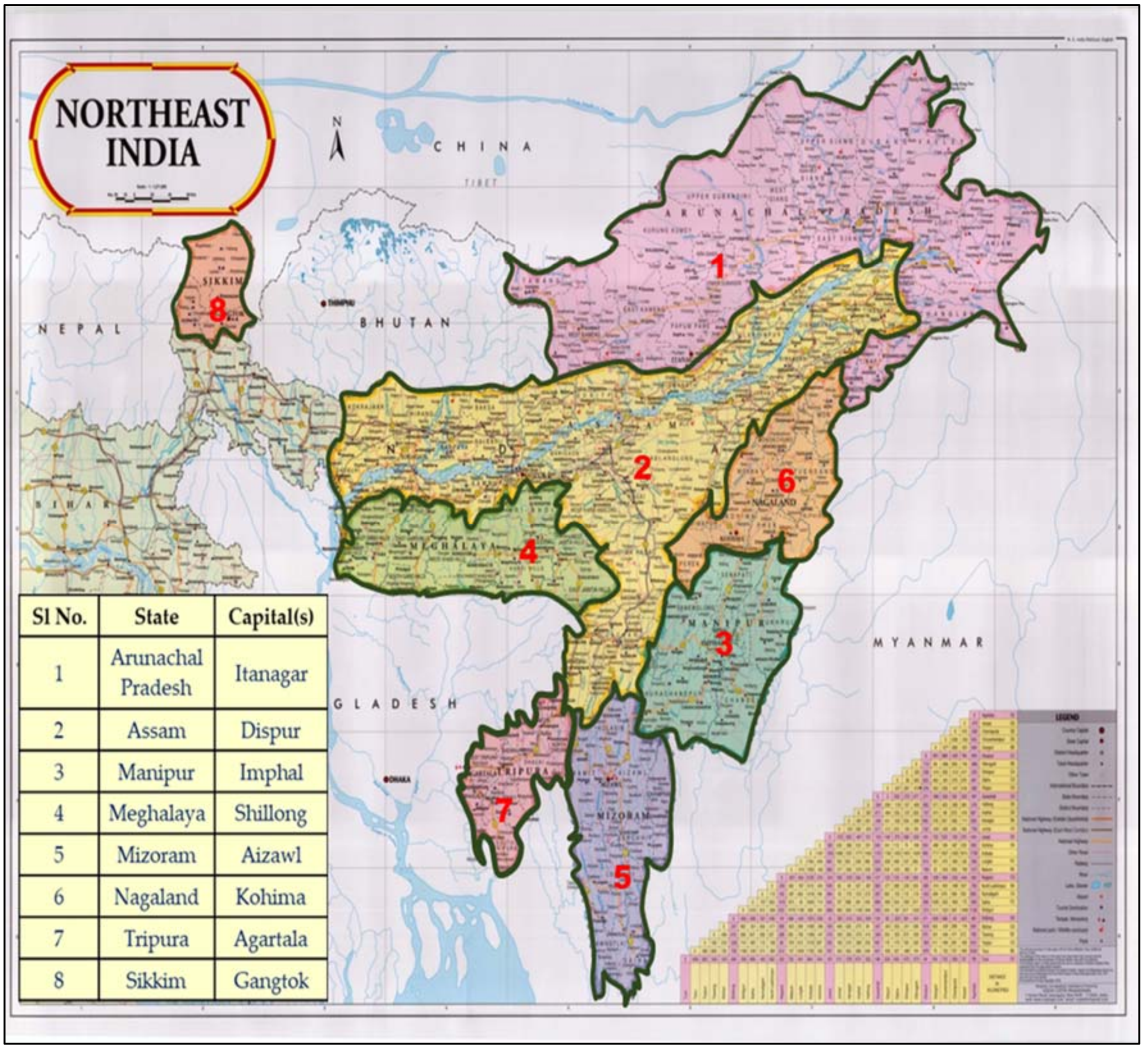



**Fig 1.1 Index Map of the Project Road**




| Sl No. | State | Capital(s) |
|---|---|---|
| 1 | Arunachal Pradesh | Itanagar |
| 2 | Assam | Dispur |
| 3 | Manipur | Imphal |
| 4 | Meghalaya | Shillong |
| 5 | Mizoram | Aizawl |
| 6 | Nagaland | Kohima |
| 7 | Tripura | Agartala |
| 8 | Sikkim | Gangtok |

**Fig 1.2 Project Influence Area**


**Fig 1.3 Project Location Map**

The Letter of Acceptance was issued on 22nd march 2018 vide letter ref no NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package-III/2017/66, however the letter of commencement was issued on 02nd July 2018 vide letter ref no. NHIDCL/Bharatmala/DPR/Phase-I/Lot-1/Package-III/2017/107. The contract agreement was signed on 19.06.2018.

Draft Inception was submitted on 14.09.2018 and final inception report was submitted on 18.10.2018.

Final Alignment Report was submitted on 19.08.2019 wide letter Transys/B'Lore/410-40157/2019-20/40248.

Final Alignment Report was approved on 23rd October 2019 via letter no NHIDCL/Bharatmla/V-S/ DPR/ Mizoram/2019-20//353.

Draft Feasibility Reports were submitted in packages with different dates. First package was submitted on 15.05.2020 followed by last package in the month of Sep'20 i.e., on 19th September 2020 via letter no Transys/B'Lore/410/Silchar-Sairang/2020-21/40300. DFR was reviewed by DGM (P) - PMU Tezpur dated 06th Oct' 2020 with a note of an acceptance of DFR and further submission of final feasibility report (FFR) via letter no 990012/DPR/SCH/NHIDCL/Tez/2569/228.

Accordingly, Final Feasibility Report (FFR) was submitted in packages SJ, P1 & P2 on 19.01.2021 vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2020-21/ 40319 and Draft detailed Project Report (DDPR) on 20.06.2022 vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2021-22/ 40386.

However, after successful submission of Draft DPR, Competent Authority had decided during MD VC meeting that SIlchar – Jiribam shall be on hold as the project stretch has not been included in the priority list due to uncertainty of 4-lane development of said stretch. Accordingly, the matter was conveyed to DPR consultant to hold the project DPR study and field investigation till further instructions.

However, in the month of May 2023 the said project has been reopened under the direction of MD & D(T) during VC meeting and DPR had been asked to accelerate the remaining pending assignment pertaining to said project as the project stretch was included under current year development plan.

Final DPR was submitted vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2022-23/404037 dated 27.07.2023 but collectively decision was taken to bifurcate the project corridor in to two (02) packages due to tunnel proposal & its cost constraints and several other limitations.

Hence, project corridor is as below.

1. **Package: SJ-1 (Existing km 260+000=D. Ch. 4+560 at Silchar/ Nutan Dayapur to existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam State).**
2. **Package: SJ-2 (Existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam state to Existing km 212+060=D. Ch 37+650 at Jiribam in Manipur State).**

Eventually, This Final Detailed Project Report (FDPR) is being submitted under R1 for package: SJ-1 in response to the Terms of Reference Clause 10.10 and contains the findings by our Project Team during detailed survey and investigations of the project road and initial interaction with officials of NHIDCL.

## 1.2 Objectives of the Consultancy Services

a) The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project reports for development of economic corridors, Inter-corridors and feeder routes, as the case may be. These corridors are proposed for development to at least 4-lane access controlled (fully access control for Economic Corridors), however, DPR for access controlled 6-laning/8-laning may be required, in certain stretches, depending upon traffic. The selected Consultant shall mandatorily consult State/Central Governments, authorities, Corporations and bodies dealing with works related to freight movement to assess the project requirement.

b) The study shall include topographic surveys, traffic survey, finalization of alignment for approval of the Govt., land plans and preliminary design of geometrics, pavement, structures, safety devices, toll plazas, project facilities, finalization of document for environmental clearance & other statutory clearances, estimation of probable cost of construction and documents required for tendering purpose.

c) The study would inter-alia include, firming up the requirements in respect of development and construction of the Project Highway and Project Facilities and enabling the prospective bidders to assess the requirements in a clear and predictable manner with a view to ensuring:

- Enhanced safety and level of service for the road users.
- Minimal adverse impact on environment.
- minimal additional acquisition of land; and

d) The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis within the given time frame.

e) The Detailed Project Report (DPR) would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, solutions for congestions/bottlenecks in highway/routes including bypass alignment & design, if needed, safety aspects, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.

f) The DPR consultant should ensure detailed project preparation incorporating aspects of value engineering, quality audit and safety audit requirement in design and implementation. The Consultant shall ensure to carry out Road Safety Audit at various stages as per supplement-III (Additional Requirement for Safety Audit) of TOR.

g) The consultant should, along with Feasibility Report, clearly bring out through financial analysis the preferred mode of implementation on which the Civil Works for the stretches are to be taken up. The consultant should also give cost estimates along with feasibility report/ detailed Project Report.

h) The consultant shall prepare the bid documents including required schedules as per EPC documents. The Consultant shall assist the Authority and its Financial Consultant and the Legal Adviser by furnishing clarifications as required for the financial appraisal and legal scrutiny of the Project Highway and Bid Documents.

## 1.3 Scope of Consultancy Services

The scope of consultancy services as set out in the TOR includes, but not limited, to the following major tasks:

- Review of all available reports and published information about the project area;
- Detailed reconnaissance with GPS;
- Inventory and condition surveys of existing Road;
- Inventory and condition surveys for bridges, cross-drainage structures, other Structures, river Bank training/Protection works and drainage provisions;
- Detailed topographic survey using mobile/ aerial LiDAR or equivalent technology. Fixing of TBM and all reference Point on Ground during survey; and this should be clearly shown on detailed survey drawings;
- Detailed traffic studies including traffic surveys and Axle load survey and demand forecasting for next thirty years;
- Pavement Investigations;
- Sub-grade characteristics and strength: investigation of required sub-grade and sub-soil characteristics and strength for road and embankment design and sub soil investigation;
- Identification of sources of construction materials;
- Detailed design of road, its x-sections, horizontal and vertical alignment and design of embankment of height more than 6m and also in poor soil conditions and where density consideration require, even lesser height embankment.

Detailed design of structures preparation of GAD and construction drawings and cross-drainage structures and underpasses etc;

- Identification of the type and the design of intersections;
- Design of complete drainage system and disposal point for storm water;
- Value analysis / value engineering and project costing;
- Economic and financial analysis;
- Contract packaging and implementation schedule;
- Strip plan indicating the scheme for carriageway widening, location of all existing utility services (both over- and underground) and the scheme for their relocation, trees to be felled, transplanted and land acquisition requirements including schedule for LA;
- To find out financial viability of project for implementation and suggest the preferred mode on which the project is to be taken up;
- Preparation of detailed project report, cost estimate, approved for construction Drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works through budgeting resources;
- Design of toll plaza and identification of their numbers and location;
- Preparation of social plans for the project affected people as per policy of the lending agencies/ Govt. of India R & R Policy.

### 1.4 Review of scope of TOR and gap identification

Consultant has carefully reviewed the Terms of reference (TOR). The Terms of Reference (TOR) are found to be concise, clear and quite elaborate and are based on the practical basis. We consider that the TOR defines the project needs and performance requirements quite adequately. The main objective is to establish the technical, economic and financial viability of the project and prepare a Detailed Project Report for specified roads under economic corridors, Inter-corridors and feeder routes. Subjected to at least 4 lane access controlled or 6 lane access controlled in certain stretches, depending upon the traffic condition. Understanding of TOR as follows:

(i) Financial viability of the project for implementation and suggestions regarding preferred mode on which the project shall be taken up;

(ii) Enhanced safety and level of service for the road users;

(iii) Superior operation and maintenance enabling enhanced operational efficiency of the Project Highway;

(iv) Minimal adverse impact on the local population and road users due to road construction.

(v) Minimal adverse impact on environment; and

(vi) Minimal additional acquisition of land

The design proposals would have to be evolved and finalized taking into account the existing conditions, techno-economic feasibility, financial viability of the project, preferred mode of implementation on which the civil works for the stretches shall be taken up, aspects of value engineering, requirement of quality & safety, safety of operation and efficient maintenance of the facility. The expert services would also have to ensure the correctness and authenticity of all information pertaining to the design and documentation.

**Gap Identification**

i) Information regarding Details of available data regarding structures, pavement, traffic, past accident data, freight movement scenario etc. available with client may please be shared.

ii) Information regarding existing ROW available with client for the project stretch may please be shared.

Support from the Client would be very helpful during the collection of revenue records including ownership details from revenue officials for preparation of Land Plan Schedules

## 1.5 Reports and documents to be submitted by the consultants

As per ToR, Project preparation activities have been split into eight stages as given below;

**Table 1.1 Stage Submission Details**

| Sl. No | Stages | Key activities | Deliverables |
|---|---|---|---|
| 1 | Inception | Project planning and mobilization | Inception Report and QAP |
| 2 | Feasibility | Alignment finalization, Preliminary surveys | Alignment Options Report and Feasibility Report |
| 3 | LA and Clearances I | LA, utilities identification; creation of draft notifications and proposals | Strip Plan, LA Report (3a, 3A), Clearances and Utility Shifting proposals |
| 4 | DPR | Detailed design of highway, preparation of detailed project report with drawings | Draft DPR Report, Final DPR Report, documents and drawings |
| 5 | Technical Schedules | Preparation of bid documents and technical schedules | Civil Works Contract Agreement and Schedules |
| 6 | (i) LA II<br>(ii) Project<br>(iii) Clearances | Land acquisition process, obtaining final utilities estimate and required clearances | JMS and 3D Report, Final Project Clearances and Utilities Report |
| 7 | LA III- Award Determination | Land acquisition award determination | 3G Report |
| 8 | LA IV- Possession | Obtaining possession of land | Land Possession Report |

Final Detailed Project Report (R1) of Section: Silchar/ Nutan Dayapur to Budha Nagar, Package: SJ-1 D. Ch. 4+560 (existing Km 260+000 of NH-37) to D. Km 24+560 (existing KM 233+000 of NH-37) in accordance with the accepted Final Detailed Project Report and the report shall contain the following:

i. **Volume-I, Main Report:** This report shall be present the project background, details of surveys and investigations carried out, analysis and interpretation of survey and investigation data, traffic studies and demand forecasts, pavement design, improvement proposals, cost estimation and environmental impact assessment and management plan. The report shall include Executive Summary giving brief accounts of the findings of the study and recommendations.

The Report shall also include maps, charts and diagrams showing locations and details of existing features and the essential features of improvement and upgrading.

The above details in this volume have been described in ten chapter, are mentioned below,

0. Executive summary
1. Overview of Executive Engineer, National Highway Division, National Highways & Infrastructure Development Corporation Limited (NHIDCL.), organization and activities, and project financing and cost recovery mechanisms
2. Project description including possible alternative alignments / bypasses and technical / engineering alternatives.
3. Analysis and Interpretation of Engineering Surveys and Investigation.
4. Traffic Studies & Demand Forecast.
5. Indicative design standards, methodologies and specifications.
6. Pavement Design.
7. Improvement Proposal on Highway & Structure.
8. Cost estimates based on preliminary rate analysis and bill of quantities.
9. Environmental screening and preliminary environmental assessment
10. Initial social assessment and preliminary land acquisition / resettlement plan
11. Conclusions and recommendations

The basic data obtained from the field studies and investigations and input data used for the preliminary design shall be submitted in the volume as an **Appendix to Main Report**.

ii. **Volume - II Design Report:** This volume shall contain design calculations, supported by **computer printout of calculations wherever applicable. The Report shall clearly bring out** the various features of design standards adopted for the study. The design report will be in two parts. **Part-I** shall primarily deal with the design of road features and pavement composition while **Part-II** shall deal with the design of bridges, tunnels and cross-drainage structures. The sub-soil exploration report including the complete details of boring done, analyses and interpretation of data and the selection of design parameters shall be included as an Appendix to the Design Report.

The detailed design for all features should be carried out as per the requirements of the Design Standards for the project. However, there may be situations wherein it has not been possible to strictly adhere to the design standards due to the existing site conditions, restrictions and other considerations. The report should clearly bring out the details of these aspect and the standards adopted.

iii. **Volume - III, Materials Report:** The Materials Report shall contain details concerning the proposed borrow areas and quarries for construction materials and possible sources of water for construction purposes. The report shall include details on locations of borrow areas and quarries shown on maps and charts and also the estimated quantities with mass haul diagram including possible end use with leads involved, the details of sampling and testing carried out and results in the form of important index values with possible end use thereof.

The materials Report shall also include details of sampling, testing and test results obtained in respect physical properties of subgrade soils. The information shall be presented in tabular as well as in graphical representations and schematic diagrams. The Report shall present soil profiles along the alignment.

The material Report should also clearly indicate the locations of areas with problematic soils. Recommendations concerning the improvement of such soils for use in the proposed construction works, such as stabilization (cement, lime, mechanical) should be included in the Report.

iv. **Volume - IV, Environmental Assessment Report including Environmental Management Plan (EMP) & Resettlement Action Plan (RAP):** The Report shall be prepared conforming to the Guidelines of the Government of India, State Government and World Bank / ADB as appropriate for construction package.

v. **Technical Specifications (Read as Technical Schedule):** The MORT&H's Technical Specifications for Road and Bridge works will be followed for this study. However, Volume - V: Shall be referred as ''Technical Schedule'' shall contain the special technical specifications which are not covered by MoRT&H Specifications for Roads and Bridges (latest edition / revision) in this technical schedule and also specific quality control norms for the construction of works.

vi. **Volume - VI, Rate Analysis:** This volume will present the analysis of rates for all items of works. The details of unit rate of materials at source, carriage charges, any other applicable charges, labour rates, and machine charges as considered in arriving at unit rates will be included in this volume.

vii. **Volume - VII, Cost Estimates:** This volume will present the contract package wise cost of each item of work as well as a summary of total cost.

viii. **Volume - VIII, Bill of Quantities:** This volume shall contain the package-wise detailed Bill of Quantities for all items of works.

ix. **Volume - IX, Drawing Volume:** All drawings forming part of this volume shall be 'good for construction' drawings. All plan and profile drawings will be prepared in scale 1:250V and 1:2500H scale to cover one km in one sheet. In addition this volume will contain 'good for construction' drawings for the following:

I. Horizontal Alignment and Longitudinal Profile.

II. Cross-section @ 50m interval along the alignment within ROW

III. Typical Cross-Sections with details of pavement structure.

IV. Detailed Working Drawings for individual Culverts and Cross Drainage Structures.

V. Detailed Working Drawings for individual Bridges, tunnels and Structures.

VI. Detailed Drawings for Improvement of At-Grade and Grade-Separated

VII. Intersections and Interchanges.

VIII. Drawings for Road Sign, Markings, Toll Plazas, and other Facilities.

IX. Schematic Diagrams (linear chart) indicating but be not limited to be following:

- Widening scheme.
- Locations of median openings. Intersections, interchanges. Underpasses. Overpasses, bypasses.
- Locations of service roads.
- Location of traffic signals, traffic signs, road markings, safety features; and,
- Locations of toll plaza, parking areas, weighing stations, bus bays, rest areas, if

X. Drawings for toll plaza, Bus Bays, Parking areas, Rest areas, weighing stations etc. All drawings will be prepared in A2 size sheets. The format for plan, cross section and profile drawings shall be finalised in consultation with the concerned Officer of NHIDCL. The drawings shall also include details of all BM and reference pillars, HIP and VIP. The co-ordinates of all points should be referenced to a common datum, preferably GTS referencing system. The drawings shall also include the locations of all traffic safety features including traffic signals, signs, markings, crash barriers, delineators and rest areas, bus bays, parking areas etc.

XI. The typical cross-section drawings should indicate the scheme for future widening of the carriageway. The proposed cross-sections of road segment passing through urban areas should indicate the provisions for pedestrian movements and suitable measures for surface and sub-surface drainage and lighting, as required.

The Final Detailed Project Report incorporating comments, revisions and modifications suggested by NHIDCL shall be submitted within 15 days of receipt comments from NHIDCL on Draft Detailed Project Report.

## 1.6 Compliance to observations / comments raised during Feasibility and DPR study.

## 1.7 Status of Work

- Internal meetings with all discipline heads were conducted at our regional office (Design office) for the preparation and submission of Inception/ Feasibility/ Detailed project Report.
- Kick-off meeting had been arranged at GM office, NHIDCL Aizawl along with the DPR consultant team on 11.07.2018.
- Kick-off meeting regarding various site activities had been held at GM office, NHIDCL, Aizawl along with sub-divisional officers and DPR consultant team on 06th August 2018.
- A presentation on Draft Inception Report was furnished at GM's office, Aizawl on 08.10.2018. Observations made by the client during presentation were incorporated in Final Inception Report and was submitted on 18th October 2018.
- Presentation on Final Inception report was also held at GM (T- Mizoram) office, New Delhi on 28th December 2018.
- Presentation on Alignment report was given on 15th January 2019 at NHIDCL, Delhi.
- A meeting regarding Alignment report was held at CE office, NH-PWD, Aizawl on 15th January 2019.
- Site visit of entire stretch with GM (T/P) was held during 26th and 27th of January 2019

- Several correspondences were made regarding alignment approval vide letter no Transys / B'lore /410-40157/ 2019-20/ 40247 accordingly Team Leader was called for final review on alignment on 14th August 2019 followed by 9th October 2019. Based on review meeting, observation was incorporated in Final Alignment report and submitted on 19th August 2019.
- Presentation on Alignment report was given on 9th October 2019 at NHIDCL (HQ), Delhi
- Eventually, the Final Alignment report was approved through wide letter no NHIDCL/Bharatmala/V-S DPR/ Mizoram/ 2019-20/ 353 dated 23rd October 2019.
- A review meeting was held with MD-NHIDCL (HQ) on 7th February 2020.
- A presentation was given to General Manager (Shilong) on 15.02.2020 at Silchar SO.
- Soon after alignment approval, PPT presentation was also delivered at respective DCs offices including DC-Kolasib on 20.02.2020, DC-Aizawl on 04.03.2020, DC-Cachar (Silchar) on 02.03.2020 moreover, draft MoM was also prepared on-behalf and forwarded by NHIDCL through mail **dated 03.03.2020 (enclosed for ref.)** to DC-Cachar with an acceptance / approval of all stakeholders including DFO-Cachar however, due to covid pandemic crisis followed by lockdown and subsequent transfer of existing DC- Silchar, the Minutes of meeting (MoM) could not be signed and issued.
- Stakeholders meeting ware re-arranged by DC-cachar dated 16.02.2022 and 26.02.2022, inviting all stakeholders including Hon'ble MP of Cachar, respective MLAs, Grampanchayat Presidents, DFO-Cachar and all concerned departments. **MoM issued dated 16.02.2022 and 26.02.2022 (attached).** As per stakeholders' meetings, preceded by Hon'ble MP and DC-cachar, it was agreeable to all stakeholders by carrying out Economy Corridor 4-lane development along open/greenfield bypassing all major settlements after analysing 'pros & cons' between improvement of existing road and development of new 4-lane road along greenfield.
- Number of virtual and in-person meetings were also acknowledged with MD, ED (P), ED(T), respective GM/DGM (P & T), Forest department, ADC/CALA (Revenue dept.), NH-PWDs and hon'ble MP and MLAs to brief about development project road.

1.8 **Present Submission: Final Detailed Project Report** (FDPR) **R1** is under submission.

2

# Chapter 2- Socioeconomic profile of the Project Area, Project Description and Existing Scenario

**Section: Silchar to Jiribam (Package: SJ-1, From D. Km 4+560 to D. Km 24+560)**

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# 2 Chapter 2 – Socioeconomic profile of the Project Area Project Description and Existing Scenario

## 2.1 Profile of Assam State:

Assam, the gateway to the Northeast India is the largest State in the North East is bordering seven states (also called as 07 sisters) viz. Arunachal Pradesh, Monipur, Meghalaya, Mizoram, Nagaland, Tripura and Assam and two countries viz. Bangladesh & Bhutan. The State is endowed with abundant fertile land and water resources with total geographical area of 78,438 sq.km. Of which 98.4% area is rural. Assam shares about 2.4% of the country's total geographical area and provides shelter to 2.6% population of the country. Most of the state population lives in the lush valleys of its two major river system in the 30 districts of the Brahmaputra valley & 3 districts of the Barak valley. Less densely populated three hill districts viz. Karbi-Anglong, West Karbi-Anglong & Dima Hasao, set in the low-laying hills that separate the two valleys. For administrative and revenue purposes, the state has 33 districts including four districts Under the Bodoland Territorial Council (BTC) area viz. Kokrajhar, Chirang, Baska & Udalguri and 6 newly created districts viz., Biswanath, Charaideo, Hojai, South Salmara-Macachar , West Karbi-Anglong and Majuli.

The State has been blessed bountiful by nature. The mighty Brahmaputra truncating the state, the Barak River in the south and their tributaries provide abundant water resource; the dense forest cover is home to a wide range of valuable timber, bamboo & medical plants; the state reserve of oil and natural gas; the fertile valleys & hills lopes nourish tea gardens and horticultural crops while the rich and fertile soil lend itself to raising vital food-grains.

Assam is administratively divided into 33 districts with 80 sub-division, 219 Development Blocks and 2202 Gaon Panchayats, out of which 3 districts with 4 sub-divisions & 16 Development Blocks are under three hill districts of Karbi-Along, East Karbi-Along & Dima Hasao. Further, four districts with eight sub-divisions are under Bodoland Territorial Council (BTC) area viz Kokrajhar, Chirang, Baska & Udalguri. The Brahmaputra valley consists of North Bank Plains Zone (NBPZ), Upper Brahmaputra valley Zone (UBVZ), Central Brahmaputra valley Zone (CBVZ) and Lower Brahmaputra Valley Zone (LBVZ), whereas the Barak Valley Zone mainly consists of plain area of three districts, viz. Cachar, Karimganj & Hailakandi.

The State is severely affected by floods during rainy seasons causing enormous damage to crop, livestock, land, property & bringing untold miseries to the people at large. Both the Brahmaputra and Barak Valley witness devastating floods every year, which not only washes away valuable life & crops, but also lead to bank erosion and drainage congestion, virtually destroy the economy, more particularly, the rural economy of the State.

Assam has heterogeneous population with socio-cultural & ethnic diversity. According to the Census of India, 2011 the population of Assam stands at 312.05 lakh of which 159.39 lakh are male and 152.66 lakh are female. The decadal growth of the State's population works out at 17.07 percent during the decade 2001-2011 as against 17.68 percent for the country as a whole. Out of the total 312.05 lakh population, 86 percent population live in rural areas & 14 percent population live in urban areas of the State. The density of the population of Assam has increased to 398 persons in 2011 from 340 persons in 2001 Census or on an average, 58 more people inhabit every square kilometre in the State as compared to a decade ago.

## 2.2 History of Assam

The history of Assam is the history of a confluence of people from the east, west and the north; the confluence of the Tibeto-Burman (Sino-Tibetan), Indo-Aryan and Austroasiatic cultures. Although invaded over the centuries, it was never a vassal or a colony to an external power until the third Burmese invasion in 1821, and, subsequently, the British ingress into Assam in 1824 during the First Anglo-Burmese War.

The Assamese history has been derived from multiple sources. The Ahom kingdom of medieval Assam maintained chronicles, called Buranjis, written in the Ahom and the Assamese languages. History of ancient Assam comes from a corpus of Kamarupa inscriptions on rock, copper plates, clay; royal grants, etc. that the Kamarupa kings issued during their reign. Protohistory has been reconstructed from folklore: epics like Mahabharata, and two medieval texts compiled in the Assam region—the Kalika Purana and the Yogini Tantra.

The history of Assam can be divided into four eras. The ancient era began in the 4th century with the mention of Kamarupa in Samudragupta's inscriptions on the Allahabad pillar and the establishment of the Kamarupa kingdom. The medieval era began with the attacks from the Bengal Sultanate, the first of which took place in 1206 by Bakhtiyar Khilji as mentioned in the Kanai-boroxiboa rock inscription, after the breakup of the ancient kingdom and the sprouting of medieval kingdoms and chieftain-ships in its place. The colonial era began with the establishment of British control after the Treaty of Yandaboo in 1826, and the post-colonial era began in 1947 after the Independence of India.

## 2.3 Culture of Assam

Assam is the meeting ground of diverse cultures. The people of the enchanting state of Assam are an intermixture of various racial stocks such as Mongoloid, Indo-Burmese, Indo-Iranian and Aryan. The Assamese culture is a rich and exotic tapestry of all these races evolved through a long assimilative process. The natives of the state of Assam are known as "Asomiya" (Assamese), which is also the state language of Assam. A majority of the Assamese is the Vaishnavas (a sect of Hinduism). The Vaishnavas do not believe in idol worshiping and perform Namkirtana where the glory of Lord Vishnu is recited. The two important cultural and religious institutions that influence the cultural fabric of Assam: the Satras, the site of religious and cultural practice which have been in existence for over 400 years and and the Naamghar, the house of prayers. Villagers generally associate on the basis of membership of a local center of devotional worship called "Naamghar". The most important social and cultural celebrations are the three Bihu festivals observed with great enthusiasm irrespective of caste, creed and religious affinity.

## 2.4 Climate of Assam

The climate of Assam is typically 'tropical monsoon rainfall' type, with high levels of humidity and heavy rainfall. People here enjoy a moderate climate all throughout the year, with warm summers and mild winters. In the monsoon season, the whole state comes alive with the beauty of nature. Climatic variations can be seen regionally. While the plains of Assam have a tropical climate with high humidity, the hills have a sub-alpine type of climate. There are four distinct seasons in Assam - summer, monsoon, autumn and winter. The best time to visit the place is the winter season i.e. from October to April, which is also the festive season of Assam. Let us gather some more information on the weather and climate of Assam

The summer season in Assam starts from the month of March and extends till the end of June. The season is characterized by extreme humidity and frequent showers. The average temperature during this time of the year is between 35 and 38 degree Celsius. In fact, the mercury level never rises more than 38 degrees, even in the hottest month of the year. So, light cotton clothes are the best option during summers.

This season brings relief from the scorching heat of the summers. The neighboring areas of Cherapunji and Mawsynram have the highest rainfall in the world. The average annual rainfall in the state is around 70 inches in the west and around 120 inches in the east. In the afternoons, thunderstorms known as Bordoicila are very common. The season covers the entire state with a green blanket.

The winter season in Assam is basically characterized by scanty rainfall and misty mornings and afternoons. It starts in November and continues till the month of February. The mercury reading at this time of the year is around 6 to 8 degree Celsius or 43- 46 degree Fahrenheit. This is the best time to visit the northeastern state of Assam.

In Assam, spring (March- April) and autumn (September- October) present pleasant seasons, with moderate temperature and rainfall. These are amongst the popular months for tourist rush. As it is neither too cold nor too hot, you don't have to carry any special type of garment for these seasons. Therefore, if you are planning a trip to Assam, spring and autumn may be your choice.

## 2.5 About Cachar

The District of Cachar is located in the Southernmost part of Assam is one of the oldest districts of Assam. It is bounded on the North by Barali and Jayantia hill ranges, on the South by the State Mizoram, on the East by the State of Manipur and West by sister districts Hailakandi and Karimganj. The district was created in 1830 after annexation of Kachari Kingdom by British. In 1854, North Cachar was annexed and tagged to the district. The name Cachar traces its origin to the Kachari kingdom called Dimasa Kingdom in medieval times. Cachar district occupies an area of 3,786 square kilometres. The Barak is the main river of the district and apart from that there are numerous small rivers which flow from Dima Hasao district, Manipur or Mizoram. The district is mostly made up of plains,but there are a number of hills spread across the district. Cachar receives an average annual rainfall of more than 3,000 mm. The climate is Tropical wet with hot and wet summers and cool winters. The district headquarters, Silchar, is one of the most important business centres of Assam. In 2006 the Indian government named Cachar one of the country's 250 most backward districts out of a total of 640. It is one of the eleven districts in Assam currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). There are seven Assembly constituencies in this district, viz. Silchar, Sonai, Dholai, Udharbond, Lakhipur, Barkhola and Katigorah. Dholai is designated for scheduled castes. The seven constituencies make up the Silchar Lok Sabha constituency. According to the 2011 census Cachar district has a population of 1736319, roughly equal to the nation of The Gambia or the US state of Nebraska. This gives it a ranking of 278th in India out of a total of 640. Cachar has a sex ratio of 958 females for every 1000 males, and a literacy rate of 80.36%. Bengali is the status of Official Language in this district with majority of the people primarily speaking Bengali and Sylheti. Apart from Bengali, other minority languages spoken in the district include Meitei Manipuri, Bishnupuriya Manipuri, Dimasa and Rongmei-Naga. There are also few Mizo, Kuki and Khasi people who form microscopic minority. The district of Cachar has a number of well-known educational institutes in North East India. Silchar, the district headquarters, is a major learning hub of Assam. The district has a central university, the Assam University, which is situated at Durgakona, 18 km from Silchar. It also has NIT Silchar, one of the 30 NITs in India. The Silchar Medical College and Hospital is the only medical college of southern Assam.

## 2.6 Profile of Manipur State:

Manipur is one of the Border States in the northeaster part of the country having an international boundary of about 352 kms Long stretch of land with Myanmar in the southeast. It is bounded by Nagaland in the north, Assam in the west and Mizoram in the south. It has a total area of 22327 sq. kms. It lies between 23.80 N to 25.70 N latitude and 93.50 E to 94.80 E longitude. Geographically, the State of Manipur could be divided into two regions, viz. the hill and the valley. The valley lies in the central part of the State and the hills surround the valley. The average elevation of the valley is about 790 m above the sea level and that of the hills is between 1500 m and 1800m. The hill region comprises of five districts viz. Senapati, Tamenglong, Churachandpur, Chandel and Ukhrul and the valley region consists of four districts, viz. Imphal East, Imphal West, Thoubal and Bishnupur. The hill districts occupy about 90 percent (20089 sq km) of the total area of the State and the valley occupies only about tenth (2238 sq km) of the total area of the State. Imphal is the capital city of Manipur. The maximum temperature in the summer months is 32 °C. In winter the temperature often falls below 0 °C, bringing frost. Snow sometimes falls in hilly regions due to the Western Disturbance. The coldest month is January, and the warmest July. It receives an average annual rainfall of 1,467.5 millimetres. Manipur has a population of 2,855,794 as per 2011 census. The official languages are Meitei language and English. Tulihal Airport, Changangei, Imphal, the only airport of Manipur, connects directly with Delhi, Kolkata, Guwahati, and Agartala. It has been upgraded as an International airport. As India's second largest airport in the northeast, it serves as a key logistical centre for northeastern states.[20] National Highway NH-39 links Manipur with the rest of the country through the railway stations at Dimapur in Nagaland at a distance of 215 km (134 mi) from Imphal. National Highway 53 (India) connects Manipur with another railway station at Silchar in Assam, which is 269 km (167 mi) away from Imphal. The road network of Manipur, with a length of 7,170 km (4,460 mi) connects all the important towns and distant villages. However, the road condition throughout the state is often deplorable. In 2010, Indian government announced that it is considering an Asian infrastructure network from Manipur to Vietnam. The proposed Trans-Asian Railway (TAR), if constructed, will pass through Manipur, connecting India to Burma, Thailand, Malaysia and Singapore.

### 2.7 History of Manipur State

Since ancient times, the Meitei people have lived in the valleys of Manipur alongside the highlanders in the hills and valley in peace. Meitei Pangal people settled in the valleys during the reign of Meidingu Khagemba in the year 1606. Since then, they also lived along with the Meitei. Manipur became a princely state under British rule in 1891, the last of the independent states to be incorporated into British India. During the Second World War, Manipur was the scene of battles between Japanese and Allied forces. The Japanese were beaten back before the Allies could enter Imphal. This proved to be one of the turning points of the war. After the war, the Manipur Constitution Act, 1947, established a democratic form of government with the Maharaja as the Executive Head and an elected legislature. In 1949, Maharaja

Budhachandra was summoned to Shillong, capital of the Indian province of Meghalaya where he signed a Treaty of Accession merging the kingdom into India. Thereafter the legislative assembly was dissolved and Manipur became part of the Republic of India in October, 1949. It was made a union territory in 1956 nd a full-fledged state in 1972. Mairembam Koireng Singh became the first Chief Minister in 1972 of the State of Manipur.

## 2.8 Culture of Manipur State

Secular theatre is mostly confined to themes that are not religious; it is performed in the secular or profane spheres. In these are Shumang lila and Phampak lila (stage drama). Shumang lila is very popular. Etymologically Shumang lila is the combination of "Shumang" (courtyard) and "Lila" (play or performance). It is performed in an area of 13×13 ft in the centre of any open space, in a very simple style without a raised stage, set design, or heavy props such as curtains, background scenery, and visual effects. It uses one table and two chairs, kept on one side of the performance space. Its claim as the "theatre of the masses" is underlined by the way it is performed in the middle of an audience that surrounds it, leaving one passage as entrance and exit.

The world of Phampak lila (stage drama) performed in the proscenium theatre is similar, in form, to the Western theatrical model and Indian Natyasastra model though its contents are indigenous. The so-called modern theatre descended on Manipur theatre culture with the performance of Pravas Milan (1902) under the enthusiastic patronage of Sir Churchand Maharaj (1891–1941). The pace of theatrical movement was geared up with the institution of groups such as Manipur Dramatic Union (MDU) (1930), Arian Theatre (1935), Chitrangada Natya Mandir (1936), Society Theatre (1937), Rupmahal (1942), Cosmopolitan Dramatic Union (1968), and the Chorus Repertory Theatre of Ratan Thiyam (1976). Today Manipur theatre is well respected because of excellent productions shown in India and abroad. Manipur plays, both Shumang lila and stage lila, have been a regular feature in the annual festival of the National School of Drama, New Delhi. Iskcon led by Bhaktisvarupa Damodara Swami started a network of schools in Northeastern India, where more than 4000 students receive education centred on Vaishnava spiritual values. In 1989 he founded "Ranganiketan Manipuri Cultural Arts Troupe", which has approximately 600 performances at over 300 venues in over 15 countries. Ranganiketan (literally "House of Colorful Arts") is a group of more than 20 dancers, musicians, singers, martial artists, choreographers and craft artisans. Some of them have received international acclaim.

## 2.9 About Jiribam

Jiribam is a municipal council in the Jiribam district of Manipur, India. Followed by the Hmar, it is one of the fastest growing towns in Manipur. The town is located on the state's western-most boundary adjoining the Cachar district of Assam. It is also known as the western gate of Manipur. The recorded history of Jiribam began during the British colonial period. At the beginning of the 19th Century, several tribes and religious groups began to migrate to the area along the Jiri River. During this era, the Jiri River was a famous landmark and Jiribam was a major trade center. There are three seasons: the dry season, the rainy season, and the winter season. The average rainfall ranges from 1,000 mm to 1,600 mm. The months of May and June are the hottest season, is about 40 °C. The lowest temperatures are recorded from the second half of December to the first half of January (i.e., below 2.78 °C) at late night. Jiribam had a population of 6426. Males constitute 49% of the population and females 51%. Jiribam has an average literacy rate of 73%, higher than the national average of 59.5%: male literacy is 80%, and female literacy is 66%. In Jiribam, 13% of the population is less than 6 years of age. Jiribam is home to Manipur's first railway station. Jiribam is currently connected to the rest of India by a recently converted Broad Gauge track towards Silchar. A rail project to connect Imphal through Jiribam–Tupul–Imphal is being executed and is expected to be complete by 2018. This project is on the alignment of a railway line proposed to connect with Myanmar. There are 2 highways that connect with Imphal: one with the capital of Manipur and the other with Assam and Meghalaya. Railway construction is not expected to be completed soon.

## 2.10 History of Road Development in Assam and Manipur

Railways, which are the cheapest form of travel, have only a taken presence of some kilometers. Inland waterways are practically non-existent even though at one time the small rivers criss-crossing the valleys were used for transporting goods and people by boats. In Churachandpur district, goods are transported from Jiribam to the southernmost subdivision of Tipaimukh mainly on the river Barak. The states are coming mostly in Hilly terrain, which facing the issues of land acquisition for highway projects in the North East. To overcome the issues, Centre has been appointed NHIDCL. Now the road transport is developing in the states with many National and State highways providing means for fast transportation. Assam and Manipur are three most progressive and an important state of India. Economy of the states has shown tremendous progress due to the improvement of roads that can be found even in the remotest part of the state. All the districts are well connected to provide efficiency and quick access to any place. The roads contribute a lot towards the progress of the state. Sufficient modes of transport like the taxis, buses and auto rickshaws, cycles, scooters can be seen in plenty on the roads due to the progressive demands of the state. This is in progress of implementing of a multi-sectorial Road Safety Action Plan (RSAP), undertaking demonstration projects on road safety engineering measures, road safety assessments of core network, establishing road accident database etc.

The road network construction and upgrade had received a boost with the implementation of the Special Accelerated Road Development Programme (SADRP) in 2006. The first phase envisaged a 6,500 km network for completion by 2016, but only about 1,000 km of the proposed network has been completed; a 3,723 km network is planned for the second phase. An uncertain security situation with threats of violence by local insurgent groups demanding payoff has resulted in slow progress.

## 2.11 Importance of Project Road

The Northeast, strategically important yet economically underdeveloped, has been witnessing spurts of road building activities since independence. The need to establish connection with the rest of India following partition, the Chinese aggression, economic development, and trans-border connectivity are some of the main drivers which have been impelling the central government to construct roads in the region since independence. However, impediments such as terrain and climatic conditions, insurgency, and mismanagement of resources have also put brakes on the development of the road network in the region. The paper identifies the drivers and brakes, which have fashioned the evolution of the road network in the region and suggests some measures to overcome the hurdles.

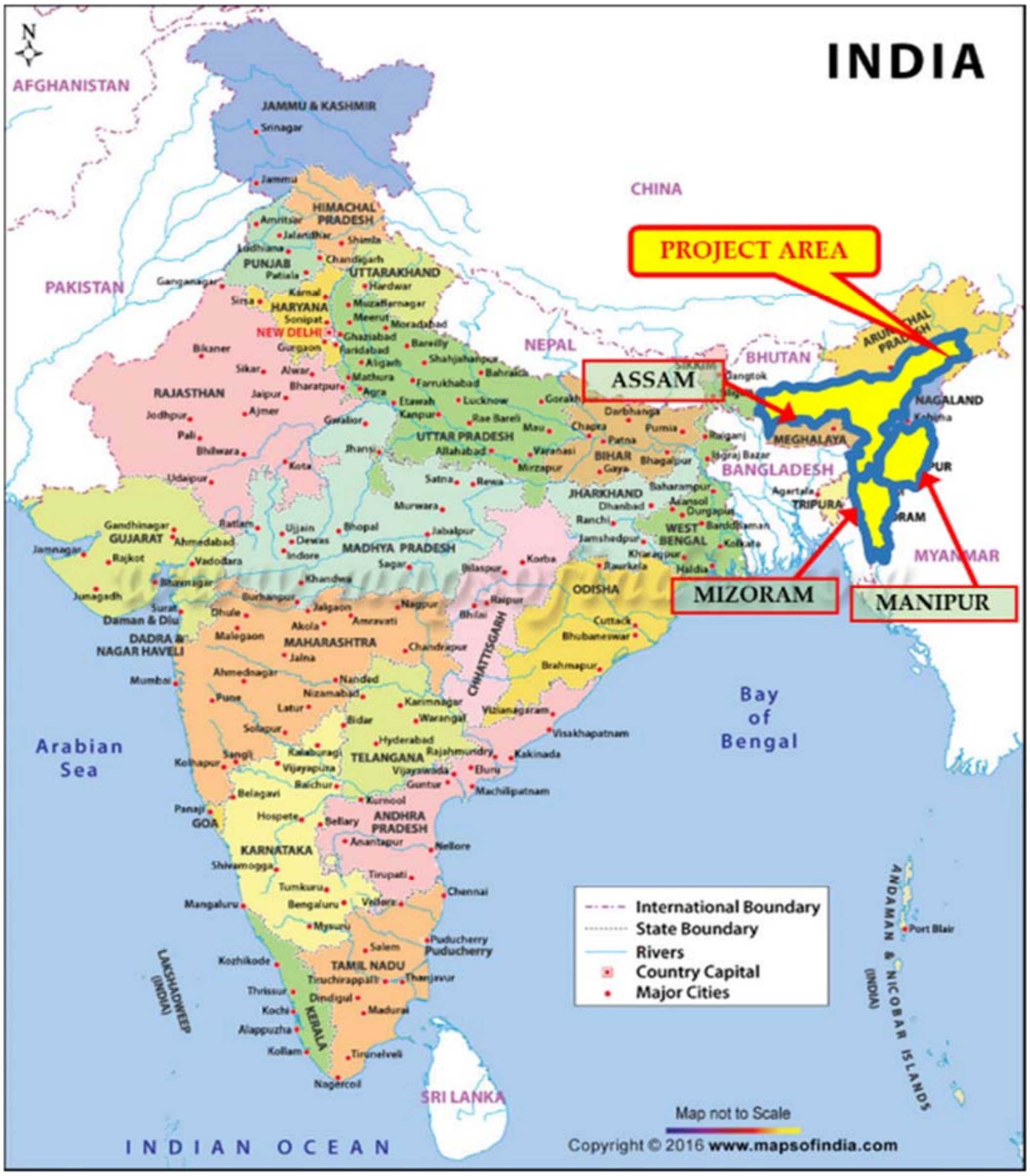



**Fig 2.1 Index Map**

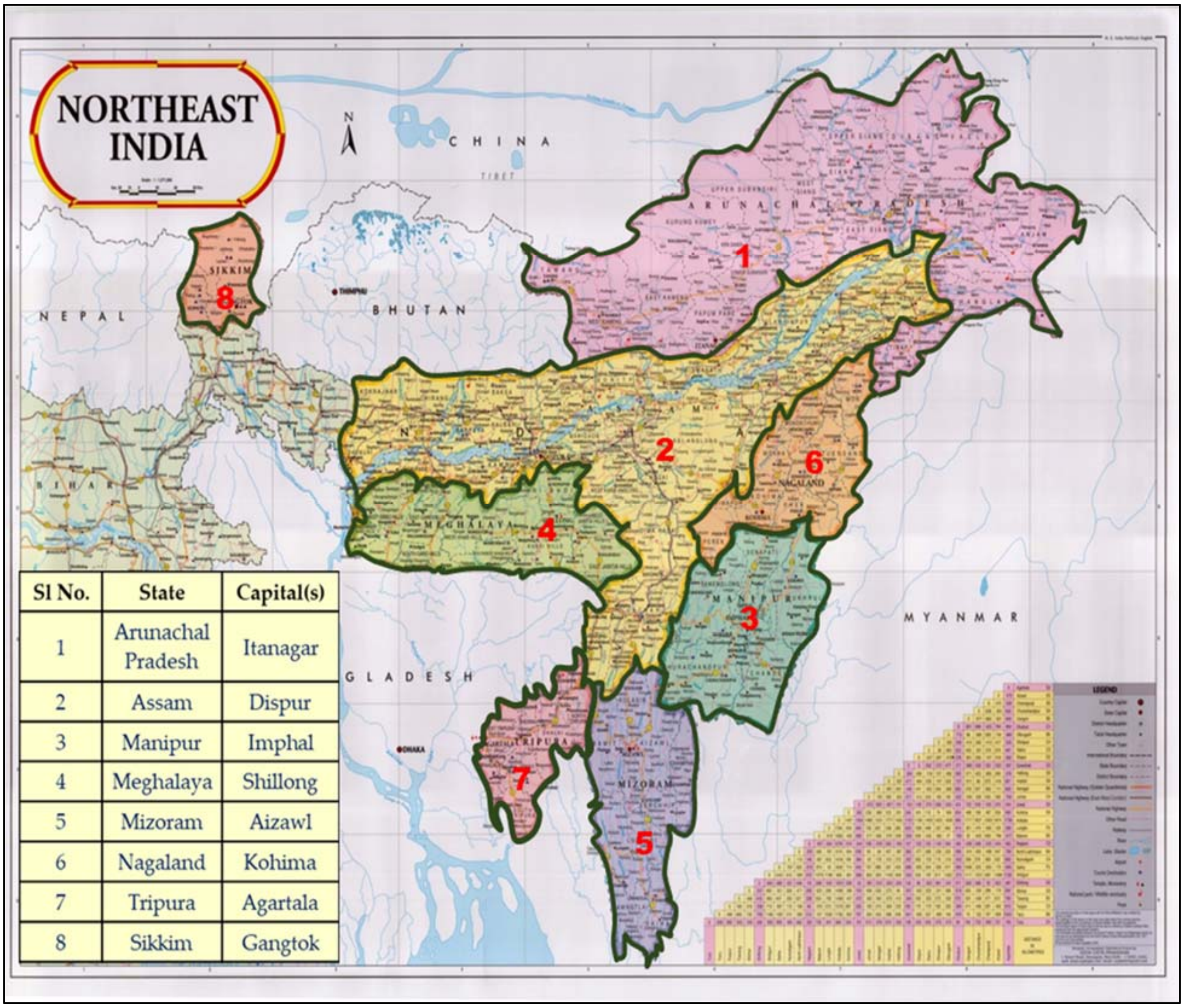



**Fig 2.2 North Eastern States (7 Sisters State) : Project Influence Area**

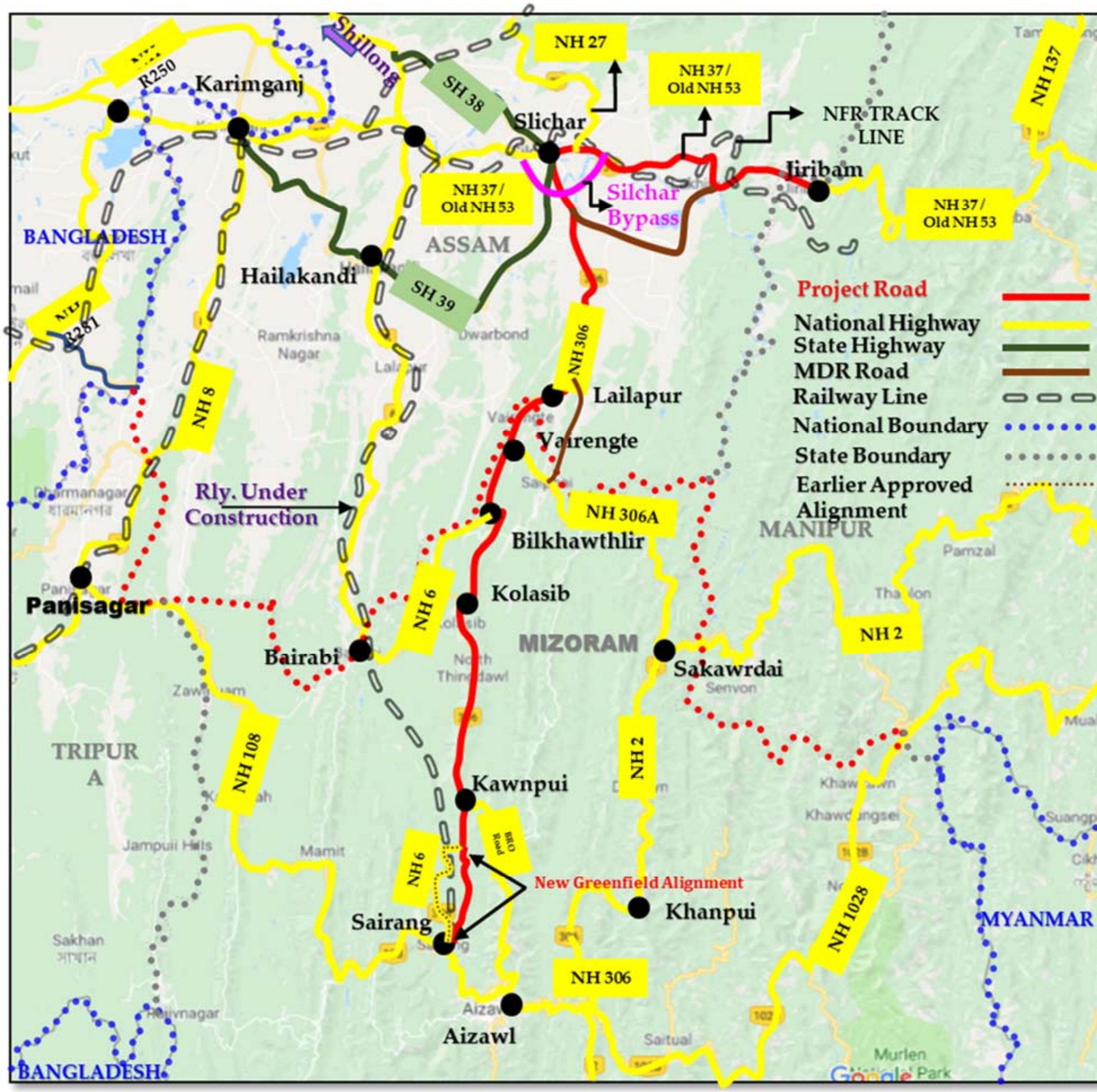



**Fig 2.3 Key Map of Road Network in Assam, Mizoram and Manipur**

Northeast (NE) region comprises eight states – Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Assam. The process of development has been rather slow in the North Eastern region for many reasons. The traditional system of self-governance and social customs of livelihood in the NE had remained virtually untouched during the British rule. Creation of a rail network for tea-growing areas for commercial interests was perhaps, the only major economic activity in the region. This was coupled with extraction of oil and some coal in the Assam, Meghalaya and Nagaland belt. Partition of the country in 19447, which carved out Bangladesh, hitherto East Pakistan, completely isolated the North Eastern region save for the slender Siliguri corridor, also known as the 'Chicken's Neck', leading to severe distortion in the socio-economic situation. The region, for geographic and sometimes strategic reasons, continued to have a very thin railway network too, and air services cannot be the sole channel to take care of the humungous transport needs of even one state, leave alone eight states. It was much later, after 1971 that civil aircraft were permitted to overfly Bangladesh. Railways are considered the best mode of mass transportation in the country. However, in the hilly terrains of the NE region, it is difficult and expensive to build an exhaustive setup of rail networks.

Roads are the nucleus of economic development, more so in the North East. Road transportation is an important mode of travel in the hilly areas as other modes are either too expensive or difficult to construct. However, road infrastructure is relatively deficient in the area. It is only now, after the announcement of India's "Look East" policy, that due importance has been given to the development of the area.

The consultant team, comprising of Team leader, Highway Engineer and Bridge Engineer undertook a detailed reconnaissance along the project area to assess and appreciate the existing site conditions. During the survey, the consultant team also had detailed discussions with the representatives of state PWDs and PIUs, under which these roads are presently being maintained. This chapter describes the findings of the reconnaissance surveys and highlights the basic features of highway, pavement and structures. Various key aspects that were studied during the reconnaissance survey include the following characteristics:

- Details of developmental works in progress or being planned by various agencies.
- Land use & existing RoW;
- Substandard geometric locations and extent of improvements required.
- Congested built-up areas and requirements of bypasses.
- Forest areas along project roads.
- Existing road configuration.
- Major road and rail crossings.
- Flood prone stretches and other Miscellaneous information

## 2.12 Location of the project road

a) As per the CA the project road from Silchar to Jiribam starts at Km 268+500 junction of NH-37 & SH-38 (kalian Jn.) in Silchar and end at Km 213+500 Jiribam in the state of Manipur. The project road is part of NH-37 (old NH-53) (Sutarakandi-Bhali NH road), connecting Sutarakandi, silchar and Jirighat) having a total length of 55.00km from Silchar to Jiribam.

b) After reconnaissance survey and further discussion held with NHICL, the DPR consultant has revised the start point of the project road for Silchar to Jiribam section from existing km 268+500 to km 263+500 near junction of NH-37 & NH-27 (towards Guwhathi) at Rongpur village due to already 4-lane developed under NH-PWD.

Further, new 4-lane development between km 263+500 and km 260+000 stretch has been included under Package-1 in Silchar-Vairengte DPR section of Silchar-Vairengte-Sairang-Aizawl Economic Corridor due to prioritising of NHs development specially section of Guwahati-Silchar-Aizawal and Shilong/Dawki/Karimganj to Silchar.

Hence, start point of Silchar – Jiribam has been fixed at Km 260+000 of NH-37 and End point at Km 212+060. Accordingly, the total existing length of the project road comes to 47.940Km.

**Therefore, Start Chainage shall be read with existing Km 260+000 (D. Ch. 4+560) and End with exiting km 212+060 (D. Ch. 37+650). Total Design length of the proposed 4-lane road turn into 33.09km.**

The latitude and longitude of the start and end point of the project road are as given below in table.

**Table 2.1 Latitude and Longitude of both ends of Project Road**

| Package | Start | | Location | Altitude | End | | Location | Altitude |
|---|---|---|---|---|---|---|---|---|
| | Latitude | Longitude | | | Latitude | Longitude | | |
| SJ-1 | 24° 50' 9.105"N | 92° 52' 7.142"E | Nutan Dayapur | 42 | 24° 49' 51.791"N | 93° 3' 33.84"E | Budhan Nagar | 85 |
| SJ-2 | 24° 49' 51.791"N | 93° 3' 33.84"E | Budhan Nagar | 85 | 24° 47' 37.333"N | 93° 10' 18.259"E | Jiribam | 75 |

## 2.13 Existing Chainage system

In order to identify reference point during construction, Existing chainage plays important however during reconnaissance survey, it was unveiled that KM stone hardly available along project road. In such circumstances, DPR consultant had made best effort to synchronize between available KM stone and physical measurement of existing road from start to end and outcome of same had been presented in the report.

The project road starts from Km 260+000 near Arkatipur village / Kasipur Junction and navigates progressively towards Jiribam however, as NH chainage has been set and originates from Imphal via Jiribam to Silchar (destining to Bangadesh border at Sutarkandi border. The reverse order chainage has been secured to have better illustration in terms of generating geometrics and hence, P & P assembling. Further, Design chainages have also been reflected against existing chainages wherever applicable for better understanding. The Design chainage at present shown, is the final design chainage extracted during design from MX- Road software and hence the total design length works out to 33.090 Km from Silchar to Jiribam as an against 47.940 Km along existing road.

*Hence, for an obvious reason please accord these existing chainages for reference purpose "as tentative chainage" only.*

Based on above record and clarifications, DPR consultant has considered the start point as existing Km 260+000 with Design Ch. 4+560 at Silchar, Assam State and end point at existing Km 212+060 with Design Ch. 37+650 at Jiribam, Manipur state leading towards Imphal.

**In addition, this report mainly deals with Package: SJ-1 that starts at existing Km 260+000 with Design Ch. 4+560 at Silchar/ Nutan Dayapur and end point at Existing Km 233+000 with Design Ch. 24+560 at Budha Nagar in the state of Assam.**

## 2.14 The Project Area

As mentioned earlier, project road lies in Cachar district of Assam state and Jiribam district of Manipur state, it traverses through major built up areas like; Rongpur Pt 1, Rongpur Pt2, Kashipur, Lakhipur, Banskhandi, Pailapool, Fulerthal and Jiribam. Some portion of the project road runs through forest with constraints for geometric improvement of the alignment. However, the confirmation regarding section of forest and non-forest are identified by forest and revenue department (through CALA & SO). Accordingly, 3'a' has been uploaded in "Bhumirashi" portal and 3'A' is also submitted for review by CALA office.

Since, collective decision was taken by NHIDCL to bifurcate the project corridor in to two (02) packages due to tunnel proposal & its cost constraints and several other limitations.

Hence, project corridor is as below.

1. Package: SJ-1 (Existing km 260+000=D. Ch. 4+560 at Silchar/ Nutan Dayapur to existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam State).
2. Package: SJ-2 (Existing km 233+000= D. Ch 24+560 at Budha Nagar in Assam state to Existing km 212+060=D. Ch 37+650 at Jiribam in Manipur State).

## 2.15 Land use and Settlements along Project Road

Project existing road passes through plain/ rolling (mostly) and hilly terrain at few locations. The alignment mostly passes through agricultural area, semi built-up and built-up areas. The land use pattern along the project road is as tabulated below.

**Table 2.2 Summary of Land use along project road**

| Sl. No. | Land use Description | Existing Length (km) | % of Length |
|---|---|---|---|
| 1 | Built up Area | 29.650 | 64.00 |
| 2 | Semi Built up Area | 7.500 | 15.00 |
| 3 | Agricultural Land | 3.350 | 7.00 |
| 5 | Hill Cum Forest Area | 4.500 | 9.00 |
| 6 | Hilly Area | 2.940 | 5.00 |

**Settlements:**

The existing road passes through several habitations. Major Built – up areas on route are Rongpur Pt 1, Rongpur Pt2, Kashipur, Lakhipur, Banskhandi, Pailapool, Fulerthal and Jiribam. Aggregate length of built-up areas along the Stretch is 64% of total length of project road.

The major built – up areas mentioned above are clustered with commercial, residential and industrial activities on both sides of existing road. Besides the above, the appreciable movement of pedestrians crisscrossing the road is observed at these locations. Existing horizontal geometrics are not as per NH standard at many locations, which are required to be upgraded. The Existing ROW along the project road varies from 9m to 30m as per PWD records. As the project road is 4/6 Lane Economic corridor, improving the geometry is not possible with in the available ROW wherever there is reduced EROW and it would entail for the demolition of structures with in the immediate vicinity of the existing road, more over this does not ensure the safety of the designed facility as it would be passing through the built up and congested sections.

Initially to avoid excessive demolition of permanent buildings, shops etc. and to reduce traffic congestion in town/built-up areas and to ensure free and un-interrupted flow for through traffic, two options were studied. **Option A**: Improvement of existing road with bypass options at Major built up and **Option** B: Green filed alignment. The details of the same are given below.

**Option A: Improvement of existing road with bypass options at Major Built up**

a) Kashipur Bypass : Km 259+600 to Km 254+600
b) Banskandi Bypass : Km 254+135 to Km 249+500
c) Ujan Tarapur, Pailapool, Fulerthal Bypass : Km 246+000 to Km 231+800 and
d) Jiribbam Bypass : Km 225+000 to Km 215+750

**Option B: Option of Green Field Alignment: Km 260+000 to Km 212+060**

Option B was selected and approved during the presentation due to significant length reduction and better scope of geometrics improvement and future rural communities and its market growth. The detailed description about individual bypass option is discussed in further paragraph.

The Green field alignment takes-off on LHS from Km 260+000 of NH-37 and passes through agricultural filed and Tea plantation at few locations and terminates / joins at NH-37 near Jiribam at km 212+060. The length along green filed alignment comes to is 33.090 Kms as compared to existing road length of 47.940 Kms causing drastic reduction in length however, 01 tunnel being proposed to avoid extensive route via permissible contour gradient. The chosen green alignment also mitigates the effects on residential and commercial buildings.

The existing project road has total 27 nos. of villages/towns along the project road and entire numbers of village/ town is avoided, science the proposed alignment is virgin alignment and passing through green filed. The details of the village/town along the existing road and along Green field alignment are presented in tables below.

**Table 2.3 Land Use pattern and villages /Towns along Project Road**

| Sl. No. | Existing Chainage | | Length (m) | Land use | Side | Village/Town Name | Remarks |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| * | 262+500 | 260+000 | 2500 | Built up | BHS | Rongpur | |
| 1 | 260+000 | 259+250 | 750 | Built up | BHS | Arkatipur | Package-1 (260+000 to 233+000) |
| 2 | 259+250 | 256+500 | 2750 | Built up | BHS | Kasipur | |
| 3 | 256+500 | 255+000 | 1500 | Built up | BHS | Badripar Part I | |
| 4 | 255+000 | 250+200 | 4800 | Built up/ Semi Built up | BHS | Banshkhandi Pt I | |
| 5 | 250+200 | 249+300 | 900 | Built up | BHS | Monipur | |
| 6 | 249+300 | 247+250 | 2050 | Built up | BHS | Chirirpar | |
| 7 | 247+250 | 245+000 | 2250 | Built up/ Semi Built up | BHS | Uzan Tarapur | |
| 8 | 245+000 | 244+750 | 250 | Built up | BHS | Lalang | |
| 9 | 244+750 | 242+500 | 2250 | Agricultural Land/Built up | BHS | Sibpur | |
| 10 | 242+500 | 241+500 | 1000 | Semi Built up | BHS | Sribar | |
| 11 | 241+500 | 239+750 | 1750 | Built up | BHS | Lalangkitta | |

| Sl. No. | Existing Chainage | | Length (m) | Land use | Side | Village/Town Name | Remarks |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 12 | 239+750 | 238+000 | 1750 | Built up | BHS | Pailapool | Package-1 (260+000 to 233+000) |
| 13 | 238+000 | 235+000 | 3000 | Built up | BHS | Lakhipur (Chiri Pool) | |
| 14 | 235+000 | 234+750 | 250 | Built up | BHS | Tolengram | |
| 15 | 234+750 | 233+500 | 1250 | Built up | BHS | Dilkushbasti | |
| 16 | 233+500 | 233+000 | 500 | Built up | BHS | Fulerthal | |
| 17 | 233+000 | 232+500 | 500 | Built up | BHS | Fulerthal | Package-2 (233+000 to 212+060) |
| 18 | 232+500 | 231+800 | 700 | Semi Built up/ Hill cum Forest Area | BHS | Hmarkhawlien | |
| 19 | 231+800 | 229+500 | 2300 | Hill cum Forest Area | BHS | Roujabad | |
| 20 | 229+500 | 227+500 | 2000 | Hill cum Forest Area | BHS | Chalitartol | |
| 21 | 227+500 | 225+700 | 1800 | Agricultural Land | BHS | Labongkhal | |
| 22 | 225+700 | 224+700 | 1000 | Semi Built up | BHS | Uttar Lalpani | |
| 23 | 224+700 | 222+700 | 2000 | Semi Built up/ Agricultural Land | BHS | Howkip Punji | |
| 24 | 222+700 | 218+500 | 4200 | Built up | BHS | Jirighat | |
| 25 | 218+500 | 216+500 | 2000 | Built up | BHS | Kamranga | |
| 26 | 216+500 | 215+000 | 1500 | Built up | BHS | Jiribam | |
| 27 | 215+000 | 213+250 | 1750 | Hilly area | BHS | Narandhor Basa | |
| 28 | 213+250 | 212+060 | 1190 | Hilly area | BHS | Uchathol | |

*The stretch from Km 262+500 to Km 260+000 has already been included under Package-1 in Silchar to Vairengte Section.


SILCHAR BANSHKANDI PAILAPOOL

**Pic 2.1 VILLAGES ALONG EXISTING ALIGNMENT (SILCHAR - JIRIBAM)**

**Forest Area:**

The Existing Road passes through hill cum thickly vegetated/forest area from Km 231+800 to Km 227+500 for an approximate length of 4.3 km. The Project Road is lined with moderate number of trees on both sides after Jiribam town from Km 215+000 to Km 212+060, which will not be frightened as the improvement follows green field and does not pass-through existing road.

## 2.16 Terrain & Climate

Terrain is classified by the general slope of the country across the highway alignment as per IRC: 73 and with these criteria the entire length of the project passes through in plain terrain.

The climate of the districts can be termed as mild to severe, with mild winters and warm summers. Monsoon will experience heavy rainfall and high humidity. The summer season in Assam starts from the month of March/April and extends till the end of July/August with average temperature between 35 and 38 ° C. The winter season in Assam is basically characterized by scanty rainfall and misty mornings and afternoons. It starts in November and continues till the month of February. The mercury reading at this time of the year is around 6 to 8° C. In Assam, spring (March-April) and autumn (September- October) present pleasant seasons, with moderate temperature and rainfall. The rainy season, as in rest of Assam begins in late June and continues up to late September. October and November constitute the post-monsoon period. The climate of the Barak Valley districts is characterised by abundant rainfall, moderate temperatures and high humidity.

**Existing carriageway configuration**

The project road has 10.0m wide carriageway for 41.0Km, 7.0 m carriageway for 12.4 Km and 14.0 m 4-Lane carriageway at the start of the project road for a length of 0.500 Km.

**Pic 2.2 EXISTING CARRIAGEWAY CONDITIONS**

The carriageway from Km 265+500 to Km 263+500 is 14m with 4-Lane divided carriageway, which is developed by PWD, NH Division, Silchar (job no 053/AS/2016-17/157) and 2-Lane paved shoulder with 10m carriage way from Km 263+500 to Km 212+500 for a length of 41.00 Km and 7m carriageway from Km 221+500 to Km 212+060.Throughout the project road, the type of pavement is of bituminous. The pavement condition is generally ranging from poor/fair to good.

**Table 2.4 List of Lane Configuration**

| Sl. no | Chainage along Existing (Km) | | Length (m) | Lane Configuration, (m) | Section | Remarks |
|---|---|---|---|---|---|---|
| | From | To | | | | |
| * | 262+500 | 260+000 | 2500 | 14.00 (2-Lane with Paved Shoulder) | Madhurapul Point-Jirighat | |
| 1 | 260+000 | 233+000 | 27000 | 10.00 (2-Lane with Paved Shoulder) | Madhurapul Point-Jirighat | Package-1 (260+000 to 233+000) |
| 2 | 233+000 | 221+500 | 11500 | 10.00 (2-Lane with Paved Shoulder) | Madhurapul Point-Jirighat | Package-2 (233+000 to 212+060) |
| 3 | 221+500 | 212+060 | 9440 | 07.00 2-Lane | Jirighat-End Point | |

*The stretch from Km 262+500 to Km 260+000 has already been included under Package-1 in Silchar to Vairengte Section.

## 2.17 Existing Alignment

Initially during the alignment study stage, many options were studied such as widening and strengthening with geometrics improvement, re-alignment / bypass options for individual settlements and appraisal of opting green field alignmnet. However, in order to avoid major demolition of built-up areas and geometric negotiations, 02 options were studied and the details of the same is given below

**Option A**: Improvement of existing road with bypass options at Major built up

a) Kashipur Bypass (Km 259+600 to Km 254+600)

b) Banskandi Bypass (Km 254+135 to Km 249+500)

c) Ujan Tarapur,Pailapool,Fulerthal Bypass (Km 246+000 to Km 231+800)

d) Jiribbam Bypass (Km 225+000 to Km 215+750)

**Option B**: **Green filed alignment**

**Option A:**

### a) Kashipur Bypass (Km 259+600 to Km 254+600)

The project road from 259+600 to Km 254+600 passes through Kashipur built up, which have sub-standard geometrics, sharp 90º curve, built up on either side of existing road and Barak River is situated on RHS of existing road. Hence the bypass options were studied for Kashipur.

### b) Banskandi Bypass (Km 254+135 to Km 249+500)

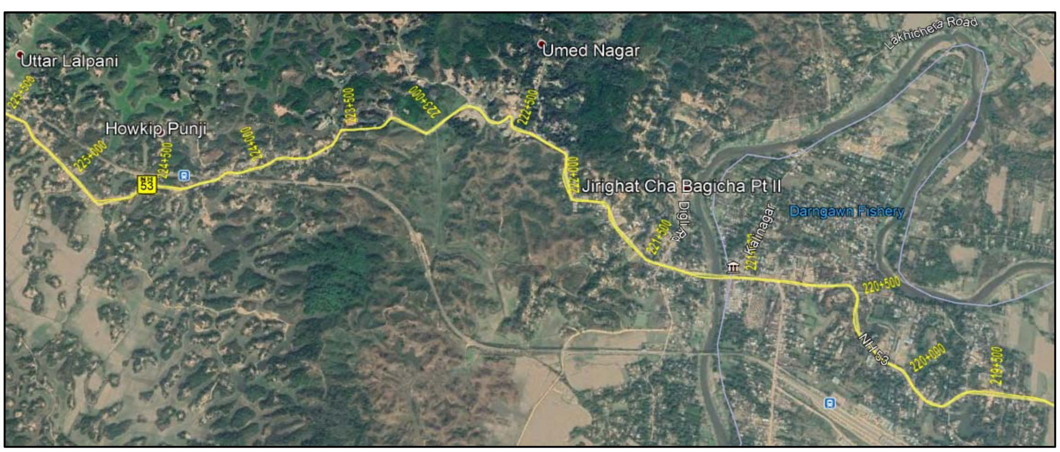
The project road from Km 254+135 to Km 249+500 passes through heavy built up of Banshkandi village (Km 251+500). The carriageway width along built up section is 10 m with side drains on both sides. The condition of road is fair with some severe edge drop at selected sections. There are many religious structures along the edge of existing road. Barak River and Baskhandi Lake is also running on RHS. So, bypass options were studied for Banskandi in order to avoid demolition of buildings and to provide free flow traffic movement.

**c) Ujan Tarapur, Pailapool, Fulerthal Bypass (Km 246+000 to Km 231+800)**

From Km 246+000 to Km 239+500, the Project road passes through minor built up like Polarband, Urzan tarapur (246+300), Chirripar (Km 242+800), Sibpur (Km 241+100). The project road is running parallel to Chirri river and passes through ROB at Km 245+450. From Km 239+500 to Km 237+500, the project road passes through thickly populated section of Pailapool and Fulerthal built up at Km 234+500. Again, the project road encounters with Rly level crossing at Km 238+400 and Major Bridge (Chirripool) at Km 235+600. So, having so many constraints and safety aspects, bypass options were studied to have better alternate alignment to minimize these limitations in line with development of 4-lane economic corridor.


**d) Jiribbam Bypass (Km 225+000 to Km 215+750)**

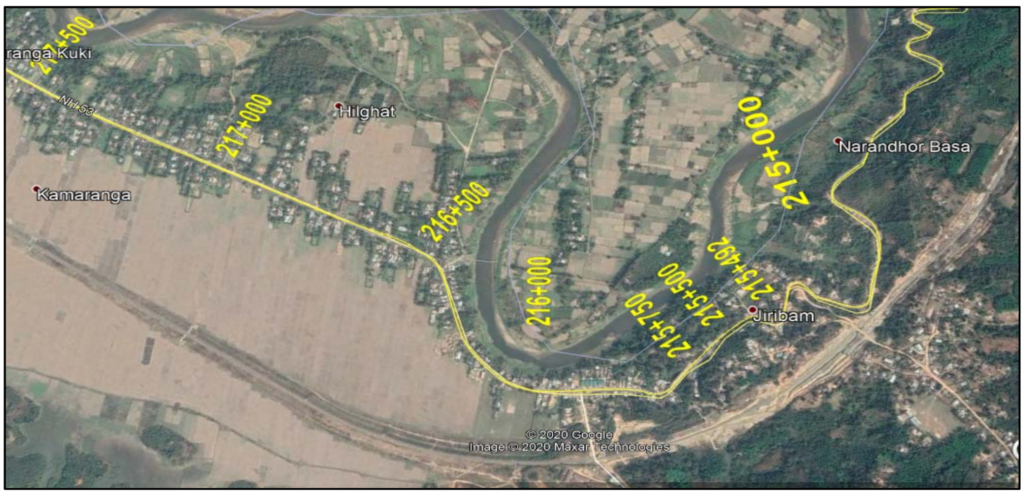
From Km 225+100 to Km 220+900, existing alignment passes through minor built up like Uttal Lalpani and Howkip Punj. The Carriageway width varies from 9.2 m to 9.5 m and shoulder width varying from 1.0 m to 2.0 m, the condition of existing road is fair with medium cracks, ravelling and severe edge drop. At Km 224+230 there exists a RUB. The clear width (Skew) of RUB is 18.4 m.




At Km 220+900 there is Jirighat check post of Assam state. From Km 221+500 to Km 221+000 project road passes through major bridge which acts as border between Assam state and Manipur state. Existing major bridge is fully congested with commercial activities and heavy movement of commercial vehicles. After the Major

Bridge from Km 220+200, the project road enters Jiribam district of Manipur state. From Km 220+300 to Km 214+500, the project road passes through Major built up like Jiribam, Kamranga Village and Gularthol village.

The carriageway width along these stretches varies from 6.5 m to 7.2 m with fair condition. The width of Earthen shoulder varies from 1.5m to 2.0 m. Condition of shoulder is poor because of heavy edge drop, poor drainage condition. At Km 215+940 there is minor junction which leads to CRPF HQ on RHS of project road. The Project road ends at Km 212+300.




So, in view of 4-lane development of existing substandard existing curves, it was nearing to impractical, DPR consultant has recommended bypass with options.

**Option B Green Field Alignment Km 260+000 to Km 212+060**

From Km 262+500 to Km 212+060 the existing road passes through many built up locations such as Kashipur, Banskandi, Ujain Tarapur, Pailapool, Fulertal and Jiribam.

In this option a green filed alignment is proposed in view of bypassing all above built up areas through single alignment navigating through open / green field and fulfils the requirement of developing 4-lane economic corridor.

The Green field alignment takes-off on LHS from Km 260+000 of NH-37 and passes through agricultural filed and Tea plantation at few locations and terminates / joins at NH-37 near Jiribam at km 212+060. The approximate length along green filed alignment comes to 33.090 Km as compared to existing road length of 47.940 causing drastic reduction in length however, 01 tunnel (aapx.800m) being proposed to avoid extensive route via permissible contour gradient. The chosen green alignment also mitigates the effects on residential and commercial buildings. However, the proposed green filed alignment crosses existing railway line at Km 5+190, Km 22+535 and Km 26+385 that need to propose ROBs at these locations. Detailed discussion of Greenfield alignment option can be referred under chapter "Improvement proposal".

## 2.18 Existing Right-of-way

As per the records available with PWD, NH division and Road inventory the land availability in town/built-up areas vary from 9m to 25m whereas, in rural areas, ROW varies from 30m to 45m as per NH PWD record. The existing ROW along the stretch is given in following.

**Table 2.5 Details of Existing ROW/Available land along the Project Road**

| SL No. | Existing Chainage | | Length (m) | Land Available / EROW Width (m) | Remarks |
|---|---|---|---|---|---|
| | From | To | | | |
| * | 262+500 | 260+000 | 2500 | 30 | |
| 1 | 260+000 | 259+250 | 750 | 30 | Package-1 (260+000 to 233+000) |
| 2 | 259+250 | 250+200 | 9050 | 20 | |
| 3 | 250+200 | 247+250 | 2950 | 15 | |
| 4 | 247+250 | 244+750 | 2500 | 10 | |
| 5 | 244+750 | 242+500 | 2250 | 12 | |
| 6 | 242+500 | 241+500 | 1000 | 8 | |
| 7 | 241+500 | 239+750 | 1750 | 25 | |
| 8 | 239+750 | 238+000 | 1750 | 15 | |
| 9 | 238+000 | 234+750 | 3250 | 16 | |
| 10 | 234+750 | 233+500 | 1250 | 12 | |
| 11 | 233+500 | 233+000 | 500 | 20 | |
| 12 | 233+000 | 231+800 | 1200 | 20 | Package-2 (233+000 to 212+060) |
| 13 | 231+800 | 227+500 | 4300 | 10 | |
| 14 | 227+500 | 212+060 | 15440 | 8 | |

*The stretch from Km 262+500 to Km 260+000 has already been included under Package-1 in Silchar to Vairengte Section.

## 2.19 Road Junctions

There are 5 major road junctions with National highway, State Highways and MDR and 198 minor junctions with village roads, which need to be designed.

**Table 2.6 List of Major Road Junctions**

| Sl. No. | Location | | At Grade | Category of cross road | Remarks |
|---|---|---|---|---|---|
| | Ex. Chainage | Name of junction | | | |
| * | 262+500 | Guwahati Silchar Road | T | NH-27 | |
| 1 | 257+325 | Silchar Bypass | T | - | Package-1 (260+000 to 233+000) |
| 2 | 239+200 | Joypur Road | Y | MDR | |
| 3 | 234+200 | Sonabharighat | Y | MDR | |
| 4 | 221+000 | Jiribam | T | MDR | Package-2 (233+000 to 212+060) |

*The stretch from Km 262+500 to Km 260+000 has already been included under Package-1 in Silchar to Vairengte Section.

**Table 2.7 List of Minor Road Junctions**

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 1 | 259+595 | BT | T | LHS | Village Road | Package-1 (260+000 to 233+000) |
| 2 | 259+113 | BT | Y | LHS | Village Road | |
| 3 | 258+566 | BT | Y | LHS | NEW DAYAPUR BAGAN ROAD | |
| 4 | 257+554 | BT | T | RHS | Village Road | |
| 5 | 256+997 | BT | Y | RHS | OLD LAKIPUR ROAD | |
| 6 | 257+004 | ER | Y | RHS | Village Road | |
| 7 | 256+601 | BT | Y | RHS | Village Road | |
| 8 | 256+318 | BT | Y | LHS | Village Road | |
| 9 | 255+641 | BT | T | RHS | Village Road | |
| 10 | 254+709 | BT | T | RHS | Village Road | |
| 11 | 254+508 | BT | Y | LHS | Village Road | |
| 12 | 254+291 | BT | X | BOTH | Village Road | |
| 13 | 254+027 | BT | T | RHS | Village Road | |
| 14 | 253+301 | BT | X | BOTH | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 15 | 252+958 | BT | T | LHS | Lambabasti road | Package-1 (260+000 to 233+000) |
| 16 | 252+717 | BT | Y | RHS | Gobindapur road | |
| 17 | 251+874 | BT | T | RHS | Village Road | |
| 18 | 251+690 | BT | Y | RHS | Banskandi sonai road | |
| 19 | 251+560 | BT | Y | RHS | Village Road | |
| 20 | 251+446 | BT | Y | LHS | Village Road | |
| 21 | 251+308 | BT | Y | LHS | Village Road | |
| 22 | 250+775 | BT | T | LHS | Village Road | |
| 23 | 250+564 | BT | Y | RHS | Village Road | |
| 24 | 250+498 | BT | Y | LHS | Village Road | |
| 25 | 249+657 | BT | Y | LHS | Village Road | |
| 26 | 249+623 | BT | Y | RHS | Village Road | |
| 27 | 248+793 | BT | Y | LHS | Village Road | |
| 28 | 248+703 | BT | X | BOTH | Village Road | |
| 29 | 248+070 | BT | Y | LHS | BMCH ROAD | |
| 30 | 247+723 | BT | T | RHS | Village Road | |
| 31 | 247+371 | ER | T | RHS | Village Road | |
| 32 | 247+213 | BT | T | RHS | Village Road | |
| 33 | 246+958 | BT | T | RHS | Village Road | |
| 34 | 246+825 | BT | T | RHS | Village Road | |
| 35 | 246+664 | BT | T | RHS | Village Road | |
| 36 | 246+389 | BT | T | LHS | Village Road | |
| 37 | 246+381 | BT | T | RHS | Village Road | |
| 38 | 245+865 | BT | T | LHS | Village Road | |
| 39 | 245+745 | BT | Y | RHS | Village Road | |
| 40 | 245+462 | BT | T | RHS | Village Road | |
| 41 | 245+414 | BT | Y | LHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 42 | 245+111 | BT | X | BOTH | Village Road | Package-1 (260+000 to 233+000) |
| 43 | 244+966 | BT | T | LHS | Village Road | |
| 44 | 244+112 | BT | Y | LHS | Village Road | |
| 45 | 243+682 | BT | T | LHS | Village Road | |
| 46 | 243+324 | BT | Y | LHS | Narayanpur tea garden road | |
| 47 | 243+176 | BT | Y | RHS | Village Road | |
| 48 | 243+016 | BT | Y | RHS | Village Road | |
| 49 | 242+912 | BT | Y | RHS | Village Road | |
| 50 | 242+673 | ER | Y | LHS | Village Road | |
| 51 | 242+558 | BT | Y | RHS | Village Road | |
| 52 | 242+491 | BT | Y | LHS | To sibpur | |
| 53 | 242+358 | BT | Y | RHS | Village Road | |
| 54 | 242+064 | BT | Y | RHS | Village Road | |
| 55 | 241+393 | BT | T | RHS | Village Road | |
| 56 | 241+196 | BT | T | RHS | Village Road | |
| 57 | 241+180 | BT | Y | LHS | Village Road | |
| 58 | 240+800 | BT | T | LHS | Village Road | |
| 59 | 240+508 | BT | Y | RHS | Village Road | |
| 60 | 240+468 | BT | Y | LHS | Village Road | |
| 61 | 240+189 | BT | Y | LHS | Village Road | |
| 62 | 240+163 | BT | Y | RHS | Village Road | |
| 63 | 240+019 | BT | Y | RHS | Village Road | |
| 64 | 239+937 | ER | T | RHS | Village Road | |
| 65 | 239+885 | ER | T | LHS | Village Road | |
| 66 | 239+792 | BT | Y | RHS | Village Road | |
| 67 | 239+492 | BT | Y | RHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 68 | 239+436 | BT | Y | LHS | Village Road | Package-1 (260+000 to 233+000) |
| 69 | 239+344 | BT | Y | RHS | Village Road | |
| 70 | 239+279 | BT | Y | RHS | Village Road | |
| 71 | 239+135 | BT | Y | LHS | Village Road | |
| 72 | 239+019 | BT | Y | RHS | Village Road | |
| 73 | 238+971 | BT | Y | LHS | Village Road | |
| 74 | 238+930 | BT | T | RHS | Village Road | |
| 75 | 238+912 | BT | Y | LHS | Village Road | |
| 76 | 238+840 | BT | X | BOTH | Village Road | |
| 77 | 238+731 | BT | Y | RHS | Village Road | |
| 78 | 238+581 | BT | T | LHS | Village Road | |
| 79 | 238+579 | BT | Y | RHS | Village Road | |
| 80 | 238+486 | BT | Y | LHS | Village Road | |
| 81 | 238+360 | BT | Y | RHS | Village Road | |
| 82 | 238+158 | BT | Y | LHS | Village Road | |
| 83 | 237+987 | BT | Y | RHS | Village Road | |
| 84 | 237+671 | ER | T | LHS | Village Road | |
| 85 | 237+431 | BT | T | LHS | Village Road | |
| 86 | 237+333 | BT | Y | LHS | Village Road | |
| 87 | 237+290 | BT | Y | LHS | Village Road | |
| 88 | 237+255 | BT | Y | LHS | Village Road | |
| 89 | 236+771 | BT | Y | RHS | Village Road | |
| 90 | 236+575 | BT | Y | RHS | Village Road | |
| 91 | 236+150 | BT | Y | RHS | Village Road | |
| 92 | 235+872 | BT | Y | LHS | Gabind nagarroad | |
| 93 | 235+732 | BT | T | RHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 94 | 235+653 | BT | Y | RHS | Village Road | Package-1 (260+000 to 233+000) |
| 95 | 235+520 | BT | Y | RHS | Chiripar road | |
| 96 | 235+504 | BT | T | LHS | Village Road | |
| 97 | 234+733 | BT | Y | LHS | Village Road | |
| 98 | 234+653 | BT | Y | RHS | Fulertal barrage road | |
| 99 | 234+411 | BT | T | RHS | Village Road | |
| 100 | 234+095 | BT | T | LHS | Village Road | |
| 101 | 234+082 | BT | Y | RHS | Fulertal ferry ghat | |
| 102 | 234+047 | BT | T | LHS | Rabindrasarani | |
| 103 | 233+865 | BT | T | LHS | Village Road | |
| 104 | 233+648 | BT | Y | LHS | Village Road | |
| 105 | 233+320 | BT | Y | LHS | Village Road | |
| 106 | 233+288 | BT | Y | RHS | Village Road | |
| 107 | 233+216 | BT | Y | LHS | Village Road | |
| 108 | 233+089 | BT | Y | RHS | Village Road | |
| 109 | 232+939 | BT | Y | LHS | Village Road | Package-2 (233+000 to 212+060) |
| 110 | 232+938 | BT | Y | LHS | Village Road | |
| 111 | 227+609 | BT | Y | RHS | Village Road | |
| 112 | 227+231 | BT | T | LHS | Village Road | |
| 113 | 226+734 | BT | T | LHS | Village Road | |
| 114 | 226+283 | BT | Y | LHS | Village Road | |
| 115 | 225+688 | ER | T | LHS | Village Road | |
| 116 | 225+590 | BT | T | RHS | Village Road | |
| 117 | 225+486 | BT | Y | RHS | Village Road | |
| 118 | 224+966 | BT | Y | RHS | Village Road | |
| 119 | 224+843 | BT | Y | RHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 120 | 224+412 | BT | T | RHS | Village Road | Package-2 (233+000 to 212+060) |
| 121 | 224+341 | BT | Y | RHS | Village Road | |
| 122 | 224+203 | BT | Y | LHS | Village Road | |
| 123 | 224+000 | BT | Y | RHS | Village Road | |
| 124 | 223+969 | BT | Y | LHS | Village Road | |
| 125 | 223+818 | ER | Y | RHS | Village Road | |
| 126 | 223+571 | BT | T | LHS | Village Road | |
| 127 | 223+292 | BT | T | LHS | Village Road | |
| 128 | 222+832 | BT | Y | LHS | Village Road | |
| 129 | 222+460 | BT | Y | LHS | Village Road | |
| 130 | 221+761 | BT | Y | LHS | Village Road | |
| 131 | 221+652 | BT | T | LHS | Village Road | |
| 132 | 221+614 | BT | Y | RHS | Village Road | |
| 133 | 221+587 | BT | Y | LHS | Village Road | |
| 134 | 221+447 | BT | X | BOTH | Village Road | |
| 135 | 221+353 | BT | Y | LHS | Village Road | |
| 136 | 221+096 | BT | X | BOTH | Village Road | |
| 137 | 220+967 | BT | Y | LHS | Village Road | |
| 138 | 220+967 | BT | Y | LHS | Village Road | |
| 139 | 220+889 | BT | Y | RHS | Village Road | |
| 140 | 220+810 | BT | Y | LHS | Village Road | |
| 141 | 220+776 | BT | Y | LHS | Village Road | |
| 142 | 220+529 | BT | Y | LHS | Village Road | |
| 143 | 220+513 | BT | Y | LHS | Village Road | |
| 144 | 220+364 | BT | T | RHS | Village Road | |
| 145 | 220+235 | BT | Y | RHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 146 | 220+118 | BT | Y | RHS | Village Road | Package-2 (233+000 to 212+060) |
| 147 | 219+972 | BT | Y | RHS | Village Road | |
| 148 | 219+922 | BT | Y | RHS | Village Road | |
| 149 | 219+862 | BT | T | LHS | Village Road | |
| 150 | 219+747 | BT | Y | RHS | Village Road | |
| 151 | 219+637 | BT | T | LHS | Village Road | |
| 152 | 219+544 | BT | Y | LHS | Village Road | |
| 153 | 219+522 | BT | Y | RHS | Village Road | |
| 154 | 219+428 | BT | Y | LHS | Village Road | |
| 155 | 219+330 | BT | T | RHS | Village Road | |
| 156 | 219+272 | BT | T | RHS | Village Road | |
| 157 | 218+980 | BT | Y | LHS | Village Road | |
| 158 | 218+779 | BT | Y | RHS | Village Road | |
| 159 | 218+758 | BT | Y | RHS | Village Road | |
| 160 | 218+664 | BT | T | LHS | Village Road | |
| 161 | 218+542 | BT | T | RHS | Village Road | |
| 162 | 218+516 | BT | Y | LHS | Village Road | |
| 163 | 218+341 | BT | Y | LHS | Village Road | |
| 164 | 218+047 | BT | Y | LHS | Village Road | |
| 165 | 218+040 | BT | T | LHS | Village Road | |
| 166 | 217+990 | BT | T | LHS | Village Road | |
| 167 | 217+893 | BT | T | LHS | Village Road | |
| 168 | 217+811 | BT | T | LHS | Village Road | |
| 169 | 217+766 | BT | Y | LHS | Village Road | |
| 170 | 217+735 | BT | Y | LHS | Village Road | |
| 171 | 217+607 | BT | Y | LHS | Village Road | |

| Sl. No. | Existing Chainge | Type of Carriageway | Type of Junctions (T, Y, X) | SIDE | Type of Road (SH/ MDR/ PMGSY/ VR) | Remarks |
|---|---|---|---|---|---|---|
| 172 | 217+519 | BT | T | LHS | Village Road | Package-2 (233+000 to 212+060) |
| 173 | 217+466 | BT | Y | RHS | Village Road | |
| 174 | 217+386 | BT | T | RHS | Village Road | |
| 175 | 217+341 | BT | T | RHS | Village Road | |
| 176 | 217+340 | BT | T | LHS | Village Road | |
| 177 | 217+282 | BT | T | LHS | Village Road | |
| 178 | 217+100 | BT | T | LHS | Village Road | |
| 179 | 217+041 | BT | T | LHS | Village Road | |
| 180 | 216+976 | BT | Y | LHS | Village Road | |
| 181 | 216+904 | BT | T | LHS | Village Road | |
| 182 | 216+840 | BT | T | LHS | Village Road | |
| 183 | 216+456 | BT | Y | LHS | Village Road | |
| 184 | 216+438 | BT | Y | LHS | Village Road | |
| 185 | 216+257 | BT | Y | RHS | Village Road | |
| 186 | 215+943 | BT | T | RHS | Village Road | |
| 187 | 215+612 | BT | Y | RHS | Village Road | |
| 188 | 215+471 | BT | T | LHS | Village Road | |
| 189 | 215+335 | BT | T | RHS | Village Road | |
| 190 | 215+323 | BT | T | LHS | Village Road | |
| 191 | 214+900 | BT | T | LHS | Village Road | |
| 192 | 214+126 | BT | T | LHS | Village Road | |
| 193 | 213+648 | BT | Y | RHS | Village Road | |
| 194 | 212+940 | BT | Y | LHS | Village Road | |
| 195 | 212+800 | BT | T | LHS | Village Road | |
| 196 | 212+523 | ER | T | LHS | Village Road | |
| 197 | 212+360 | ER | T | RHS | Village Road | |
| 198 | 212+334 | BT | Y | RHS | Village Road | |

## 2.20 Culverts & Bridges

The inventory data for the existing cross drainage structures, culverts and bridges, are given with details in Chapter 3: "Analysis & Interpretation of Engineering Surveys and Investigations".

Summary of the same is given in below table;

**Table 2.8 Summary of culvert & Bridges**

| Culverts | | | | Bridges | | | Causeway | ROB | RUB | LC | VUP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Slab/Arch | Box | Total | Minor | Major | Total | | | | | |
| **Section: Silchar to Jiribam (260+000 to 212+060)** | | | | | | | | | | | |
| 09 | 30 | 36 | 75 | 08 | 02 | 10 | - | 01 | 01 | 01 | 01 |
| **Package: SJ-1 (260+000 to 233+000)** | | | | | | | | | | | |
| 09 | 03 | 05 | 17 | 04 | 01 | 05 | - | 01 | - | 01 | - |
| **Package: SJ-2 (233+000 to 212+060)** | | | | | | | | | | | |
| - | 27 | 31 | 58 | 04 | 01 | 05 | - | - | 01 | - | 01 |

There are total 75 nos. of existing culverts along the project corridor, out of which 36 no's are Box, 30 no's are RCC Slab and 9 no's are Pipe culverts.

**Table 2.9 Details of Culverts**

| Sl. No. | Chainage | Type of Structure | Span Arrangement (m) | Formation Width (m) | Thickness of Deck Slab (m) | Remarks |
|---|---|---|---|---|---|---|
| 1 | 259+200 | Box | 1 x 2 | 12.60 | 0.3 | Package-1 (260+000 to 233+000) |
| 2 | 258+700 | Box | 1 x 2 | 12.60 | 0.3 | |
| 3 | 258+400 | Box | 1 x 2 | 12.60 | 0.3 | |
| 4 | 257+800 | Box | 1 x 2 | 12.60 | 0.3 | |
| 5 | 257+700 | Box | 1 x 2 | 12.00 | 0.3 | |
| 6 | 254+700 | Pipe | 2 x 1.2 | 23 | - | |
| 7 | 253+800 | Pipe | 2 x 1.2 | 23 | - | |
| 8 | 252+600 | Pipe | 2 x 1.2 | 23 | - | |
| 9 | 249+800 | Pipe | 2 x 1.2 | 23 | - | |
| 10 | 244+000 | Pipe | 1 x 1.2 | 17 | - | |

| Sl. No. | Chainage | Type of Structure | Span Arrangement (m) | Formation Width (m) | Thickness of Deck Slab (m) | Remarks |
|---|---|---|---|---|---|---|
| 11 | 243+900 | Pipe | 2 x 1.2 | 17 | - | Package-1 (260+000 to 233+000) |
| 12 | 237+980 | Slab | 1 x 4 | 12.00 | 0.45 | |
| 13 | 237+500 | Pipe | 2 x 1.2 | 15 | - | |
| 14 | 237+100 | Pipe | 2 x 1.2 | 15 | - | |
| 15 | 236+900 | Pipe | 1 x 1.2 | 15 | - | |
| 16 | 235+000 | Slab | 1 x 1.5 | 12.00 | 0.3 | |
| 17 | 234+750 | Slab | 1 x 1.5 | 10.00 | 0.3 | |
| 18 | 232+900 | Slab | 1 x 3 | 12.50 | 0.45 | Package-2 (233+000 to 212+060) |
| 19 | 232+600 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 20 | 232+400 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 21 | 232+300 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 22 | 232+200 | Slab | 1 x 6 | 12.00 | 0.5 | |
| 23 | 232+000 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 24 | 231+800 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 25 | 231+700 | Slab | 1 x 3 | 12.00 | 0.4 | |
| 26 | 231+600 | Slab | 1 x 2 | 12.00 | 0.35 | |
| 27 | 231+200 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 28 | 231+100 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 29 | 230+800 | Box | 1 x 2 | 12.00 | 0.3 | |
| 30 | 230+300 | Box | 1 x 2 | 12.00 | 0.3 | |
| 31 | 230+000 | Box | 1 x 2 | 12.00 | 0.3 | |
| 32 | 229+900 | Box | 1 x 2 | 12.00 | 0.3 | |
| 33 | 229+600 | Box | 1 x 2 | 12.00 | 0.3 | |
| 34 | 229+500 | Box | 1 x 2 | 12.00 | 0.3 | |
| 35 | 229+400 | Box | 1 x 2 | 12.00 | 0.3 | |
| 36 | 229+300 | Box | 1 x 2 | 12.00 | 0.3 | |
| 37 | 229+100 | Box | 1 x 2 | 12.00 | 0.3 | |

| Sl. No. | Chainage | Type of Structure | Span Arrangement (m) | Formation Width (m) | Thickness of Deck Slab (m) | Remarks |
|---|---|---|---|---|---|---|
| 38 | 229+000 | Box | 1 x 2 | 12.00 | 0.3 | Package-2 (233+000 to 212+060) |
| 39 | 228+900 | Box | 1 x 2 | 12.00 | 0.3 | |
| 40 | 228+600 | Box | 1 x 2 | 12.00 | 0.3 | |
| 41 | 228+450 | Box | 1 x 2 | 12.00 | 0.4 | |
| 42 | 228+350 | Box | 1 x 2 | 12.00 | 0.4 | |
| 43 | 228+200 | Box | 1 x 2 | 12.00 | 0.4 | |
| 44 | 228+000 | Box | 1 x 2 | 12.00 | 0.4 | |
| 45 | 227+900 | Box | 1 x 2 | 12.00 | 0.4 | |
| 46 | 227+500 | Box | 1 x 2 | 12.00 | 0.4 | |
| 47 | 227+400 | Slab | 1 x 2 | 12.00 | 0.4 | |
| 48 | 227+000 | Slab | 1 x 3 | 12.00 | 0.4 | |
| 49 | 226+900 | Box | 1 x 2 | 12.00 | 0.4 | |
| 50 | 226+800 | Box | 1 x 2 | 12.00 | 0.3 | |
| 51 | 226+700 | Box | 1 x 2 | 12.00 | 0.4 | |
| 52 | 226+400 | Slab | 1 x 2 | 12.00 | 0.4 | |
| 53 | 225+900 | Slab | 1 x 2 | 12.60 | 0.4 | |
| 54 | 225+200 | Slab | 1 x 2 | 12.00 | 0.3 | |
| 55 | 224+600 | Box | 1 x 2 | 10.00 | 0.4 | |
| 56 | 224+500 | Box | 1 x 2 | 10.00 | 0.4 | |
| 57 | 224+400 | Box | 1 x 2 | 10.00 | 0.4 | |
| 58 | 224+350 | Box | 1 x 2 | 10.00 | 0.3 | |
| 59 | 224+250 | Box | 1 x 2 | 10.00 | 0.3 | |
| 60 | 224+200 | Box | 1 x 2 | 10.00 | 0.3 | |
| 61 | 224+000 | Box | 1 x 2 | 10.00 | 0.3 | |
| 62 | 223+700 | Box | 1 x 2 | 10.00 | 0.3 | |
| 63 | 223+200 | Box | 1 x 2 | 10.00 | 0.3 | |
| 64 | 222+500 | Box | 1 x 2 | 10.00 | 0.3 | |

| Sl. No. | Chainage | Type of Structure | Span Arrangement (m) | Formation Width (m) | Thickness of Deck Slab (m) | Remarks |
|---|---|---|---|---|---|---|
| 65 | 221+950 | Slab | 1 x 2 | 11.00 | 0.45 | Package-2 (233+000 to 212+060) |
| 66 | 221+700 | Slab | 1 x 2 | 10.00 | 0.3 | |
| 67 | 221+600 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 68 | 220+800 | Slab | 1 x 1.5 | 11.00 | 0.3 | |
| 69 | 220+000 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 70 | 217+950 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 71 | 217+850 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 72 | 217+300 | Slab | 1 x 1.5 | 10.00 | 0.3 | |
| 73 | 217+000 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 74 | 216+900 | Slab | 1 x 1 | 10.00 | 0.3 | |
| 75 | 216+600 | Slab | 1 x 1 | 10 | 0.3 | |

There are total 10 nos. of existing bridges out of which 2 is major bridge, whereas the other 8 nos. are minor bridges.

The Major Bridge cross Chiri River near Pailapool at km 236+200, having a span arrangement of 1x63m having a deck width of 11.0m a total length of 63m. Super structure consists of RCC Box girder. The Bridge across Jiri River in Jiribam at Km 222+200. The super structure consists of RCC Box girder. The Bridge is having a span arrangement of 2 x 56m having a total length of 112m with a deck width of 11.0m.

Out of 8 Nos. of Minor Bridges, 2 Nos. are RCC Slab Type, 3 No. is Box type, 2 Nos. are Box girder type and 1 No. is RCC-I girder type .

**Table 2.10 Details of Bridges**

| Sl. No. | Locations | Type of Structure | Span Arrangement (m) | Length of Structure (m) | Structure Configuration | Carriageway Width (m) | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 256+000 | MNB | 1 x 43.00 | 43 | RCC I-girder | 10 | Package-1 (260+000 to 233+000) |
| 2 | 250+400 | MNB | 1 x 10.00 | 10 | RCC Slab | 7.5 | |
| 3 | 247+200 | MNB | 1 x 19.40 | 19.4 | Box Girder | 7.5 | |
| 4 | 243+300 | MNB | 3 x 6.50 | 21.5 | Box | 11 | |
| 5 | 236+200 | MJB | 1 x 63.00 | 63 | RCC Box girder | 10 | |

| Sl. No. | Locations | Type of Structure | Span Arrangement (m) | Length of Structure (m) | Structure Configuration | Carriageway Width (m) | Remarks |
|---|---|---|---|---|---|---|---|
| 6 | 232+900 | MNB | 2 x 6.00 | 19.2 | Box | 11 | Package-2 (233+000 to 212+060) |
| 7 | 228+600 | MNB | 1 x 7.00 | 7 | RCC Solid Slab | 9 | |
| 8 | 225+500 | MNB | 2 x 7.00 | 14 | Box | 11 | |
| 9 | 222+200 | MJB | 2 x 56.00 | 112 | RCC Box girder | 10 | |
| 10 | 216+500 | MNB | 1 x 46.50 | 46.5 | Box-Girder | 11.5 | |

## 2.21 Traffic Flow Conditions

There is mixed traffic plying on the Project Highway comprising of trucks, buses, cars, two wheelers, non-motorised vehicles, etc. Two homogeneous sections tabulated below have been considered to know the traffic flow conditions as shown in the traffic report.

**Table 2.11 Details of Homogenous Sections**

| Sl. No. | Section | Exist. Chainage | | Length (Km) |
|---|---|---|---|---|
| | | From | To | |
| 1 | Silchar (Rongpur) to Pailapool | 263+500 | 240+000 | 23.500 |
| 2 | Pailapool to Jiribam | 240+000 | 212+060 | 27.940 |

The above homogeneous sections are considered based on the traffic flow, carriageway, commercial establishments, stopping of buses, pedestrian crossing, slow moving vehicles etc.

## 2.22 Railway line crossing

The project road crosses railway lines only at one location in Package-1 (260+000 to 233+000) at Existing Km 238+400 near Pailapool.

**Pic 2.3 LC at Km 238+400**

## 2.23 Railway over Bridge (ROB)/Railway under Bridge (RUB)

There is 1 no. ROB at Km 245+600 and one RUB at Km 224+900 along the project road. The details of the same is given in below table

RUB at Km 224+900

ROB at Km 245+600

**Pic 2.4 PICTURES OF ROB & RUB**

**Table 2.12 Details of ROB/RUB**

| Sl. No. | Locations | Type of Structure | Span Arrangement (m) | Structure Configuration | Overall Deck Width (m) | Remarks |
|---|---|---|---|---|---|---|
| 1 | 245+600 | ROB | 3 x 8.3 | RCC Solid slab with RCC sub structure. | 8.50m | Package-1 (260+000 to 233+000) |
| 2 | 224+900 | RUB | 2 x 6.1 + 1 x 18.3 | Steel Concrete composite girder with RCC substructure. | 12.50m | Package-2 (233+000 to 212+060) |

## 2.24 VUP and PUP

There is 1 no. of VUP at Km 222+000 and the details of underpasses are shown below.

**Table 2.13 Details of Grade Separation**

| Sl. No. | Locations | Type of Structure | Span Arrangement (m) | Structure Configuration | Overall Deck Width (m) | Remarks |
|---|---|---|---|---|---|---|
| 1 | 222+000 | VUP | 1 x 5 | RCC Solid slab with Masonry substructure | 11.0m | Package-2 (233+000 to 212+060) |

## 2.25 Petrol Pumps

There are 3 Nos. of Petrol / Diesel pump stations present along the project road from Silchar to Jiribam. These stations are being used by vehicular traffic regularly. The location of these stations is indicated below.

**Table 2.14 Petrol/Diesel Filling Stations along Project Road**

| Sl. No. | Existing Chainage (Km) | Direction | Near Villages | Remarks |
|---|---|---|---|---|
| 1 | 240+450 | RHS | Pailapul | Package-1 (260+000 to 233+000) |
| 2 | 220+100 | RHS | Jiribam | Package-2 (233+000 to 212+060) |
| 3 | 218+500 | LHS | Khamrang | |

## 2.26 Hospitals and Schools

There are number of schools, colleges and hospitals present along the project road. The approximate locations of these are shown below.

**Table 2.15 Schools/Hospitals etc. along Project Road**

| Sl. No. | Existing Chainage (Km) | Side (LHS/RHS) | School/ Hospital | Near Villages | Remarks |
|---|---|---|---|---|---|
| * | 262+450 | LHS | Government School | Rongpur | Package-1 (260+000 to 233+000) |
| * | 262+400 | RHS | Government School | Rongpur | |
| 1 | 258+850 | LHS | School | Natun | |
| 2 | 256+600 | LHS | Vallabh Bhai Patel School | Kashipur | |
| 3 | 254+100 | LHS | Secondary School | Kashipur | |
| 4 | 251+600 | RHS | School | Baskandi | |
| 5 | 250+500 | LHS | Hospital | Baskandi | |
| 6 | 249+700 | RHS | School | Ranipur | |
| 7 | 249+000 | LHS | School | Ranipur | |
| 8 | 244+900 | LHS | School | Ujan Tarapur | |
| 9 | 241+200 | LHS | School | Sibpur | |
| 10 | 239+600 | LHS | School | Pailapool | |
| 11 | 239+200 | RHS | Sunrise Primary School | Pailapool | |

| Sl. No. | Existing Chainage (Km) | Side (LHS/RHS) | School/ Hospital | Near Villages | Remarks |
|---|---|---|---|---|---|
| 12 | 237+800 | LHS | School | Pailapool | Package-1 (260+000 to 233+000) |
| 13 | 234+650 | RHS | Paradise high School | Fulertal | |
| 14 | 234+450 | RHS | College | Lakhipur | |
| 15 | 233+600 | LHS | Hospital | Fulertal | |
| 16 | 233+300 | LHS | Asapalli English Medium School | Khawlien | |
| 17 | 233+200 | LHS | PMS School | Khawlien | |
| 18 | 233+000 | LHS | VG School | Khawlien | |
| 19 | 224+600 | LHS | School | Laalpani | Package-2 (233+000 to 212+060) |
| 20 | 224+300 | RHS | School | Laalpani | |
| 21 | 223+500 | LHS | Laalpani Corporation School | Laalpani | |
| 22 | 220+900 | LHS | School | Jirighat | |
| 23 | 220+400 | LHS | Hospital | Jiribam | |
| 24 | 219+600 | LHS | School | Jiribam | |
| 25 | 219+500 | LHS | School | Jiribam | |
| 26 | 218+900 | RHS | School | Jiribam | |
| 27 | 217+800 | LHS | Jirighat School | Khamrang | |
| 28 | 216+550 | LHS | Little angel School | Gularthol | |

*The stretch from Km 262+500 to Km 260+000 has already been included under Package-1 in Silchar to Vairengte Section.

## 2.27 Constraints along project road

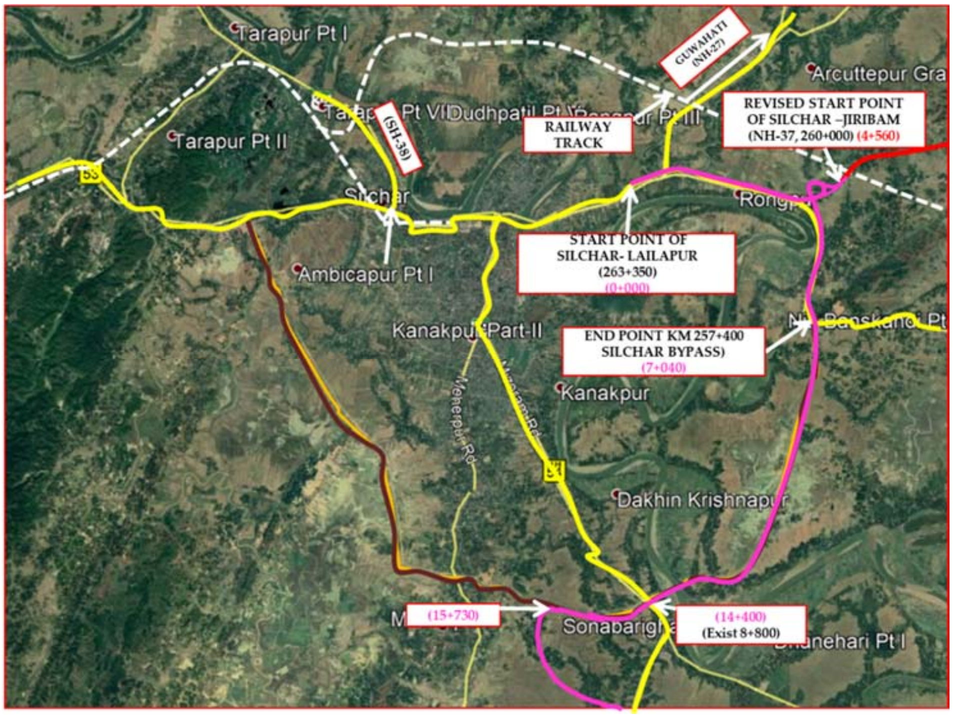
There are number of constraints for widening the existing project road. Some of them are:

- Rivers like Barak, Chiri and Jiri are running parallel to RHS of existing road at most of the sections say for a length of 35 km (approx.) (Project Road crosses 3 Major Bridges)
- Railway line connecting Manipur from Silchar is also running towards LHS of Existing Road (Project Road crosses 1 ROB, 1 RUB and 1 Level crossing).

- Commercial traffic carrying different commodities from Guwahati and Karimganj (NH-27) uses the project road (NH-37) to reach various parts of Manipur state.
- Inadequate existing ROW width at built-up areas,
- Settlements close to project road involving in rehabilitation and resettlement.
- Presence of religious structures along the project road – there are approx. 23 nos. of temples, 16 mosques, 04 Church and 3 Graveyards along the project road.
- Presence of utility service lines like water pipes, electricity lines, telephone and OFC line on both sides of highway,
- Presence of number of trees along the project road within EROW.
- Some stretches are flying in hilly area with pineapple plantation.
- The existing alignment is also facing so many accident-prone zones, which has been described separately in upcoming paragraphs.
- Bypass to Silchar town is already proposed and under construction / partially constructed by PWD, NH Division Silchar. History / Details of Siclchar bypass has been discussed separately in upcoming para.

***Considering numbers of constraints, DPR consultant has recommended and thereafter approved a fresh alignment as "Green Field Alignment".***

- Exiting Sichar Bypass
- Proposed by PWD NH Division (Under Construction).
- The proposed bypass has been considered on RHS as the major river (Barak) is running on LHS of Silchar town along with Railway line.
- The bypass takes off point from Silchar Badarpur Road (NH-53) at Km 6+250.
- Traverses along RHS of Silchar town and terminates near Kashipur village at Km 257+325 of Silchar Jiribam Road (NH-37).
- The proposed bypass intersects project road alignment at Km 8.40 of Silchar-Lailapur Vairengte Road (Old NH-54 / new NH 306).
- The traffic from Guwahati, Imphal can be diverted to proposed bypass towards Mizoram so that traffic congestion can be mitigated in Silchar town.
- Length of proposed bypass is 20.0 Km.




**Pic 2.5 SILCHAR BYPASS**

## 2.28 Black Spot / Accident Prone Zone

Exiting project road has very poor geometrics in terms of horizontal sharp turn / acute / sub-standard curves and ribbon settlement all along the existing road that leads to accident-prone zones and black spot zones as listed below section.

**Table 2.16 Black Spot (please check with Abed as per latest data supplied by NHIDCL)**

| Sl. No | Date | Vehicle Type | Case No | Location | Injured | Killed | chainage |
|---|---|---|---|---|---|---|---|
| 1 | 14/10/2018 | Alto K-10 | 3649/18 | Rongpur pt IV | | 2 | 265+500 |
| 2 | 16-06-18 | Traveler Bus | 2198/18 | Kashipur Turning | 1 | 1 | 258+800 |
| 3 | 6/4/2018 | Ambassador | 1102/18 | Kashipur B R T F Camp | - | 1 | 259+500 |
| 4 | 2/5/2018 | Tipper | 1555/18 | Rongpur (Ram Krishna Petrol Pump) | - | 1 | 265+700 |

**Table 2.17 Accident black spot for the calender year 2016-2018**

| Name of Dist. (Traffic unit) | Name of Jurisdictional Police Station | Showing NH/SH/MDR/ OR Number | Limits of High Accident Prone Location | | Total of all three Years | Total of all three Years | Total of all three Years |
|---|---|---|---|---|---|---|---|
| | | | Starting from () | Ending to () | | | |
| Cachar | Lakhipur PS | NH-37 | 1) Basnkhandi near Degree College-1/2 (253+000)<br>2) Ujan Tarapur near Shibpur-2 , 245+500 | 1) Badribasti Turning-1 (256+000)<br>2) Khunjow Basti near Pailapool- 1 1/2 , km -239+000 | 23 | 12 | 64 |
| | Silchar PS | NH-37/54 | 1) Kashipur Tri-Junction, Km 256+700<br>2) Rongpur M.V School, km263+500<br>3) Ramnagar (Khelma flower Mill<br>4) Srikuna Daily Bazar<br>5) Krishnapaur, Rana MLA house, km 6+500<br>6) Saidpur near bridge, km 12+000 | 1) Kashipur T.E Road-1/2 , 258+500<br>2) Madhurapul Tri Junction-1/2, 262+200<br>3) Srikuna Army Gate- 2<br>4) Surtara Bridge-2<br>5) Sonabarighat P/Pump, 8+500<br>6) Katagastola-2, 10+500 | 50 | 23 | 80 |
| | Dholai PS | NH-54 | Nutan Bazar area Norshingpur-1/2 | Near Kabuganj km 24+500 to Kathakal-1 Km19+500 Bhagabazar near Trainingkm 35+300 | 26 | 18 | 45 |

## 2.29 Utilities

Utilities like telephone cables, O.F.C. lines, water pipelines and electric lines present along and across the Project Highway. Some of these utilities will be affected by the road widening, thus requiring them to be shifted. Details/locations of all the utilities / OFC and trees will be part of final strip plans and will be submitted in the Final Feasibility Report. The details of the utilities and trees which are required to be shifted/ cut will also be shown in the Strip Plans.

Details of utilities along the existing are mentioned below,

**Table 2.18 Summary of Utilities along existing**

| TYPES | Nos. |
|---|---|
| HT Lines | 10 |
| Electric pole | 1043 |
| Transformer | 56 |

**Pic 2.6** UTILITIES ALONG EXISTING ALIGNMENT (SILCHAR – JIRIBAM)

## 2.30 Environmentally Sensitive Areas

As the project road is in operation and likely to be improved / upgraded, there will not be any major changes/impact on the ecological and environmental features along the project road however, since Green field alignment proposed, it encounters forest section between D. Ch 31+500 and D. Ch 36+700 (5.2kms) that may impact environmentally, the detailed information shall be referred from EIA report. Also, the existing project road will not pass through any Reserve Forest, Elephant corridor or Wildlife sanctuary etc. The findings of the environmental study will be dealt separately in “Environmental Impact Assessment” report.

## 2.31 Government / Private Agencies to be consulted

Following Government departments need to be consulted to seek their consent / guidance form improvement of Project Road.

a) Department of Land Survey & revenue for land/buildings records and acquisition,
b) Electricity Department for relocation of LT lines, HT lines, Transformers etc.
c) Irrigation, RWS and Town Panchayat for relocation of canal, water supply, sewer lines if any, along the project road
d) District Forest Officer of respective district.
e) Geological and Mining Department of respective district.
f) NH / SH Public Works Departments.
g) Industrial Area Development Board,

## 2.32 Recommendations concerning the alignment.

### Along the existing road

4-lane development follows existing road NH-37 from existing km 262+950 to 260+000 for a length of 2.95 Km which is part of Silchar – Vairengte-Sairang project, already awarded to the EPC contractor however, Silchar – Jiribam project start at proposed junction of pkg-1, existing km 260+000 (D. Ch. 4+100 of Silchar -Vairengte) and traverse along greenfield alignment.

### Green Filed alignment

The project road which is presently Intermediate/2-lane shall be developed to 4-lane divided carriageway with paved shoulder configuration through green field. Salient features of the proposed improvements are summarized below.

**Table 2.19 Summarized Table**

| Classification | Section | Road | Existing Project Road Length (km) | Approved Green Field Alignment (km) |
|---|---|---|---|---|
| **Economic Corridor (EC)** | **Silchar-Jiribam** | **NH-37 (Old NH 53)** | **47.940 Km** | **33.090 Km** |

**Table 2.20 Comparation between Existing Road vs Green field alignment**

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| 1 | **Existing Road Alignment** | | |
| | Total exiting Road Length (from km 262+950 to km 212+060) | Km | 50.890 |
| 2 | **Green Field Alignment Green Field Alignment** | | |
| | **1) On Green Field: from km260+000 to km212+060** | Km | 47.940 |
| 3 | **Actual Design Length of Green filed alignment (from Km 4+560 to Km 37+650)** | **Km** | **33.090** |

The above green field alignment length of 47.940 Km is along the existing road. Whereas the proposed length of green field alignment is 33.090 Km. Hence, total reduction of design length comes out to 14.850 Km. Detailed discussion on same has been dealt in Chapter: 7.

**Table 2.21 Comparation between Existing Road vs Green field alignment for Package-1, Km 260+000 to Km 233+000**

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| 1 | **Green Field Alignment Green Field Alignment** | | |
| | **On Green Field: from km 260+000 to km 233+000** | Km | 27.000 |
| 2 | **Actual Design Length of Green filed alignment (from Km 4+560 to Km 24+560)** | **Km** | **20.000** |

The above green field alignment length of 27.000 Km is along the existing road. Whereas the proposed length of green field alignment is 20.000 Km. Hence, total reduction of design length comes out to 7.000 Km. Detailed discussion on same has been dealt in Chapter: 7.

3

# Chapter 3 - Analysis & Interpretation of Engineering Surveys and Investigations

**Section: Silchar to Jiribam (Package: SJ-1, From D. Km 4+560 to D. Km 24+560)**

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# 3 Chapter 3 – Analysis & Interpretation of Engineering Surveys and Investigations

## 3.1 General

As per requirements of the study, the Consultants had carried out different types of field studies, engineering surveys and investigations to gather data and information necessary for Feasibility Study (FS). The aim of the investigations was to develop an adequate supportive database for selecting and preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The engineering investigations and surveys have been carried out in line with the specifications laid out in IRC: SP-19:2001.

The major aspects of surveys and investigations relevant to the present FS/DPR Study cover the following:

**Topographic Survey**

- Carrying out detailed topographic survey using high precision instruments i.e LiDAR (Light Detection and Ranging)
- Fixing of GPS pillars and Benchmark pillars
- Carrying the benchmark levels from GTS benchmarks
- Traversing to transfer the coordinates to traverse stations
- Collecting the details and making drawing.
- Data processing and drawing in presentable format and checking at site.

**Road Inventory and Geometric**

- Carriageway type/width (m)
- Land use and roadside environment
- Right of way details
- Intersections and Junctions
- Geometric (Horizontal and Vertical)

**Pavement Surveys and Investigations**

- Pavement condition survey
- Pavement structural evaluation
- Pavement composition
- Subgrade characteristics and strength

**Traffic**

- Classified traffic volume count
- Origin & Destination survey
- Turning movement survey
- Axle loading spectrum

**Drainage**

- Roadside drainage
- Inventory of cross drainage works and bridges
- Condition and structural adequacy
- Hydraulic adequacy
- Road-side drainage

**Material Investigations**

- Borrow areas for locating suitable soils for use in embankment and sub-grade.
- Quarries for locating hard stone/granular materials for use in sub-bases, bases, bituminous mixes and concrete works.
- Source of sand for use in DBM/BC layers and cement concrete works.

The data regarding the above aspects are required for the design and to establish the economic viability. The consultants carried out both "Secondary" and "Primary Surveys" for the study. The Secondary Surveys covers the collection and compilation of the data so to assimilate the available information regarding the Project Road. The Primary Surveys were carried out to determine the current scenario and also to augment the available information. The analysis of available data was also useful while planning "Primary Surveys".

This chapter presents the findings of the field studies concerning road inventory, pavement investigations and analysis, bridge and cross drainage inventory and cross-drainage condition and interpretation of data. The basic data and results of investigation are compiled and included in **Volume I – Appendices to Main Report.** The traffic volume data are included in **Chapter 4 – Traffic Studies and Demand Forecast.**

## 3.2 Topographic Surveys

### 3.2.1 General

As per the TOR, the Consultants have to carry out detailed topographic survey along the project corridor using high precision instrument i.e LiDAR ((Light Detection and Ranging) along the existing road and Total station instrument was used along green field alignment where LiDAR instrument is not accessible. The accuracy levels of the instrument should meet following requirements as mentioned in the RFP.

For land-based surveys, (a) Fundamental horizontal accuracy of 2 cm or better (b) Fundamental vertical accuracy of 2 cm or better (c) More than 50 points shall be measured per Sqm.

For aerial based surveys, (a) Fundamental horizontal accuracy of 5cm or better (b) Fundamental vertical accuracy of 5 cm or better (c) More than 10 points shall be measured per Sqm.

Other parameters include establishment of primary control points using GPS at every 5 Km intervals and fixing of Benchmark pillars at every 250m interval with reference to GTS Benchmark.

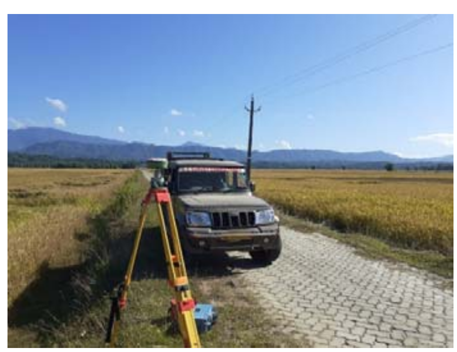
Detailed Topographic Survey was undertaken by the Consultants for capturing all the physical features along the project corridor and along the green field alignment for facilitating proposals for the final centreline of the proposed 4/6 lane. The survey covered a strip of 60m width, broadly 30m either side of the proposed centreline. Full cross sections for 60m width have been collected at every 25m interval to form Digital Terrain Model (DTM). The details i.e. spot levels, typical features; habitation; rock outcrops and streams etc. have been mapped during topographic survey. The plan covers all permanent features near the alignment, the existing roadway, locations of culverts, bridges, retaining walls, house /buildings, utility services, trees etc.

### 3.2.2 Control Survey

Control survey includes following:

- Establishment of horizontal control network using DGPS
- Traverse control along the road using total station
- Elevation control of all the above control points using auto level

GPS control points are marked on cement concrete pillars embedded in the ground. In order to ensure a high degree of survey accuracy, control points at an approximate interval of 5 to 6 km are established along the length of the road. Each GPS control pillar is supplemented by one additional inter-visible pillar of same specification within the vicinity of 200 to 300 m. The co-ordinates of all these control points are observed using GPS receivers in differential mode. The twin pillars facilitate the checking of bearings and are being used for the starting of independent survey in any 5 to 6 km stretch. The concrete pillars are



suitably numbered, and their description has been prepared, to ensure easy identification and accessibility in future.

Total station traverse has been carried out to establish additional secondary control points, 250 m to 300 m apart, starting with one pair of GPS control point and closing on to the next pair of GPS control point. These traverse control points are used for further detailed survey.

The elevations of all control points have been established using auto levels. The elevation of the control points has been established with respect to the GTS (Great Triangulation Survey) benchmarks established by Survey of India available at **"Executive Engineer Water Resources E&D office, Tarpur,** ***Silchar, Assam*****"** has been used in carrying out the levelling work along the project road.

**Table 3.1 List of GPS Control Points**

| Sl. No. | Station ID | Existing Chainage (m) | Design Chainage (m) | Location of Pillar w.r.t green filed | Co-Ordinate | | Level |
|---|---|---|---|---|---|---|---|
| | | | | | Easting | Northing | |
| 1 | GPSA3 | Green filed | 4+732 | LHS | 486797.17 | 2746959.93 | 21.442 |
| 2 | GPSA4 | Green filed | 4+791 | RHS | 486926.73 | 2746904.12 | 21.2456 |
| 3 | GPSA5 | Green filed | 7+902 | RHS | 489854.12 | 2747622.66 | 20.8508 |
| 4 | GPSA6 | Green filed | 8+077 | LHS | 489997.15 | 2747741.75 | 21.9838 |
| 5 | GPSA7 | Green filed | 11+913 | RHS | 493677.29 | 2748635.31 | 21.992 |
| 6 | GPSA8 | Green filed | 11+935 | RHS | 493694.81 | 2748531.92 | 22.064 |
| 7 | GPSA9 | Green filed | 15+076 | RHS | 496814.41 | 2748307.92 | 24.9185 |
| 8 | GPSA10 | Green filed | 15+073 | LHS | 496827.34 | 2748380.39 | 24.9074 |
| 9 | GPSA11 | Green filed | 19+614 | RHS | 501220.12 | 2747346.36 | 24.4106 |
| 10 | GPSA12 | Green filed | 19+605 | LHS | 501252.57 | 2747439.19 | 23.812 |
| 11 | GPSA13 | Green filed | 22+671 | LHS | 504201.95 | 2746804.89 | 29.1648 |
| 12 | GPSA14 | Green filed | 22+651 | RHS | 504161.85 | 2746744.12 | 29.1532 |
| 13 | GPSA15 | Green filed | 26+064 | RHS | 507411.38 | 2745471.96 | 59.5132 |
| 14 | GPSA16 | Green filed | 26+010 | RHS | 507359.07 | 2745489.1 | 69.4592 |
| 15 | GPSA17 | Green filed | 28+440 | RHS | 509836.39 | 2745624.88 | 46.5413 |
| 16 | GPSA18 | Green filed | 28+462 | RHS | 509853.05 | 2745556.79 | 44.365 |
| 17 | GPSA19 | Green filed | 31+695 | RHS | 512999.81 | 2745164.93 | 29.443 |
| 18 | GPSA20 | Green filed | 31+656 | RHS | 512985.37 | 2745244.5 | 29.443 |

The details of location and values of Northing, Easting and Altitude (MSL) of GPS pillars and benchmark pillars are given in **Volume-I Appendices to Main Report (Appendix 3.1).**

### 3.2.3 Survey

Based on the above control network (both for plan and elevation), topographical survey using high precision instrument i.e. LiDAR has been carried out along the existing road and Total station instrument was used to do the survey along the proposed green field alignment where LiDAR instrument cannot be used. The details such as co-ordinate data (x, y, z) of all the topographical points as required for the preparation of strip plan submitted as part of the interim report. In general, these include:

**Mobile LiDAR used for the Project**

- Road centre line
- Pavement top & bottom edges
- Outer shoulder edges
- Toe lines of fills and cuts
- Longitudinal and transverse drains / ditches

All man-made and natural topographical features have been surveyed, including:

- Water sources
- Structures
- Buildings
- Utilities etc. as visible, falling inside the survey corridor

Additional surveys for geometric improvements bridge sites, junctions and RoBs were also undertaken. At locations, where the existing alignment/ proposed alignment crosses other roads, the survey was extended to a minimum of 100m on either side of the road centre and of sufficient width to allow for the improvements to be designed.

LiDAR Survey was carried out by Vehicle mounted (Mobile) as well as Unmanned Aerial Vehicle (UAV). Mobile Lidar was used along the existing roads and UAV were used where the location is not accessible for Total station survey. Total station survey was carried out at proposed green field alignment where Lidar was not approachable. After which both data were combined in order to make sure that no data is missed.

Surveys for longitudinal and cross-sections for major and minor streams as required for preliminary design were also carried out.

### 3.2.4 Data Processing

All data from the mobile LiDAR, Unmanned Aerial Vehicle (UAV), Total station and other field records, were downloaded regularly on to the field computer to ensure completion of data processing at the field itself. Further processing, for production of requisite outputs, was carried out using other software in the field or at headquarters, as required.

LiDAR is a surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target. They can be used to create a DTM (Digital Terrain Model) or DEM (Digital Elevation Model). The Laser data is processed using a multidimensional occupancy grid. Data from a four-layer laser is pre-processed at the signal level and then processed at a higher level to extract the features of the obstacles. A combination two-dimensional and three-dimensional grid structure is used and the space in these structures is tessellated into several discrete cells. This method allows a huge amount of raw measurement data to be effectively handled by collecting it in spatial containers, the cells of the evidence grid. This probability is calculated by using the range measurement of the LiDAR sensor obtained over time and a new range measurement, which are related using Bayes' theorem. A two-dimensional grid can observe an obstacle in front of it, but cannot observe the space behind the obstacle. To address this, the unknown state behind the obstacle is assigned a probability of 0.5. By introducing the third dimension or in other terms using a multi-layer laser, the spatial configuration of an object could be mapped into the grid structure to a degree of complexity. This is achieved by transferring the measurement points into a three-dimensional grid. The grid cells which are occupied will possess a probability greater than 0.5 and the mapping would be colour coded based on the probability. The cells that are not occupied will possess a probability less than 0.5 and this area will usually be white space. This measurement is then transformed to a grid coordinate system by using the sensor position on the vehicle and the vehicle position in the world coordinate system. The coordinates of the sensor depends upon its location on the vehicle and the coordinates of the vehicle is computed using ego motion estimation, which is estimating the vehicle motion relative to a rigid scene. In addition to the LiDAR detection, RADAR data obtained by using two short range radars is integrated to get additional dynamic properties of the object, such as its velocity. The measurements are assigned to the object using a potential distance function.

Data were supplied to the design team in a format suitable for the preparation of drawings and road design alignment.

**Deliverables to be submitted after completion of survey include.**

(a) Raw DGPS data for the entire highway length and adjoining areas of interest.

(b) Point cloud data/ Data of points captured for the entire highway length and adjoining areas of interest.

(c) Topographic map of scale 1:1000 of the entire highway length and adjoining areas of interest.

(d) Contour map of 50 cm of entire highway length and adjoining areas of interest.

(e) Cross section of the highway at every 1 m in *.dwg format.

(f) 360-degree panoramic images of the entire highway length and adjoining areas of interest.

## 3.3 Road Inventory Data

A detailed inventory of the project road has been prepared through dimensional measurements and visual inspection to assess the existing status as per IRC SP: 19 and keeping in mind that these will become part of concession agreement as Schedules. Features like kilo meterage, terrain, land use, width of pavement and shoulders, height of embankment, geometric deficiencies, important road junctions, utilities etc. were recorded in the prescribed format. The road inventory data for the project road length was collected for each kilometre and part thereof as warranted by appreciable change in the physical features. The detailed inventory data have been included in **Volume I - Appendix 3.2.**

## 3.4 Pavement Investigations

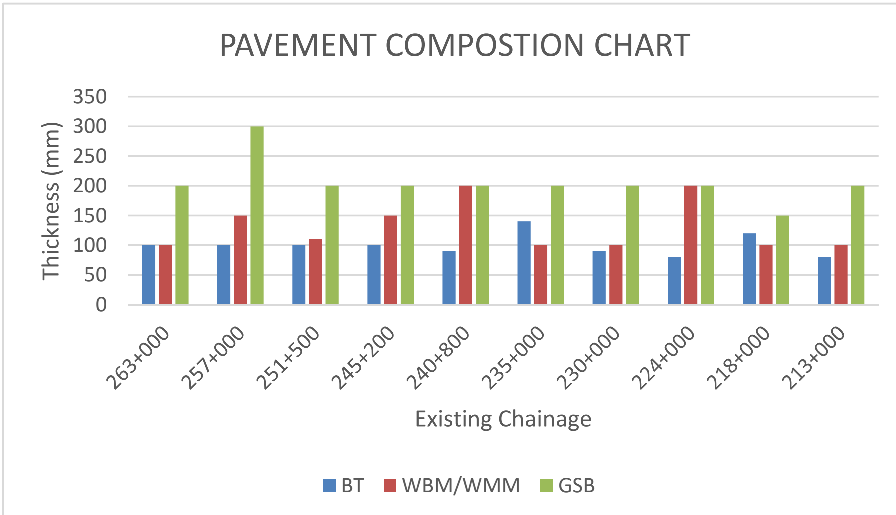
Pavement investigation of the project road as per TOR comprises of

- Pavement composition
- Pavement condition surveys
- Pavement structural strength

These investigations have been completed for the project road, data was analysed, and results are presented in the subsequent sections.

### 3.4.1 Existing Pavement Composition (Trial Pits)

The details of Trial pits excavation, subgrade soil collection and existing crest thickness are discussed in **Section 3.7.5.** The observed variations of thickness of different pavement layers have been shown graphically below.




The existing pavement consist of Bituminous Concrete (BC), Dense Bituminous Macadam (DBM) as binding course on base course of wet mix macadam (WMM)/ water bound macadam (WBM) and granular sub base as sub base course on varying type of sub grade all along the project road. Results of the test pit survey indicate appreciably varying thickness of pavement layers for the carriageway. Total thickness of the pavement is varying between 370 mm and 550 mm. The thickness of bituminous layer is varying between 80-140 mm.

### 3.4.2 Pavement Condition Survey

**Field Study**

Detailed field studies have been carried out to collect road and pavement surface conditions based on visual observation during inventory. The data collected include pavement surface distress, shoulder, embankment, and drainage conditions. Approximate area of pothole, ravelling, length of edge break and rut depth in mm are measured using 3m straight edge. The data collected regarding road, pavement surface condition and drainage are presented in **Volume-I Appendices to Main Report (Appendix 3.4)** and few photograph of existing road is given below. This data forms the basis for the input into economic analysis and the deterioration models that are being used for the economic analysis.




**Pic 3.1 Photographs of Existing Road condition**

### Analysis of Data

By studying, the pavement condition of the project road, each category of distress mode was then given a definite quantitative value and data sheet prepared in the field in the coded form, which was later converted into the quantitative values. For determining the pavement condition for each km of road, the yardstick as given in the following table has been used to designate the pavement condition.

**Table 3.2 Yardstick of Pavement Condition**

| Sl. No. | Pavement Condition | Potholes (%) | Cracking (%) | Patching (%) | Ravelling (%) | Rut (mm) |
|---|---|---|---|---|---|---|
| 1 | Excellent | Nil | ≤5 | Nil | ≤1.0 | ≤5 |
| 2 | Good | ≤5 | > 5 ≤ 10 | ≤ 0.5 | >1.0 ≤ 2.0 | > 5 ≤10 |
| 3 | Fair | >5 <10 | > 10 ≤ 20 | > 0.5 ≤ 2.0 | 2.0 ≤ 5.0 | > 10 ≤ 20 |
| 4 | Poor | >10 <50 | >20 ≤ 30 | >2 ≤ 6.0 | >5.0 ≤10.0 | >20 |
| 5 | Very poor | >50 | >30 | >6.0 | >10.0 | - |

An overall assessment of performance / serviceability of the road has been analysed with reference to Standard Yard Stick and the variation of Condition survey elements like Cracking, Ravelling, Patching and Potholes and the summary of the pavement condition is given in the following Table.

**Table 3.3 Summary of Distresses on Project Road**

| Sl. No. | Section (Existing Chainage) | Cracks (%Area) | Potholes (%Area) | Ravelling (% Area) | Patching (%Area) | Rut Depth (mm) | Edge Drop (mm) |
|---|---|---|---|---|---|---|---|
| 1 | 263+500 to 212+060 along NH-37 | 16% | 17% | 39% | 4.3% | 9 | 40 |

**Note:** The road condition survey was conducted in the year 2018. However as per the latest site visit during February 2020, overlay has been laid at some locations along the project road.

The pavement condition survey was conducted in the year 2018 for the section from Silchr to Jiribam, at the time of survey the condition of the pavement was Good, fair and poor some locations. However as per the recent site visit during February 2020 it is observed that the new overlay was laid at some locations. Based on the data obtained during inventory, the road segments of equal performance are identified based on IRC 81-1997 and presented in the following table.

**Table 3.4 Pavement Condition on Project Road**

| Chainage (km) | | Length (m) | Classification | Remarks |
|---|---|---|---|---|
| From | Km | | | |
| 263+500 | 262+700 | 800 | Fair | |
| 262+700 | 262+300 | 400 | Good | |
| 262+300 | 262+200 | 100 | Fair | |
| 262+200 | 261+600 | 600 | Poor | |
| 261+600 | 257+000 | 4600 | Good | |
| 257+000 | 256+500 | 500 | Fair | |
| 256+500 | 256+400 | 100 | Poor | |
| 256+400 | 253+900 | 2500 | Fair | |
| 253+900 | 252+800 | 1100 | Good | |
| 252+800 | 250+700 | 2100 | Fair | |
| 250+700 | 250+600 | 100 | Good | |

| Chainage (km) | | Length (m) | Classification | Remarks |
|---|---|---|---|---|
| From | Km | | | |
| 250+600 | 250+000 | 600 | Fair | |
| 250+000 | 249+300 | 700 | Good | |
| 249+300 | 248+800 | 500 | Fair | |
| 248+800 | 248+000 | 800 | Good | |
| 248+000 | 235+600 | 12400 | Fair | |
| 235+600 | 235+000 | 600 | Poor | |
| 235+000 | 234+800 | 200 | Fair | |
| 234+800 | 233+900 | 900 | Poor | |
| 233+900 | 232+900 | 1000 | Bad | |
| 232+900 | 214+700 | 18200 | Fair | |
| 214+700 | 212+060 | 2640 | Poor | |

## 3.5 Traffic Surveys

Consultant carried out classified Traffic Volume Count Survey's using ATCC systems. ATCC system used in this project is Pneumatic Tube Detector type. All other type of surveys was done manually using experienced enumerators. As per the requirements of the TOR, the following surveys were undertaken to obtain the traffic data in the desired form.


Traffic Survey using ATCC near Rongpur (NH-37)

- Classified Traffic Volume Count Survey
- Intersection Volume Count
- Axle-load Spectrum
- Origin – Destination (O-D) Survey

The traffic data collected through the Classified Traffic Volume Count Survey were used to estimate the average annual daily traffic (AADT), which is considered as base year (Yr. 2020) 'normal traffic'. The traffic was further projected till the horizon years. Origin – Destination survey has been done to ascertain the traffic flow pattern and to study the possibility of diversion of the traffic to project roads, as a result of road improvement and better operating conditions. The axle-load surveys were carried-out at selected locations for eliciting the load carried by the vehicles and estimating the vehicle damage factor.

The detailed data and analysis of traffic surveys were presented in the **Chapter 4 – Traffic Studies & Demand Forecast.**

## 3.6 Cross Drainage Structures

There are number of streams/rivers crossing the project road. The widths of these crossings vary from 1.2m to 62m. The culverts are of Pipe, Slab and Box type whereas most of the Minor bridges have Bridge structures with RCC slab type / Girder type super structures and 2 no's Major bridge will come in this section.

Besides these Bridge structures, there are many pipe and slab culverts. The pipe culverts are having NP2 to NP4 type of pipes. In respect of slab culverts, the super structures are RCC Slab as their decks.

### 3.6.1 Inventory of Cross Drainage Structures (along existing project road)

Bridge and culvert inventory were carried out in the year 2018 and information was collected in the format recommended by IRC. The detailed information on all the structural components, HFL, LWL dimensions of all the components, linear water way, vertical clearances, drainage spouts, handrails etc. are all given in the tabular form, and presented in **Volume-I Appendices to Main Report (Appendix 3.5A, 3.5B and 3.5C)**. The inventory also contains the recommendations whether the bridge is to be retained/repaired/or dismantled. There are total 75 culverts, 2 Major bridge, 8 Minor Bridge, 1 VUP, 1 ROB, 1RUB, 1 Level crossing and 1 VUP on the project road. A summary of cross-drainage structures are given in the following table.

**Table 3.5 Summary of Culverts, Bridges, ROB/RUB and LC**

| Culverts | | | | Bridges | | | Causeway | ROB | RUB | LC | VUP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Slab/Arch | Box | Total | Minor | Major | Total | | | | | |
| Section: Silchar to Jiribam (260+000 to 212+060) | | | | | | | | | | | |
| 09 | 30 | 36 | 75 | 08 | 02 | 10 | - | 01 | 01 | 01 | 01 |
| Package: SJ-1 (260+000 to 233+000) | | | | | | | | | | | |
| 09 | 03 | 05 | 17 | 04 | 01 | 05 | - | 01 | - | 01 | - |
| Package: SJ-2 (233+000 to 212+060) | | | | | | | | | | | |
| - | 27 | 31 | 58 | 04 | 01 | 05 | - | - | 01 | - | 01 |

There are 75 nos. of existing culverts, out of which 30 no's are Slab, 36 no's are Box and 09no's are Pipe culverts.

There is 2 no's of existing Major bridge along Silchar to Jiribam Section and the Major Bridge cross Chiri River near Pailapool at km 236+200, having a span arrangement of 1x63m having a deck width of 11.0m a total length of 63m. Super structure consists of RCC Box girder. The Bridge across Jiri River in Jiribam at Km 222+200. The super structure consists of RCC Box girder. The Bridge is having a span arrangement of 2 x 56m having a total length of 112m with a deck width of 11.0m

There 08 no's of existing Minor bridges. Out of 08 Nos. of Minor Bridges, 3 Nos. are RCC Slab Type, 2 no's are box type and 3 no's is Girder/I-Girder/Box girder type.

Most of these bridges are having open / Raft foundations and substructures are of RCC. Pipe culverts are having too small vent of 1200 mm with 1200mm dia of pipes, but most of these pipes are of NP2 type.

**Pic 3.2 Photographs of Existing Structures**

### 3.6.2 Condition of Cross Drainage Structures

Detailed condition survey of the existing structures was carried out simultaneously based on the detailed inventory survey. Visual examination of these structures was carried out to find out whether any of the structures have shown any signs of degradation or deterioration or distress to declare them not safe for retention. In general parapets, kerbs and wearing coat at some places were damaged / broken. It is envisaged to repair these parapets and kerbs.

In general, some cracks & spalling of concrete has been noticed at the bottom of deck slabs of some bridges/slab culverts. Detailed conditions of various items of these CD structures are presented in **Volume-I Appendices to Main Report (Appendix 3.5A, 3.5B and 3.5C).**

## 3.7 Material Investigations

### 3.7.1 Introduction

The bulk of materials used in the construction of modern highway pavement are obtained from naturally occurring sources. The choice of materials for various components of highway pavements calls for rigorous investigation of both quality and quantity of material available for economical use on highway projects.

Suitable sources have been identified along the project stretch by local enquiry and the as per the details given from respective forest departments. However, consultant is carrying out the tests on selected sources to find their suitability for use and the results of the same will be submitted in further stage of submission. Sufficient number of quarries has been identified to verify availability of materials within economical leads.

### 3.7.2 Objective of Material Investigations

In general, the objective of the material investigation is to analysis the material of existing pavement, identify the suitable sources of the material and their availability required for the construction of embankment, subgrade, sub-base, base and top layers (bituminous/concrete) of road pavement.

In particular, material investigation has been carried out to establish the following requirements

- Collect all the information regarding availability of construction materials which enables better planning and economic optimization of the project.
- To locate with all details of potential and economic borrow pits all along the project corridor for embankment and sub grade material and to ascertain their availability and suitability for use.
- To determine the nature and physical characteristics of the original ground soils along the existing embankment toe all along the project corridor and original ground soil along the re-aligned section of the project corridor, and to ascertain their suitability as foundation of the embankment/sub grade construction.
- To locate with all details of Aggregate Quarries in the project vicinity and ascertain the suitability of their use in concrete, non-bituminous and bituminous pavement layers.
- To locate with all details of Sand Quarries in the project vicinity and ascertain their suitability for use in concrete, pavement layers etc.
- To locate fly ash availability within a 300km radius of the project corridor for embankment material.
- Examine the engineering properties of the materials relevant to the project as per specification.
- Prepare the Lead Chart of Borrow and Quarry areas for rate analysis & BOQ.

- Identify the cement, steel and bitumen in project vicinity to take their lead for cost estimation purpose.

The soils and materials investigations have been divided into the following components incorporated all the above-mentioned objectives:

- Geological survey
- Existing subgrade soil and pavement material investigations
- Sub grade survey on new alignment
- Material Survey

Testing procedures listed in the section 3.7.5 will be followed for investigation, sampling and testing for soil materials are in accordance with BIS and ASTM wherever applicable to determine their suitability in accordance with MoRT&H specifications.

### 3.7.3 Trial Pits

Soil investigations along the existing road pavement were carried out at all the test location. Science the proposed road is passing through green field, the trial Test sections are considered at every 5 km intervals and testing were carried out to provide a reprehensive indication for the entire study network. The investigations include several operations viz., field and laboratory testing as described below along with the approach and methodology adopted in this project. Trial pits of size 0.75m x 0.75m at every 5 Km intervals were excavated manually staggered left and right side of the existing road pavement and pavement-shoulder interface, extending through the pavement layers and to the level of subgrade and 500 mm below soil subgrade. Field Tests are also to be conducted at soil subgrade level and also at 500mm below sub grade (viz., existing embankment soil) and bulk soil samples were collected for carrying out laboratory investigations.

The details of existing pavement layers crest thicknesses, visual subgrade soil and existing embankment soil classification recorded. The existing bulk sample of Soil sub grade and packed in polythene bags, labelled, numbered and sent to laboratory for conducting necessary laboratory testing. The details of chainage wise pavement investigation carried out are given in table below.

**Table 3.6 Details of Chainage-wise Subgrade Soil Collected**

| Sl No. | Chainage | Sample Type | Remarks |
|---|---|---|---|
| 1 | 263+000, LHS | Subgrade | Package: SJ-1 (260+000 to 233+000) |
| 2 | 257+000, RHS | Subgrade | |
| 3 | 251+500, LHS | Subgrade | |
| 4 | 245+200, RHS | Subgrade | |
| 5 | 240+800, LHS | Subgrade | |
| 6 | 235+000, RHS | Subgrade | |

| Sl No. | Chainage | Sample Type | Remarks |
|---|---|---|---|
| 7 | 230+000, RHS | Subgrade | Package: SJ-2 (233+000 to 212+060) |
| 8 | 224+000, LHS | Subgrade | |
| 9 | 218+000, RHS | Subgrade | |
| 10 | 213+000, LHS | Subgrade | |

The details of crust thickness of existing pavement layers (embankment, soil subgrade, and sub-base, base and asphalt layers) is given in ***Appendix 3.3 of Volume-I.***

***Note:*** *Science the Proposed alignment is passing through green filed and not following the existing NH-37 alignment, the subgrade samples were collected at 5 Km interval.*

**Trial Pit at Km 251+000 (LHS)**


**Trial Pit at Km 245+200 (RHS)**

**Trial Pit at Km 263+000 (LHS)**

**Trial Pit at Km 257+000 (RHS)**

**Trial Pit at Km 240+800 (LHS)**


**Trial Pit at Km 235+000 (RHS)**

**Trial Pit at Km 230+000 (RHS)**

**Trial Pit at Km 224+000 (LHS)**

**Trial Pit at Km 218+000 (RHS)**

**Trial Pit at Km 213+000 (LHS)**

**Pic 3.3 Photographs Showing Trial Pit**

### 3.7.4 Laboratory Investigations

The following Laboratory tests were conducted on collected bulk soil sub grade & embankment / OGL soil as per IS SP 36-Part-2 and CBR at 3 energy levels as per AASHTO T193-93 and the results of the same will be updated in further submission.

- Grain size Analysis – by Wet sieving (24 hours soaked) as per IS 2720 Part 4
- Atterberg's limits (LL, PL & PI) as per IS 2720 Part 5
- Differential Free Swelling Index as per IS 2720 Part 40
- Compaction Tests (MDD & OMC) as per IS 2720 Part
- CBR @ 3 energy Levels as per AASHTO T 193 -93 in 4 days soaked condition
- Soil classification as per IS, HRB & AASHTO

### 3.7.5 Soil classification - IS, HRB and AASHTO Soil Classifications

IS, HRB and AASHTO Classifications of sub grade and embankment Soil Samples is to be carried out based on the Grain Size analysis data, plasticity characteristics and swelling characteristics. The following symbols are used to designate the type of soils.

HRB classifications are also called AASHTO classification of revised Public Roads Administration (PRA) soil classification system. In this classifications, the soils are subdivided in to seven groups A-1 to A-7 based on Grainsize analysis, Atterberg's

Limits and percentage fines. A-1, A-2, A-3 soils are granular soils, percentage fines passing 0.075 mm sieve being less than 35. A-4, A-5, A-6 and A-7 soils are fine grained or silty clay soils, passing 0.075 mm sieve being greater than 35 %.

| | |
|---|---|
| G - Gravels | W - Well graded |
| S - Sand | P - Poorly graded |
| M - Silt | B - Clay Binder |
| C - Clay | Pt - Peat |
| I - Inorganic | O - Organic |
| L - Low Plasticity | W - Well Graded |
| H - High Plasticity | SP - Poorly graded sand |
| SM - Silty Sand | GW - Well graded Gravels |
| SW - Well Graded Sand | SC - Sandy Clay |
| CL - Clay with low compressibility | CH - Clay with high compressibility |
| ML - Silt with low compressibility | MH - Silt with high compressibility |
| GC - Gravelly Clay | CI - Inorganic Clay |
| MI - Inorganic Silt | GM - Gravelly Silt |

### 3.7.5.1 Analysis of Existing Subgrade Soil

The laboratory test results of existing subgrade soil samples are furnished as **Appendix 3.6 of Vol-I Appendix to Main report** Summaries of the Laboratory test results of subgrade soil samples as discussed below.

A total of 10 subgrade samples were collected from Silchar to Jiribam. All the samples collected are belongs to Silty sand SM group IS soil classification system. Liquid limit varies from NP to 35%, plasticity Index ranging from NP to 21.79% and free swelling index varies from 26% to 33%. One of the most important components influencing the structural strength requirements of a pavement is the subgrade strength, which in turn is influenced by the moisture content and degree of compaction of the subgrade soil. Laboratory Maximum Dry Density is in the range of 1.81gm/cc to 2.006gm/cc and optimum moisture content varies from 10.08%to 17.0%. The 4-days soaked CBR values have been determined at three energy levels i.e. at three different dry density. From this relationship of CBR and corresponding dry density, CBR at 97% MDD laboratory maximum dry density have been assessed and the same are furnished and Soaked CBR at 97% varies from 6.4% to 7.0%. The summary of the test results is given in below table.

The Percentage distribution of Existing Subgrade soil, variation of laboratory MDD and Soaked CBR at 97% laboratory maximum dry density along the alignment are shown in below;

The detailed test results (like grain size curves, compaction test curves and CBR test curves) are furnished **Appendix 3.6 of Vol – I Appendix to Main report**. The images of trail pit are presented in below fig;

**Table 3.7 Test results of Existing Subgrade**

| Sl. No | Chainage/Location | Side | Particle Size Analysis | | | | | Atterberg Limits | | | FSI,% | Specific Gravity | Modified Compaction Test Results | | Soaked CBR Value (3-Energy Level) at 97% MDD, % | Soil Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Boulders % | Cobbles % | Gravel % | Sand % | Silt & Clay, % | Liquid Limit % | Plastic Limit % | PI | | | MDD, g/cc | OMC, % | | |
| 1 | 263+000 | LHS | 0 | 0 | 1.09 | 70.38 | 28.54 | NP | NP | NP | 32.00 | 2.66 | 1.94 | 13.76 | 6.80 | SM |
| 2 | 257+000 | RHS | 0 | 0 | 7.53 | 50.43 | 42.05 | NP | NP | NP | 31.00 | 2.68 | 1.96 | 13.36 | 6.60 | SM |
| 3 | 251+500 | LHS | 0 | 0 | 16.74 | 43.37 | 39.90 | NP | NP | NP | 33.00 | 2.65 | 1.97 | 13.30 | 6.70 | SM |
| 4 | 245+200 | RHS | 0 | 0 | 13.19 | 59.43 | 27.39 | NP | NP | NP | 30.00 | 2.59 | 2.00 | 11.90 | 7.00 | SM |
| 5 | 240+800 | LHS | 0 | 0 | 16.00 | 35.18 | 48.83 | 35.00 | 16.50 | 18.50 | 27.00 | 2.67 | 1.81 | 17.00 | 6.40 | SM |
| 6 | 235+000 | RHS | 0 | 0 | 8.07 | 51.97 | 39.96 | NP | NP | NP | 31.00 | 2.66 | 1.98 | 10.80 | 6.85 | SM |
| 7 | 230+000 | RHS | 0 | 0 | 29.26 | 39.96 | 30.78 | 17.00 | 13.82 | 3.18 | 27.00 | 2.61 | 1.82 | 14.80 | 6.80 | SM |
| 8 | 224+000 | LHS | 0 | 0 | 7.26 | 71.02 | 21.73 | NP | NP | NP | 30.00 | 2.68 | 1.98 | 12.70 | 6.80 | SM |
| 9 | 218+000 | RHS | 0 | 0 | 2.94 | 20.10 | 76.97 | 35.00 | 21.79 | 13.21 | 26.00 | 2.61 | 1.83 | 14.90 | 6.50 | SM |
| 10 | 213+00 | LHS | 0 | 0 | 2.93 | 21.00 | 74.00 | 34.00 | 21.79 | 13.21 | 26.00 | 2.61 | 1.81 | 16.00 | 6.40 | SM |

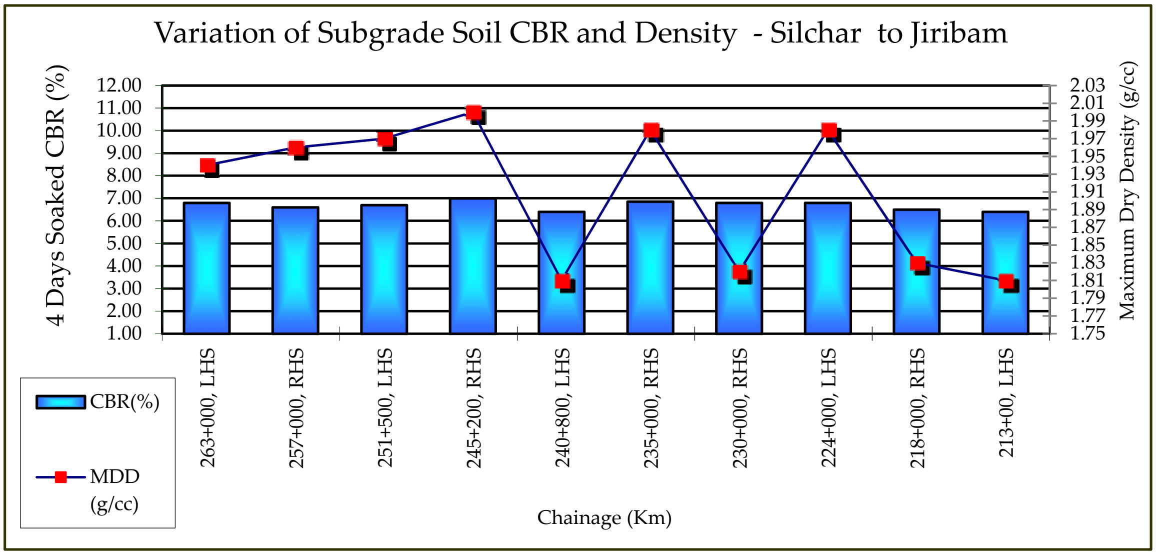



**Fig 3.1 Soaked (4 Days) CBR vs MDD Graph of Subgrade Soi**

### 3.7.6 Green filed alignment Section Soil Sample

A total of 4 soil samples were collected along the proposed green field alignment to understand the characteristic and strength of original ground soil. The details of green field alignment soil given in table below.

**Table 3.8 Details of Chainage wise Green field Soil Collected**

| Sl No. | Design Chainage | Sample Type | Remarks |
|---|---|---|---|
| 1 | 7+800 | Green field | |
| 2 | 12+000 | Green field | |
| 3 | 20+700 | Green field | |
| 4 | 30+500 | Green field | |

**Trial Pit at Km 12+000**

**Trial Pit at Km 7+800**

**Trial Pit at Km 30+500**

**Trial Pit at Km 20+700**

**Pic 3.4 Photographs Showing Soil samples**

### 3.7.7 Laboratory Investigations

The following Laboratory tests were conducted on collected bulk soil sub grade & embankment / OGL soil as per IS SP 36-Part-2 and CBR at 3 energy levels as per AASHTO T193-93 and the results of the same will be updated in further submission.

- Grain size Analysis – by Wet sieving (24 hours soaked) as per IS 2720 Part 4
- Atterberg's limits (LL, PL & PI) as per IS 2720 Part 5
- Differential Free Swelling Index as per IS 2720 Part 40
- Compaction Tests (MDD & OMC) as per IS 2720 Part
- CBR @ 3 energy Levels as per AASHTO T 193 -93 in 4 days soaked condition
- Soil classification as per IS, HRB & AASHTO

### 3.7.8 Soil classification - IS, HRB and AASHTO Soil Classifications

IS, HRB and AASHTO Classifications of sub grade and embankment Soil Samples is to be carried out based on the Grain Size analysis data, plasticity characteristics and swelling characteristics. The following symbols are used to designate the type of soils.

HRB classifications are also called AASHTO classification of revised Public Roads Administration (PRA) soil classification system. In this classifications, the soils are subdivided in to seven groups A-1 to A-7 based on Grainsize analysis, Atterberg's Limits and percentage fines. A-1, A-2, A-3 soils are granular soils, percentage fines passing 0.075 mm sieve being less than 35. A-4, A-5, A-6 and A-7 soils are fine grained or silty clay soils, passing 0.075 mm sieve being greater than 35 %.

| | |
|---|---|
| G - Gravels | W - Well graded |
| S - Sand | P - Poorly graded |
| M - Silt | B - Clay Binder |
| C - Clay | Pt - Peat |
| I - Inorganic | O - Organic<br>W - Well Graded |
| L - Low Plasticity | SP - Poorly graded sand |
| H - High Plasticity | GW - Well graded Gravels |
| SM - Silty Sand | SC - Sandy Clay |
| SW - Well Graded Sand | CH - Clay with high compressibility |
| CL - Clay with low compressibility | MH - Silt with high compressibility |
| ML - Silt with low compressibility | CI - Inorganic Clay |
| GC - Gravelly Clay | GM - Gravelly Silt |
| MI - Inorganic Silt | |

### 3.7.8.1 Analysis of Green filed alignment Soil

The laboratory test results of existing subgrade soil samples are furnished as **Appendix 3.6 of Vol-I Appendix to Main report** Summaries of the Laboratory test results of subgrade soil samples as discussed below.

A total of 4 Soil samples were collected along green filed alignment. Out of 4 samples 3 samples collected are belongs to belongs to Silty with low compressibility ML IS soil classification system and 1 belongs to Silty sand with gravel (SM) IS soil classifications. Liquid limit varies from NP to 57.5%, plasticity Index ranging from NP to 20.00 and free swelling index varies from 26% to 32%. One of the most important components influencing the structural strength requirements of a pavement is the subgrade strength, which in turn is influenced by the moisture content and degree of compaction of the subgrade soil. Laboratory Maximum Dry Density is in the range of 1.69gm/cc to 1.88gm/cc and optimum moisture content varies from 13.5%to 19.6%. The 4-days soaked CBR values have been determined at three energy levels i.e. at three different dry density. From this relationship of CBR and corresponding dry density, CBR at 97% MDD laboratory maximum dry density have been assessed and the same are furnished and Soaked CBR at 97% varies from 5.3% to 6.8%. The summary of the test results is given in below table.

The Percentage distribution of Existing Subgrade soil, variation of laboratory MDD and Soaked CBR at 97% laboratory maximum dry density along the alignment are shown below;

The detailed test results (like grain size curves, compaction test curves and CBR test curves) are furnished **Appendix 3.6 of Vol – I Appendix to Main report**. The images of trail pit are presented in below fig;

**Table 3.9 Test results of along green filed alignment**

| Sl. No | Chainage/Location | Side | Particle Size Analysis | | | | | Atterberg Limits | | | FSI,% | Specific Gravity | Modified Compaction Test Results | | Soaked CBR Value (3-Energy Level) at 97% MDD, % | Soil Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Boulders % | Cobbles % | Gravel % | Sand % | Silt & Clay, % | Liquid Limit % | Plastic Limit % | PI | | | MDD, g/cc | OMC, % | | |
| 1 | 7+600 | GF | 0 | 0 | 0 | 11.26 | 88.74 | 57.5 | 37.61 | 19.89 | 26 | 2.55 | 1.74 | 19.6 | 6.2 | ML |
| 2 | 12+000 | GF | 0 | 0 | 13.19 | 59.43 | 27.39 | NP | NP | NP | 32 | 2.61 | 1.88 | 14 | 6.8 | SM |
| 3 | 20+700 | GF | 0 | 0 | 1.47 | 49.64 | 48.9 | NP | NP | NP | 31 | 2.63 | 1.86 | 13.5 | 6.7 | ML |
| 4 | 30+500 | GF | 0 | 0 | 0 | 6.48 | 93.525 | 46.1 | 32.11 | 13.99 | 28 | 2.63 | 1.69 | 21.5 | 5.3 | ML |

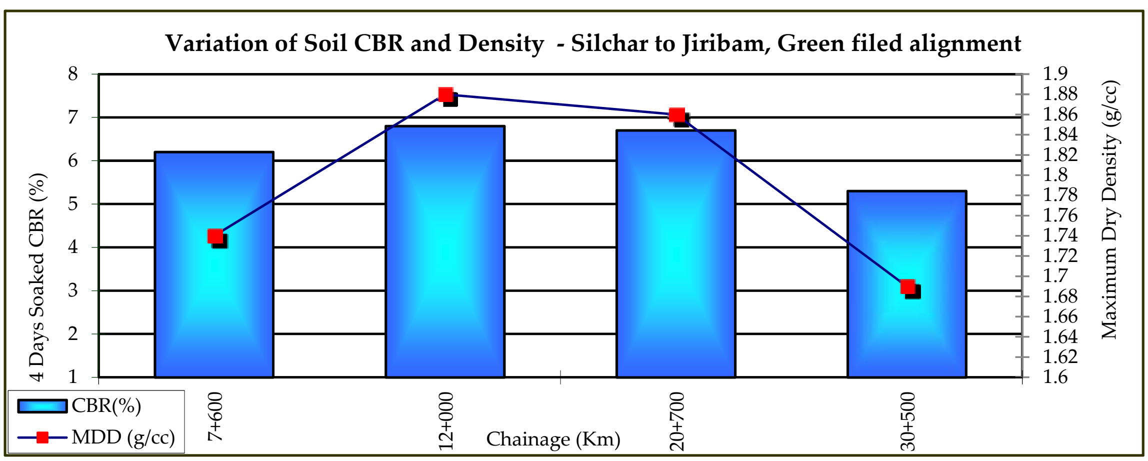



**Fig 3.2 oaked (4 Days) CBR vs MDD Graph of Green filed alignment Soil**

## 3.8 Quarry and Materials Investigations

The information about existing stone Quarries, Murrum Quarries/ Borrow pits, Sand Quarries, Water Sources, Bitumen Manufacturing refineries, Solid Blocks / RCC Hume pipe Manufacturing Industries, cement manufacturing industries and other construction material sources was collected from local PWD Divisional Offices and Sub divisional Offices, local Construction Contractors and local material suppliers throughout the project area, from other sources and also from direct observation through site Visits. The location details of the approved stone and sand quarry was collected officially from the respective forest department and the same was considered. Location Maps and type of material available in each project road were also collected and produced. The original available test results of the Materials from these identified sources were also collected. The suitability of the materials sources is evaluated based on laboratory test results and detailed analysis. After analysing the suitability of those material sources quantitatively and qualitatively, the lead chart is prepared.

## 3.9 Identification of Material Sources

Field Visits were made to NH-PWD Divisional Offices, Forest departments, PWD Sub-Divisional Offices, Mines and Geology approved Stone Metal Quarries, Private Stone Metal Quarries, River Sand Quarries, Locally available Murrum Borrow pits, and RCC Hume pipe manufacturing Industries, Solid Block making Units, Cement Manufacturing Industries if located along the project road / nearby project road. The available details including available test results were collected from respective the above.

The details of existing approved stone quarries, Mines and Geology approved Stone Metal Quarries, Sand Quarries, Murrum Borrow pit details were also collected from the forest department and local construction materials suppliers.

## 3.10 Field Visits to Quarry and Materials Sources

Field visits were made to the following Quarry and Materials Sources located along the project road and nearby sources. The approximate area, quantity availability was assessed, recorded and the samplings were made, packed, labelled and transported to Materials Testing laboratory.

- Stone Metal Quarries
- Murrum Borrow pits
- Sand Quarries
- Cement Manufacturing Industries
- RCC Hume Pipe Manufacturing Industries
- Solid Block, Paving Block, Brick Manufacturing Industries
- Bitumen Refineries and Petrochemicals
- Fly Ash / Pond Ash Producing Power Plants / Steel Industries
- Steel Manufacturing Industries
- Water Sources

### 3.10.1 Sampling of Materials from Sources

The Stone Aggregates, borrow pit Murrum, Sand, Solid Block, Bricks, Laterite Blocks and Water Samples were collected, packed, labelled and transported to Materials Testing laboratory for carrying out relevant tests.

- Stone Aggregates
- Borrow pit Murrum
- Sand
- Cement
- Solid Block, Paving Block and Bricks
- Water

## 3.11 Murrum Borrow Soil

The investigation is aimed at locating the potential borrow areas for sub-grade/ embankment fill and granular sub-base along the project road within economic haulage. To obtain this information regarding probable borrow pits along the corridor and to obtain this objective, the offices of public works department and local people have been contacted.

There 2nos of borrow areas that are located along Silchar to Jiribam is considered for Silchar to Vaitrengte section. The locations, lead, and owner of borrow soil are given in table below. The distance of these borrow areas from the project road location varies from 0.1 km as shown in the lead chart in below paragraph**.** Borrowing soil from these areas would require prior approval of the local authorities' negotiations with private people.

**Table 3.10 Details of Barrow Area**

| SL No. | Sample No. | Existing Chainge (km) | Left/ Right | Location/ Name of Village | Lead (Km) | Remarks |
|---|---|---|---|---|---|---|
| 1 | BA 01 | 214+000 (NH-37) | Right | Tatbung Village (Manipur) | 0.1 | Private Land |
| 2 | BA 02 | 225+000 (NH-37) | Left | Uttar Lalpani (Assam) | 0.1 | Private Land |



**Pic 3.5 Borrow Area**

## 3.12 Quarries for Aggregates

The details of the approved Stone and sand quarries near Silchar were collected from respective forest department, the details of the quarries near Silchar are listed in below table.

The following aspects are considered while selecting the quarry for obtaining road metal:

- It should have sufficient crushing strength to with stand stresses due to high volume of traffic.
- It should be sufficiently hard and offer maximum possible resistance to abrasion.
- It should be tough and with stand breaking under hammer.
- Rock structure should be crystalline in nature.
- Texture of rock should be equiangular and interlocking.
- Specific gravity of rock should be moderately high.
- Rock should not be porous.

Identified stone aggregate quarries along project road are given in below table.

**Table 3.11 Details of Stone Quarries**

| Quarry No. | Name of the Quarry / Address / Location | Material Supplying | Existing Chainge | LHS/ RHS | Lead (Km) |
|---|---|---|---|---|---|
| Q1 | **Stone Quarry** Madhura River Miner Minaral (Unit-1) | Metal sizes available are 40mm, 20mm, 12mm, 6mm and stone dust | 262+500 (NH-37) | LHS | 22.00 |
| Q2 | **Stone Quarry** Madhura River Miner Minaral (Unit-2) | Metal sizes available are 40mm, 20mm, 10mm, 6mm and stone dust | 262+500 (NH-37) | LHS | 22.00 |
| Q3 | **Stone Quarry** Dora Nala Minor Minaral unit | Metal sizes available are 40mm, 20mm, 10mm, 6mm and stone dust | 262+500 (NH-37) | LHS | 25.00 |

## 3.13 Natural Sand

The natural sand is collected from the approved Madhura River and Nakti nala sand quarry, which is at a distance of 22km and 18km from NH-37 along NH-27 (Guwhathi Rd). The permission has been given at following locations for sand mining from the government. All the sources have both coarse and fine sand deposits. These are very useful for bituminous and concrete work. Sand-samples were collected from sources for testing purposes.

Location of sand source and the details locations, lead, and river names are also tabulated below;

**Table 3.12 Details of Sand Sources**

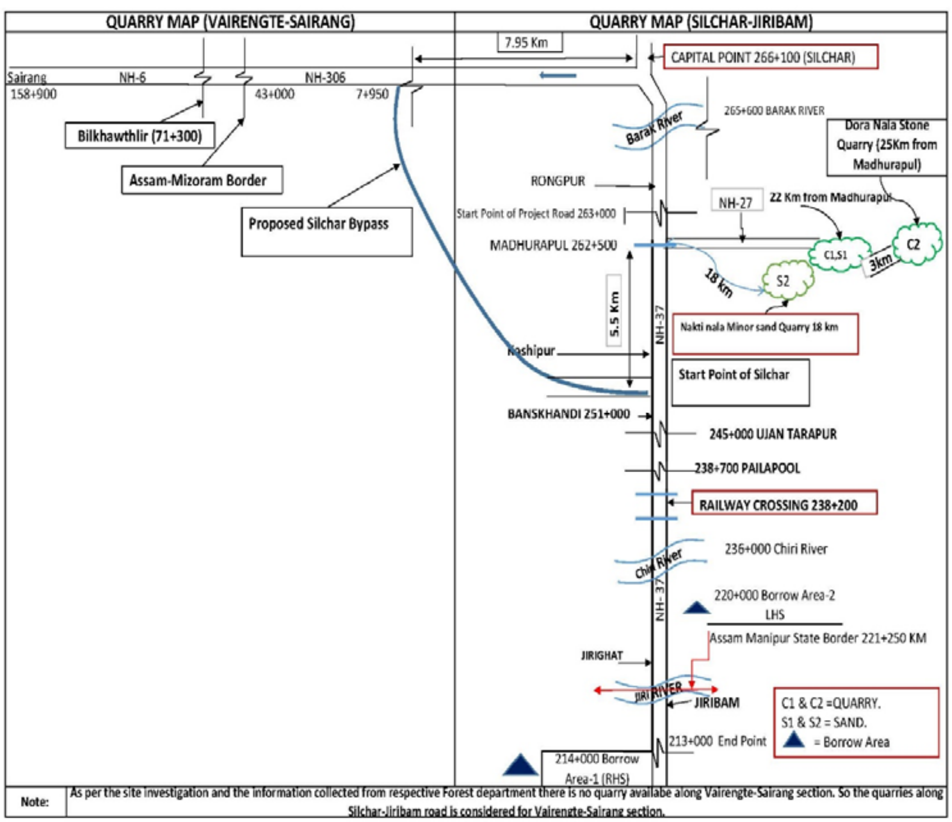
| Sl. No | Chainge | Left/ Right | Name of Village/River | Lead (Km) |
|---|---|---|---|---|
| P 1 | 262+500 (NH-37) | Left | Madhura River at Udharbond Range | 22.00 |
| P 2 | 262+500 (NH-37) | Left | Nakti nala at Udharbond Range | 18.00 |

### 3.14 Water Sources for Construction Works

There are mainly two Water Sources identified along the project road, they are Barak River Water and Madhura River Water.

### 3.15 Recommendation of Materials Sources

After analysing all the above field investigations and Laboratory Testing data, the suitability of Material Sources along with the lead Map and Lead Chart was prepared and recommended. Map showing locations of the various sources of material is given below.




**Pic 3.6 Lead Map**

## 3.16 Other Construction Materials

**Bitumen**

Bitumen in grade of VG-30, VG-40, CRMB-55, CRMB-60, and PMB-40 & Bitumen emulsion will be obtained from IOCL refinery at Haldia, West Bengal. Selection of refinery shall be as per the availability of material and lead.

**Cement**

Cement of all varieties/types i.e. Ordinary Portland, Portland Slag, and Portland confirming to relevant IS standards are readily available in the market in sufficient quantity, and also, would be directly supplied by the manufacturer to the project site for such a huge quantum of work and may be at rebated price.

**Reinforcement Steel**

Reinforcement steel confirming to relevant IS standard is readily available in market.

**NP-4 Pipes**

Numbers of pipe manufacturers are available at Sichar and Guwhathi. Good quality pipes of all sizes are being manufactured to the IS specifications.

**Other materials**

Retro reflective signage's, galvanized W-beam steel crash barrier, thermoplastic pavement marking paint, Bearings for structures, special admixtures for concrete, pre-stressed steel strands have to be obtained from Silchar and Guwhathi.

4

# Chapter 4 – Traffic Studies & Demand Forecast

**Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte(49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km))**

**Section: Silchar to Jiribam (Package: SJ-1, From Km D. 4+560 to Km D. 24+560)**

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# 4 Chapter 4 – Traffic Studies & Demand Forecast

## 4.1 General

The traffic volume forms an important input to financial analysis that is required for financial justification of the project road. It is also a major input for deciding improvement strategies for the project road. Through traffic surveys, the volume of present traffic and the extent of traffic diversion on to the project road can be ascertained and quantified.

Traffic gets generated as a result of several inter-connected factors, encompassing the prevailing socio-economic conditions such as population, gross domestic product, vehicle ownership, sectoral economic activities etc. Traffic forecasting, therefore, requires detailed studies and investigations concerning these factors as well as the magnitude and characteristics of the existing traffic flows and its past trend in respect of nature, composition and growth. With regards to this, the Consultant has undertaken detailed traffic studies in order to identify present and likely future scenarios and to device suitable remedial measures and to evolve appropriate design method. Various steps followed in this regard are described in the following paragraphs.

## 4.2 Objective of Traffic Study

The objective of traffic study is to provide basic input for the following part of the Study:

- Finding out the present level of traffic flow and its various characteristics (through Classified Traffic Volume Count).
- Capacity assessment based on demand forecasting for next 30 years.
- Identifications of zone of influence of the project stretch as per O-D Survey and Commodity movement Characteristics survey.
- Intersection turning movement data defines the requirement of geometric improvement of present intersection layout to improve the junction capacity or to provide underpass or flyover.
- Provision of service road to ascertain the need of segregation of local traffic in congested areas based on traffic data.
- Pavement design.
- Deriving Growth Factor for Traffic demand Forecasting.
- Study of possible location & design of toll plaza.
- Development of wayside amenities.

## 4.3 Project road

The project road from Silchar to Jiribam is a part of Silchar-Impal road, which is considered as an important connecting road between Assam, Manipur, Meghalaya and

Mizoram. The project road attracts the traffic from Shillong, Karimganj, Dawki, Manipur, Guwhati, Silchar and other parts of Assam. The project road is the single source of trade between Silchar and Imphal. Hence the project road needs to be improved on priority under Bharatmala Pariyojana as an Economic corridor.

## 4.4 Homogeneous traffic links

The project road from Silchar to Jiribam is characterized by different level of traffic at individual sections falls within the State of Assam & Manipur and taking into account of the traffic in terms of volume and character, it can be divided in two homogeneous section. The section details are indicated in below in **table;**

**Table 4.1 Details of homogeneous sections**

| Section | Homogenous Section | Chainage | | Length (Km) |
|---|---|---|---|---|
| | | From (Km) | To (Km) | |
| Section - 1 | Silchar (Rongpur) to Pailapool | 263+500 | 240+000 | 23.50 |
| Section – 2 | Pailapool to Jiribam | 240+000 | 212+060 | 27.94 |

## 4.5 Estimation of Base Year Traffic

The base year traffic pattern is the primary input for determination of future traffic demand of project influence area and reliable financial analysis. As per the requirements of the TOR, the following traffic surveys have been carried out to obtain all necessary data to estimate the base year traffic levels in respect of goods and passenger vehicles.

- Classified Traffic Volume Counts
- Intersection turning movement surveys
- Axle load spectrum
- Origin & Destination Study

For the purpose of traffic estimation and projection, the year 2020 has been taken as the base year.

## 4.6 Traffic Survey Locations

The various survey locations summarized below have been selected careful assessment of the traffic characteristics including entry and exit points along the project corridor. The following **Table 4.2** gives details of various traffic surveys conducted with location and period of survey from Silchar to Jiribam.

**Table 4.2 Details of traffic Survey locations**

| Sl. No. | Type of Survey | Duration | Location (Existing Km) | Period | |
|---|---|---|---|---|---|
| | | | | From | To |
| **Silchar to Jiribam** | | | | | |
| 1 | Classified Volume Count -1 | 7 Days | Km 262+00 | 17-02-2020 | 23-02-2020 |
| | Classified Volume Count -2 | 7 Days | Km 217+000 | 17-02-2020 | 23-02-2020 |
| | **Classified Volume Count -3** | **3 Days** | **Binnakandi Ghat** | **20-02-202** | **22-02-2020** |
| 2 | Origin & Destination Survey 1 | 1 Day | Km 262+00 | 19-02-2020 | 20-02-2020 |
| | Origin & Destination Survey 2 | 1 Day | Km 217+000 | 21-02-2020 | 22-02-2020 |
| | Origin & Destination Survey 3* | 1 Day | **Binnakandi Ghat** | 20-02-2020 | 21-02-2020 |
| 3 | Axle Load Survey 1 | 2 Days | Km 262+00 | 19-02-2020 | 21-02-2020 |
| | Axle Load Survey 2 | 2 Days | Km 217+000 | 21-02-2020 | 23-02-2020 |
| 4 | Intersection Volume Count - 01 | Peak Hours | Jn. with NH-37 and NH-27) | 20-02-2020 | 20-02-2020 |
| ***Silchar to Vairengte** | | | | | |
| 1 | Classified Volume Count -1 | 7 Days | Km 29+200 | 15-02-2020 | 21-02-2020 |
| 2 | Origin & Destination Survey 1 | 1 Day | Km 29+200 | 17-02-2020 | 18-02-2020 |
| 3 | Axle Load Survey 1 | 2 Days | Km 29+200 | 17-02-2020 | 19-02-2020 |
| 4 | Intersection Volume Count-01 | Peak Hours | Jn. with NH-306 and Sonai Rd (Sonbarighat) | 18-02-2020 | 18-02-2020 |
| 5 | Intersection Volume Count-02 | Peak Hours | Jn. with NH-306 and MR Road (Baga Bazar) | 18-02-2020 | 18-02-2020 |
| ***Vairengte to Sairang** | | | | | |
| 1 | Classified Volume Count -2 | 7 Days | Km 98+000 | 12-02-2020 | 19-02-2020 |
| | Classified Volume Count -3 | 7 Days | Km 166+000 | 8-02-2020 | 15-02-2020 |
| | *Classified Volume Count -4 (additional) | 3 Days | Zanlawn (NH-6) | 12-02-202 | 15-02-2020 |
| 2 | Origin & Destination Survey 2 | 1 Day | Km 98+000 | 13-02-2020 | 14-02-2020 |
| | Origin & Destination Survey 3 | 1 Day | Km 166+000 | 11-02-2020 | 12-02-2020 |
| | Origin & Destination Survey4 | 1 Day | Zanlawn (NH-6) | 14-02-2020 | 15-02-2020 |
| 3 | Axle Load Survey 2 | 2 Days | Km 98+000 | 13-02-2020 | 15-02-2020 |
| | Axle Load Survey 3 | 2 Days | Km 166+000 | 10-02-2020 | 12-02-2020 |
| 4 | Intersection Volume Count-03 | Peak Hours | Jn of NH-306 and NH-6 at Km 88+500 (Rengtekawn) | 12-02-2020 | 12-02-2020 |
| | Intersection Volume Count–04 | Peak Hours | Jn of NH-306 and NH-6 at Km 121+500 (Kawnpui) | 12-02-2020 | 12-02-2020 |
| | Intersection Volume Count-05 | Peak Hours | Jn of NH-306 and NH-108 at Km 157+800 (Sairang) | 10-02-2020 | 10-02-2020 |

**The detailed traffic study and analysis for Silchar-Vairengte and Vairengte-Sairang section is done separately under different package and submitted along with DFR submission of Silchar-Sairang.*

*As per ToR, Classified Volume Count survey shall be conducted for 7 continuous days at minimum 3 locations. However, we have carried out 7 days CVC at 5 locations for the project sections ie Silchar-Vairengte, Vairengte-Sairnage and Silchar-Jiribam.*

Key plan on Google Map and Linear Plan showing the traffic survey locations is given below;

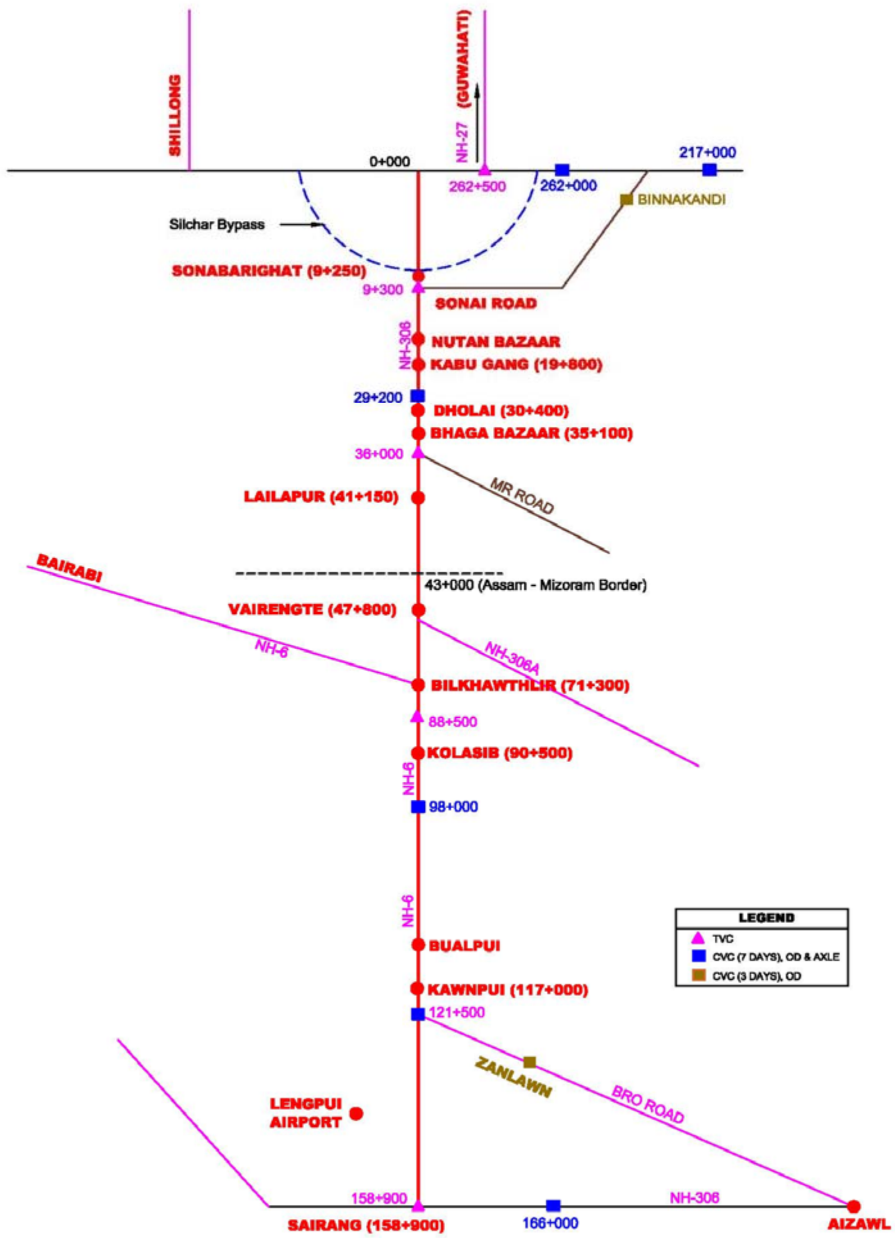


**Figure 4.1 Traffic survey Linear Plan**

## 4.7 Traffic Surveys

### 4.7.1 Classified Volume Count Survey

Consultant carried out traffic surveys using ATCC systems along with videography. ATCC system used in this project is Pneumatic Tube Detector. This traffic data is used for carrying out traffic analysis, forecast and financial analyses.
Traffic count was done for both motorized and non-motorized vehicles and are listed below. In the motorized vehicle category, 13 types of vehicles were included, while the non-motorized vehicle category included 3 types of vehicles. Recorded traffic data has been converted into Passenger Car Units using PCU factors as shown in **Table 4.3**. These equivalency factors are extracted from IRC: 64 – 1990, 'Guidelines for Capacity of Roads in Rural Areas'.

This study would help in realistic forecast of traffic volume for pavement design, to optimize the cost of improvement and realistic approach in assessing economic and financial viability.

**Table 4.3 PCU Factor**

| Sl. No. | Vehicle Category | PCU Factors |
|---|---|---|
| **Toll-able Vehicles** | | |
| 1 | Car | 1.0 |
| 2 | Mini-Bus | 1.5 |
| 3 | Pvt. Bus | 3.0 |
| 4 | Govt. Bus | 3.0 |
| 5 | LCV | 1.5 |
| 6 | Truck: 2 Axle | 3.0 |
| 7 | Truck: 3 Axle | 3.0 |
| 8 | Truck: 4-6 Axle | 4.5 |
| 9 | Truck: >=7 Axle | 4.5 |
| **Non-Tollable Vehicles** | | |
| 10 | 2W | 0.5 |
| 11 | 3W | 1.0 |
| 12 | Tractor with trailer | 4.5 |
| 13 | Tractor without trailer | 1.5 |
| 14 | Cycle | 0.5 |
| 15 | Cycle Rickshaw | 2.0 |
| 16 | Animal Drawn | 6.0 |

### 4.7.2 Description of locations

The project road from Silchar to Jiriabm is a part of Silchar-Imphal road and divided into 02 homogeneous sections as the project road falls in two different states and link road form Sonbarighat (Aizawl Road) meets at km 235+00 of NH-37. 1 homogeneous sections have been considered in between Silchar and Pailapool and another homogeneous section is considered between Pailapool and Jiribam.

07 days classified volume count (CVC) was conducted at Km 262+000 for homogenous section (HS) 1, whereas, CVC was conducted at Km 217+000 for HS-2.

Apart from that an additional 3-days CVC was also conducted on Sonai road in order to determine traffic diversion towards NH-306 from our project road (NH-37) which was mandatory on obvious ground. The few photographs of traffic surveys conducted along the project road is shown below

**Traffic Study using ATCC on Project Road at Km 262+000**

**Traffic Study using ATCC on Project Road at Km 217+000**


**Traffic Study using Videography on Sonai Road at Binnakandi Ghat**

**Brief description of traffic count location is given below:**

**(i) (Km 262+000) near Rongpur – 7 days**

This count station is non-urban stretch of NH-37. This station represents the traffic for section from Silchar to Jiribam via Kashipur, Banskandi, Ujain Tarapur, Pailapool, Fulurthel, Jirighat and will account for through traffic that is diverted towards NH-37 from NH-27 (Guwahati road).

**(ii) (Km 217+000) near Jiribam – 7 days**

This count station is non-urban stretch of NH-37 near Jiribam in the state of Manipur. This station represents the traffic that is coming from Manipur and travelling towards Assam and Mizoram state. This count station will accord the traffic that is travelling towards Jirighat and Silchar.

**(iii) On NH-6, near Zanlawn – 3 days**

This station is an additional location taken on the non-urban stretch of Kawnpui-Aizawl Road (BRO road) via Serkhan, Sentlang, Lungdai, Siphir, Durtlang in order to determine traffic diversion towards Aizawl from our project road which was mandatory on obvious ground.

**The classified traffic volume survey data for 3 count locations are analysed in order to obtain the following traffic characteristics:**

- Average Daily Traffic (ADT)
- Traffic Composition
- Average hourly variation of traffic volume
- Daily variation of traffic volume
- Directional distribution of traffic
- Annual Average Daily Traffic (AADT)

### 4.7.3 Origin-Destination Survey

Roadside interview or Origin-Destination (O-D) survey provides the input for estimating the traffic in respect of:

- ♦ Percentage of divertible traffic
- ♦ Traffic influence region for estimation of traffic growth rate
- ♦ Commodity movement pattern

The O-D survey was carried out for one day (24 hours) simultaneously along with the classified traffic volume counts (CVC). Roadside interview method was adopted for the survey. The vehicles were stopped on random sample basis with the help of police, and trained enumerators interviewed the drivers to obtain the required data. During the surveys, the information pertaining to trip length, commodity types, loading pattern and trip purpose as applicable for various vehicle types were recorded.

**Origin & Destination Study on Project Road at 262+000**

**Origin & Destination Study on Project Road at Km 262+000**

**Origin & Destination Study on Project Road at Km 217+000**

**Origin & Destination Study on Project Road at Km 262+000**

**Origin & Destination Study on Sonai Road at Binnakandi Ghat**

**Origin & Destination Study on Sonai Road at Binnakandi Ghat**

### 4.7.4 Axle Load Surveys

Axle load survey was carried out to get the spectrum of vehicle loading pattern of commercial vehicles to estimate the repetitions of Single, Tandem and Tridem axles in each direction expected during the design period and also to arrive at Vehicle Damage Factor (VDF). The survey is carried out using portable weigh pads for 48 hrs duration. Axle loads of 2 & 3 axle trucks, and multi axle trucks are recorded on random basis.

**Axle Load Survey is on Project Road at Km: 262+000**

**Axle Load Survey is on Project Road at Km: 262+000**

**Axle Load Survey is on Project Road at Km: 217+000**

**Axle Load Survey is on Project Road at Km: 217+000**

### 4.7.5 Turning Movement Surveys

**Turning Movement Survey on Project Road at Km 262+500**

**Turning Movement on Project Road at Km 262+500**

Manual turning volume counts for 16-hour duration were conducted at 1 Major junctions covering both morning and evening peak hour to analyse the existing turning movement pattern and to plan the required improvements at the junctions.

## 4.8 Average Daily Traffic

The CVC survey was conducted for both tollable and non-tollable traffic during the month of February 2020. ADT averaged for both 7 days and 3 days data of tollable and non-tollable traffic is given in the following table. However, we recommend adopting the 7 days AADT as base year traffic.

Traffic data was collected at each of the traffic count stations on hourly basis, round-the-clock, continuously for seven/three days. The hourly traffic for each vehicle type and for both the traffic flow directions was added to obtain the daily traffic. The daily traffic for seven days was added and averaged out to obtain average daily traffic (ADT). The location wise summary of data for each of the seven days in both the directions at all locations is presented in **Volume-I Appendices to Main Report (Appendix 4.1).** Summary of vehicle-wise ADT in terms of number of vehicles and in PCUs is presented in the following tables.

**Table 4.4 Average Daily Traffic (ADT – in nos.)**

| Sl. No | Vehicle Type | ADT (In nos.) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| **Tollable Traffic** | | | | |
| 1 | Car | 3106 | 2182 | 1209 |
| 2 | Mini-Bus | 135 | 4 | 10 |
| 3 | Pvt. Bus | 100 | 11 | 1 |
| 4 | Govt. Bus | 5 | 2 | 1 |
| 5 | LCV | 316 | 138 | 75 |
| 6 | 2 Axle | 650 | 511 | 63 |
| 7 | 3 Axle | 135 | 133 | 5 |

| Sl. No | Vehicle Type | ADT (In nos.) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| 8 | 4-6 Axle | 46 | 68 | 2 |
| 9 | >=7 Axle | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | |
| 10 | 2W | 4072 | 1928 | 1591 |
| 11 | 3W | 1768 | 1714 | 1277 |
| 12 | Tractor with Trailer | 0 | 1 | 0 |
| 13 | Tractor without Trailer | 1 | 1 | 0 |
| 14 | Cycle | 758 | 141 | 560 |
| 15 | Rickshaw | 26 | 1 | 2 |
| 16 | Animal Drawn | 0 | 0 | 0 |
| **ADT in Nos.** | | | | |
| **Tollable** | | **4493** | **3049** | **1366** |
| **Non - Tollable** | | **6625** | **3786** | **3430** |
| **Total** | | **11118** | **6835** | **4796** |

**Table 4.5 Average Daily Traffic (ADT – in PCU)**

| Sl. No | Vehicle Type | ADT (In PCU) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| **Tollable Traffic** | | | | |
| 1 | Car | 3106 | 2182 | 1209 |
| 2 | Mini-Bus | 203 | 6 | 15 |
| 3 | Pvt. Bus | 300 | 33 | 3 |
| 4 | Govt. Bus | 15 | 6 | 3 |
| 5 | LCV | 474 | 207 | 113 |
| 6 | 2 Axle | 1950 | 1533 | 189 |
| 7 | 3 Axle | 405 | 399 | 15 |
| 8 | 4-6 Axle | 207 | 306 | 9 |
| 9 | >=7 Axle | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | |
| 10 | 2W | 2036 | 964 | 796 |
| 11 | 3W | 1768 | 1714 | 1277 |
| 12 | Tractor with Trailer | 0 | 5 | 0 |
| 13 | Tractor without Trailer | 2 | 2 | 0 |
| 14 | Cycle | 379 | 71 | 280 |
| 15 | Rickshaw | 52 | 2 | 4 |
| 16 | Animal Drawn | 0 | 0 | 0 |

| Sl. No | Vehicle Type | ADT (In PCU) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| ADT in PCU. | | | | |
| Tollable | | 6660 | 4672 | 1556 |
| Non - Tollable | | 4237 | 2757 | 2357 |
| Total | | 10896 | 7429 | 3912 |

### 4.8.1 Traffic Composition

Composition of traffic as observed at various survey locations is presented in the following table. As can be seen, the proportion of non-motorized vehicle using this section of road is very less. The combined share of freight traffic is 27% in terms of Nos. (49% in terms of PCU) of Tollable Traffic.

Passenger traffic is also in considerable volume – 73% in terms of Nos. and 51% in terms of PCU.

**Table 4.6 Traffic Composition (%)**

| Location | Car | Mini Bus | Pvt. Bus | Govt. Bus | LCV | 2-Axle | 3-Axle | 4-6 Axle | >7 Axle | Pass. | Comm. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Traffic Composition (Nos. %)** | | | | | | | | | | | |
| Km 262+000 | 69.13 | 3.00 | 2.23 | 0.11 | 7.03 | 14.47 | 3.00 | 1.02 | 0.00 | 74 | 26 |
| Km 217+000 | 71.56 | 0.13 | 0.36 | 0.07 | 4.53 | 16.76 | 4.36 | 2.23 | 0.00 | 72 | 28 |
| Binnakandi | 88.51 | 0.73 | 0.07 | 0.07 | 5.49 | 4.61 | 0.37 | 0.15 | 0.00 | 89 | 11 |
| **Traffic Composition (PCU %)** | | | | | | | | | | | |
| Km 262+000 | 46.64 | 3.04 | 4.50 | 0.23 | 7.12 | 29.28 | 6.08 | 3.11 | 0.00 | 54 | 46 |
| Km 217+000 | 46.70 | 0.13 | 0.71 | 0.13 | 4.43 | 32.81 | 8.54 | 6.55 | 0.00 | 48 | 52 |
| Binnakandi | 77.72 | 0.96 | 0.19 | 0.19 | 7.23 | 12.15 | 0.96 | 0.58 | 0.00 | 79 | 21 |

**Table 4.7 Percentage Composition of Traffic**

| Location | Nos. | | PCU | |
|---|---|---|---|---|
| | Tollable | Non-Tollable | Tollable | Non-Tollable |
| Km 262+000 | 40.41 | 59.59 | 61.12 | 62.89 |
| Km 217+000 | 44.61 | 55.39 | 62.89 | 37.11 |
| Binnakandi | 28.48 | 71.52 | 39.76 | 60.24 |

From the above table it can be observed that considerable volume of non tollable traffic is flowing on the project road. It can also be observed that the tollable traffic is approx. 62% to total traffic PCU.

Further analysis of this data is done to obtain the daily and hourly variation, directional distribution, mode wise distribution and peak hour characteristics of ADT and is presented in the following sections.

### 4.8.2 Average hourly variation of traffic volume

The analysis of hourly traffic variation is helpful in knowing the highway type (characteristics of the traffic moving on it) as well as identifying the percentage of peak hour traffic flow to the total ADT. The hourly variation of traffic at all count locations presented in the following figure.

From the figure it is observed that the hourly traffic flow pattern is different at every location. Generally, the peak period at Km 262+000 and Km 217+000 is between 17:00 hours – 18:00 hours. Following table depicts the peak hour traffic characteristics in terms of peak hour traffic (vehicle/hr) and percentage peak hour flow (to total ADT) on each of the homogeneous section. From the analysis it is observed that the peak hour flow ranges from 424 PCU - 761 PCU.

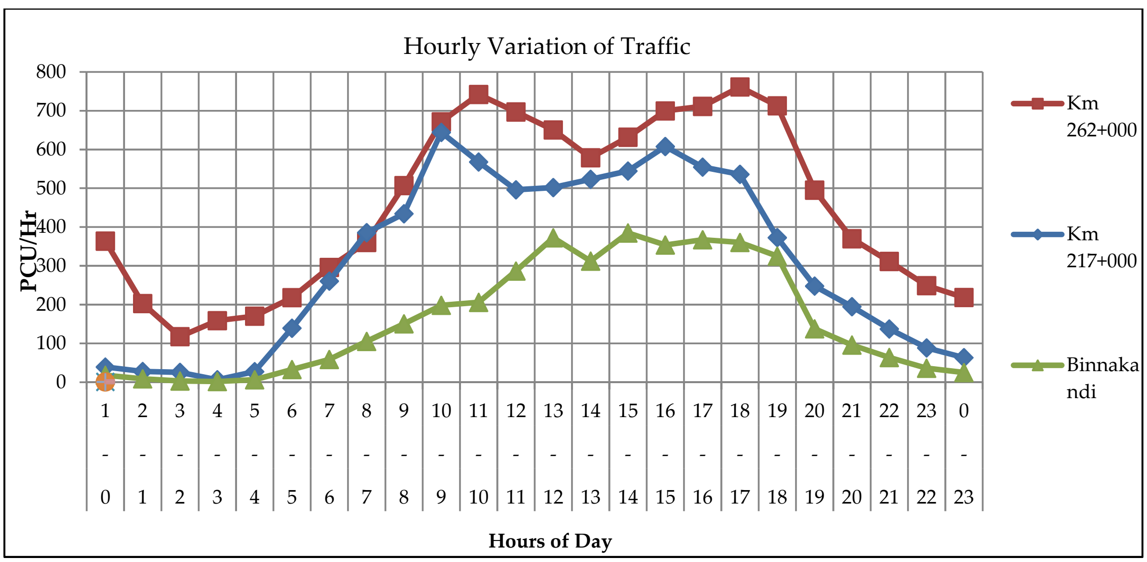


**Figure 4.2 Hourly Variation of Traffic (Average of 7/3 days)**

**Table 4.8 Peak hour factor**

| Location | Peak Hour | Peak Hour Flow (PCU) | Peak Hour Factor (PHF) |
|---|---|---|---|
| Km 262+000 | 17 - 18 | 761 | 6.99 |
| Km 217+000 | 17 - 18 | 644 | 8.67 |
| Binnakandi | 14 - 15 | 385 | 9.84 |

### 4.8.3 Daily variation of traffic volume

Daily variation of traffic for all the locations is shown in **Figure 4.3**. From the analysis it is found that, at Km 262+000 the traffic values are higher on Monday and Thursday compare to other days with in the week, whereas at Km 217+000 the traffic values is higher on Friday. The daily variations of observed traffic volumes at five counting stations are given in below table;

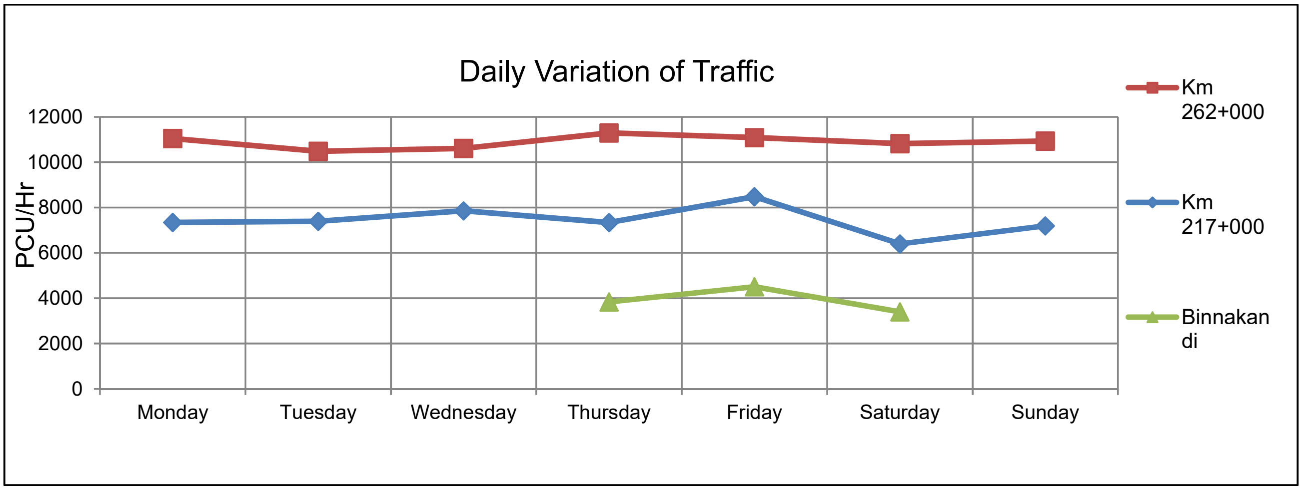


**Figure 4.3 Daily Variations of traffic volume at 3 locations**

**Table 4.9 Daily Variations of traffic volume in PCUs**

| Day | Km 262+000 | Km 217+000 | Binnakandi |
|---|---|---|---|
| **Monday** | 11043 | 7346 | Additional Survey point |
| **Tuesday** | 10485 | 7388 | |
| **Wednesday** | 10607 | 7852 | |
| **Thursday** | 11292 | 7335 | 3837 |
| **Friday** | 11088 | 8478 | 4507 |
| **Saturday** | 10822 | 6398 | 3396 |
| **Sunday** | 10935 | 7194 | |

### 4.8.4 Directional distribution of traffic

Directional split at each of the location is shown in **Table 4.10**. This is a useful input for capacity analysis and pavement design. As seen, from **Table 4.10** that the traffic flow is evenly distributed (almost 50:50 in each direction) and Binnakhandi where the traffic survey is conducted for 3 days and data of these locations are not used in capacity analysis and pavement design), and there is no necessity for applying capacity reduction factor for directional split.

**Table 4.10 Directional Split in %**

| Location | Towards Jiribam | Towards Silchar |
|---|---|---|
| Km 262+000 | 49.23 | 50.77 |
| Km 217+000 | 49.99 | 50.01 |

### 4.8.5 Mode-wise Traffic Distribution

In order to know the vehicle-mix, an analysis of the percentage traffic composition was carried out and the results are set out in **Table 4.11**. It can be observed that the share of 2 wheelers traffic is very high about 32% of total traffic. Beside this cars and 3 wheelers constitute high percentage of the ADT on all along the road accounting to about 50% of the traffic. With the low availability of public transport vehicles in the rural/ semi-rural areas, the reliance on personal vehicles has increased.

Share of passenger vehicles is 85% (82.00% to 85.00%) when compared to commercial traffic of 12% (10% to 12%). The composition of goods vehicles is observed to be in the range of 2-9.2%, the majority of them being 2/3 Axle trucks followed by multi axle trucks and LCVs. The composition of slow moving vehicles (cycles, cycle rickshaws and bullock carts) is observed to be in the range of 2.08% to 7.05 %, where more number of cycles are observed.

**Table 4.11 Mode-wise Distribution of Traffic on the Project Road (in %)**

| Location | 2W | Car/ Van/ 3W | Mini Bus/ Bus | Tempo/ LCV | 2-Axle/ 3-Axle | Multi-Axle | Agri. Tractor | MT | | NMT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Pass. | Comm. | |
| Km 262+000 | 36.63 | 43.84 | 2.16 | 2.84 | 7.06 | 0.41 | 0.01 | 82.62 | 10.33 | 7.05 |
| Km 217+000 | 28.21 | 57.00 | 0.25 | 2.02 | 9.42 | 0.99 | 0.03 | 85.46 | 12.47 | 2.08 |
| Binnakandi | 33.17 | 51.83 | 0.25 | 1.56 | 1.42 | 0.04 | 0.00 | 85.26 | 3.02 | 11.72 |

*MT- Motorized Vehicles; NMT – Non-Motorized Vehicles*

### 4.8.6 Annual Average Daily Traffic (AADT)

AADT is the base year (2020) traffic. This is a product of ADT and seasonal factor. Because of the non-availability of regular counts, monthly fuel sales for the year 2019-20 was collected from various fuel outlets along the project influence area to know the seasonal variation. Seasonal variation factor for each month was calculated by taking ratio of sale of petrol and diesel in respective months and average annual monthly sale of fuel.

Monthly petrol and diesel sale data at various locations on the project road and seasonal correction factors are given in the following tables.

**Table 4.12 Monthly Fuel Sales (in KL) in the Project Influence Area**

| Month | Pailapool | | Jiribam | |
|---|---|---|---|---|
| | Diesel | Petrol | Diesel | Petrol |
| Jan-19 | 161.3 | 153.2 | 615.8 | 42.5 |
| Feb-19 | 160.0 | 150.8 | 400.0 | 44.2 |
| Mar-19 | 171.4 | 165.4 | 546.3 | 52.9 |
| Apr-19 | 183.5 | 154.2 | 374.3 | 58.0 |
| May-19 | 167.9 | 154.1 | 378.2 | 63.0 |
| Jun-19 | 158.1 | 146.3 | 329.5 | 62.4 |
| Jul-19 | 167.1 | 133.0 | 322.7 | 53.8 |
| Aug-19 | 185.9 | 150.7 | 308.2 | 43.4 |
| Sep-19 | 163.6 | 135.2 | 337.7 | 37.6 |
| Oct-19 | 164.0 | 151.2 | 360.7 | 48.5 |
| Nov-19 | 224.7 | 145.0 | 364.2 | 38.6 |
| Dec-19 | 189.7 | 125.6 | 358.0 | 45.0 |
| **Average** | **175** | **147** | **391** | **49** |

**Table 4.13 Seasonal Variation and Correction Factors**

| Month | Seasonal Variation | | Seasonality Factor | |
|---|---|---|---|---|
| | Diesel | Petrol | Diesel | Petrol |
| Jan-19 | 1.373 | 0.998 | 0.728 | 1.002 |
| **Feb-19** | **0.989** | **0.994** | **1.011** | **1.006** |
| Mar-19 | 1.268 | 1.112 | 0.789 | 0.899 |
| Apr-19 | 0.985 | 1.082 | 1.015 | 0.925 |
| May-19 | 0.965 | 1.106 | 1.037 | 0.904 |
| Jun-19 | 0.861 | 1.063 | 1.161 | 0.940 |
| Jul-19 | 0.865 | 0.952 | 1.156 | 1.050 |
| Aug-19 | 0.873 | 0.989 | 1.146 | 1.011 |
| Sep-19 | 0.886 | 0.881 | 1.129 | 1.135 |
| Oct-19 | 0.927 | 1.017 | 1.079 | 0.983 |
| Nov-19 | 1.040 | 0.936 | 0.961 | 1.069 |
| Dec-19 | 0.967 | 0.869 | 1.034 | 1.150 |

Since the traffic surveys have been carried out in the month of February, seasonal correction factors for the month of February will be applicable to convert the ADT into AADT.

The Seasonal Correction Factors (SCF) adopted for the study is given below:

For Petrol Driven Vehicles : **1.0061**

For Diesel Driven Vehicles : **1.0108**

**Table 4.14 Average Annual Daily traffic (AADT) on Project road for 2020**

| Sl. No | Vehicle Type | AADT (In nos.) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| **Tollable Traffic** | | | | |
| 1 | Car | 3125 | 2195 | 1216 |
| 2 | Mini-Bus | 136 | 4 | 10 |
| 3 | Pvt. Bus | 101 | 11 | 1 |
| 4 | Govt. Bus | 5 | 2 | 1 |
| 5 | LCV | 319 | 139 | 76 |
| 6 | 2 Axle | 657 | 517 | 64 |
| 7 | 3 Axle | 136 | 134 | 5 |
| 8 | 4-6 Axle | 46 | 69 | 2 |
| 9 | >=7 Axle | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | |
| 10 | 2W | 4097 | 1940 | 1601 |
| 11 | 3W | 1787 | 1733 | 1291 |
| 12 | Tractor with Trailer | 0 | 1 | 0 |
| 13 | Tractor without Trailer | 1 | 1 | 0 |
| 14 | Cycle | 758 | 141 | 560 |
| 15 | Rickshaw | 26 | 1 | 2 |
| 16 | Animal Drawn | 0 | 0 | 0 |
| **ADT in Nos.** | | | | |
| **Tollable** | | **4527** | **3072** | **1375** |
| **Non - Tollable** | | **6669** | **3816** | **3453** |
| **Total** | | **11196** | **6888** | **4829** |

**Table 4.15 Average Annual Daily Traffic (AADT in PCU)**

| Sl. No | Vehicle Type | AADT (In PCU.) | | |
|---|---|---|---|---|
| | | Km 262+000 | Km 217+000 | Binnakandi Ghat |
| **Tollable Traffic** | | | | |
| 1 | Car | 3125 | 2195 | 1216 |
| 2 | Mini-Bus | 205 | 6 | 15 |
| 3 | Pvt. Bus | 303 | 33 | 3 |
| 4 | Govt. Bus | 15 | 6 | 3 |
| 5 | LCV | 479 | 209 | 114 |
| 6 | 2 Axle | 1971 | 1550 | 191 |
| 7 | 3 Axle | 409 | 403 | 15 |
| 8 | 4-6 Axle | 209 | 309 | 9 |
| 9 | >=7 Axle | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | |
| 10 | 2W | 2048 | 970 | 800 |
| 11 | 3W | 1787 | 1733 | 1291 |
| 12 | Tractor with Trailer | 0 | 5 | 0 |
| 13 | Tractor without Trailer | 2 | 2 | 0 |
| 14 | Cycle | 379 | 71 | 280 |
| 15 | Rickshaw | 52 | 2 | 4 |
| 16 | Animal Drawn | 0 | 0 | 0 |
| **ADT in PCU.** | | | | |
| **Tollable** | | **6717** | **4712** | **1567** |
| **Non - Tollable** | | **4268** | **2781** | **2375** |
| **Total** | | **10985** | **7493** | **3942** |

## 4.9 O-D Survey

### 4.9.1 Data Collection

The main objective of the origin-destination surveys is to analyse the goods and passenger flows in the influence area of the project roads. For this, the survey locations were identified so as to capture the maximum traffic flows on the project roads. O-D survey has been carried out at 2 locations (at Km 262+000 and at Km 217+000 along the project road and at 1 loacation at Binnakandi Ghat (Sonai road). However the analysis of OD data at Binnakandi Ghat is used for calculation of diverted traffic. The location of O-D survey stations are marked in **Figure 4.1**.

The O-D surveys were organized through trained enumerators and with the assistance from police department for one day (24 hour). The survey was carried out by roadside interview method as described in IRC: 102-1988 covering both goods (two-axle trucks, LCVs, Multi axle trucks) and passenger (small/ standard bus and cars) vehicles. Along with the O-D survey, classified traffic count surveys were also carried at the same locations (as that of O-D survey), for the same time period (one day) for working out the 'raising factor' to obtain daily traffic flows and also to know the sample size of vehicles covered by the O-D survey.

Through the O-D survey, vital information such as flow pattern in terms of Origin and Destination of vehicles, type of commodity movement etc., were collected. Passenger O-D survey was conducted for 24 Hours (1 Day) and Goods vehicle O-D survey was conducted for 48 Hours (2 Days) along with Axle Load Survey. **Table 4.16** presents the location and sample size of the O-D survey points. The sample size for each vehicle type seems to be adequate for obtaining the daily O-D flows for goods as well as passenger traffic.

**Table 4.16 Sample Size and Expansion Factors**

| Vehicle Type | O - D Sample Size | Volume Count Data during OD | % of sample collected | Volume Count Data, ADT | Expansion factors |
|---|---|---|---|---|---|
| | A | B | C = A/B | D | E = D/A |
| **At Km 262+000** | | | | | |
| Car | 850 | 2550 | 33.34% | 2550 | 3.00 |
| Bus | 50 | 276 | 18.11% | 276 | 5.52 |
| LCV | 59 | 525 | 11.24% | 525 | 8.90 |
| 2A Truck | 410 | 1422 | 28.84% | 1422 | 3.47 |
| 3A Truck | 105 | 259 | 40.51% | 259 | 2.47 |
| MAV | 61 | 99 | 61.90% | 99 | 1.62 |
| **Total =** | **1535** | **5130** | **29.92%** | | |

| Vehicle Type | O - D Sample Size | Volume Count Data during OD | % of sample collected | Volume Count Data, ADT | Expansion factors |
|---|---|---|---|---|---|
| | A | B | C = A/B | D | E = D/A |
| **At Km 217+000** | | | | | |
| Car | 378 | 2360 | 16.02% | 2360 | 6.24 |
| Bus | 7 | 12 | 58.33% | 12 | 1.71 |
| LCV | 37 | 143 | 25.86% | 143 | 3.87 |
| 2A Truck | 318 | 998 | 31.87% | 998 | 3.14 |
| 3A Truck | 72 | 197 | 36.53% | 197 | 2.74 |
| MAV | 34 | 108 | 31.48% | 108 | 3.18 |
| **Total =** | **846** | **3818** | **22.16%** | | |

### 4.9.2 Traffic Zones

Having collected the data through O-D survey, the next step is to analyse it to obtain traffic flows in the form of O-D matrix. It was done by dividing the study area into traffic zones and analysing the data among these zones to form goods and passenger O-D matrix. These matrices were useful in knowing the passenger and commodity flows, and on this basis, estimating the divertible traffic to the project roads from alternate routes was possible.

**Zoning:** A total of 23 traffic zones are outlined keeping in view the influence areas of the project road. The list of traffic zones is give in the following table and influence areas of O-D zones are shown below;

**Table 4.17 Zone list for the study area**

| Zone No. | Zone | Location |
|---|---|---|
| 1 | Silchar, Chamragudam,Rongpur Part IV,Tarapur,Ramnagar | Assam |
| 2 | Silchar Airport,Damcharanagar,Durganagar, Gossaipur,Udarbond | Assam |
| 3 | Guwahati,Alipur, Bhalapur, Damcharan, Haripur, Kadamtala, Madanpur | Assam |
| 4 | Badarpur, Gumra, Hari Nagar, Karimghanj, Katigorah, Panchgram | Assam |
| 5 | Masughat,Kalain | Assam |
| 6 | Halkandi | Assam |
| 7 | Rongpur, Arkatipur | Assam |
| 8 | Kashipur,Badribasti | Assam |
| 9 | Banskandi,Camp | Assam |
| 10 | Fulertal,Hmarkhawlien | Assam |
| 11 | Pailapool | Assam |
| 12 | Joypur | Assam |
| 13 | Lakhipur | Assam |
| 14 | Binnakandi, Mothi Nagar, Palonghat | Assam |
| 15 | Ujian Tarapur | Assam |
| 16 | Jirighat, Umed Nagar | Assam |
| 17 | Sonai, Sonbharighat | Assam |
| 18 | Baga Bazar, Dhloai, Ganhapur, Lailapur | Assam |
| 19 | Jiribam, Makhan Nagar | Manipur |
| 20 | Imphal, Manipur, Noney, Nungba, Phaitol, Thangal | Manipur |
| 21 | Meghalay, Shilong | Rest of India |
| 23 | Kolasib,Aizawl, Champhai,Serchhip | Mizoram |
| 24 | Rest of India (Mumbai, Delhi, Jaipur, Kolkata, Andra Pradesh) | Rest of India |

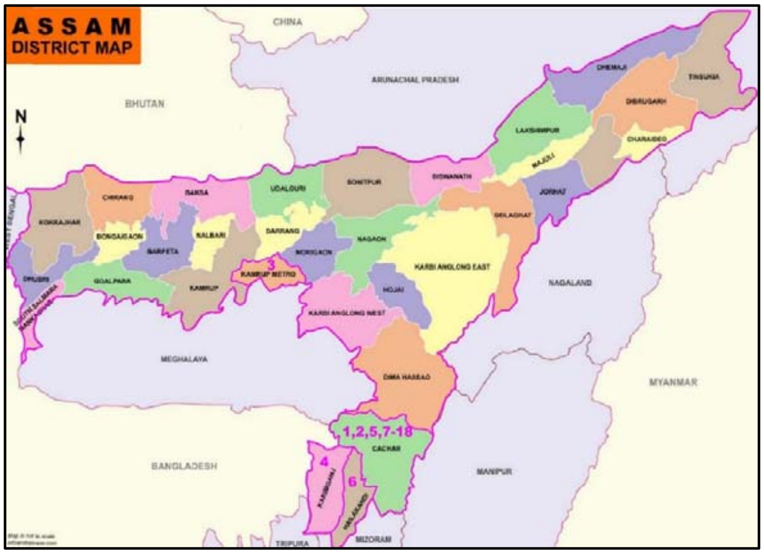


**Figure 4.4 Traffic Zones for Assam (Section : Silchar to Jiribam)**

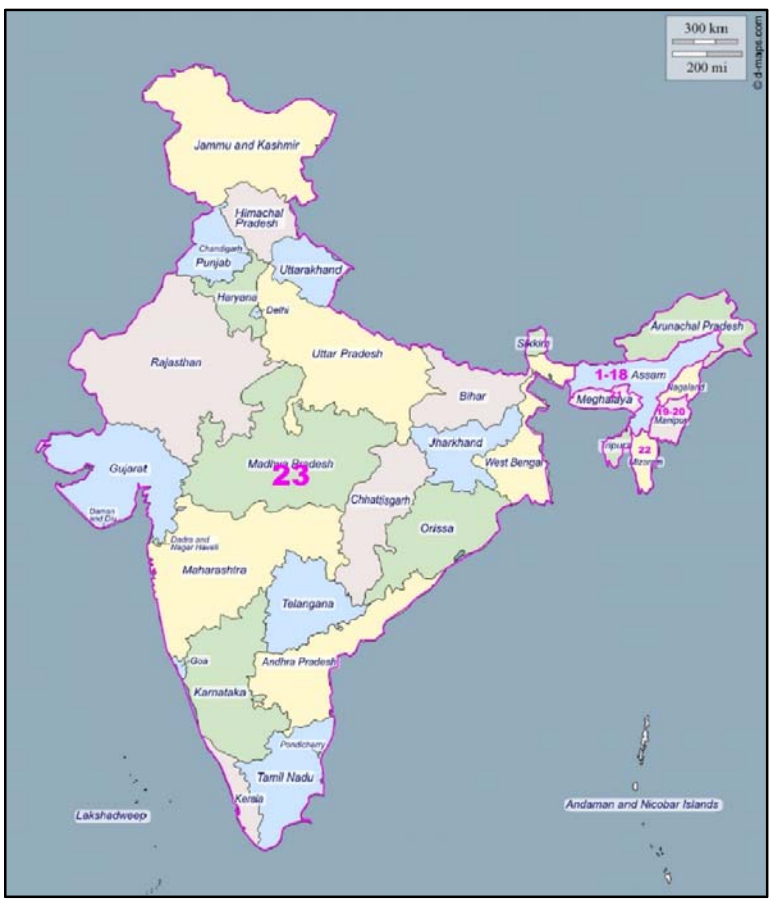


**Figure 4.5 Zoning Scheme (Rest of India) for Silchar to Jiribam**

### 4.9.3 Origin-Destination Matrix

The data collected from the survey were coded and entered into the computer according to the zoning system described above and the O-D matrices were prepared for both passenger and goods traffic. The O-D matrix for Car, Bus and Truck with their zone-wise distribution in percentage and in numbers is presented in **Volume-I Appendices to Main Report (Appendix 4.2).** The movements of the vehicles (in %) in the project influence area is summarized below:

| Sl. No | O-D Location | Passenger OD | Goods OD |
|---|---|---|---|
| 1 | Km 262+000 | • Major OD pairs are zone 1(Silchar) to zone 7, 8, 9, 10 and 11 (Arkatipur, Kashipur, Banskandi, Fulertal and Pailapool) and 1(Silchar) to zone 19 (Jiribam) and other part of Manipur.<br>• 90% of the traffic has origin/destination with in the Cachar district (Assam State).<br>• About 75% of the traffic distributes with in the zones- 1 to 10 (within Assam). | • Major OD pairs are zone 1(Silchar) to zone 7, 8, 9, 10 and 11 (Arkatipur, Kashipur, Banskandi, Fulertal and Pailapool), 1(Silchar) to zone 19 and 20 (Jiribam and Imphal) and from 3 (Guwahati) to 11, 12, 13, 19 and 20 (Pailapool, Joypur, Lakhipur, Jiribam and Imphal) other part of Manipur.<br>• 72% of the traffic has origin/destination with in the Assam State<br>• About 50% to 55% of the traffic distributes with in the zones- 1 to 10. |
| 2 | Km 217+000 | • Major OD pairs are zone 1 (Silchar) to zone 19 (Jiribam) and 19 (Jiribamr) to zone 20 (Imphal).<br>• 50% of the traffic has origin/destination with in the Assam state and 50% of the traffic has origin/destination with in Manipur state. | • Major OD pairs are zone 1 (Silchar) to zone 20 (Imphal) and 3 (Guwahati) to zone 20 (Imphal).<br>• 65% of the traffic has origin/destination with in the Manipur State. |

### 4.9.4 Commodity Movement

The analysis of O-D survey data also highlights the commodity movement in the project influence area. The commodities have been sub divided into Miscellaneous & Provisions, Animal Food, Food Items, Construction Materials, Petroleum Products, Chemicals, Cotton & Products, Machinery Equipment's, Perishable Goods and Automobile Parts, etc. for the analysis. The different commodities recorded during the O - D survey have been classified into 16 categories as presented in the following table. Due consideration has been given to include a possible commodities and to categorize them into homogeneous groups. The summary of the commodity analysis is presented in the table below:

**Table 4.18 Commodity Movement Pattern**

**Km 262+000 (Numbers)**

| Sl. No. | Commodity | No. of Vehicles | | | | | |
|---|---|---|---|---|---|---|---|
| | | Towards Jiribam | | | Towards Silchar | | |
| | | 2 Axle | 3 Axle | M Axle | 2 Axle | 3 Axle | M Axle |
| 1 | Empty | 60 | 4 | 4 | 146 | 64 | 19 |
| 2 | Misc. & Provision | 1 | 1 | 1 | 2 | 1 | 0 |
| 3 | Grains & Pulses | 33 | 2 | 8 | 5 | 0 | 0 |
| 4 | Fruits & Vegetables | 13 | 2 | 5 | 0 | 0 | 0 |
| 5 | Coal | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Cement | 29 | 5 | 15 | 1 | 1 | 1 |
| 7 | House Material | 1 | 0 | 0 | 1 | 0 | 0 |
| 8 | Other Construction Material | 7 | 0 | 1 | 44 | 0 | 0 |
| 9 | Petroleum Products | 7 | 16 | 0 | 2 | 0 | 0 |
| 10 | Chemical and Fertilizers | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Metals | 7 | 1 | 0 | 0 | 1 | 0 |
| 12 | Cotton & Wooden Products | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Machinery & Equipment's | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Other industrial products & parcel | 34 | 5 | 6 | 7 | 1 | 1 |
| 15 | Perishable goods (milk, eggs, animal, animal food) | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Automobile & Parts | 2 | 1 | 0 | 0 | 0 | 0 |
| Total | | 194 | 37 | 40 | 208 | 68 | 21 |

**Km 262+000 (Percentage)**

| Sl. No. | Commodity | % of Vehicles | | | | | |
|---|---|---|---|---|---|---|---|
| | | Towards Jiribam | | | Towards Silchar | | |
| | | 2-Axle | 3-Axle | MAV | 2-Axle | 3-Axle | MAV |
| 1 | Empty | 30.93% | 10.81% | 10.00% | 70.19% | 94.12% | 90.48% |
| 2 | Misc. & Provision | 0.52% | 2.70% | 2.50% | 0.96% | 1.47% | 0.00% |
| 3 | Grains & Pulses | 17.01% | 5.41% | 20.00% | 2.40% | 0.00% | 0.00% |
| 4 | Fruits & Vegetables | 6.70% | 5.41% | 12.50% | 0.00% | 0.00% | 0.00% |
| 5 | Coal | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | Cement | 14.95% | 13.51% | 37.50% | 0.48% | 1.47% | 4.76% |
| 7 | House Material | 0.52% | 0.00% | 0.00% | 0.48% | 0.00% | 0.00% |

| Sl. No. | Commodity | % of Vehicles | | | | | |
|---|---|---|---|---|---|---|---|
| | | Towards Jiribam | | | Towards Silchar | | |
| | | 2-Axle | 3-Axle | MAV | 2-Axle | 3-Axle | MAV |
| 8 | Other Construction Material | 3.61% | 0.00% | 2.50% | 21.15% | 0.00% | 0.00% |
| 9 | Petroleum Products | 3.61% | 43.24% | 0.00% | 0.96% | 0.00% | 0.00% |
| 10 | Chemical and Fertilizers | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 11 | Metals | 3.61% | 2.70% | 0.00% | 0.00% | 1.47% | 0.00% |
| 12 | Cotton & Wooden Products | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 13 | Machinery & Equipment's | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 14 | Other industrial products & parcel | 17.53% | 13.51% | 15.00% | 3.37% | 1.47% | 4.76% |
| 15 | Perishable goods (milk, eggs, animal, animal food) | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 16 | Automobile & Parts | 1.03% | 2.70% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | | **100.0%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

**Km 217+000 (Numbers)**

| Sl. No. | Commodity | No. of Vehicles | | | | | |
|---|---|---|---|---|---|---|---|
| | | Towards Jiribam | | | Towards Silchar | | |
| | | 2 Axle | 3 Axle | M Axle | 2 Axle | 3 Axle | M Axle |
| 1 | Empty | 13 | 3 | 1 | 18 | 2 | 7 |
| 2 | Misc. & Provision | 15 | 2 | 1 | 0 | 1 | 0 |
| 3 | Grains & Pulses | 6 | 0 | 0 | 4 | 1 | 0 |
| 4 | Fruits & Vegetables | 1 | 0 | 0 | 7 | 1 | 0 |
| 5 | Coal | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Cement | 82 | 28 | 1 | 2 | 1 | 0 |
| 7 | House Material | 4 | 0 | 0 | 5 | 6 | 4 |
| 8 | Other Construction Material | 1 | 0 | 0 | 11 | 0 | 0 |
| 9 | Petroleum Products | 0 | 0 | 0 | 5 | 1 | 0 |
| 10 | Chemical and Fertilizers | 0 | 0 | 0 | 4 | 0 | 0 |
| 11 | Metals | 5 | 1 | 0 | 11 | 0 | 0 |
| 12 | Cotton & Wooden Products | 0 | 0 | 0 | 10 | 0 | 0 |
| 13 | Machinery & Equipment's | 5 | 0 | 0 | 8 | 1 | 1 |
| 14 | Other industrial products & parcel | 4 | 2 | 3 | 47 | 11 | 8 |
| 15 | Perishable goods (milk, eggs, animal, animal food) | 10 | 0 | 0 | 23 | 3 | 2 |
| 16 | Automobile & Parts | 13 | 8 | 4 | 4 | 0 | 2 |
| **Total** | | 159 | 44 | 10 | 159 | 28 | 24 |

**Km 217+000 (Percentage)**

| Sl. No. | Commodity | % of Vehicles | | | | | |
|---|---|---|---|---|---|---|---|
| | | Towards Jiribam | | | Towards Silchar | | |
| | | 2-Axle | 3-Axle | MAV | 2-Axle | 3-Axle | MAV |
| 1 | Empty | 8.18% | 6.82% | 10.00% | 11.32% | 7.14% | 29.17% |
| 2 | Misc. & Provision | 9.43% | 4.55% | 10.00% | 0.00% | 3.57% | 0.00% |
| 3 | Grains & Pulses | 3.77% | 0.00% | 0.00% | 2.52% | 3.57% | 0.00% |
| 4 | Fruits & Vegetables | 0.63% | 0.00% | 0.00% | 4.40% | 3.57% | 0.00% |
| 5 | Coal | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | Cement | 51.57% | 63.64% | 10.00% | 1.26% | 3.57% | 0.00% |
| 7 | House Material | 2.52% | 0.00% | 0.00% | 3.14% | 21.43% | 16.67% |
| 8 | Other Construction Material | 0.63% | 0.00% | 0.00% | 6.92% | 0.00% | 0.00% |
| 9 | Petroleum Products | 0.00% | 0.00% | 0.00% | 3.14% | 3.57% | 0.00% |
| 10 | Chemical and Fertilizers | 0.00% | 0.00% | 0.00% | 2.52% | 0.00% | 0.00% |
| 11 | Metals | 3.14% | 2.27% | 0.00% | 6.92% | 0.00% | 0.00% |
| 12 | Cotton & Wooden Products | 0.00% | 0.00% | 0.00% | 6.29% | 0.00% | 0.00% |
| 13 | Machinery & Equipment's | 3.14% | 0.00% | 0.00% | 5.03% | 3.57% | 4.17% |
| 14 | Other industrial products & parcel | 2.52% | 4.55% | 30.00% | 29.56% | 39.29% | 33.33% |
| 15 | Perishable goods (milk, eggs, animal, animal food) | 6.29% | 0.00% | 0.00% | 14.47% | 10.71% | 8.33% |
| 16 | Automobile & Parts | 8.18% | 18.18% | 40.00% | 2.52% | 0.00% | 8.33% |
| **Total** | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

### 4.9.5 Trip Length Distribution

The lead characteristics of passenger and goods vehicles obtained from the roadside Interview surveys. The average trip lengths travelled by each vehicle as shown in below table.

**Table 4.19 Trip Length Distribution**

**Km 262+000 (Percentage)**

| Trip Length (Kms) | | | Car | Bus | LCV | 2 Axle | 3Axle | MAV |
|---|---|---|---|---|---|---|---|---|
| **Towards Jiribam** | | | | | | | | |
| 0 | - | 5 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 41.63% | 3.85% | 26.67% | 10.95% | 10.81% | 7.50% |
| 21 | - | 30 | 13.26% | 15.38% | 13.33% | 15.42% | 2.70% | 5.00% |
| 31 | - | 50 | 18.84% | 11.54% | 16.67% | 17.91% | 10.81% | 0.00% |
| 51 | - | 100 | 22.56% | 57.69% | 23.33% | 19.90% | 18.92% | 17.50% |
| 101 | - | 200 | 0.70% | 0.00% | 6.67% | 0.00% | 0.00% | 2.50% |
| 201 | - | 500 | 2.79% | 7.69% | 13.33% | 28.36% | 43.24% | 45.00% |
| 501 | - | 1000 | 0.23% | 3.85% | 0.00% | 7.46% | 13.51% | 22.50% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| **Towards Silchar** | | | | | | | | |
| 0 | - | 5 | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 39.52% | 8.33% | 24.14% | 9.09% | 7.35% | 4.76% |
| 21 | - | 30 | 11.43% | 25.00% | 6.90% | 3.35% | 1.47% | 0.00% |
| 31 | - | 50 | 27.14% | 54.17% | 37.93% | 24.88% | 10.29% | 19.05% |
| 51 | - | 100 | 19.29% | 12.50% | 13.79% | 15.31% | 22.06% | 9.52% |
| 101 | - | 200 | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 4.76% |
| 201 | - | 500 | 1.19% | 0.00% | 17.24% | 41.63% | 50.00% | 57.14% |
| 501 | - | 1000 | 0.00% | 0.00% | 0.00% | 5.74% | 8.82% | 4.76% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| **Combined** | | | | | | | | |
| 0 | - | 5 | 0.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 40.59% | 6.00% | 25.42% | 10.00% | 8.57% | 6.56% |
| 21 | - | 30 | 12.35% | 20.00% | 10.17% | 9.27% | 1.90% | 3.28% |
| 31 | - | 50 | 22.94% | 32.00% | 27.12% | 21.46% | 10.48% | 6.56% |
| 51 | - | 100 | 20.94% | 36.00% | 18.64% | 17.56% | 20.95% | 14.75% |
| 101 | - | 200 | 0.94% | 0.00% | 3.39% | 0.00% | 0.00% | 3.28% |
| 201 | - | 500 | 2.00% | 4.00% | 15.25% | 35.12% | 47.62% | 49.18% |
| 501 | - | 1000 | 0.12% | 2.00% | 0.00% | 6.59% | 10.48% | 16.39% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

**Km 217+000 (Percentage)**

| Trip Length (Kms) | | | Car | Bus | LCV | 2 Axle | 3Axle | MAV |
|---|---|---|---|---|---|---|---|---|
| **Towards Jiribam** | | | | | | | | |
| 0 | - | 5 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 2.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 21 | - | 30 | 21.70% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 31 | - | 50 | 1.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 51 | - | 100 | 58.02% | 33.33% | 73.33% | 0.00% | 2.27% | 0.00% |
| 101 | - | 200 | 6.13% | 0.00% | 0.00% | 1.26% | 2.27% | 0.00% |
| 201 | - | 500 | 9.91% | 66.67% | 26.67% | 67.92% | 59.09% | 20.00% |
| 501 | - | 1000 | 0.00% | 0.00% | 0.00% | 26.42% | 34.09% | 50.00% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 4.40% | 2.27% | 30.00% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| **Towards Silchar** | | | | | | | | |
| 0 | - | 5 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 2.41% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 21 | - | 30 | 31.33% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 31 | - | 50 | 1.20% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 51 | - | 100 | 45.18% | 25.00% | 14.29% | 6.92% | 3.57% | 16.67% |
| 101 | - | 200 | 10.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 201 | - | 500 | 9.64% | 75.00% | 71.43% | 68.55% | 78.57% | 70.83% |
| 501 | - | 1000 | 0.00% | 0.00% | 14.29% | 24.53% | 17.86% | 12.50% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| **Combined** | | | | | | | | |
| 0 | - | 5 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 6 | - | 20 | 2.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 21 | - | 30 | 25.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 31 | - | 50 | 1.59% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 51 | - | 100 | 52.38% | 28.57% | 62.16% | 3.46% | 2.78% | 11.76% |
| 101 | - | 200 | 7.94% | 0.00% | 0.00% | 0.63% | 1.39% | 0.00% |
| 201 | - | 500 | 9.79% | 71.43% | 35.14% | 68.24% | 66.67% | 55.88% |
| 501 | - | 1000 | 0.00% | 0.00% | 2.70% | 25.47% | 27.78% | 23.53% |
| 1001 | - | 10000 | 0.00% | 0.00% | 0.00% | 2.20% | 1.39% | 8.82% |
| **Total** | | | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |

### 4.9.6 Summary of Results (OD)

The results of the Origin - Destination analysis is summarized below:

- Maximum share of the trips for passenger vehicles are originated from or destined to the state of Assam with its share being approx. 85%.
- For Goods vehicles share of Assam is approx. 70%. The share of the trips for goods vehicles originated from or destined to the state of Manipur is around 25%.

This is mainly due to the fact that all the constructed materials and other essential food products are transported to Imphal (Manipur) from Assam. It is also observed that approx. 33% of multi axle vehicles are originated from or destined to the state of Manipur carrying Construction materials like Cement and other goods.

- Commodity movement pattern on this corridor shows that there is considerable movement of Construction materials like Cement, steel, industrial products & products, in addition to other miscellaneous goods like food products, petroleum products and miscellaneous goods etc. On the other hand, the share of goods vehicle carrying vegetables, grains & pulses and construction materials from Assam to Imphal.
- On the corridor, most of the commercial vehicles have a lead of more than 100 km. The vehicle wise distribution of trips by various lead ranges (%) shows that at both the locations significant numbers of MAV have a lead of ranging from 200 Km to 500 Km, the percentage being approx. 45%, which clearly shows all this traffic is coming from Manipur state. Amongst the passenger vehicles, buses having lead of more than 200 km is less than 7% and cars having a lead of more than 200km is approx. 3% only. This shows that the majority of passenger traffic movement is within the state only and some traffic movement from other state is observed.

## 4.10 Diverted traffic on proposed Green filed alignment

The expected traffic on the proposed green filed alignment shall be some percentage of the traffic which is using the existing road presently and some percentage of the traffic diverted from other road. The assessment for expected tollable traffic on the proposed green filed has been done on the basis of analysis of the OD studies done at Km 262+000 and at Km 217+000 along existing road and along the link road between Fulerthal (NH-37) and Sonbarighat (NH-306); however the percentages of likely diversions of non tollable vehicles have been assessed on the basis of Consultants experience with regard to the traffic network in the project influence area.

There is link road between Fulerthal on NH-37 and Sonabarighat in NH-306 is via Binnakandi Ghat, Binnakandi and Sonai. This route is shortest route between Fuerthal and Sonabarighat with length Approx. 30 Km. Presently majority of the traffic that are travelling from Pailapool, Joypur, Jirighat & Jiribam from NH-37 towards Sonabarighta, Kabuganj, Dholai, Bhaga and Aizawl are using this road as the length less compared to travelling via Silchar. This road is majorly use by the passenger vehicles and some part of commercial vehicles.

Further from traffic studies on Sonai road it is observed that majority of the passenger traffic that are travelling from Pailapool, Fulerthal, Joypur & Jiribam on NH-37 towards NH-306 via Sonai. Once the proposed green filed alignment is developed to 4-lane standards, majority of the traffic that are using this road will be diverted towards green filed alignment.

From the OD studies it is observed that majority number of commercial vehicle from Guwahati, Silchar, Karimganj are travelling towards Imphal (Manipur). Once the proposed green filed alignment is developed to 4-lane standards almost 90% of the commercial vehicles that are presently using the existing road will be diverted towards proposed green filed alignment.

The details of diverted traffic on green filed alignment is presented below in Table

**Table 4.20 Percentage diversion of tollable traffic on proposed Green Filed alignment**

| Car | Bus | LCV | 2A Trucks | 3A Trucks | 4-6 Axle Trucks |
|---|---|---|---|---|---|
| 60% | 60% | 70% | 90% | 90% | 90% |

**Table 4.21 Assumed % diversion of non-tollable traffic on Green Filed alignment**

| 3W | 2W | Tractors | Non-motorised |
|---|---|---|---|
| 30% | 40% | 70% | 70% |

Based on the results and analysis of O-D along with assumptions on the likely diverted traffic, the base year (2020) traffic for proposed green filed alignment has been calculated. The detail of diverted AADT on green filed alignment is presented in table below.

**Table 4.22 Average Daily Traffic on proposed green filed alignment (AADT – in nos.)**

| Sl. No | Vehicle Type | AADT (In nos.) | | | | |
|---|---|---|---|---|---|---|
| | | Actual traffic on existing road (km 217+000) | Diverted traffic on Green filed alignment from Km 217+000 (A) | Actual traffic on Sonai Road | Diverted traffic on Green filed alignment from Km Sonai road (B) | Total traffic on Green filed alignment (C = A+B) |
| **Tollable Traffic** | | | | | | |
| 1 | Car | 2195 | 1756 | 1216 | 851 | 2608 |
| 2 | Mini-Bus | 4 | 2 | 10 | 6 | 8 |
| 3 | Pvt. Bus | 11 | 7 | 1 | 1 | 7 |
| 4 | Govt. Bus | 2 | 1 | 1 | 1 | 2 |
| 5 | LCV | 139 | 98 | 76 | 53 | 151 |
| 6 | 2 Axle | 517 | 465 | 64 | 57 | 522 |
| 7 | 3 Axle | 134 | 121 | 5 | 5 | 126 |
| 8 | 4-6 Axle | 69 | 62 | 2 | 2 | 64 |
| 9 | >=7 Axle | 0 | 0 | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | | | |
| 10 | 2W | 1940 | 776 | 1601 | 160 | 936 |
| 11 | 3W | 1733 | 520 | 1291 | 129 | 649 |
| 12 | Tractor with Trailer | 1 | 1 | 0 | 0 | 1 |

| Sl. No | Vehicle Type | AADT (In nos.) | | | | |
|---|---|---|---|---|---|---|
| | | Actual traffic on existing road (km 217+000) | Diverted traffic on Green filed alignment from Km 217+000 (A) | Actual traffic on Sonai Road | Diverted traffic on Green filed alignment from Km Sonai road (B) | Total traffic on Green filed alignment (C = A+B) |
| 13 | Tractor without Trailer | 1 | 1 | 0 | 0 | 1 |
| 14 | Cycle | 141 | 14 | 560 | 56 | 70 |
| 15 | Rickshaw | 1 | 0 | 2 | 0 | 0 |
| 16 | Animal Drawn | 0 | 0 | 0 | 0 | |
| **ADT in Nos.** | | | | | | |
| **Tollable** | | **3072** | **2512** | **1375** | **975** | **3487** |
| **Non - Tollable** | | **3816** | **1311** | **3453** | **345** | **1657** |
| **Total** | | **6888** | **3823** | **4829** | **1321** | **5144** |

**Table 4.23 Average Daily Traffic on proposed green filed alignment (AADT – in PCU)**

| Sl. No | Vehicle Type | AADT (In PCU) | | | | |
|---|---|---|---|---|---|---|
| | | Actual traffic on existing road (km 217+000) | Diverted traffic on Green filed alignment from Km 217+000 (A) | Actual traffic on Sonai Road | Diverted traffic on Green filed alignment from Km Sonai road (B) | Total traffic on Green filed alignment (C = A+B) |
| **Tollable Traffic** | | | | | | |
| 1 | Car | 2195 | 1756 | 1216 | 851 | 2608 |
| 2 | Mini-Bus | 6 | 4 | 15 | 9 | 13 |
| 3 | Pvt. Bus | 33 | 20 | 3 | 2 | 22 |
| 4 | Govt. Bus | 6 | 3 | 3 | 2 | 5 |
| 5 | LCV | 209 | 146 | 114 | 80 | 226 |
| 6 | 2 Axle | 1550 | 1395 | 191 | 172 | 1567 |
| 7 | 3 Axle | 403 | 363 | 15 | 14 | 377 |
| 8 | 4-6 Axle | 309 | 278 | 9 | 8 | 287 |
| 9 | >=7 Axle | 0 | 0 | 0 | 0 | 0 |
| **Non-Tollable Traffic** | | | | | | |
| 10 | 2W | 970 | 388 | 800 | 80 | 468 |
| 11 | 3W | 1733 | 520 | 1291 | 129 | 649 |
| 12 | Tractor with Trailer | 5 | 3 | 0 | 0 | 3 |
| 13 | Tractor without Trailer | 2 | 1 | 0 | 0 | 1 |
| 14 | Cycle | 71 | 7 | 280 | 28 | 35 |
| 15 | Rickshaw | 2 | 0 | 4 | 0 | 1 |
| 16 | Animal Drawn | 0 | 0 | 0 | 0 | 0 |
| **ADT in PCU** | | | | | | |
| **Tollable** | | **4712** | **3965** | **1567** | **1137** | **5103** |
| **Non - Tollable** | | **2781** | **919** | **2375** | **238** | **1157** |
| **Total** | | **7493** | **4885** | **3942** | **1375** | **6259** |

## 4.11 Turning Movement Surveys

Turning movement survey has been carried out at the following 1 Major junction intersections for 16 hours which includes morning and evening peak hour traffic. The Turning movement survey was not conducted at other junction along the project road, science the proposed alignment is passing through green filed and will not encounter those junctions along the existing road.

Details of junctions are given below;

**Table 4.24 Junction Details**

| Sl. No | Location | Chainage (Km) | Type | Classification of Road | X-Road leading to |
|---|---|---|---|---|---|
| 1 | Madhurapul | 262+500 | 3-Legged | NH-27 | Guwahati NH-27 |

Survey data of Intersection volume count is presented in **Volume-I Appendices to Main Report (Appendix 4.4)** and the summary along with traffic flow diagrams are given in the following table;

**Table 4.25 Details of Turning Movement Survey**

| Sl. No | Location | Chainage, Km | Type of Junction | Peak Hour | Peak Hour PCU |
|---|---|---|---|---|---|
| 1 | Madhurapul | 262+500 | 3-legged | 20.00 – 21.00 | 2792 |

### 4.11.1 Guwahati Junction (Km 262+500)

The Peak hour traffic at this junction is 2752 PCU and the peak hour timing is 20.00 to 21.00 hrs. The total traffic for 16 hrs at this junction is 24942 PCU. The major movement of traffic is observed between Silchar-Guwahati vice versa. The turning traffic means the traffic coming from or going to Guwahati at this junction is 1637.

## 4.12 Axle Load Survey

Axle load survey was carried out to get the spectrum of vehicle loading pattern and also to arrive at Vehicle Damage Factor (VDF) for using in the design of overlays and new pavement design for widening/new lanes. The survey was carried out at two locations (km 262+000 and Km 217+000) using two portable weigh pads, one for each direction. Axle loads of Bus, LCVs, 2 & 3 axle trucks and multi axle trucks were recorded on random basis. In addition, information about origin, destination and type of goods transported by commercial vehicles were also recorded. Laden, un-laden commercial vehicles as well as few passenger buses have also been weighed.

The axle load survey data has been used to calculate the Vehicle Damage Factor (VDF), which is an important parameter in pavement design. Vehicle wise VDF is calculated based on the standard axle loads given in IRC 37-2018.

### 4.12.1 Methodology

The axle weight data obtained from the surveys have been compiled and analysed to obtain the vehicle loading behaviour along the existing road. The data have been analysed for vehicle type to obtain the following information:

i. Overloading pattern; and
ii. Vehicle Damage Factor, i.e., equivalent single axle (ESAL) load factor.

The vehicle damage factor is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions. It is defined as equivalent number of standard axles per commercial vehicle. The VDF varies with the vehicle axle configuration, axle loading, terrain, type of road and from region to region.

The ESAL for each axle has been calculated as per the following relationship. The relationship is sometimes referred to as "Fourth Power Rule" which states that the damaging effect of an axle load increases as a fourth power of the weight of an axle. For instance, an axle load of 16.32 ton will impact the pavement 4 times more than the axle load of 8.16 t.

$$ESAL_i = \left[\frac{LOAD_i}{STD.LOAD_i}\right]^4$$

Where,

$ESAL_i$ = is Equivalent Standard Axle for axle "i "
$LOAD_i$ = is load on axle "i "in tonnes.
STD $LOAD_i$ = is standard axle load in tonnes for axle group "i "
The axle load equivalency factors recommended in the AASHTO guide are considered for arriving at the ESAL.

STD $LOAD_i$ = 6.628 ton for single-wheel single axle
STD $LOAD_i$ = 8.157 ton for dual-wheel single axle
STD $LOAD_i$ = 15.097 ton for tandem axle -dual wheel
STD $LOAD_i$ = 22.840 ton for tridem axle -dual wheel
In order to convert the ESAL into VDF, the frequency distribution of ESAL for each category of vehicle and weighted average of ESAL is calculated to arrive at the VDF for that category of vehicle.

The Axle load frequency data is presented in **Volume-I Appendices to Main Report (Appendix 4.3)**. Following table gives a summary of analysis carried out to find the Vehicle Damage Factor on the project road.

**Table 4.26 Vehicle Damage Factor (VDF) for Commercial Vehicles**

**Km 262+000**

| Type of Vehicle | Sample (%) | Silchar - Jiribam | | Jiribam-Silchar | | Adopted VDF |
|---|---|---|---|---|---|---|
| | | No. of Vehicle | VDF | No. of Vehicle | VDF | |
| LCV | 11.2% | 30 | 0.73 | 29 | 0.12 | 0.73 |
| 2-Axle Truck | 28.8% | 201 | 7.74 | 209 | 4.71 | 7.74 |
| 3-Axle Truck | 40.5% | 37 | 9.09 | 68 | 1.00 | 9.09 |
| Multi-Axle Truck | 48.7% | 27 | 9.32 | 21 | 0.38 | 9.32 |
| Bus | 6.2% | 7 | 0.72 | 10 | 0.61 | 0.72 |

**Km 217+000**

| Type of Vehicle | Sample (%) | Silchar - Jiribam | | Jiribam-Silchar | | Adopted VDF |
|---|---|---|---|---|---|---|
| | | No. of Vehicle | VDF | No. of Vehicle | VDF | |
| LCV | 34.9% | 30 | 0.75 | 7 | 0.06 | **0.75** |
| 2-Axle Truck | 31.6% | 157 | 7.64 | 158 | 2.52 | **7.64** |
| 3-Axle Truck | 37.0% | 44 | 6.91 | 29 | 0.24 | **6.91** |
| Multi-Axle Truck | 34.3% | 14 | 5.22 | 23 | 0.27 | **5.22** |
| Bus | 63.0% | 7 | 0.72 | 10 | 0.61 | **0.72** |

## 4.13 Traffic Assignment

The project envisages the improvement and widening of existing intermediate lane 2-lane road to 4-Lane divided carriageway facility. Therefore, normal traffic on the project road remains to be the main user of the improved facility. However, other kind of traffic anticipated during the project service life is discussed under following paragraphs:

### 4.13.1 Normal Traffic

Normal traffic on the project road is derived from primary survey on the various sections. Analysis of the same and annual average daily traffic (AADT) for individual homogeneous sections is brought out in the preceding paragraphs.

### 4.13.2 Traffic Projections

The investment priorities are governed by the traffic demand, assessed benefits and cost of the project. Demand is one which governs type of facility / infrastructure to be created. This in turn determines likely benefits and costs to develop the same. A highway project of this nature calls for significant investment. Prediction of traffic demand becomes an important task and has to be carried out near accurately. The accurate estimation of traffic has direct bearing on design of the facility and the viability of project. Recognising this, efforts are made to carefully assess all the parameters that help in predicting the traffic demand in future.

Traffic forecasting using traffic growth pattern, which is the most important governing factor, in the present state of knowledge can at best be only approximate. Traffic is generated as a result of the interplay of a number of contributory factors like population, gross domestic product, vehicle ownership, agriculture output, fuel consumption etc. to name a few. Any change in the pattern of these factors can only be estimated approximately with a limited degree of accuracy.

To establish the future traffic growth rates, following approaches have been explored.

- Past trends in traffic growth on project road
- Socio-Economic Scenario & Transport Demand Elasticity

### 4.13.3 Past Traffic Trends

For the project road past traffic trends are not available. Hence regression analysis has been done using past trends on vehicle registration (for Factor 1) and socio-economic indicators (for Factor 2) to estimate elasticity for each type of vehicle.

### 4.13.4 Socio-Economic Scenario & Transport Demand Elasticity

As per methodology contained in the "Guidelines for analysis of highway investments" the traffic demand along the project roads should not be limited merely to annual growth rate of population and the growth rate of real income per capita estimated in the project influence area (PIA); but should also take into account the elasticity of transport demand in relation to income and estimated annual production increases in the PIA, so that the prospective plans for development could well be incorporated in the traffic projection.

The formulae for annual growth of passenger vehicles & trucks and elasticity of transport demand for passenger vehicles for different year slabs, as suggested by the World Bank has been adopted. As per the guidelines, the following data inputs pertaining to the project influence area would be required:

- Net State Domestic Product (NSDP)
- Population growth rate; and (Pgr)
- Real per capita income growth rate (PCIgr)

The above indicators should pertain to the project influence area. The data pertaining to the socio-economic profile of the State and industrial and social development programs have been collected.

The details of growth rates of Assam, Mizoram and Manirpur as collected from different statistical handbooks are presented below. The real per capita income of the state is collected from secondary sources. After analysing the % growth of per capita income of the state and viewing overall economic performances of the country as well as the State.

The growth rate for mining and industrial sector has been worked out on the basis of the data available from 2004-05 onwards. The Net State Domestic Product (NSDP) at constant prices base year 2004-05 is considered.

**Table 4.27 Economic Indicators of the project influence area**

| State | Mizoram | | Assam | | Manipur | | Rest Of India | |
|---|---|---|---|---|---|---|---|---|
| Year | NSDP, in Crores | PCI, in Rs. | NSDP, in Crores | PCI, in Rs. | NSDP, in Crores | PCI, in Rs. | NSDP, in Crores | PCI, in Rs. |
| **Base Year 2004-2005** | | | | | | | | |
| 2004 - 05 | 2400 | 24662 | 47181 | 16782 | 4603 | 18640 | 24402 | 901816 |
| 2005 - 06 | 2577 | 25826 | 48602 | 17050 | 4907 | 19479 | 26643 | 967736 |
| 2006 - 07 | 2693 | 26308 | 50797 | 17579 | 4992 | 19431 | 29569 | 1046820 |
| 2007 - 08 | 2988 | 28467 | 52968 | 18089 | 5267 | 20106 | 32306 | 1114623 |
| 2008 - 09 | 3437 | 31921 | 56123 | 18922 | 5652 | 21169 | 34239 | 1178031 |
| 2009 - 10 | 3832 | 34699 | 61294 | 20406 | 6039 | 22197 | 36949 | 1284939 |
| 2010 - 11 | 4160 | 36732 | 66280 | 21793 | 6339 | 22867 | 40575 | 1377684 |
| 2011 - 12 | 4594 | 39546 | 70544 | 22910 | 6763 | 23953 | 43895 | 1450697 |
| 2012 - 13 | | | 75417 | 24198 | 7248 | 25205 | | |
| CAGR | 7.48% | 5.39% | 5.35% | 4.15% | 5.17% | 3.41% | 6.74% | 5.42% |

### 4.13.5 Transport Demand Elasticity

Transport demand elasticity is one of the methods of establishing relationships between transport demand (i.e. number of vehicles) and the parameters (prices, GDP, per capita income etc.) affecting the demand for vehicles (passenger and freight). This relationship may remain static or may change in future due to disproportionate changes in the future growth or parameters and/or technological changes in vehicle characteristics. Transport elasticity is a measure of percentage change in transport demand w.r.t. percentage change in the parameters (such as prices, per capita income, population etc.) influencing the demand.

On the basis of the above formulation the transport demand elasticity for passenger and freight vehicles were estimated by using the following equations:

Elasticity for Passenger Traffic:

$$E = G / ((1+G_P) \times (1+G_{PCI}) - 1)$$

Where, E = Elasticity of Transport Demand

$G_P$ = Population growth rate

$G_{PCI}$ = Per Capita income growth rate

G = growth factor

Elasticity for Freight Traffic:

$$E = G / G_{NSDP}$$

Where, E = Elasticity of Transport Demand

$G_{NSDP}$ = Net State Domestic Product growth rate

G = growth factor

#### 4.13.6 Traffic Growth Rate

Using the above growth rates relevant to (i) passenger vehicles and (ii) freight vehicles separately, the growth rates for different vehicles have been estimated. The formulae and methods for passenger vehicles and freight vehicles are illustrated below:

**Passenger Vehicles**

The growth rates of population, per capita income and elasticity of transport demand in relation to the income have been used to estimate the growth rates, as suggested in the World Bank guidelines using the following formula: -

**Passenger Vehicles** : Tgr = ((1+Pgr)*(1+PCI gr)-1)*100*E

Where,

Tgr = Traffic Growth Rate

Pgr = Population Growth Rate (1.33%)

PCI gr = Per Capita Income Growth Rate (5.73%)

E = Elasticity value

**Freight Vehicles**

The forecast growth rates for trucks has been made by calculating the average growth rates of the core sectors of economy, viz., Agriculture, Industrial and mining sectors and by multiplying the projected growth rates of these sectors of the following elasticity factors for the different periods:

Freight Vehicles : Tgr = ½ (Agr + NSDPgr) x E x 100

Where,

Agr = Growth rate of agricultural sector

NSDPgr = Growth rates of industrial & mining sectors

The growth rates for different vehicle categories have been estimated as per the methodology outlined above and the adopted growth rate figures are presented in the following table.

**Table 4.28 Proposed Traffic Growth rates for Silchar to Jiribam section**

| Vehicle Type | Upto 2025 | 2026-30 | 2031-35 | 2036-40 | Beyond 2040 |
|---|---|---|---|---|---|
| **Most Likely Scenario** | | | | | |
| Car/Van/Jeep | 5.00% | 9.70% | 8.50% | 5.00% | 5.00% |
| Bus/Minibus | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| LCV | 5.00% | 12.40% | 10.85% | 5.00% | 5.00% |
| 2A Trucks | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| 3A Trucks | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |
| MAV | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |
| **Optimistic Scenario** | | | | | |
| Car/Van/Jeep | 6.00% | 10.70% | 9.50% | 6.00% | 6.00% |
| Bus/Mini Bus | 6.00% | 6.00% | 6.00% | 6.00% | 6.00% |
| LCV | 6.00% | 13.40% | 11.85% | 6.00% | 6.00% |
| 2A Trucks | 6.00% | 6.00% | 6.00% | 6.00% | 6.00% |
| 3A Trucks | 6.00% | 8.00% | 7.50% | 7.00% | 6.00% |
| MAV | 6.00% | 8.00% | 7.50% | 7.00% | 6.00% |
| **Pessimistic Scenario** | | | | | |
| Car/Van/Jeep | 4.00% | 8.70% | 7.50% | 4.00% | 4.00% |
| Bus/Mini Bus | 4.00% | 4.00% | 4.00% | 4.00% | 4.00% |
| LCV | 4.00% | 11.40% | 9.85% | 4.00% | 4.00% |
| 2A Trucks | 4.00% | 4.00% | 4.00% | 4.00% | 4.00% |
| 3A Trucks | 4.00% | 6.00% | 5.50% | 5.00% | 4.00% |
| MAV | 4.00% | 6.00% | 5.50% | 5.00% | 4.00% |

The slow-moving vehicle non-motorised traffic is, in general, showing declining trends in the country except for a few areas where a gentle growth has been observed. For purpose of traffic projection in the present study, 1-2% growth has been adopted for the slow-moving vehicles till next 10 years and after 10 years no growth has been considered the slow-moving vehicles.

The estimated growth rate for different types of vehicles in subsequent years are given below in table.

**Table 4.29 Proposed yearly Traffic Growth rates (Most Likely Scenario) for Silchar to Jiribam section**

| Year | Car | Mini-Bus | Full Bus | LCV | TRUCKS | | | | 2W | 3W | Tractor | Cycle | Rickshaw | Animal drawn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2A | 3A | 4-6A | >=7A | | | | | | |
| 2020 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2021 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2022 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2023 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2024 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2025 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2026 | 9.70% | 5.00% | 5.00% | 12.40% | 5.00% | 7.00% | 7.00% | 7.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 9.70% |
| 2027 | 9.70% | 5.00% | 5.00% | 12.40% | 5.00% | 7.00% | 7.00% | 7.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 9.70% |
| 2028 | 9.70% | 5.00% | 5.00% | 12.40% | 5.00% | 7.00% | 7.00% | 7.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 9.70% |
| 2029 | 9.70% | 5.00% | 5.00% | 12.40% | 5.00% | 7.00% | 7.00% | 7.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 9.70% |
| 2030 | 9.70% | 5.00% | 5.00% | 12.40% | 5.00% | 7.00% | 7.00% | 7.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 9.70% |
| 2031 | 8.50% | 5.00% | 5.00% | 10.85% | 5.00% | 6.50% | 6.50% | 6.50% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 8.50% |
| 2032 | 8.50% | 5.00% | 5.00% | 10.85% | 5.00% | 6.50% | 6.50% | 6.50% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 8.50% |
| 2033 | 8.50% | 5.00% | 5.00% | 10.85% | 5.00% | 6.50% | 6.50% | 6.50% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 8.50% |
| 2034 | 8.50% | 5.00% | 5.00% | 10.85% | 5.00% | 6.50% | 6.50% | 6.50% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 8.50% |
| 2035 | 8.50% | 5.00% | 5.00% | 10.85% | 5.00% | 6.50% | 6.50% | 6.50% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 8.50% |
| 2036 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 6.00% | 6.00% | 6.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2037 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 6.00% | 6.00% | 6.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2038 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 6.00% | 6.00% | 6.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2039 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 6.00% | 6.00% | 6.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2040 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 6.00% | 6.00% | 6.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2041 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2042 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2043 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2044 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |

| Year | Car | Mini-Bus | Full Bus | LCV | TRUCKS | | | | 2W | 3W | Tractor | Cycle | Rickshaw | Animal drawn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2A | 3A | 4-6A | >=7A | | | | | | |
| 2045 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2046 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2047 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2048 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2049 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2050 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2051 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2052 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |
| 2053 | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% | 2.00% | 2.00% | 2.00% | 5.00% |

### 4.13.7 Projected Traffic

The summary of the projected traffic along the existing road is given in table below.

**Table 4.30 Projected Traffic (PCU) - Section 1 From Km 0+000 to Km 221+00 ( Silchar to Jirighat)**

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailor | Cycle | Rickshaw | Animal Drawn | Volume | PCU |
| **2020** | **3125** | **136** | **106** | **319** | **657** | **136** | **46** | **4097** | **1787** | **0** | **1** | **758** | **26** | **0** | **11196** | **10985** |
| 2021 | 3281 | 143 | 111 | 335 | 690 | 143 | 49 | 4302 | 1876 | 0 | 1 | 773 | 27 | 0 | 11732 | 11521 |
| 2022 | 3445 | 150 | 117 | 352 | 724 | 150 | 51 | 4517 | 1970 | 0 | 1 | 789 | 27 | 0 | 12295 | 12084 |
| 2023 | 3618 | 158 | 123 | 370 | 761 | 158 | 54 | 4743 | 2069 | 0 | 1 | 804 | 28 | 0 | 12885 | 12675 |
| 2024 | 3798 | 166 | 129 | 388 | 799 | 166 | 57 | 4980 | 2172 | 0 | 1 | 820 | 28 | 0 | 13504 | 13295 |
| **2025** | **3988** | **174** | **135** | **408** | **839** | **174** | **59** | **5229** | **2281** | **0** | **1** | **837** | **29** | **0** | **14154** | **13945** |
| 2026 | 4188 | 183 | 142 | 428 | 880 | 183 | 62 | 5490 | 2395 | 0 | 1 | 854 | 29 | 0 | 14836 | 14628 |
| 2027 | 4594 | 192 | 149 | 481 | 924 | 196 | 67 | 5765 | 2515 | 0 | 1 | 871 | 30 | 0 | 15784 | 15606 |
| 2028 | 5040 | 202 | 157 | 541 | 971 | 209 | 71 | 6053 | 2640 | 0 | 1 | 888 | 30 | 0 | 16803 | 16658 |
| 2029 | 5528 | 212 | 165 | 608 | 1019 | 224 | 76 | 6356 | 2772 | 0 | 1 | 906 | 31 | 0 | 17898 | 17792 |
| **2030** | **6065** | **222** | **173** | **683** | **1070** | **240** | **82** | **6673** | **2911** | **0** | **1** | **924** | **32** | **0** | **19076** | **19014** |
| 2031 | 6653 | 233 | 182 | 768 | 1124 | 256 | 87 | 7007 | 3057 | 0 | 1 | 942 | 32 | 0 | 20343 | 20331 |

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailor | Cycle | Rickshaw | Animal Drawn | Volume | PCU |
| 2032 | 7218 | 245 | 191 | 851 | 1180 | 273 | 93 | 7357 | 3209 | 0 | 1 | 961 | 33 | 0 | 21614 | 21649 |
| 2033 | 7832 | 257 | 200 | 944 | 1239 | 291 | 99 | 7725 | 3370 | 0 | 1 | 981 | 34 | 0 | 22972 | 23061 |
| 2034 | 8498 | 270 | 210 | 1046 | 1301 | 310 | 106 | 8111 | 3538 | 0 | 1 | 1000 | 34 | 0 | 24426 | 24574 |
| **2035** | **9220** | **284** | **221** | **1159** | **1366** | **330** | **112** | **8517** | **3715** | **0** | **1** | **1020** | **35** | **0** | **25981** | **26196** |
| 2036 | 10004 | 298 | 232 | 1285 | 1434 | 351 | 120 | 8943 | 3901 | 0 | 1 | 1041 | 36 | 0 | 27645 | 27935 |
| 2037 | 10504 | 313 | 243 | 1350 | 1506 | 372 | 127 | 9390 | 4096 | 0 | 1 | 1061 | 36 | 0 | 29000 | 29330 |
| 2038 | 11029 | 328 | 255 | 1417 | 1581 | 395 | 135 | 9860 | 4301 | 0 | 1 | 1083 | 37 | 0 | 30422 | 30795 |
| 2039 | 11581 | 345 | 268 | 1488 | 1660 | 419 | 143 | 10353 | 4516 | 0 | 1 | 1104 | 38 | 0 | 31915 | 32334 |
| **2040** | **12160** | **362** | **282** | **1562** | **1743** | **444** | **151** | **10870** | **4742** | **0** | **1** | **1126** | **39** | **0** | **33482** | **33951** |
| 2041 | 12768 | 380 | 296 | 1640 | 1830 | 470 | 160 | 11414 | 4979 | 0 | 2 | 1149 | 39 | 0 | 35127 | 35650 |
| 2042 | 13406 | 399 | 310 | 1722 | 1922 | 494 | 168 | 11984 | 5228 | 0 | 2 | 1172 | 40 | 0 | 36848 | 37412 |
| 2043 | 14076 | 419 | 326 | 1809 | 2018 | 518 | 177 | 12584 | 5489 | 0 | 2 | 1195 | 41 | 0 | 38654 | 39263 |
| 2044 | 14780 | 440 | 342 | 1899 | 2119 | 544 | 185 | 13213 | 5764 | 0 | 2 | 1219 | 42 | 0 | 40549 | 41206 |
| **2045** | **15519** | **462** | **359** | **1994** | **2225** | **572** | **195** | **13873** | **6052** | **0** | **2** | **1244** | **43** | **0** | **42539** | **43245** |
| 2046 | 16295 | 485 | 377 | 2094 | 2336 | 600 | 205 | 14567 | 6354 | 0 | 2 | 1268 | 44 | 0 | 44627 | 45386 |
| 2047 | 17110 | 509 | 396 | 2198 | 2453 | 630 | 215 | 15295 | 6672 | 0 | 2 | 1294 | 44 | 0 | 46819 | 47634 |
| 2048 | 17965 | 535 | 416 | 2308 | 2576 | 662 | 225 | 16060 | 7006 | 0 | 2 | 1320 | 45 | 0 | 49120 | 49993 |
| 2049 | 18863 | 562 | 437 | 2424 | 2704 | 695 | 237 | 16863 | 7356 | 0 | 2 | 1346 | 46 | 0 | 51535 | 52470 |
| **2050** | **19807** | **590** | **459** | **2545** | **2840** | **730** | **249** | **17706** | **7724** | **0** | **2** | **1373** | **47** | **0** | **54070** | **55071** |
| 2051 | 20797 | 619 | 482 | 2672 | 2982 | 766 | 261 | 18592 | 8110 | 0 | 2 | 1400 | 48 | 0 | 56730 | 57801 |
| 2052 | 21837 | 650 | 506 | 2806 | 3131 | 804 | 274 | 19521 | 8515 | 0 | 2 | 1428 | 49 | 0 | 59523 | 60667 |
| 2053 | 21848 | 651 | 506 | 2807 | 3132 | 805 | 274 | 19531 | 8520 | 0 | 2 | 1429 | 49 | 0 | 59553 | 60697 |

**Table 4.31 Projected Traffic (PCU) – Section 2 From Km 221+500 to Km 212+300 ( Jirighat -Jiribam)**

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailer | Cycle | Rickshaw | Animal | Volume | PCU |
| **2020** | **2195** | **4** | **13** | **139** | **517** | **134** | **69** | **1940** | **1733** | **1** | **1** | **141** | **1** | **0** | **6888** | **7493** |
| 2021 | 2305 | 4 | 14 | 146 | 542 | 141 | 72 | 2037 | 1819 | 1 | 1 | 144 | 1 | 0 | 7228 | 7866 |
| 2022 | 2420 | 4 | 14 | 154 | 569 | 148 | 76 | 2139 | 1910 | 1 | 1 | 147 | 1 | 0 | 7585 | 8257 |
| 2023 | 2541 | 5 | 15 | 161 | 598 | 156 | 80 | 2246 | 2006 | 1 | 1 | 150 | 1 | 0 | 7960 | 8667 |
| 2024 | 2668 | 5 | 16 | 170 | 628 | 163 | 84 | 2358 | 2106 | 1 | 1 | 153 | 1 | 0 | 8353 | 9098 |
| **2025** | **2802** | **5** | **17** | **178** | **659** | **172** | **88** | **2476** | **2211** | **1** | **1** | **156** | **1** | **0** | **8766** | **9551** |
| 2026 | 2942 | 5 | 18 | 187 | 692 | 180 | 92 | 2599 | 2322 | 1 | 1 | 159 | 1 | 0 | 9200 | 10026 |
| 2027 | 3227 | 6 | 18 | 210 | 727 | 193 | 99 | 2729 | 2438 | 1 | 1 | 162 | 1 | 0 | 9813 | 10703 |
| 2028 | 3540 | 6 | 19 | 236 | 763 | 206 | 105 | 2866 | 2560 | 1 | 1 | 165 | 1 | 0 | 10471 | 11431 |
| 2029 | 3884 | 6 | 20 | 265 | 801 | 221 | 113 | 3009 | 2688 | 2 | 1 | 169 | 1 | 0 | 11180 | 12214 |
| **2030** | **4260** | **7** | **21** | **298** | **841** | **236** | **121** | **3160** | **2822** | **2** | **1** | **172** | **1** | **0** | **11943** | **13057** |
| 2031 | 4674 | 7 | 22 | 335 | 883 | 253 | 129 | 3318 | 2963 | 2 | 1 | 175 | 1 | 0 | 12764 | 13966 |
| 2032 | 5071 | 7 | 24 | 372 | 928 | 269 | 138 | 3484 | 3111 | 2 | 1 | 179 | 1 | 0 | 13586 | 14875 |
| 2033 | 5502 | 8 | 25 | 412 | 974 | 287 | 147 | 3658 | 3267 | 2 | 1 | 182 | 1 | 0 | 14465 | 15847 |
| 2034 | 5970 | 8 | 26 | 457 | 1023 | 305 | 156 | 3841 | 3430 | 2 | 1 | 186 | 1 | 0 | 15406 | 16888 |
| **2035** | **6477** | **8** | **27** | **506** | **1074** | **325** | **166** | **4033** | **3602** | **2** | **1** | **190** | **1** | **0** | **16413** | **18003** |
| 2036 | 7028 | 9 | 29 | 561 | 1127 | 346 | 177 | 4234 | 3782 | 2 | 1 | 194 | 1 | 0 | 17492 | 19197 |
| 2037 | 7379 | 9 | 30 | 589 | 1184 | 367 | 188 | 4446 | 3971 | 2 | 1 | 197 | 1 | 0 | 18366 | 20172 |
| 2038 | 7748 | 10 | 32 | 619 | 1243 | 389 | 199 | 4668 | 4169 | 2 | 1 | 201 | 1 | 0 | 19284 | 21197 |
| 2039 | 8135 | 10 | 33 | 650 | 1305 | 412 | 211 | 4902 | 4378 | 3 | 1 | 205 | 1 | 0 | 20248 | 22274 |
| **2040** | **8542** | **11** | **35** | **682** | **1370** | **437** | **223** | **5147** | **4597** | **3** | **1** | **210** | **1** | **0** | **21260** | **23407** |
| 2041 | 8969 | 11 | 37 | 716 | 1439 | 463 | 237 | 5404 | 4827 | 3 | 2 | 214 | 2 | 0 | 22323 | 24597 |
| 2042 | 9418 | 12 | 38 | 752 | 1511 | 486 | 249 | 5674 | 5068 | 3 | 2 | 218 | 2 | 0 | 23433 | 25823 |
| 2043 | 9889 | 12 | 40 | 790 | 1586 | 511 | 261 | 5958 | 5321 | 3 | 2 | 222 | 2 | 0 | 24598 | 27111 |
| 2044 | 10383 | 13 | 42 | 829 | 1666 | 536 | 274 | 6256 | 5588 | 3 | 2 | 227 | 2 | 0 | 25821 | 28463 |
| **2045** | **10902** | **14** | **44** | **871** | **1749** | **563** | **288** | **6569** | **5867** | **3** | **2** | **231** | **2** | **0** | **27105** | **29883** |
| 2046 | 11447 | 14 | 47 | 914 | 1837 | 591 | 302 | 6897 | 6160 | 4 | 2 | 236 | 2 | 0 | 28453 | 31373 |
| 2047 | 12020 | 15 | 49 | 960 | 1928 | 621 | 317 | 7242 | 6468 | 4 | 2 | 241 | 2 | 0 | 29869 | 32938 |
| 2048 | 12621 | 16 | 52 | 1008 | 2025 | 652 | 333 | 7604 | 6792 | 4 | 2 | 245 | 2 | 0 | 31355 | 34581 |

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailor | Cycle | Rickshaw | Animal | Volume | PCU |
| 2049 | 13252 | 17 | 54 | 1058 | 2126 | 684 | 350 | 7984 | 7131 | 4 | 2 | 250 | 2 | 0 | 32915 | 36307 |
| **2050** | **13914** | **17** | **57** | **1111** | **2232** | **719** | **367** | **8384** | **7488** | **4** | **2** | **255** | **2** | **0** | **34553** | **38118** |
| 2051 | 14610 | 18 | 60 | 1167 | 2344 | 755 | 386 | 8803 | 7862 | 5 | 2 | 261 | 2 | 0 | 36273 | 40020 |
| 2052 | 15341 | 19 | 63 | 1225 | 2461 | 792 | 405 | 9243 | 8255 | 5 | 2 | 266 | 2 | 0 | 38079 | 42017 |
| 2053 | 15348 | 19 | 63 | 1226 | 2462 | 793 | 405 | 9247 | 8259 | 5 | 2 | 266 | 2 | 0 | 38098 | 42038 |

**Table 4.32 Projected Traffic (PCU) – Proposed Green filed alignment ( Silchar -Jiribam)**

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailor | Cycle | Rickshaw | Animal Drawn | Volume | PCU |
| **2020** | **2608** | **8** | **9** | **151** | **522** | **126** | **64** | **936** | **649** | **1** | **1** | **70** | **0** | **0** | **5144** | **6259** |
| 2021 | 2738 | 9 | 9 | 158 | 548 | 132 | 67 | 983 | 681 | 1 | 1 | 72 | 0 | 0 | 5399 | 6571 |
| 2022 | 2875 | 9 | 10 | 166 | 576 | 138 | 70 | 1032 | 715 | 1 | 1 | 73 | 0 | 0 | 5667 | 6899 |
| 2023 | 3019 | 10 | 10 | 174 | 604 | 145 | 74 | 1084 | 751 | 1 | 1 | 74 | 0 | 0 | 5948 | 7242 |
| 2024 | 3170 | 10 | 11 | 183 | 635 | 153 | 77 | 1138 | 789 | 1 | 1 | 76 | 0 | 0 | 6243 | 7603 |
| **2025** | **3328** | **11** | **11** | **192** | **666** | **160** | **81** | **1195** | **828** | **1** | **1** | **77** | **0** | **0** | **6553** | **7982** |
| 2026 | 3495 | 11 | 12 | 202 | 700 | 168 | 85 | 1254 | 869 | 1 | 1 | 79 | 0 | 0 | 6878 | 8380 |
| 2027 | 3834 | 12 | 12 | 227 | 735 | 180 | 91 | 1317 | 913 | 1 | 1 | 81 | 0 | 0 | 7404 | 9002 |
| 2028 | 4205 | 13 | 13 | 255 | 771 | 193 | 98 | 1383 | 959 | 1 | 1 | 82 | 0 | 0 | 7974 | 9676 |
| 2029 | 4613 | 13 | 14 | 287 | 810 | 206 | 105 | 1452 | 1007 | 1 | 1 | 84 | 0 | 0 | 8592 | 10405 |
| **2030** | **5061** | **14** | **14** | **322** | **851** | **221** | **112** | **1525** | **1057** | **1** | **1** | **85** | **0** | **0** | **9264** | **11194** |
| 2031 | 5552 | 15 | 15 | 362 | 893 | 236 | 120 | 1601 | 1110 | 1 | 1 | 87 | 0 | 0 | 9993 | 12049 |
| 2032 | 6024 | 15 | 16 | 402 | 938 | 251 | 127 | 1681 | 1165 | 1 | 1 | 89 | 0 | 0 | 10710 | 12895 |
| 2033 | 6536 | 16 | 17 | 445 | 985 | 268 | 136 | 1765 | 1223 | 1 | 1 | 91 | 0 | 0 | 11483 | 13804 |
| 2034 | 7091 | 17 | 17 | 494 | 1034 | 285 | 145 | 1853 | 1285 | 1 | 1 | 92 | 0 | 0 | 12315 | 14782 |
| **2035** | **7694** | **18** | **18** | **547** | **1086** | **304** | **154** | **1946** | **1349** | **1** | **1** | **94** | **0** | **0** | **13212** | **15834** |
| 2036 | 8348 | 19 | 19 | 606 | 1140 | 323 | 164 | 2043 | 1416 | 2 | 1 | 96 | 0 | 0 | 14178 | 16966 |

| Years | Motorized Vehicles | | | | | | | | | | | Non-Motorized Vehicles | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Car | Mini Bus | Bus | LCV | 2-Axle | 3 Axle | M Axle | 2W | 3W | Tractor | Tractor without Trailor | Cycle | Rickshaw | Animal Drawn | Volume | PCU |
| 2037 | 8765 | 19 | 20 | 637 | 1197 | 343 | 174 | 2145 | 1487 | 2 | 1 | 98 | 0 | 0 | 14889 | 17829 |
| 2038 | 9204 | 20 | 21 | 669 | 1257 | 363 | 184 | 2253 | 1561 | 2 | 1 | 100 | 0 | 0 | 15635 | 18737 |
| 2039 | 9664 | 21 | 22 | 702 | 1320 | 385 | 195 | 2365 | 1640 | 2 | 1 | 102 | 0 | 0 | 16419 | 19692 |
| **2040** | **10147** | **23** | **23** | **737** | **1385** | **408** | **207** | **2483** | **1722** | **2** | **1** | **104** | **0** | **0** | **17243** | **20695** |
| 2041 | 10654 | 24 | 24 | 774 | 1455 | 433 | 219 | 2608 | 1808 | 2 | 1 | 106 | 0 | 0 | 18108 | 21750 |
| 2042 | 11187 | 25 | 26 | 813 | 1528 | 454 | 230 | 2738 | 1898 | 2 | 1 | 108 | 0 | 0 | 19010 | 22836 |
| 2043 | 11746 | 26 | 27 | 853 | 1604 | 477 | 242 | 2875 | 1993 | 2 | 1 | 111 | 0 | 0 | 19958 | 23976 |
| 2044 | 12334 | 27 | 28 | 896 | 1684 | 501 | 254 | 3019 | 2093 | 2 | 1 | 113 | 0 | 0 | 20952 | 25173 |
| **2045** | **12950** | **29** | **30** | **941** | **1768** | **526** | **267** | **3170** | **2197** | **2** | **1** | **115** | **0** | **0** | **21996** | **26430** |
| 2046 | 13598 | 30 | 31 | 988 | 1857 | 552 | 280 | 3328 | 2307 | 3 | 1 | 117 | 1 | 0 | 23093 | 27749 |
| 2047 | 14278 | 32 | 33 | 1037 | 1950 | 580 | 294 | 3494 | 2422 | 3 | 1 | 120 | 1 | 0 | 24244 | 29135 |
| 2048 | 14992 | 33 | 34 | 1089 | 2047 | 609 | 309 | 3669 | 2544 | 3 | 1 | 122 | 1 | 0 | 25452 | 30590 |
| 2049 | 15741 | 35 | 36 | 1144 | 2149 | 639 | 324 | 3853 | 2671 | 3 | 1 | 124 | 1 | 0 | 26721 | 32117 |
| **2050** | **16528** | **37** | **38** | **1201** | **2257** | **671** | **340** | **4045** | **2804** | **3** | **1** | **127** | **1** | **0** | **28053** | **33721** |
| 2051 | 17355 | 39 | 40 | 1261 | 2370 | 705 | 357 | 4247 | 2944 | 3 | 1 | 130 | 1 | 0 | 29452 | 35405 |
| 2052 | 18222 | 40 | 42 | 1324 | 2488 | 740 | 375 | 4460 | 3092 | 3 | 1 | 132 | 1 | 0 | 30921 | 37174 |
| 2053 | 18232 | 40 | 42 | 1324 | 2489 | 740 | 376 | 4462 | 3093 | 3 | 1 | 132 | 1 | 0 | 30936 | 37192 |

## 4.14 Road Capacity Analysis

Capacity and design service volumes for various lane configurations are specified in IRC: 64 – 1990, 'Capacity of Roads in Rural Areas', IRC: SP: 73 – 2018, 'Manual of Specifications and Standards for Two-laning of Highways through Public Private Partnership' and IRC: SP: 84 – 2019, 'Manual of Specifications and Standards for Four-laning of Highways through Public Private Partnership'.

As per table 2.9 of IRC: SP: 84-2019 the design service volume in PCU/Day for a 4-Lane is 40,000, however as per clause no. 6.2 of IRC: 64-1990, for LOC "C", design services volumes can be taken as 40% higher than those for LOS "B".

**Table 4.33 Capacities for different Lane Configurations for Plain Terrain**

| Nature of Terrain | Design Service Volume in PCUs per day | |
|---|---|---|
| | LOS B | LOS C |
| Plain and Rolling | 40,000 | 60,000 |
| Mountainous and Steep | 20,000 | 30,000 |

*As per clause 2.18 table 2.9 of IRC: SP: 84-2019*

As per latest IRC SP: 73-2018, in light of changing socio-economic conditions in the country and in order to ensure safe and comfortable mobility of road users and reduction in road accidents, widening of road and decongestion of traffic is required and accordingly, Ministry has revised the traffic at which the upgradation from two lane to four lane will trigger, as indicated in below table;

**Table 4.34 Design Capacity for upgradation from Two Lane to Four Lane**

| Nature of Terrain | Traffic at which upgradation to four lane will trigger (in PCUs per Day) |
|---|---|
| Plain | 10,000 |
| Rolling | 8,500 |
| Mountainous and Steep | 6,000 |

*As per table 2.8 of IRC: SP: 73-2018*

Based on the above table, as the project road from Silchar to Jiribam is passing through plain terrain the following capacity values has been adopted.

- For 2-Lane Highway capacity (4-Lane requirement) : 10,000 PCU/day
- 4-Lane Highway capacity (6-Lane requirement) : 60,000 PCU/day

**Projected Traffic Levels**

The capacity analysis was done for entire project road with respective homogeneous sections using all 3 scenarios (Most Likely, Optimistic and Pessimistic). The projected traffic volumes for the project road are given in **below table.**

**Table 4.35 Projected sectional traffic (AADT) in PCUs**

| Homogeneous Section | Section-1 Silchar to Jirighat (Km 263+500 to Km 221+500) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 10985 | 10985 | 10985 |
| 2021 | 11521 | 11631 | 11411 |

| Homogeneous Section | Section-1 Silchar to Jirighat (Km 263+500 to Km 221+500) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2022 | 12084 | 12315 | 11855 |
| 2023 | 12675 | 13041 | 12316 |
| 2024 | 13295 | 13809 | 12795 |
| 2025 | 13945 | 14623 | 13293 |
| 2026 | 14628 | 18582 | 15192 |
| 2027 | 15606 | 19892 | 16056 |
| 2028 | 16658 | 21314 | 16978 |
| 2029 | 17792 | 22857 | 17964 |
| 2030 | 19014 | 24534 | 19018 |
| 2031 | 20331 | 26346 | 20146 |
| 2032 | 21649 | 28202 | 21252 |
| 2033 | 23061 | 30206 | 22426 |
| 2034 | 24574 | 32372 | 23673 |
| 2035 | 26196 | 34714 | 25000 |
| 2036 | 27935 | 37197 | 26411 |
| 2037 | 29330 | 39333 | 27465 |
| 2038 | 30795 | 41599 | 28563 |
| 2039 | 32334 | 44001 | 29705 |
| 2040 | 33951 | 46548 | 30893 |
| 2041 | 35650 | 49246 | 32130 |
| 2042 | 37412 | 52082 | 33398 |
| 2043 | 39263 | 55086 | 34716 |
| 2044 | 41206 | 58270 | 36087 |
| 2045 | 43245 | 61644 | 37512 |
| 2046 | 45386 | 65220 | 38994 |
| 2047 | 47634 | 69009 | 40535 |
| 2048 | 49993 | 73025 | 42138 |
| 2049 | 52470 | 77280 | 43805 |
| 2050 | 55071 | 81790 | 45538 |
| 2051 | 57801 | 86569 | 47340 |
| 2052 | 60667 | 91634 | 49214 |
| 2053 | 60697 | 92163 | 49409 |

| Homogeneous Section | Section-2 Jirighat to Jiribam (Km 221+500 to Km 212+300) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 7493 | 7493 | 7493 |
| 2021 | 7866 | 7941 | 7791 |
| 2022 | 8257 | 8415 | 8100 |
| 2023 | 8667 | 8917 | 8422 |

| Homogeneous Section | Section-2 Jirighat to Jiribam (Km 221+500 to Km 212+300) | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2024 | 9098 | 9450 | 8756 |
| 2025 | 9551 | 10014 | 9104 |
| 2026 | 10026 | 10613 | 9466 |
| 2027 | 10703 | 11435 | 10011 |
| 2028 | 11431 | 12327 | 10592 |
| 2029 | 12214 | 13295 | 11212 |
| 2030 | 13057 | 14346 | 11874 |
| 2031 | 13966 | 15488 | 12582 |
| 2032 | 14875 | 16650 | 13275 |
| 2033 | 15847 | 17904 | 14010 |
| 2034 | 16888 | 19259 | 14791 |
| 2035 | 18003 | 20723 | 15619 |
| 2036 | 19197 | 22304 | 16500 |
| 2037 | 20172 | 23660 | 17173 |
| 2038 | 21197 | 25098 | 17874 |
| 2039 | 22274 | 26625 | 18603 |
| 2040 | 23407 | 28245 | 19363 |
| 2041 | 24597 | 29963 | 20154 |
| 2042 | 25823 | 31757 | 20958 |
| 2043 | 27111 | 33658 | 21793 |
| 2044 | 28463 | 35673 | 22662 |
| 2045 | 29883 | 37809 | 23566 |
| 2046 | 31373 | 40073 | 24505 |
| 2047 | 32938 | 42472 | 25483 |
| 2048 | 34581 | 45016 | 26499 |
| 2049 | 36307 | 47712 | 27556 |
| 2050 | 38118 | 50569 | 28656 |
| 2051 | 40020 | 53598 | 29799 |
| 2052 | 42017 | 56808 | 30988 |
| 2053 | 42038 | 56842 | 31000 |

| Homogeneous Section | Traffic on Proposed Green filed alignment | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2020 | 6259 | 6259 | 6259 |
| 2021 | 6571 | 6634 | 6509 |
| 2022 | 6899 | 7031 | 6768 |
| 2023 | 7242 | 7451 | 7037 |
| 2024 | 7603 | 7897 | 7318 |
| 2025 | 7982 | 8370 | 7609 |
| 2026 | 8380 | 8871 | 7913 |
| 2027 | 9002 | 9618 | 8421 |
| 2028 | 9676 | 10433 | 8967 |
| 2029 | 10405 | 11324 | 9552 |

| Homogeneous Section | Traffic on Proposed Green filed alignment | | |
|---|---|---|---|
| | Most Likely | Optimistic | Pessimistic |
| 2030 | 11194 | 12296 | 10182 |
| 2031 | 12049 | 13358 | 10858 |
| 2032 | 12895 | 14429 | 11512 |
| 2033 | 13804 | 15591 | 12209 |
| 2034 | 14782 | 16850 | 12952 |
| 2035 | 15834 | 18217 | 13744 |
| 2036 | 16966 | 19701 | 14589 |
| 2037 | 17829 | 20901 | 15186 |
| 2038 | 18737 | 22174 | 15808 |
| 2039 | 19692 | 23526 | 16455 |
| 2040 | 20695 | 24960 | 17129 |
| 2041 | 21750 | 26481 | 17831 |
| 2042 | 22836 | 28068 | 18543 |
| 2043 | 23976 | 29750 | 19283 |
| 2044 | 25173 | 31533 | 20053 |
| 2045 | 26430 | 33423 | 20854 |
| 2046 | 27749 | 35426 | 21686 |
| 2047 | 29135 | 37549 | 22552 |
| 2048 | 30590 | 39799 | 23453 |
| 2049 | 32117 | 42185 | 24390 |
| 2050 | 33721 | 44713 | 25364 |
| 2051 | 35405 | 47393 | 26377 |
| 2052 | 37174 | 50234 | 27430 |
| 2053 | 37192 | 50264 | 27441 |

### Capacity Augmentation Proposals (Lane Requirement)

Projected AADT was compared with design service volume. The design service volume for project road is considered as per **IRC SP: 73-2018** and **IRC SP: 84-2019** for Plain terrain.

**Table 4.36 Capacity Augmentation**

| Sl. No | Section | Scenario | 2 Lane with Paved Shoulder (Warranting for 4-Lane) | 4 Lane divided Carriageway (Warranting for 6-Lane) |
|---|---|---|---|---|
| 1 | Section – 01 (From Km 263+500 to Km 221+500) | Most Likely Scenario | 2020 | 2052 |
| | | Optimistic Scenario | 2020 | 2047 |
| | | Pessimistic Scenario | 2020 | ➢ 2053 |
| 2 | Section – 02 (From Km 263+500 to Km 212+500) | Most Likely Scenario | 2026 | ➢ 2053 |
| | | Optimistic Scenario | 2025 | ➢ 2053 |
| | | Pessimistic Scenario | 2027 | ➢ 2053 |

| Sl. No | Section | Scenario | 2 Lane with Paved Shoulder (Warranting for 4-Lane) | 4 Lane divided Carriageway (Warranting for 6-Lane) |
|---|---|---|---|---|
| 3 | Proposed Green filed alignment | Most Likely Scenario | 2029 | ➢ 2053 |
| | | Optimistic Scenario | 2028 | ➢ 2053 |
| | | Pessimistic Scenario | 2030 | ➢ 2053 |

## 4.15 Recommendations:

The Capacity analysis shows that considerable amount of traffic plying on this road (in terms of PCUs per day). This is mainly because the project road is largely being utilized by commercial vehicles which carry essential domestic products, cement, stone, and other construction material from Silchar to Imphal and other part of Manipur State. This road also caters for the passenger vehicles, commercial vehicle that are coming from NH-306 and NH-27. Same has been observed during the traffic surveys also.

The Section between Silchar to Jiribam via Kashipur, Banskandi, Uzan Tarapur, Pailapool, Fulerthal, Jirighat and Jiribam is the part of Silchar-Imphal road, which observes more commercial vehicle that are coming from Shillong, Karimganj, Dawki, Silchar and Guwahati.

This project road is essential to provide connectivity for the traffic between NH-27, NH-37 and NH-306. Development of this road will help in social and economic growth region surrounding this corridor.

**Four lane Divided carriageway** is recommended for the section 01 from Km 263+500 to Km 221+500 as the design capacity of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2020, which is the current year.

**Four lane Divided carriageway** is recommended for the section 02 from Km 221+500 to Km 212+300 as the design capacity of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2026, which is after 2 years of construction of road.

The existing project road from Silchar to Jiribam is passing through many built up locations such as Kashipur, Banskandi, Uzan Tarapur, Pailapool, Fulertal & Jiribam and having a substandard road geometric with $90^0$ curves. Improving the existing road will lead to demolition of buildings and considering other factors a green filed alignment has been proposed from Silchar to Jirbam, which will bypass all the built up locations.

The from the traffic projection it is found that for Green filed alignment 4-Lane divided carriage will be required in the year 2029 i.e. after 4years from the construction of the road. Hence 4-lane divided carriageway is recommended for green filed alignment.

5

# Chapter 5 – Design Standards

## Table of Content

**List of Tables**

# 5 Chapter 5 – Design Standards

## 5.1 General

The formulation of the design standards is required in order to avoid any inconsistency in design from one section to the other and provide desired level of service and safety. This section describes the standards and principles based on which the various designs will be carried out. These proposed standards are consistent with and fall within the parameters recommended in the related standards of the Indian Roads Congress (IRC). The basic design philosophy is based on the consideration of providing suitable alignment, cross-sectional layout and geometrics to cater to the safe and uninterrupted movement of traffic. All designs will need to recognize the need for maintaining the traffic flow through restricted corridors. A rigid adherence to a particular design standard would necessitate substantial realignments, which in turn would need substantial land acquisition, environmental impacts and social hardships to the population. The consultants propose adhering to the IRC standards in that context to suit prevailing conditions.

It is proposed to follow Design Standards given in IRC: SP: 84-2019 "Manual of Specifications and Standards for 4-Laning of Highways (*Second Revision*)", and shall be used as main guidelines along with other relevant IRC codes, guidelines and special publications, and MoRT&H circulars as applicable to National Highways. Suitable modifications / additions have been incorporated to suit local conditions and study requirements. The objective of the exercise has been to have an optimal utilisation of funds without sacrificing technical requirements.

The various geometric design elements and factors, which govern the functioning of any highway, can be broadly grouped under the following:

- Terrain
- Design Speed
- Cross-sectional layout
- Geometric Design, Alignment and Profile
- Pavement
- Cross Drainage Works and Structures
- Junctions and intersections

The present project and the objectives for designing 4-Lane with or without service road facility at essential sections/locations for the project road are:

- Segregation of fast moving and slow-moving traffic.
- Segregation of through traffic from local traffic
- Mobility and safety of NH users and cross traffic
- Avoiding or limiting traffic disruption during construction activity
- Facilities for pedestrians to travel along and across the NH sections

## 5.2 Items detailed for design standards

The basic design philosophy is based on the consideration of providing suitable alignment, cross-sectional layout, geometrics and safety to cater to the fast and uninterrupted movement of through traffic. The design standards of all the elements of a highway corridor can be grouped into the following categories as given below;

**Table 5.1 Categorization of elements for design standards**

| Category | Design element |
|---|---|
| Design Capacity | Design service volume standards<br>Design capacity standards |
| Geometric Design | Cross-sectional elements<br>Sight distance<br>Horizontal curves<br>Vertical curves |
| Pavement Design | CBR, Traffic, Structural Strength (Deflection value) |
| Cross Drainage Structures | Bridges<br>Culverts |
| Intersections | At grade intersections<br>Acceleration and deceleration lanes |
| Drainage system | Longitudinal, Cross drainage |
| Safety Measures | Guard rails & safety barriers<br>Traffic signals<br>Road signage & pavement markings<br>Footpaths and sidewalks |
| Protection Works | Breast Walls<br>Retaining Walls<br>And other measures |

## 5.3 Design Capacity standards

The prevailing roadway and traffic conditions that influence the traffic flow in a particular segment would include the geometric features, lane width, and lateral clearances on edges of carriageway, percentage composition of various traffic category and driver characteristics. Restricted lane width and lateral clearance influence the traffic flow, as the vehicles would be forced to travel closer and shy away from the roadside objects resulting in reduced speed. The horizontal and vertical profiles of the highway would be designed adequately to meet the design speed requirements.

The proposal for widening of any road depends on the capacity analysis. Capacity analysis is a fundamental aspect of planning, design and operation of roads, and provides, among other things, the basis for determining the carriageway width to be provided with respect to the volume and composition of traffic. An analysis for project road section has been carried out to define the level of service (LOS) of the road under prevailing roadway and traffic conditions.

Capacity and design service volumes specified in IRC:SP:84-2019 along with recommendation for level of service (LOS) mentioned in IRC: 64:-1990 "Capacity of Roads in Rural Areas " has been adopted for determining the Level of Service offered by the road sections during design period.

As per table 2.9 of IRC: SP: 84-2019 the design service volume in PCU/Day for a 4-Lane is 40,000, however as per clause no. 6.2 of IRC: 64-1990, for LOC "C", design services volumes can be taken as 40% higher than those for LOS "B".

**Table 5.2 Design Service Volume of Four-Lane Highway**

| Nature of Terrain | Design Service Volume in PCUs per day | |
|---|---|---|
| | LOS B | LOS C |
| Plain and Rolling | 40,000 | 60,000 |
| Mountainous and Steep | 20,000 | 30,000 |

*As per clause 2.18 table 2.9 of IRC: SP: 84-2019*

However as per latest IRC SP: 73-2018, in light of changing socio-economic conditions in the country and in order to ensure safe and comfortable mobility of road users and reduction in road accidents, widening of road and decongestion of traffic is required and accordingly, Ministry has revised the traffic at which the upgradation from two lane to four lane will trigger, as indicated in below table;

**Table 5.3 Design Service Volume of Two-Lane Highway**

| Nature of Terrain | Design Service Volume in PCUs per day |
|---|---|
| Plain | 10,000 |
| Rolling | 8,500 |
| Mountainous and Steep | 6,000 |

*As per table 2.8 of IRC: SP: 73-2018*

Hence the design service volume adopted for capacity analysis of the project road for different LOC has been taken as follows.

- For 2-Lane Highway capacity (4-Lane requirement) : 10,000 PCU/day
- For 4-Lane Highway capacity (6-Lane requirement) : 60,000 PCU/day

## 5.4 Geometric Design Standards

Design standards for the highways call for an in-depth study of available and internationally adopted criteria for economy and safety. The consultants initiated the study in this direction and the broad criteria emerging out of them and proposed for the project road are given in this section. The relevant standards consulted include:

- IRC: 5-2015 : Standard Specifications and Code of Practice for Road Bridges, Section I – General Features of Design (Eighth Revision)
- IRC: 6-2017 : Standard Specifications and Code of Practice for Road Bridges, Section-II Loads and Stresses (Revised Edition)
- IRC: 22-2015 : Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design) (Third Revision)
- IRC: 24-2010 : Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method) (Third Revision)
- IRC: 28-1967 : Construction of Soil Stabilised Roads with Soft Aggregates in Moderate & High Rainfall Areas
- IRC: 36-2010 : Earthen Embankments
- IRC: 37-2018 : Tentative Guidelines for the design of Flexible Pavements
- IRC: 54-1974 : Lateral and Vertical Clearance at Underpasses
- IRC: 58-2015 : Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Fourth Revision)
- IRC: 62-1976 : Control of Access on Highway
- IRC: 64-1990 : Capacity of Roads in Rural Areas
- IRC: 65-2017 : Traffic Rotaries
- IRC: 66-1976 : Sight Distance on Rural Highways
- IRC: 73-1980 : Geometric Design Standards for Rural Highways
- IRC: 75-2015 : Design of High Embankment
- IRC: 78-2014 : Standard Specifications and Code of Practice for Road Bridges, Section VII- Foundations and Substructures (Revised Edition)
- IRC: 80-1981 : Type Designs for Pick-up Bus Stops on Rural Highways
- IRC: 81-1997 : Strengthening of Flexible Road Pavements
- IRC: 83-2015 (Part I) : Metallic Bearings
- IRC: 83-2018 (Part II) : Elastomeric Bearings
- IRC: 108-2015 : Guidelines for Traffic Forecast on Highways (First Revision)

- IRC: 112-2011 : Code of Practice for Concrete Road Bridges
- IRC: SP:13-2004 : Guidelines for the Design of Small Bridges and Culverts (First Revision)
- IRC: SP: 19-2001 : Survey, Investigation and Preparation of Road Projects
- IRC: SP: 23-1983 : Vertical Curves for Highways
- IRC: SP:30-2009 : Manual on Economic Evaluation of Highway Projects in India (Second Revision)
- IRC: SP:42-2014 : Guidelines on Road Drainage (First Revision)
- IRC: SP: 44-1996 : Highway Safety Code
- IRC: SP:48-1998 : Hill Road Manual
- IRC: SP: 59-2019 : Guild lines for use of Geosynthetics in Road pavements and associates works.
- IRC:SP:73-2018 : Manual of Specifications and Standards for Two laning of Highways with Paved Shoulders (First Revision)
- IRC: SP:83-2018 : Standard Specifications and Code of Practice for Road Bridges, Section IX Bearings
- IRC:SP:84-2019 : Manual of Specifications and Standards for Four laning of Highways through public private partnership
- IRC: SP:93-2017 : Guidelines on Requirements for Environmental Clearance for Road Projects
- MoRT&H : Specifications for Road and Bridge Works, 2013 (Fifth Revision)
- MoRT&H : Standard Data Book for Analysis of Rates, 2003 (First Revision)
- AASHTO : A Policy on Geometric Design of Highways and Streets, 2004 and Guide for Design of Pavement Structure, 1993.

## 5.5 Conceptualization of Partially Access Controlled Highway

As the project road is of 4-Lane configuration and accesses the existing alignment barring realignment stretches. The proposed scheme presents the 4-Lane in such a way that the project highway will be operated as a partially controlled access highway so as to improve the safety and operational efficiency of the highway. The partial control on access for the project highway shall be achieved through measures such as provision of 4-Lane carriageway at habitations, properly designed intersections, acceleration/deceleration lanes, vehicular and pedestrian underpasses, median openings etc. The service roads will be provided based on the intensity of local traffic and available ROW.

## 5.6 Terrain

The following **Table 5.2** gives the terrain classification adopted for the project road as per IRC 73-1980.

**Table 5.2 Terrain classification**

| Sl. No. | Terrain Classification | Per cent of Cross-slope of the Country |
|---|---|---|
| i | Plain | < 10 |
| ii | Rolling | 10 – 25 |
| iii | Mountainous | 25 – 60 |
| iv | Steep | > 60 |

As per the above classification, the project road traverses through plain/rolling terrain at most of the places expect majorly from Km 23+000 to Km 27+500 and few small stretches, where proposed alignment traverses through mountainous terrain and Tunnel is proposed. Thus, design standards for design of alignment in Plain/Rolling terrain are followed in the design of the project road.

## 5.7 Design Speed

The ruling design speed is the guiding criteria for correlating features such as sight distance, curvature and super elevation upon which the safe operation of the vehicle depends. Minimum design speed, however, be adopted in sections where site conditions do not permit adoption of ruling design speed. As per table 2.1 of IRC: SP: 84-2019 and IRC: SP: 73-2018 the design speeds for terrain have been proposed as given in **Table 5.3** under:

**Table 5.3 Design Speed (Km/h)**

| Plain and Rolling Terrain | | Mountainous Terrain | |
|---|---|---|---|
| Up to 25% cross slope of the ground | | More than 25% cross slope of the ground | |
| **Ruling** | **Minimum** | **Ruling** | **Minimum** |
| 100 | 80 | 60 | 40 |

In general, ruling design speed will be adopted for the various geometric design features of the road. Minimum design speed, however, be adopted in sections where, terrain conditions do not permit adoption of ruling design speed.

## 5.8 Cross - Sectional Elements

### 5.8.1 Right of Way (ROW)

Right of way width is important from the planning and construction point of view. IRC guidelines clearly specify the requirements of land widths for different terrain conditions are as given below;

**Table 5.4 Desirable Road Land widths**

| Type of Road | Terrain | Open areas | | Built up area | |
|---|---|---|---|---|---|
| | | Normal | Exceptional | Normal | Exceptional |
| 2-Lane | Plain/Rolling | 45 | 30 | 30 | 30 |
| 4-Lane | Plain/Rolling | 60 | - | 60 | - |

In present case, the project requirement is to provide 4-lane carriageway configurations. 4-Lane carriageway would be designed and accommodated with a Row of 60m. The proposed improvement would need minimal height/depth of construction of banks/cuts on the terrain. However, additional LA required as the case may be, has also been considered where high cut/fill required due to introduction of ROBs/Grade separator OR nature of terrain.

As per clause no. 2.3 of IRC: SP: 84-2019, 4- Laning shall be accommodated if possible, within the existing ROW. However additional land, if required for accommodating the 4- laning cross sections, improvement of geometrics, realignment, junctions, bypasses etc., shall be acquired. For bypasses and new alignment a minimum right of way (ROW) width of 60m is desirable. At high banks, the land width would be suitably increased.

As per table 3 of IRC:73-1980, in mountainous and steep terrains minimum right-of-way (ROW) width shall be 24m and 20m at open areas and built-up areas respectively. As per section 6.1.2 of IRC: 73-1980, in high banks and deep cuts the RoW shall be suitably increased.

As per TOR clause no 3.1.3 where it becomes absolutely unavoidable and necessary to keep the alignment through such reserve forest / restricted areas, would be acquired with Row of not more than 30m.

In line with the above clause, the proposed ROW has been worked out on the basis of actual requirement in order to accommodate the proposed 4-lane road along with cut/fill slopes keeping 30m as minimum RoW at open areas and 24m at built-up areas.

### 5.8.2 Traffic Lanes, Carriageway Width & Shoulders (Cross Section)

The highway is proposed 4-Lane with service road at selected sections of the project road. The Consultants have studied various alternatives provided/proposed in similar projects, appropriate design standards satisfying the terrain and traffic scenario. Accordingly, the consultants are of the opinion that the minimum effective roadway width for the project road derived and recommended is as given below;

**Table 5.5 Design Standards of Cross-sectional elements**

| **Four-lane road (Built-up area)** | |
|---|---|
| Paved Carriageway | 2 x 7.0 m = 14.00m |
| Paved Shoulders | 2 x 2.5m = 5.00m |
| Kerb shyness | 4 x 0.50m = 2.00m |
| Median | 1 x 2.50m = 2.50m |
| Separator | 2 x 1.75 = 3.5m |
| Service Road | 2 x 7.00 = 14.0m |
| Drain cum Footpath | 2 x 1.50 = 3.0 m |
| Space for Service | 2 x 2.00 = 4.0m |
| Total Roadway Width | 48.00 m |

| **Four-lane road (Rural area)** | | |
|---|---|---|
| Paved Carriageway | | 2 x 7.0 m = 14.0m |
| Shoulders | Paved | 2 x 2.5m = 5.0m |
| | Unpaved | 2 x 1.5m = 3.0m |
| Kerb shyness | | 2 x 0.50m = 1.00m |
| Median | | 4.00 m |
| **Total Roadway Width** | | **27.00 m** |
| In case of Service Road/Slip Road provision with soft shoulder | | 2 x 9.00 = 18.0m |
| **Total Roadway Width with Service Road** | | **45.00 m + cut/fill slope width** |

### 5.8.3 Camber/Cross Fall

The values of camber proposed to be applied on straight (i.e. without super-elevation) sections of Main Carriageway; Paved Shoulder & Service Road would be 2.5% and 2.0% for bituminous and cement concrete surfaces respectively and 3.0% for Earthen Shoulders.

Where the project road is passing through hilly terrain, coupled with continuous gradients and high intensity of rainfall calls for effective drainage of roads. Uncontrolled water is the primary cause of problems like erosion of valley side slopes, potholes, rutting, washed out shoulders, and even failure of complete sections of roadway structures. Hence the camber of road is proposed to be uni-directional, completely sloping towards hillside, so that water flows into longitudinal drains on hill side and then to culverts. However, on horizontal curves camber/superelevation shall be provided as per the direction of curve.

The camber of shoulders on straight portions shall be at least 0.5 percent steeper than the slope of pavement subject to a minimum of 3.0 percent. On super elevated sections, the shoulders shall have the same cross fall as the carriageway

### 5.8.4 Service Roads

Service roads are proposed for the urban/ built-up areas for effective segregation of traffic and to enforce access control measures. Suitable width of 5.5m / 7.0m is proposed for Carriageway.

### 5.8.5 Median Width

A median width of 1.5m / 4.0m raised is proposed to be adopted in plain and rolling terrain. At bridge locations, median is varying from 1.5m to 5.0m.

## 5.9 Horizontal Alignment

The horizontal alignment for this project will be designed in accordance with the requirements stipulated in IRC: 73-1980. Horizontal alignment essentially comprises three major elements: 1) tangent section, 2) circular curve and 3) transition curve. A balanced control on the above elements is required to provide safe and continuous flow of vehicles under general traffic conditions

The design parameters governing the curve elements are given in following sections

### 5.9.1 Horizontal Curve

Horizontal alignment essentially comprises three major elements: tangent section, circular curve and transition curve. A balanced control on the above elements is required to provide safe and continuous flow of vehicles under general traffic conditions.

The minimum radius of horizontal curves is calculated from the following formula:

$R = V^2 / 127 (e + f)$

Where,

V = vehicle speed in Kmph

e = Super elevation in metre per metre

f = coefficient of friction between vehicle tyre and pavement (taken as 0.15)

R = radius in metres

Based on this equation and the maximum permissible value of super-elevation of 5% and 7%, radii for horizontal curves corresponding to ruling and minimum design speeds will be as per **Table 5.6** given below:

**Table 5.6 Minimum Radii of Horizontal Curves: IRC: SP: 84-2019**

| Nature of Terrain | Desirable Minimum Radius (m) | Absolute Minimum Radius (m) |
|---|---|---|
| Plain and Rolling | 400 | 250 |
| Mountainous & Steep | 150 | 75 |

### 5.9.2 Super-elevation

On a straight length of road, transverse drainage shall be accomplished by the use of cross fall at a standard rate of 2.5%. The surface of pavement shall fall towards hill side edge on mountainous terrain.

On horizontal curves superelevation is provided to counter the effects of centrifugal force and is calculated from the following equation:

$e = V^2 / 225R$,

Where,

e = super elevation in metre per metre

V = Speed in Kmph and

R = Radius in metres

Super elevation shall be limited to 7%, if radius of curve is less than the desirable minimum. It shall be limited to 5%, if the radius is more than desirable minimum and also at section where project highway passes through an urban section or falls on a major junction.

*Superelevation run-off:*

Super elevation transition will be attained gradually over the length of transition so that the design super elevation is attained fully at the point of the circular portion. In developing the required superelevation, the pavement edge is to be rotated such that, the longitudinal slope of the pavement edge compared to the centreline (i.e. the rate of change of superelevation) is not steeper than 1 in 150 for roads in plain and rolling terrain, and 1 in 60 in mountainous and steep terrain.

### 5.9.3 Curves without Super Elevation

When the value of super elevation obtained from the parameters stated above is less than the road camber, the normal cambered sections are continued on the curve portion, without providing any super elevation. Radius requiring no super-elevation has been recommended considering camber 2.5%. **Table 5.7** given below indicates the radius of horizontal curves for different rates of camber beyond which super elevation will not be required.

**Table 5.7 Radius beyond which super elevation is not required**

| Design Speed (Kmph) | Radius (m) |
|---|---|
| 100 | 1800 |
| 80 | 1100 |
| 65 | 750 |

### 5.9.4 Transition Curves

Transition curves are necessary for vehicle to progress smoothly from a straight section into a circular curve or between curves of different radius. The transition curve also facilitates a gradual application of the super elevation and any widening of the carriageway that may be required for the horizontal curves.

The minimum length of the transition curve is determined from the following three considerations:

a) Ls = $0.0215V^3/CR$
b) Ls = $2.7\ V^2/R$ (for plain & rolling terrain) and
$1.0V^2/R$ (for mountainous and steep terrain)
c) Ls = e x w x 60 considering rate of change of SE

Where:

Ls = length of transition in meters
V = speed in Km/h
R = radius of circular curve in meters
C = 80/(75+V) (*subject to a maximum of 0.8 and min. of 0.5*)
e = Super elevation

The rate of change of super elevation should not be steeper than 1 in 150 for design in plain and rolling terrain, and 1 in 60 in mountainous and steep terrain.

Transition curves shall not be required if the radius of horizontal curves is greater than the values indicated in below table:

**Table 5.8 Curve Radius (m) Not Requiring Transition**

| Design Speed (Kmph) | 100 | 80 | 65 | 50 | 40 |
|---|---|---|---|---|---|
| Radius (m) | 2000 | 1200 | 800 | 500 | 300 |

### 5.9.5 Sight Distance

Visibility is an important requirement for safety on roads. For this, it is necessary that sight distance of sufficient length is available to permit drivers enough time and distance to control their vehicles so that chances of accidents are minimized.

The recommended sight distances for various speeds are given below:

**Table 5.9 Sight Distance**

| Design Speed (Kmph) | Intermediate Sight Distance (m) | Stopping Sight Distance (m) |
|---|---|---|
| 100 | 360 | 180 |
| 80 | 260 | 130 |
| 60 | 180 | 90 |
| 40 | 90 | 45 |

***Criteria for design of geometric elements:***

Desirable – Intermediate Sight Distance
Minimum – Stopping Sight Distance

Where horizontal and summit vertical curves overlap, the design should provide for the required sight distance both in vertical direction, along the pavement and in horizontal direction on the inside of the curve.

### 5.9.6 Extra widening on curves

The rear wheels of vehicles do not exactly follow the track of front wheels, and therefore it is necessary to widen the pavement on low radius curves. The width of extra widening at different radii is given below:

**Table 5.10 Width of Extra Widening on Horizontal Curves (m)**

| Radius of Curve | Extra Width |
|---|---|
| < 75 m | 1.2 m |
| 75 – 100 m | 0.9 m |
| 101 – 300 m | 0.6 m |

As per section 9.6.5 of IRC 73, Widening is applied on inside of curve for 2-lane road and on outer carriageway edge for 4-lane road and is transitioned in entire length of transition curve.

### 5.9.7 Vertical Alignment

Vertical alignment essentially comprises two major elements: longitudinal gradient and vertical curve. A balanced control on the above elements is required to provide safe and continuous flow of vehicles under general traffic conditions. The design parameters governing the curve elements are given in following sections.

### Gradients

The selection of suitable maximum gradient is dependent on vehicle characteristics, particularly those of trucks. Recommended gradients for different classes of terrain as per IRC: SP: 84-2019 are given below:

**Table 5.9 - Recommended Gradients for different terrain conditions**

| Sl. No. | Terrain | Ruling Gradient | Limiting Gradient |
|---|---|---|---|
| 1 | Plain or Rolling | 2.5 % | 3.3 % |
| 2 | Mountainous | 5.0 % | 6.0 % |
| 3 | Steep | 6.0 % | 7.0 % |

It is not envisaged that there will be any major changes to the existing vertical alignment except at locations for proposed bridges / ROBs or other major structures and at locations to be raised to alleviate flooding. However, wherever this becomes necessary the following criteria will apply.

The following gradients shall be adopted in Plain/ Rolling Terrain:

- Ruling gradient at approaches of Underpass : 2.5 per cent (1 in 40)
- Limiting gradient at approaches of Underpass : 3.3 per cent (1 in 30)

The "Limiting Gradient" is adopted only where the adoption of gentle gradient would result in excessive cost or other limiting factor like underpasses and intersections necessitating a change in gradient.

The cumulative rise/fall in elevation over 2 Km length shall not exceed l00 in mountainous terrain and 120 m in steep terrain.

### Grade Compensation at horizontal curves

At horizontal curves, the gradients would be eased by an amount known as the 'grade compensation', which is intended to offset the extra tractive effort involved at curves. This is calculated from the following formula:

Grade Compensation (per cent) = $(30 + R) / R$

Subjected to a maximum of 75/R, Where, R = Radius of the curve in meters; Grade compensation is not necessary for gradients flatter than 4 percent.

### Vertical Curves

Parabolic vertical curves shall be provided at all changes in grade except where the change is 0.5% or less. The minimum length of vertical curve for the ruling design speed of 100 Kmph shall be 60m.

**A. Summit Curves**

Summit curves are designed for choice of sight distance.

(i) For safe stopping sight distance the length of summit curve shall be calculated from the following formula:

When the length of curve (L) exceeds the required sight distance (S) i.e. L > S,

$L = NS^2 / 4.4$

Where,

N = Deviation angle

L = Length of parabolic vertical curve

S = Sight distance in metres.

When the length of curve (L) is less than the required sight distance (S) i.e. L < S,

$L = 2S – 4.4 / N$

(ii) For intermediate or overtaking sight distance the length of summit curve shall be calculated from the following formula:

When the length of curve (L) exceeds the required sight distance (S) i.e. L > S,

$L = NS^2 / 9.6$

Where,

N = Deviation angle

L = Length of parabolic vertical curve

S = Sight distance in metres.

When the length of curve (L) is less than the required sight distance (S) i.e. L < S,

$L = 2S – 9.6 / N$

**B. Valley Curves**

Valley curves are designed for head light sight distance. The length of valley curves shall be calculated by the following two criteria:

(i) When the length of curve (L) exceeds the required sight distance (S), i.e. L > S,

$L = NS^2 / (1.50 + 0.035S)$

(ii) When the length of curve (L) is less than the required sight distance (S), i.e. L < S,

$L = 2S- [(1.50 + 0.035S)/N]$

Where,

N = Deviation angle

L = Length of parabolic vertical curve

S = Sight distance in metres.

### C. "K" Value

Vertical curves will be designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values will be adopted wherever this is economically feasible. Valley curves will be designed for headlight sight distance. The 'K' values for design control and the minimum length of vertical curves will be as follows.

**Table 5.11 "K" Value of Summit and Valley Curve**

| Terrain | 'K' value for summit curves | | 'K' value for valley curves | | Minimum length of curve (m) |
|---|---|---|---|---|---|
| | Desirable | Minimum | Desirable | Minimum | |
| Rolling | 38 | 18 | 28 | 18 | 60 |
| Mountainous/ Steep | 9 | 5 | 10 | 7 | 30 |

## 5.10 Speed Changing Lanes

### Acceleration lanes

Acceleration lanes are provided so that slow moving traffic on service road can join the nearside lane of the main CW at approximately the same speed as that of nearside lane of road. Recommended lengths of the acceleration lane can be referred to table 4.8 of IRC: SP: 41 – 1994, Guidelines for the design of at – grade intersection in rural and urban areas. Below table shows the length of acceleration lanes depending on the speed of service lane and Inner side lane of main highway.

**Table 5.12 Minimum Acceleration Lane Lengths**

| Highway | | Acceleration Length (m) for entrance curve design speed (Kmph) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Stop condition | 25 | 30 | 40 | 50 | 60 | 65 | 75 | 80 |
| Design Speed (Kmph) | Speed Reached (Kmph) | And initial speed (Kmph) | | | | | | | | |
| | | 0 | 20 | 30 | 35 | 40 | 50 | 60 | 65 | 70 |
| 80 | 60 | 230 | 210 | 190 | 180 | 150 | 100 | 50 | - | - |
| 100 | 75 | 360 | 340 | 330 | 300 | 280 | 240 | 160 | 120 | 50 |

As the target design speed of road is expected to reach 100 Kmph after the provision of partially access controlled 2 laning and design speed of service road is expected to be 60 Kmph, so the acceleration lane length of 150m followed by 1:15 taper and 60m nose length is recommended for safe operation of acceleration lane. Width of Acceleration lane is 5.5m minimum.

**Deceleration lane**

Deceleration lanes are provided are provided for the fast moving vehicles to take diversion from main road to service road. The deceleration lane is also provided where fast moving traffic intends to enter into U turn configuration. Recommended lengths of the deceleration lane can be referred to table 4.9 of IRC: SP: 41 – 1994, Guidelines for the design of at – grade intersection in rural and urban areas. Below table shows the length of deceleration lanes.

**Table 5.13 Minimum Deceleration Lane Lengths**

| Highway | | Acceleration Length (m) for entrance curve design speed (kmph) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Stop condition | 25 | 30 | 40 | 50 | 60 | 65 | 75 | 80 |
| Design Speed (kmph) | Speed Reached (kmph) | Initial speed (kmph) | | | | | | | | |
| | | 0 | 20 | 30 | 35 | 40 | 50 | 60 | 65 | 70 |
| 80 | 70 | 130 | 120 | 120 | 110 | 100 | 90 | 70 | 50 | - |
| 100 | 85 | 160 | 150 | 150 | 140 | 130 | 125 | 100 | 90 | 70 |

The length of deceleration lane should be sufficient for vehicles to slow down from the average speed of traffic in the near side lane to the speed necessary for negotiating the curve at the end of it. The curve radius must permit a speed of at least 40-60 Kmph but not less than 40m.

## 5.11 Vertical Clearance

The vertical clearances as per the IRC: 54 – 1974 and Manual of Specifications and Standards for two laning shall be adopted, as applicable:

- **Vertical clearance at underpasses**

Two types of underpasses are proposed as per the requirement of vertical clearances.

- **Vertical clearance for power/ telecommunication lines**

| | | |
|---|---|---|
| Lines carrying low voltage up to 110V | - | 5.5 m |
| Electric power lines up to 650V | - | 6.0 m |
| Electric power lines > 650V | - | 6.5 m |

Lateral and Vertical Clearances per IRC: SP: 84-2019

Vertical and Horizontal clearances at underpasses shall not be less that hr values give below;

| Sl. No. | Types of Underpass | Vertical Clearance | Horizontal Clearance |
|---|---|---|---|
| 1 | Vehicular Underpass (VUP) | 5.5 m | 20.0 m |
| 2 | Light Vehicular Underpass (VUP) | 4.0 m | 12.0 m |
| 3 | Smaller Vehicular Underpass (VUP) | 4.0 m | 7.0 m |

Wherever existing slab/box culverts and bridges allow a vertical clearance of more than 2 m, these can be used in dry season for pedestrian and cattle crossing by providing necessary flooring. However, these will not be a substitute for normal requirements of LVUP/SVUP.

In case of VUP/LVUP/SVUP, the proposed structure base shall be kept 150 mm above the ground level to ensure that these VUPs don't become water accumulation points.

Guard rails/crash barriers shall be provided for protection of vehicles from colliding with the abutments and piers and the deck of the structures.

## 5.12 Traffic Safety Features, Road Furniture, Road Markings and Other facilities

For safety and operational reasons it will be necessary to provide suitable safety features, road furniture and other facilities along the project road. These features will include safety barriers, road signs, road markings, road lighting, route markers, kilometre and hectometre stones, road delineators, ROW pillars, parking areas & rest areas, bus stops/bays, Truck Lay bye and landscaping. Where possible these features will be provided in accordance with relevant IRC or other standard, as detailed below. If no IRC Codes or the MoRT&H Specifications are available, international standards such as BIS /AASHTO /ASTM /British Standards should be used in detail design.

**Safety Barriers -** The Safety Barrier shall confirm to NHAI /MoRT&H Circulars. Safety barriers shall be located at sharp horizontal curves, high embankments and at bridge approaches.

**Road Signs-** The colour, configuration, size and location of road signs shall be in accordance with IRC: 67-2012.

**Road Markings-** Road markings shall be as per IRC: 35-1997. These markings shall be applied to road centre lines, edge line, continuity line, stop lines, give-way lines, diagonal/chevron markings, zebra crossing and at parking areas by means of an approved self-propelled machine which has a satisfactory cut-off value capable of applying broken lines automatically. The approach noses of the traffic islands will be marked for additional guidance of traffic by means of diagonal markings and chevrons.

**Road Lighting-** Solar Street light system is proposed to be provided at the junctions provided in or nearby urban/semi-urban areas and over/ underpass/ flyovers. Lighting is also proposed to be provided at the bus stops, pedestrian crossings, truck terminals and maintenance buildings, if any. In case of truck rest areas, the lighting shall be provided. It is proposed to provide solar lights with maintenance free battery or operation & maintenance of such streetlights may be given to the same supplier.

**Route Markers-** The design and location of route marker signs shall be as per IRC: 2-1968.

**Overhead Signs-** Standards prescribed by MoRT&H and IRC: 67-2012 shall be followed for overhead signs.

**Kilometre/Hectometre Stones/Posts-** The design and placement of Highway kilometre stones, their dimensions, size, colour and arrangement of letters shall be as per IRC: 8-1980. For the 200-metre stones, IRC: 26-1967 shall be applied. These stones are to be made of precast M-15 grade reinforced cement concrete and lettering / numbering as per the respective IRC codes.

**Road Delineators-** The design and location for road delineators shall be as per IRC: 79-1981.

**ROW Pillars-** If any land is acquired for the project then new ROW pillars at 200 m interval on each side shall require to be established in accordance with IRC: 25-1967.

**Parking Areas and Rest Areas-** For parking in urban and semi-urban areas, IRC: SP: 12-2015 shall be followed. Local authorities shall be consulted before making final decisions. NHAI has prepared standard drawings and details of rest areas. Rest areas shall be provided at every 50 kms interval.

**Highway Landscaping-** IRC: SP: 21-2009 "Manual on Landscaping" shall guide the plantation of rows of trees with staggered pitch on either side of the road. The choice of the trees shall also be made as per the same code. Local, indigenous species that grow in the project area microclimate shall be planted. Indicative arrangements for plantation of trees shall be in accordance with the MoRT&H Technical Circular No. NHI-41 (34)/69 dated. A spacing of 10-15m c/c is recommended for spacing of trees parallel to the roads. Setback distance of trees needed in different situations shall be as per the IRC: SP: 21-2009 and the IRC: 66-1976.

**Service Roads**

Provision of Service roads is considered as of utmost requirement and 7.0m/5.5m wide service road is proposed on either of the project road wherever required. Service road is discontinued at the location of Major Bridges and ROBs. Width of service roads is proposed to 7.0m/5.5m.

**Bus Stops**

The layout, design and location of the bus stops in rural areas shall be as per IRC: 80-1981. In urban/semi-urban areas the recommendations given in IRC: 70-1977 will be considered, taking into account land availability. The bus stop layout shall provide safe entry and exit of buses from the service road and safe movement of passengers. Bus stops with passenger shelter are proposed at suitable selected locations.

**Truck Parking Areas**

The proposed layout of truck lay bye is generally based on the recommendations of "Planning Norms and Guidelines on Wayside and Terminal Facilities" (MoRT&H sponsored study). The truck lay bye is proposed at the location of Rest area.

## 5.1 At-grade intersections

Road junction/intersection is a key element of highway design. The efficiency, safety, speed and capacity of road system very much depend on the intersection design. The main objective of intersection design is to reduce the severity of potential conflicts between motor vehicles, buses, trucks, bicycles, pedestrians and facilities while facilitating the convenience, ease and comfort of people traversing the intersections. The standards proposed in IRC SP: 41 "Guidelines for the Design of At-Grade Intersection in Rural and Urban Areas" will generally be followed.

Direct entry & exit shall be provided between Main carriageway and service roads. Standard drawings as given in IRC: SP: 84-2019, fig. 3.8, 3.9, 3.10, 3.11, 3.12 & 3.13 will be adopted by giving normal tapering of 1 in 15.

**Alignment & Profile**– Depends on physical condition of site such as topography, available right-of-way, land use and developments along the intersecting roads. The intersecting roads shall meet at or nearly right angle. Roads intersecting at acute angles need extensive turning roadway areas and tend to limit visibility. The gradient of intersecting roads should be as flat as practicable up to sections that are used for storage space.

**Radii of turning roadways** – selection of appropriate curve radii, influence the vehicle speed at various points. The speed should be such that the vehicle should either be able to stop before the conflict point or accelerate to suitable speed to merge with traffic flow. The radii of curves to be provided shall as per Table 5.3 of IRC: SP: 41considering the terrain conditions

**Width of turning roadways** – determination of widths of turning lanes is primarily based on the type of vehicle using it, the length of lanes, the volume of traffic and the necessity to pass a stalled vehicle and radius of turning curve. The following table gives the recommended widths of turning lanes.

**Table 5.11 - Width of turning lanes at intersections**

| Inner Radius (m) | Design Speed (km/h) | Single lane width (m) | Two lane width (m) |
|---|---|---|---|
| 10.5 | 18 | 5.50 | 11.50 |
| 15 | 23 | 5.50 | 10.50 |
| 20 | 27 | 5.00 | 10.00 |
| 30 | 32 | 5.50 | 9.00 |
| 40 | 37 | 5.50 | 8.00 |
| >40 | - | 5.50 | 8.00 |

**Exclusive Left-Turn Lanes** – The provision of exclusive left-turn lanes depends on volume of left-turn traffic, opposing volume and safety considerations. The width of auxiliary should be at least 3m and should desirably be the same width as the through lanes. The relationship between left-turn volumes and probable need for left-turn lanes is given in the following table.

**Table 5.12 - Turning volumes requiring exclusive right-turn lanes**

| Turn lane | Minimum Turn Volume (Veh/h) |
|---|---|
| Single exclusive right-turn lane | 100 |
| Double exclusive right-turn lane | 300 |

*Source: Exhibit 10-13, HCM 2000*

The length of these lanes depends on number of vehicles or queue, likely to accommodate during a critical period. This storage length should be sufficient to avoid turning vehicles stopping in the through lanes waiting for a signal change or for a gap in the opposing traffic flow. Normal design procedure provided for a storage length is based on 1.5 times the average number of vehicles that would store per cycle in turning lane at peak hour.

**Exclusive Left-Turn Lanes** – Required if left-turn volume exceeds 300 veh/h and the adjacent mainline volume exceeds 300 veh/hr/lane

## 5.13 Pavement Design

As per section 5.4 of IRC:84:2019 and as per IRC: 37-2018 the new pavement shall be designed for 20 years in case of flexible pavement, subject to the condition that design traffic shall not be less than 20 MSA and for 30 years in case of rigid pavement and overlay on existing pavement for 10 years.

**New flexible pavement**

New flexible pavement shall be designed as per IRC: 37-2018 and IRC: SP: 59-2019.

Depending upon the available CBR and Cumulative Million Standard axles on the road, new flexible pavement may comprise of Bituminous Concrete (BC) wearing course over laid on Dense Bituminous Macadam (DBM). Underneath the DBM, Wet Mix Macadam (WMM) shall be provided to act as a base course and a layer of geogrid shall be provided between WMM layers. To ensure internal drainage of the pavement, the GSB layer shall be provided under WMM course and shall be extended to full width across the shoulder on the embankment to the side drain.

**New Rigid Pavement**

Rigid pavement shall be designed as per IRC: 58-2015, considering CBR and commercial vehicles per day.

Based on the commercial traffic that is plying on the project road and the effective k-value of subgrade soil, the rigid pavement shall be designed. The Rigid pavement shall have layer of PQC, DLC and GSB layer. A separation membrane shall be provided between PQC and DLC layers. To ensure internal drainage of the pavement, the GSB layer shall be provided under DLC course and shall be extended to full width across the shoulder on the embankment to the side drain.

**Strengthening of existing pavement**

The Overlay design for strengthening portion is based on the guidelines in IRC: 115-2014 "Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements using Falling Weight Deflectometer (FWD) Technique". The design method is based on characteristic deflection and traffic projected for design life in terms of million standard axles.

## 5.14 Roadside Drainage

Roads will affect the natural surface and subsurface drainage pattern of watershed or individual hill slope. Road drainage design has its basic objective the reduction and/or elimination of energy generated by flowing water. The destructive power of flowing water increases exponentially as its velocity increases. Therefore, water must not be allowed to develop sufficient volume or velocity so as to cause excessive wear along ditches, below culverts, or along exposed running surfaces, cuts, or fills.

A cardinal rule while planning drainage would be least interference with natural drainage. This is ideally achieved by aligning roads along ridges or drainage divides. However the alignment is determined by other various obligatory considerations and therefore a planned system is being designed for the road. New culverts along new alignment have been proposed which are as per locations of streams but not less than 5 No in general. Extra culverts have been added along existing alignment also whereas present number of culverts has been found to be less as compared to requirements based on topography and rainfall.

Water flowing towards the road surface has been diverted and guided to follow a definite path and the flow on valley side controlled so that the stability is not affected. A network of drains helps in confining and controlling flow of water and thus checks adverse effect on road structure. Adequate drains in the form of catch water drains collecting flow from hill side to bring it to side drain leading to cross drains and further discharge it into natural drainage channels through valley side drain/chutes (if erosion is likely on valley side) shall be designed for stability of road.

The design of drains will be carried out as per the guidelines given in IRC: SP: 48 – 1998 (Hill Road Manual) and IRC: SP: 42 (Guidelines on Road Drainage). The section and type of drain is being decided on the basis of hydraulic calculations. Drainage pattern would be designed in such a way that side drains and cross drains are integrated with each other.

An effective drainage system shall be planned for the drainage of roadway as per stipulations or IRC: SP: 42-2014 and IRC: SP: 50-2013 for maintaining structural soundness and functionality of the project road. The following types of drains shall be provided for surface drainage of roadway and ROW:

- Longitudinal katcha/ pucca drains between main carriageway and service roads with outfalls at cross-drainage structure in rural sections. The drain size shape and material shall be adequate to take design run off and prevent soil erosion and stagnation of water.
- Covered RCC drains at the outer edge of service road in urban area.
- Combination of longitudinal drains and chute drains in high embankments of 3m and above.
- Providing catch pits (wherever required) with provision of outflow at suitable location through buried Hume pipes.
- Part of drain water needs to be allowed to percolate or be lost by evaporation. Thus alongside drains, natural depressions and waterways and artificial ponds are recommended to drain out the water in rural stretches.

## 5.15 Embankments

### Side Slopes

For earthen embankments the side slopes recommended from consideration of safety of traffic as per IRC: 36-1970, are as follows:

| | | |
|---|---|---|
| Up to 1.5m height | - | 1: 4 (V: H) |
| 1.5m to 3.0m height | - | 1: 3 (V: H) |
| 3.0m to 4.5m height | - | 1: 2.5 (V: H) |
| 4.5m to 6.0m height | - | 1: 2 (V: H) |

Slope shall be designed for embankment height greater than 6.0m using MoRT&H software for High Embankment design.

The foregoing slopes require an appreciable width of land. It is therefore felt that the side slopes of 1V:2H and 1V:3H are enough for embankments height up to 3m and higher than 3m respectively. These slopes are considered adequate from stability point of view. The reaches having embankment height more than 3m shall have W Beam Metal Crash Barriers on the outer edge of the highway to meet the safety standards.

### Slope Protection

Slopes on embankment height less than 3m shall be turfed and those above this height shall be protected with stone pitching.

## 5.16 Roadway cutting

As per IRC: SP: 48-1998, the earthwork for formation of the hill road involves mostly side cut to achieve designed formation width. For the purpose of excavation the soil is classified in three broad categories as mentioned below;

**a) Ordinary/Heavy Soil**

This comprises of organic soil, clay, and sand, moorum and stiff clay which can be excavated manually with normal effort. This can be cut to side slopes of 1: 1 to ½: 1 (H: V). Soil mixed with boulders is also deemed to come under this category.

**b) Ordinary/Soft Rock**

This Comprises of soft verities of rock such as lime stone, sand stone, laterite, conglomerate or other disintegrated rocks, which can be excavated by bars or pick axes without blasting or with casual blasting . This can be cut to side slope of ¼: 1 to 1/8:1 (H: V).

**c) Hard Rock**

This covers any hard rock. Excavation of which involves intensive drilling and blasting. This can stand vertical or even overhanging cut depending on the type / mass and dip of rock. Normally the cut may vary from 80°- 90° to horizontal

## 5.17 Design Parameters for Bridges

### 5.17.1 General

The structures are classified based on their functional use. The structures for the project road are classified as given below:

**i) Drainage Structures**

- Major Bridges
- Minor Bridges
- Culverts

**ii) Viaducts**

**iii) Grade Separators**

- Overpasses
- Underpasses

The Bridges having an overall length varying above 6 m to 60 m are termed as minor bridges and those having an overall length more than 60 m are termed as major bridges.

The structures carrying the project road over land and spanning across the valleys are termed as viaducts. The structures carrying the crossroads above the project road are termed as overpasses and the structures carrying the cross roads below the project road are called underpasses.

### 5.17.2 Width of Structures

New Minor and Major Bridge structures are proposed to be designed as 4-lane carriageway facilities with footpath.

The overall width of the new bridges is proposed as under:

It is proposed to provide an overall deck width of 2x13.50 m for bridges consisting of 10.5 m for carriageway, 1.50 m for footpath 0.550 m for the concrete crash barrier on either side of deck and 0.40 m for double w-beam crash barrier between footpath & carriageway.

### 5.17.3 Deck Levels of Structures

The deck levels of the structures carrying the project road would be worked out based on the following parameters:

- Vertical clearance required above the cross roads;
- Vertical profile of the proposed project road and
- Vertical clearance required above the high flood level.

### 5.17.4 Design Loading

The design of the structures has been carried out to sustain safely the most critical combination of various loads, forces and stresses that can co-exist as per the provisions of IRC: 6-2017. The allowable stresses and the permissible increase in stresses for various load combinations shall be adopted as per the relevant IRC codes.

**Carriageway Live Load**

a) Structures carrying the proposed project road with carriageway width of 10.5 m have been designed for 3 lanes of Class-A loading or one lane of 70-R wheeled/tracked loading or 1 lane of class A and one lane of 70-R wheeled/tracked combination or 1 lane of special vehicle whichever produces the most severe effect.

b) Structures carrying cross roads of 2-lane carriage way shall be designed for 2 lanes of Class-A loading or one lane of 70-R wheeled/tracked loading whichever produces the most severe effect.

c) For combination of different class of vehicle, reference to Table 6 & 6A of IRC:6 shall be made

d) SV loading shall be considered in accordance with clause 204.5 for structural design verification under Ultimate Limit State and Serviceability Limit State.

e) The impact factor corresponding to length of span shall be considered as per clause 208 of IRC: 6-2017. For superstructure and abutment cap/pier cap the impact will be 100%. For top 3m from bottom abutment cap/pier cap, impact shall be considered as decreasing uniformly from 50% to 0%. No impact below 3m from bottom of abutment cap/pier cap.

f) Lane reduction factor as per clause 205 of IRC: 6-2017 shall be applied for multi-lane live load (more than two lanes) applied simultaneously. This shall be considered for bearing loads/reactions and Shear force/Bending moment/Torsional moment in superstructure in longitudinal direction.

g) Appropriate congestion factor as per clause 214.4 of IRC: 6-17 shall be considered for live load for bearing load calculation and Shear force/Bending moment/Torsional moment calculation in longitudinal direction.

**Tractive and Braking Force**

The tractive and braking forces have been considered as per the provisions of clause no. 211 of IRC: 6-2017.

**Footpath Live Load**

The footpath live load has been considered as per the provisions of clause no. 206 of the IRC: 6-2017. The intensity of the footpath loading has been considered as 500 Kg/sq. m as per clause no. 206.1 of IRC: 6-2017.

**Wind Forces**

The effect of wind as per clause no. 209 of IRC: 6-2017 have been considered for the design of the various components of the structures.

**Water current**

The force due to water current on pier will be considered as per clause 210 of IRC: 6. under seismic condition, the MSL shall be considered as 0.9 times the scour depth as per clause 703.3.1.2 of IRC: 78.

**Force due to earth pressure**

The Abutment is proposed to resist earth pressure up to scour level/ well cap bottom level whichever is higher. The active earth pressure shall be calculated using Coulomb's theory as per clause 214.1 of IRC: 6. Density of earth shall be considered as 2.0 t/m2.

**Seismic Forces**

Since the Project road falls in the seismic Zone V, as per IRC:6-2017 all the structures have been designed by considering seismic coefficient as applicable for Zone V. Seismic forces have been calculated in accordance with IRC SP114-2018. Longitudinal and transverse seismic retainers have also been proposed as per IRC: 6-2017.

**Buoyancy Effects**

The following buoyancy effects have been considered wherever applicable for the design of various components of the structures:

| | |
|---|---|
| For Foundations | 100 % |
| For Substructure below water level | 15 % |

### 5.17.5 Material

**Cement**

For construction of structures 43 grade ordinary Portland cement conforming to IS: 8112 and 53 grade ordinary Portland cement conforming to IS: 12269 will be used.

**Concrete**

The grade of concrete will be as per design requirement and will be mentioned in the drawings for each component of the structure. Cement and water content will be as per mix design requirement; however minimum grade of concrete, minimum cement content and maximum water cement ratio will be conforming to table 14.2 of IRC: 112 for moderate condition. The maximum cement content will be restricted to 450 kg/m3 of concrete as per clause 14.3.2.5 of IRC: 112-2011.

**Water**

Water used for mixing and curing will be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water will not be less than 6. Other permissible limits for solids in water are given in table – 18.6 of IRC: 112.

**Admixtures**

To improve workability of concrete, admixtures conforming to IS: 9103 will be used

**Aggregates**

Aggregates will consist of clean, hard, strong, dense, non-porous and durable crushed stone for coarse aggregates and natural particles for sand. The aggregates will conform to IS: 383 and will be tested to conform to IS: 2386 parts I to VIII. Size of coarse aggregate will be selected as per mix design requirement. Details of size of aggregate are as follows:

a. For Foundation: 40 mm down

b. For Substructure & Superstructure: 20 mm down

**Reinforcement**

Deformed or TMT reinforcement bar conforming to IS: 1786 will be used for components of the structures. The reinforcement grade will be Fe500D.

**Prestressing Steel**

Prestressing tendons normally take the form of separate wires, wires spun together helically to form strands or bars. For pre-tensioned steel, wires, strands and occasionally bars are used, simply to permit the concrete to bond directly to them; when post-tensioning is used, it is common practice to group the separate tendons together, so as to reduce the number of anchorages and ducts required to accommodate them. When grouped in this way, the tendons in each duct are usually termed a cable.

Uncoated stress relieved low relaxation steel conforming to IS: 14268 will only be used for pre-stressing steel so as to reduce losses due to relaxation. Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress-strain curve etc. will necessarily be obtained from manufacturers. Pre-stressing steel will be subjected to acceptance tests prior to actual use on the works (guidance may be taken from BS: 4447). The modulus of elasticity value, as per acceptance tests, will conform to the design value which will be within a range not more than 5 percent between the maximum and minimum.

Many cables with different arrangements of wires and strands and different methods of anchorage are available as pre-stressing steel. So, type and size of cable and methods of anchorage will be decided on the basis of design requirement.

**Sheathing**

The duct or sheath for cables to be used of Corrugated HDPE having coefficient of friction as 0.17 and wobble coefficient per meter length of steel 0.002. The thickness of sheathing will be as specified in clause 13.4.3 of IRC: 112. The sheathing will conform to the requirement specified in clause 13.4 of IRC: 112 and test certificate will be furnished by the manufacturer. The joints of all sheathing will be water tight and conform to the provision contained in clause 13.4.1 of IRC: 112.

### 5.17.6 Design Methodology

**Structural Analysis**

In this report, a general approach proposed to be adopted for the analysis is stated. For the purpose of analysis, STAAD.PRO/CSI Bridge/MIDAS CIVIL software will be used extensively. For design of various structural components, several validated in-house software's will be used. Linear Elastic method of Analysis will be generally followed for all the structures.

**Open Foundation**

The design of open foundation will confirm to provisions of IRC: 78-2014. The various specific assumptions to be made for the design of pile and pile cap will be as follows:

- Open foundations may be provided where the foundations can be laid in a stratum which is in-erodible or where the extent of scour of the bed is reliably known. The foundations are to be reliably protected by means of suitably designed aprons, cut-off walls or/and launching aprons as may be necessary.
- The thickness of the footings shall not be less than 300 mm.
- For solid wall type substructure with one-way reinforced footing, the bending moments can be determined as one-way slab for the unit width subjected to worst combination of loads and forces.
- For two-way footing, bending moment at any section of the footing shall be determined by passing a vertical plane through the footing and computing the moment of the forces acting over the entire area of footings one side of the vertical plane.
- The shear strength of the footing may be checked at the critical section which is the vertical section at a distance'd' from the face of the wall for one-way action where'd' is the effective depth of the section at the face of the wall.
- To ensure proper load transfer, a limiting value of ratio of depth to length/ Width of footing equal to 1:3 is specified. Based on this, for sloped footings the depth effective at the critical section shall be the minimum depth at the end plus 1/3rd of the distance between the extreme edges of the footing to the critical section for design of the footing for all purposes.

**Well Foundation**

In general, the design of well and well cap will conform to provisions of IRC: 78-2014. The various specific assumptions to be made for the design of Well and Well cap will be as follows:

a. Well foundations shall be taken down to the depth which will provide a minimum grip of 1/3$^{rd}$ the maximum depth of scour below the design scour level specified in Clause 703.3 of IRC: 78-2014. The minimum dimension of dredge-hole shall not be less than 3 m.

b. The thickness of the staining should be such that it is possible to sink the well without excessive Kent ledge and without getting damaged during sinking or during rectifying the excessive tilts and shift. The staining should also be able to resist differential earth pressure developed during sand blow or other conditions, like, sudden drop.

c. The minimum thickness of staining shall be not less than 500 mm and also satisfy the following relationship:

$$H = Kd \sqrt{l}$$

h = minimum thickness of staining in m
d = external diameter of circular well of dumb dell shaped well or in case of twin D wells smaller dimensions in plan area in meters
l = depth of well in meters below the toe of well cap or LWL whichever is more (for floating cassion 'l" may be taken as depth of well in meters below bed level)
K = a constant

Values of constant shall be as follows:

| | |
|---|---|
| Well in cement concrete | K = 0.03 |
| Well in brick masonry | K = 0.05 |
| Twin D wells | K = 0.039 |

**Bottom Plug**

The bottom plug shall be provided in all wells and the top shall be not kept lower than 300 mm in the centre above the top of the curb as shown in Appendix – 3 (Fig. 2) of IRC 078: 2014.

**Well Cap**

The bottom of well cap shall be laid as low as possible but above the LWL in the active channel. Where the bed level is higher than LWL the bottom of well cap may be suitably raised

The design of well cap shall be based on any acceptance rational method, considering the worst combination of loads and forces as per Clause 706 if IRC 078: 2014

**Pile Foundation**

In general, the design of pile and pile cap will conform to provisions of IRC:78. The various specific assumptions to be made for the design of pile and pile cap will be as follows:

a. The vertical load carrying capacity of the pile will be determined based on static formula given in Appendix-5 of IRC:78 which shall be given by Geo-tech

b. The vertical load carrying capacity as calculated by static formula will be verified by conducting initial load tests and routine load tests on piles conforming to IS:2911 (Part 4).

c. The lateral load carrying capacity of the pile will be determined by using empirical formula given in IS:2911 (Part-1/Sec-2) by limiting the lateral deflection to 1% of pile diameter at its tip considering it as fixed headed pile under normal conditions. The capacity so evaluated will be used purely for the purpose of arriving at the upper bound of lateral load capacity. Routine load test shall be conducted to verify lateral load carrying capacity of pile. This deflection limitation will not be applicable in load combination with seismic/wind conditions for which the resulting stresses and the structural capacity of the section would be the governing criteria.

d. Soil stiffness for lateral loads will be taken from IS: 2911 (Part-1/Sec-2), Appendix C. Unconfined compressive strength will be calculated from the results of Geotechnical Investigation Reports. Cohesion, as calculated using unconsolidated undrained test with required modification of angle of internal friction will be used for working out unconfined compressive strength. For cohesionless soil (sand), standard penetration resistance (N), as calculated from Standard penetration test will be used.

e. For calculating the bending moment in a pile shaft corresponding to unit lateral force, a single pile is idealized in STAAD.PRO. The pile is restrained by spring supports along the length of pile representing soil stiffness with appropriate value as per IS: 2911 (Part 1/Sec 2). Then, reinforcement in pile shaft will be curtailed as per the bending moment of the pile shaft.

**Pile cap**

a. The minimum thickness of pile cap will be kept as 1.5 times the pile diameter.
b. Top of the pile will project 50mm into the pile cap.
c. Pile cap will be designed either by truss analogy or by bending theory, depending upon the spacing and number of piles in a pile group.
d. Pile cap will be provided with an offset of at least 150mm beyond the outer face of the outer piles.

**Pier and Pier cap**

a. The piers are to be designed for combined axial load and biaxial bending as per the provisions of IRC: 112. Piers shall also be checked for Slenderness as per clause 11.2 of IRC: 112.
b. Pier cap is checked as either as a flexural member or as a bracket, depending upon the span/depth ratio.
c. In case it is a flexural member, the bending moments are checked at the face of pier support. Shear force will be checked at a distance deff away from the face of support.
d. In case the pier cap acts as a bracket, the design will conform to clause 16.7 of IRC: 112 for bracket design.

e. Analysis, design and detailing will in general conform to the stipulations of relevant clauses of IRC: 112 and good engineering practices.

f. In case of PSC pier cap: stress check will be applied under SLS condition under different stages of loading with appropriate load factors. The ultimate stage check of flexure capacity and shear reinforcement calculation, appropriate load factors shall be considered.

### 5.17.7 Superstructure

#### a. Design of RCC I Girder

- For span up to 20 mts. span RCC girders will be considered for design
- The structure behaves as composite section for all loads since the staging is released only after the deck slab gains strength.
- The deck structure will be analyzed for dead loads, SIDL and live loads using grillage analogy method. The superstructure will be idealized into a criss cross set of discrete members which are able to resist the loads applied in a plane perpendicular to the plane of assemblage, through bending, shear and torsional rigidities of the members.
- The minimum dimension of various elements will be provided conforming to the latest IRC codes and standards. The minimum deck slab thickness will be kept as not less than 200mm. Thickness of cross girders will not be less than the thickness of longitudinal girder.
- For obtaining maximum shear stress, the section at a distance equal to effective depth from the face of the support will be checked and the shear reinforcement calculated at the section will be continued up to the support.
- The design of deck slab supported transversely on the precast girder will be carried out assuming un-yielding support at the girder points and using effective width method.

#### b. Design of PSC I Girder

- For span up to equal to 20 mts. or more PSC girders will be considered for design
- The design of such type of structure is very much dependent on the construction sequence. The structure is in iso-static condition up to the stages of casting of deck slab {Deck Slab is to be casted in two parts: (a) Precast Planks, (b) Cast-In Situ} and diaphragm. After developing proper bond with girder, the structure behaves as composite section.
- The design therefore will be done with only the girder section being effective up to the stage of casting of deck slab and diaphragm and composite section will be considered for all subsequent loads (i.e. for SIDL and live loads).
- The deck structure will be analyzed using grillage analogy method for SIDL and Live Loads. Self-weight of girder and Dead Load of slab will be applicable on girder section alone and hence the design forces for DL will be

calculated separately and results superimposed. The superstructure will be idealized into a criss cross set of discrete members which are able to resist the loads applied in a plane perpendicular to the plane of assemblage, through bending, shear and torsional rigidities of the members.

- The minimum dimension of various elements will be provided conforming to the latest IRC codes and standards. The minimum deck slab thickness will be kept as not less than 200mm. Thickness of cross girders will not be less than the thickness of longitudinal girder.
- For obtaining maximum shear stress, the section at a distance equal to effective depth from the face of the support will be checked and the shear reinforcement calculated at the section will be continued up to the support.
- The design of deck slab supported transversely on the precast girder will be carried out assuming un-yielding support at the girder points.
- Effect of differential shrinkage and creep between precast girder and in-situ slab will be considered.

**c. Design of PSC segmental box girder**

- For 50m span or greater, PSC segmental Box Girder can be adopted.

- The longitudinal analysis of superstructure will be done using stick model. Self-weight of girder, super imposed dead load, live load and other loads shall be applied to obtain BM & SF at salient points. Stress check will be applied under SLS condition with appropriate partial safety factors. For ultimate stage check of flexural capacity of section and for shear (and torsion) reinforcement calculations, appropriate ULS partial safety factors as specified in IRC:6 will be considered.

- For transverse analysis and reinforcement design, a segmental slice of box girder will be idealized in STAAD.PRO and all other loads are applied on this model. The support under the frame will be provided at center of webs. The forces (bending moment & shear force) are obtained. Ultimate bending moment and shear force is calculated by applying load factors as per IRC:6 and sections are checked for ultimate bending and shear as per section 10 of IRC:112.

### 5.17.8 Seismic Design & Detailing

Elastic Seismic Acceleration Method (Seismic Coefficient Method):

The project falls under seismic zone-V as per seismic map given in IRC SP:114, Seismic analysis of the bridge structure is proposed to be carried out in 3 steps.

Step-1: To carry out modal analysis to obtain the fundamental vibration period (T) of the bridge in two orthogonal directions (i.e. longitudinal & transverse direction).

Step-2: To calculate Sa/g as 1/T or 1.36/T this depends on soil condition.

Step-3: To estimate seismic forces as defined in IRC SP: 114.

Vertical seismic coefficient will be taken as per the provisions of the code.

The calculation for fundamental period shall be done by modelling the structure in analysis software and carrying out dynamic analysis

**Seismic Detailing**

**Superstructure**

Since the bridges are located in Seismic Zone V, seismic thrust blocks (reaction blocks) shall be provided as additional safety measure to prevent dislodgement of superstructure in the event of failure of bearings (If applicable). In case of Integral structures, no such arrangement is required.

**Bearings (If applicable)**

POT PTFE/Spherical, Pin & Guided bearings will be used to resist the vertical loads and horizontal loads arising out of braking/tractive, wind/seismic etc. for the service life of 50 years as per clause 6.7.3 of IRC SP: 99.

Bearings & connections shall be designed to resist the lesser of the following forces, i.e.

(a) Design seismic forces obtained by using the response reduction factors.

(b) Forces developed due to over strength moment when hinge is formed in the substructure.

(c) When bearings & stoppers are designed as additional safety measures in the event of failure of bearings, R value as specified above which are confirming to Table 4.1 of IRC SP: 114 for appropriate substructure shall be adopted.

**Substructure & Foundation**

In loose sands or poorly graded sands with little or no fines, vibrations due to earthquake may cause liquefaction or excessive total and differential settlements. Liquefaction potential will be assessed. If found necessary, remedial measures will be undertaken to mitigate liquefaction potential. For liquefaction analysis specialist literature may be referred. Liquefied soil will not offer any resistance to the foundation system and it has to be ignored in design of foundation.

Plastic hinges should develop in columns rather than in capping beams or superstructure under seismic conditions. And the force demands on foundations should be based on capacity design principle that is, plastic capacity of bases of columns/piers multiplied with an appropriate over strength factor. Pile Foundations may experience limited inelastic deformations; in such cases these should be designed and detailed for ductile behaviour.

**Ductile detailing specification**

Since the project lies in seismic zone-III, ductile detailing will be done as per clause 17.2 of IRC: 112 & clause 9.1 of IRC SP: 114 for all piers and columns and as per clause 17.3 of IRC: 112 for foundations. In general, clauses given in IRC SP: 114 shall be followed. The ductile detailing will be done only in substructure if plastic hinge will be formed in substructure first. If first formation of plastic hinge is not ensured in substructure, then ductile detailing will be done in foundation too.

Minimum grade of concrete will be M25 for RCC Works (fck = 25 MPa) and M15 for PCC works.

Steel reinforcement of grade Fe 500D (see IS 1786: 1985) will be used.

### 5.17.9 Bearings

Bridge bearing must be designed to transmit all the loads and appropriate horizontal forces. From the material point of view, these bearings can be made from metal, rubber, metal and elastomer and even concrete.

**Elastomeric Bearings**

Elastomeric bearing can accommodate translation movements in any direction and rotational movements in any axis by elastic deformation. They should not be used in tension or when rotation is high and vertical load small. The basis of design is that the elastomer is an elastic material, the deflection of which under a compressive load is influenced by its shape (shape factor). Reinforcing plates should be bonded to the elastomer to prevent any relative movement at the steel/elastomer interface. The dimension and the number of internal layers of elastomer chosen will satisfy the following clauses of IRC: 83(Part-II).

IRC: 83 (Part-II) recommends that chloroprene (CR) only will be used in the manufacture of bearing. The elastomer will conform to all the properties specified in table 1 of IRC: 83 (Part-II), and tolerances in dimensions specified in table2 of IRC: 83 (Part-II).

**Pot/PTFE Bearings, Metallic Pin / Guided Bearings**

Due to easy availability, maintenance free and easy replacement, for simply supported structures elastomeric bearing will be used. Wherever it is unavoidable POT/ PTFE bearings will be used. However, for continuous structure POT/ PTFE bearing will be used.

The design of the POT/ PTFE bearing will be done by the manufacturer conforming the provisions of material as well as design parameters IRC: 83(part-III). However, the forces, movements and rotation etc. will be provided by the designer of the project on the format given in appendix –1 of IRC: 83 (part-III). In support of quality assurance, acceptance specification given in clause 928 of IRC: 83(part-III) will be followed.

In case horizontal force on Pot/ PTFE bearings exceeds 25% of vertical load, then Metallic Pin & Guided bearings will be provided to transfer the horizontal load. These bearing will not transfer any vertical force for which free Pot-PTFE bearing will be provided.

### 5.17.10 Loading

**Superimposed dead load**

Loads corresponding to the dimensions given for bridge furniture details in item 5.0 will be considered as SIDL for design of structure. For the purpose of loading, the load is taken as 200 kg/m2 (Surfacing) & 800 kg/m (Crash Barrier).

**Differential Settlement**

In case of structure sensitive to differential settlement such as continuous/Integral structures the value of differential settlement will be taken as recommended by soil consultant. Long term values of Modulus of Elasticity of concrete will be considered to account for creep effects in this case.

**Global Temperature Variation**

Global Temperature Variation is considered as per clause 215.3 IRC: 6-2017 for the purpose of analysis. The coefficient of thermal expansion (alpha) is considered as 12.0 x 10-6 per degree Celsius. For design purpose, maximum variation in temperature is considered as below:

Maximum temperature = 40$^{o}$C (As per Fig. 15 of IRC: 6-2017)

Minimum temperature = 2.5$^{o}$ C (As per Fig. 16 of IRC: 6-2017)

While deriving the effect of global temperature variation, long term modulus of concrete of superstructure (half the instantaneous modulus of concrete) shall be taken.

**Differential Temperature Gradient**

The Superstructure is designed for the positive & reverse temperature gradient along the depth of superstructure as per clause 215.3 of IRC: 6-2017.

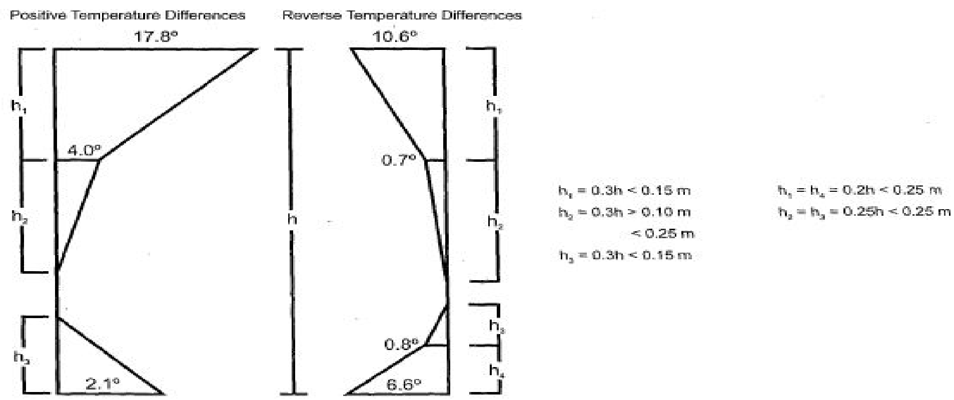


Fig. 10 (a) Design Temperature Differences for Concrete Bridge Decks

While deriving the effect of temperature gradient variation, short term/instantaneous modulus of concrete shall be taken.

**Wind Force**

Maximum wind speed will be taken as 50m/sec estimated from figure 10 of IRC:6-2017. Wind pressure will be estimated for plain terrain from table 12 of IRC:6-2017.

**Seismic Force**

The seismic forces will be calculated for seismic zone IV, with zone factor Z=0.24 and Importance factor I= 1.2. Response reduction factor for various structural components will be taken from Table 4.1 of IRC SP: 114-2018.

**Condition of exposure**

Moderate Exposure conditions shall be adopted as per table14.1 of IRC: 112-2011.

**Other Loads**

The loads which are not mentioned in this Clause, will be as per IRC: 6-2017.

**Load Combinations and Stress Levels**

Various load combinations for the purpose of design of various structural elements are as per Annexure B (Clause 202.3) of IRC: 6-2017. Every element of bridge is designed for ultimate limit state (ULS) and checked for limiting stresses under serviceability limit state (SLS).

As per IRC: 112-2011, under SLS condition, maximum compressive stress in concrete at any fibre shall be restricted to 0.48 fcj. Maximum tensile stress in steel is restricted to 0.8 fyk in rare combinations.

The section is checked for flexure, shear & torsion under ULS condition.

### 5.17.11 Deflection Limitations

For RCC/PSC structures, deflection criteria shall be checked as per clause 12.4 of IRC: 112.

a. For vehicular live load: Span/800

b. For vehicular LL on cantilever: cantilever span/300

### 5.17.12 Cover

Minimum clear cover to any reinforcement bar closest to concrete surface for different component will be as follows. Provisions of IRC: 112-2011 will be followed in any case.

| Component | Minimum Cover in mm |
|---|---|
| Superstructure | 40 |
| Substructure | 40/50 |
| Foundation | 75 |
| Pre-stressing cable duct | 75 (Post Tensioning)<br>65 (Pre-Tensioning) |
| Pre-cast elements | 35 |

### 5.17.13 Minimum Diameter of Bar

Diameter of any reinforcing bar including transverse ties, stirrups etc., will not be less than 8 mm. Diameter of any longitudinal reinforcement bars in columns/vertical member will not be less than 12 mm. However, diameter of the reinforcing bars will not exceed 25 mm in deck slab, and 32mm in all other components. Bundling of bars wherever required shall be adopted as per clause 15.2.7 of IRC: 112.

### 5.17.14 Expansion Joints

Provisions of IRC: SP: 69-2011 will be followed. These will also conform to Section 2600 Specifications for Roads & Bridge Works issued by MoRT&H.

Types of Expansion joints based upon the length of the span and movements are given below:

| Sr. No. | Span | Expansion Joints |
|---|---|---|
| (i). | For RCC slabs up to 11 m span only | Buried type expansion joints |
| (ii). | For all other bridges having span longer than 11 m and where movements are up to total 80mm | Elastomeric Single Strip Seal type expansion joints |
| (iii). | For all other bridges having span longer than 11 m and where movements are more than 80mm | Elastomeric Modular Strip Seal type expansion joints |

### 5.17.15 Approach slab & Bracket to support Approach Slab

Reinforced concrete approach slabs, 3.5 m long and 300 mm thick, in M30 grade concrete at either end of the bridge, will be provided. One end will be supported on the reinforced concrete bracket projecting from the wall over abutment and the other end resting over the soil, in accordance with the guidelines issued by MoRT&H.

A levelling course, 15 cm thick, in M-15 grade concrete will be laid under the approach slabs.

### 5.17.16 Drainage Spouts

Drainage spouts will be provided in accordance with MOST standard plans. The minimum spacing will be kept preferably as 5.0m c/c which may be adjusted to suit span length.

6

# Chapter 6 – Pavement Design

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# 6 Chapter 6 – Pavement Design

## 6.1 General

This chapter is intended to give brief descriptions concerning the aspect of pavement design new 4-lane divided carriageway along green filed proposed alignment from Silchar to Jiribam.

The basic design philosophy for the pavement is based on the consideration of providing pavement design for project specific, strong, sustainable with adverse environmental and traffic conditions. Further, the pavement design should also be consistent with construction and maintenance technology available in the project area.

## 6.2 Introduction

Pavement structure is the most vital component of a Road and therefore its design must be assured to support the projected traffic loading throughout the design period. The purpose of pavement design and option study is to make analysis of different pavement alternatives to provide a basis for selection of the most advantageous solution, considering all costs occurring during the life of the pavement viz. construction cost, road user cost and maintenance cost.

### 6.2.1 Pavement Options

*Option-01: Design of Flexible pavement as IRC-37 2018.*

*Option-02: Design of Flexible pavement with cement treated base (CTB) and cement treated sub-base (CTSB) as per IRC-37 2018.*

*Option-03: Design of Geo-grid Reinforced pavement section as per IRC: SP: 59-2019.*

*Option-04: Design of Rigid pavement as per IRC 58-2015*.

### 6.2.2 Option-01: Flexible Pavement Design for Main Carriage way (IRC: 37-2018)

Depending upon the available CBR and Cumulative Million Standard axles on the road, new flexible pavement may comprise of Bituminous Concrete (BC) wearing course is laid over Dense Bituminous Macadam (DBM). Underneath the DBM, Wet Mix Macadam (WMM) shall be provided to act as a base course. To ensure internal drainage of the pavement, the Granular Sub-Base (GSB) layer shall be provided under WMM course and shall be extended to full width across the shoulder on the embankment to the side drain.

### 6.2.3 Design Life

As per IRC: 37-2018 clause 4.3.1, for National Highways flexible pavement shall be designed for minimum 20 years and as per IRC: SP-84-2019 clause 5.4.2, the rigid pavement shall be designed for a minimum design period of 30 years.

### 6.2.4 Design CBR

4-days soaked CBR tests have been carried out on the subgrade soil to determine their suitability as subgrade and embankment material. Soaked CBR value of existing subgrade and barrow area varies from 6.2% to 7.1% for subgrade layer. Hence CBR of embankment soil is considered as 6%, CBR of Subgrade is considered as 8% and effective CBR of Subgrade is taken as 7.57%.

### 6.2.5 Homogeneous section for Pavement design

As the proposed alignment is passing through green filed for the design purpose based on the traffic along the proposed green filed alignment 1-ho,ogenious section has been considered and the details of the homogeneous section is given in below table.

**Table 6.1 Details of Homogenous Section**

| Section | Homogenous Section | Chainage (Tentative) | | Design Length (Km) |
|---|---|---|---|---|
| | | Existing | Design | |
| Section – 1 | Start point of proposed green filed alignment to Sairang (Green filed alignment) | From Km 260+000 to 212+060 of (NH-37) | From Km 4+560 to Km 37+650 | 33.090 |

### 6.2.6 Axle load survey

The axle load survey provides data to enable the assessment of the damaging effect of the loaded vehicles. The survey was carried out 48 hours using the electronic axle-weighing pad. Due to the requirement of stopping the vehicle for weighing, it was not possible to weigh all the commercial vehicles passing through the site. So commercial vehicles were weighed on a random sampling basis. About 30% to 50% of commercial vehicles in both directions were stopped for weighing in the 48-hour duration (two days) on a random sampling basis to get the vehicle Damage Factor (VDF). The time of measurement, the axle load, and the axle load group have been recorded.

Axle load pads have been calibrated on a weigh bridge before commencement of surveys. Necessary police help and other arrangements for lighting and shade have been made before the commencement of survey. Enumerators for the surveys were trained properly for the identification of axle type and vehicle type. The traffic volume survey has also been carried out in conjunction with axle load surveys.

Based on the Axle load survey data, Vehicle Damage Factor (VDF) for estimation of cumulative Million Standard Axles (MSA) for thickness design of Flexible Pavements and Spectrum of axles loads for rigid pavement design where cumulative damage principle is used for determining fatigue life of cementitious bases for heavy traffic are calculated.

The Vehicle Damage Factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration into the number of repetitions of standard axle load of magnitude 80 KN. It is defined as equivalent number of standard axles per commercial vehicles. The VDF varies with the vehicle axle configuration and axle loading.

The equations for computing equivalency factors for single, tandem and tridem axles as given below has been used for converting different axle load repetitions into equivalent standard axle load repetitions.

| | | |
|---|---|---|
| Single axle with single wheel on either side | = | $\left(\frac{axle\ load\ in\ KN}{65}\right)^4$ |
| Single axle with dual wheels on either side | = | $\left(\frac{axle\ load\ in\ KN}{80}\right)^4$ |
| Tandem axle with dual wheels on either side | = | $\left(\frac{axle\ load\ in\ KN}{148}\right)^4$ |
| Tridem axle with dual wheels on either side | = | $\left(\frac{axle\ load\ in\ KN}{224}\right)^4$ |

Analysis of axle load data for finding the value of VDF for individual category of commercial vehicles has been given at Chapter: 04 "Traffic Studies and Demand Forecast. Based on analysis, the VDF values of each category of commercial vehicles for the different homogeneous sections of the project road are given in below table.

**Table 6.2 Vehicle Damage Factor (VDF)**

| Sl No | Section | Section (Design Chainage) | Direction | LCV | Bus | 2-Axle Trucks | 3-Axle Trucks | Multi Axle Trucks |
|---|---|---|---|---|---|---|---|---|
| 1 | Section 1 | From Km 4+560 to Km 37+650 | Silchar to Jiribam | 0.73 | 0.72 | 7.74 | 9.09 | 9.32 |
| | | | Jiribam to Silchar | 0.12 | 0.61 | 4.71 | 1.00 | 0.38 |
| | | | **Adopted VDF** | **0.73** | **0.72** | **7.74** | **9.90** | **9.32** |

*Axle load survey was carried at Km 262+000 (Ext. Chainage) and at Km 217+000 (Ext. Chainage). For section along green filed from 4+560 to 37+650 (Design Chainage) the maximum VDF values/ axle load spectrum at Km 262+000 and at Km 217+000 is considered.*

### 6.2.7 Design commercial traffic:

The design traffic in terms of the cumulative number of standard axles to be carried during the design life of the road has been computed based on the

- Annual Average Daily Traffic of Commercial vehicles
- Annual growth rate of commercial vehicles at different horizon years.

**Base year commercial traffic:** The base-year (2020) average daily classified commercial traffic volumes based on the classified traffic volume count surveys carried out for the project road are given in Chapter 4: under "Traffic Studies and Demand Forecast". Since, the section from Silchar to Jiribam, the proposed alignment is passing through proposed green filed alignment, the traffic that will be diverted to green field alignment is determined based on the traffic study and the same is considered for the design of flexible pavement. The summary of the same is given in table below.

**Table 6.3 Summary of commercial traffic volumes**

| Section (Design Chainage) | Bus | LCV | Truck | | |
|---|---|---|---|---|---|
| | | | 2 Axle | 3 Axle | Multi Axle |
| From Km 4+560 to Km 37+650 | 9 | 151 | 522 | 126 | 64 |

**Traffic Volume Growth Factor:** The mode-wise percentage growth factors derived on the basis of traffic demand estimates are given in **Chapter 4 of traffic report** submitted and the summary is given in table below:

**Table 6.4 Summary of Growth Factors adopted for the project road from Silchar to Jiribam**

| Vehicle Type | Upto 2025 | 2026-30 | 2031-35 | 2036-40 | Beyond 2040 |
|---|---|---|---|---|---|
| Bus/Minibus | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| LCV | 5.00% | 12.40% | 10.85% | 5.00% | 5.00% |
| 2A Trucks | 5.00% | 5.00% | 5.00% | 5.00% | 5.00% |
| 3A Trucks | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |
| MAV | 5.00% | 7.00% | 6.50% | 6.00% | 5.00% |

*The details of the traffic growth rates are given in the chapter 4 Traffic report*

***Design Traffic Loading :*** *As suggested in IRC: 37 – 2018, the design traffic loading is considered in terms of the cumulative number of standard axles in the lane carrying maximum traffic, to be carried during the design life of the road. Design Traffic loads were computed using the following equation:*

$$N = 365 \times \left\{(1+r)^{n-1}\right\} \times A \times D \times \frac{F}{r}$$

*Where,*

$N$ = *the cumulative number of standard axles to be catered for in the design in terms of CSA (Cumulative Standard Axles)*

| | | |
|---|---|---|
| *A* | = | *Initial traffic in the years of completion of construction in terms of the number of commercial vehicles per day* |
| *D* | = | *lane distribution factor as per IRC: 37 – 2018 (cl: 4.5.1)* |
| *F* | = | *Vehicle Damage Factors* |
| *n* | = | *Design life in years (15 years)* |
| *r* | = | *Annual growth rate of commercial vehicles* |

The traffic in the year of completion is estimated using the following formula:

$A=P\ (1+r/100)^{x}$

*Where,*

| | | |
|---|---|---|
| *P* | = | *Number of commercial vehicles* |
| *x* | = | *Number of years between the count and the year of completion of construction i.e. 5 years* |
| *A* | = | *Traffic in the year after completion of construction* |
| *r* | = | *Annual growth rate of commercial vehicles* |

The detail calculation sheets for cumulative number of standard axles at different design period for different volume count locations have been presented in ***Annexure 6.1A.*** The design traffic volume for different design period in terms of Million Standard Axles for different section based on volume count stations of the project road is given below.

**Table 6.5 Design Traffic in Million Standard Axles (MSA)**

| Sl. No | Section (Design Chainage) | Million Standard Axles (For both side Carriageway) | | | | Remark |
|---|---|---|---|---|---|---|
| | | 8 Year | 10 Year | 15 Year | 20 Year | |
| 1 | From Km 4+560 to Km 37+650 | 12.93 | 16.24 | 26.27 | 39.23 | Annex.6.1A |

## 6.3 Design of Flexible Pavement for Main Carriageway)

The pavement design for flexible pavements for main carriageways is carried out in accordance with IRC: 37-2018 “Guidelines for the Design of Flexible Pavements and with the recommendations as per IRC: SP: 84-2019 “Manual of Specifications & Standards for Four laning of Highways with paved shoulder”. IITPAVE software has been used to compute the strain of the pavement layers. To give proper consideration to the aspects of performance, the following types of pavement distress resulting from repeated (cyclic) application of traffic loads are considered.

- Vertical compressive strain at the top of the sub-grade which can cause sub-grade deformation resulting in permanent deformation at the pavement surface.
- Horizontal tensile strain or stress at the bottom of the bituminous layer which can cause fracture of the bituminous layer.
- Horizontal tensile strain or stress at the bottom of the bituminous layer which can cause fracture of the Cement Treated Base.

A flexible pavement is modelled as an elastic multilayer structure. Stress and strains at critical locations are computed using linear layered elastic model. The Stress analysis software IIT-PAVE has been used for the computation of stresses and strains in flexible pavements. Tensile strain (εt) at the bottom of the bituminous layer and the vertical subgrade strain (εv) on the top of the subgrade are conventionally considered as critical parameters for pavement design to limit cracking and rutting in the bituminous layers and non-bituminous layers respectively. Figure 6.1 shows the critical locations for stress and strain at pavement layers.

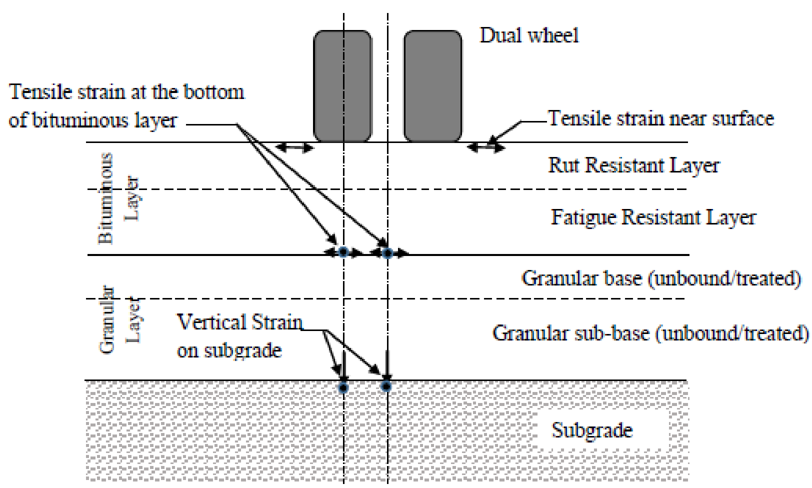



**Figure 6-1: Critical locations of Stress and Strain in Flexible Pavement**

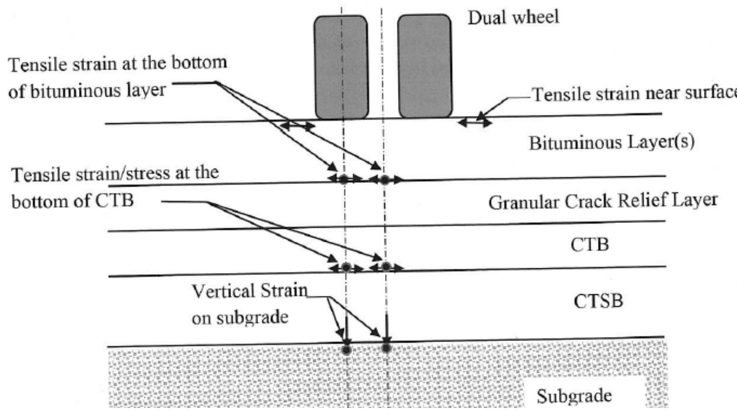



**Figure 6-2: Critical locations of Stress and Strain in CTB and CTSB**

### 6.3.1 Design Traffic (Million Standard Axles - MSA):

The design traffic is defined in terms of the cumulative number of standard axles in MSA that can be carried before a major strengthening, rehabilitation or capacity augmentation of the pavement is necessary. The design MSA calculation for different traffic count locations of the road has been presented at clause 6.2.7. The recommended design MSA considered for flexible pavement design is given below.

**Table 6.6 Adopted MSA for different sections of the road.**

| Sl. No | Section (Design Chainage) | Million Standard Axles (For both side Carriageway) | Remark |
|---|---|---|---|
| | | 20 Year | |
| 1 | From Km 4+560 to Km 37+650 | 40 | |

**Design period is considered after 4 years from base year 2020 i.e. from 2020 to 2024 due to LA process which has not been started and spill-over time period for COD.*

### 6.3.2 Pavement Material Properties:

**Properties of Sub-Grade:**

The subgrade is the top 500 mm of the embankment immediately below the bottom sub-base layer of the pavement, and is made up of in-situ material, selected soil, or stabilized soil that forms the foundation of a pavement. It should be well compacted to limit the scope of rutting in pavement due to additional densification during the service life of pavement. The selected soil forming the subgrade should have a minimum CBR of 8 per cent. Based on the test results of the existing subgrade materials, borrow area soil samples and the existing OGL soil, the recommended Effective CBR value of the proposed subgrade soils for different sections of the road is given below table.

The behaviour of the subgrade is essentially elastic under the transient traffic loading with negligible permanent deformation in a single pass. Resilient modulus is the measure of its elastic behaviour determined from recoverable deformation in the laboratory tests. The Resilient Modulus is an important parameter for design and the performance of a pavement. This can be determined in the laboratory by conducting tests as per procedure specified in AASHTO T 307-99 (2003). Since the repetitive triaxle testing facility is not widely available and is expensive, the default resilient modulus can be estimated from generally acceptable correlations which are as follows.

The relations between resilient modulus and the effective CBR is given as:

$M_R$ (MPa) = 10 x CBR   for CBR < 5

$M_R$ (MPa) = 17.6 x $(CBR)^{0.64}$ for CBR ≥5

$M_R$ = Resilient modulus of subgrade soil.

The proposed effective CBR value adopted for different sections of the road is given below.

**Table 6.7 Properties of proposed Subgrade Material**

| Sl No | Section (Design Chainage) | Effective CBR value in % | $M_R$ (MPa) Resilient Modulus | μ Poisson's Ratio |
|---|---|---|---|---|
| 1 | From Km 4+560 to Km 37+650 | 7.57 | 64.29 | 0.35 |

**Limiting Strain in Subgrade (Rutting Model):**

Rutting is the permanent deformation in pavement usually occurring longitudinally along the wheel path. The rutting may partly be caused by deformation in the subgrade and other non-bituminous layers which would reflect to the overlying layers to take a deformed shape. The bituminous mixes also may undergo rutting due to secondary compaction and shear deformation under heavy traffic load and higher temperature. Excessive rutting greatly reduces the serviceability of the pavement and therefore, it has to be limited to a certain reasonable value.

Subgrade strain criterion is used to limit the compressive strain in the top of subgrade to a tolerable level throughout the life of the pavement. The pavement is designed for limiting rutting as per the equations given below table.

**Table 6.8 Rutting Model equations**

| Design MSA | Reliability Factor | Equation |
|---|---|---|
| Less than equal to 30 MSA | 80 % | $N = 4.1656 \times 10^{-08} \times \left[1/\varepsilon_v\right]^{4.5337}$ |
| Greater than 30 MSA | 90 % | $N = 1.41 \times 10^{-08} \times \left[1/\varepsilon_v\right]^{4.5337}$ |

Where,
N = Number of cumulative standard axles, and

$\varepsilon_v$ = Vertical strain in the subgrade

**Properties for Granular Sub- Base layer:**

Unbound granular subbase is proposed for pavement design. The material to be used for Granular Subbase is **Crusher broken aggregate** conforming to MoRT&H Specifications. Granular subbase material is obtained from crushed natural aggregates. The Physical property of subbase is tabulated below.

**Table 6.9 Physical Properties of GSB:**

| Properties | Requirement as per MoRT&H |
|---|---|
| Water absorption value (%) | Less than 2%, if more than 2% Wet AIV should be performed. |
| Aggregate Impact | 40 % Maximum |
| Liquid Limit | Maximum 25 |
| Plasticity Index | Maximum 6 |
| CBR at 98% dry density | Minimum 30 |

**Properties for Granular Base Layer:**

Unbound granular base (Wet Mix Macadam) is proposed for pavement design. The material to be used for WMM shall conform to MoRT&H specification. Granular base material is obtained from crushed natural aggregates. The physical property of WMM is tabulated in the table below.

**Table 6.10 Physical properties of WMM**

| Properties | Requirement as per MoRT&H |
|---|---|
| Water absorption value (%) | Less than 2 %, if more than 2% soundness test should be carried out |
| Aggregate Impact Value | 30% Maximum |
| Combined Flakiness and Elongation index (Total) | Maximum 35% |

When both Sub-Base and Base layers are made up of granular layers, the composite resilient modulus of the granular sub-base and the base is given as:

$M_{R\_Granular} = 0.2 * h^{0.45} x\ M_{R\_Subgrade}$

Where h= thickness of granular sub-base and base, mm

Poisson's ratio of granular bases and sub-base is recommended as 0.35.

**Properties of Bituminous Layer:**

Pavement Temperature: for the purpose of design Average annual pavement temperature is considered as 35°C. For a National highway with design traffic in terms of MSA ranging from 20 to 50 MSA and less than 20 MSA, richer bituminous mixes with stiffer VG-40 binder should be used.

The Resilient Modulus of Bituminous mixes with different temperature conditions and with different grade of binders as adopted is given in below;

**Table 6.11 Properties of Bituminous Mixes:**

| Design traffic | Mix Type | Adopted weather Temperature | Resilient Modulus of Mix, (MPa) |
|---|---|---|---|
| 20 MSA to 50 MSA | BC(CRMB) & DBM with VG-40 Bitumen | 35°C | 3000 |

**Fatigue Criteria for Bituminous layer:**

**Table 6.12 Fatigue Model equations**

| Reliability Factor | Equation |
|---|---|
| 90 % | $N = 0.516 \times C \times 10^{-04} \times \left[{}^{1}/_{\varepsilon_t}\right]^{3.89} \times \left[{}^{1}/_{M_R}\right]^{0.854}$ |

$C = 10^{M}$

$M = (V_{be} / (V_a + V_{be}))$
$V_a$ = 3.5 % (Per cent volume of air voids in the mix used in the bottom bituminous layer)
$V_{be}$ = 11.5 % (Per cent volume of air voids in the mix used in the bottom bituminous layer)

**Fatigue cracking in cement treated base layers -** As per equation 3.5, IRC: 37-2018 fatigue life of cement treated layers in terms of standard axles is given below:

$N = RF\,[(113000/E^{0.804} + 191) / \varepsilon t]^{12}$

N : Fatigue life of cemented layer in number of standard axles
RF : Reliability factor (1)
E : Elastic modulus of cemented layer
εt : Allowable tensile strain at the bottom cement treated base layer

## 6.4 Option 01: Flexible pavement design

Pavement crust in this option has been designed by considering the following materials in different layers-

- Surface Layer - BC with (CRMB/PMB)
- Bituminous Base layer - DBM with VG40
- Granular Base layer – Wet mix macadam (WMM)
- Sub-base layer – Granular sub-base (GSB)

The Proposed pavement layer thickness is computed based on IRC: 37-2018 for a CBR of 7.57% and for the traffic as shown in Table 6.7. The pavement has been modelled as a three layer system and strain at critical locations have been computed using the linear viscoelastic model IITPAVE analytical design of flexible pavements. The proposed crust thickness, corresponding allowable strains from fatigue/rutting models and computed strains from IITPAVE software are given below.

**Table 6.13 Proposed Pavement Crust (Option-1)**

| | |
|---|---|
| Design Period | 20 Years |
| Design Traffic (MSA) - BT | 40.0 |
| Effective CBR of Subgrade | 7.57 |
| Grade of Bitumen for DBM | VG40 |
| Grade of Bitumen for BC | PMB/CRMB |
| Bitumen Content (%) | 4.50 |
| Volume of air voids (%) | 3.50 |

| **Pavement Crust (mm)** | |
|---|---|
| Granular Sub-base (GSB) | 200 |
| Wet Mix Macadam (WMM) | 250 |
| Dense Bituminous Macadam (DBM) | 110 |
| Bituminous Concrete (BC) | 40 |

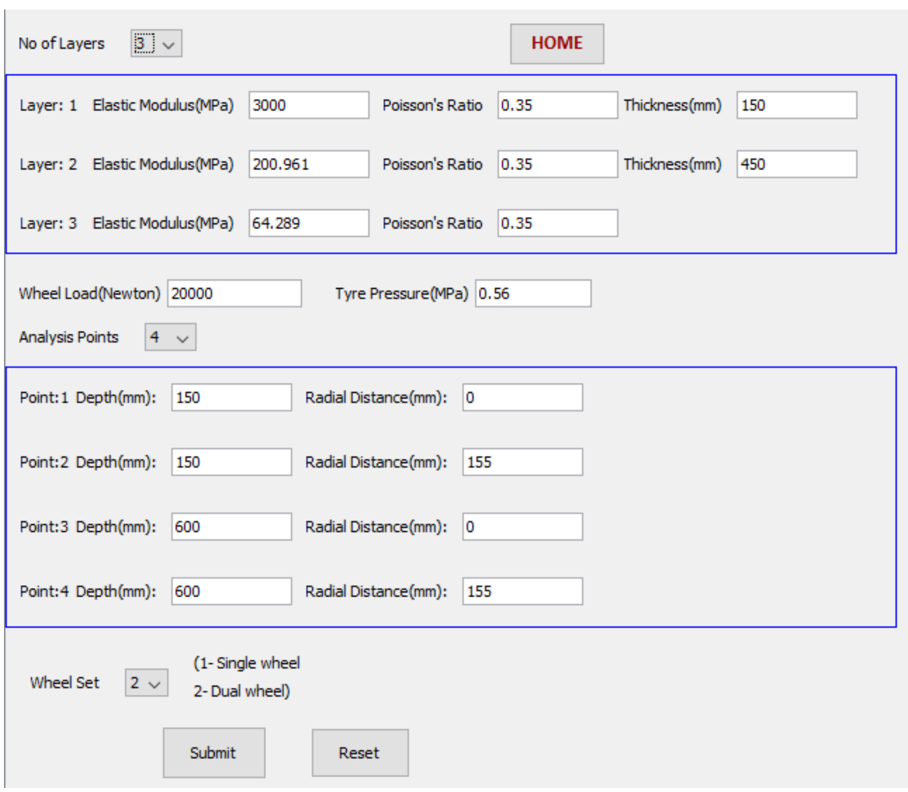
| **Resilient Modulus in Mpa of** | |
|---|---|
| Subgrade | 64.29 |
| Granular layer (GSB+WMM) | 200.96 |
| Bituminous Layers (DBM & BC) | 3000.00 |

| **Poissons Ratio (μ) of** | |
|---|---|
| Subgrade | 0.35 |
| Granular layer (GSB+WMM) | 0.35 |
| Bituminous Layers (DBM & BC) | 0.35 |

| **Allowable Strains** | |
|---|---|
| Volume of air voids (Va) | 3.50 |
| Volume of Bitumen (Vb) | 11.50 |
| "C" Value | 2.35 |
| Horizontal tensile strain at the bottom of DBM layer (εt) | 188.647E-06 |
| Vertical strain at top of subgrade (εv) | 390.45E-06 |

| **Computed strains** | |
|---|---|
| Horizontal tensile strain at the bottom of DBM layer (εt) | 185.500E-06 |
| Vertical strain at top of subgrade (εv) | 311.90E-06 |

**Input Screen**



**Output screen**

```
No. of layers               3
E values (MPa)        3000.00  200.96   64.29
Mu values                0.350.350.35
thicknesses (mm)       150.00  450.00
single wheel load (N) 20000.00
tyre pressure (MPa)       0.56
Dual  Wheel
  Z        R      SigmaZ      SigmaT     SigmaR     TaoRZ      DispZ      epZ        epT        epR
150.00    0.00-0.1009E+00 0.7179E+00 0.5754E+00-0.1451E-01 0.4028E+00-0.1845E-03 0.1839E-03 0.1198E-03
150.00L   0.00-0.1009E+00-0.2577E-02-0.1212E-01-0.1451E-01 0.4028E+00-0.4763E-03 0.1839E-03 0.1198E-03
150.00  155.00-0.9166E-01 0.6404E+00 0.3313E+00-0.4418E-01 0.4140E+00-0.1439E-03 0.1855E-03 0.4640E-04
150.00L 155.00-0.9167E-01-0.3156E-02-0.2386E-01-0.4419E-01 0.4140E+00-0.4091E-03 0.1855E-03 0.4640E-04
600.00    0.00-0.1789E-01 0.2562E-01 0.2264E-01-0.2750E-02 0.2910E+00-0.1731E-03 0.1192E-03 0.9919E-04
600.00L   0.00-0.1805E-01 0.1574E-02 0.6668E-03-0.2750E-02 0.2911E+00-0.2930E-03 0.1191E-03 0.1001E-03
600.00  155.00-0.1909E-01 0.2705E-01 0.2524E-01-0.3468E-02 0.2975E+00-0.1861E-03 0.1239E-03 0.1118E-03
600.00L 155.00-0.1909E-01 0.1661E-02 0.1084E-02-0.3469E-02 0.2975E+00-0.3119E-03 0.1239E-03 0.1118E-03
```

## 6.5 Option 02: Flexible pavement design

Pavement crust in this option has been designed by considering the following materials in different layers-

- Surface Layer - BC with (CRMB/PMB)
- Bituminous Base layer - DBM with VG40
- Aggregate inter layer - Wet mix macadam (WMM)
- Bound Base layer – Cement treated Wet mix macadam (CT-WMM)
- Sub-base layer – Cement Treated Granular sub-base (CT-GSB)

The Proposed pavement layer thickness is computed based on IRC: 37-2018 for a CBR of 7.57% and for the traffic as shown in Table 6.7. The proposed crust thickness, corresponding allowable strains from fatigue/rutting models and computed strains from IITPAVE software are given below.

**Table 6.14 Proposed Pavement Crust (Option-2)**

| | |
|---|---|
| Design Period | 20 Years |
| Design Traffic (MSA) | 40.0 |
| Grade of Bitumen for DBM | VG40 |
| Grade of Bitumen for BC | PMB/CRMB |
| Volume of Bitumen (%) Vbe | 11.50 |
| Volume of Air Voids (%) Va | 3.50 |
| CBR of embankment soil (Upper 500mm) | 6.00 |
| CBR of Subgrade (%) | 8.00 |
| Effective CBR of Subgrade (%) | 7.57 |

| **Pavement Crust (mm)** | |
|---|---|
| Cement Treated Sub-base (CTGSB) | 200 mm |
| Cement Treated Base (CTWMM) | 165 mm |
| Crack Relief Layer (WMM) | 100 mm |
| Dense Bituminous Macadam (DBM) | 80 mm |
| Bituminous Concrete (BC) | 40 mm |

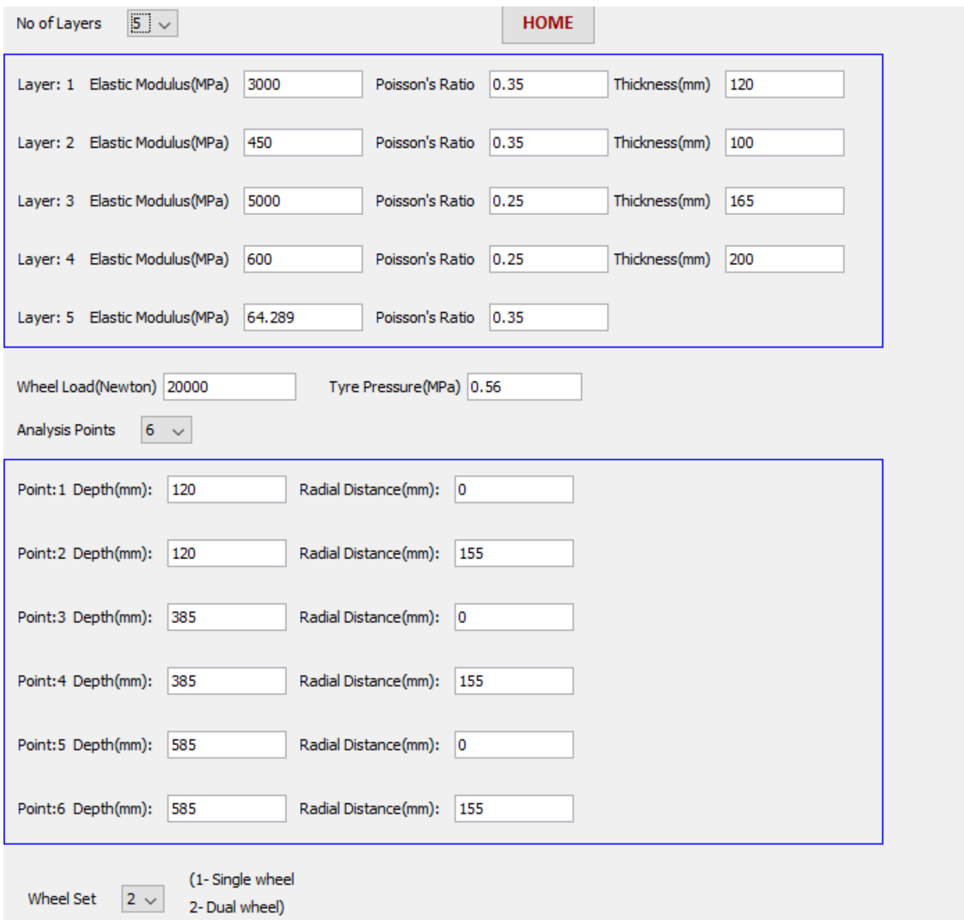
| **Resilient Modulus in Mpa of** | |
|---|---|
| Subgrade | 64.27 |
| Cement Treated Sub-base (CTGSB) | 600.00 |
| Cement Treated Base (CTWMM) | 5000.00 |
| Crack Relief Layer (WMM) | 450.00 |
| Bituminous Layers (DBM & BC) | 3000.00 |

| **Poissons Ratio (μ) of** | |
|---|---|
| Subgrade | 0.35 |
| Cement Treated Sub-base (CTGSB) | 0.25 |
| Cement Treated Base (CTWMM) | 0.25 |
| Crack Relief Layer (WMM) | 0.35 |
| Bituminous Layers (DBM & BC) | 0.35 |

| **Allowable Strains** | |
|---|---|
| Volume of Air Voids (%) Va | 3.50 |
| Volume of Bitumen (%) Vbe | 11.50 |
| "C" Value | 2.35 |
| Tensile strain at the bottom of DBM layer ($\varepsilon t$) | 188.65E-06 |
| Compressive strain at top of subgrade ($\varepsilon_v$) | 390.45E-06 |
| Tensile strain at the bottom of CTB layer ($\varepsilon t$) | 072.31E-06 |

| **Computed strains** | |
|---|---|
| Horizontal tensile strain at the bottom of DBM layer (εt) | 113.2 E-06 |
| Vertical strain at top of subgrade (εv) | 182.8 E-06 |
| Tensile strain at the bottom of CTB layer (εt) with 0.80 Mpa tyre contact pressure | 045..4 E-06 |

**Input Screen**



## Output Screen

```
No. of layers               5
E values (MPa)         3000.00  450.00 5000.00  600.00   64.29
Mu values                 0.350.350.250.250.35
thicknesses (mm)        120.00  100.00  165.00  200.00
single wheel load (N) 20000.00
tyre pressure (MPa)       0.56
Dual  Wheel
  Z        R      SigmaZ      SigmaT     SigmaR     TaoRZ      DispZ      epZ        epT        epR
120.00    0.00-0.2222E+00 0.3575E+00 0.2732E+00-0.1511E-01 0.2662E+00-0.1477E-03 0.1132E-03 0.7528E-04
120.00L   0.00-0.2222E+00-0.4810E-01-0.6075E-01-0.1511E-01 0.2662E+00-0.4092E-03 0.1132E-03 0.7528E-04
120.00  155.00-0.1708E+00 0.2015E+00-0.1278E+00-0.6968E-01 0.2641E+00-0.6555E-04 0.1020E-03-0.4617E-04
120.00L 155.00-0.1708E+00-0.4797E-01-0.9736E-01-0.6968E-01 0.2641E+00-0.2666E-03 0.1020E-03-0.4617E-04
385.00    0.00-0.3281E-01 0.2532E+00 0.2070E+00-0.1215E-01 0.2327E+00-0.2957E-04 0.4193E-04 0.3038E-04
385.00L   0.00-0.3281E-01 0.2076E-01 0.1521E-01-0.1215E-01 0.2327E+00-0.6967E-04 0.4193E-04 0.3038E-04
385.00  155.00-0.3641E-01 0.2728E+00 0.2324E+00-0.2070E-01 0.2372E+00-0.3254E-04 0.4476E-04 0.3465E-04
385.00L 155.00-0.3641E-01 0.2205E-01 0.1720E-01-0.2070E-01 0.2372E+00-0.7704E-04 0.4476E-04 0.3465E-04
585.00    0.00-0.1087E-01 0.4856E-01 0.4270E-01-0.1535E-02 0.2214E+00-0.5614E-04 0.6767E-04 0.5547E-04
585.00L   0.00-0.1088E-01 0.5223E-03-0.5725E-04-0.1535E-02 0.2214E+00-0.1718E-03 0.6767E-04 0.5550E-04
585.00  155.00-0.1148E-01 0.5123E-01 0.4748E-01-0.2013E-02 0.2249E+00-0.6026E-04 0.7038E-04 0.6257E-04
585.00L 155.00-0.1148E-01 0.5808E-03 0.2087E-03-0.2013E-02 0.2249E+00-0.1828E-03 0.7038E-04 0.6257E-04
```

***Check for fatigue cracking in cementations layers using cumulative damage analysis:***

The thickness of cement treated base layer is first evaluated from fatigue considerations in terms of cumulative standard axles and corresponding tensile stresses at the bottom of cement treated base layer due to individual wheel load was computed using IITPAVE software.

Since there are plenty of single, tandem and Tridem axle loads which are far higher than standard axle load used for pavement design, thickness of cemented layer is checked for sudden fracture of cemented base due to higher axle loads using cumulative damage principle. Axle weights of tandem and Tridem axle are taken as equivalent to two and three single axles respectively. The fatigue life has been calculated using the following equation.

Where,

$$\text{Log } N_{fi} = \frac{0.972 - (\sigma_t / M_{Rup})}{0.0825}$$

Nfi : Fatigue life in terms of cumulative number of axle load of class i

σt : tensile stress under cement treated base layer.

Mrup : 28 day flexural strength of cement treated base layer

Computed Tensile stress below cement treated base layer – 0.354 (From IITPAVE); Flexural strength of cement treated base layer – 1.4 Mpa

Cumulative fatigue damage analysis has been carried out for all axle configurations and is given below:

**Table 6.15 - Commercial vehicles (nos.)**

| Year | in both directions | | | | | Total Veh. in one direction per year | Cumulative Comm Veh. |
|---|---|---|---|---|---|---|---|
| | Bus | LCV | 2A Truck | 3A Truck | M Axle Truck | | |
| 2020 | 9 | 151 | 522 | 126 | 64 | 317880 | |
| 2021 | 9 | 158 | 548 | 132 | 67 | 333774 | |
| 2022 | 10 | 166 | 576 | 138 | 70 | 350463 | |
| 2023 | 10 | 174 | 604 | 145 | 74 | 367986 | |
| 2024 | 11 | 183 | 635 | 153 | 77 | 386386 | |
| 2025 | 11 | 192 | 666 | 160 | 81 | 405705 | 405705 |
| 2026 | 12 | 202 | 700 | 168 | 85 | 425990 | 831695 |
| 2027 | 12 | 227 | 735 | 180 | 91 | 454596 | 1286291 |
| 2028 | 13 | 255 | 771 | 193 | 98 | 485438 | 1771729 |
| 2029 | 14 | 287 | 810 | 206 | 105 | 518721 | 2290450 |
| 2030 | 14 | 322 | 851 | 221 | 112 | 554671 | 2845121 |
| 2031 | 15 | 362 | 893 | 236 | 120 | 593538 | 3438659 |
| 2032 | 16 | 402 | 938 | 251 | 127 | 632899 | 4071558 |
| 2033 | 17 | 445 | 985 | 268 | 136 | 675194 | 4746752 |
| 2034 | 17 | 494 | 1034 | 285 | 145 | 720669 | 5467421 |
| 2035 | 18 | 547 | 1086 | 304 | 154 | 769593 | 6237013 |
| 2036 | 19 | 606 | 1140 | 323 | 164 | 822259 | 7059272 |
| 2037 | 20 | 637 | 1197 | 343 | 174 | 865150 | 7924422 |
| 2038 | 21 | 669 | 1257 | 363 | 184 | 910293 | 8834716 |
| 2039 | 22 | 702 | 1320 | 385 | 195 | 957806 | 9792522 |
| 2040 | 23 | 737 | 1385 | 408 | 207 | 1007815 | 10800336 |
| 2041 | 24 | 774 | 1455 | 433 | 219 | 1060451 | 11860787 |
| 2042 | 26 | 813 | 1528 | 454 | 230 | 1113473 | 12974261 |
| 2043 | 27 | 853 | 1604 | 477 | 242 | 1169147 | 14143408 |
| 2044 | 28 | 896 | 1684 | 501 | 254 | 1227604 | 15371012 |

Total Number cumulative commercial vehicles in the design year (2044) - 23396105

**Table 6.16 -Cumulative Fatigue Damage Analysis – Option 2**

| Axle load in KN | Expected single axle repetitions (ni) | Tensile Stress at the bottom of CTB σt, in Mpa | Stress Ratio (σt/Mrup) | Fatigue life (Nf) | Fatigue life consumed (ni/Nf) |
|---|---|---|---|---|---|
| **Single Axles** | | | | | |
| 190 | 166817 | 0.63 | 0.45 | 2.35E+06 | 0.071 |
| 180 | 250226 | 0.59 | 0.42 | 4.52E+06 | 0.055 |
| 170 | 417043 | 0.56 | 0.40 | 8.71E+06 | 0.048 |
| 160 | 917495 | 0.53 | 0.38 | 1.68E+07 | 0.055 |
| 150 | 166817 | 0.49 | 0.35 | 3.23E+07 | 0.005 |
| 140 | 2085215 | 0.46 | 0.33 | 6.23E+07 | 0.033 |
| 130 | 583860 | 0.43 | 0.31 | 1.20E+08 | 0.005 |
| 120 | 500452 | 0.39 | 0.28 | 2.31E+08 | 0.002 |
| 110 | 1918398 | 0.36 | 0.26 | 4.46E+08 | 0.004 |
| 100 | 750677 | 0.33 | 0.23 | 8.59E+08 | 0.001 |
| 90 | 750677 | 0.30 | 0.21 | 1.65E+09 | 0.000 |
| 85 | 11844020 | 0.28 | 0.20 | 2.30E+09 | 0.005 |
| **Cumulative Fatigue Damage in CTB due to Single Axles** | | | | | **0.258** |
| **Tandem Axles** | | | | | |
| 400 | 0 | 0.66 | 0.47 | 1.22E+06 | 0.000 |
| 380 | 0 | 0.63 | 0.45 | 2.35E+06 | 0.000 |
| 360 | 0 | 0.59 | 0.42 | 4.52E+06 | 0.000 |
| 340 | 0 | 0.56 | 0.40 | 8.71E+06 | 0.000 |
| 320 | 2776699 | 0.53 | 0.38 | 1.68E+07 | 0.165 |
| 300 | 6941747 | 0.49 | 0.35 | 3.23E+07 | 0.215 |
| 280 | 3470874 | 0.46 | 0.33 | 6.23E+07 | 0.056 |
| 260 | 4165048 | 0.43 | 0.31 | 1.20E+08 | 0.035 |
| 240 | 1388349 | 0.39 | 0.28 | 2.31E+08 | 0.006 |
| 220 | 8330097 | 0.36 | 0.26 | 4.46E+08 | 0.019 |
| 200 | 0 | 0.33 | 0.23 | 8.59E+08 | 0.000 |
| 180 | 0 | 0.30 | 0.21 | 1.65E+09 | 0.000 |
| 170 | 15966019 | 0.28 | 0.20 | 2.30E+09 | 0.007 |
| **Cumulative Fatigue Damage in CTB due to Tandom Axles** | | | | | **0.502** |

| Axle load in KN | Expected single axle repetitions (ni) | Tensile Stress at the bottom of CTB σt, in Mpa | Stress Ratio (σt/Mrup) | Fatigue life (Nf) | Fatigue life consumed (ni/Nf) |
|---|---|---|---|---|---|
| Tridem Axles | | | | | |
| 600 | 0 | 0.66 | 0.47 | 1.22E+06 | 0.000 |
| 570 | 0 | 0.63 | 0.45 | 2.35E+06 | 0.000 |
| 540 | 0 | 0.59 | 0.42 | 4.52E+06 | 0.000 |
| 510 | 0 | 0.56 | 0.40 | 8.71E+06 | 0.000 |
| 480 | 0 | 0.53 | 0.38 | 1.68E+07 | 0.000 |
| 450 | 0 | 0.49 | 0.35 | 3.23E+07 | 0.000 |
| 420 | 0 | 0.46 | 0.33 | 6.23E+07 | 0.000 |
| 390 | 0 | 0.43 | 0.31 | 1.20E+08 | 0.000 |
| 360 | 0 | 0.39 | 0.28 | 2.31E+08 | 0.000 |
| 330 | 0 | 0.36 | 0.26 | 4.46E+08 | 0.000 |
| 300 | 32279125 | 0.33 | 0.23 | 8.59E+08 | 0.038 |
| 270 | 0 | 0.30 | 0.21 | 1.65E+09 | 0.000 |
| 255 | 32279125 | 0.28 | 0.20 | 2.30E+09 | 0.014 |
| **Cumulative Fatigue Damage in CTB due to Tridem Axles** | | | | | **0.052** |

| Cumulative Fatigue Damage | | | |
|---|---|---|---|
| **Due to Single Axles** | **Due to Tandem Axles** | **Due to Tridem Axles** | **Total CFD** |
| 0.285 | 0.502 | 0.052 | 0.839 |

The cumulative fatigue life consumed is less than 1, the design is safe from fatigue considerations. Similar analysis has been carried out for other option also and summary is given below:

## 6.6 Option 03: Flexible Pavement Design with Geo grid provision in hill / mountainous region

Pavement crust in this option has been designed by considering the following materials in different layers-

- Surface Layer - BC with (CRMB/PMB)
- Bituminous Base layer - DBM with VG40
- Biaxial Geo-grid
- Granular Base layer – Wet mix macadam (WMM)
- Sub-base layer – Granular sub-base (GSB)

**Table 6.17 – Proposed Pavement Crust (Option-3)**

| | |
|---|---|
| Design Period | 20 Years |
| Design Traffic (MSA) - BT | 40.0 |
| Effective CBR of Subgrade | 7.57 |
| Grade of Bitumen for DBM | VG40 |
| Grade of Bitumen for BC | PMB/CRMB |
| Bitumen Content (%) | 4.50 |
| Volume of air voids (%) | 3.50 |

| **Pavement Crust (mm)** | |
|---|---|
| Granular Sub-base (GSB) | 200 |
| Wet Mix Macadam (WMM) | 250 |
| Geo-Grid | Biaxial |
| Dense Bituminous Macadam (DBM) | 65 |
| Bituminous Concrete (BC) | 40 |

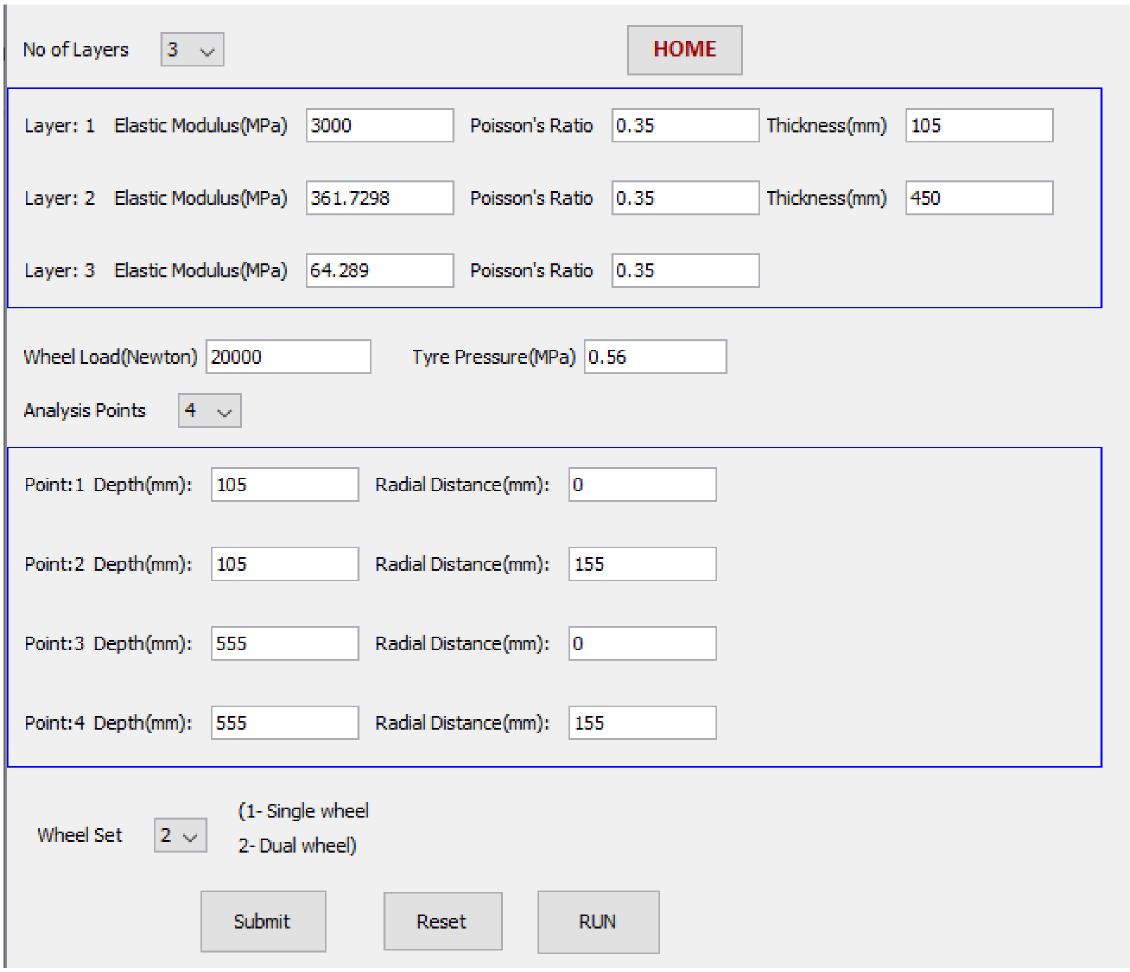
| **Resilient Modulus in Mpa of** | |
|---|---|
| Subgrade | 64.29 |
| Granular layer (GSB+WMM) | 361.73 |
| Bituminous Layers (DBM & BC) | 3000.00 |

| **Poissons Ratio (μ) of** | |
|---|---|
| Subgrade | 0.35 |
| Granular layer (GSB+WMM) | 0.35 |
| Bituminous Layers (DBM & BC) | 0.35 |

| **Allowable Strains** | |
|---|---|
| Volume of air voids (Va) | 3.50 |
| Volume of Bitumen (Vb) | 11.50 |
| "C" Value | 2.35 |
| Horizontal tensile strain at the bottom of DBM layer (εt) | 188.647E-06 |
| Vertical strain at top of subgrade ($\varepsilon_v$) | 390.45E-06 |

| **Computed strains** | |
|---|---|
| Horizontal tensile strain at the bottom of DBM layer (εt) | 181.800E-06 |
| Vertical strain at top of subgrade ($\varepsilon_v$) | 319.70E-06 |

## Input Screen




## Output screen

```
No. of layers                 3
E values (MPa)          3000.00  361.73   64.29
Mu values                  0.350.350.35
thicknesses (mm)         105.00  450.00
single wheel load (N) 20000.00
tyre pressure (MPa)        0.56
Dual  Wheel
  Z        R      SigmaZ      SigmaT     SigmaR     TaoRZ      DispZ      epZ        epT        epR
105.00    0.00-0.2009E+00 0.6584E+00 0.5241E+00-0.2064E-01 0.3873E+00-0.2049E-03 0.1818E-03 0.1213E-03
105.00L   0.00-0.2009E+00-0.1574E-01-0.3194E-01-0.2064E-01 0.3873E+00-0.5092E-03 0.1818E-03 0.1213E-03
105.00  155.00-0.1451E+00 0.4564E+00-0.1325E-02-0.9562E-01 0.3909E+00-0.1015E-03 0.1692E-03-0.3676E-04
105.00L 155.00-0.1451E+00-0.1368E-01-0.6887E-01-0.9563E-01 0.3909E+00-0.3212E-03 0.1692E-03-0.3676E-04
555.00    0.00-0.1832E-01 0.5553E-01 0.4885E-01-0.2992E-02 0.2858E+00-0.1516E-03 0.1240E-03 0.9905E-04
555.00L   0.00-0.1820E-01 0.1819E-02 0.6294E-03-0.2997E-02 0.2859E+00-0.2964E-03 0.1239E-03 0.9896E-04
555.00  155.00-0.1948E-01 0.5952E-01 0.5477E-01-0.4045E-02 0.2929E+00-0.1644E-03 0.1304E-03 0.1127E-03
555.00L 155.00-0.1948E-01 0.1955E-02 0.1105E-02-0.4147E-02 0.2929E+00-0.3197E-03 0.1305E-03 0.1126E-03
```

## 6.7 Option 04: Rigid Pavement Design for Main Carriageway

Cement concrete pavements are subjected to stresses due to a variety of factors acting simultaneously. The severest combination of different factors that induce the maximum stress in the pavement will give the critical stress condition. The factors commonly considered for the design of pavement thickness are flexural Stresses due to traffic loads and temperature differentials between the top and bottom fibres of the concrete slab, as the two are assumed to be additive under critical condition. The maximum combined tensile stress in three regions of the slab will thus be caused when effects of temperature differential are such as to be additive to the load effects. This would occur during the day in case of interior and edge regions at the time of maximum temperature differential in the slab. In the corner region temperature stress is negligible but the load stress is maximum at night when the slab corners have a tendency to lift up due to warping and loose partly the foundation support. Considering the total combined stress for the three regions i.e. corner, edge and interior, for which the load stresses decreases in that order while the temperature stress increases. The critical stress condition is reached in the edge region. The effective modulus of Subgrade reaction (k) is obtained based on the Subgrade CBR. The axle loads are divided into axle load spectrum and pavement is checked for the cumulative fatigue damage for night and day traffic.

### 6.7.1 Wheel Load

The legal axle load limits in India are 10.2, 19 and 24 tonnes for single axle, tandem axle and Tridem axles respectively. However, the design axle loads for the project road has been arrived through the axle load surveys conducted along the project road 2020. The details of axle load surveys are given in Traffic Report.

### 6.7.2 Tyre Pressure

Tyre pressures and shape of contact areas of the commercial vehicles (CV) also govern load stresses. For most of the commercial vehicles, it ranges from 0.7 to 1 MPA, but it is found that stresses in concrete pavements having thickness of 20cm or more are not affected significantly by the variation of tyre pressure. A tyre pressure of 0.8 MPa has been adopted for design as per section 5.2 of IRC: 58-2015.

### 6.7.3 Design Traffic

As per clause 5.5.2.2 and 5.5.2.3 of IRC:58-2015, Design traffic for bottom-up cracking and top-down cracking shall be 25% and 12.5% of total traffic in the direction of predominant traffic. The cumulative number of axles during the design period have been computed using the below equation.

$$C = \frac{365\, A\, [(1+r)n-1]}{r} \text{ X A}$$

C= Cumulative number of axles during the design period

A= Initial number of axles per day in the year when the road is operations.

r = Annual rate of growth of commercial vehicles traffic.

n = Design period in years.

Expected number of applications of different axle load groups during the design period is estimated from the axle load spectrum.

### 6.7.4 Temperature Differential

Temperature differential between the top and bottom of concrete pavements causes the concrete slab to warp, giving rise to stresses. For the slab proposed thickness of 300 mm for main carriageway, the temperature differential adopted is 16 $^0$C /14.3 $^0$C as given in table 1 of IRC: 58-2015.

| Zone | State / Region | Max. temperature differential °C in Slab thickness | | | |
|---|---|---|---|---|---|
| | | 150 mm | 200 mm | 250 mm | 300 to 400 mm |
| III | Assam | 15.6 | 16.4 | 16.6 | 16.8 |

### 6.7.5 Characteristics of Sub grade and Subbase

The strength of Subgrade is expressed in terms of modulus of Subgrade reaction (k). It is obtained from Table 2 of IRC: 58-2015 for the design CBR. A Dry Lean Concrete (DLC) subbase is generally recommended for modern concrete pavements particularly those with high intensity of traffic. The effective modulus of sub grade reaction over DLC is obtained from Table 4 of IRC: 58-2015.

Design CBR of subgrade is 8 is considered for Silchaar to Jiribam section, k value corresponding 8% CBR is 50.3 MPa/m and effective k over 150mm DLC is 285 MPa/m.

### 6.7.6 Characteristics of Concrete

- Dry Lean Concrete (DLC) conforming to MORTH specifications shall be provided as base course. The DLC shall have average 7 day strength of 7 MPa as per IRC: SP: 49. DLC shall have thickness of 150mm and shall extend beyond the PQC by 0.75 m or as required for facilitating the paver movement
- The Pavement Quality Concrete (PQC) shall conform to MORTH specifications and shall have 28 day flexural strength of 4.5 MPa. The design parameters of PQC have been considered in accordance with IRC: 58-2015 and the same have been shown in Table below.

| | |
|---|---|
| Elastic Modulus of PQC, MPa | 30000 |
| Poisson's Ratio (μ) | 0.15 |
| Unit weight of PQC, kN/m3 | 24 |
| 28 days flexural strength, MPa | 4.5 |
| Grade of Concrete | M40 |

### 6.7.7 Fatigue behaviour of Cement Concrete

Due to repeated application of Flexural stresses by the traffic loads, progressive fatigue damage takes place in the cement concrete slab in the form of gradual development of micro cracks especially when the applied stress in terms of Flexural strength of concrete is high. The ratio between the Flexural stress due to the load and Flexural strength of the concrete is termed as Stress Ratio (SR). If the SR is less than 0.45 the concrete is expected to sustain infinite number of repetitions. As the SR increases the number of load repetitions (N) required to cause cracking decreases.

N = Infinite for SR <0.45

$$\log_{10} N = \frac{0.9718 - SR}{0.0828} \quad For\ SR > 0.55$$

$$N = \left[\frac{4.2577}{SR - 0.4325}\right]^{3.268} \text{When } 0.45 <= SR <= 0.55$$

### 6.7.8 Stress Calculation:

For bottom-up cracking, Stresses are calculated using regression equations V.1 given in Appendix - V of IRC: 58-2015.

For top-down cracking, Stresses are calculated by using regression equations V.2 shown in Appendix - V of IRC: 58-2015.

### 6.7.9 Dowel bars at Transverse Joints

Load transfer to relieve part of the load stresses in edge and corner regions of pavement slab at transverse joints is provided by means of mild steel round dowel bars at transverse joints.

$$\sigma_{\max} = \frac{KP_t}{4\beta^3 EI}(2 + \beta z) \qquad \beta = \sqrt[4]{\frac{kb}{4EI}}$$

The bearing stress in concrete is responsible for the performance of dowel bars at the joints. High concrete bearing stress can fracture the concrete surrounding the dowel bars, leading to the looseness of the dowel bar and the deterioration of the load transfer system with eventual faulting of the slab. Larger diameter dowel bars are found to provide better performance.

Maximum bearing stress between the concrete and dowel bar is obtained from the equation:

β = Relative stiffness of the bar embedded in concrete.
K = Modulus of dowel/concrete interaction (dowel support, MPa/m)
b = Diameter of the dowel, m
z = Joint width (5 mm for contraction joint and 20mm for expansion joint)
E = Modulus of the elasticity of the dowel, MPa
I = Moment of inertia of the dowel, mm4
$P_t$= Load transferred by a dowel bar, KN.
Modulus of dowel support is 415,000 MPa/M. Each dowel bar should transfer load that is less than design load for the maximum bearing pressure. The allowable bearing stress is calculated by using the equation presented below.

$$F_b = \frac{(10.16 - b)f_{ck}}{9.525}$$

Where;
$F_b$ = Allowable bearing stress, MPa
b = Dowel diameter, mm
$f_{ck}$ = Ultimate compressive strength of concrete, MPa (For M40 concrete, fck = 40 MPa (28 days) and 48 MPa (90 days)

### 6.7.10 Tie bars at Longitudinal Joints

Tie bars are used across the joints of concrete pavements wherever it is necessary or desirable to ensure firm contact between slab faces or to abutting slabs from separating. The area of steel required per meter length is computed by using the following formula:

$$As = \frac{bfw}{S}$$

Where;
A = Area if steel in mm$^2$ required for per meter length of joint
b = Distance between the joint in question and nearest free joint or edge in m
f = Co-efficient of friction between pavement and Sub grade (usually taken at 1.5)
W = Weight of pavement slab per sq meter in kg, i.e., 24 KN/sqm per cm thickness and
S = Allowable working stress of steel in kg/sqm

The length of any tie bar should be at least twice that required to develop bond strength equal to the working stress of the steel. It is calculated by using the equation shown below.

$$L = \frac{2SA}{BP}$$

Where;
L = Length of tie bar, cm
S = Allowable working stress in steel, MPa
A = Cross-sectional area of one tie bar $mm^2$
B = Maximum permissible bond stress, MPa

## 6.8 Design of Rigid Pavement

### 6.8.1 Design of Rigid Pavement for Main Carriageway

Rigid pavement design for new construction and reconstruction stretches of main carriageway has been carried out in accordance with IRC: 58-2015. Detailed design calculation for each section is presented below.

### 6.8.2 Design of Slab Thickness for Section from Km 4+560 to Km 37+650 (Design Chainage)

As the proposed road is passing through green filed alignment the pavement compisiotion is calculated based on the traffic diverted on green filed alignment and the loading is considered based on the axle load survey conducted at Km 262+000 and at Km 217+000. The loading pattern between Silchar to Jiribma is more critical as compared to the loading pattern between Jiribam to Silchar.

The input data considered and detailed design calculations are given below:

Pavement Structure Details

| | | | |
|---|---|---|---|
| Design Period | = | 30 | Years |
| Thickness of Subgrade | = | 0.500 | m |
| Thickness of Granular Sub base (GSB) | = | 0.150 | m |
| Thickness of Dry Lean Concrete (DLC) | = | 0.150 | m |
| Thickness of Pavement Quality Concrete (PQC), h | = | 0.270 | m |
| Effective CBR of compacted subgrade | = | 8 | |
| Modulus of subgrade reaction of subgrade | = | 50.3 | Mpa/m |
| Modulus of subgrade reaction of foundation (Subgrade, GSB, DLC) | = | 284.67 | Mpa/m |
| Unit weight of concrete | = | 24 | KN/m3 |
| Grade of Concrete | = | 40 | |
| 28 day Flexural strength of cement concrete | = | 4.5 | Mpa |
| Modulus of elasticity of concrete, E | = | 30000 | Mpa |
| Poisson's ratio, $\mu$ | = | 0.15 | |
| Radius of relative stiffness, l | = | 0.648 | |
| Coefficient of thermal expansion of concrete, $\propto$ | = | $10 \times 10^{-6}$ | per $^0C$ |

| | | | |
|---|---|---|---|
| Maximum day-time temperature differential in slab (for bottom-up cracking) | = | 16.6 | $^0$C |
| Night-time temperature differential in slab (for top-down cracking) | = | 13.3 | $^0$C |

If two texturing is considered in a design life of 30 years, a thickness of 0.28 m will be appropriate.

| | | | |
|---|---|---|---|
| Spacing of Transverse Joints (L) | = | 3.50 | m |
| Maximum Spacing of Longitudinal Joints (W) | = | 4.50 | m |
| Diameter of dowel bars | = | 36 | mm |
| Spacing between dowels | = | 300 | mm |
| Length of dowel bar | = | 450 | mm |
| Diameter of tie bar (Deformed) | = | 12 | mm |
| Spacing of tie bar | = | 460 | mm |
| Length of tie bar | = | 640 | mm |

### 6.8.3 Projected commercial traffic:

The base year traffic has been projected for the period of 30 years with the above growth rates and given in the following table along with year-wise cumulative number of commercial vehicles.

**Table 6.18 Cumulative number of commercial vehicle**

| Year | On proposed green filed | | | | | Total Vehicle in both directions per year | Cumulative Vehicle in both directions |
|---|---|---|---|---|---|---|---|
| | Bus | LCV | 2A Truck | 3A Truck | Multi Axle Truck | | |
| 2020 | 9 | 151 | 522 | 126 | 64 | 317880 | Design, Land acquisition and Construction period |
| 2021 | 9 | 158 | 548 | 132 | 67 | 333774 | |
| 2022 | 10 | 166 | 576 | 138 | 70 | 350463 | |
| 2023 | 10 | 174 | 604 | 145 | 74 | 367986 | |
| 2024 | 11 | 183 | 635 | 153 | 77 | 386386 | |
| 2025 | 11 | 192 | 666 | 160 | 81 | 405705 | 405705 |
| 2026 | 12 | 202 | 700 | 168 | 85 | 425990 | 831695 |
| 2027 | 12 | 227 | 735 | 180 | 91 | 454596 | 1286291 |
| 2028 | 13 | 255 | 771 | 193 | 98 | 485438 | 1771729 |

| Year | On proposed green filed | | | | | Total Vehicle in both directions per year | Cumulative Vehicle in both directions |
|---|---|---|---|---|---|---|---|
| | Bus | LCV | 2A Truck | 3A Truck | Multi Axle Truck | | |
| 2029 | 14 | 287 | 810 | 206 | 105 | 518721 | 2290450 |
| 2030 | 14 | 322 | 851 | 221 | 112 | 554671 | 2845121 |
| 2031 | 15 | 362 | 893 | 236 | 120 | 593538 | 3438659 |
| 2032 | 16 | 402 | 938 | 251 | 127 | 632899 | 4071558 |
| 2033 | 17 | 445 | 985 | 268 | 136 | 675194 | 4746752 |
| 2034 | 17 | 494 | 1034 | 285 | 145 | 720669 | 5467421 |
| 2035 | 18 | 547 | 1086 | 304 | 154 | 769593 | 6237013 |
| 2036 | 19 | 606 | 1140 | 323 | 164 | 822259 | 7059272 |
| 2037 | 20 | 637 | 1197 | 343 | 174 | 865150 | 7924422 |
| 2038 | 21 | 669 | 1257 | 363 | 184 | 910293 | 8834716 |
| 2039 | 22 | 702 | 1320 | 385 | 195 | 957806 | 9792522 |
| 2040 | 23 | 737 | 1385 | 408 | 207 | 1007815 | 10800336 |
| 2041 | 24 | 774 | 1455 | 433 | 219 | 1060451 | 11860787 |
| 2042 | 26 | 813 | 1528 | 454 | 230 | 1113473 | 12974261 |
| 2043 | 27 | 853 | 1604 | 477 | 242 | 1169147 | 14143408 |
| 2044 | 28 | 896 | 1684 | 501 | 254 | 1227604 | 15371012 |
| 2045 | 30 | 941 | 1768 | 526 | 267 | 1288985 | 16659997 |
| 2046 | 31 | 988 | 1857 | 552 | 280 | 1353434 | 18013430 |
| 2047 | 33 | 1037 | 1950 | 580 | 294 | 1421106 | 19434536 |
| 2048 | 34 | 1089 | 2047 | 609 | 309 | 1492161 | 20926697 |
| 2049 | 36 | 1144 | 2149 | 639 | 324 | 1566769 | 22493465 |
| 2050 | 38 | 1201 | 2257 | 671 | 340 | 1645107 | 24138573 |
| 2051 | 40 | 1261 | 2370 | 705 | 357 | 1727363 | 25865935 |
| 2052 | 42 | 1324 | 2488 | 740 | 375 | 1813731 | 27679666 |
| 2053 | 42 | 1324 | 2489 | 740 | 376 | 1814638 | 29494304 |
| 2054 | 42 | 1325 | 2491 | 741 | 376 | 1815545 | 31309849 |

### 6.8.4 Design Traffic Estimation

**i. On proposed green filed**

| | |
|---|---|
| Design Period (years) | 30 |
| Cumulative No of Commercial vehicles during design period (two-way), **A** | 31309849 |
| % of Day Traffic (8 AM to 8 PM) | 30% |
| % of Night Traffic (8 PM to 8 AM) | 70% |
| Average No of axles per commercial vehicle, **B** | 2.29 |
| Cumulative No of Commercial Axles during design period (two-way), **C = A*B** | 71565369 |
| Proportion of traffic in predominant direction, **D** | 48% |
| Lateral Placement factor, **E = 0.25*D** | 8587844 |
| Factor for selection of traffic for BUC analysis (for six-hour period during day), **F** | 0.15 |
| Factor for selection of traffic for TDC analysis (for six-hour period during day), **G** | 0.35 |
| Design axle repetitions for BUC analysis (for 6 hour day time traffic), **H = C*E*F** | 1288177 |
| Proportion of vehicles with spacing between front and the first rear axle less than the spacing of transverse joints, **I** | 17.32% |
| Design axle repetitions for TDC analysis (for 6-hour night time traffic), **J = C*E*G*I** | 520490 |

| | | |
|---|---|---|
| Proportion of Front single (steering) Axles, **K1** | As per Axle load surveys | 0.488 |
| Proportion of Rear single Axles,**K2** | | 0.399 |
| Proportion of Tandem Axles, **K3** | | 0.109 |
| Proportion of Tridem Axles, **K4 = (1-K1-K2-K3)** | | 0.004 |

**Design Axle Load Repetitions for Fatigue Analysis**

**For Bottom-up Cracking Analysis**

| | |
|---|---|
| Front single (steering) Axles = H * K1 | 629110 |
| Rear single Axles = H * K2 | 514272 |
| Tandem Axles = H * K3 | 139802 |

Tridem Axles = H * K4 4993

**For Top-Down Cracking Analysis**

Front single (steering) Axles = J * K1 254193

Rear single Axles = J * K2 207793

Tandem Axles = J * K3 56487

Tridem Axles = J * K4 2017

### 6.8.5 Axle load spectrum

Expected number of applications of different axle load groups have been estimated using the details of commercial traffic volume, expected rate of growth of commercial traffic. As per the axle load surveys conducted, the loading pattern in the stretch between Silchar to Jiribam is more critical than between Jiribam to Silchar. The axle load spectrum corresponding to Km 262+000 (existing Chainage) and Km 217+000 (existing Chainage) is considered and is given below:

**Table 6.19 Axle load spectrum**

| Load (KN) | % of Vehicles at along existing road | | | | | |
|---|---|---|---|---|---|---|
| | Silchar To Jiribam | | | Jiribam To Silchar | | |
| | Single Axle | Tandem Axle | Tridem Axle | Single Axle | Tandem Axle | Tridem Axle |
| 0-85 | 43.22 | 7.14 | 0.00 | 92.02 | 96.15 | - |
| 85-95 | 5.53 | 0.00 | 0.00 | 0.00 | 3.85 | - |
| 95-105 | 5.03 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 105-115 | 7.04 | 3.57 | 0.00 | 0.53 | 0.00 | - |
| 115-125 | 6.53 | 0.00 | 0.00 | 0.53 | 0.00 | - |
| 125-135 | 8.04 | 5.36 | 0.00 | 1.06 | 0.00 | - |
| 135-145 | 8.54 | 3.57 | 0.00 | 1.06 | 0.00 | - |
| 145-155 | 1.01 | 1.79 | 0.00 | 1.06 | 0.00 | - |
| 155-165 | 2.51 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 165-175 | 9.55 | 3.57 | 0.00 | 0.00 | 0.00 | - |
| 175-185 | 2.51 | 10.71 | 0.00 | 1.06 | 0.00 | - |
| 185-195 | 0.50 | 3.57 | 0.00 | 0.00 | 0.00 | - |
| 195-205 | 0.00 | 7.14 | 0.00 | 2.66 | 0.00 | - |

| Load (KN) | % of Vehicles at along existing road | | | | | |
|---|---|---|---|---|---|---|
| | Silchar To Jiribam | | | Jiribam To Silchar | | |
| | Single Axle | Tandem Axle | Tridem Axle | Single Axle | Tandem Axle | Tridem Axle |
| 205-215 | 0.00 | 5.36 | 0.00 | 0.00 | 0.00 | - |
| 215-225 | 0.00 | 8.93 | 0.00 | 0.00 | 0.00 | - |
| 225-235 | 0.00 | 7.14 | 100.00 | 0.00 | 0.00 | - |
| 235-245 | 0.00 | 5.36 | 0.00 | 0.00 | 0.00 | - |
| 245-255 | 0.00 | 7.14 | 0.00 | 0.00 | 0.00 | - |
| 255-265 | 0.00 | 3.57 | 0.00 | 0.00 | 0.00 | - |
| 265-275 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 275-285 | 0.00 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 285-295 | 0.00 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 295-305 | 0.00 | 5.36 | 0.00 | 0.00 | 0.00 | - |
| 305-315 | 0.00 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 315-325 | 0.00 | 1.79 | 0.00 | 0.00 | 0.00 | - |
| 325-335 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 335-345 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 345-355 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 355-365 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 365-375 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 375-385 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 385-395 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 395-405 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 405-415 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| 415-425 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

### 6.8.6 Fatigue Damage Analysis

Due to the simultaneous application of traffic loads and temperature differentials between the top and bottom of a concrete slab, concrete pavements are subjected to Bottom-Up Cracking (BUC) during day hours and Top-Down Cracking (TDC) during night hours. Hence, the pavement design is checked for cumulative bottom-up and top-down cracking damages.

*Analysis has been done for the following cases:*

*Bottom-up Cracking – For single rare axle and tandem rare axle*
*Top-down Cracking – For single, tandem and Tridem rare axle*

**Location: - Proposed green filed**

**Table 6.20 Cumulative Fatigue Damage Analysis**

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| **i) Cumulative Fatigue Damage Analysis for Bottom-up Cracking (BUC)** | | | | | | | |
| **Rear Single Axles** | | | | | | | |
| <=85 | 190 | 2.61 | 0.527 | 43.22 | 222248 | 256613.4861 | 0.866 |
| 85-95 | 90 | 1.74 | 0.351 | 5.53 | 28427 | Infinite | 0.000 |
| 95-105 | 100 | 1.83 | 0.369 | 5.03 | 25843 | Infinite | 0.000 |
| 105-115 | 110 | 1.91 | 0.386 | 7.04 | 36180 | Infinite | 0.000 |
| 115-125 | 120 | 2.00 | 0.404 | 6.53 | 33596 | Infinite | 0.000 |
| 125-135 | 130 | 2.09 | 0.421 | 8.04 | 41349 | Infinite | 0.000 |
| 135-145 | 140 | 2.17 | 0.439 | 8.54 | 43933 | Infinite | 0.000 |
| 145-155 | 150 | 2.26 | 0.456 | 1.01 | 5169 | 22475442.05 | 0.000 |
| 155-165 | 160 | 2.35 | 0.474 | 2.51 | 12921 | 3730355.486 | 0.003 |
| 165-175 | 170 | 2.43 | 0.492 | 9.55 | 49101 | 1178385.191 | 0.042 |
| 175-185 | 180 | 2.52 | 0.509 | 2.51 | 12921 | 503535.2051 | 0.026 |
| 185-195 | 190 | 2.61 | 0.527 | 0.50 | 2584 | 256613.4861 | 0.010 |
| 195-205 | 200 | 2.69 | 0.544 | 0.00 | 0 | 146794.7142 | 0.000 |
| 205-215 | 210 | 2.78 | 0.562 | 0.00 | 0 | 89511.39792 | 0.000 |
| 215-225 | 220 | 2.87 | 0.579 | 0.00 | 0 | 54939.13678 | 0.000 |
| 225-235 | 230 | 2.95 | 0.597 | 0.00 | 0 | 33719.82586 | 0.000 |

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| 235-245 | 240 | 3.04 | 0.614 | 0.00 | 0 | 20696.11433 | 0.000 |
| 245-255 | 250 | 3.13 | 0.632 | 0.00 | 0 | 12702.59076 | 0.000 |
| 255-265 | 260 | 3.22 | 0.650 | 0.00 | 0 | 7796.430256 | 0.000 |
| 265-275 | 270 | 3.30 | 0.667 | 0.00 | 0 | 4785.19114 | 0.000 |
| 275-285 | 280 | 3.39 | 0.685 | 0.00 | 0 | 2936.992122 | 0.000 |
| 285-295 | 290 | 3.48 | 0.702 | 0.00 | 0 | 1802.628667 | 0.000 |
| 295-305 | 300 | 3.56 | 0.720 | 0.00 | 0 | 1106.393881 | 0.000 |
| **Fatigue Damage from Rear Single Axles** | | | | | | | **0.947** |
| **Rear Tandem Axles** | | | | | | | |
| <=205 | 200 | 1.47 | 0.297 | 50.00 | 69901 | Infinite | 0.000 |
| 205-215 | 210 | 1.51 | 0.305 | 5.36 | 7489 | Infinite | 0.000 |
| 215-225 | 220 | 1.55 | 0.313 | 8.93 | 12482 | Infinite | 0.000 |
| 225-235 | 230 | 1.59 | 0.321 | 7.14 | 9986 | Infinite | 0.000 |
| 235-245 | 240 | 1.63 | 0.329 | 5.36 | 7489 | Infinite | 0.000 |
| 245-255 | 250 | 1.67 | 0.336 | 7.14 | 9986 | Infinite | 0.000 |
| 255-265 | 260 | 1.70 | 0.344 | 3.57 | 4993 | Infinite | 0.000 |
| 265-275 | 270 | 1.74 | 0.352 | 0.00 | 0 | Infinite | 0.000 |
| 275-285 | 280 | 1.78 | 0.360 | 1.79 | 2496 | Infinite | 0.000 |
| 285-295 | 290 | 1.82 | 0.368 | 1.79 | 2496 | Infinite | 0.000 |
| 295-305 | 300 | 1.86 | 0.376 | 5.36 | 7489 | Infinite | 0.000 |
| 305-315 | 310 | 1.90 | 0.384 | 1.79 | 2496 | Infinite | 0.000 |
| 315-325 | 320 | 1.94 | 0.392 | 1.79 | 2496 | Infinite | 0.000 |
| 325-335 | 330 | 1.98 | 0.400 | 0.00 | 0 | Infinite | 0.000 |
| 335-345 | 340 | 2.02 | 0.408 | 0.00 | 0 | Infinite | 0.000 |
| 345-355 | 350 | 2.06 | 0.416 | 0.00 | 0 | Infinite | 0.000 |
| 355-365 | 360 | 2.10 | 0.423 | 0.00 | 0 | Infinite | 0.000 |
| 365-375 | 370 | 2.14 | 0.431 | 0.00 | 0 | Infinite | 0.000 |

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| 375-385 | 380 | 2.17 | 0.439 | 0.00 | 0 | Infinite | 0.000 |
| 385-395 | 390 | 2.21 | 0.447 | 0.00 | 0 | Infinite | 0.000 |
| 395-405 | 400 | 2.25 | 0.455 | 0.00 | 0 | 27167467.79 | 0.000 |
| 405-415 | 410 | 2.29 | 0.463 | 0.00 | 0 | 10194164.98 | 0.000 |
| 415-425 | 420 | 2.33 | 0.471 | 0.00 | 0 | 4800788.387 | 0.000 |
| 425-435 | 430 | 2.37 | 0.479 | 0.00 | 0 | 2604344.282 | 0.000 |
| 435-445 | 440 | 2.41 | 0.487 | 0.00 | 0 | 1556122.186 | 0.000 |
| 445-455 | 450 | 2.45 | 0.495 | 0.00 | 0 | 997430.2015 | 0.000 |
| 455-465 | 460 | 2.49 | 0.503 | 0.00 | 0 | 674355.1707 | 0.000 |
| 465-475 | 470 | 2.53 | 0.510 | 0.00 | 0 | 475439.6066 | 0.000 |
| 475-485 | 480 | 2.57 | 0.518 | 0.00 | 0 | 346720.4 | 0.000 |
| **Fatigue Damage from Rear Tandem Axles** | | | | | | | **0.000** |
| **ii) Cumulative Fatigue Damage Analysis for Top-down Cracking (TDC)** | | | | | | | |
| **Single Axle** | | | | | | | |
| <=85 | 80 | 1.81 | 0.366 | 43.22 | 89800 | Infinite | 0.000 |
| 85-95 | 90 | 1.87 | 0.378 | 5.53 | 11486 | Infinite | 0.000 |
| 95-105 | 100 | 1.93 | 0.390 | 5.03 | 10442 | Infinite | 0.000 |
| 105-115 | 110 | 1.99 | 0.402 | 7.04 | 14619 | Infinite | 0.000 |
| 115-125 | 120 | 2.05 | 0.414 | 6.53 | 13574 | Infinite | 0.000 |
| 125-135 | 130 | 2.11 | 0.426 | 8.04 | 16707 | Infinite | 0.000 |
| 135-145 | 140 | 2.17 | 0.438 | 8.54 | 17751 | Infinite | 0.000 |
| 145-155 | 150 | 2.23 | 0.450 | 1.01 | 2088 | Infinite | 0.000 |
| 155-165 | 160 | 2.29 | 0.462 | 2.51 | 5221 | 11396631.2 | 0.000 |
| 165-175 | 170 | 2.35 | 0.474 | 9.55 | 19839 | 3718917.682 | 0.005 |
| 175-185 | 180 | 2.41 | 0.486 | 2.51 | 5221 | 1617556.994 | 0.003 |
| 185-195 | 190 | 2.47 | 0.498 | 0.50 | 1044 | 833605.5603 | 0.001 |
| 195-205 | 200 | 2.53 | 0.510 | 0.00 | 0 | 480538.5109 | 0.000 |

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| 205-215 | 210 | 2.59 | 0.522 | 0.00 | 0 | 299960.3672 | 0.000 |
| 215-225 | 220 | 2.64 | 0.534 | 0.00 | 0 | 198713.5415 | 0.000 |
| 225-235 | 230 | 2.70 | 0.546 | 0.00 | 0 | 137855.6621 | 0.000 |
| 235-245 | 240 | 2.76 | 0.558 | 0.00 | 0 | 98189.07358 | 0.000 |
| 245-255 | 250 | 2.82 | 0.571 | 0.00 | 0 | 70217.46014 | 0.000 |
| 255-265 | 260 | 2.88 | 0.583 | 0.00 | 0 | 50214.2604 | 0.000 |
| 265-275 | 270 | 2.94 | 0.595 | 0.00 | 0 | 35909.4724 | 0.000 |
| 275-285 | 280 | 3.00 | 0.607 | 0.00 | 0 | 25679.76105 | 0.000 |
| 285-295 | 290 | 3.06 | 0.619 | 0.00 | 0 | 18364.23883 | 0.000 |
| 295-305 | 300 | 3.12 | 0.631 | 0.00 | 0 | 13132.72609 | 0.000 |
| 305-315 | 310 | 3.18 | 0.643 | 0.00 | 0 | 9391.540598 | 0.000 |
| **Fatigue Damage from Single Axles** | | | | | | | **0.010** |
| **Rear Tandem Axles** | | | | | | | |
| <=205 | 200 | 1.93 | 0.390 | 50.00 | 28244 | Infinite | 0.000 |
| 205-215 | 210 | 1.96 | 0.396 | 5.36 | 3026 | Infinite | 0.000 |
| 215-225 | 220 | 1.99 | 0.402 | 8.93 | 5044 | Infinite | 0.000 |
| 225-235 | 230 | 2.02 | 0.408 | 7.14 | 4035 | Infinite | 0.000 |
| 235-245 | 240 | 2.05 | 0.414 | 5.36 | 3026 | Infinite | 0.000 |
| 245-255 | 250 | 2.08 | 0.420 | 7.14 | 4035 | Infinite | 0.000 |
| 255-265 | 260 | 2.11 | 0.426 | 3.57 | 2017 | Infinite | 0.000 |
| 265-275 | 270 | 2.14 | 0.432 | 0.00 | 0 | Infinite | 0.000 |
| 275-285 | 280 | 2.17 | 0.438 | 1.79 | 1009 | Infinite | 0.000 |
| 285-295 | 290 | 2.20 | 0.444 | 1.79 | 1009 | Infinite | 0.000 |
| 295-305 | 300 | 2.23 | 0.450 | 5.36 | 3026 | Infinite | 0.000 |
| 305-315 | 310 | 2.26 | 0.456 | 1.79 | 1009 | 24056663.34 | 0.000 |
| 315-325 | 320 | 2.29 | 0.462 | 1.79 | 1009 | 11396631.2 | 0.000 |
| 325-335 | 330 | 2.32 | 0.468 | 0.00 | 0 | 6206750.961 | 0.000 |

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| 335-345 | 340 | 2.35 | 0.474 | 0.00 | 0 | 3718917.682 | 0.000 |
| 345-355 | 350 | 2.38 | 0.480 | 0.00 | 0 | 2388668.309 | 0.000 |
| 355-365 | 360 | 2.41 | 0.486 | 0.00 | 0 | 1617556.994 | 0.000 |
| 365-375 | 370 | 2.44 | 0.492 | 0.00 | 0 | 1141885.507 | 0.000 |
| 375-385 | 380 | 2.47 | 0.498 | 0.00 | 0 | 833605.5603 | 0.000 |
| 385-395 | 390 | 2.50 | 0.504 | 0.00 | 0 | 625618.7266 | 0.000 |
| 395-405 | 400 | 2.53 | 0.510 | 0.00 | 0 | 480538.5109 | 0.000 |
| 405-415 | 410 | 2.56 | 0.516 | 0.00 | 0 | 376452.396 | 0.000 |
| 415-425 | 420 | 2.59 | 0.522 | 0.00 | 0 | 299960.3672 | 0.000 |
| 425-435 | 430 | 2.62 | 0.528 | 0.00 | 0 | 242566.4512 | 0.000 |
| 435-445 | 440 | 2.64 | 0.534 | 0.00 | 0 | 198713.5415 | 0.000 |
| 445-455 | 450 | 2.67 | 0.540 | 0.00 | 0 | 164666.8333 | 0.000 |
| 455-465 | 460 | 2.70 | 0.546 | 0.00 | 0 | 137855.6621 | 0.000 |
| 465-475 | 470 | 2.73 | 0.552 | 0.00 | 0 | 116110.6845 | 0.000 |
| 475-485 | 480 | 2.76 | 0.558 | 0.00 | 0 | 98189.07358 | 0.000 |
| **Fatigue Damage from Tandem Axles** | | | | | | | **0.000** |
| **Rear Tridem Axles** | | | | | | | |
| <=205 | 200 | 1.73 | 0.349 | 0.00 | 0 | Infinite | 0.000 |
| 205-215 | 210 | 1.75 | 0.353 | 0.00 | 0 | Infinite | 0.000 |
| 215-225 | 220 | 1.77 | 0.358 | 0.00 | 0 | Infinite | 0.000 |
| 225-235 | 230 | 1.79 | 0.362 | 100.00 | 56487 | Infinite | 0.000 |
| 235-245 | 240 | 1.81 | 0.366 | 0.00 | 0 | Infinite | 0.000 |
| 245-255 | 250 | 1.83 | 0.370 | 0.00 | 0 | Infinite | 0.000 |
| 255-265 | 260 | 1.85 | 0.374 | 0.00 | 0 | Infinite | 0.000 |
| 265-275 | 270 | 1.87 | 0.378 | 0.00 | 0 | Infinite | 0.000 |
| 275-285 | 280 | 1.89 | 0.382 | 0.00 | 0 | Infinite | 0.000 |
| 285-295 | 290 | 1.91 | 0.386 | 0.00 | 0 | Infinite | 0.000 |

| Axle load (AL), KN | | Flexural Stress, MPa | Stress Ratio | % of Axles | Expected Repetitions (ni) | Allowable Repetitions (Ni) | Fatigue Damage (ni/Ni) |
|---|---|---|---|---|---|---|---|
| 295-305 | 300 | 1.93 | 0.390 | 0.00 | 0 | Infinite | 0.000 |
| 305-315 | 310 | 1.95 | 0.394 | 0.00 | 0 | Infinite | 0.000 |
| 315-325 | 320 | 1.97 | 0.398 | 0.00 | 0 | Infinite | 0.000 |
| 325-335 | 330 | 1.99 | 0.402 | 0.00 | 0 | Infinite | 0.000 |
| 335-345 | 340 | 2.01 | 0.406 | 0.00 | 0 | Infinite | 0.000 |
| 345-355 | 350 | 2.03 | 0.410 | 0.00 | 0 | Infinite | 0.000 |
| 355-365 | 360 | 2.05 | 0.414 | 0.00 | 0 | Infinite | 0.000 |
| 365-375 | 370 | 2.07 | 0.418 | 0.00 | 0 | Infinite | 0.000 |
| 375-385 | 380 | 2.09 | 0.422 | 0.00 | 0 | Infinite | 0.000 |
| 385-395 | 390 | 2.11 | 0.426 | 0.00 | 0 | Infinite | 0.000 |
| 395-405 | 400 | 2.13 | 0.430 | 0.00 | 0 | Infinite | 0.000 |
| 405-415 | 410 | 2.15 | 0.434 | 0.00 | 0 | Infinite | 0.000 |
| 415-425 | 420 | 2.17 | 0.438 | 0.00 | 0 | Infinite | 0.000 |
| 425-435 | 430 | 2.19 | 0.442 | 0.00 | 0 | Infinite | 0.000 |
| 435-445 | 440 | 2.21 | 0.446 | 0.00 | 0 | Infinite | 0.000 |
| 445-455 | 450 | 2.23 | 0.450 | 0.00 | 0 | Infinite | 0.000 |
| 455-465 | 460 | 2.25 | 0.454 | 0.00 | 0 | 32230598.38 | 0.000 |
| 465-475 | 470 | 2.27 | 0.458 | 0.00 | 0 | 18392652.12 | 0.000 |
| 475-485 | 480 | 2.29 | 0.462 | 0.00 | 0 | 11396631.2 | 0.000 |
| **Fatigue Damage from Rear Tridem Axles** | | | | | | | **0.000** |

| CFD for BUC Case | | CFD for TDC Case | | | Total CFD |
|---|---|---|---|---|---|
| Due to Single Axles | Due to Tandem Axles | Due to Single Axles | Due to Tandem Axles | Due to Tridem Axles | |
| 0.947 | 0.000 | 0.010 | 0.000 | 0.000 | 0.958 |

The sum of cumulative fatigue damage for both cases of Bottom-up cracking and Top-down cracking is less than 1. Hence, the thickness of 270 mm is safe for the expected traffic.

Considering two retexturing in 30 years, a thickness of 280 mm is recommended. The load for the design of Dowel bar is considered based on maximum axle load irrespective of direction at each location. The traffic estimation, Dowel bar & Tie bar design is done for the data.

### 6.8.7 Design of Dowel Bars

#### i. Proposed green field

**Input Data**

| | | | |
|---|---|---|---|
| Dia of dowel bar, $b_d$ | = | 36 | mm |
| Spacing between the dowel bars | = | 300 | mm |
| Length of the dowel bar | = | 450 | mm |
| Slab Thickness, h | = | 280 | mm |
| Joint width at contraction joints, z | = | 5 | mm |
| Joint width at expansion joints, z | = | 20 | mm |
| Modulus of subgrade reaction, k | = | 50.33 | MPa/m |
| Modulus of the elasticity of the dowel, E | = | 200000 | Mpa |
| Modulus of dowel support, $k_{mds}$ | = | 415000 | MPa/m |
| Grade of concrete | = | 40 | |
| Characteristic compressive strength of concrete cube(15cm) after 28 days curing concrete, fck | = | 40 | Mpa |
| Permissible bearing stress in concrete, $F_b$ | = | 28 | Mpa |

**Check for Bearing Stress**

| | | | |
|---|---|---|---|
| Maximum single axle load | = | 160.000 | KN |
| Maximum single wheel load | = | 80.000 | KN |
| Wheel load for dowel bar design | = | 56.000 | KN |
| Percentage of load transfer through dowel bar | = | 50.000 | |
| Load to be transferred by dowel bar | = | 28.000 | KN |
| Moment of Inertia of the dowel, I | = | 82406 | $mm^4$ |
| Radius of relative stiffness, l | = | 1027.686 | mm |
| Relative stiffness of bar embedded in concrete | = | 0.022 | $mm^{-1}$ |
| Number of dowel bars participating in load transfer | = | 4.0 | |
| The total load transferred by dowel bar system | = | 2.337 | Pt |

| | | | |
|---|---|---|---|
| Load carried by the outer dowel bar, Pt | = | 12 | KN |
| Bearing stress in dowel bar at contraction joints | = | 15 | < 29 |
| Bearing stress in dowel bar at expansion joints | = | 18 | < 29 |

Hence assumed spacing and dia of dowel bar are safe

**Adopted Design**

| | | | |
|---|---|---|---|
| Diameter of dowel bar | = | 36 | mm |
| Spacing between dowels | = | 300 | mm |
| Length of dowel bar | = | 450 | mm |

### 6.8.8 Design of Tie Bars

**ii. Proposed green field**

**Design Parameters**

| | | | |
|---|---|---|---|
| Slab thickness, h | = | 0.28 | m |
| Lane width, b | = | 4.50 | m |
| Co-efficient of friction, f | = | 1.5 | |
| Density of concrete | = | 24 | $KN/m^3$ |
| Allowable tensile stress in deformed bars, S | = | 200 | Mpa |
| Allowable bond stress in deformed tie bars, B | = | 2.46 | Mpa |
| Diameter of tie bar, d | = | 12 | mm |

**Spacing and length of the deformed tie bar**

| | | | |
|---|---|---|---|
| Area of steel bar per metre width of joint to resist the frictional force at slab bottom , As | = | 226.8 | $mm^2/m$ |
| Cross sectional area of tie bar , A | = | 113.10 | $mm^2$ |
| Perimeter of tie bar , P | = | 37.70 | mm |
| Spacing of tie bars , A/As | = | 498.0 | mm |
| Length of tie bar , L | = | 487.80 | mm |

Increase length by 10 cm for loss of bond due to painting and another 5 cm for tolerance in placement.

| | | | |
|---|---|---|---|
| Therefore, Length of tie bar , L | = | 637.80 | cm |
| | Say | 640.0 | cm |

**Adopted Design**

| | | | |
|---|---|---|---|
| Diameter of tie bar (Deformed) | = | 12 | mm |

Spacing of tie bar = 460 mm

Length of tie bar = 640 mm

## 6.9 Recommendation

As discussed above 3 pavement options has been studied 1) Flexible Pavement, 2) Reinforced Flexible pavement with geo-grid and 3) Rigid pavement. As the proposed alignment is a new green filed alignment and in submerged area, DPR consultant has recommended Flexible pavement with Geo grid provision and the same has been used for arriving the cost. The summary of the recommended pavement thickness is given below;

**Table 6.21 Summary of Pavement Type**

| Sl No | Sections (design Chainage) | Length (Km) | *Type of Pavement | Thickness |
|---|---|---|---|---|
| 1 | From Km 4+560 to Km 37+650 | 33.09 | Flexible with Geogrid | BC = 40 mm<br>DBM = 65 mm<br>WMM = 250 mm<br>Geogrid (Biaxial)<br>GSB = 200 mm<br>Subgrade = 500 mm |

*Note: * Rigid pavement is proposed at toll plaza and tunnel portion.*

Based on above recommendation the BOQ and cost estimate has been estimated.

Further, the proposed alignment is passing through open field having varying CBR value of 5 % to 6% an additional geogrid layer has been introduced between natural ground (after clearing and grubbing) and selected earth (Embankment). A sand blanket has been considered between subgrade and selected earth (embankment) wherever applicable/as per site condition. Please refer the typical resection details provided in Chapter 7: Improvement proposals for the location details for provision of Geogrid and Sand blanket.

The typical figure of the pavement cross section is given below.

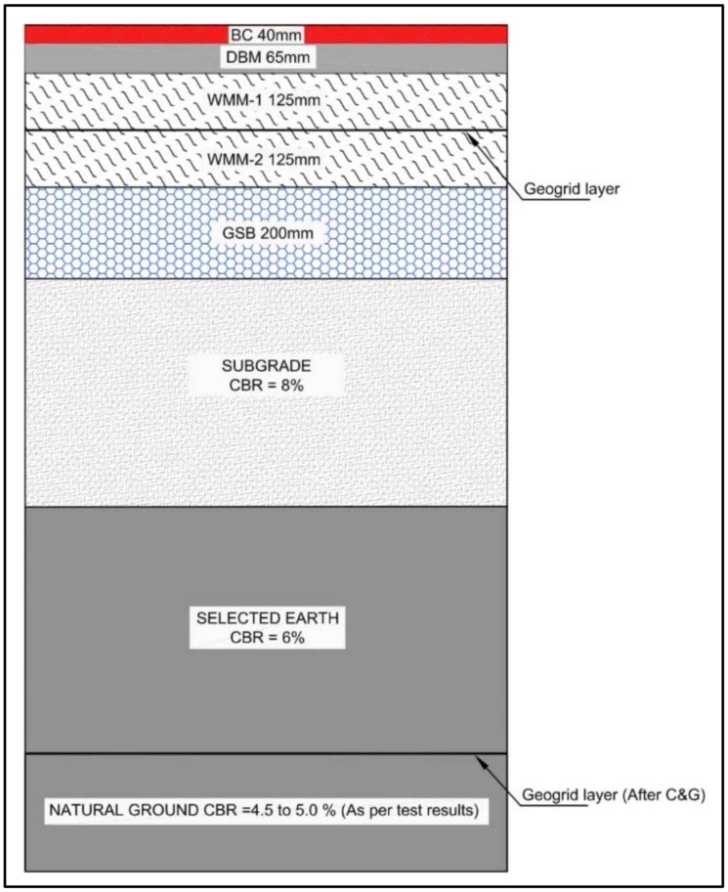



**Figure 6-3: Flexible Pavement cross section with Geo grid provision**

## 6.10 Design thickness for Toll Plaza

Rigid pavement is proposed for toll plaza & tunnel portion and the details of proposed rigid pavement thickness is given in below table.

**Table 6.22 Summary of Pavement Type and Thickness for Toll Plaza and Tunnel portion**

| Sl No | Sections | Type of Pavement | Thickness |
|---|---|---|---|
| 1 | Toll Plaza and Tunnel portion | Rigid | PQC = 280 mm<br>DLC = 150 mm<br>GSB = 150 mm<br>Subgrade = 500 mm |

## 6.11 Design thickness for service road

As per the Clause 5.5.4 of IRC SP: 84-2019 service road shall be designed for 10 MSA. The pavement layer thickness for design traffic of 10 MSA and 8% CBR is given in below table.

**Table 6.23 Summary of Pavement thickness for Service Road**

| Sl No | Sections (design Chainage) | Design MSA | Length (Km) | Type of Pavement | Thickness |
|---|---|---|---|---|---|
| 1 | From Km 4+560 to Km 37+650 | 10 | 33.09 | Flexible | BC = 30 mm<br>DBM = 60 mm<br>WMM = 250 mm<br>GSB = 200 mm<br>Subgrade = 500 mm |

## 6.12 Design thickness for Bus Bay:

If the Bus shelter comes adjacent to the main carriage way, then the thickness for bus shelter will be same as the thickness of main carriageway, if the bus shelter will come adjacent to the service road, then the thickness service road will be taken as the thickness of Bus shelter.

## 6.13 Design thickness for Truck Lay by:

If the Truck layby comes adjacent to the main carriage way, then the thickness for Truck layby will be same as the thickness of main carriageway, if the Truck layby will come adjacent to the service road, then the thickness service road will be taken as the thickness of Truck layby.

7

# Chapter 7 – Improvement Proposal (Highways)

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# 7 Chapter 7 – Improvement Proposals (Highways)

## 7.1 General

This chapter is intended to give brief descriptions concerning the various improvement proposals for the up-gradation of existing 2-lane carriageway facility of Silchar–Jiribam to at-least 4-lane configuration. These improvement proposals are based on the findings from various engineering activities/ surveys carried out on the project roads such as Traffic Surveys, Engineering Surveys & Investigations. Recommendations given in IRC: SP: 84- 2019, "Manual of Specifications and Standards for 4-laning of Highways - 2019" has been followed while finalising the various improvement proposals.

## 7.2 Construction Packages

The project corridor has been identified from Silchar to Imphal under national highway NH-37 with total length of 265 Km.

After successful submission of Draft DPR vide through letter Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40386, it was conveyed by NHIDCL that Silchar – Jiribam (SJ) corridor shall be on hold for further investigation and study as the project stretch has not been included in the priority list due to uncertainty of 4-lane development of said stretch.

However, in the month of May 2023 the said project was reopened under the direction of MD & D(T) during VC meeting and DPR had been asked to accelerate the remaining pending assignment pertaining to said project as the project stretch was included under current year development plan.

Final DPR was submitted vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2022-23/404037 dated but collectively decision was taken to bifurcate the project corridor in to two (02) packages due to tunnel proposal & its cost constraints and several other limitations.

Hence, based on assessment and in consultation with NHIDCL officers, the package distributions are as under,

**Table 7.1 Package Distribution**

| Sl. No. | Construction Packages | Design Chainage | | | Existing Chainage | | | Bypassing to |
|---|---|---|---|---|---|---|---|---|
| | | From | To | Length (km) | From | To | Length (km) | |
| **1** | **Package: SJ-1** | **4+560** | **24+560** | **20.000** | **260+000 on NH-37, Assam** | **233+000 on NH-37, Assam** | **27.000** | **(Kasipur, Banshkandi, Paiilapool, Fulertal etc.)** |
| 2 | Package: SJ-2 | 24+560 | 37+650 | 13.090 | 233+000 on NH-37, Assam | 212+060 on NH-37, Manipur | 20.940 | Uttar Lalpani, Jirighat, Jiribam etc. |
| | **Total Design Length** | | | **33.090** | **Total Existing Length** | | **47.940** | |

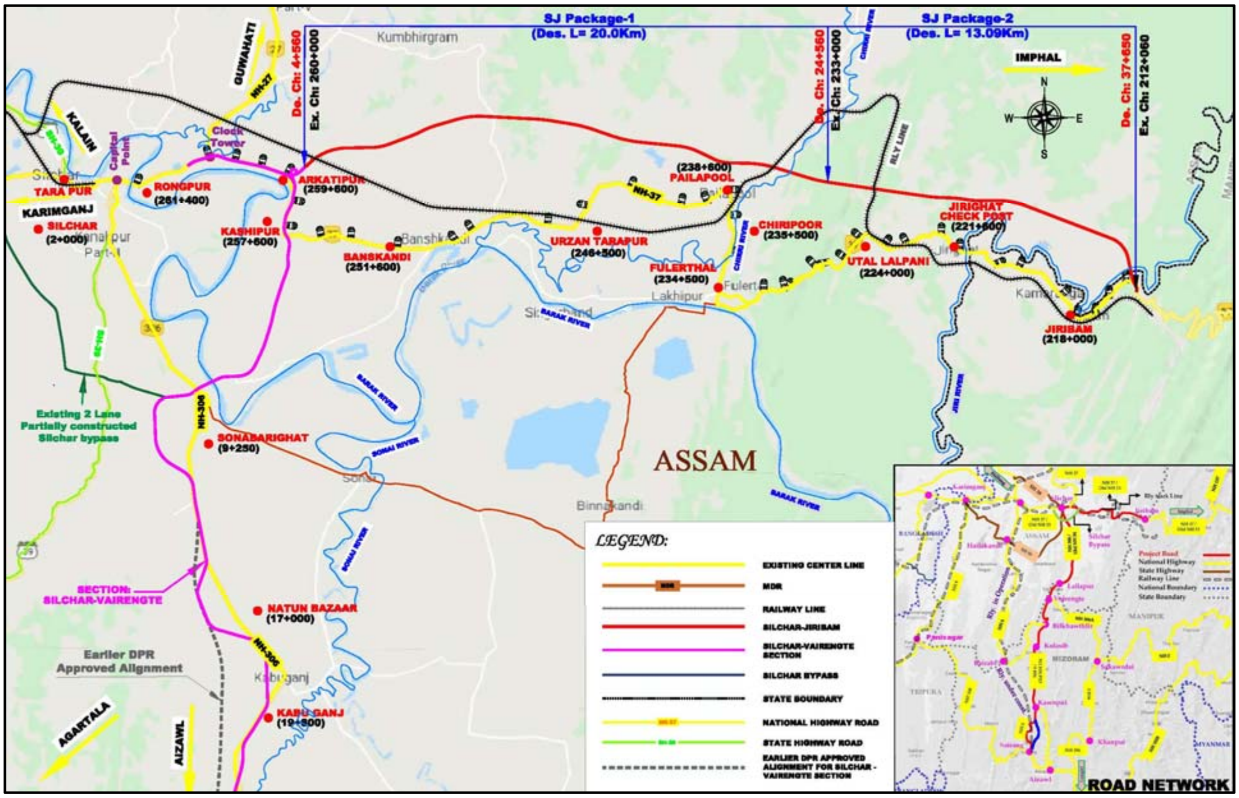



**Fig 7.1 Key Plan for Proposed Construction Packages**

**This Report mainly contains Improvement proposal pertaining to Package: SJ-1.**

## 7.3 Improvement / Construction Proposals

Improvement proposals for a highway essentially consist of two components, geometric and structural. Geometric improvement deals with visible dimensions of roadway and is dictated by the traffic and economic considerations. Geometric design involves several design elements such as horizontal and vertical alignments, sight distance considerations, cross sectional elements, lateral and vertical clearances, intersection treatment, control of access etc. The structural component deals with the pavement, embankment and structure design aspects i.e., the ability of the highway to adequately carry and support the vehicle/ wheel loads over the design period.

The improvement proposals for the proposed to 4-lane configuration system includes the provisions for the following major items:

- Alignment and Geometry;
- Lane Configuration;
- Cross-Sectional elements;
- Access control measures

- Pavement Improvement Options
- Cross-Drainages works
- Bridges and Cross-Drainage structures
- Road Appurtenances

## 7.4 Alignment & Geometrics

Alignment design is one of the most important features influencing the efficiency and safety of a highway. The ideal highway alignment is the one which will cause the least over-all transportation cost taking into account the cost of construction, maintenance and recurring cost of vehicles operation. Hence, the aim of designing the geometric is been to establish a safe, easy, short and economically possible alignment, considering the physical features of the region and traffic needs apart from least disturbance to the eco-system.

The existing alignment of the project road is linear throughout except at few locations, where alignment needs geometric improvements. To develop the project road to 4-Lane standards entails a thorough and elaborate study of the corridor of project road.

The alignment proposals are based on the findings from various engineering activities/ surveys carried out on the project road. The proposed alignment has been selected in consistent with the prevailing terrain conditions of the area in such a way that,

- It fits well with natural terrain and requires least mitigation measures against adverse environmental impacts with due consideration to least deforestation, resettlement etc.;
- Least disturbance to existing traffic during construction;
- As direct as possible so that there is maximum economy in vehicle operations and maintenance;
- To utilize the existing facility as much as possible in order to minimize the cost and effort of land acquisition;
- Consistent with the IRC guidelines.

Initially, reconnaissance was carried out by physical assessment and then by referring topo map, Google map to identifying most feasible route and its general characteristics followed by stakeholder's views after successive meeting.

Prior to taking up the ground reconnaissance survey, the following maps and secondary data, pertaining to project influence area, were collected and studied:

- Topo sheets of Survey of India on a scale of 1:50,000.
- Google Earth images of project area to know about most recent developments.
- Realignments options under consideration by NHIDCL.

For each of the realignments, possible alignment options were first marked on the Topo Sheets and Google image maps as well, and then these alignment options were verified physically on ground & necessary alterations were made. Comparative studies with respect to the Realignments/ Bypasses & other critical aspects were thoroughly studied. A site visit was also conducted by a team of experts from consultants along with GM (T/P) and other department officials and Suggestions were incorporated while finalizing the alignment options.

After necessary approval of alignment report topographical survey using high precision instrument i.e., LiDAR was used along the existing road and however, in consultation with NHIDCL HQ, total station instrument was used to do the detailed survey along the proposed bypasses in order to have high accuracy as far as elevation (ground level) concerns so that variation in earthworks should not cross (+/-) 5 to 10% during construction stage.

The improvement of alignment has been done by the proposal of Bypass and Greenfield option. A description of each alignment is given below:

Planimetry of the geometric improvements is given **in Vol IX – Drawings.** Locations of these improvements are given below.

### 7.4.1 Bypasses

There are some major settlement areas with ribbon developments along the project road. These settlements require bypasses because of continuous and thick ribbon developments, poor geometry and non-availability of ROW. Bypasses have been studied as it would not be possible to accommodate the proposed cross section through these settlements within the available ROW.

The proposed bypasses were critically examined / studied for individual built-up vs option of Green field single alignment for entire stretch.

**Study were classified in to 02 options as below,**

**Option A**: Improvement of existing road with individual bypass options at Major built up

**Option B**: Green filed alignment.

The detail of the same is given below in listed table.

**Table 7.2 List of Bypass Proposals.**

| Sl. No | Location | Exist. Chainage (Km) | | Exist. Length (Km) | Prop. Chainage (Km) | | Prop Length (Km) |
|---|---|---|---|---|---|---|---|
| | | Start | End | | Start | End | |
| **A.** | **Improvement of existing road with bypass options at Major Built up** | | | | | | |
| 1 | Kashipur Bypass (under Pkg: SJ-1) | 259+600 | 254+600 | 5.000 | These bypasses sections studied but ultimately merged / added with Approved green field alignment. | | 3.500 |
| 2 | Banskhandi Bypass (under Pkg: SJ-1) | 254+135 | 249+500 | 4.240 | | | 4.100 |
| 4 | Ujan Tarapur, Pailapool, Fulerthal Bypass (under Pkg: SJ-1) | 246+000 | 231+800 | 14.000 | | | 8.300 |
| 5 | Jiribam Bypass (under Pkg: SJ-2) | 225+000 | 215+750 | 9.250 | | | 8.100 |
| | | **Total Length (m)** | | **32.490** | | | **24.000** |
| **B** | **Green Field Alignment** | | | | | | |
| 1 | Green Field Alignment (under Pkg: SJ-1) | 260+000 | 233+000 | 27.000 | 4+560 | 24+560 | 20.000 |
| | Green Field Alignment (under Pkg: SJ-2) | 233+000 | 212+060 | 20.940 | 24+560 | 37+650 | 13.090 |
| | | **Total Length (m)** | | **47.940** | | | **33.090** |
| | **Total Approval Length (m) along bypasses / Green Field Alignment** | | | **47.940** | | | **33.090** |

## A. Improvement of existing road with bypass options at Major Built up

### A.1 Kashipur Bypass

The project road from 259+600 to Km 254+600 passes through Kashipur heavily built up areas, which has sub-standard geometrics, sharp 90º curve, built up on either side of existing road and Barak River is situated on RHS of existing road till Km 257+000.

Thus, to avoid the thickly habituated Kashipur town the 3 bypass options were studied. The detailed study shall be referred from earlier submitted Alignment Report however, brief information on final options are presented here under;

The selected alignment for bypassing Kashipur takes off from Km.259+600 on LHS of Kashipur and ends at Km.254+600, the approximate length of which is 3.50 Kms as against 5.0Kms along existing alignment, this alignment passes through mainly agriculture field that gives enough space for 4-lane development however, marginal buildings are affected as compared to other options. Also, since, the proposed alignment is fairly away from the built up, scope of further development around the settlement shall be established. Cost of improvement is also less in this option.

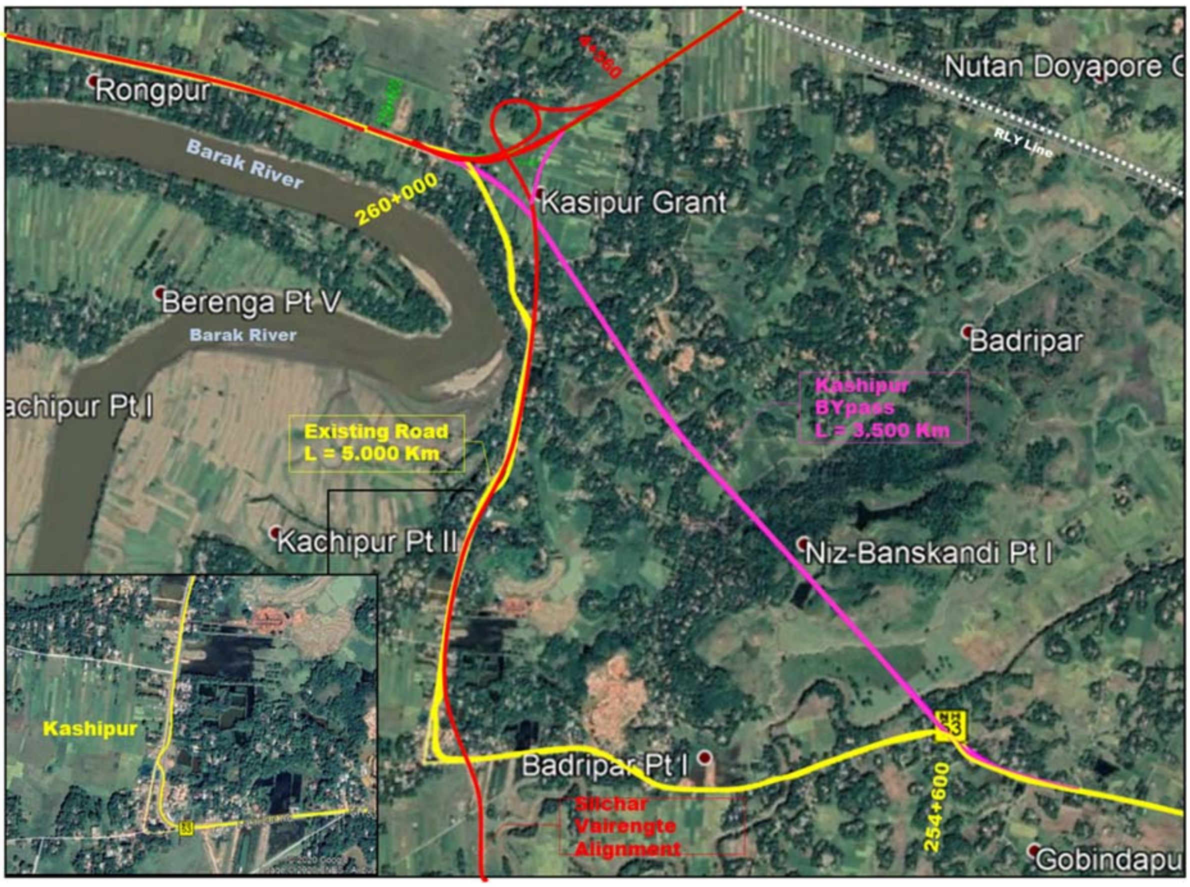



**Fig 7.2 Bypass for Kashipur**

### A.2 Banskhandi Bypass

The project road from Km 254+135 to Km 249+500 passes through heavy built up of Banshkandi village (Km 251+500). The carriageway width along built up section is 10 m with side drains on both sides. The condition of road is fair with some severe edge drop at selected sections. There are many religious structures along the edge of existing road and there is a Lake running along RHS. So, 4 bypass options were studied for Banskandi in order to avoid demolition of buildings and to provide free flow movement of the traffic. The length of bypass in this option works out to 4.10km.

Recommended bypass option takes off from Km 253+900 on LHS of Banskandi and terminates at Km 249+660. The alignment passes through mainly agriculture filed whereas a smaller amount of buildings needs to be acquired. Barak river and Baskhandi lake is also running on RHS, proposal of bypass on LHS found to be more feasible to develop in terms of-lane development. This gives better geometrics and free traffic flow to road users moreover; scope of further development around the settlement can be established. Cost is also less as compare to other options.

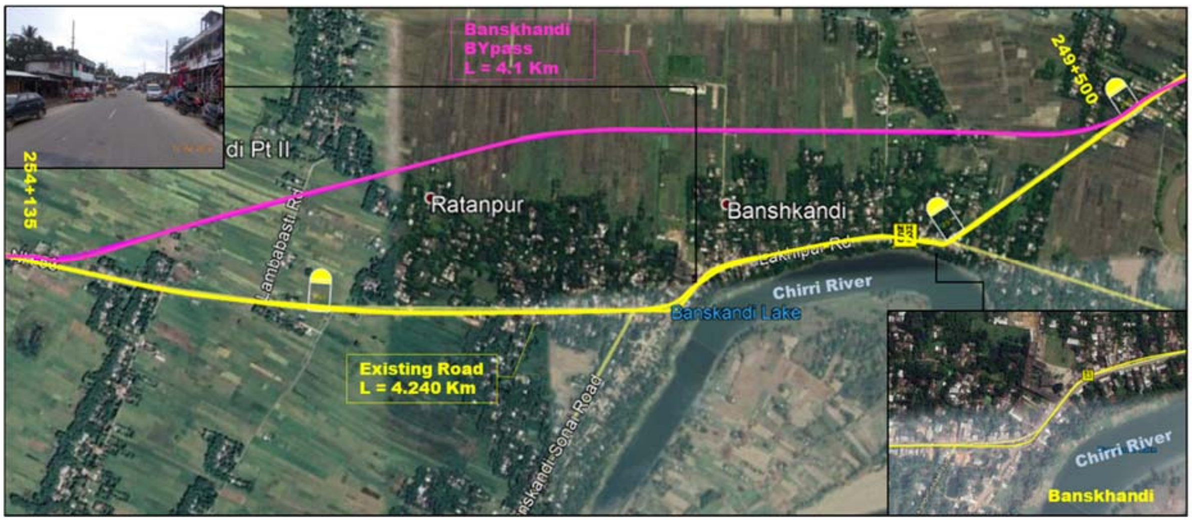


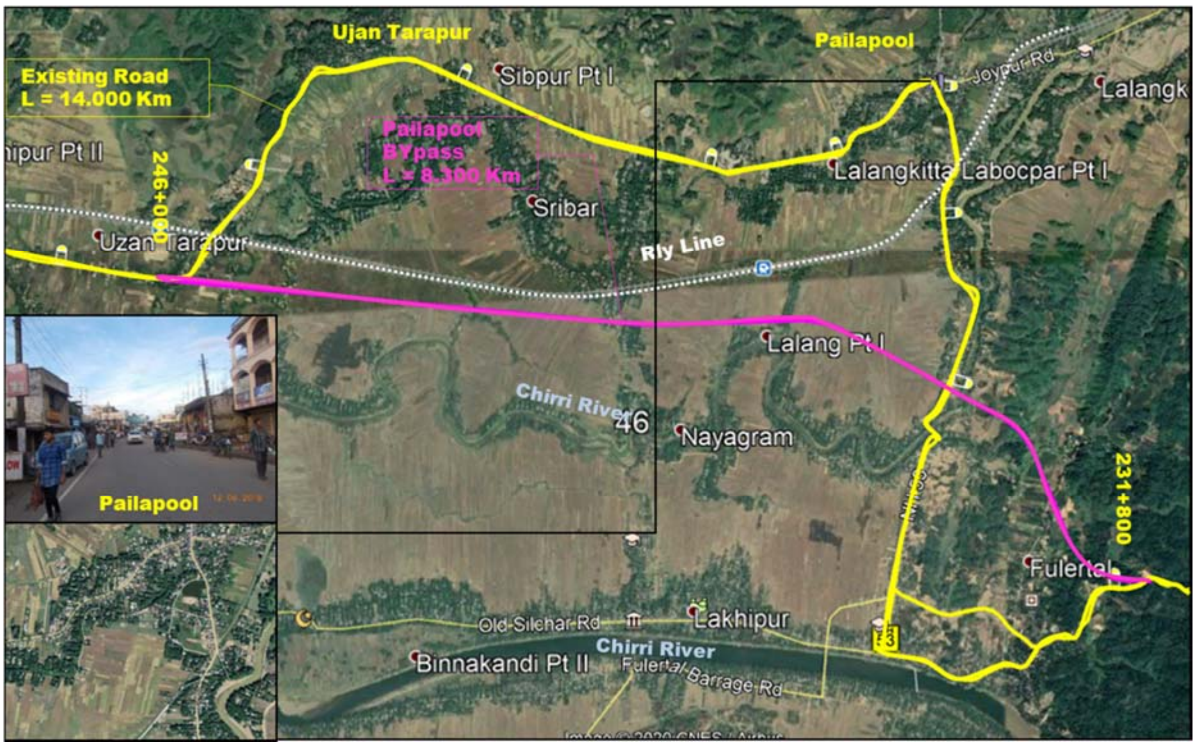

**Fig 7.3 Bypass for Banskhandi**

### A.1 Ujan Tarapur, Pailapool bypass

Project road traverse through minor built up like Polarband, Urzan tarapur (246+300), Chirripar (Km 242+800), Sibpur (km 241+100) from Km 246+000 to Km 239+500. The project road is running parallel to Chirri River along these locations passes through ROB at Km 245 + 450. There are religious structures, Schools and utilities like Electric poles, Transformers, water pipelines running along the existing road. Also, number of small ponds is observed at frequent locations along both sides of existing road. From Km 239+500 to Km 237+500, the project road passes through thickly populated section of Pailapool and at Km 234+500 passes through Fulerthal built up section. Fulerthal built up area is heavily congested with Religious and Commercial structures. At Km 238+400, project road passes through Railway Level crossing and at Km 235+600 there is major bridge called Chirripool across Chirri River. In order to avoid all these constrains and to provide free flow movement for the traffic a 4 bypass options are studied.

The recommended alignment takes off from Km.246+000 on RHS of existing road and intersects existing road at Km.236+350, from Km.236+350 the proposed alignment passes on LHS of the existing alignment and terminates at Km.231+800. The approximate length of this alternative is 8.30 Kms, as against existing length of 14.20 Kms. The entire alignment passes through green field/agriculture land and bypasses Uzan Tarapur, Pailapool and Fulerthal built up location. The recommended alignment achieves desirable design speed and gives more room for socio economic improvement all along the areas. The recommended alignment has also averted 01 existing ROB and 01 level crossing. Cost is also less as compared to other options.

**Fig 7.4 Bypass for Ujan Tarapur & Pailapool**




### A.2 Jiribam Bypass

Existing alignment passes through minor built up like Uttal Lalpani and Howkip Punj from Km 225+100 to Km 220+900. The Carriageway width varies from 9.2 m to 9.5 m and shoulder width varying from 1.0 m to 2.0 m, the condition of existing road is fair with medium cracks, ravelling and severe edge drop. At Km 224+230, one RUB exit with clear width (Skew) of RUB is 18.4 m. At Km 220+900, there is Jirighat check post of Assam state.

Thereafter, from Km 221+500 to Km 221+000 project road passes through major bridge which acts as border between Assam state and Manipur state. Existing major bridge is fully congested with commercial activities and heavy movement of commercial vehicles. After the Major Bridge from Km 220+200, the project road enters Jiribam district of Manipur state. From Km 220+300 to Km 214+500, the project road passes through Major built up like Jiribam, Kamranga Village and Gularthol village. The carriageway width along these stretches varies from 6.5 m to 7.2 m with fair condition. The width of Earthen shoulder varies from 1.5m to 2.0 m. Condition of shoulder is poor because of heavy edge drop, poor drainage condition. At Km 215+940 there is minor junction which leads to CRPF HQ on RHS of project road. The Project road ends at Km 212+300. Improvement of the existing road to 4/6 lane specially curve improvement leads to demolition of the residential and commercial buildings in Jiribam town. LA cost was also concern in this matter hence, 4 bypass options were studied.

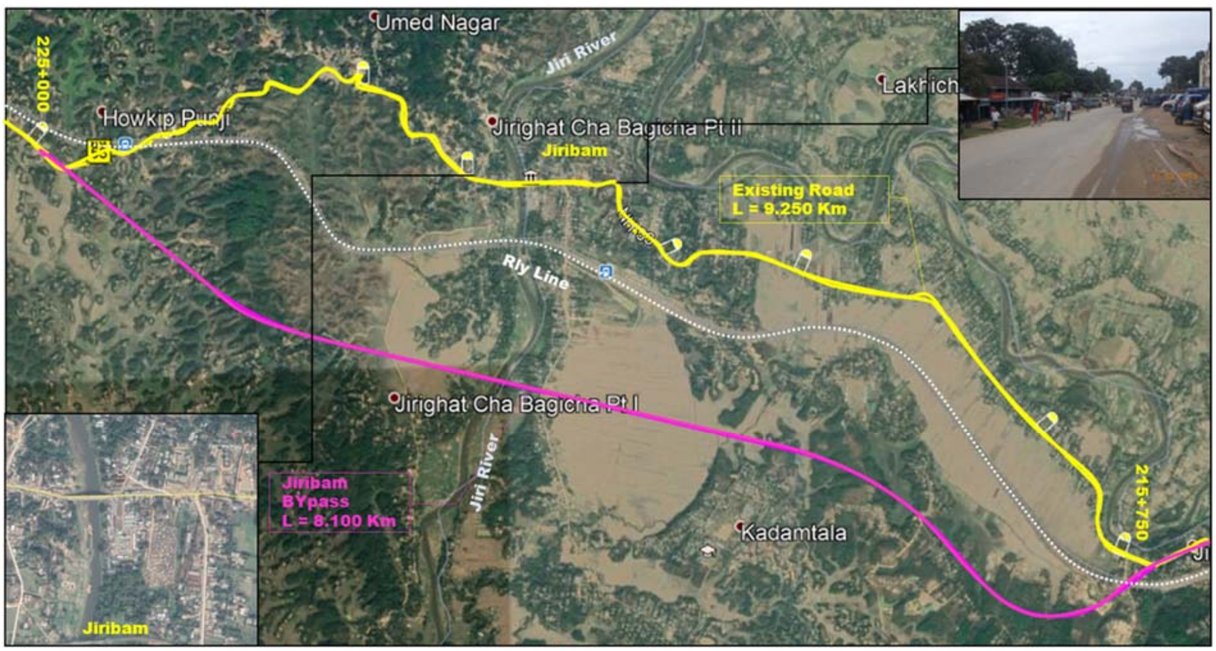



**Fig 7.5 Bypass for Jiribam**

The recommended bypass alignment takes off from Km.225+000 on RHS of Jiribam and terminates at Km.215+750. The approximate length of this alternative has been proposed to 8.10 Km. the entire alignment passes through green field/agriculture land however, marginal buildings get affected but not as much of other options. This option has fair chance of socio-economic growth. Cost wise also the recommended alignment is better than others.

## B. Green Field Alignment

### B.1 Option of Green Field alignment

From Km 262+500 to Km 212+060 the existing road passes through many built up locations such as Kashipur, Banskandi, Ujain Tarapur, Pailapool, Fulertal and Jiribam. As discussed above options have been studied for improving the existing road along with the bypasses at built up locations. In this segment effort has been made to study the green filed alignment, which passes through green filed/agriculture land. The alignment of green filed vs. improving of existing alignment with bypass options are shown below.

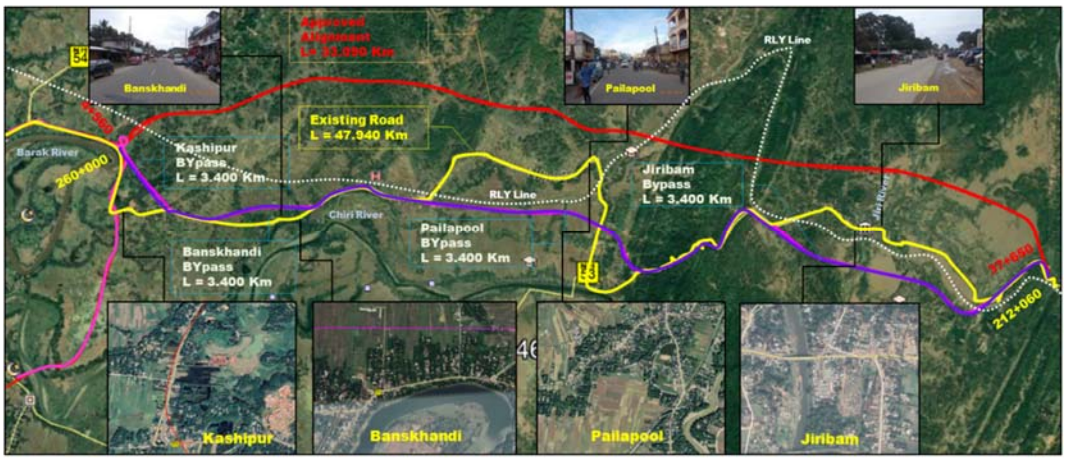



**Fig 7.6 Approved Green Field Alignment**

The Green field alignment takes-off on LHS from Km 260+000 of NH-37 and passes through agricultural filed and Tea plantation at few locations and terminates / joins at NH-37 near Jiribam at km 212+060. The approximate length along green filed alignment comes to is 33.090 Kms as compared to existing road length of 47.940 Kms causing drastic reduction in length however, 01 tunnel (aapx.800m) being proposed to avoid extensive route via permissible contour gradient. The chosen green alignment also mitigates the effects on residential and commercial buildings. However, the proposed green filed alignment crosses existing railway line at Km 5+190, Km 22+535 and Km 26+385 that need to propose ROBs at these locations. In this option a green filed alignment is proposed to be bypassing all above built up areas through single alignment navigating through open / green field and fulfils all the requirement of developing 4-lane economic corridor.

Eventually, all the above options were discussed during the presentation furnished on 15th January 2019 and 14th August at NHIDCL HQ, Delhi and green filed alignment (Option-V) were agreed by all the delegates during the presentation followed by letter no NHIDCL/Bharatmla/V-S/ DPR/ Mizoram/2019-20//353 on 23rd October 2019.

The detail comparison diagram of different bypass option is given below.

### 7.4.2 Villages / Towns along Approved Alignment

There are 24 Nos. of villages without major settlement side of proposed alignment under this package, where the proposed alignment is taken through the villages. The consultant has exercised various possible alternatives to improve the existing geometrics to be within proposed geometric standards.

**Table 7.3 List of Villages along Proposed Alignment**

| Sl.no | State | District | Block | Village Name | Proposed Chainage | | Length | Side |
|---|---|---|---|---|---|---|---|---|
| | | | | | From | To | | |
| 1 | Assam | Cachar | Udarbond | Nutan Dayapur | 4+560 | 5+530 | 970 | Both |
| 2 | | | Udarbond | Arcuttepur Grant | 5+530 | 6+660 | 1130 | Both |
| 3 | | | Udarbond | Digar Khasipur Grant | 6+660 | 9+055 | 2395 | Both |
| 4 | | | Udarbond | Badri par | 9+055 | 10+980 | 1925 | Both |
| 5 | | | Udarbond | Latigram Grant (Lathigram) | 10+980 | 11+820 | 840 | Both |
| 6 | | | Banskandi | Palerbond Grant (P.B. Grant T.E) | 11+820 | 13+065 | 1245 | RHS |
| 7 | | | Banskandi | Dulalgram Grant | 11+820 | 12+760 | 940 | LHS |
| 8 | | | Banskandi | Alipur cha Bagicha | 13+065 | 14+850 | 1785 | Both |
| 9 | | | Banskandi | Monipur Kitta Uttar Sonapur | 14+850 | 15+600 | 750 | Both |
| 10 | | | Banskandi | Narainpur Grant Pt I | 15+600 | 17+855 | 2255 | Both |
| 11 | | | Banskandi | Laboc Grant | 17+855 | 21+600 | 3745 | Both |
| 12 | | | Lakhipur | Lalang Grant | 21+600 | 21+780 | 180 | Both |
| 13 | | | Lakhipur | Lalangkitta Labocpar Pt III | 21+780 | 23+430 | 1650 | Both |
| 14 | | | Lakhipur | Lalangkitta Lobocpar Purba Pt III | 23+430 | 23+675 | 245 | Both |
| 15 | | | Lakhipur | Cherenga Punji | 23+675 | 23+780 | 105 | Both |
| 16 | | | | | 24+100 | 24+300 | 200 | RHS |
| 17 | | | Lakhipur | Revenue survey not done | 23+800 | 24+560 | 760 | Both |

## 7.5 Geometric Design

### 7.5.1 General Controls

Along with the cross section elements, the horizontal and vertical alignments form the components, which define a geometric design. Since the latter two are essentially permanent elements of the design, careful attention must be paid to their development.

In addition to safety considerations, the major parameters that controlled the design of the project road alignment included topography, design speed, curvature, superelevation, stopping sight distance etc. In addition to these parameters, social and environmental impacts (e.g., erosion, sedimentation) were also considered.

The nature of the terrain in the project area, which affected many aspects of the design. In practical terms, topography limits the effective design speed, and in turn, set the maximum severity and proliferation of curves that can be economically constructed. In this regard, sight distances were also subject to limitations imposed by the characteristics of the prevailing terrain. Appearance is another determinant in the design process that was directly affected by the terrain type.

Among the most important of the proposed improvements to the existing road geometrics was the reduction in the number or severity of horizontal curves. The alignment of the project highway is designed to ease the curvature of the road to the extent possible so that, the highway is safe and design speed is uniform for substantial lengths of highway. The liberality with which some curves were designed was restricted to some extent by the terrain and cost considerations. Where conditions permit, the curves were designed within the limitations of the design criteria.

### 7.5.2 Horizontal Geometry

Efforts have been made, during design of horizontal alignment, to take the proposed centre line within or near to existing road, to make maximum use of existing roadway without making any compromise in standards. Desirable values have been adopted in conformity with the stated design standards except at few locations where minimum radius of 50m has been kept.

The horizontal alignment was done design software MOSS/MX - Roads on the base ground modelling developed from topographical surveys. Generally, the alignment of the centreline is designed such that, the widening of the existing road would be hill side and the proposed outer/valley side shoulder edge matches with the existing shoulder edge.

In case of realignments, the detailed ground reconnaissance, available topo-sheets, topographical survey maps and obligatory points through which alignment should pass were studied in detail and the general alignment was traced. Base plan of proposed alignment showing all natural and man-made features was prepared using the topographical data. All the features within the specified bandwidth were captured with a unique "description code" during the survey. This data is downloaded into "Highway Design Software – MX" environment to prepare the base plan. The horizontal alignment was designed freely along the centre of the specified bandwidth. The super elevation and the length of transition curves have been finalised with maximum super-elevation of 7%, if radius of curve is less than the desirable minimum and limited to 5%, if the radius is more than desirable minimum.

Details of proposed geometrics with all curve points like, Beginning of Spiral (BS), Beginning of Curve (BC), End of Curve (EC), End of Spiral (ES), Side of curve, Radius of Horizontal Curve, Length of Transition curve and Design speed achieved and location plan have been shown in **Volume-IX**: Drawings.

The details of proposed horizontal curves are given in below table;

**Table 7.4 Summary of Horizontal Curves**

| Curve No. | HIP | | | Deflection Angle | | | Speed (Kmph) | Radius (m) | Transition Length (m) | Length of Curve (m) | Tangent Length | Direction of Curve | Superelevation | Start of Transition (Ch) | Start of Curve (Ch) | End of Curve (Ch) | End of Transition (Ch) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chainage | Easting | Northing | Deg | Min | Sec | | | | | | | | | | | |
| Start | 4560.000 | 471435.036 | 2697625.124 | 0 | 0 | 0 | | | | | | | | | | | 4560.000 |
| 1 | 5590.528 | 471230.643 | 2697066.581 | 342 | 17 | 13.6 | 100 | 2000 | 0.000 | 1425.456 | 52346.148 | Right | 2.500% | 4877.800 | 4877.800 | 6303.256 | 6303.256 |
| 2 | 7581.016 | 471218.130 | 2696766.363 | 20 | 29 | 49.7 | 100 | -2000 | 0.000 | 679.744 | 53849.243 | Left | 2.500% | 7241.144 | 7241.144 | 7920.888 | 7920.888 |
| 3 | 8929.102 | 471073.546 | 2696423.815 | 299 | 38 | 29.2 | 100 | -5000 | 0.000 | 485.948 | 55069.078 | Left | 2.500% | 8686.128 | 8686.128 | 9172.076 | 9172.076 |
| 4 | 9527.257 | 471364.726 | 2696043.995 | 69 | 56 | 12.1 | 100 | 3000 | 0.000 | 523.835 | 55727.754 | Right | 2.500% | 9265.339 | 9265.339 | 9789.174 | 9789.174 |
| 5 | 11051.341 | 471140.920 | 2695692.175 | 329 | 30 | 10.6 | 100 | 3000 | 0.000 | 1002.184 | 56953.643 | Right | 2.500% | 10550.249 | 10550.249 | 11552.433 | 11552.433 |
| 6 | 13760.253 | 471125.429 | 2695240.643 | 35 | 38 | 53.1 | 100 | 6000 | 0.000 | 666.130 | 58514.739 | Right | 2.500% | 13427.188 | 13427.188 | 14093.318 | 14093.318 |
| 7 | 15220.016 | 470918.647 | 2694972.257 | 345 | 57 | 17.1 | 100 | 5000 | 0.000 | 853.210 | 59249.295 | Right | 2.500% | 14793.411 | 14793.411 | 15646.621 | 15646.621 |
| 8 | 16907.870 | 470764.585 | 2694619.081 | 274 | 11 | 38.6 | 100 | -5000 | 0.000 | 1168.207 | 59899.282 | Left | 2.500% | 16323.766 | 16323.766 | 17491.973 | 17491.973 |
| 9 | 19241.749 | 471159.649 | 2694411.124 | 80 | 53 | 41.8 | 100 | 2500 | 0.000 | 898.292 | 60703.429 | Right | 2.500% | 18792.603 | 18792.603 | 19690.895 | 19690.895 |
| 10 | 20543.300 | 471058.879 | 2694112.670 | 352 | 17 | 7.7 | 100 | -1500 | 45.000 | 616.079 | 61248.796 | Left | 2.963% | 20190.260 | 20235.260 | 20851.339 | 20896.339 |
| 11 | 22037.111 | 471026.043 | 2693942.829 | 9 | 20 | 41.2 | 100 | 4000 | 0.000 | 1127.478 | 61900.315 | Right | 2.500% | 21473.372 | 21473.372 | 22600.850 | 22600.850 |
| 12 | 24197.953 | 470950.514 | 2693738.505 | 339 | 14 | 12.1 | 100 | -6000 | 0.000 | 945.542 | 62840.958 | Left | 2.500% | 23725.182 | 23725.182 | 24670.724 | 24670.724 |
| END | 24560.000 | 506002.215 | 2746242.018 | 0 | 0 | 0 | | | | | | | | 24560.000 | | | |

The summary of proposed horizontal curves are given below

**Table 7.5 Summary of Proposed Horizontal Curves**

| Total No. of Curves | No. of Curves with Radius | | | | No of curves with speed | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | R<75 | R 76-150 | R 151-300 | R >300 | 40 | 50 | 60 | 80 | 100 |
| 12 | - | - | - | 12 | - | - | - | - | 12 |

| Length (m) | | | % Length | |
|---|---|---|---|---|
| Total | In Straight | In Curve | In Straight | In Curve |
| 20000 | 9629 | 10371 | 48% | 52% |

### 7.5.3 Vertical Alignments

The design undertook to provide a smooth grade line with gradual changes that were consistent with the character of the terrain. Parabolic curves were used to connect vertical tangents. These are considered more appropriate than circular curves in affording driving comfort, visual appearance, and sight distance. A liberal rate of change in vertical curvature was applied to counter the effects of gravitational and centrifugal forces on driver comfort. Likewise, curves were designed to meet for stopping sight distance requirements.

Grades were fixed to conform to the existing terrain and merges well with the existing contours. Wherever possible, ruling values for the terrain class were met. It is inevitable though, that in some portions of the project roads, limiting values were met due to adverse social and environmental impacts. This practice was an exception rather than a "must" in designing the gradients.

Details of proposed geometrics with all curve points like, Gradient, Beginning of Curve, End of Curve, Vertical Curve etc. are shown in **Volume-IX: Drawings** and details of proposed vertical alignment is given below.

**Table 7.6 Summary of Vertical Curves**

| Sl.No. | Vertical Intersection Points | | | Element | Vertical Tangent Points | | | | | Radius | M Value | K Value | Length of Element |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chainage | Level | %Grade Diff. | | Start Chainage | Level | End Chainage | Level | Grade (%) | | | | |
| 1 | | | | Grade | 4560.000 | 25.126 | 4742.744 | 29.695 | 2.500 | | 182.744 | 1 | |
| 2 | 5082.744 | 38.195 | -5.00 | Hog Curve | 4742.744 | 29.695 | 5422.744 | 29.695 | | 136.001 | 680 | 2 | 5082.744 |
| 3 | | | | Grade | 5422.744 | 29.695 | 5476.000 | 28.363 | -2.500 | | 53.256 | 3 | |
| 4 | 5576.000 | 25.863 | 3.00 | Sag Curve | 5476.000 | 28.363 | 5676.000 | 26.364 | | 66.667 | 200 | 4 | 5576.000 |
| 5 | | | | Grade | 5676.000 | 26.364 | 5769.000 | 26.829 | 0.500 | | 93 | 5 | |
| 6 | 5869.000 | 27.329 | -1.70 | Hog Curve | 5769.000 | 26.829 | 5969.000 | 26.129 | | 117.647 | 200 | 6 | 5869.000 |
| 7 | | | | Grade | 5969.000 | 26.129 | 6095.000 | 24.616 | -1.200 | | 126 | 7 | |
| 8 | 6170.000 | 23.716 | 0.90 | Sag Curve | 6095.000 | 24.616 | 6245.000 | 23.491 | | 166.667 | 150 | 8 | 6170.000 |
| 9 | | | | Grade | 6245.000 | 23.491 | 6375.000 | 23.101 | -0.300 | | 130 | 9 | |
| 10 | 6450.000 | 22.876 | 1.30 | Sag Curve | 6375.000 | 23.101 | 6525.000 | 23.626 | | 115.384 | 150 | 10 | 6450.000 |
| 11 | | | | Grade | 6525.000 | 23.626 | 6685.000 | 25.226 | 1.000 | | 160 | 11 | |
| 12 | 6820.000 | 26.576 | -2.00 | Hog Curve | 6685.000 | 25.226 | 6955.000 | 25.227 | | 135.000 | 270 | 12 | 6820.000 |
| 13 | | | | Grade | 6955.000 | 25.227 | 7164.000 | 23.137 | -1.000 | | 209 | 13 | |
| 14 | 7239.000 | 22.386 | 0.70 | Sag Curve | 7164.000 | 23.137 | 7314.000 | 22.161 | | 214.284 | 150 | 14 | 7239.000 |
| 15 | | | | Grade | 7314.000 | 22.161 | 7666.056 | 21.105 | -0.300 | | 352.056 | 15 | |
| 16 | 7741.056 | 20.880 | 1.80 | Sag Curve | 7666.056 | 21.105 | 7816.056 | 22.005 | | 83.333 | 150 | 16 | 7741.056 |
| 17 | | | | Grade | 7816.056 | 22.005 | 8000.000 | 24.764 | 1.500 | | 183.944 | 17 | |
| 18 | 8110.000 | 26.414 | -1.90 | Hog Curve | 8000.000 | 24.764 | 8220.000 | 25.974 | | 115.789 | 220 | 18 | 8110.000 |
| 19 | | | | Grade | 8220.000 | 25.974 | 8925.000 | 23.155 | -0.400 | | 705 | 19 | |
| 20 | 9000.000 | 22.855 | 0.70 | Sag Curve | 8925.000 | 23.155 | 9075.000 | 23.080 | | 214.284 | 150 | 20 | 9000.000 |
| 21 | | | | Grade | 9075.000 | 23.080 | 9267.500 | 23.657 | 0.300 | | 192.5 | 21 | |
| 22 | 9342.500 | 23.882 | 0.70 | Sag Curve | 9267.500 | 23.657 | 9417.500 | 24.632 | | 214.284 | 150 | 22 | 9342.500 |
| 23 | | | | Grade | 9417.500 | 24.632 | 9475.000 | 25.207 | 1.000 | | 57.5 | 23 | |
| 24 | 9575.000 | 26.207 | -1.50 | Hog Curve | 9475.000 | 25.207 | 9675.000 | 25.707 | | 133.333 | 200 | 24 | 9575.000 |
| 25 | | | | Grade | 9675.000 | 25.707 | 9885.000 | 24.657 | -0.500 | | 210 | 25 | |

| Sl.No. | Vertical Intersection Points | | | Element | Vertical Tangent Points | | | | | Radius | M Value | K Value | Length of Element |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chainage | Level | %Grade Diff. | | Start Chainage | Level | End Chainage | Level | Grade (%) | | | | |
| 26 | 9960.000 | 24.282 | 0.80 | Sag Curve | 9885.000 | 24.657 | 10035.000 | 24.507 | | 187.501 | 150 | 26 | 9960.000 |
| 27 | | | | Grade | 10035.000 | 24.507 | 13455.000 | 34.767 | 0.300 | | 3420 | 27 | |
| 28 | 13605.000 | 35.217 | -1.30 | Hog Curve | 13455.000 | 34.767 | 13755.000 | 33.717 | | 230.771 | 300 | 28 | 13605.000 |
| 29 | | | | Grade | 13755.000 | 33.717 | 14265.000 | 28.617 | -1.000 | | 510 | 29 | |
| 30 | 14365.000 | 27.617 | 1.38 | Sag Curve | 14265.000 | 28.617 | 14465.000 | 27.997 | | 144.93 | 200 | 30 | 14365.000 |
| 31 | | | | Grade | 14465.000 | 27.997 | 15000.000 | 30.030 | 0.380 | | 535 | 31 | |
| 32 | 15075.000 | 30.315 | -1.08 | Hog Curve | 15000.000 | 30.030 | 15150.000 | 29.790 | | 138.889 | 150 | 32 | 15075.000 |
| 33 | | | | Grade | 15150.000 | 29.790 | 15515.000 | 27.235 | -0.700 | | 365 | 33 | |
| 34 | 15590.000 | 26.710 | 1.00 | Sag Curve | 15515.000 | 27.235 | 15665.000 | 26.935 | | 149.999 | 150 | 34 | 15590.000 |
| 35 | | | | Grade | 15665.000 | 26.935 | 15992.778 | 27.918 | 0.300 | | 327.778 | 35 | |
| 36 | 16067.778 | 28.143 | 0.90 | Sag Curve | 15992.778 | 27.918 | 16142.778 | 29.043 | | 166.667 | 150 | 36 | 16067.778 |
| 37 | | | | Grade | 16142.778 | 29.043 | 16611.000 | 34.662 | 1.200 | | 468.222 | 37 | |
| 38 | 16796.000 | 36.882 | -2.70 | Hog Curve | 16611.000 | 34.662 | 16981.000 | 34.107 | | 137.04 | 370 | 38 | 16796.000 |
| 39 | | | | Grade | 16981.000 | 34.107 | 17432.118 | 27.340 | -1.500 | | 451.118 | 39 | |
| 40 | 17532.118 | 25.840 | 1.70 | Sag Curve | 17432.118 | 27.340 | 17632.118 | 26.040 | | 117.65 | 200 | 40 | 17532.118 |
| 41 | | | | Grade | 17632.118 | 26.040 | 19980.657 | 30.737 | 0.200 | | 2348.539 | 41 | |
| 42 | 20055.657 | 30.887 | 1.80 | Sag Curve | 19980.657 | 30.737 | 20130.657 | 32.387 | | 83.333 | 150 | 42 | 20055.657 |
| 43 | | | | Grade | 20130.657 | 32.387 | 20533.000 | 40.434 | 2.000 | | 402.343 | 43 | |
| 44 | 20803.000 | 45.834 | -4.00 | Hog Curve | 20533.000 | 40.434 | 21073.000 | 40.434 | | 135.000 | 540 | 44 | 20803.000 |
| 45 | | | | Grade | 21073.000 | 40.434 | 21380.000 | 34.294 | -2.000 | | 307 | 45 | |
| 46 | 21455.000 | 32.794 | 2.30 | Sag Curve | 21380.000 | 34.294 | 21530.000 | 33.019 | | 65.218 | 150 | 46 | 21455.000 |
| 47 | | | | Grade | 21530.000 | 33.019 | 21990.000 | 34.399 | 0.300 | | 460 | 47 | |
| 48 | 22065.000 | 34.624 | 1.70 | Sag Curve | 21990.000 | 34.399 | 22140.000 | 36.124 | | 88.236 | 150 | 48 | 22065.000 |
| 49 | | | | Grade | 22140.000 | 36.124 | 22182.182 | 36.968 | 2.000 | | 42.182 | 49 | |
| 50 | 22452.182 | 42.368 | -4.00 | Hog Curve | 22182.182 | 36.968 | 22722.182 | 36.968 | | 135.000 | 540 | 50 | 22452.182 |
| 51 | | | | Grade | 22722.182 | 36.968 | 22846.094 | 34.490 | -2.000 | | 123.912 | 51 | |
| 52 | 22996.094 | 31.490 | 4.50 | Sag Curve | 22846.094 | 34.490 | 23146.094 | 35.240 | | 66.667 | 300 | 52 | 22996.094 |

| Sl.No. | Vertical Intersection Points | | | Element | Vertical Tangent Points | | | | | Radius | M Value | K Value | Length of Element |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chainage | Level | %Grade Diff. | | Start Chainage | Level | End Chainage | Level | Grade (%) | | | | |
| 53 | | | | Grade | 23146.094 | 35.240 | 24494.756 | 68.956 | 2.500 | | 1348.662 | 53 | |
| 54 | 24819.756 | 77.081 | -4.50 | Hog Curve | 24494.756 | 68.956 | 25144.756 | 70.581 | | 144.444 | 650 | 54 | 24819.756 |

Summary of proposed alignment length as per gradient is given below;

**Table 7.7 Distribution of proposed vertical grades**

| Gradient -->> | <=4 | >4 & <=5 | >5 & <=6 | >6 & <=7 | >7 |
|---|---|---|---|---|---|
| Length (m) | 20000 | - | - | - | - |
| % of Length | 100% | - | - | - | - |

### 7.5.4 Speed Zoning

As given in Chapter 5 - Design Standards, the ruling and minimum design speeds for Plain ana Rolling terrain are 100 Kmph and 80 Kmph respectively. Where practicable, the road geometry was designed to meet these criteria while conforming to an acceptable degree of uniformity and consistency. Social and environmental impacts were also considered in the geometric design whereby where adverse impacts are present, exceptions to the standards were introduced. The design speeds adopted at each section of the project highway are given below:

**Table 7.8 Speed Zoning**

| From | To | Length (m) | Des Speed (Km/h) |
|---|---|---|---|
| 4+560 | 24+560 | 20000 | 100 |

| Speed (Kmph) -->> | 40 | 50 | 60 | 80 | 100 |
|---|---|---|---|---|---|
| Length (m) | - | - | - | - | 20000 |
| % Length | - | - | - | - | 100% |

## 7.6 Lane Configuration

As per the capacity requirements of traffic, details of which are given in chapter 4, the following lane configuration has been proposed at different sections.

**Table 7.9 Proposed Lane Configuration**

| Existing Chainage | | Proposed Chainage | | | Lane Configuration |
|---|---|---|---|---|---|
| From | To | From | To | Length (m) | |
| - | - | 4+560 | 24+560 | 20000 | 4-Lane |

## 7.7 Cross-Sectional elements

The cross-section/layout of the 4-lane highway is developed such that, the developed layout/cross sections for both highway as well as the service road will have operational safety such as segregation, separation, turning radii, gradients etc. and provisions for various types of movements and manoeuvres like merge, diverge, weave etc.

The cross-sectional requirements as specified in IRC: SP: 84-2019 has been adopted while developing the layout plan. These standards are given in the following table.

**Table 7.10 Design Standards for Cross Sectional Elements**

| **Four-lane road (Built-up area)** | |
|---|---|
| Paved Carriageway | 2 x 7.0 m = 14.00m |
| Paved Shoulders | 2 x 2.5m = 5.00m |
| Kerb shyness | 4 x 0.50m = 2.00m |
| Median | 1 x 2.50m = 2.50m |
| Separator | 2 x 1.75 = 3.5m |
| Service Road | 2 x 7.00 = 14.0m |
| Drain cum Footpath | 2 x 1.50 = 3.0 m |
| Space for Service | 2 x 2.00 = 4.0m |
| Total Roadway Width | 48.00 m |

| **Four-lane road (Rural area)** | | |
|---|---|---|
| Paved Carriageway | | 2 x 7.0 m = 14.0m |
| Shoulders | Paved | 2 x 2.5m = 5.0m |
| | Unpaved | 2 x 1.5m = 3.0m |
| Kerb shyness | | 2 x 0.50m = 1.00m |
| Median | | 4.00 m |
| Total Roadway Width | | 27.00 m |

### 7.7.1 Typical Cross-sections

In accordance with 4-lane manual, various cross-sectional elements discussed earlier and 10 types of typical cross sections have been proposed for the project road for various conditions expected to meet with during execution. These are shown in drawing **Volume-IX** of this report. However, same drawings are enclosed in this section for ready reference. Following table gives detailed description of each type of cross section.

**Table 7.11 List of Typical Cross Sections**

| Sl. No. | Type of Cross Section | | Description | Length (m) | Location/ Remarks |
|---|---|---|---|---|---|
| 1 | TCS 1 | 4 Lane Divided Highway without Service Road (Embankment Height ≤ 3m with Turfing reatment | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES | 3400 | Open area (Fiil Section) |
| 2 | TCS 2 | 4 Lane Divided Highway without Service Road (Embankment Height > 3m and ≤ 6m with Geo-green on Embankment slope) | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES | 4970 | Open area (Fiil Section) |
| 3 | TCS 3 | 4 Lane Divided Highway without Service Road (Embankment Height > 6m with Stone pitching on Embankment slope) | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES | 2300 | Open area (Fiil Section) |
| 4 | TCS 4 | 4 Lane Divided Highway without service road (Embankment Height > 6m height with Stone pitch and R/Wall or T/Wall) | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES | 1260 | Open area (Fiil Section) |
| 5 | TCS 5 | 4 Lane Divided Highway without Service Road in Cutting on both sides | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (2 x 2.5m) Drain & Utility | 3090 | Open area (Cut Section) |
| 6 | TCS 6 | 4 Lane Divided Highway without Service Road in Cutting with one side Breast Wall | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (2 x 2.5m) Drain & Utility | 50 | Open area (Cut Section) |
| 7 | TCS 7 | 4 Lane Divided Highway without Service Road in Cutting with both side Breast Wall | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (2 x 2.5m) Drain & Utility | 990 | Open area (Cut Section) |
| 8 | TCS 8 | 4 Lane Divided Highway without Service Road with normal Cut and Fill | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (1 x 2.5m) Drain & Utility on Cut side | 1610 | Open area (Cut & Fill Section) |
| 9 | TCS 9 | 4 Lane Divided Highway without Service Road with Breast wall in High Cut and Normal Fill | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + | 50 | Open area (Cut & Fill Section) |

| Sl. No. | Type of Cross Section | | Description | Length (m) | Location/ Remarks |
|---|---|---|---|---|---|
| | | | (1 x 2.5m) Drain & Utility on Cut side | | |
| 10 | TCS 10 | 4 Lane Divided Highway with Service Road on both sides | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (2 x 7.50m) Service Road CW + (4 x 1.5m) ES + (2 x 1.5m) Lined Drain | 1770 | Open Area with SR (BHS) |
| 11 | TCS 11 | 4 Lane Divided Highway with Service Road on one side | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (1 x 3.75m) Service Road CW + (2 x 1.5m) ES + (1 x 1.5m) Lined Drain | 510 | Open Area with SR (One Side) |
| 12 | TCS 12 | Cross Section of Bridge without Service Road at deck Level - 4-lane Divided Highway with Footpath | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) Footpath + (2 x 0.4m) Double W-Beam Barrier + (2 x 0.5m) | | Bridge |
| 13 | TCS 13 | Cross Section of Bridge with Service Road at deck Level - with Footpath 4-lane Divided Highway | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES + (2 x8.00m) Service Road CW + (2 x 1.5m) Foothpath + (2 x 0.4m) Double W-Beam Barrier | | Bridge |
| 14 | TCS 14 | Cross Section of SVUP/LVUP/VUP at deck Level - 4-lane Divided Highway | (2 x 7.00m) CW + (2 x 2.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.55m) ES | | Approach of SVUP/LVUP/VUP |
| Total Length | | | | 20000 | |

The above listed typical cross sections are depicted in TCS-1 and TCS-14 on subsequent pages.

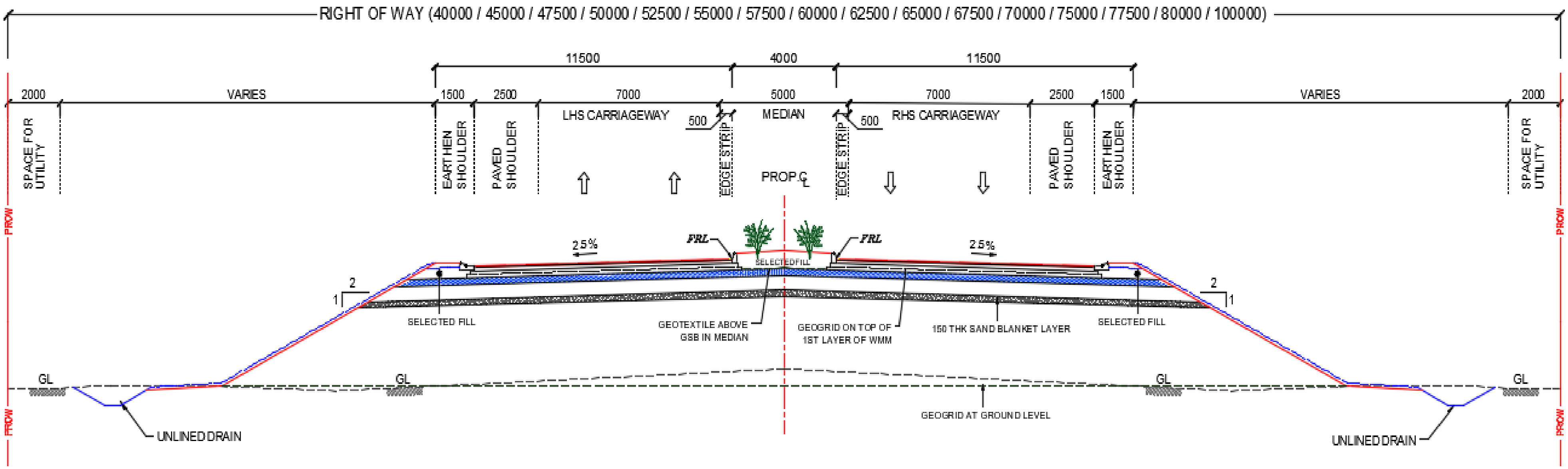



**Fig 7.7 4 Lane Divided Highway without Service Road (Embankment Height ≤ 3m with Turfing treatment) (TCS-1)**

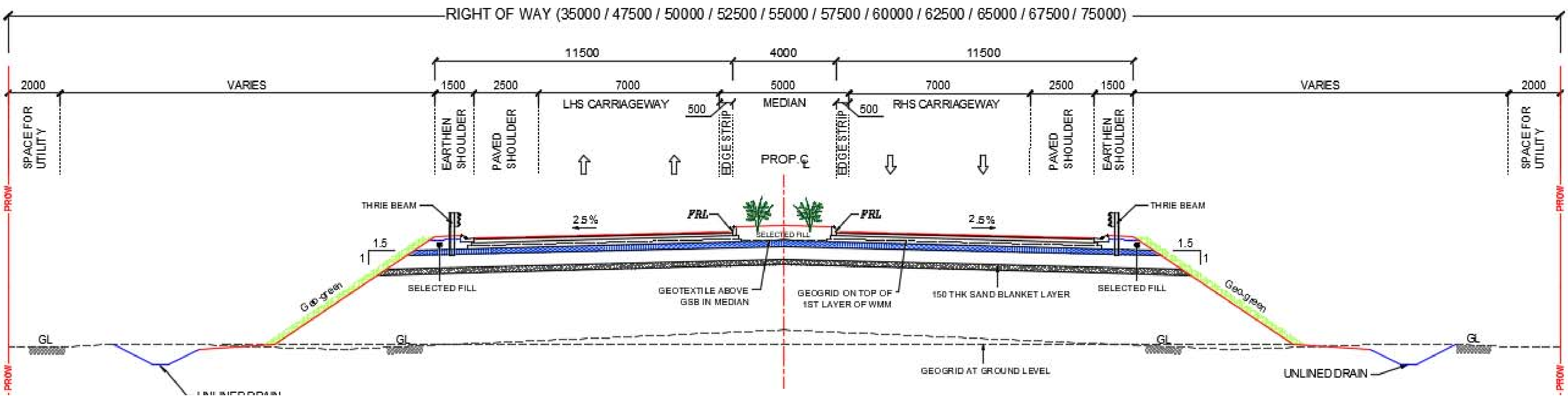



**Fig 7.8 4 Lane Divided Highway without Service Road (Embankment Height > 3m and ≤ 6m with Geo-green on Embankment slope) (TCS-2)**

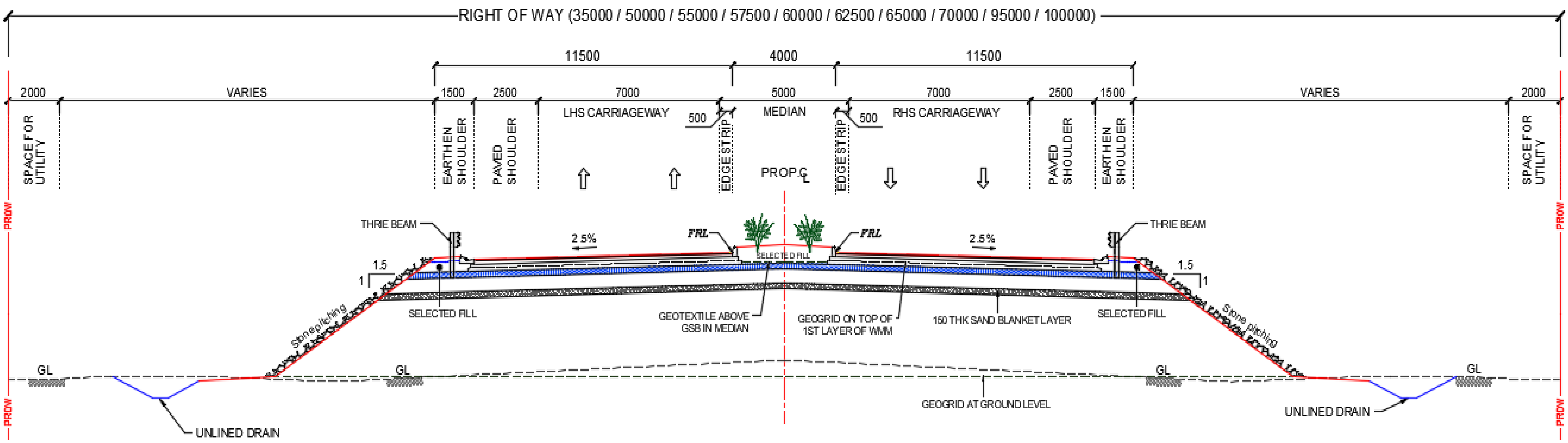



**Fig 7.9 4 Lane Divided Highway without Service Road (Embankment Height > 6m with Stone pitching on Embankment slope)** (TCS-3)

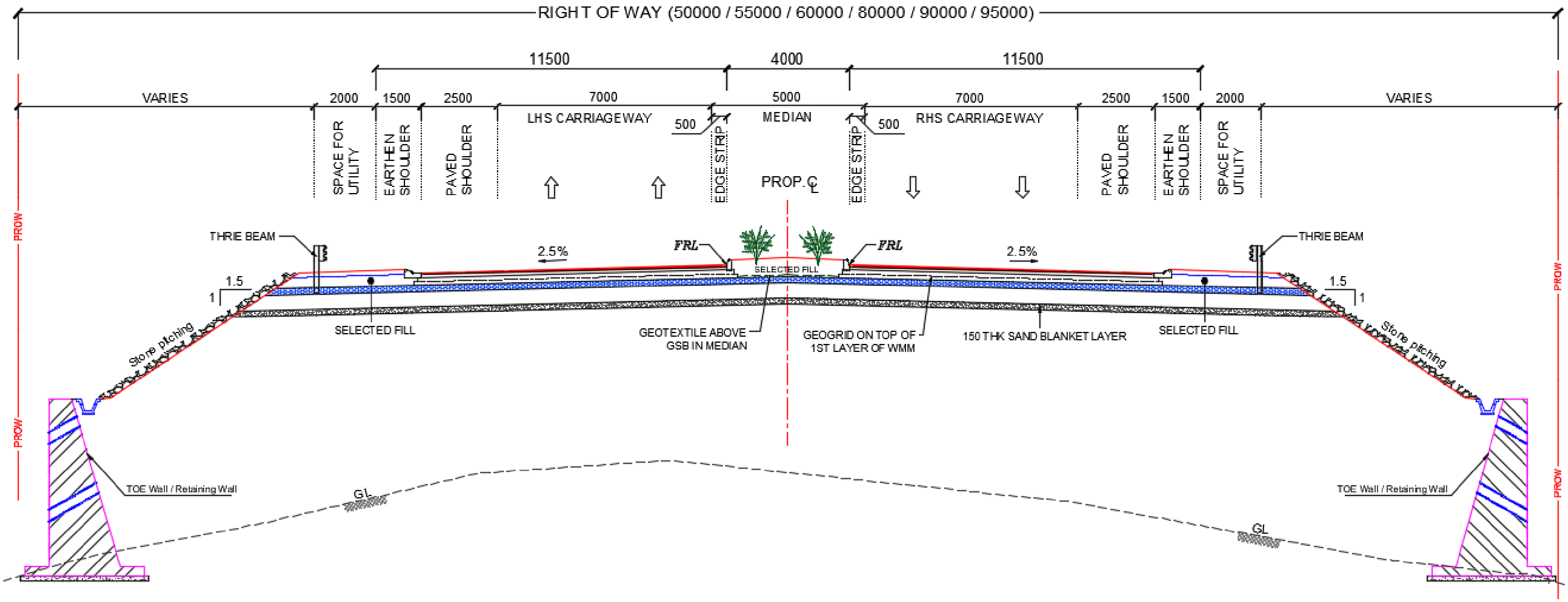



**Fig 7.10 4 Lane Divided Highway without service road (Embankment Height > 6m height with Stone pitch and R/Wall or T/Wall) (TCS-4)**

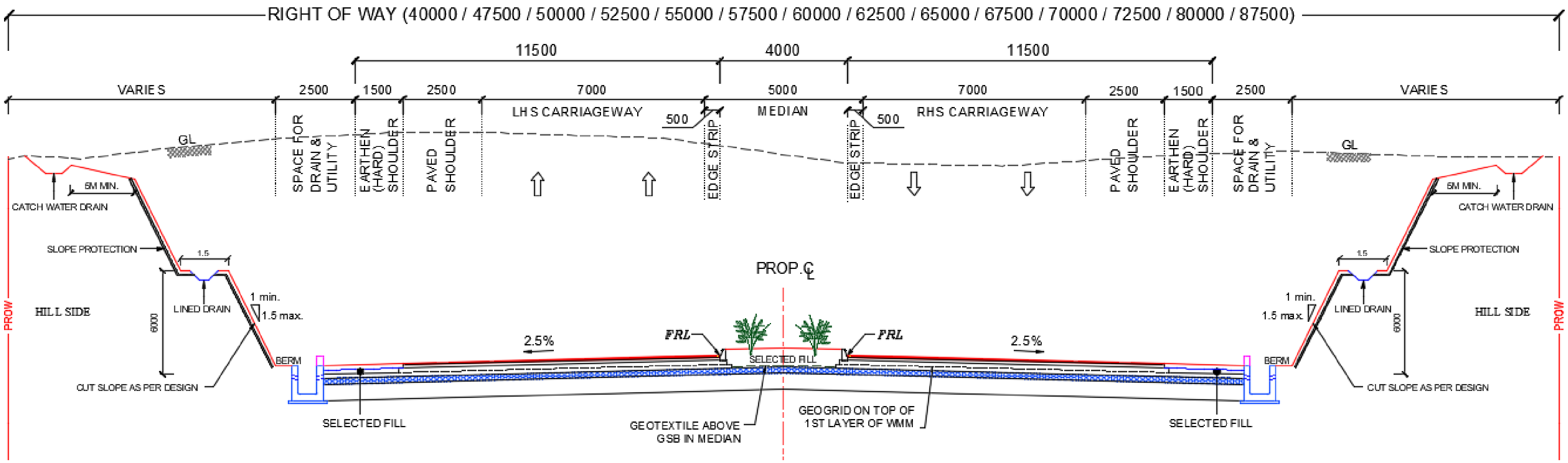



**Fig 7.11 4 Lane Divided Highway without Service Road in Cutting on both sides (TCS-5)**

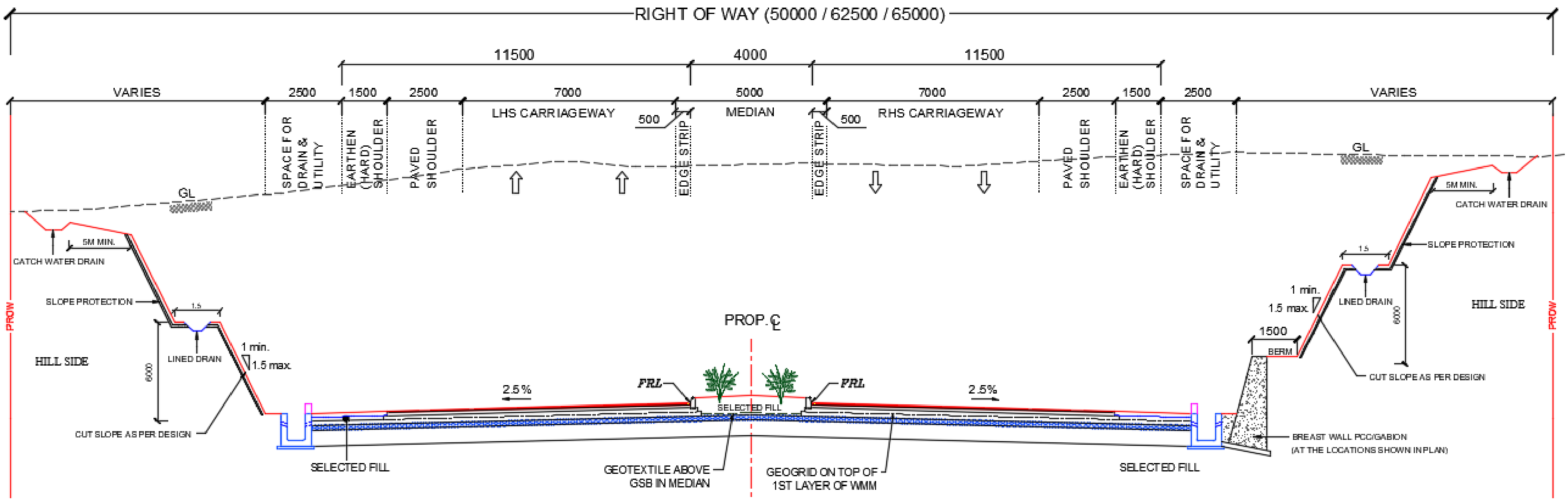



**Fig 7.12** **4 Lane Divided Highway without Service Road in Cutting with one side Breast Wall (TCS-6)**

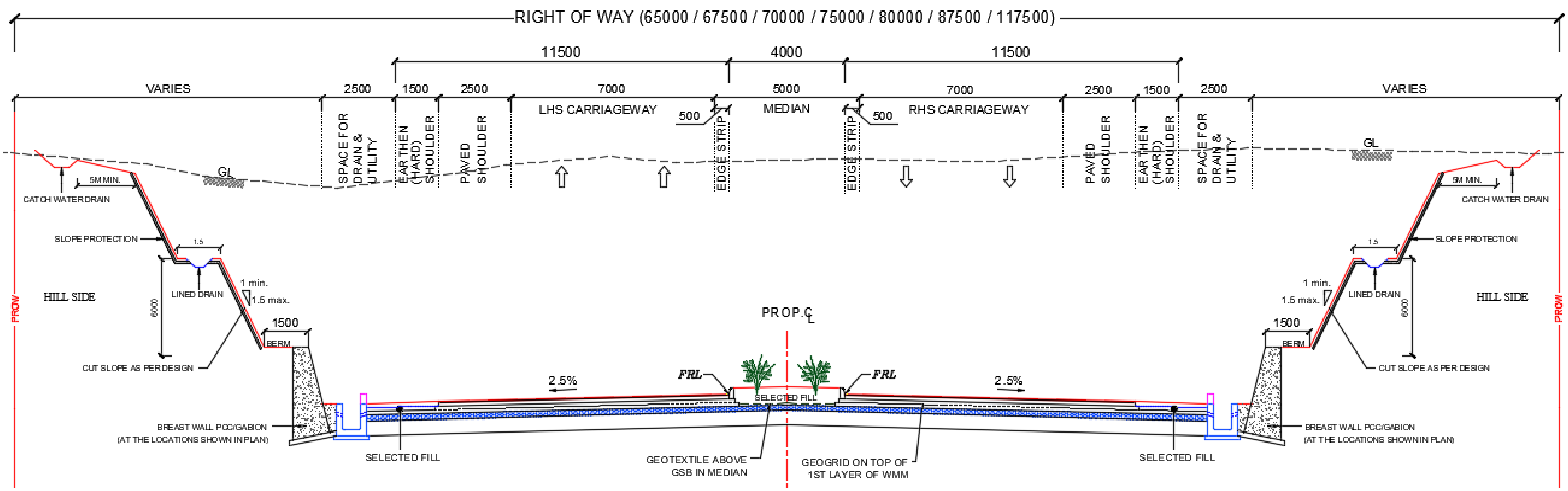



**Fig 7.13 4 Lane Divided Highway without Service Road in Cutting with both side Breast Wall (TCS-7)**

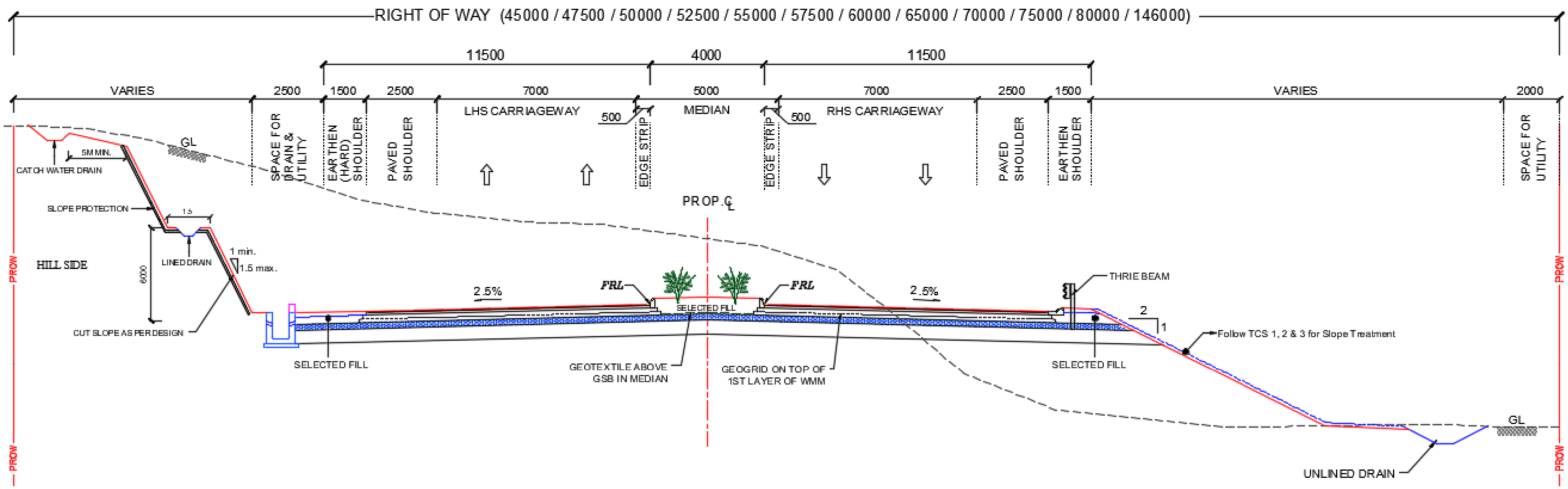



**Fig 7.14 4 Lane Divided Highway without Service Road with normal Cut and Fill (TCS-8)**

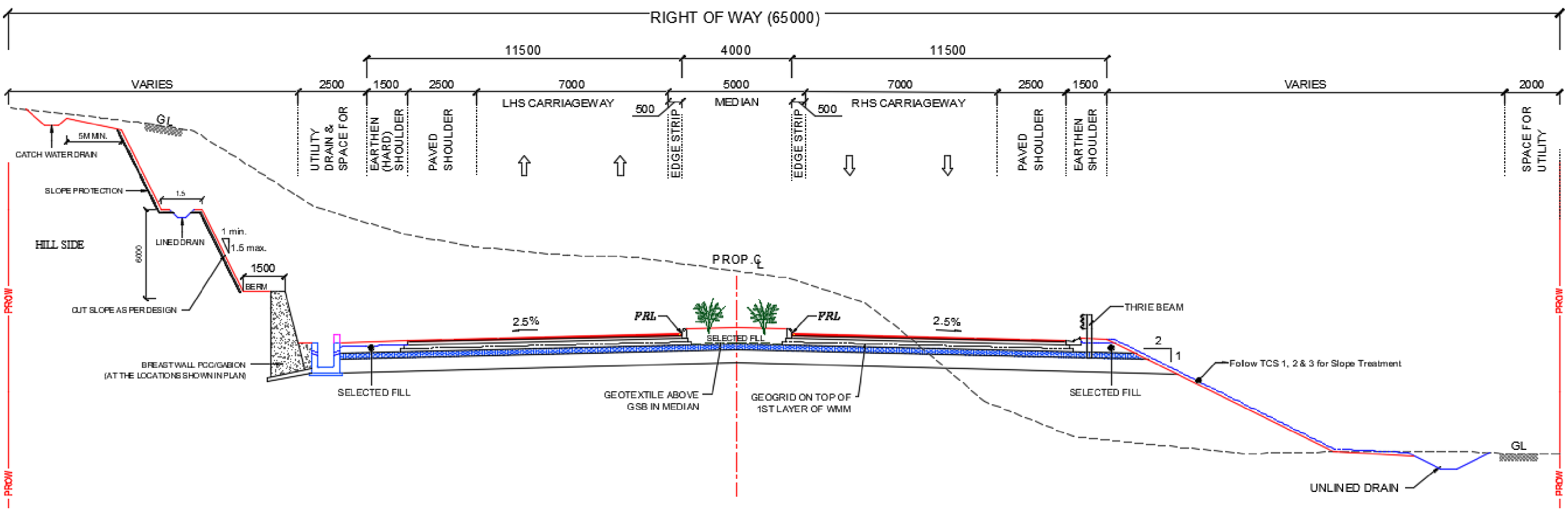



**Fig 7.15** 4 Lane Divided Highway without Service Road with Breast wall in High Cut and Normal Fill (TCS-9)

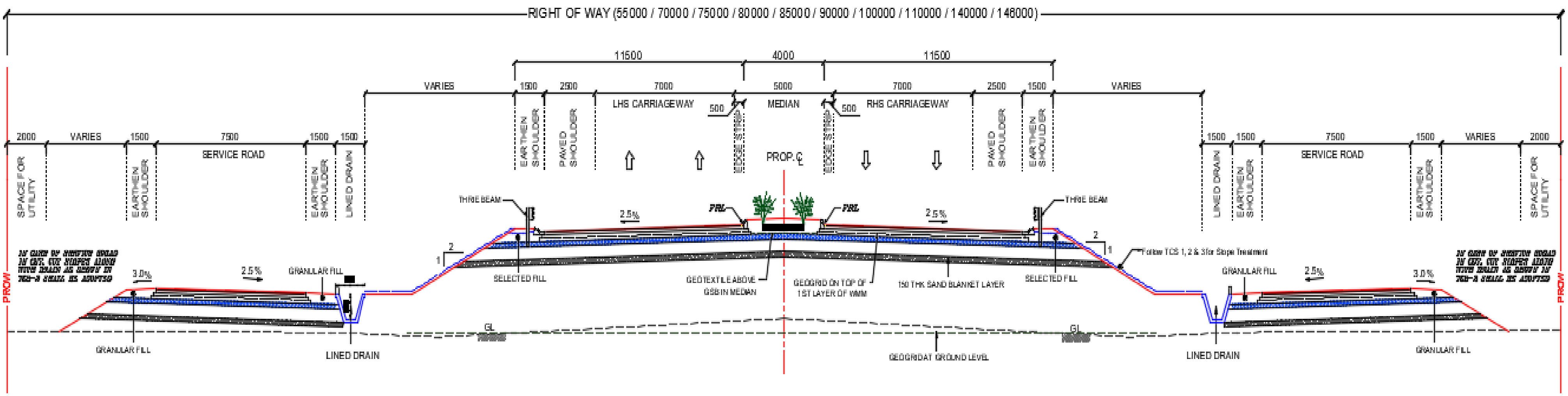



**Fig 7.16 4 Lane Divided Highway with Service Road on both sides (TCS-10)**

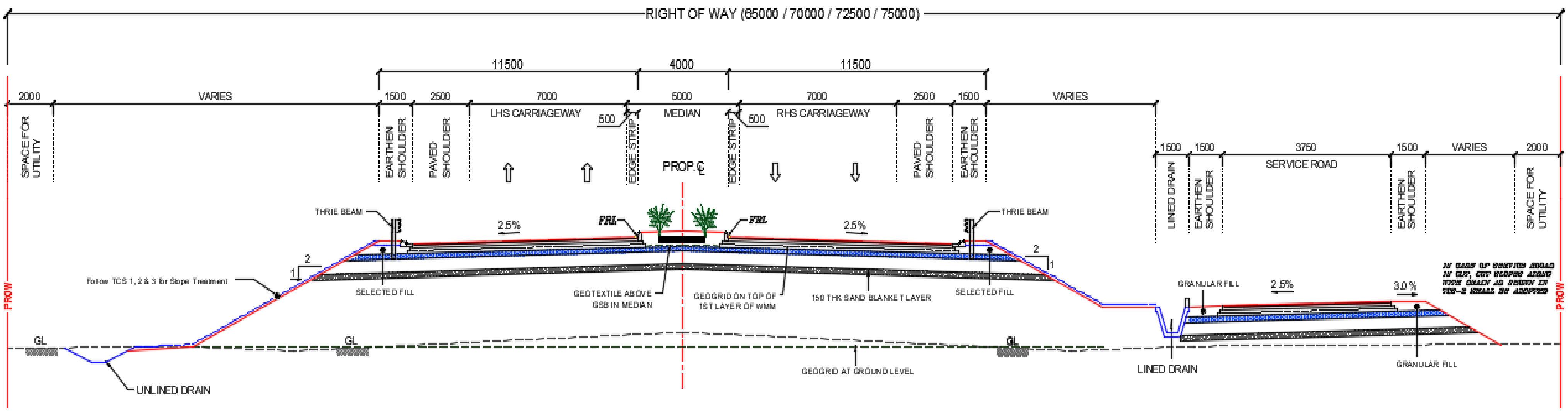



**Fig 7.17 4 Lane Divided Highway with Service Road on one side (TCS-11)**

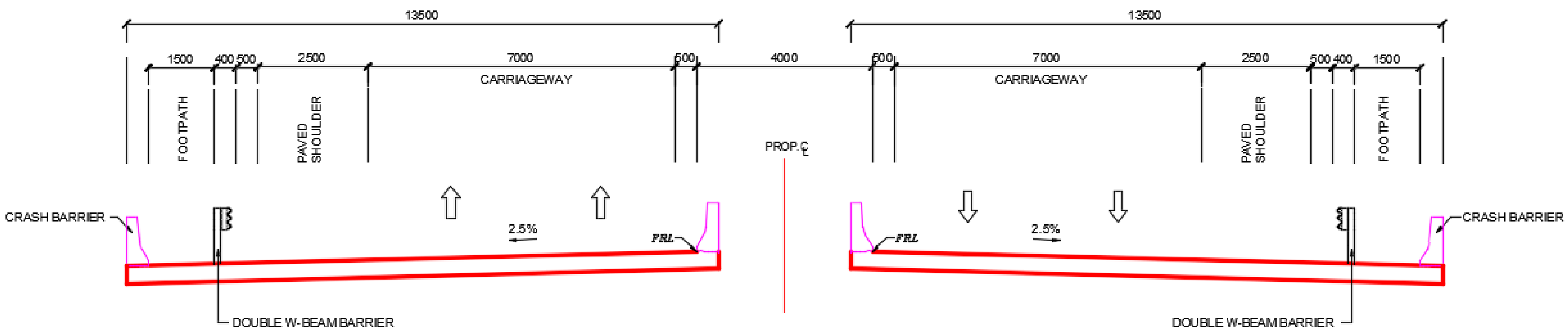



**Fig 7.18 4-Lane- Bridge at Deck Level with Footpath Bridges without Service Road (TCS-12)**

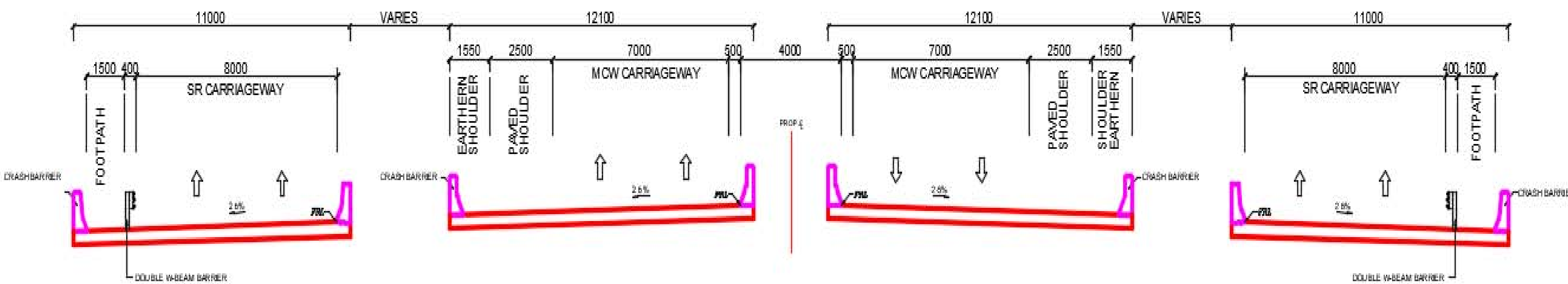



**Fig 7.19 4-Lane- Bridge at Deck Level with Footpath Bridges with Service Road (TCS-13)**

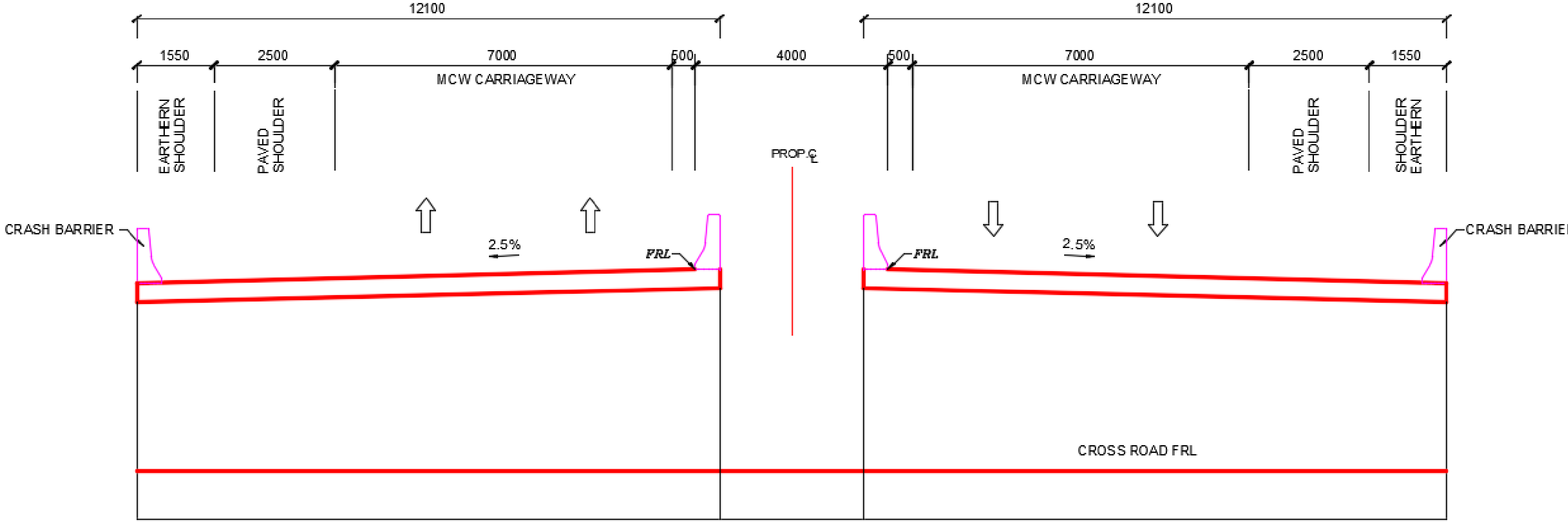



**Fig 7.20 Approach of 4-Lane Grade Separated Approach (TCS-14)**

As mentioned earlier in this report, 99% length of road follows Green Field Alignment and remaining 1% is coming on existing. Schedule of cross-sections are given below:

**Table 7.12 Schedule of Typical Cross Sections**

| SL No. | Chainage (m) | | Distance (m) | Existing CW | Const. Type | Area Type | TCS Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 1 | 4+560 | 4+790 | 230 | - | New Alignment | Open Area | TCS 3 | |
| 2 | 4+790 | 5+420 | 630 | - | New Alignment | Open Area | TCS 4 | |
| 3 | 5+420 | 5+620 | 200 | - | New Alignment | Open Area | TCS 2 | |
| 4 | 5+620 | 5+880 | 260 | - | New Alignment | Open Area | TCS 11 | |
| 5 | 5+880 | 7+860 | 1980 | - | New Alignment | Open Area | TCS 1 | |
| 6 | 7+860 | 8+110 | 250 | - | New Alignment | Open Area | TCS 11 | |
| 7 | 8+110 | 8+240 | 130 | - | New Alignment | Open Area | TCS 8 | |
| 8 | 8+240 | 8+460 | 220 | - | New Alignment | Open Area | TCS 5 | |
| 9 | 8+460 | 8+500 | 40 | - | New Alignment | Open Area | TCS 8 | |
| 10 | 8+500 | 9+000 | 500 | - | New Alignment | Open Area | TCS 1 | |
| 11 | 9+000 | 10+120 | 1120 | - | New Alignment | Open Area | TCS 3 | |
| 12 | 10+120 | 10+170 | 50 | - | New Alignment | Open Area | TCS 5 | |
| 13 | 10+170 | 10+190 | 20 | - | New Alignment | Open Area | TCS 6 | |
| 14 | 10+190 | 10+290 | 100 | - | New Alignment | Open Area | TCS 7 | |
| 15 | 10+290 | 10+300 | 10 | - | New Alignment | Open Area | TCS 6 | |
| 16 | 10+300 | 10+440 | 140 | - | New Alignment | Open Area | TCS 2 | |
| 17 | 10+440 | 10+520 | 80 | - | New Alignment | Open Area | TCS 8 | |
| 18 | 10+520 | 10+570 | 50 | - | New Alignment | Open Area | TCS 5 | |

| SL No. | Chainage (m) | | Distance (m) | Existing CW | Const. Type | Area Type | TCS Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 19 | 10+570 | 10+620 | 50 | - | New Alignment | Open Area | TCS 8 | |
| 20 | 10+620 | 10+780 | 160 | - | New Alignment | Open Area | TCS 1 | |
| 21 | 10+780 | 10+830 | 50 | - | New Alignment | Open Area | TCS 5 | |
| 22 | 10+830 | 11+050 | 220 | - | New Alignment | Open Area | TCS 7 | |
| 23 | 11+050 | 11+110 | 60 | - | New Alignment | Open Area | TCS 5 | |
| 24 | 11+110 | 11+140 | 30 | - | New Alignment | Open Area | TCS 8 | |
| 25 | 11+140 | 11+500 | 360 | - | New Alignment | Open Area | TCS 2 | |
| 26 | 11+500 | 12+350 | 850 | - | New Alignment | Open Area | TCS 10 | |
| 27 | 12+350 | 12+460 | 110 | - | New Alignment | Open Area | TCS 8 | |
| 28 | 12+460 | 12+620 | 160 | - | New Alignment | Open Area | TCS 5 | |
| 29 | 12+620 | 12+760 | 140 | - | New Alignment | Open Area | TCS 1 | |
| 30 | 12+760 | 12+800 | 40 | - | New Alignment | Open Area | TCS 8 | |
| 31 | 12+800 | 13+220 | 420 | - | New Alignment | Open Area | TCS 5 | |
| 32 | 13+220 | 13+440 | 220 | - | New Alignment | Open Area | TCS 8 | |
| 33 | 13+440 | 13+530 | 90 | - | New Alignment | Open Area | TCS 5 | |
| 34 | 13+530 | 13+620 | 90 | - | New Alignment | Open Area | TCS 8 | |
| 35 | 13+620 | 13+690 | 70 | - | New Alignment | Open Area | TCS 2 | |
| 36 | 13+690 | 13+760 | 70 | - | New Alignment | Open Area | TCS 5 | |
| 37 | 13+760 | 13+790 | 30 | - | New Alignment | Open Area | TCS 1 | |
| 38 | 13+790 | 14+220 | 430 | - | New Alignment | Open Area | TCS 5 | |
| 39 | 14+220 | 14+430 | 210 | - | New Alignment | Open Area | TCS 2 | |

| SL No. | Chainage (m) | | Distance (m) | Existing CW | Const. Type | Area Type | TCS Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 40 | 14+430 | 14+470 | 40 | - | New Alignment | Open Area | TCS 8 | |
| 41 | 14+470 | 14+510 | 40 | - | New Alignment | Open Area | TCS 2 | |
| 42 | 14+510 | 14+560 | 50 | - | New Alignment | Open Area | TCS 8 | |
| 43 | 14+560 | 14+620 | 60 | - | New Alignment | Open Area | TCS 2 | |
| 44 | 14+620 | 14+700 | 80 | - | New Alignment | Open Area | TCS 8 | |
| 45 | 14+700 | 14+780 | 80 | - | New Alignment | Open Area | TCS 2 | |
| 46 | 14+780 | 14+880 | 100 | - | New Alignment | Open Area | TCS 5 | |
| 47 | 14+880 | 14+910 | 30 | - | New Alignment | Open Area | TCS 8 | |
| 48 | 14+910 | 15+430 | 520 | - | New Alignment | Open Area | TCS 2 | |
| 49 | 15+430 | 15+560 | 130 | - | New Alignment | Open Area | TCS 5 | |
| 50 | 15+560 | 16+050 | 490 | - | New Alignment | Open Area | TCS 2 | |
| 51 | 16+050 | 16+120 | 70 | - | New Alignment | Open Area | TCS 8 | |
| 52 | 16+120 | 16+250 | 130 | - | New Alignment | Open Area | TCS 5 | |
| 53 | 16+250 | 16+280 | 30 | - | New Alignment | Open Area | TCS 8 | |
| 54 | 16+280 | 16+370 | 90 | - | New Alignment | Open Area | TCS 2 | |
| 55 | 16+370 | 16+420 | 50 | - | New Alignment | Open Area | TCS 8 | |
| 56 | 16+420 | 16+690 | 270 | - | New Alignment | Open Area | TCS 5 | |
| 57 | 16+690 | 16+760 | 70 | - | New Alignment | Open Area | TCS 3 | |
| 58 | 16+760 | 16+780 | 20 | - | New Alignment | Open Area | TCS 6 | |
| 59 | 16+780 | 16+910 | 130 | - | New Alignment | Open Area | TCS 7 | |
| 60 | 16+910 | 16+960 | 50 | - | New Alignment | Open Area | TCS 9 | |

| SL No. | Chainage (m) | | Distance (m) | Existing CW | Const. Type | Area Type | TCS Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 61 | 16+960 | 17+300 | 340 | - | New Alignment | Open Area | TCS 3 | |
| 62 | 17+300 | 17+700 | 400 | - | New Alignment | Open Area | TCS 2 | |
| 63 | 17+700 | 17+800 | 100 | - | New Alignment | Open Area | TCS 1 | |
| 64 | 17+800 | 18+630 | 830 | - | New Alignment | Open Area | TCS 2 | |
| 65 | 18+630 | 18+760 | 130 | - | New Alignment | Open Area | TCS 8 | |
| 66 | 18+760 | 18+880 | 120 | - | New Alignment | Open Area | TCS 2 | |
| 67 | 18+880 | 19+060 | 180 | - | New Alignment | Open Area | TCS 5 | |
| 68 | 19+060 | 19+110 | 50 | - | New Alignment | Open Area | TCS 1 | |
| 69 | 19+110 | 19+200 | 90 | - | New Alignment | Open Area | TCS 8 | |
| 70 | 19+200 | 19+270 | 70 | - | New Alignment | Open Area | TCS 5 | |
| 71 | 19+270 | 19+380 | 110 | - | New Alignment | Open Area | TCS 8 | |
| 72 | 19+380 | 19+730 | 350 | - | New Alignment | Open Area | TCS 2 | |
| 73 | 19+730 | 19+770 | 40 | - | New Alignment | Open Area | TCS 8 | |
| 74 | 19+770 | 19+850 | 80 | - | New Alignment | Open Area | TCS 5 | |
| 75 | 19+850 | 19+950 | 100 | - | New Alignment | Open Area | TCS 8 | |
| 76 | 19+950 | 20+060 | 110 | - | New Alignment | Open Area | TCS 2 | |
| 77 | 20+060 | 20+310 | 250 | - | New Alignment | Open Area | TCS 7 | |
| 78 | 20+310 | 20+380 | 70 | - | New Alignment | Open Area | TCS 5 | |
| 79 | 20+380 | 21+300 | 920 | - | New Alignment | Open Area | TCS 10 | |
| 80 | 21+300 | 21+370 | 70 | - | New Alignment | Open Area | TCS 1 | |
| 81 | 21+370 | 21+860 | 490 | - | New Alignment | Open Area | TCS 2 | |

| SL No. | Chainage (m) | | Distance (m) | Existing CW | Const. Type | Area Type | TCS Type | Remarks |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 82 | 21+860 | 22+200 | 340 | - | New Alignment | Open Area | TCS 3 | |
| 83 | 22+200 | 22+600 | 400 | - | New Alignment | Open Area | TCS 4 | |
| 84 | 22+600 | 22+800 | 200 | - | New Alignment | Open Area | TCS 3 | |
| 85 | 22+800 | 23+210 | 410 | - | New Alignment | Open Area | TCS 2 | |
| 86 | 23+210 | 23+460 | 250 | - | New Alignment | Open Area | TCS 5 | |
| 87 | 23+460 | 23+630 | 170 | - | New Alignment | Open Area | TCS 1 | |
| 88 | 23+630 | 23+770 | 140 | - | New Alignment | Open Area | TCS 5 | |
| 89 | 23+770 | 23+910 | 140 | - | New Alignment | Open Area | TCS 1 | |
| 90 | 23+910 | 23+980 | 70 | - | New Alignment | Open Area | TCS 5 | |
| 91 | 23+980 | 24+270 | 290 | - | New Alignment | Open Area | TCS 7 | |
| 92 | 24+270 | 24+500 | 230 | - | New Alignment | Open Area | TCS 4 | |
| 93 | 24+500 | 24+560 | 60 | - | New Alignment | Open Area | TCS 1 | |

### 7.7.2 Proposed Right of Way

As per IRC: SP: 84, minimum right-of-way (ROW) width of 60m is accommodated to 60m for National Highways at open areas and built-up are. However, the proposed ROW has been worked out on the basis of actual requirement in order to accommodate the proposed 4-lane road along with cut/fill slopes. The layout plans of road alignment are prepared and enclosed in **Volume-IX** of this report and the details are given below;

**Table 7.13 Details of Additional land to be acquired**

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 1 | 4+560 | 4+620 | 60 | | 65.00 | 65.00 | 3900.000 |
| 2 | 4+620 | 4+740 | 120 | | 70.00 | 70.00 | 8400.000 |
| 3 | 4+740 | 4+820 | 80 | | 95.00 | 95.00 | 7600.000 |

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 4 | 4+820 | 4+840 | 20 | | 90.00 | 90.00 | 1800.000 |
| 5 | 4+840 | 5+410 | 570 | | 60.00 | 60.00 | 34200.000 |
| 6 | 5+410 | 5+600 | 190 | | 50.00 | 50.00 | 9500.000 |
| 7 | 5+600 | 5+610 | 10 | | 55.00 | 55.00 | 550.000 |
| 8 | 5+610 | 5+890 | 280 | | 75.00 | 75.00 | 21000.000 |
| 9 | 5+890 | 6+130 | 240 | | 50.00 | 50.00 | 12000.000 |
| 10 | 6+130 | 6+520 | 390 | | 62.50 | 62.50 | 24375.000 |
| 11 | 6+520 | 6+550 | 30 | | 52.50 | 52.50 | 1575.000 |
| 12 | 6+550 | 6+790 | 240 | | 70.00 | 70.00 | 16800.000 |
| 13 | 6+790 | 6+850 | 60 | | 60.00 | 60.00 | 3600.000 |
| 14 | 6+850 | 7+030 | 180 | | 67.50 | 67.50 | 12150.000 |
| 15 | 7+030 | 7+140 | 110 | | 60.00 | 60.00 | 6600.000 |
| 16 | 7+140 | 7+175 | 35 | | 50.00 | 50.00 | 1750.000 |
| 17 | 7+175 | 7+240 | 65 | | 67.50 | 67.50 | 4387.500 |
| 18 | 7+240 | 7+385 | 145 | | 50.00 | 50.00 | 7250.000 |
| 19 | 7+385 | 7+395 | 10 | | 77.50 | 77.50 | 775.000 |
| 20 | 7+395 | 7+480 | 85 | | 50.00 | 50.00 | 4250.000 |
| 21 | 7+480 | 7+500 | 20 | | 45.00 | 45.00 | 900.000 |
| 22 | 7+500 | 7+570 | 70 | | 40.00 | 40.00 | 2800.000 |
| 23 | 7+570 | 7+650 | 80 | | 45.00 | 45.00 | 3600.000 |
| 24 | 7+650 | 7+850 | 200 | | 50.00 | 50.00 | 10000.000 |
| 25 | 7+850 | 8+120 | 270 | | 70.00 | 70.00 | 18900.000 |
| 26 | 8+120 | 8+230 | 110 | | 50.00 | 50.00 | 5500.000 |
| 27 | 8+230 | 8+310 | 80 | | 52.50 | 52.50 | 4200.000 |
| 28 | 8+310 | 8+370 | 60 | | 57.50 | 57.50 | 3450.000 |
| 29 | 8+370 | 8+470 | 100 | | 60.00 | 60.00 | 6000.000 |

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 30 | 8+470 | 8+560 | 90 | | 57.50 | 57.50 | 5175.000 |
| 31 | 8+560 | 8+630 | 70 | | 50.00 | 50.00 | 3500.000 |
| 32 | 8+630 | 8+780 | 150 | | 45.00 | 45.00 | 6750.000 |
| 33 | 8+780 | 8+920 | 140 | | 47.50 | 47.50 | 6650.000 |
| 34 | 8+920 | 10+170 | 1250 | | 50.00 | 50.00 | 62500.000 |
| 35 | 10+170 | 10+190 | 20 | | 62.50 | 62.50 | 1250.000 |
| 36 | 10+190 | 10+290 | 100 | | 75.00 | 75.00 | 7500.000 |
| 37 | 10+290 | 10+830 | 540 | | 50.00 | 50.00 | 27000.000 |
| 38 | 10+830 | 11+050 | 220 | | 70.00 | 70.00 | 15400.000 |
| 39 | 11+050 | 11+140 | 90 | | 52.50 | 52.50 | 4725.000 |
| 40 | 11+140 | 11+240 | 100 | | 55.00 | 55.00 | 5500.000 |
| 41 | 11+240 | 11+410 | 170 | | 62.50 | 62.50 | 10625.000 |
| 42 | 11+410 | 11+500 | 90 | | 65.00 | 65.00 | 5850.000 |
| 43 | 11+500 | 11+520 | 20 | | 70.00 | 70.00 | 1400.000 |
| 44 | 11+520 | 11+710 | 190 | | 90.00 | 90.00 | 17100.000 |
| 45 | 11+710 | 11+820 | 110 | | 100.00 | 100.00 | 11000.000 |
| 46 | 11+820 | 11+880 | 60 | | 110.00 | 110.00 | 6600.000 |
| 47 | 11+880 | 12+130 | 250 | | 100.00 | 100.00 | 25000.000 |
| 48 | 12+130 | 12+240 | 110 | | 90.00 | 90.00 | 9900.000 |
| 49 | 12+240 | 12+380 | 140 | | 75.00 | 75.00 | 10500.000 |
| 50 | 12+380 | 12+450 | 70 | | 70.00 | 70.00 | 4900.000 |
| 51 | 12+450 | 12+480 | 30 | | 60.00 | 60.00 | 1800.000 |
| 52 | 12+480 | 12+540 | 60 | | 65.00 | 65.00 | 3900.000 |
| 53 | 12+540 | 12+790 | 250 | | 55.00 | 55.00 | 13750.000 |
| 54 | 12+790 | 12+870 | 80 | | 70.00 | 70.00 | 5600.000 |
| 55 | 12+870 | 12+920 | 50 | | 60.00 | 60.00 | 3000.000 |

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 56 | 12+920 | 13+010 | 90 | | 60.00 | 60.00 | 5400.000 |
| 57 | 13+010 | 13+030 | 20 | | 65.00 | 65.00 | 1300.000 |
| 58 | 13+030 | 13+090 | 60 | | 70.00 | 70.00 | 4200.000 |
| 59 | 13+090 | 13+170 | 80 | | 55.00 | 55.00 | 4400.000 |
| 60 | 13+170 | 13+240 | 70 | | 60.00 | 60.00 | 4200.000 |
| 61 | 13+240 | 13+450 | 210 | | 55.00 | 55.00 | 11550.000 |
| 62 | 13+450 | 13+750 | 300 | | 50.00 | 50.00 | 15000.000 |
| 63 | 13+750 | 13+890 | 140 | | 55.00 | 55.00 | 7700.000 |
| 64 | 13+890 | 13+940 | 50 | | 50.00 | 50.00 | 2500.000 |
| 65 | 13+940 | 14+050 | 110 | | 60.00 | 60.00 | 6600.000 |
| 66 | 14+050 | 14+140 | 90 | | 55.00 | 55.00 | 4950.000 |
| 67 | 14+140 | 14+170 | 30 | | 60.00 | 60.00 | 1800.000 |
| 68 | 14+170 | 14+230 | 60 | | 55.00 | 55.00 | 3300.000 |
| 69 | 14+230 | 16+150 | 1920 | | 50.00 | 50.00 | 96000.000 |
| 70 | 16+150 | 16+260 | 110 | | 60.00 | 60.00 | 6600.000 |
| 71 | 16+260 | 16+410 | 150 | | 50.00 | 50.00 | 7500.000 |
| 72 | 16+410 | 16+460 | 50 | | 60.00 | 60.00 | 3000.000 |
| 73 | 16+460 | 16+510 | 50 | | 70.00 | 70.00 | 3500.000 |
| 74 | 16+510 | 16+580 | 70 | | 60.00 | 60.00 | 4200.000 |
| 75 | 16+580 | 16+660 | 80 | | 65.00 | 65.00 | 5200.000 |
| 76 | 16+660 | 16+770 | 110 | | 62.50 | 62.50 | 6875.000 |
| 77 | 16+770 | 16+960 | 190 | | 65.00 | 65.00 | 12350.000 |
| 78 | 16+960 | 17+200 | 240 | | 60.00 | 60.00 | 14400.000 |
| 79 | 17+200 | 17+360 | 160 | | 55.00 | 55.00 | 8800.000 |
| 80 | 17+360 | 18+890 | 1530 | | 50.00 | 50.00 | 76500.000 |
| 81 | 18+890 | 18+900 | 10 | | 60.00 | 60.00 | 600.000 |

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 82 | 18+900 | 19+040 | 140 | | 70.00 | 70.00 | 9800.000 |
| 83 | 19+040 | 19+050 | 10 | | 60.00 | 60.00 | 600.000 |
| 84 | 19+050 | 20+050 | 1000 | | 50.00 | 50.00 | 50000.000 |
| 85 | 20+050 | 20+380 | 330 | | 67.50 | 67.50 | 22275.000 |
| 86 | 20+380 | 20+590 | 210 | | 80.00 | 80.00 | 16800.000 |
| 87 | 20+590 | 20+600 | 10 | | 85.00 | 85.00 | 850.000 |
| 88 | 20+600 | 20+670 | 70 | | 90.00 | 90.00 | 6300.000 |
| 89 | 20+670 | 21+370 | 700 | | 100.00 | 100.00 | 70000.000 |
| 90 | 21+370 | 21+480 | 110 | | 65.00 | 65.00 | 7150.000 |
| 91 | 21+480 | 21+540 | 60 | | 57.50 | 57.50 | 3450.000 |
| 92 | 21+540 | 21+610 | 70 | | 35.00 | 35.00 | 2450.000 |
| 93 | 21+610 | 21+820 | 210 | | 57.50 | 57.50 | 12075.000 |
| 94 | 21+820 | 22+130 | 310 | | 60.00 | 60.00 | 18600.000 |
| 95 | 22+130 | 22+640 | 510 | | 55.00 | 55.00 | 28050.000 |
| 96 | 22+640 | 22+670 | 30 | | 57.50 | 57.50 | 1725.000 |
| 97 | 22+670 | 22+800 | 130 | | 60.00 | 60.00 | 7800.000 |
| 98 | 22+800 | 23+070 | 270 | | 55.00 | 55.00 | 14850.000 |
| 99 | 23+070 | 23+210 | 140 | | 35.00 | 35.00 | 4900.000 |
| 100 | 23+210 | 23+450 | 240 | | 55.00 | 55.00 | 13200.000 |
| 101 | 23+450 | 23+610 | 160 | | 47.50 | 47.50 | 7600.000 |
| 102 | 23+610 | 23+800 | 190 | | 40.00 | 40.00 | 7600.000 |
| 103 | 23+800 | 23+950 | 150 | | 47.50 | 47.50 | 7125.000 |
| 104 | 23+950 | 24+290 | 340 | | 80.00 | 80.00 | 27200.000 |
| 105 | 24+290 | 24+500 | 210 | | 55.00 | 55.00 | 11550.000 |
| 106 | 24+500 | 24+650 | 150 | | 55.00 | 55.00 | 8250.000 |
| 165 | 4+780 | MNJ | | 127.346 sqm | 585.154 sqm | | 457.807 |

| Sl. No. | Design Chainage (m) | | Length (m) | Ex. ROW (m) | Proposed ROW (m) | Additional ROW (m) | Area of additional land to be acquired (Sqm) |
|---|---|---|---|---|---|---|---|
| | From | To | | | | | |
| 166 | 5+860 | MNJ | | 75.415 sqm | 548.377 sqm | | 472.962 |
| 167 | 6+820 | MNJ | | 113.146 sqm | 571.909 sqm | | 458.762 |
| 168 | 8+110 | MNJ | | 59.896 sqm | 541.189 sqm | | 481.293 |
| 169 | 9+597 | MNJ | | 48.240 sqm | 325.351 sqm | | 277.111 |
| 170 | 11+913 | MJJ | | 918.707 sqm | 8314.138 sqm | | 7395.430 |
| 171 | 13+777 | MNJ | | 98.323 sqm | 667.738 sqm | | 569.415 |
| 172 | 14+235 | MNJ | | 102.584 sqm | 442.711 sqm | | 340.127 |
| 173 | 15+075 | MNJ | | 65.826 sqm | 346.499 sqm | | 280.674 |
| 174 | 16+796 | MNJ | | 645.623 sqm | 16790.000 sqm | | 16144.377 |
| 175 | 19+612 | MNJ | | 67.629 sqm | 292.744 sqm | | 225.115 |
| 176 | 20+803 | MJJ | | 770.986 sqm | 10095.998 sqm | | 9325.012 |
| 177 | 21+225 | MNJ | | 42.918 sqm | 712.802 sqm | | 669.885 |
| 178 | 21+718 | MNJ | | 37.406 sqm | 157.235 sqm | | 119.829 |
| 179 | 22+648 | MNJ | | 82.261 sqm | 435.314 sqm | | 353.053 |
| **Total 1230883.350 Sqm** | | | | | | | |
| **304.158 Acres** | | | | | | | |
| **123.088 Ha** | | | | | | | |

## 7.8 Access control measures

The proposed scheme presents the 4-Lanes in such a way that the project highway will be operated as a access controlled access highway so as to improve the safety and operational efficiency of the highway. The partial control on access is provided through the measures such as underpasses, acceleration/deceleration lanes, designed entry/exits .etc. In depth discussion of these facilities along with their locations has been given in structural part of this chapter.

### 7.8.1 At Grade Junctions

Road junction/intersection is a key element of highway design. The efficiency, safety, speed and capacity of road system very much depend on the intersection design. The main objective of intersection design is to reduce the severity of potential conflicts between motor vehicles, buses, trucks, bicycles, pedestrians and facilities while facilitating the convenience, ease and comfort of people traversing the intersections.

There are 02nos of proposed of major junctions and 13 nos of minor junctions with village roads, which will be developed as per IRC SP: 41 – 1994. All junctions are designed as at-grade junctions with proper acceleration and deceleration arrangements. In order to improve the functional efficiency of the proposed facility, it is very important to have smooth manoeuvring of traffic from the highway to these roads and vice versa. Typical geometric improvements are being provided without channelizing islands for minor junction improvements, as the traffic intensity is very negligible. Realignment of intersecting roads is suggested only in case of minor roads intersecting at angle less than 60 deg. The typical layouts as given in fig 3.1 and 3.3 of 4-lane manual are generally followed. In addition to these junctions all ingress/egress which will be effected due to the proposed improvements needs to be re-established.

There are 02 no's of major junctions below grade separator and 13 nos of minor junctions with village roads, which need to be designed.

**Table 7.14 List of Major Road Junctions**

| Sl. No. | Location | | Type of Junction | Leading To | Type of Road (SH/ MDR/ ODR/ VR) | Types of C/W | Remarks |
|---|---|---|---|---|---|---|---|
| | Design Chainage | Ex. Chainage | | | | | |
| 1 | 11+913 | - | + | LHS - Udharband RHS - Alipur | Udharband Road | 1-Lane BT | (Under VUP) |
| 2 | 20+803 | - | + | LHS - Mahalthal RHS - Pailapool | Dewan Road | 1-Lane BT | (Under VUP) |

**Table 7.15 List of Minor Road Junctions**

| Sl. No. | Design Chainage | Existing Chainage | Type of Junctions (T, Y, +) | Leading To | Type of Road (SH/ MDR/ ODR/ VR) | Type of Road (BT, CC, Gr.) | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 4+780 | - | + | LHS - Nutan Dayapur RHS - Kasipur Grant | Village Road | 1- Lane BT | (Under LVUP) |

| Sl. No. | Design Chainage | Existing Chainage | Type of Junctions (T, Y, +) | Leading To | Type of Road (SH/ MDR/ ODR/ VR) | Type of Road (BT, CC, Gr.) | Remarks |
|---|---|---|---|---|---|---|---|
| 2 | 5+860 | - | + | LHS - Arkatipur Tea Estate RHS - Nutan Doyapore | Village Road | 1- Lane ER | (Under SVUP) |
| 3 | 6+820 | - | + | LHS - Chappanahal Grant RHS - Banskhandi Pt IV | Village Road | 1-Lane BT | (Under SVUP) |
| 4 | 8+110 | - | + | LHS - Badripar RHS - Banskhandi | Village Road | 1- Lane ER | (Under SVUP) |
| 5 | 9+597 | - | + | LHS - Badripar RHS - Chandrapur | Village Road | 1- Lane ER | (Under SVUP) |
| 6 | 13+777 | - | + | LHS - Monipur Kitta RHS - Alipur Cha Bagicha | Village Road | 1- Lane ER | (Under SVUP) |
| 7 | 14+235 | - | + | LHS - Monipur Kitta RHS - Alipur Cha Bagicha | Village Road | 1- Lane ER | (Under SVUP) |
| 8 | 15+075 | - | + | LHS - Monipur Kitta RHS - Tarapur Grant | Village Road | 1-Lane BT | (Under LVUP) |
| 9 | 16+796 | - | + | LHS - Sibpur Pt II RHS - Sibpur Pt III | Village Road | 1-Lane BT | (Over VOP) |
| 10 | 19+612 | - | + | LHS - Mahalthal RHS - Sibpur Pt I | Village Road | 1-Lane BT | (Under SVUP) |
| 11 | 21+225 | - | T | LHS - Digliriang Punji | Village Road | 1 Lane ER | With Service Road BHS |

| Sl. No . | Design Chainage | Existing Chainage | Type of Junctions (T, Y, +) | Leading To | Type of Road (SH/ MDR/ ODR/ VR) | Type of Road (BT, CC, Gr.) | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | RHS - JNV Road | | | |
| 12 | 21+718 | - | + | LHS - Lalangkitta Labocpar Pt III RHS - Lalangkitta Labocpar Pt II | Village Road | 1-Lane BT | (Under SVUP) |
| 13 | 22+648 | - | + | LHS - JoypurRHS - Pailapool (NH-37) | Joypur Road | 1-Lane BT | (Under VUP) |

## 7.9 Railway crossings/ROB/RUB

The project road crosses 02nos of Railway line crossing along the project road, which details are mentioned below;

**Table 7.16 List of ROB**

| Sl. No. | Design Chainage | Existing Chainage | Leaading to | Name of Railway Line | Type of track | Span arrangem ent | Total Width of Structur e (m) |
|---|---|---|---|---|---|---|---|
| 1 | 5+083 | - | LHS -New Silchar Rly. Stn. RHS - oinarband Rly. Stn. | Silchar-Jiribam BG Railway Line | Single Track BG | 3x36 | 2x13.5 |
| 2 | 22+542 | - | LHS - Kamranga Rly. Stn. RHS - Sribar Rly. Stn. | Silchar-Jiribam BG Railway Line | Single Track BG | 3x36 | 2x13.5 |

## 7.10 Underpass/ Overpass

In order to continue the free flow of traffic along the project highway, Vehicular Underpass, Light Vehicular Underpass and Smaller Light Vehicular Underpass and overpass are proposed at the below locations.

The proposal, whether to elevate project road/cross road has been decided based on the terrain and profile of the roads.

These grade separation facilities are classified and tabulated in following Table.

**Table 7.17 Details of Grade Separation Structures**

| Sl. No. | Type / Location of Structure | Chainage | Concept | Leading to | Category of Road | Span arrangement and Vertical clearance | Total Width of Structure (m) |
|---|---|---|---|---|---|---|---|
| 1 | LVUP | 4+780 | 1- Lane BT | LHS - Nutan Dayapur<br>RHS - Kasipur Grant | Village Road | Span = 1 x 12m<br>Vertical Clearance = 4.0 m | 2x22 |
| 2 | SVUP | 5+860 | 1- Lane ER | LHS - Arkatipur Tea Estate<br>RHS - Nutan Doyapore | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 3 | SVUP | 6+820 | 1-Lane BT | LHS - Chappanahal Grant<br>RHS - Banskhandi Pt IV | Village Road | Span = 1 x 7.0m<br>Vertical Clearance = 4.0m | 2x12.1 |
| 4 | SVUP | 8+110 | 1- Lane ER | LHS - Badripar<br>RHS - Banskhandi | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 5 | SVUP | 9+597 | 1- Lane ER | LHS - Badripar<br>RHS - Chandrapur | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 6 | VUP | 11+913 | 1-Lane BT | LHS - Udharband<br>RHS - Alipur | Udharband Road | Span = 1 x 24m<br>Vertical Clearance = 5.5 m | 2x12.1 |
| 7 | SVUP | 13+777 | 1- Lane ER | LHS - Monipur Kitta<br>RHS - Alipur Cha Bagicha | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 8 | SVUP | 14+235 | 1- Lane ER | LHS - Monipur Kitta<br>RHS - Alipur Cha Bagicha | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 9 | LVUP | 15+075 | 1-Lane BT | LHS - Monipur Kitta<br>RHS - Tarapur Grant | Village Road | Span = 1 x 12m<br>Vertical Clearance = 4.0 m | 2x12.1 |
| 10 | Overpass | 16+796 | 1-Lane BT | LHS - Sibpur Pt II<br>RHS - Sibpur Pt III | Village Road | Span = 2 x 36m<br>Vertical Clearance = 5.5 m | 1x12.0 |
| 11 | SVUP | 17+813 | 1- Lane ER | LHS - Laboc Grant<br>RHS - Laboc Grant | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |

| Sl. No. | Type / Location of Structure | Chainage | Concept | Leading to | Category of Road | Span arrangement and Vertical clearance | Total Width of Structure (m) |
|---|---|---|---|---|---|---|---|
| 12 | SVUP | 19+612 | 1-Lane BT | LHS - Mahalthal RHS - Sibpur Pt I | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 13 | VUP | 20+803 | 1-Lane BT | LHS - Mahalthal RHS - Pailapool | Dewan Road | Span = 1 x 24m Vertical Clearance = 5.5 m | 2x12.1 |
| 14 | SVUP | 21+718 | 1-Lane BT | LHS & RHS - Lalangkitta Labocpar Pt III | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 15 | VUP | 22+648 | 1-Lane BT | LHS - Joypur RHS - Pailapool (NH-37) | Joypur Road | Span = 1 x 24m Vertical Clearance = 5.5 m | 2x12.1 |

### 7.10.1 Service / Slip Roads

Service roads facility is provided at intersections to segregate the through traffic from diverted traffic and is provided as per manual. This facility will improve the free flow of project road traffic and provides partial access control. The details of service/Slip road provided along the project road are shown below (according to proposed chainage).

**Table 7.18 Location of Service / Slip Roads**

| Sl No | LHS | | | | RHS | | | |
|---|---|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Width (m) | Chainage (m) | | Length (m) | Width (m) |
| | From | To | | | From | To | | |
| 1 | 5+620 | 5+880 | 260 | 3.75 | 7+860 | 8+110 | 250 | 3.75 |
| 2 | 11+500 | 12+350 | 850 | 7.50 | 11+500 | 12+350 | 850 | 7.50 |
| 3 | 20+380 | 21+300 | 920 | 7.50 | 20+380 | 21+300 | 920 | 7.50 |
| **Total Length=** | | | **2030** | | | | **2020** | |

### 7.10.2 Exit/Entry ramps

Exit and entry ramps are provided to fulfil the following objectives.

- To have safe and efficient merge/ diverge of service roads.
- To cater the commuting need for traffic generating and terminating from and to intermediate locations.

- To provide the opportunity to traffic coming from cross road to merge at desired location with through traffic on highway and proceed to distanced destinations.
- To provide opportunity to through traffic on project road to exist on to service road and proceed to desired destination through cross road junctions with service road.

## 7.11 Longitudinal Drainage

Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road. Pavement structure including subgrade must be protected from any ingress of water; otherwise with period of time it may weaken the subgrade by saturating it and cause distress in the pavement structure. A road either in cut or fill inevitably suffers from risk of erosion by run off resulting from rainfall. The run off has therefore to be channelized and transferred into a cross drainage structure without causing damage to any element of the road.

The drainage can be divided into two broader categories:

- Sub-surface drainage
- Surface Drainage

**Sub-surface Drainage:** Despite measures for quick drainage of pavement surface as well as provision of a fairly watertight surface, water enters from top and travels through various pavement layers and gets accumulated at the interface of sub-base / base course and subgrade, especially in a boxed type pavement section causing considerable functional problems. To overcome this problem, as per guidelines given in the IRC-SP: 42, it has been proposed to extend the granular sub-base layer over the entire formation width. The sub-base layer shall be acting as self-draining layer and care shall be exercised to provide cross fall appropriate to the draining layer to guard against any sluggish flow on account of inadequate cross-fall than needed for the type of material used in that layer. In case of road in urban area, where boxed type of pavement has been proposed, with the provision of paved shoulder it becomes fairly watertight. Besides the weep holes have been proposed opposite to the base or sub-base layer, as per the depth of the longitudinal drain.

Surface Drainage: The critical analysis of three aspects of surface drainage is given below:

| Sl. No | Design Requirements | Proposals |
|---|---|---|
| 1. | Fast dispersal of precipitation on the road surface so as to minimize danger to moving traffic | Achieved by<br>• Crowning the pavement<br>• Additional Cross-slope (+0.5%) along shoulder<br>• Minimum longitudinal gradient of 0.5% |

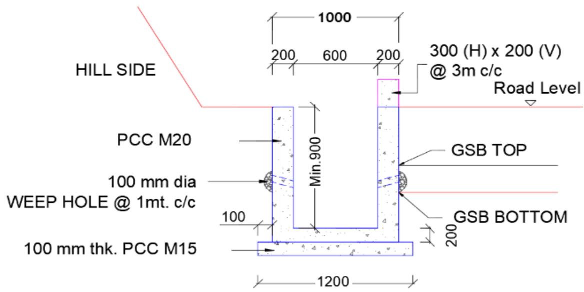
| Sl. No | Design Requirements | Proposals |
|---|---|---|
| 2. | Water from road and the surrounding area need to be successfully intercepted and led away to natural outfalls. | Accomplished by provision of<br>• Longitudinal drains / ditches |
| 3 | Cross drainage structure at streams / river crossings. | Culverts and bridges have been provided as per hydrological requirements. |

The proposed cross fall on the road pavement is 2.5% to ensure proper drainage of the road surface. For road segments traverses through plain terrain, in areas of super elevation transition a minimum longitudinal grade of 0.3% is to be adopted to ensure that the pavement surface drains properly.

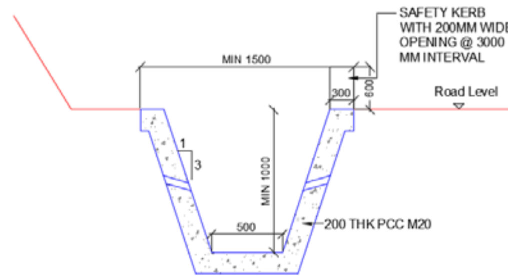
Longitudinal side drains shall be provided, on both side of road, for entire length of the project road. The type of section and size of side drain shall depend on the locations as mentioned below:

**In Rural Areas:** Unlined open trapezoidal drains have been proposed along the project road. Side drains shall be designed to a depth of minimum 300mm below sub-base which will allow drainage of the upper pavement layers as well as carry water from the road surface.

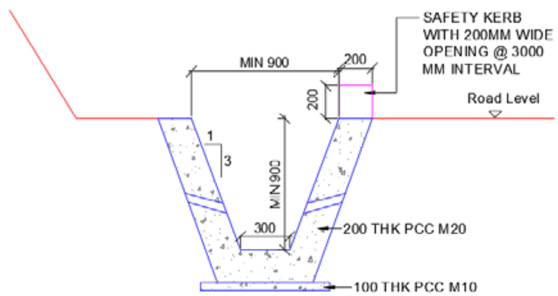
**In urban areas:** Lined covered drains have been proposed along the road passing through built-up areas. RCC covered drain, which shall serve as footpath also has been provided. And at the locations where the cross section is in cutting, trapezoidal type lined drains have been proposed.




a. **PCC Open Drain Hill Side**




b. **PCC Drain at Grade separator Side**




c. **PCC Drain other**

*Note: Ref. separate TCS drawings for more details.*

**Fig 7.21 Types of Drain**

Details of drain schedules are mentioned below;

**Table 7.19 PCC Drain at Grade Separator**

| Sl No | LHS | | | RHS | | |
|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 1 | 5+620 | 5+850 | 230 | 7+860 | 8+150 | 290 |
| 2 | 11+540 | 12+300 | 760 | 11+540 | 12+300 | 760 |
| 3 | 20+420 | 21+220 | 800 | 20+420 | 21+220 | 800 |
| | **Total Length (m)** | | **1790** | | | **1850** |

**Table 7.20 PCC Drain Other Locations**

| Sl No | LHS | | | RHS | | |
|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 1 | 8+500 | 8+750 | 250 | 8+210 | 8+220 | 10 |
| 2 | 16+525 | 16+565 | 40 | 8+460 | 8+510 | 50 |
| 3 | | | | 10+480 | 10+520 | 40 |
| 4 | | | | 12+370 | 12+430 | 60 |
| 5 | | | | 12+695 | 12+800 | 105 |
| 6 | | | | 12+885 | 12+910 | 25 |
| 7 | | | | 13+555 | 13+620 | 65 |
| 8 | | | | 14+470 | 14+510 | 40 |
| 9 | | | | 14+560 | 14+620 | 60 |
| 10 | | | | 19+055 | 19+100 | 45 |
| 11 | | | | 19+385 | 19+455 | 70 |
| | **Total Length (m)** | | **290** | | | **570** |

**Table 7.21 PCC Drain at Hill Side**

| Sl No | LHS | | | RHS | | |
|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 1 | 5+620 | 5+870 | 250 | 7+860 | 8+210 | 350 |
| 2 | 8+240 | 8+500 | 260 | 8+220 | 8+460 | 240 |
| 3 | 10+120 | 10+305 | 185 | 10+120 | 10+300 | 180 |
| 4 | 10+780 | 11+110 | 330 | 10+440 | 10+480 | 40 |
| 5 | 12+140 | 12+620 | 480 | 10+520 | 10+600 | 80 |
| 6 | 12+760 | 13+530 | 770 | 10+780 | 11+140 | 360 |
| 7 | 13+700 | 14+220 | 520 | 12+430 | 12+620 | 190 |
| 8 | 14+780 | 14+910 | 130 | 12+800 | 12+885 | 85 |
| 9 | 15+430 | 15+560 | 130 | 12+910 | 13+220 | 310 |
| 10 | 16+050 | 16+250 | 200 | 13+430 | 13+555 | 125 |
| 11 | 16+370 | 16+525 | 155 | 13+690 | 14+220 | 530 |

| Sl No | LHS | | | RHS | | |
|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 12 | 16+565 | 16+690 | 125 | 14+420 | 14+470 | 50 |
| 13 | 16+770 | 16+910 | 140 | 14+510 | 14+560 | 50 |
| 14 | 18+890 | 19+060 | 170 | 14+620 | 14+700 | 80 |
| 15 | 19+200 | 19+270 | 70 | 14+775 | 14+880 | 105 |
| 16 | 19+760 | 19+950 | 190 | 15+440 | 15+555 | 115 |
| 17 | 20+045 | 20+470 | 425 | 16+120 | 16+280 | 160 |
| 18 | 23+210 | 23+470 | 260 | 16+420 | 16+685 | 265 |
| 19 | 23+620 | 23+770 | 150 | 16+670 | 16+980 | 310 |
| 20 | 23+915 | 24+290 | 375 | 18+880 | 19+055 | 175 |
| 21 | | | | 19+100 | 19+385 | 285 |
| 22 | | | | 19+730 | 19+860 | 130 |
| 23 | | | | 20+040 | 20+570 | 530 |
| 24 | | | | 23+210 | 23+450 | 240 |
| 25 | | | | 23+630 | 23+770 | 140 |
| 26 | | | | 23+900 | 24+290 | 390 |
| **Total Length=** | | | **5315** | | | **5515** |

## 7.12 Protection Works

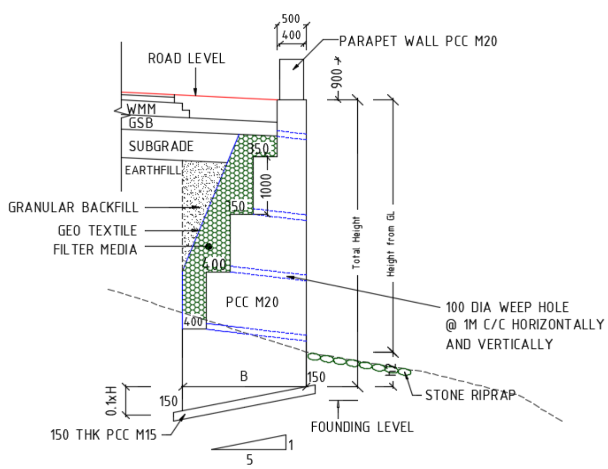
The proposed road alignment passes through hilly terrain, major stretch of the road passes through reaches with either full cutting or part cutting and filling. Due to high cut & fill natural stability of the hill slopes disturbs. Watercourses along the slopes cause erosion affecting road stability. Soil movement along slopes tend to disturb the road formation. All these have to be effectively countered to obtain a stable road, to avoid instability of the slopes and landslides in future by provision of structures/slope stability arrangements to act as retaining, restraining and protective structures.

The alignment is so designed to minimize the height of cut & fill and least disturbance to natural hill slopes. Various types of retaining structures/Slope stability arrangements are proposed considering the following factors.

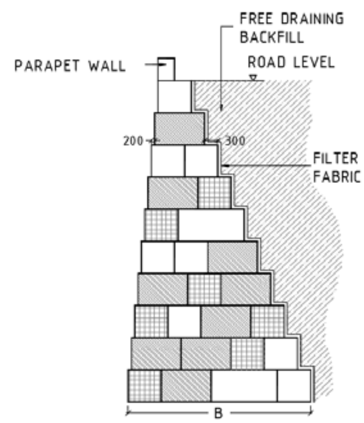
- Height of Cut/Fill
- Cross slope the existing ground/hill
- Soil properties
- Height of hill above the finished road level

### 7.12.1 Retaining Walls

Retaining walls are permanent structures usually built at the toe of the slope or at shoulder edge to resist lateral pressure due to existing soil, earth filling, back fill, water pressure etc. Retaining walls have been proposed, a) where the existing ground is steep, and embankment is not feasible b) to restrict the formation width at ROW constraint locations.




**a. PCC Retaining Wall**




**b. Gabion Retaining**

*Note: Ref. separate Standard drawings for more details.*

**Fig 7.22 Retaining Wall Types**

Detail locations of Retaining walls are given below;

**Table 7.22 Schedule of Retaining Wall**

| Sl No | LHS | | | | | RHS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Height (m) | Type | Chainage (m) | | Length (m) | Height (m) | Type |
| | From | To | | | | From | To | | | |
| 1 | 4+780 | 5+400 | 620 | 3 | PCC | 4+780 | 5+400 | 620 | 3 | PCC |
| 2 | 22+200 | 22+600 | 400 | 4 | PCC | 22+200 | 22+600 | 400 | 4 | PCC |
| 3 | 24+280 | 24+500 | 220 | 4 | PCC | 24+280 | 24+500 | 220 | 4 | PCC |
| **Total Length=** | | | **1240** | | | **Total Length=** | | **1240** | | |

### 7.12.2 Proposed Fill Slope Protection

The protection on valley side in free fall embankment using erosion control blankets component using geo-green, shall also be executed as per site condition in consult with Authority/IE.

In this section, fill slope using Turfing 58252.6 sqm, and also Erosion Control is proposed for area of 76541.8 sqm,

### 7.12.3 Proposed Cut Slope Protection

Geologically the project area comprises of normal soil with marginal length of rocks from the oldest Precambrian gneissic complex to the recent alluvium formations. As the project involve cutting of existing hill slopes, it is imperative that slopes are to be stabilized for insuring longevity of the slopes and the roads.

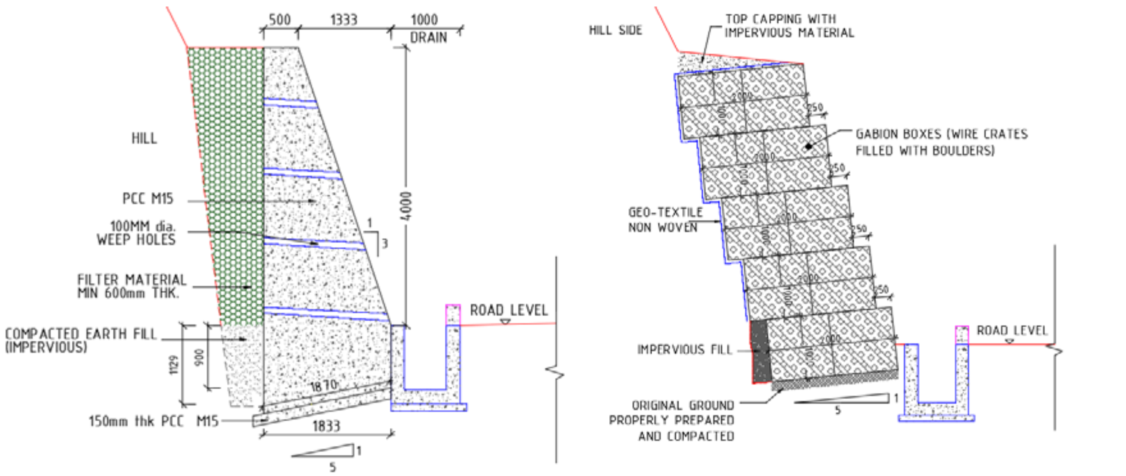
However, 24095.9 sqm of cutting area has been proposed for treatment of manmade safe designed cut slope shall be turfed with vetiver grass, seeding and mulching. Apart from that perforated PVC pipe (30 to 40mm) of desired length shall be provided at a spacing of 5m c/c.

### 7.12.4 Breast Walls

Breast walls are provided to protect uphill slopes, which fail by slumping, sliding, toe failures and failures below formation level. Breast walls would also serve the following functions.

- To keep the road edge defined
- To protect the hill slope to the height of breast wall from slips
- To protect the drain to some extent
- Drainage from hill-slope through weep holes on to side drain
- To protect the buildings/structures on uphill

Generally, breast walls have been proposed under 2 scenarios - a) At built-up areas to restrict the width cutting and thus the requirement of ROW, b) At high cutting locations. The height of breast walls considered is 1.5m and 3.0m as per site requirement. At built-up areas generally PCC breast walls have been proposed and at rural areas Gabion walls have been proposed. Detail locations of Breast walls are given below;




a. **PCC Breast Wall (Max 5.0m**

b. **Gabion Breast Wall (More than 5.0m Height)**

*Note: Ref. separate standard drawings for more details.*

**Fig 7.23 Types of Breast Wall**

Detail locations are mentioned below;

**Table 7.23 Schedule of Breast Wall**

| LHS | | | | | | RHS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sl No | Chainage (m) | | Length (m) | Height | Type | Chainage (m) | | Length (m) | Height | Type |
| | From | To | | | | From | To | | | |
| 1 | 10+190 | 10+300 | 110 | 4 | PCC | 10+170 | 10+290 | 120 | 4 | PCC |
| 2 | 10+830 | 11+050 | 220 | 4 | PCC | 10+830 | 11+050 | 220 | 4 | PCC |
| 3 | 16+780 | 16+910 | 130 | 3 | PCC | 16+760 | 16+960 | 200 | 3 | PCC |
| 4 | 20+060 | 20+310 | 250 | 5 | PCC | 20+060 | 20+310 | 250 | 5 | PCC |
| 5 | 23+980 | 24+270 | 290 | 4 | PCC | 23+980 | 24+270 | 290 | 4 | PCC |
| **Total Length=** | | | **1000** | | | | | **1080** | | |

### 7.12.5 Guard/Parapet Wall

Generally, Parapets shall be proposed on valley side at stretches where, either drains or retaining walls are not there however, proposed alignment does not encounter in this package.

### 7.12.6 Crash Barrier

Thrie beam Crash barrier is proposed where the embankment height is 3m or more, on curves having radii less than 150m for upgrades and 300m for downgrades and at locations where, ground slope is steeper than 2 horizontal 1 vertical (2:1) on valley side, on the approaches of bridges for a length of at least 30m on both sides. With these criteria, detail length of Thrie beam crash barrier is given below;

**Table 7.24 Schedule of Crash Barrier**

| Sl No | LHS | | | RHS | | |
|---|---|---|---|---|---|---|
| | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 1 | 4+560 | 5+430 | 870 | 4+560 | 6+060 | 1500 |
| 2 | 5+480 | 5+680 | 200 | 6+110 | 7+960 | 1850 |
| 3 | 5+760 | 6+060 | 300 | 8+450 | 8+700 | 250 |
| 4 | 6+130 | 7+460 | 1330 | 8+910 | 10+130 | 1220 |
| 5 | 7+660 | 8+230 | 570 | 10+300 | 10+390 | 90 |
| 6 | 8+550 | 8+570 | 20 | 10+600 | 10+730 | 130 |
| 7 | 8+730 | 9+650 | 920 | 11+140 | 12+380 | 1240 |
| 8 | 9+710 | 10+090 | 380 | 12+620 | 12+700 | 80 |
| 9 | 10+300 | 10+520 | 220 | 13+220 | 13+450 | 230 |
| 10 | 10+580 | 10+750 | 170 | 13+560 | 13+680 | 120 |
| 11 | 11+110 | 12+350 | 1240 | 14+220 | 14+430 | 210 |
| 12 | 12+620 | 12+760 | 140 | 14+470 | 14+520 | 50 |
| 13 | 13+530 | 13+700 | 170 | 14+560 | 14+620 | 60 |
| 14 | 14+250 | 14+680 | 430 | 14+880 | 15+440 | 560 |
| 15 | 14+910 | 15+430 | 520 | 15+550 | 16+070 | 520 |
| 16 | 15+560 | 16+050 | 490 | 16+280 | 16+420 | 140 |
| 17 | 16+250 | 16+370 | 120 | 16+680 | 16+760 | 80 |
| 18 | 16+670 | 16+770 | 100 | 16+990 | 18+870 | 1880 |
| 19 | 16+920 | 18+620 | 1700 | 19+380 | 19+730 | 350 |
| 20 | 18+750 | 18+890 | 140 | 19+850 | 20+050 | 200 |
| 21 | 19+060 | 19+200 | 140 | 20+430 | 23+210 | 2780 |
| 22 | 19+270 | 19+760 | 490 | 23+490 | 23+620 | 130 |
| 23 | 19+950 | 20+040 | 90 | 24+290 | 24+490 | 200 |
| 24 | 20+460 | 23+220 | 2760 | | | |

| LHS | | | | RHS | | |
|---|---|---|---|---|---|---|
| Sl No | Chainage (m) | | Length (m) | Chainage (m) | | Length (m) |
| | From | To | | From | To | |
| 25 | 23+510 | 23+610 | 100 | | | |
| 26 | 23+800 | 23+920 | 120 | | | |
| 27 | 24+290 | 24+560 | 270 | | | |
| Total Length= | | | 14000 | | | 13870 |

## 7.13 Way side amenities & Other Facilities

### 7.13.1 Bus-bays and Bus shelters

There are number of villages and towns all along the existing highway. Bus shelters are present in some locations. Parking of bus /maxi cabs on main carriageway interferes in free flow movement of NH traffic and accidents also take place. Therefore, 06numbers of bus bays have been proposed along the project highway to avoid congestion and reduce accidents. The locations of proposed bus bays along the highway are shown in layout plans, **Volume IX** and details list is given below;

**Table 7.25 Details of Bus bays**

| Sl. No. | Design Chainage | Side | Name Of Village | Remarks |
|---|---|---|---|---|
| 1 | 6+690 | LHS | Nutan Doyapore | On Main Lane |
| 2 | 6+950 | RHS | Nutan Doyapore | On Main Lane |
| 3 | 11+790 | LHS | Palerbond Grant | On Service Road |
| 4 | 12+020 | RHS | Palerbond Grant | On Service Road |
| 5 | 20+720 | LHS | Labocpar B | On Service Road |
| 6 | 20+910 | RHS | Labocpar B | On Service Road |

### 7.13.2 Truck lay-byes

Truck lay-byes have been proposed at 1 no location. Locations of truck lay-bye are given below in table.

**Table 7.26 Details of Truck Lay Bye**

| Sl. No. | Design Chainage | Side | Name Of Village |
|---|---|---|---|
| 1 | 6+330 | RHS | Nutan Doyapore |

### 7.13.3 Lighting

As per clause 12.4.3 of manual, lighting has been proposed at Built-up sections, Grade separated structures, bus bays, truck lay-byes, rest area, toll plaza etc.

### 7.13.4 Rest Areas

User amenities in the form of rest areas are proposed along the project road corridor. The rest area is 300 x 75 m (2.25 hectare) in size and is generally proposed at 50 Km apart in staggered manner. The area should accommodate the services such as parking, catering, toilets, essential shopping, repair and refuelling, highway information etc. In the opinion of the consultant the following two locations are most suitable for rest areas.

However, after assessment the DPR Consultant has not recommended to provide any Rest area in this package. Whereas, truck Lay bye provision on either side of the project road has been recommended this will cater the requirement.

**Hence, Rest area =Nil**

### 7.13.5 Toll Plaza

There is no proposal of Toll Plaza has been proposed in this Section.

### 7.13.6 Traffic Signs & Other Road Appurtenances

Provision have to be made for the traffic safety all along the stretches of the proposed road i.e. road sign- mandatory, informatory & cautionary, road markings, way side amenities etc. as per IRC: 35-1997, IRC: 67-2012, IRC: 93-1985, and IRC: SP: 73-2007.

The road furniture proposed to be provided includes routine and special road signs, hectometre, and kilometre and 200 m stones. Road delineators and warning/caution/informatory signs are also considered in the estimate. Road marking would be generally standard centre-line using thermoplastic paints. Boundary Pillars are proposed in the entire length on both sides at an interval of 200m.

Reflective Pavement Marker (RPM) or road stud is a device, which is bonded to or anchored within the road surface for lane marking and delineation for night time visibility. It reflects incident light in directions close to the direction from which it came. Design details, Optical performance details and details of fixing and placement shall be in-accordance with Ministry’s letter No.RW/NH-33023/10/97-DO III dated, the 11th June, 1997 on ‘Technical Specifications for Reflective Pavement Markers (Road Studs)’.

The size of “Chevron” Signboard is 400mm x 550mm.The signboard shall be in accordance with specification Cl. 801.3 of MoRTH guidelines for high intensity grade sheeting. Chevron sign boards shall be installed at 10m c/c at all curves with their embankments height more than 3 along the outer edge facing the traffic of nearby lane.

## 7.14 Summary of Improvement Proposal

**Table 7.27 Summary of Improvement Proposals**

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| 1 | **Alignment & Geometrics** | | |
| | Total Length | Km | 20.000 |
| | **Re-alignments** | Km | - |
| | **Green Field Alignment** | | |
| | Green Field Alignment | Km | 20.000 |
| | **Total (Green Field Alignment)** | **Km** | **20.000** |
| 2 | **Cross Section** | | |
| | 4-Lane Road | Km | 20.000 |
| | 6-Lane Road (Tunnel portion along with approaches) | Km | Nil |
| 3 | **Bridges** | | |
| | **Existing** | Nos | 05 |
| | Major | Nos | 01 |
| | Minor | Nos | 04 |
| | **Rehabilitation Proposal of Existing Bridges** | | |
| | **Existing Bridges reconstruction (Major and Minor)** | Nos | - |
| | **Existing Bridges Repair/ Retain MJB** | Nos | - |
| | **Existing Bridges Widening (Major and Minor)** | Nos | - |
| | **Abandoned (not in use)** | Nos | 05 |
| | **New Bridges** | **Nos** | 22 |
| | a. Major Bridges | Nos | 02 |
| | b. Minor Bridges | Nos | 14 |
| 4 | **Culverts** | | |
| | Existing Culverts | Nos | 17 |
| | Proposed Culverts | Nos | 61 |
| | **Rehabilitation Proposal of Culvert** | | |

| Sl. No. | Description | | Unit | Total |
|---|---|---|---|---|
| | Existing Culverts reconstruction / widened / Retained | | Nos | - |
| | Existing Culverts Abandon | | Nos | 17 |
| | New Culvert along project road | | Nos | 49 |
| | New Culvert for cross roads | | Nos | 12 |
| 5 | **Major & Minor Junctions** | | | |
| | Major Junction | | Nos | 02 |
| | Minor Junctions | | Nos | 13 |
| 6 | **Tunnel** | | Nos | Nil |
| 7 | **Toll Plaza** | | Nos | Nil |
| 8 | **Service/Slip Road (LHS/RHS)** | | Km | 4.050 |
| 9 | **Rest Area** | | Nos | - |
| 10 | **Grade Separator** | | | |
| | **Overpass** | | Nos | 01 |
| | **Vehicular Underpass (VUP)** | | Nos | 03 |
| | **Light Vehicular Underpass (LVUP)** | | Nos | 02 |
| | **Smaller Vehicular Underpass (SVUP)** | | Nos | 09 |
| | **Railway over Bridge (ROB)** | | Nos | 02 |
| 11 | **Bus Bay** | | Nos | 06 |
| 12 | **Truck Lay bye (Km 6+330, RHS)** | | Nos | 01 |
| 13 | **Protection Work** | | | |
| | **Retaining Wall** | **LHS** | Mts | 1240 |
| | | **RHS** | Mts | 1240 |
| | **Breast Wall** | **LHS** | Mts | 1000 |
| | | **RHS** | Mts | 1080 |
| | **Crash Barrier** | **LHS** | Mts | 14000 |
| | | **RHS** | Mts | 13870 |
| 14 | **Drain** | | | |
| | **PCC Drain @ Grade Separator** | **LHS** | Mts | 1790 |
| | | **RHS** | Mts | 1850 |
| | **PCC Drain @ Other Location** | **LHS** | Mts | 290 |
| | | **RHS** | Mts | 570 |
| | **PCC Drain at Hill side** | **LHS** | Mts | 5315 |
| | | **RHS** | Mts | 5515 |
| 15 | **Additional Land requirement for the project** | | Km. | 20.000 |
| 16 | **% of Land Requirement for the Project (Length wise)** | | % | 100.00 |
| | **Pavement Design Life** | | | |

| Sl. No. | Description | Unit | Total |
|---|---|---|---|
| 17 | **Flexible** | Year | 20 |
| | **Rigid** | Year | 30 |
| 18 | **Traffic in MSA : Km 4+560 to Km 24+560** | MSA | 40 |
| 19 | **Pavement Type Proposed**<br>**1. Km 4+560 to Km 24+560** | Flexible | Flexible –4L |
| | **Existing Type** | BT | |
| | **Proposed new 4 Lane ( Main Carriageway)** | **Flexible** | |
| | **BC(PMB/CRMB)** | **mm** | 40 |
| | **DBM (VG-40)** | **mm** | 65 |
| | **WMM** | **mm** | 250 |
| | **Geogrid** | | Biaxial |
| | **Granular Sub-Base (GSB)** | **mm** | 200 |
| | **Subgrade** | **mm** | 500 |
| | **Service Road** | **Flexible** | |
| | **BC(VG-30)** | mm | 30 |
| | **DBM (VG-30)** | mm | 60 |
| | **WMM** | mm | 250 |
| | **Granular Sub-Base (GSB)** | mm | 200 |
| | **Subgrade** | mm | 500 |

7

# Chapter 7 – Improvement Proposals (Structures)

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# 7 Chapter 7 – Improvement Proposals (Structures)

## 7.1 Introduction

This chapter is intended to give brief descriptions concerning the various improvement proposals for culverts, bridges and other grade separated structures. The structural arrangement for structures has been finalized based upon inventory & condition surveys, geo-technical studies, cost effectiveness and ease of construction. Modification scheme of existing structures and design of new structures are based on detailed plan of 4-Laning and 6-Laning scheme. The typical of General Arrangement Drawings (GADs) has been prepared for each group type of structure as per IRC guidelines. The various features of Design Standards have been indicated in Chapter-5 and detailed drawings in **Volume IX**.

The following are the various types of structures proposed.

- Culverts
- Cattle Underpasses (CUP)
- Light Vehicular Underpass (LVP)
- Vehicular Underpasses (VUP)
- Small Vehicular Underpasses (SVUP)
- Flyover
- Minor Bridges
- Major Bridges
- ROB

## 7.2 Culverts

Uncontrolled water is the primary cause of problems like soft surfaces, pot holes and even failure of complete sections of road. Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road.

The existing drainage infrastructure consists mainly of small diameter pipe culverts and slab culverts. Culverts which are found in good condition are proposed to be widened in case of proposed alignment follows existing road and the culverts which are in bad condition are proposed to be reconstructed. There are 75nos. of existing culverts, out of which 30nos are Slab, 36nos are Box and 09 nos are Pipe culverts on NH-37 on Silchar to Jiribam Section however in Package-1 17nos of existing culverts are falling, out of which 09 nos are Pipe, 03 nos are Slab and 05 nos are Box culvert.

Treatment of culverts on the project road was determined after carrying out detailed inventory and condition surveys to note all details including structural condition and hydraulic adequacy.

Existing road is a 2-Lane road, which has to be 4-Lanes road with improved vertical and horizontal geometric. Following categories of existing culverts have been proposed for reconstruction:

- Culverts whose pipe / box/ slab or its abutment are damaged.
- Culverts where the proposed centerline of the project road falls outside of the existing carriageway, because of improvement of geometric.
- Culvert requires reconstruction on account of the vertical profile of proposed road not matching with existing road or deck level of the culvert due to geometric improvements.
- Culverts where bedding underneath the pipe has been washed away due to storm water action. Now water flows underneath the pipe until water level increases above inlet level.
- Pipe culvert-having dia. of less than 0.9m, considered for reconstruction with 1.2m dia. pipe.

It has been found that there is not even single culvert, which does meet any one or many of above-mentioned conditions. Hence all new culverts will be constructed on new alignment of 4/2-lane road.

New culverts along the proposed alignment have been proposed which are as per locations of streams. Extra culverts have been added along existing alignment also where present number of culverts has been found to be less as compared to requirements based on topography. Locations of culverts are designed in such a way that side drains and culverts are integrated with each other.

RCC Box culverts/ Pipe culverts are provided as per the prevailing site condition to ease out the pressure of the cross flow of water. Generally, at perennial nallahs, Box culverts of different sizes are proposed. To drain of the road surface drainage and local hill side storm water, 1x1.2m dia. pipe culverts are proposed.

The overall width of culverts between innermost faces of parapets shall be equal to the roadway width of approaches (Paved carriageway + Shoulders), and in service road stretches will extend to the shoulder of service road. In case of high banks, the width of culvert shall be increased to avoid high face walls. The minimum width of the culverts is 2 x 11m.

Summary of Existing and Proposed culverts, proposed culvert according to sizes and Improvement Proposal of culvert are presented in below table;

**Table 7.1 Summary of Culverts**

| Existing | | | | Proposed | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Pipe | Slab | Box | Total | New Box on MCW | New Box on CR | Reconstruction | Widening | Retained | Abandoned (does not fall under PCL) | |
| 09 | 03 | 05 | 17 | 49 | 12 | - | - | - | 75 | 61 |

**Table 7.2 Summary of proposed culvert according to sizes**

| Type | Size | Nos. | Total no. |
|---|---|---|---|
| BOX | 1 x 2 | 07 | 49 |
| BOX | 1 x 3 | 32 | |
| BOX | 1 x 5 | 10 | |

**Table 7.3 Culverts Improvement Proposal**

| Sl. No. | Existing Details | | | | Design Chainage (Km) | | | Proposal | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Existing Design Chainage (Km) | Type | Size | Deck Width (m) | Chainage (Km) | Type | Size | | |
| 1 | - | - | - | - | 4+590 | Box | 1 x 3 x 3 | New Construction | Green Field |
| 2 | - | - | - | - | 5+420 | Box | 1 x 3 x 3 | New Construction | |
| 3 | - | - | - | - | 5+605 | Box | 1 x 3 x 3 | New Construction | |
| 4 | - | - | - | - | 5+815 | Box | 1 x 3 x 3 | New Construction | |
| 5 | - | - | - | - | 6+120 | Box | 1 x 3 x 3 | New Construction | |
| 6 | - | - | - | - | 6+560 | Box | 1 x 3 x 3 | New Construction | |
| 7 | - | - | - | - | 7+670 | Box | 1 x 3 x 3 | New Construction | |
| 8 | - | - | - | - | 8+535 | Box | 1 x 3 x 3 | New Construction | |
| 9 | - | - | - | - | 8+770 | Box | 1 x 3 x 3 | New Construction | |
| 10 | - | - | - | - | 9+510 | Box | 1 x 3 x 3 | New Construction | |
| 11 | - | - | - | - | 9+960 | Box | 1 x 3 x 3 | New Construction | |
| 12 | - | - | - | - | 10+360 | Box | 1 x 3 x 3 | New Construction | |
| 13 | - | - | - | - | 10+670 | Box | 1 x 3 x 3 | New Construction | |
| 14 | - | - | - | - | 11+210 | Box | 1 x 5 x 4 | New Construction | |
| 15 | - | - | - | - | 11+940 | Box | 1 x 2 x 2 | New Construction | |
| 16 | - | - | - | - | 12+110 | Box | 1 x 3 x 3 | New Construction | |

| Sl. No. | Existing Details | | | | Design Chainage (Km) | | | Proposal | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Existing Design Chainage (Km) | Type | Size | Deck Width (m) | Chainage (Km) | Type | Size | | |
| 17 | - | - | - | - | 12+650 | Box | 1 x 5 x 5 | New Construction | Green Field |
| 18 | - | - | - | - | 12+921 | Box | 1 x 2 x 2 | New Construction | |
| 19 | - | - | - | - | 13+440 | Box | 1 x 3 x 3 | New Construction | |
| 20 | - | - | - | - | 13+630 | Box | 1 x 3 x 4 | New Construction | |
| 21 | - | - | - | - | 14+590 | Box | 1 x 3 x 3 | New Construction | |
| 22 | - | - | - | - | 14+740 | Box | 1 x 2 x 2 | New Construction | |
| 23 | - | - | - | - | 15+060 | Box | 1 x 2 x 2 | New Construction | |
| 24 | - | - | - | - | 15+088 | Box | 1 x 2 x 2 | New Construction | |
| 25 | - | - | - | - | 15+380 | Box | 1 x 3 x 3 | New Construction | |
| 26 | - | - | - | - | 15+590 | Box | 1 x 5 x 5 | New Construction | |
| 27 | - | - | - | - | 15+870 | Box | 1 x 5 x 5 | New Construction | |
| 28 | - | - | - | - | 16+310 | Box | 1 x 2 x 2 | New Construction | |
| 29 | - | - | - | - | 16+720 | Box | 1 x 2 x 2 | New Construction | |
| 30 | - | - | - | - | 17+160 | Box | 1 x 3 x 3 | New Construction | |
| 31 | - | - | - | - | 17+450 | Box | 1 x 3 x 5 | New Construction | |
| 32 | - | - | - | - | 17+650 | Box | 1 x 3 x 5 | New Construction | |
| 33 | - | - | - | - | 17+835 | Box | 1 x 5 x 5 | New Construction | |
| 34 | - | - | - | - | 18+300 | Box | 1 x 5 x 5 | New Construction | |
| 35 | - | - | - | - | 18+590 | Box | 1 x 3 x 3 | New Construction | |
| 36 | - | - | - | - | 18+790 | Box | 1 x 3 x 3 | New Construction | |
| 37 | - | - | - | - | 19+080 | Box | 1 x 3 x 3 | New Construction | |
| 38 | - | - | - | - | 19+520 | Box | 1 x 3 x 3 | New Construction | |
| 39 | - | - | - | - | 19+680 | Box | 1 x 3 x 4 | New Construction | |

| Sl. No. | Existing Details | | | | Design Chainage (Km) | | | Proposal | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Existing Design Chainage (Km) | Type | Size | Deck Width (m) | Chainage (Km) | Type | Size | | |
| 40 | - | - | - | - | 20+000 | Box | 1 x 3 x 3 | New Construction | Green Field |
| 41 | - | - | - | - | 20+650 | Box | 1 x 3 x 3 | New Construction | |
| 42 | - | - | - | - | 21+080 | Box | 1 x 5 x 4 | New Construction | |
| 43 | - | - | - | - | 21+225 | Box | 1 x 5 x 4 | New Construction | |
| 44 | - | - | - | - | 21+375 | Box | 1 x 3 x 3 | New Construction | |
| 45 | - | - | - | - | 22+060 | Box | 1 x 5 x 4 | New Construction | |
| 46 | - | - | - | - | 22+890 | Box | 1 x 5 x 5 | New Construction | |
| 47 | - | - | - | - | 23+515 | Box | 1 x 3 x 3 | New Construction | |
| 48 | - | - | - | - | 23+810 | Box | 1 x 3 x 3 | New Construction | |
| 49 | - | - | - | - | 24+380 | Box | 1 x 3 x 3 | New Construction | |

In addition to the above culverts 11 No. of 1x2x2m Box culverts of 7.5 m length are proposed for cross roads.

**Table 7.1 Culverts for Cross Road**

| Sl. No. | Design Chainage | Type | Span (m) | Minimum Vent Height (m) |
|---|---|---|---|---|
| 1 | 7+770 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 2 | 8+100 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 3 | 9+600 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 4 | 11+920 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 5 | 13+770 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 6 | 14+235 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 7 | 15+080 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 8 | 16+790 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 9 | 19+615 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 10 | 20+760 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 11 | 21+720 (at Cross Road) | Box Culvert | 1x2 | 2.0 |
| 12 | 22+650 (at Cross Road) | Box Culvert | 1x2 | 2.0 |

## 7.3 Grade Separated Structures

The project road cuts across Major Roads at number of locations are proposed grade separation facilities of different configuration for different classes of crossings along the route. In addition, there are many crossings of other district and village roads through no. of places of habitation are to be upgraded with at grade junction so as to comfort the manoeuvre of the traffic diverting from the main carriageway by providing deceleration lane and acceleration lane for the traffic exiting from and entering into the main carriageway. As all the National highways are joining the project highway at habitations, at grade junction improvement is proposed.

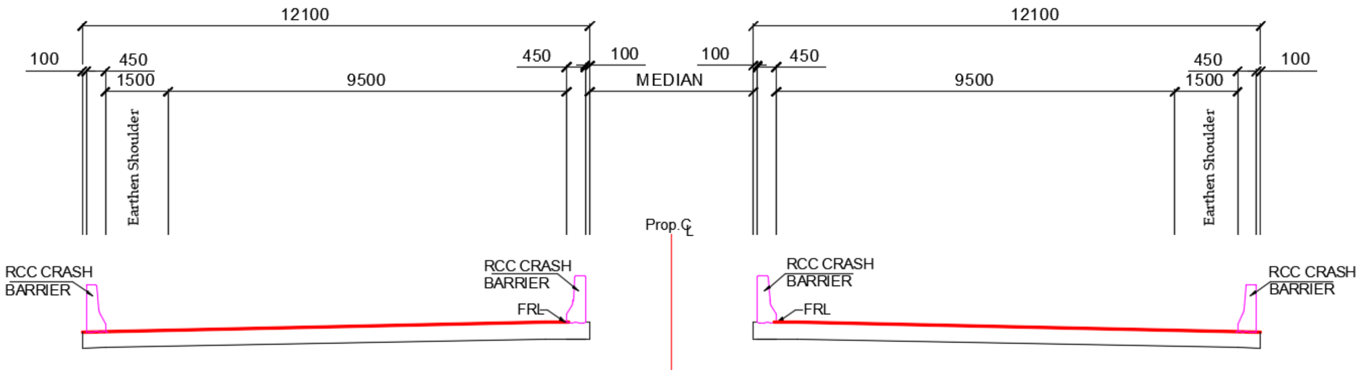


**Fig 7.1 Grade Separator Structure at Deck Level**

### 7.3.1 Underpasses (VUP/LVUP/SVUP)

The project road cuts major road like NH, SH, major junctions, major road at built up sections. In order to continue the free flow of traffic along the project highway, Vehicular Underpass, Light Vehicular Underpass, Small Light Vehicular Underpass and Overpass are proposed as per site requirement. The proposal, whether to elevate project road/cross road has been decided based on the terrain and profile of the roads.

These grade separation facilities are classified and tabulated in following Table;

**Table 7.4 Details of Grade Separated Structures**

| Sl. No. | Type / Location of Structure | Name | Concept | Leading to | Category of Road | Span arrangement and Vertical clearance | Total Width of Structure (m) |
|---|---|---|---|---|---|---|---|
| 1 | LVUP | 4+780 | 1- Lane BT | LHS - Nutan Dayapur<br>RHS - Kasipur Grant | Village Road | Span = 1 x 12m<br>Vertical Clearance = 4.0 m | 2x22 |
| 2 | SVUP | 5+860 | 1- Lane ER | LHS - Arkatipur Tea Estate<br>RHS - Nutan Doyapore | Village Road | Span = 1 x 7m<br>Vertical Clearance = 4.0 m | 2x12.1 |

| Sl. No. | Type / Location of Structure | Name | Concept | Leading to | Category of Road | Span arrangement and Vertical clearance | Total Width of Structure (m) |
|---|---|---|---|---|---|---|---|
| 3 | SVUP | 6+820 | 1-Lane BT | LHS - Chappanahal Grant<br>RHS - Banskhandi Pt IV | Village Road | Span = 1 x 7.0m Vertical Clearance = 4.0m | 2x12.1 |
| 4 | SVUP | 8+110 | 1- Lane ER | LHS - Badripar<br>RHS - Banskhandi | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 5 | SVUP | 9+597 | 1- Lane ER | LHS - Badripar<br>RHS - Chandrapur | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 6 | VUP | 11+913 | 1-Lane BT | LHS - Udharband<br>RHS - Alipur | Udharband Road | Span = 1 x 24m Vertical Clearance = 5.5 m | 2x12.1 |
| 7 | SVUP | 13+777 | 1- Lane ER | LHS - Monipur Kitta<br>RHS - Alipur Cha Bagicha | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 8 | SVUP | 14+235 | 1- Lane ER | LHS - Monipur Kitta<br>RHS - Alipur Cha Bagicha | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 9 | LVUP | 15+075 | 1-Lane BT | LHS - Monipur Kitta<br>RHS - Tarapur Grant | Village Road | Span = 1 x 12m Vertical Clearance = 4.0 m | 2x12.1 |
| 10 | Overpass | 16+796 | 1-Lane BT | LHS - Sibpur Pt II<br>RHS - Sibpur Pt III | Village Road | Span = 2 x 36m Vertical Clearance = 5.5 m | 1x12.0 |
| 11 | SVUP | 17+813 | 1- Lane ER | LHS - Laboc Grant<br>RHS - Laboc Grant | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 12 | SVUP | 19+612 | 1-Lane BT | LHS - Mahalthal<br>RHS - Sibpur Pt I | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 13 | VUP | 20+803 | 1-Lane BT | LHS - Mahalthal<br>RHS - Pailapool | Dewan Road | Span = 1 x 24m Vertical Clearance = 5.5 m | 2x12.1 |
| 14 | SVUP | 21+718 | 1-Lane BT | LHS & RHS - Lalangkitta Labocpar Pt III | Village Road | Span = 1 x 7m Vertical Clearance = 4.0 m | 2x12.1 |
| 15 | VUP | 22+648 | 1-Lane BT | LHS - Joypur<br>RHS - Pailapool (NH-37) | Joypur Road | Span = 1 x 24m Vertical Clearance = 5.5 m | 2x12.1 |

### 7.3.2 Vehicular Underpass:

This grade-separation facility is at crossings of 2-Lane road having medium traffic. The proposal for grade separation structures, have been identified from traffic surveys and other investigations.

Locations of these structures are mentioned above in table. These structures are provided for bridging over a 2-Lane roadway and the span of the VUP shall be 1 x 20m. The typical arrangement is shown in the following diagram. Vertical Clearance at these locations is 5.5m.

### 7.3.3 Light Vehicular Underpass:

These structures are provided for bridging over a 2-Lane roadway and the span of these LVUP's shall be 1 x 12m. The typical arrangement is shown in the following diagram. Vertical Clearance at these locations is 4.0m.

### 7.3.4 Small Vehicular Underpass:

These structures are provided for bridging over a 2-Lane roadway and the span of these LVUP's shall be 1 x 7m. The typical arrangement is shown in the following diagram. Vertical Clearance at these locations is 4.0m.

### 7.3.5 Overpass:

These structures are provided at 16+796, junction with Sibpur Village road. Overpass (OP) has been proposed, where cross road is elevated and project road at ground level with a span of 2 x 36m, vertical clearance of 5.5m and total structure width of 1x12m.

### 7.3.6 Railway Level Crossings/ROB/RUB

The project road crosses 01 no ROB (exist. Km 245+600) and 01 no LC (exist. Km 238+400 on existing road, which is abandoned by following Green field alignment encounters 2nos of railway line, which are proposed for ROB. Details are mentioned below;

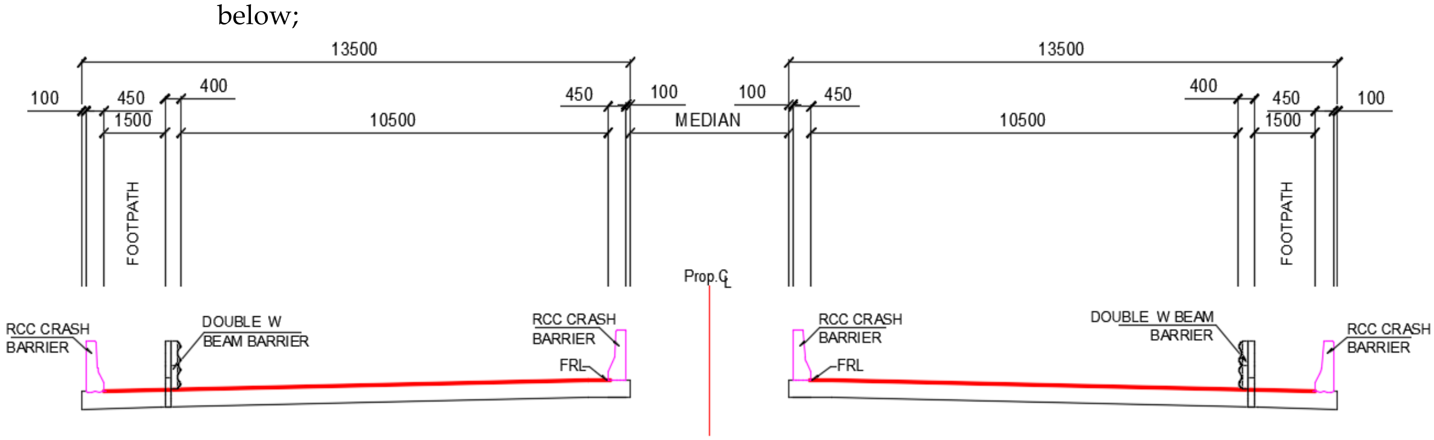


**Fig 7.2 ROB Structure at Deck Level**

**Table 7.5 Improvement Proposal for ROB**

| Sl. No. | Type of Structure | Location of Structure | Concept | Leading to | Category of Road | Span arrangement and Vertical clearance | Total Width of Structure (m) |
|---|---|---|---|---|---|---|---|
| 1 | ROB | 5+083 | Single Track BG | LHS - New Silchar Rly. Stn. RHS - Moinarband Rly. Stn. | Silchar-Jiribam BG Railway Line | 3 x 36m | 2x13.5 |
| 2 | ROB | 22+452 | Single Track BG | LHS - Kamranga Rly. Stn. RHS - Sribar Rly. Stn. | Silchar-Jiribam BG Railway Line | 3 x 36m | 2x13.5 |

## 7.4 Bridges

As we discussed in previous chapter i.e. we are starting Package: SJ-1, from D. Km 4+560 at Silchar/ Nutan Dayapur and ending at Budha Nagar D. Km 24+560. There is 01no of existing major bridge falling under this section, which are abandoned by the proposal of Green field Alignment and 2nos of new bridges are proposed on green field alignment by lying on Chiri river at Km 23+138 and on a Nallah at Km 21+575.

Hence there are new proposal of bridges as per the site requirement with standard design. The new bridges are proposed in standard of per IRC: SP: 84- 2019.

The following improvement proposals have been considered for new bridges.

**Table 7.6 Summary of Proposal of Major Bridges**

| Existing | | Proposed | | | | Abandoned (does not fall under PCL) | Total |
|---|---|---|---|---|---|---|---|
| Type | No. | New | Reconstruction | Widening | Retained | | |
| Major Bridge | 01 | 02 | - | - | - | 01 | 02 |

**Table 7.7 Improvement Proposal for Major Bridges**

**New Major bridges:**

| Sl. No. | Ex. Des Ch. (Km) | Des.Ch (Km) | Span Arrangement Proposed | | Type of Structure | Proposed Deck Width (m) | Remarks |
|---|---|---|---|---|---|---|---|
| | | | No. of Span | Span Length (m) | | | |
| 1 | - | 21+575 | 2 | 36 | Girder | 2 x13.5 | Nalla (MCW) |
| 2 | - | 23+138 | 3 | 36 | Girder | 2 x13.5 | Chiri River (MCW) |

**Minor Bridges:**

There are total 04 Nos. of minor bridges falling under this section, which are abandoned by the proposal of Green Field Alignment and 14 nos are new propose Minor bridges along green field alignment.

The following improvement proposals have been considered for the minor bridges.

**Table 7.8 Summary of Minor Bridges**

| Existing | | Proposed | | | | Abandoned | Total |
|---|---|---|---|---|---|---|---|
| Type | No | New | Reconstruction | Widening | Retained | | |
| Minor Bridge | 04 | 14 | - | - | - | 04 | 14 |

**Table 7.9 Improvement Proposal of Minor Bridges**

**New Construction of Minor Bridges**

| Sl. No. | Ex. Des Ch. (Km) | Des.Ch. (Km) | Span Arrangement | | Type of Structure Proposed | Total Deck Width (m) | Remarks |
|---|---|---|---|---|---|---|---|
| | | | No. of Span | Span Length(m) | | | |
| 1 | - | 4+730 | 3 | 4 | Box | 2x30 | MCW |
| 2 | - | 4+780 | 3 | 4 | Box | 1x12 | Cross Road |
| 3 | - | 6+010 | 1 | 12 | Box | 2x13.5 | MCW |
| 4 | - | 7+239 | 3 | 10 | Box | 2x13.5 | MCW |
| 5 | - | 7+390 | 1 | 12 | Box | 2x13.5 | MCW |
| 6 | - | 7+771 | 2 | 25 | PSC "I" Girder | 2x13.5 | MCW |
| 7 | - | 8+980 | 5 | 10 | Box | 2x13.5 | MCW |
| 8 | - | 9+255 | 1 | 12 | Box | 2x13.5 | MCW |
| 9 | - | 9+780 | 5 | 10 | Box | 2x13.5 | MCW |
| 10 | - | 11+795 | 1 | 8 | Box | 2x12.1 + 1x11 + 1x14 | MCW + SR |
| 11 | - | 11+913 | 1 | 8 | Box | 2x14 | Cross Road |
| 12 | - | 14+355 | 2 | 12 | Box | 2x13.5 | MCW |
| 13 | - | 15+250 | 4 | 10 | Box | 2x13.5 | MCW |
| 14 | - | 21+830 | 1 | 30 | PSC "I" Girder | 2x13.5 | MCW |

### 7.4.1 Width of the bridges:

i. All new/ reconstructed bridges are proposed with 2 x 12.05m total deck width as per Fig 7.6 of 4-lane manual.

ii. For the bridges, which are in proposed 6-lane configuration, total width of 2 x 17m with central median of 1.5m/4.0m as per below figure of 4-lane road manual.

iii. Additional width shall be provided at curve locations as per extra widening requirements.

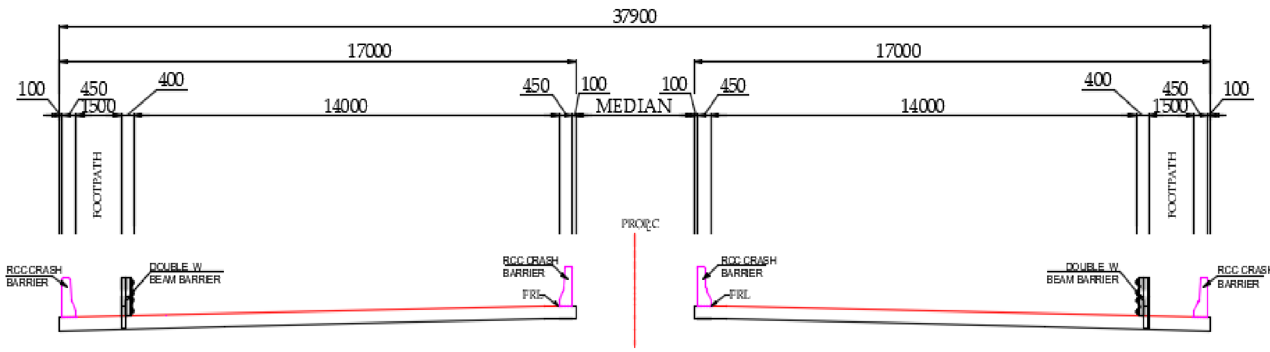


**Fig 7.3 Bridge at Deck Level in 6-Lane**

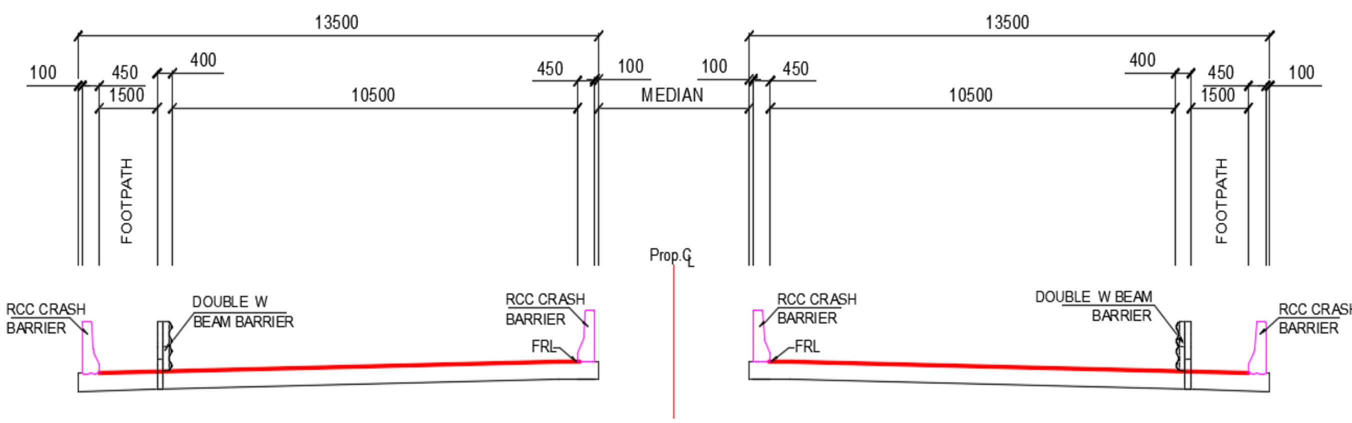


**Fig 7.4 Bridge at Deck Level in 4-Lane**

### 7.4.2 Span Arrangement

The section of the project road passes through rolling and mountainous terrain, most of the bridges are located across the channels of varying widths and depths. In general, the span length of bridges has been decided on the basis of bank-to-bank distances rather than requirement from hydraulic considerations. At existing bridge locations, existing spans have been adopted. For the bypasses/ realignments, single span of required length has been proposed, span lengths being decided from the consideration of safe and suitable locations of abutments.

### 7.4.3 Superstructure

Appropriate type of superstructure has been proposed at each location bearing in mind type and appearance of the existing structures, innovative type with ease of construction in difficult locations, having good aesthetics and cost effectiveness. In general following types of superstructures have been adopted.

| | | |
|---|---|---|
| Spans < or = 12m | - | RCC Solid Slab. |
| Spans >12m to < or = 20m | - | RCC I-Girder |
| Spans >20m to < or = 40m | - | PSC I-Girder |

### 7.4.4 Substructure

Substructure for the proposed bridges will generally consist of RCC wall type abutments and solid circular piers.

### 7.4.5 Foundations

Open foundation is proposed for most of the bridges where bearing capacity is good and pile foundation is proposed where bearing capacity is poor.

### 7.4.6 Bearings

Since the bridges fall in seismic zone II, Fixed Pot, guided sliding POT-cum-PTFE and free sliding POT-cum-PTFE bearings have been proposed. As second line of defence against seismic forces suitably designed seismic stoppers in transverse directions will be provided over all supports to prevent any possibility of dislodgement of the single/ multiple span superstructures.

# 8

# Environmental Screening and Initial Environmental Assessment

**Section: Silchar to Jiribam (Package: SJ-1, From D. Km 4+560 to D. Km 24+560)**

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# 8 Environmental Screening and Environmental Impact Assessment

## 8.1 Introduction

Recognising the need for improvement of capacity of road network in tune with intensity of traffic, the Ministry of Road Transport and Highways (MoRT&H) acting through the National Highways Infrastructure Development Corporation Ltd. (NHIDCL) has decided to take up the development of various National Highways stretches/Corridors of 10,000 kms out of 50,000 kms under proposed Bharatmala Pariyojna.

The project roads under Lot-1/ Package-3 comprise of following three stretches which are part of four Economic Corridors.

1) Silchar to Vairengte (Part of Silchar-Aizawl Economic Corridor NER) in the state of Assam and Mizoram.
2) Vairengte to Sairang (Part of Silchar-Aizawl Economic Corridor NER) in the state of Mizoram.
3) Silchar to Jiribam (Part of Silchar-Imphal Economic Corridor NER) in the state of Assam and Manipur.

The project corridor has been identified from Silchar to Jiribam under national highway NH-37 with total design length of 33.090 Km.

After successful submission of Draft DPR vide through letter Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40386, it was conveyed by NHIDCL that Silchar – Jiribam (SJ) corridor shall be on hold for further investigation and study as the project stretch has not been included in the priority list due to uncertainty of 4-lane development of said stretch.

However, in the month of May 2023 the said project was reopened under the direction of MD & D(T) during VC meeting and DPR had been asked to accelerate the remaining pending assignment pertaining to said project as the project stretch was included under current year development plan.

Final DPR was submitted vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2022-23/404037 dated but collectively decision was taken to bifurcate the project corridor in to two (02) packages due to tunnel proposal & its cost constraints and several other limitations.

Hence, based on assessment and in consultation with NHIDCL officers, the package distributions are as under,

**Table 8.1 Package Distribution**

| Sl. No. | Construction Packages | Design Chainage | | | Existing Chainage | | | Bypassing to |
|---|---|---|---|---|---|---|---|---|
| | | From | To | Length (km) | From | To | Length (km) | |
| 1 | **Package: SJ-1** | **4+560** | **24+560** | **20.000** | **260+000 on NH-37, Assam** | **233+000 on NH-37, Assam** | **27.000** | **(Kasipur, Banshkandi, Paiilapool, Fulertal etc.)** |
| 2 | Package: SJ-2 | 24+560 | 37+650 | 13.090 | 233+000 on NH-37, Assam | 212+060 on NH-37, Manipur | 20.940 | Uttar Lalpani, Jirighat, Jiribam etc. |
| | **Total Design Length** | | **33.090** | **Total Existing Length** | | **47.940** | | |

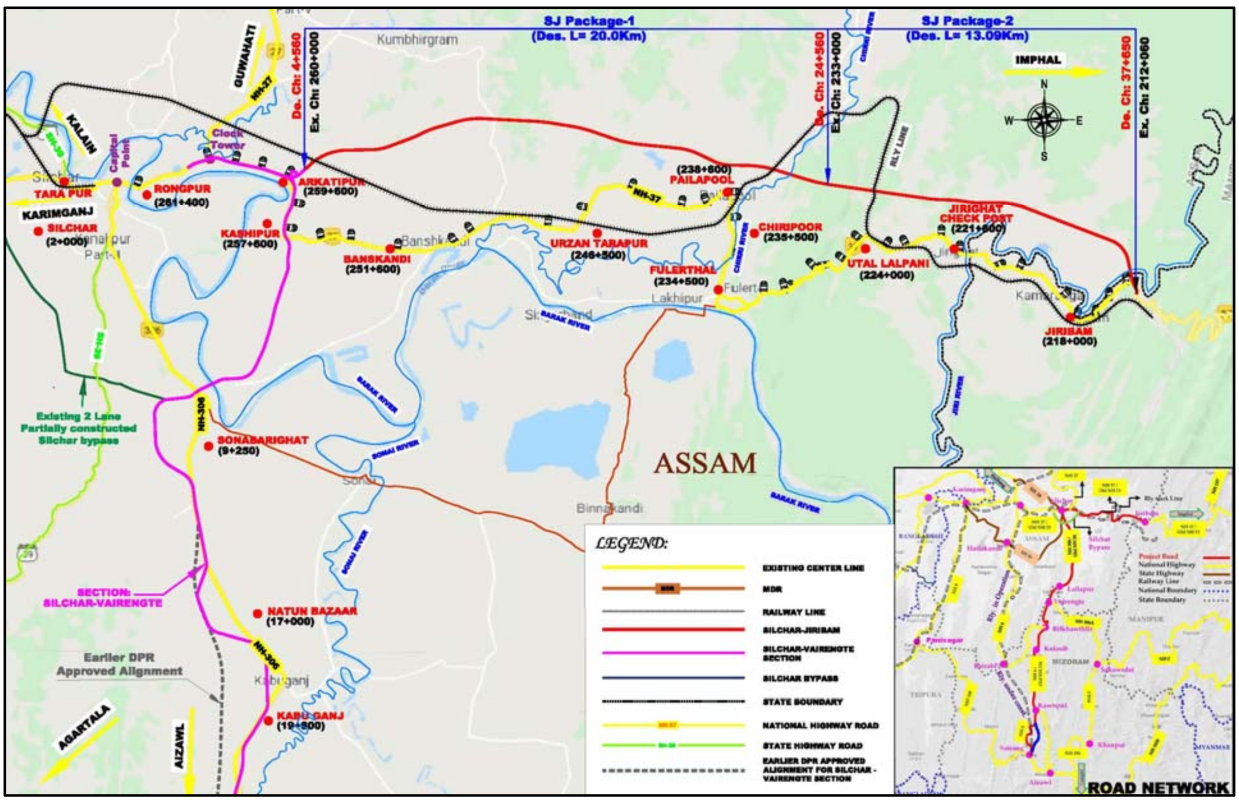


**Fig 8.1 Key Plan for Proposed Construction Packages**

**This Report mainly contains Improvement proposal pertaining to Package: SJ-1.**

### 8.1.1 Expected benefits from the projects:

Following are the expected benefits due to the improvement in the project road:

- Development of project road will lead to good connectivity to the important areas of the state, which will contribute to the economic growth of the state.
- Development of project road will also contribute to the growth in tourism sector.
- Faster transportation will ultimately lead to massive savings in the form of

reduced wear and tear of vehicles, reduced vehicle operating costs (VOCs) and total reduction in transportation costs etc.

- Enhanced connectivity between rural & urban population which will benefit the all sections of the society like general population, small-medium-large scale industries, farmers, businessmen etc.
- Improved access to higher education facilities & modern health facilities.
- Improved road connectivity helps in better implementation and management of government schemes.
- With improvement in economy, generation of more employment opportunities.
- Development of project road will help in maintaining military posts and supplies in various strategic parts of the state.
- Overall Environment and social improvement of the region.

### 8.1.2 Various studies/reports being prepared for the project and how the environment screening study relates to feeds into the overall project preparation.

Various studies/reports being prepared for the project.

- Inception Report
- Feasibility Report
- Environmental Impact assessment & Social Impact Assessment Report (under preparation and will be submitted separately)
- Detailed Project Report

The environment screening study relates to feeds into the overall project preparation at various stages.

The various activities / components involved in the project include design process and construction activities. Some of the major activities likely to take place to implement the proposed up-gradation / improvement project are: Site clearing & grubbing, earthwork, construction of granular sub-base, water bound macadam base, bituminous pavement layers, drainage, safety measures, bridge & culvert construction, waste material management, equipment & materials staging, operation of aggregate and sand quarries etc. These major activities have been taken into account while finalizing the methodology for the impact assessment of the project. The details of the environmental features have been shown in below table;

**Table 8.2 Details of Environmental Features**

| Project Component for Design | Details of Environmental. Features |
|---|---|
| **Alignment** | |
| Geometric Design & Cut / Fill Balance | Final alignment should be determined so as to land acquisition, air pollution, and the impact on people and animals and also to avoid unfavourable geological condition and cultural relics. Unusable debris shall be disposed at nearest disposal sites as approved by competent Authority. |
| | The design should attempt to equalize cut and fill. The centreline should be aligned so that on all slopes below 60 degrees, half cut and half fill can be achieved. |
| | The improvements to the road section may involve the cutting of hill slopes. At few locations, amount of cut and fill work expected to be significant mainly at curves and bridge locations. |
| **Ecology** | |
| Roadside Plantation | Trees to be cut within the proposed ROW shall be identified / marked in consultation with the forest department. |
| | Trees shall be removed as identified and with prior approval of the forest department. |
| **Water** | |
| Water Sources | Water resources shall be protected and enhanced by redesigning as per enhancement measures plan. |
| Road Drainage | Provision of adequate size and number of cross-drainage structures (culverts/Bridges) as well as drains along the road. |
| **Quarries and borrow area** | |
| Illegal and / or improper mining | • Only approved and licensed Quarries and Borrow pits shall be permitted. |
| | • Non-Productive, barren lands, raised lands, riverbeds are recommended for borrowing the material. |
| **Location of Camps** | |
| Site selection/ Location of Labour Camp/ Construction Camps | • Labour Camp/ Construction camps should be located at least 500 m away from existing habitations and one kilometre away from reserve forest / inner line reserve forest. |
| | • All sites used for camps should be adequately drained and they should not be subjected to periodic flooding. |
| | • Camps should be located such that drainage from and through the camps will not endanger any domestic or public water supply. |

| Project Component for Design | Details of Environmental. Features |
|---|---|
| | • Living accommodation and ancillary facilities should be erected and maintained to standards and scales parameters set by the concerned authorities. |
| | • Toilets and urinals should be provided in accessible places away from the asphalt plant and mixing yard. |
| | • Construction Camp should not be placed in ecologically sensitive areas. |
| **Utilities** | |
| Relocation of utility lines / community utilities. | • Affected utilities like electric poles, water pipelines, hand pumps, etc. shall be relocated with prior approval of the concerned agencies/departments. |
| | • All the cultural properties that have been identified as affected shall be relocated in consultation with district administration/concern department. |
| **Road Safety** | |
| Traffic control system | • Temporary traffic arrangement during construction shall be planned in an advance. |
| | • The contractor shall take all necessary measures for the traffic during demolition and site clearing activities. |
| Pedestrian safety | • Special considerations shall be given in the local traffic management to the pedestrian safety especially at congested/ built-up locations. |
| **Environmental Quality** | |
| Clearance/ permission for establishment of Hot mix plants/ Batching plants etc. | • NOC from State Pollution Control Board / statutory authorities. |
| | • NOC for quarry sites, HMP, Crushers etc. |
| Noise Level - For Hot mix plant and construction machinery &At sensitive receptors. | • Improved traffic speeds and riding conditions shall reduce noise levels. |
| | • Noise screening by trees plantation scheme proposed as noise barriers. |
| | • Provide noise attenuation at critical locations like Hospital, school etc. |
| Generation of Debris from Dismantling Structures and Road Surface | • Vegetation will be removed from the proposed RoW before the commencement of construction. All works will be carried out such that the damage or disruption to flora other than those identified for cutting is minimized. |
| | • Only ground cover/shrubs that impinge directly on the permanent works or necessary temporary works will be removed with prior approval from the Environmental Expert of the Authority. The concessionaire/contractor, |

| Project Component for Design | Details of Environmental. Features |
|---|---|
| | under any circumstances will not damage trees other than those already identified to be cut. Compensatory afforestation shall be provided for the cutting of trees. |

## 8.2 Methodology Adopted for Environment Screening Exercise

### 8.2.1 Purpose / Objectives of the Environment Screening Exercise:

Screening is the first stage of the EIA process. The screening procedure is necessary because of highway project (Development of Roads) and related activities that are potentially subject to EIA. It is intended to ensure that the form or level of impact on Environmental parameters review is commensurate with the importance of the issues raised by a proposal.

The conduct of screening thus involves making a preliminary determination of the expected impact of a proposed project of rehabilitation and widening of highway on the environment and of its relative significance. A certain level of basic information of the proposed project and its location is required for this purpose.

The screening process can have one of four outcomes:

- No further level of EIA is required.
- A full and comprehensive EIA is required.
- A more limited EIA is required (often called preliminary or initial assessment);
- Further study is necessary to determine the level of EIA required (often)

Screening establishes the basis for scoping, which identifies the key impacts to be studied and establishes terms of reference for an EIA. EIA systems have screening and scoping procedures. On occasion, the screening and scoping stages may overlap if a further study is undertaken to determine whether or not the potential impacts are significant enough to warrant a full EIA.

### 8.2.2 Methodology (Step by Step Process) adopted for Environmental Screening Exercise:

The requirements for screening and the procedure to be followed are often defined in the applicable EIA law or regulations. The screening is being done prior to development of the project so that the proponent and other participants are aware of the EIA obligations. It should be applied systematically and consistently so that the same decisions would be reached if others conducted the screening process.

Specific methods used in screening include:

- Legal (or policy) approach for the applicability of EIA.
- Inclusion list of projects (with or without thresholds) for which an EIA is

automatically required.

- Exclusion list of activities which do not require EIA because they are insignificant or are exempt by law (e.g., national security or emergency activities); and
- Criteria for case-by-case screening of proposals to identify those requiring an EIA because of their potentially significant environmental effects.

In this context, screening is a flexible process and can be extended into preliminary forms of EIA study. These 'extended screening' procedures include:

- Initial environmental examination – carried out in cases where the environmental impacts of a proposal are uncertain or unknown (e.g., new technologies or undeveloped areas).
- Environmental overview – carried out as a rapid assessment of the environmental issues and impacts of a proposal; and
- Class screening – carried out for a family of small projects or repetitive activities, where the environmental effects and means of mitigation are known but there is potential for cumulative impacts (e.g., dredging, road realignment, bank stabilization).

**Study Methodology:**

The World Bank operational manual for piloting of the social and environmental safeguard policies procedures & practices and following Government of India's guidelines are reviewed.

- "Environmental Guidelines for Selected Infrastructure Projects".
- "Project Terms of Reference (TOR)".
- "Environmental guidelines for Road/Rail/Highway Projects", Government of India, 1989
- "Handbook of environmental procedures and guidelines", 1994, Government of India
- "Guidelines for Environmental Impact Assessment of Highway Projects" (IRC: 104-1988); and
- The Environmental (Protection) Act, 1986 and EIA Notification 2006 dated 14th September 2006.

**The study is carried out in following stages:**

- The baseline environmental information in the study area viz., climate, physiographic features, drainage, geology, flora, fauna, ambient air, water and noise and socio-economic conditions.
- Reviews of literature, laws and guidelines and discussions with concerned agencies and organizations, National / State Authorities and on-site.

- Reconnaissance survey along with public consultation was undertaken to inform the people about the project and collect the information / suggestions on environmental issues. The environmental data was collected within a corridor of 200 meters of centre of road. The vegetation analysis was done within corridor of direct impact and observing the vegetation density along the project road.
- Interaction with other members of the Project Team to ensure that environmental considerations were given adequate weight in project planning and design – data and other material from the Inception and Feasibility Reports have also been used for the preparation of this report; and
- The monitoring network with regard to air, water and noise pollution.
- Assessment of the potential significant impacts and identification of the mitigate measures to address impacts adequately.
- The study of analysis of alternatives incorporating environmental concerns including 'with' and 'without' project scenario and modification in the proposed project due to environmental considerations.
- The preparation of the "Environmental Screening" report.

### 8.2.3 Project Influence Area

The Environmental Screening Study is carried out considering likely potential impacts on physical, biological, socio-economic and cultural resources within approximately 200 m each side of the project road. The important ecological sensitive area up to 10 Km from the project road have also been covered in screening. This is in accordance with the commonly accepted international standards. The 200 m study area is considered adequate for the assessment of most physical and social effects arising from project development. However, it is also recognized that a number of potential (positive and negative) impacts could also have effects beyond this boundary, such as effects on road linkages, employment effects, and some community activities. These are also considered in the impact assessment. The important ecological sensitive area up to 10 Km from the project road has also been covered in screening.

Baseline environmental data play a key role in identification of environmental parameters likely to be affected due to the project. The environmental baseline data comprise the features present within a strip of 10 km on either side of the existing road. This area is referred to as study area in the report. It includes environmental features such as forest areas, conservation areas, water bodies (rivers, lakes and ponds), industries, wildlife and, places of historical importance, tourism etc. The data / features documented hereunder have been collected through field investigation, interaction with local population and desk research and published data sources.

As mentioned, project road is situated in the districts of Cachar located in the state of Assam.

### 8.2.4 Type and Source of Data Collection

Base line environmental data collections of the study area are comprised of the following:

1) Carrying out detailed field investigations (through specific reconnaissance survey formats and recording sensitive features to prepare an environmental baseline of the project area.
2) Collection of secondary information of physical, biological / ecological and social environment discussions with the local officials on the salient features of the project area, etc.

Available secondary information was collected for the other components of Base line environment.

**Table 8.3 Type and Source of Data Collection**

| Sl. No. | Parameter | Source of Data Collection |
|---|---|---|
| (I) | Physical Resources: | |
| | Air quality, Water quality, Noise Levels and soil quality | To be conducted through MoEFCC authorized agency |
| | Topography and soils, | By Conducting Topographic Survey & Topo sheet developed by Survey of India (SOI). |
| | Surface water | By Conducting Survey & Key plan |
| | Geology / seismology | Survey of India |
| (II) | Ecological Resources: (e.g.) | |
| | Wildlife | Not found - Forest Department |
| | Reserved forests | Forest Department |
| | Rare or endangered species | Not found - Forest Department |
| | Protected areas | Forest Department |
| (III) | Economic Development: | |
| | Industries | District /State statically Diary/ Profile |
| | Infrastructure facilities (e.g., water supply, sewerage, flood control) | District /State statically Diary/ Profile, Census data/ District Disaster Management |
| | Transportation (roads, harbours, airports, and navigation) | District /State statistical Diary/ Profile |
| | Land use (e.g., dedicated area uses) | By Conducting Survey |
| | Agricultural development, mineral development, and tourism facilities | By Conducting Survey, District /State statistical Diary/ Profile |
| Iv | Social and Cultural: | |

| Sl. No. | Parameter | Source of Data Collection |
|---|---|---|
| | Population and communities (e.g., numbers, locations, composition, employment) | Census data, District /State statistical Diary/ Profile |
| | Health facilities | Census data, District /State statically Diary/ Profile |
| | Education facilities | Census data, District /State statically Diary/ Profile |
| | Socio-economic conditions (e.g., community structure, family structure, social well-being) | Census data, District /State statically Diary/ Profile |
| | Physical or cultural heritage current use of lands and resources for traditional purposes by Indigenous | By Conducting Survey, District /State statically Diary/ Profile |
| | Structures or sites that are of historical, archaeological, paleontological, or architectural significance | By Conducting Survey District /State Profile |

### 8.2.5 Weightage / Ranking System Used

The Weightage / ranking system used for screening exercise is as per MoEFCC and International Funding agencies guidelines of Environmental Screening Methodology.

### 8.2.6 Data Gaps / Constraints

1) Secondary data on Ambient Air quality
2) Secondary data on Water quality
3) Secondary data on Noise levels
4) Exact locations & length of Reserved Forests

### 8.2.7 Structure of the Environmental Screening Report

The report structured in seven chapters as per the following details:

1) Introduction
2) Methodology adopted for Environment Screening Exercise
3) Baseline Environmental Conditions
4) Stakeholder Consultation
5) Regulatory and Institutional Regime
6) Assessment of Key Environmental Impacts
7) Findings and Recommendations of Environmental Screening Exercise
8) Reference

## 8.3 Baseline Environmental Conditions

### 8.3.1 Natural Environment

**Over-all environmental setting of the project:**

Baseline environmental data plays a key role in identification of environmental parameters likely to be affected due to the project. This also facilitates the decision maker to assess a particular environmental parameter which needs to be incorporated during the detailed Environmental Assessment study and for further detailed investigation. The scope of this chapter is limited to only those issues, which are of concern in the environmental assessment. With rapid strides in economic development, the need to rationalize the development is imperative. During the process of development, there has been intensive use of natural resources, very often leading to ecological imbalances. In a road project like this involving wide range of construction activities, conservation of flora, fauna and the ecosystem form important aspect of overall sustainable development process. The data/ features documented here under have been collected through field investigation, interaction with local population and desk research and published data sources.

The environmental baseline data comprise the features present within a strip of 10 km on either side of the proposed alignment. This area is referred to as study area/ project area in the report. It includes environmental features such as forest areas, conservation areas, water bodies (rivers, lakes ponds and reservoirs), industries, wildlife and, places of historical importance, tourism etc.

**Geographical Location of the project road:**

The project road from Silchar to Jiribam is new alignment (as green field) and improvement against existing road NH-37 up to Jiribam. Total design length of project road is 33.090km. The Entire Project road passes through Cachar district in Assam and Jiribam district in Manipur.

The topography of Cachar district is in general is undulating with mostly made up of plains,but there are a number of hills spread across the district. The district headquarters, Silchar, is one of the most important business centres of Assam. In 2006 the Indian government named Cachar one of the country's 250 most backward districts out of a total of 640. It is one of the eleven districts in Assam currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). There are seven Assembly constituencies in this district, viz. Silchar, Sonai, Dholai, Udharbond, Lakhipur, Barkhola and Katigorah. Dholai is designated for scheduled castes. The seven constituencies make up the Silchar Lok Sabha constituency. According to the 2011 census Cachar district has a population of 1736319, roughly equal to the nation of The Gambia or the US state of Nebraska. This gives it a ranking of 278th in India out of a total of 640. Cachar has a sex ratio of 958 females for every 1000 males, and a literacy rate of 80.36%. Bengali is the status of Official Language in this district with majority of the people primarily speaking Bengali and Sylheti. Apart from Bengali, other minority languages spoken in the district include Meitei Manipuri, Bishnupuriya Manipuri, Dimasa and Rongmei-Naga. There are also few Mizo, Kuki and Khasi people who form microscopic minority. The district of Cachar has a number of well-known educational institutes in North East India. Silchar, the district headquarters, is a major learning hub of Assam. The district has a central university, the Assam University, which is situated at Durgakona, 18 km from Silchar. It also has NIT Silchar, one of the 30 NITs in India. The Silchar Medical College and Hospital is the only medical college of southern Assam.

Jiribam is a municipal council in the Jiribam district of Manipur, India. Followed by the Hmar, it is one of the fastest growing towns in Manipur. The town is located on the state's western-most boundary adjoining the Cachar district of Assam. It is also known as the western gate of Manipur. The recorded history of Jiribam began during the British colonial period. At the beginning of the 19th Century, several tribes and religious groups began to migrate to the area along the Jiri River. During this era, the Jiri River was a famous landmark and Jiribam was a major trade center. Jiribam is currently connected to the rest of India by a recently converted Broad Gauge track towards Silchar. A rail project to connect Imphal through Jiribam–Tupul–Imphal is being executed and is expected to be complete by 2018. This project is on the alignment of a railway line proposed to connect with Myanmar. There are 2 highways that connect with Imphal: one with the capital of Manipur and the other with Assam and Meghalaya. Railway construction is not expected to be completed soon.

**Climate and Micro-Meteorological Parameters:**

- ***Climate:***

Cachar district is located in the southernmost part of Mizoram state and enjoys a moderate climate owing to its tropical location. It is neither very not nor too cold throughout the year. The Barak is the main river of the district and apart from that there are numerous small rivers which flow from Dima Hasao district, Manipur or Mizoram. Cachar receives an average annual rainfall of more than 3,000 mm. The salient thermos characteristics of the district typically 'tropical monsoon rainfall' type, with high levels of humidity and heavy rainfall. People here enjoy a moderate climate all throughout the year, with warm summers and mild winters. The highest temperature observed during past decades was 38¯c in the month of July. The temperature normally falls down from the month of November and is at its lowest in December and January is around 6 to 8 degree Celsius.

Jiribam experience three seasons: the dry season, the rainy season, and the winter season. The average rainfall ranges from 1,000 mm to 1,600 mm. The months of May and June are the hottest season, is about 40 °C. The lowest temperatures are recorded from the second half of December to the first half of January (i.e., below 2.78 °C) at late night.

## 8.4 Environment Screening

The main objectives of the study are: i) identify the impacts of the project improvement on environment and ii) alleviate the unsafe condition and congestion of the existing highway on NH 306 by enhancing the capacity and quality of the road to the users in a sustainable and environment friendly manner.

MoEF, GoI, has enforced Environment (Protection) Act 1986 and Notification on Environmental Impact Assessment dated 14th September 2006 and subsequent amendments to avoid, mitigate and prevent the environmental impacts from project activities. The EIA Report is prepared in line with EIA Notification guidelines. The report attempts to identify, predict and communicate information on impacts of the proposed subproject on the environment along with mitigation and management measures for the indicated impacts

**Key Environmental Laws & Policies:**

The Constitutional Provisions like Article 48 and 51-A (g) and 74th Amendment to the Constitution serve as principle guidelines of environmental protection. Further Regulations, Acts, Policies applicable to sustainability and environmental protection are as follows.

- *EIA Notification, September 2006 & subsequent Amendments*
- *The Environment (Protection) Act, 1986*
- *The Water (Prevention and Control) Act, 1974*
- *The Air (Prevention and Control) Act, 1981*
- *The Indian Forest Act, 1927*
- *The Karnataka Forest Act, 1963*
- *The Forest (Conservation) Act, 1980 (as amended in 1988)*
- *The Forest Conservation Rules, 1981*
- *The Wildlife Protection Act, 1972*
- *The Hazardous Waste (Management and Handling) Rules, 1989*
- *Fly ash Notification, 2009*
- *The Ancient Monuments and Archaeological Sites and Remains Act 1958*
- *The Motor Vehicles Act 1988*
- *Public Liability Insurance Act, 1991*
- *Coastal Regulation Zones Act*
- *The Factories Act 1956*

The other guidelines and norms related to road construction by Indian Road Congress that help for environmental protection include, IRC: 104-1988, IRC: 36-1974, IRC: 10-1961, IRC: 36-1970, IRC: 43-1972, IRC: 72-1978, IRC: 33-1982, etc.

**Baseline Environment:**

Information on baseline environment is collected from secondary sources of data for the macro environmental parameters like climate, physiography (geology and geomorphology), biological and socio-economic environment of the project influence area. The micro-environmental details within the Corridor of Impact (CoI) have been collected from primary source of data such as base maps prepared by reconnaissance survey, extrapolation of environmental features on the proposed design, tree enumeration, analysis for environmental attributes along the project road.

**Analysis of Alternatives:**

The National Highway NH-306 is an existing Highway being up-graded with new alignment, except for minor realignments for improving the road geometrics and for smoothening the sharp curves and bypasses to avoid narrow and congested stretches of the project road. Hence analysis has been done only for bypasses in terms of alternatives to alignment. Different cross section alternatives have been considered for proposed stretch of the project road. Different cross section alternatives have been considered for the project to suit the different classes of land uses and reduce the impact of land acquisition.

**Stakeholder Consultation:**

During the survey, informal and unstructured stakeholder consultations were conducted at DC office Silchar, the purpose of the surveys and salient features of the proposed project were explained to the stakeholders to gather their opinions and concerns regarding the project.

**Anticipated environmental impacts and mitigation measures:**

The key Environmental impacts, both direct and indirect on various environmental attributes during construction and operational phases of proposed NH improvement project are discussed in detail in the report. Significant positive and negative impacts due to project are summarized in the following impact matrix.

| Environmental Attributes | Physical Environment | | | Biological Environment | | Geology | | Topo-graphy |
|---|---|---|---|---|---|---|---|---|
| | Air | Water | Noise | Flora | Fauna | Natural Drainage | Soil | |
| **I. Construction Phase** | | | | | | | | |
| Labour Camp Activities | | -ve/t | | | | | | |

| **Environmental Attributes** | **Physical Environment** | | | **Biological Environment** | | **Geology** | | **Topo-graphy** |
|---|---|---|---|---|---|---|---|---|
| | **Air** | **Water** | **Noise** | **Flora** | **Fauna** | **Natural Drainage** | **Soil** | |
| Quarrying | **-ve/t** | | **-ve/t** | -ve/t | | -ve/t | **-ve/p** | **-ve/p** |
| Material Transport & Storage | -ve/t | -ve/t | -ve/t | -ve/t | | -ve/t | -ve/t | |
| Drilling and Blasting | **-ve/t** | | **-ve/t** | -ve/t | | | | **-ve/p** |
| Pavement works | -ve/t | -ve/t | -ve/t | -ve/t | -ve/t | **-ve/p** | -ve/t | **-ve/p** |
| Use of Construction Equipment | **-ve/t** | **-ve/t** | **-ve/t** | | | | | |
| Cutting of Trees | | | | **-ve/p** | | | | |
| Plantation | +ve/p | | +ve/p | **+ve/p** | | | +ve/p | |
| Culvert and Bridge Construction | | -ve/t | -ve/t | | | **-ve/p** | | |
| Stripping of Topsoil | | | | -ve/t | | -ve/t | **-ve/t** | |
| Debris Generation | -ve/t | -ve/t | | | | -ve/t | -ve/t | |
| Oil and Grease | | -ve/t | | | | | -ve/t | |
| **II. Operational Phase** | | | | | | | | |
| Vehicular Movement | +ve/p | | +ve/t | +ve/t | -ve/p | | | |

***Note: t – Temporary; p- Permanent; Impacts indicated in bold letters are Significant Impacts.***

**Environmental Management Plan:**

Environmental Management Plan (EMP) deals with the implementation procedure of the guidelines and mitigation measures recommended to avoid, minimize and mitigate foreseen environmental impacts of the project. The implementation of environmental management plan needs suitable organization set up and the success of any environmental management plan depends on the efficiency of the group responsible for implementation of the programme. It is proposed to carryout regular environmental monitoring to provide information to the management for periodic review to ensure that environmental protection is optimized at all stages of the project implementation.

**Conclusion:**

The proposed improvement to the existing National Highway section road and it is proposed to be up-graded with new.

The Environmental Assessment study nation report attempts to identify significant potential environmental impacts associated with the construction and operational phases of the proposed road Project. Apart from positive impacts road projects could also generate some adverse direct and indirect environmental impacts. Direct environmental impacts are usually due to construction activities, while indirect environmental impacts are usually related to the operation of improved roads.

Other than the temporary insignificant impacts during construction phase, the two most significant issues involved are cutting of road side trees along the proposed stretch of NH-37 and acquisition of forest land in the reserve forest along the proposed green field alignment.

## 8.5 Social Assessment

Social Assessment details the processes for assessing the project's potential social impacts and defining opportunities to enhance benefits and mitigate adverse social impacts. It contains the modalities for profiling socio-economic conditions, identifying stakeholder groups and analysing their interests and concerns, conducting social screening to assess potential impacts and linking these findings to project design. This will provide input for the Resettlement Action Plan, which will be prepared in due course.

**Expected Socio-Economic Benefits Of the Project**

The project will help to increase new economic and employment opportunities by providing improved linkages to markets, production centres and other areas of economic opportunities. The project is major transportation corridor which connects Silchar and Imphal. The road will increase the connectivity of the project area as well as the state as a whole to the surrounding region.

This project aims at maximizing project benefits while minimizing the negative social impacts. The social development outcome of the project will include:

i) The project road connects Assam, Manipur and Mizoram State. The project will serve the settlements along the corridor with better access to economic activities. Improved connectivity will facilitate travel, will help to have better access to amenities such as health, education, town/market, and improved social networking.

ii) The project will improve the accessibility of the population along the project corridor to education, health, employment, trading and employment opportunities and in the long run help towards poverty alleviation.

iii) The project will help to increase new economic and employment opportunities by providing improved linkages to markets, production centers and other areas of economic opportunities. Better and quicker transportation would help the rural population to transport their produce faster and get more profit margins instead of depending solely on local 'markets' and middlemen. This corridor has abundant tourism potential other places of tourist interests.

iv) Women will benefit, as their mobility will be facilitated both in terms of access to social services, as well as access to higher levels of schooling. Women's access to higher levels of health care outside the village particularly during the time of childbearing will also improve considerably.

v) Targeted assistance will be provided to vulnerable groups including below poverty line families, women headed households, and handicapped persons, through the Resettlement Policy for the Project.

The likely adverse impacts of the project are:

i) Potential adverse impacts associated with land acquisition;

ii) Loss of livelihood and

iii) Social exclusion where the affected non-titleholder and encroachers may not be eligible for assistance and compensation under local laws and procedures

Overall, the proposed Project will bring in economic and social changes, which in turn would bring economic prosperity and would lead to poverty alleviation.

**Methodology**

Collection and Analysis of Secondary Data: Secondary data pertaining to various socioeconomic parameters was collected from government departments like Census of India, Department of Industries, Department of Economics and Statistics, Department of Agriculture, etc.

Screening survey: A preliminary screening survey was conducted within a width of 45 meter to quantify the impact on buildings/structures that likely to be affected by the widening of the road. The number of residences, commercial buildings, common property resources and religious structures were surveyed for RHS and LHS separately. The survey covered: the settlements along the alignment, structures likely to be affected, community structures likely to be affected and communities affected.

Focused Group Discussions (FGD): Focus Group Discussions were conducted at selected places throughout the corridor to understand the people's perception about the project as well as their issues and concerns. The willingness of the people to part with their land for the project and the compensation anticipated also noticed.

9

# Chapter 9 – Preliminary Cost Estimate

**Section: Silchar to Jiribam (Package: SJ-1, From D. Km 4+560 to D. Km 24+560)**

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# 9 Chapter 9 – Preliminary Cost Estimate Chapter

## 9.1 General

The cost estimates for the project are extremely important as its entire viability and implementation depends on the project cost. Therefore, cost estimates have been carried out with due care. It is envisaged that the project would involve construction of formation in cut/fill in hilly area, construction of pavement, cross-drainage structures, bridges and protection works etc.

## 9.2 Estimation of Quantities

The detailed cost estimate presented in this report has been worked out using quantities of different items of works derived from the preliminary designs, drawings and based on the specifications as specified in IRC:SP:84-2019 "Manual of Specifications and Standards for four Laning of Highways".

The unit rates have been referred from latest Schedule of Rates (SOR) for Roads, Bridge and Culvert works for National Highways Under Assam Public Works (Building and NH) Department for the Year 2020-21, and for comparison purpose, analysis of rates has been done with Standard Data Book 2019 published by IRC.

Since there is no circular or guidelines to apply escalation on SOR rates, the same SOR is applicable for the year till revised SOR is published. Hence SOR 2020-21 has been adopted for current fiscal year.

The project road is is divided in to two packages as shown in the following table and the estimate are presented separately for each Packages. The instant Package: SJ-1 is from near Silchar/ Nutan Dayapur at existing km 260+000 on NH-37 (D. Ch: 4+560) to existing km 233+000 on NH-37 (D. Ch: 24+560) near Budha Nagra in the state of Assam.

**Table 9.1 Package Distribution**

| Sl. No. | Construction Packages | Design Chainage | | | Existing Chainage | | |
|---|---|---|---|---|---|---|---|
| | | From | To | Length (km) | From | To | Length (km) |
| **1** | **Package: SJ-1** | **4+560** | **24+560** | **20.000** | **260+000 on NH-37, Assam** | **233+000 on NH-37, Assam** | **27.000** |
| 2 | Package: SJ-2 | 24+560 | 37+650 | 13.090 | 233+000 on NH-37, Assam | 212+060 on NH-37, Manipur | 20.940 |
| | **Total Design Length** | | | **33.090** | | | **47.940** |

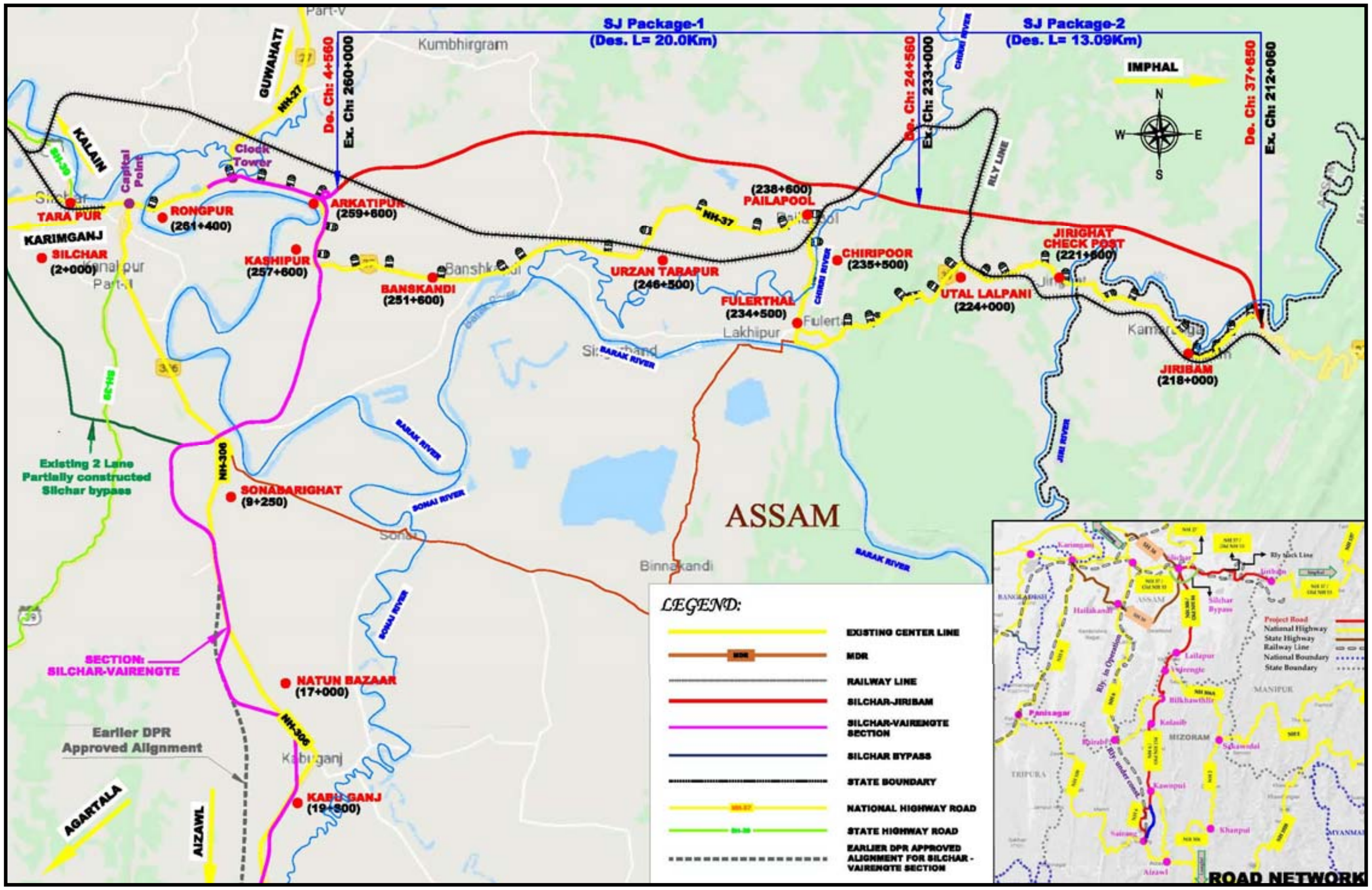



**Fig 9.1 Key Plan for Proposed Construction Packages**

## 9.3 Cost Estimate

In general, the work is to be executed as per the Technical Specifications contained in "Specifications Road and Bridge Works" (Fifth Revision) issued by MOR&TH, with suitable modifications depending on the project requirements.

The quantities of major items of work have been worked out based on typical cross sections, detailed survey and preliminary designs. The following are the major items of works, which have been estimated separately:

**Table 9.2 Summary of Estimate Items**

| Bill No. | Item of works |
|---|---|
| **A** | **Highways** |
| 1 | Site Clearances |
| 2 | Earthwork |
| 3 | Granular Sub-Base & Base Courses |
| 4 | Bituminous Base & Surface Courses |
| 5 | Drain works |
| 6 | Protection Works |
| 6A | Reinforced earth wall |
| 6B | Slope protection work |
| 7 | Traffic Signs, Markings & Road Appurtenances |
| 8 | Miscellaneous works |
| 9 | Toll Plaza |
| 10 | Cross Drainage Works (Box Culverts) |
| 11 | Minor Bridges |
| 12 | Major Bridges |
| 13 | SVUP |
| 14 | LVUP |
| 15 | VUP/VOP |
| 16 | ROBs |
| 17 | Tunnel |

## 9.4 Site Clearance

Site clearance quantity is estimated, as overall area required clearance for construction of road. It includes necessary excavation, back filling, grubbing & disposal of cleared material etc. The area has been calculated considering the width between the proposed toe lines on both sides.

## 9.5 Earth Works

The earthwork quantity is calculated from cross-section generated by the design software MX Road and presented in excel sheet. Considering the uneven surface of existing ground, the calculation is done at 10m intervals to increase the accuracy of quantity of earthwork. Earthwork quantities are calculated as per the proposed cross sections and cut/fill slopes @ 10m interval. The bridge gaps and all other structures are considered for deduction for the earth work and also for different pavement layers

- Earthwork in cut/fill have been calculated considering: in case of fill sections – up to bottom of subgrade level; in case of cut sections – up to top of subgrade level.
- An average lead of 1km has been considered for the disposal of cut material.
- Subgrade - At cut locations, preparation of subgrade had been considered and at fill locations soil deposited from hill cut is considered.
- Median filling has been considered with soil obtained from earth work in cutting.
- Geo grid layer was placed before proceeding with embankment filling since there is saturated soil with moisture.
- In the embankment fill area, geogrid layer is place on the natural ground in full width of embankment toe after clearing and grubbing and is followed with the layer of embankment fill.
- In the area of Marshy land, a sand blanket of 15 cm thick has been considered at 1.5 m depth from finish road level throughout the formation.

## 9.6 Pavement Material

The quantities are calculated as per the proposed cross-sectional width including extra widening at curves, junctions @ 10m interval. At junctions, the area of improvement has been measured in AutoCAD and accordingly quantities are calculated.

Type of pavement –

| From | To | Length (m) | Type of Pavement | Remarks |
|---|---|---|---|---|
| 4+560 | 24+560 | 20000 | Flexible | Pkg.: SJ-1 |
| 24+560 | 25+700 | 1140 | Rigid | Tunnel portion proposed under Pkg.: SJ-2 |
| 25+700 | 27+300 | 1600 | Flexible | Pkg: SJ-2 |
| 27+300 | 27+770 | 470 | Rigid | toll plaza approach proposed under Pkg.: SJ-2 |
| 27+770 | 37+650 | 9880 | Flexible | Pkg: SJ-2 |
| **Total** | | **33090** | | |

| Flexible pavement | Main Carriage Way | Service Road |
|---|---|---|
| BC | 40 | 30 |
| DBM | 65 | 60 |
| WMM | 250 | 250 |
| Geogrid | BI-AXIAL | - |
| GSB | 200 | 200 |

Flexible pavement includes BC (Bituminous concrete), DBM (Dense bituminous macadam), WMM (Wet mix macadam), WMM (Wet Mix Macadam), biaxial geogrid layer underneath WMM and GSB (Granular Subbase). Crust for flexible pavement is 40mm BC, 65mm DBM, 250mm WMM (two layers each has 125mm thick), geogrid layer underneath WMM and 200mm GSB.

For Service Road is proposed for flexible with crust thickness of 30mm BC, 60mm DBM, 250mm WMM (two layers each has 125mm thick) and 200mm GSB.

## 9.7 Cross Drainage Structures, Underpasses and Flyovers

The construction of new bridges, underpasses, interchanges and culverts are assessed on proposed length and the earthwork, pavement and shoulders for bridge approaches have been included as appropriate roadwork items. The other items like RCC and PCC work of bridges, culverts and Underpasses are calculated as per design and drawings.

## 9.8 Drainage and Protection Works

### 9.8.1 Longitudinal Drains

Unlined open longitudinal drains have been provided throughout the length h of project road in rural areas. On Approach of Underpasses, Built up areas and service road location, PCC open drain has been provided. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII.**

### 9.8.2 Reinforced Earth wall and Slope

Geologically the project area comprises of rocks from the oldest Precambrian gneissic complex to the recent alluvium formations. Hence in valley region where more filling is required, a Reinforced Soil slope (RS Slope protection) and Reinforced soil Wall (RS wall) is provided. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII.**

### 9.8.3 Breast Wall

Breast walls are provided to protect uphill slopes, which fail by slumping, sliding, toe failures and failures below formation level. PCC/RR Masonry/Gabion breast walls has been proposed at open areas. There are two types of PCC and Gabion breast wall has been considered in this package. For height upto 4m PCC breast wall has been considered and height more than 4m gabion breast wall was been considered. PCC breast detailed locations and quantity calculations are given in **Volume-VI, VII & VIII.**

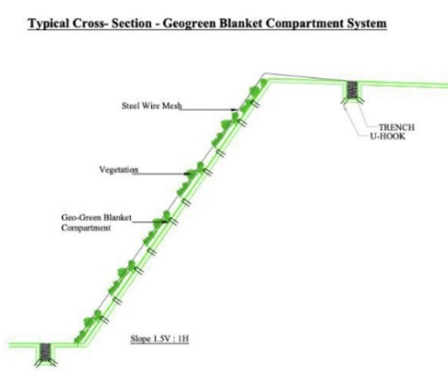
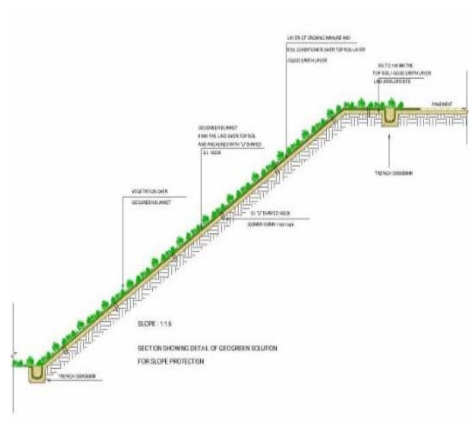
### 9.8.4 Retaining wall & Parapet Wall

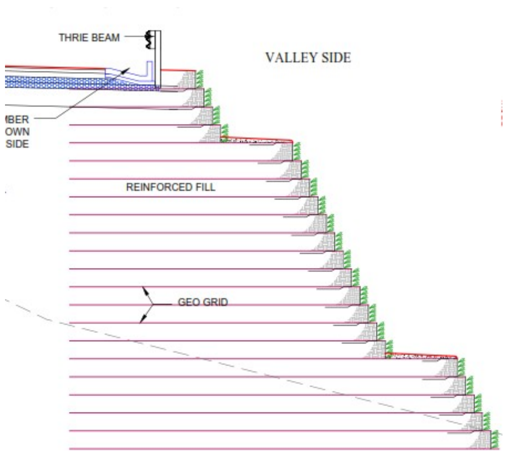
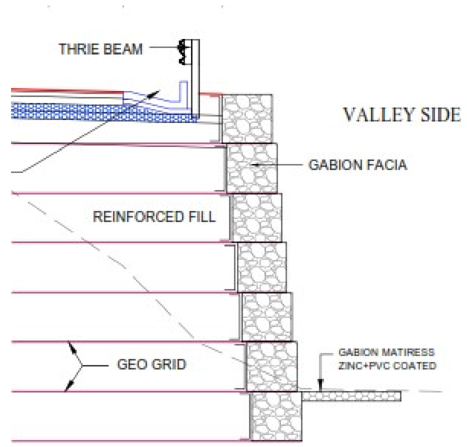
Retaining walls have been proposed, a) where the existing ground is steep and embankment is not feasible b) to restrict the formation width at RoW constraint locations. Retaining wall are of two types PCC and Gabion. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII.**

For heights up to 5m PCC and for heights more than 5m gabion retaining walls have been proposed. For PCC parapet walls over PCC & Gabion retaining wall has been proposed.

### 9.8.5 Slope Protection

Turfing has been provided for embankment height up to 4m. Cut slope protection work has been considered for depth of cutting greater than 4m. For embankment fill height greater than 4m, geomembrane slope protection has been considered. Also for embankment height greater than 6m chute drains has been considered. Location and quantities are given in **Volume-VI, VII & VIII.** Four types has been considered as under:

| | |
|---|---|
| A. **Cut slope protection** - geo composite product with Soil nailing, made from natural coconut fibre reinforced with closely woven polymer nettings impregnated with seeds. | B. **Erosion control on fill Slope**- anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely woven polymer nettings and seeds broadcasting on the treated site. |
|   |  |
| **Cut Slope Protection** | **Erosion Control** |

| | |
|---|---|
| **C. Reinforced soil –** installation of RS slope with Welded Wire Mesh (WWM) fascia with vegetation | **D. Reinforced soil wall -** installation of Gabion fascia wall with geogrid with Vegetation**.** |
|  |  |
| **Reinforced soil** | **Reinforced soil Wall** |

**(**Soil nailing – Soil nailing may be required in cutting area beyond 10m height of cutting and for costing, total area for soil nailing has been considered 40% of total cutting slope area.)

**Fig 9.2 Protection Wall**

## 9.9 Road Junctions, Interchange, Bus Stops and Truck Lay Byes

The quantities for Road junctions, Interchanges has been referred from "Type designs for Intersections on Economic Corridor" published by MoRTH and for safety measures like truck lay-byes and Bus Stops etc have been referred from IRC:SP:84-2019. Quantities have been calculated based on the Design drawings provided in the Drawing Volume Report.

## 9.10 Traffic Signs, Markings & Other Road Appurtenances

Provision have to be made for the traffic safety all along the stretches of the proposed road i.e. road sign- mandatory, informatory & cautionary, road markings, way side amenities etc. as per IRC: 35-1997, IRC: 67-2012.

Barrier kerb has been considered throughout the length of project road at median edge and Kerb channel on outer edge of carriageway throughout the length.

## 9.11 Toll Plazas- Location and quantities are given in Volume-VI, VII & VIII.

## 9.12 Other Miscellaneous Works

Provision for Traffic Management and Miscellaneous has been taken in the estimate. The following items are considered in the Estimate. Street lighting is provided at the locations of built-up areas, toll plaza, bus stops, truck lay byes, underpasses, flyover and throughout length of service road and slip road. High Mast lightings are considered at all major junctions and toll plaza locations.

## 9.13 Land Acquisition and Compensation for Structure

The land for bypasses and new alignment has been acquired in varying width as per site requirement. Land acquisition requirements also cover the provision of Service Road.

Toll Plaza, Lay-Byes and Interchange etc. will require additional land to accommodate the proposed carriageway facility. Based on alignment design, land and structure acquisition cost including rehabilitation and Resettlement costs are assessed.

The LA cost has been assessed based on tentative rate obtained from revenue department however, final LA cost is updated in final DPR only after CALA verified estimate which is in progress at moment.

***Please refer Appendix 17.0 for Land acquisition.***

## 9.14 Rehabilitation and Social Costs

The rehabilitation and social costs of the project-affected people have been assessed based on the assumption (with multiplication factor of 2 but without solatium) however, final R&R cost will be incorporated after CALA verified estimate during further stage.

***Please refer Appendix 17.0 for Land acquisition***

## 9.15 Environmental Improvement Works

The cost of environmental improvements works including the cost of tree cutting, replanting, monitoring during construction i.e., all the civil and non-civil works have been included in the project cost estimate.

***Please refer Appendix 15.0 for Environmental Cost***

## 9.16 Rate Analysis

### 9.16.1 Basic Rates

The unit rates have been referred from Schedule of Rates (SOR) for Roads, Bridge and Culvert works for National Highways Under Assam Public Works (Building and NH) Department for the Year 2013-14, and items which are not listed in the SOR have been analysed on the basis of the 'Standard Data Book for Analysis of Rates' published by IRC.

A comparative state of rates have also been prepared with rates of latest SOR 2020-21 at current year and analysed rates based on basic input rates from current SOR.

Rate of escalation has been worked out from WPI indices available in web page of Ministry of Commerce and Industry. Rate of escalation percentage for SOR Year 2020-21 has been tabulated below:

| Year | WPI Index |
|---|---|
| 2013 - 14 | 112.5 |
| 2014 - 15 | 113.9 |
| 2015 - 16 | 109.7 |
| 2016 - 17 | 111.6 |
| 2017 - 18 | 114.9 |
| 2018 - 19 | 119.8 |
| 2019-2020 | 121.8 |
| 2020-2021 | 123.4 |
| 2021-2022 | 139.4 |

From the above table adopted percentage rate of escalation for SOR 2020-21 to arrive at current fiscal year 2022-23 is 13%. Since there is no circular or guidelines to apply escalation on SOR rates, the same SOR is applicable for the year till revised SOR is published. **Hence SOR 2020-21 has been adopted for current fiscal year**.

For comparison, Rate have been analysed using standard Data Book 2019 for current fiscal year considering the basic rates of material, labour and machineries referred from SOR and escalated basic rates up to current fiscal year and considering input for analysis of rates.

### 9.16.2 Basis of Analysing item rates

For those items of work which are not listed in the SOR, rates are analysed as per Standard Data Book 2019 by MORTH. The basic rates were analysed on the basis of material study undertaken, the prices of construction materials collected from various sources and anticipated distance of source to the site of work. Manpower rates and Hire charges of various equipment have been calculated with the escalation on the hire charge mentioned in SOR Wherever rate analysis was not available in Standard Data Book, the rates were adopted as per previous experience of the consultant / Market rates and prevailing percentage over these rates were considered.

### 9.16.3 Man power

Rates are referred from Appendix I "Labour Rates" of PWD (Building & NH) SOR Assam 2020-21 and escalated @ 13% to arrive at the current rates. Adopted labour rates are tabulated below:

**Table 9.3 Man power Charges**

| Sl. No. | Description of Labour | Unit | SOR Assam 2020-21 | Escalated by 13% for 2022-23 |
|---|---|---|---|---|
| L-01 | Blacksmith (IInd class) | day | 380.79 | 430.00 |
| L-02 | Blacksmith (Ist class)/ Welder/ Electrician | day | 500.47 | 566.00 |
| L-03 | Blaster (Stone cutter) | day | 315.42 | 356.00 |
| L-04 | Carpenter I Class | day | 500.47 | 566.00 |
| L-05 | Chiseller (Head Mazdoor) | day | 380.79 | 430.00 |
| L-06 | Driller (Jumper) | day | 380.79 | 430.00 |
| L-07 | Driver | day | 380.79 | 430.00 |
| L-08 | Fitter | day | 402.55 | 455.00 |

| Sl. No. | Description of Labour | Unit | SOR Assam 2020-21 | Escalated by 13% for 2022-23 |
|---|---|---|---|---|
| L-09 | Mali | day | 315.42 | 356.00 |
| L-10 | Mason (IInd class) | day | 315.42 | 356.00 |
| L-11 | Mason (Ist class) | day | 500.47 | 566.00 |
| L-12 | Mate / Supervisor | day | 500.47 | 566.00 |
| L-13 | Mazdoor | day | 271.97 | 307.00 |
| L-14 | Mazdoor/Dresser (Semi Skilled) | day | 315.42 | 356.00 |
| L-15 | Mazdoor/Dresser/Sinker (Skilled) | day | 380.79 | 430.00 |
| L-16 | Medical Officer | day | 2200.00 | 2,486.00 |
| L-17 | Operator(grouting) | day | 500.47 | 566.00 |
| L-18 | Painter I class | day | 500.47 | 566.00 |
| L-19 | Para medical personnel | day | 700.00 | 791.00 |

### 9.16.4 Machinery Charges

Machinery hire charges are referred from “Hire Charges of Machinery” of PWD (Building & NH) SOR Assam and escalated @ 18.45% to arrive at FY 2020-21.

### 9.16.5 Lead & Basic rate of materials including carriage charges

The conveyance of materials from source of supply to final placement may be in stage or in multi stage, depending on the nature of works. The conveyance of materials within the site area is reckoned as “initial lead” and is generally included in the basic rate provided in the SoR. The lead up to the site/plant is reckoned as “Additional lead”.

While estimating lead of materials, the consultants assumed that:

- Moorum, boulders, filler materials, and granular materials for embankment protection works and granular sub-base would be directly transported to the construction site, and
- Stone boulders, spalls, sand etc would be transported to the plant location and ready mixed material such as concrete, bitumen mix then be carried to the work site.

## 9.17 Material Rates

### 9.17.1 Plant Location

The following locations have been considered for WMM/Bitumen/Concrete plants to arrive at the lead of various construction materials, which will be subsequently used in the analysis of rates. These locations are arrived considering the terrain, location of built-up areas, package limits and minimum lead distances from plant to site.

Plant location – At Existing Ch: 238+700 (Pailapool).

### 9.17.2 Cement

Rate of cement as per SOR Assam 2020-21, as per ( C) Material rate sheet item no. M-086 Page 241, is – 6365/71- per ton excluding GST and escalated by 13% rate of cement for the current year 2022-23 is 7193/- per ton.

As per current price list of cement in Guwahati (March 2022) from web portal of https://www.cementprice.in, OPC costs Rs. 6600/MT (Rs. 330 per bag). Current market rate has been adopted for rate analysis. Cartridge cost from source to plant location has been added to arrive rate at site.

Lead from source to the plant location is 325 km

**Table 9.4 Rate Adopted for cement**

| Basic Rate March 2022 as per inampronic.in | 28% GST | Lead charges | Total rate |
|---|---|---|---|
| Rs. 6600/MT | - | Rs. 761/MT | Rs 7361/MT |

### 9.17.3 Steel

Rate of steel as per SOR Assam 2020-21, as per (C) Material rate sheet item no. M-088 Page 241, is – 46200- per ton excluding GST and escalated by 13% rate of cement for the current year 2022-23 is 52,206/- per ton.

For steel, the nearest outlet is Guwahati in Assam. Rate of steel has been referred from Steel Authority of India Limited (SAIL) web page. This rate has been compared with SOR Assam rate with escalation of @3%. The minimum rate has been adopted for the rate analysis. Cartridge cost from source to plant location has been added to arrive rate at site.

As per SAIL web site average rate of reinforcing steel for May 2022 for Guwahati inclusive of GST @18% - 96459/-and exclusive of GST is 81,745/- per MT. Hence adopted rate for the analysis is the minimum of the two i.e. Rs. 52,206/- per MT.

Since the SOR rate are valid in all district of the Assam, Lead from Silchar market to start point of Project road is 6 km.

Average lead up to plant location is 12 km.

Total lead from source to plant location is 18 km.

**Table 9.5 Rate Adopted for steel**

| Basic Rate as per SOR 2020-21 | Escalated rate @ 13% | Lead charges |
|---|---|---|
| Rs. 46,200/MT | Rs. 52,206/MT | Rs. 40/MT |

### 9.17.4 Bitumen

The nearest outlet for bitumen is Haldia refinery in West Bengal which is 1446 Km upto plant location. The latest rate effective from 03/06/2022 as per the Bitumen India web page, rate of bitumen outlet at Haldia has been adopted. Since instant project road is section of national highway NH-306 and traffic in this stretch is 40 MSA, as per IRC:37-2018, Bitumen grade VG40 has been used in DBM and BC, Hence in Rate Analysis, rate of bitumen grade VG 40 has been adopted for DBM and BC.

**Table 9.6 Rate Adopted for Bitumen**

| Grade | Basic Cost (Rs.) | Unit | GST @ 18% | Lead Charges | Total Price per Tonne (Rs) |
|---|---|---|---|---|---|
| Bitumen Emulsion | 56682 | MT | | 3398 | 60080 |
| Bitumen (60-70 grade) VG-30 | 49882 | MT | | 3398 | 53280 |
| Bitumen (80-100 grade) VG-10 | 56682 | MT | | 3398 | 60080 |
| **Bitumen (30-40 / 40-50 grade) VG-40** | 52992 | **MT** | | **3398** | **56390** |

### 9.17.5 Borrow Soil

Soil required will be available within the project area. As the project road passes through rolling terrain, volume of earthwork in filling is much more than the volume of earthwork in cutting. Quantity required for fill is approx.90% whereas cutting quantity is 10% of the total earth work. The soil parameters of the project area fulfill the requirement and characteristics of soil to be used in embankments and hence 70% of earth obtained from cutting material has been utilized for embankment filling and balance earth has been borrowed from borrow pit.

Average lead of earth material from borrow pit is 5 km.

### 9.17.6 Stone boulders, Aggregates

There is stone quarry at Madhurapaul at km. 262+500 NH-53 and is 22km away along NH-22 on left side. Also there is Doranal stone quarry which is at 25 km away on left along NH-27. The material at these locations is suitable for both bituminous and concrete works. The location plan of tentative quarries is shown in the figure below:

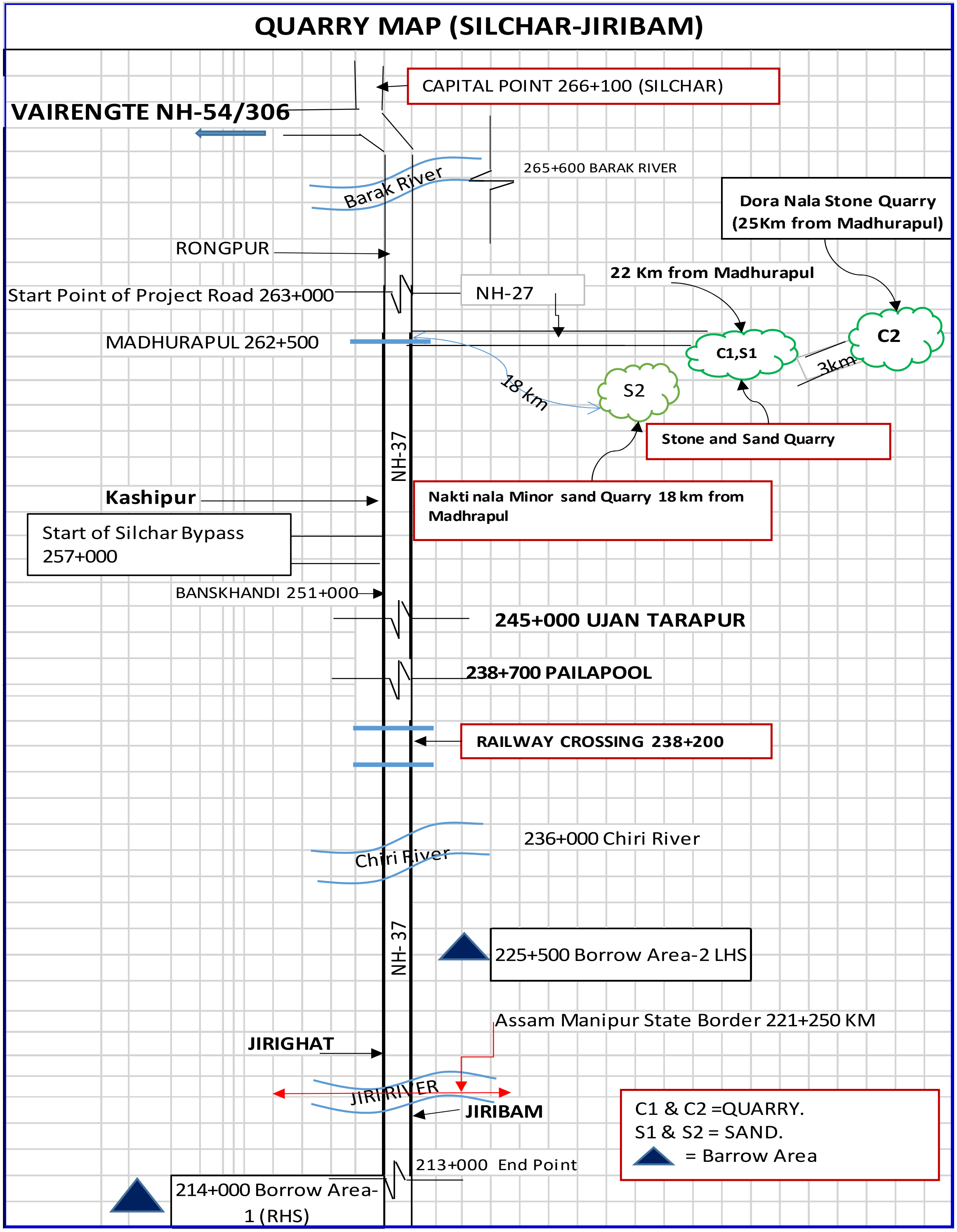



Fig 9.3 Lead Map

## 9.18 Overhead and Contractor's profit

Contractor's profit and Overhead charges have been incorporated in the rate analysis in accordance with guide lines in the MoRT&H Standard Data Book 2019 and reproduced as under:

Small project: Civil works cost less than INR 200 Cr.

Medium Project: Civil works cost greater than INR 200 Cr. and less than INR 500 Cr.

Large Project: Civil works cost greater than INR 500 Cr.

Current project fall under category of large project. So overhead and contractor' profit considered in the rate analysis for large project are as below:

- Overhead for road works - 8%
- Contractor's profit for road works - 10%
- Overhead for new/widening/ structure works - 20%
- Overhead for rehabilitation of bridges/ structure work - 30%
- Contractor's profit for bridge work - 10%

## 9.19 Project Total Cost

**Table 9.7 GENERAL ABSTRACT OF COST**

| Bill No. | Item of works | Quantity | Cost (Rs. Crores) |
|---|---|---|---|
| 1 | Site Clearance | | 0.57 |
| 2 | Earthwork | | 172.01 |
| 3 | Granular Sub-base & Base Courses | 20.00 Km. | 104.56 |
| 4 | Bituminous Base and Surface Courses | 20.00 Km. | 47.82 |
| 5 | Drain works | 41746 m. | 14.76 |
| 6 | Protection Works | | |
| | a) Breast wall | 2080 m. | 13.20 |
| | b) Retaining /Toe wall | 1240 m. | 9.58 |
| | c) Slope protection work | 100638 Sqm. | 5.09 |
| 7 | Traffic Signs, Markings and Other Road Appurtenances | 20.00 Km. | 29.74 |
| 8 | Miscellaneous works | 20.00 Km. | 17.34 |
| 9 | Cross Drainage Works - Box Culverts | | 38.78 |
| 10 | Bridges | | |
| | a) Minor Bridge | 13284.95 Sqm | 62.86 |
| | b) Major Bridge | 5894.25 Sqm | 29.31 |
| 11 | Underpasses | | - |
| | a) SVUP | 1878.16 Sqm | 14.31 |
| | b) LVUP | 924.66 Sqm | 4.53 |
| | c) VUP/VOP | 3687.56 Sqm | 18.16 |
| 12 | ROBs | 10260.00 Sqm | 34.88 |
| **I** | **Cost of Civil Works (in Crores)** | | **617.49** |
| II | Utility Shifting Cost with GST | | 12.80 |
| **III** | **Total Civil Cost (I+II+III)** | | **630.29** |
| IV | Contingencies @ 1% of civil cost (I) as per circular dated Aug 2021 | | 6.17 |
| V | Supervision charges @ 3% of civil cost excluding GST (II) (as per MORTH Letter no.EW-Nh-33044/10/2019-S&B9P&B dated March 7 2019) | | 18.52 |
| VI | Administrative charges @ 3.0% of civil cost (I) | | 18.52 |
| VII | Annual maintenance for 5 years (in total) @ 2.5% of Civil Cost (I) as per EPC Agreement Clause 14.1 (i) (a) - 0%+0.5%+0.5%+0.5%+1.0% | | 15.44 |

| Bill No. | Item of works | Quantity | Cost (Rs. Crores) |
|---|---|---|---|
| VIII | Price escalation @ 5% per annum for two years i.e. 10% of Civil Cost (I) | | 61.75 |
| **IX** | **Centages over civil cost (IV+V+VI+VII+VIII)** | | **120.40** |
| X | GST @ 18% of civil cost (I) | | 111.15 |
| XI | GST @ 18% of Utility cost | | **2.30** |
| **XII** | **Total Project cost including centages XII =IX+X+XI (in Crores)** | | **864.15** |
| | | | |
| **XIII** | **Non-Civil Cost** | | |
| | Environmental Cost | | 3.09 |
| | AGCL (132 KV) | | 14.47 |
| | PGCIL (400 KV & 132 KV) | | 17.91 |
| | Land Acquisition and Rehabilitation & Resettlement cost | | 209.62 |
| | **Sub-Total (in Crores)** | | **245.09** |
| | | | |
| **XIV** | **Total project completion cost XIV = XII+XIII (Rs. Crores)** | | **1109.24** |
| | Length of the project road (Km) | | 20.00 |
| | Civil Cost Rate per km (in Crores) | | 30.87 |
| | Total Project Complation Cost Rate per km (in Crores) | | 55.47 |