Ministry of Road Transport and Highways
(GOVERNMENT OF INDIA)

NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

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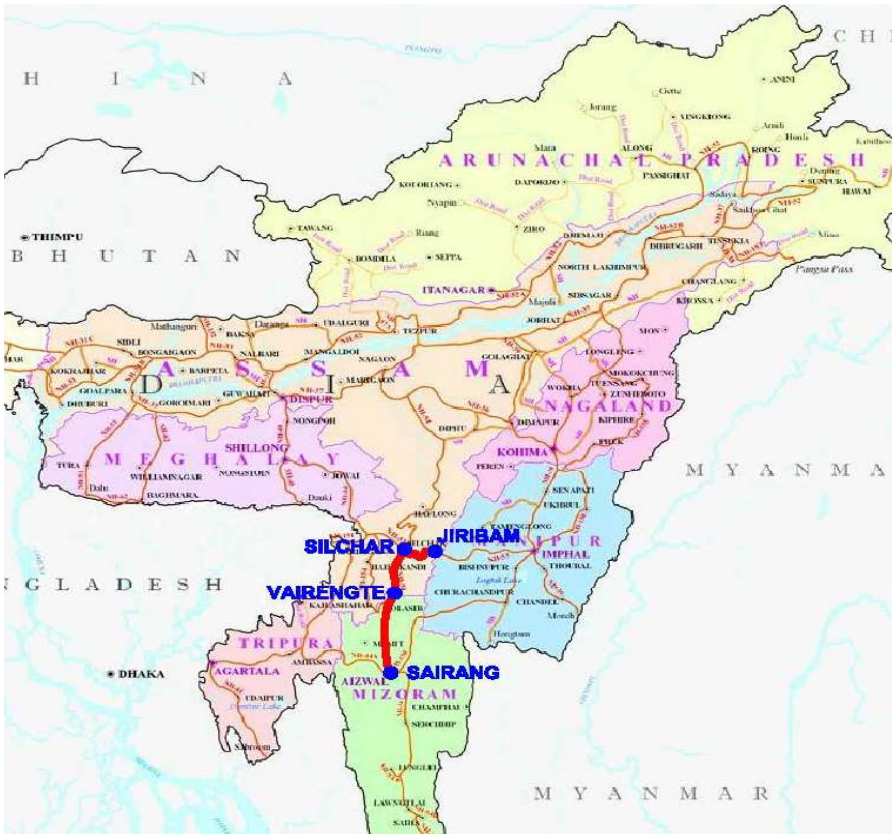
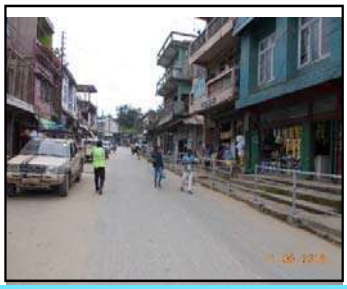
Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).





Final Detailed Project Report - R2 (Silchar-Jiribam) Package: SJ-1 (From D. Km 4+560 to D. Km 24+560) Volume-I (MAIN REPORT)

November 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 - R2

VOLUME : I	**MAIN REPORT**	√
	APPENDICES TO MAIN REPORT	
VOLUME : II	DESIGN REPORT	
VOLUME :III	MATERIALS REPORT	
VOLUME : IV	ENVIRONMENTAL ASSESSMENT REPORT INCLUDING ENVIRONMENTAL MANAGEMENT PLAN(EMP) AND RESETTLEMENT ACTION PLAN(RAP)	
VOLUME : V	TECHNICAL SCHEDULE	
VOLUME : VI, VII & VIII	RATE ANALYSIS, COST ESTIMATE, BILL OF QUANTITIES	
VOLUME : IX	DRAWINGS (ROAD & STRUCTURES)	

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

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Chapter 0 - Executive Summary

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 (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)

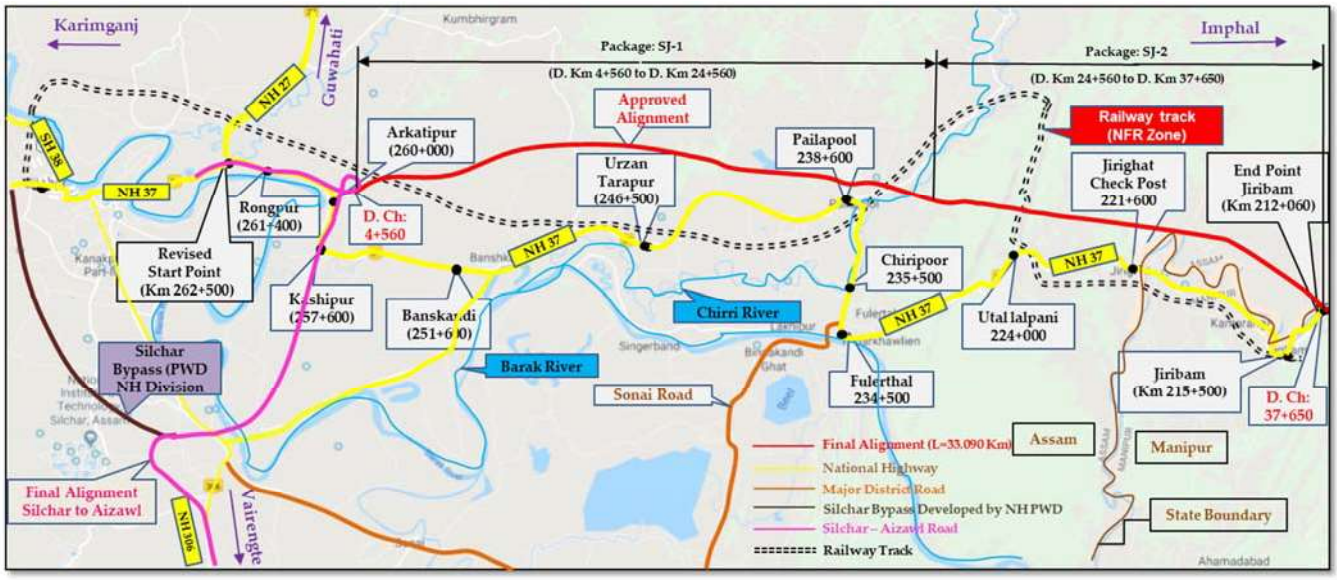

Fig 0.1 Section (Silchar - Jiribam)

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.

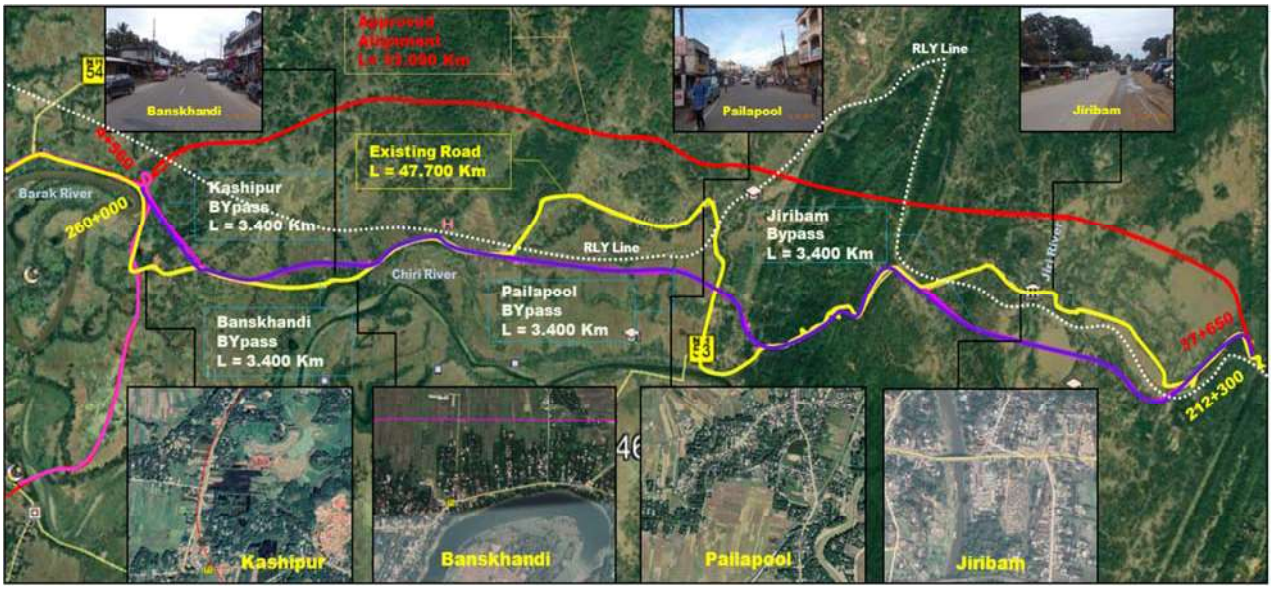

Fig 0.2 Approved Green Field Alignment

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

However, during PATSC (25.09.2023), it has been recommended to modify pavement design of the main carriageway and service road, the CBR value as obtained at site shall be taken for design if less than 6%. The maximum value of CBR to be taken for design shall not exceed 6%.

Therefore, pavement design thickness has been modified considering 6% CBR value for design traffic of 40 MSA with a minimum design period of 20 years for flexible.

Sl. No	Sections (design Chainage)	Length (Km)	*Type of Pavement	Modified Thickness
1	From Km 4+560 to Km 37+650	33.09	Flexible with Geogrid	BC = 40 mm DBM = 75 mm WMM = 250 mm Geogrid (Biaxial) GSB = 200 mm Subgrade = 500 mm

PMB / CRMB shall be used for BC.

The pavement layer thickness for Service road design traffic of 10 MSA and 6% CBR is given in below table.

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 = 40 mm DBM = 70 mm WMM = 250 mm GSB = 200 mm Subgrade = 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
	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

Sl. No.	Description		Unit	Total
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** **1. Km 4+560 to Km 24+560**		Flexible	Flexible –4L
	Existing Type		BT	
	<u>Proposed new 4 Lane (Main Carriageway)-6% CBR</u>		**Flexible**	
	BC(PMB/CRMB)		**mm**	40
	DBM (VG-40)		**mm**	75
	WMM		**mm**	250
	Geogrid			Biaxial
	Granular Sub-Base (GSB)		**mm**	200
	Subgrade		**mm**	500
	<u>Service Road (CBR 6%)</u>		**Flexible**	
	BC(VG-30)		mm	40
	DBM (VG-30)		mm	70
	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

However, collective decision was made during PATSC (25.09.2023) to modify TCS mainly modification of paved shoulder from 2.5 m to 1.5 m and earthen shoulder from 1.5 m to 2.0 m. The revised cross-sectional element is as below,

Four-lane road (Rural area)		
Paved Carriageway		2 x 7.0 m = 14.0m
Shoulders	Paved	2 x 1.5m = 3.0m
	Unpaved	2 x 2.0m = 4.0m
Kerb shyness		2 x 0.50m = 1.00m
Median		4.00 m
Total Roadway Width		26.00 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 Vertical Clearance = 4.0
2	SVUP	5+860	Span = 1 x 7 Vertical Clearance = 4.0
3	SVUP	6+820	Span = 1 x 7 Vertical Clearance = 4.0
4	SVUP	8+110	Span = 1 x 7 Vertical Clearance = 4.0
5	SVUP	9+597	Span = 1 x 7 Vertical Clearance = 4.0
6	VUP	11+913	Span = 1 x 24 Vertical Clearance = 5.5
7	SVUP	13+777	Span = 1 x 7 Vertical Clearance = 4.0
8	SVUP	14+235	Span = 1 x 7 Vertical Clearance = 4.0
9	LVUP	15+075	Span = 1 x 12 Vertical Clearance = 4.0
10	Overpass	16+796	Span = 2 x 36 Vertical Clearance = 5.5
11	SVUP	17+813	Span = 1 x 7 Vertical Clearance = 4.0
12	SVUP	19+612	Span = 1 x 7 Vertical Clearance = 4.0
13	VUP	20+803	Span = 1 x 24 Vertical Clearance = 5.5
14	SVUP	21+718	Span = 1 x 7 Vertical Clearance = 4.0

Sl. No.	Type / Location of Structure	Type of Structure	Span arrangement and Vertical clearance
15	VUP	22+648	Span = 1 x 24 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	14	-	-	-	4	14

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	2x12.5
2	22+452	ROB	Silchar-Jiribam BG Railway Line	3 x 36	2x12.5

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 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.

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

Annexure

Annexure 1. DPR Checklist – Stage 4 – Final Detailed Project Report (R2)

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	

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 • Sight distance details • Horizontal Alignment Details • Vertical Alignment Details • Height of Embankment	Yes ☑ No ☐ NA ☐		
4.2	Topographical Survey using LiDAR (or equivalent technology) as per IRC:SP:19 • Gradient • 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 • Geological Map of the Area • Seismicity	Yes ☑ No ☐ NA ☐	NA	
4.7	Climatic Conditions • Temperature • Rainfall • Wind	Yes ☑ No ☐ NA ☐	NA	
4.8	Land Use along the existing alignment • 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 • 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 • Details of Borrow Pits with Distance from Project Site • 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 • Details of Suppliers with Distance from Project Site • 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: • Road alignment geometry • Proposed highway • 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.

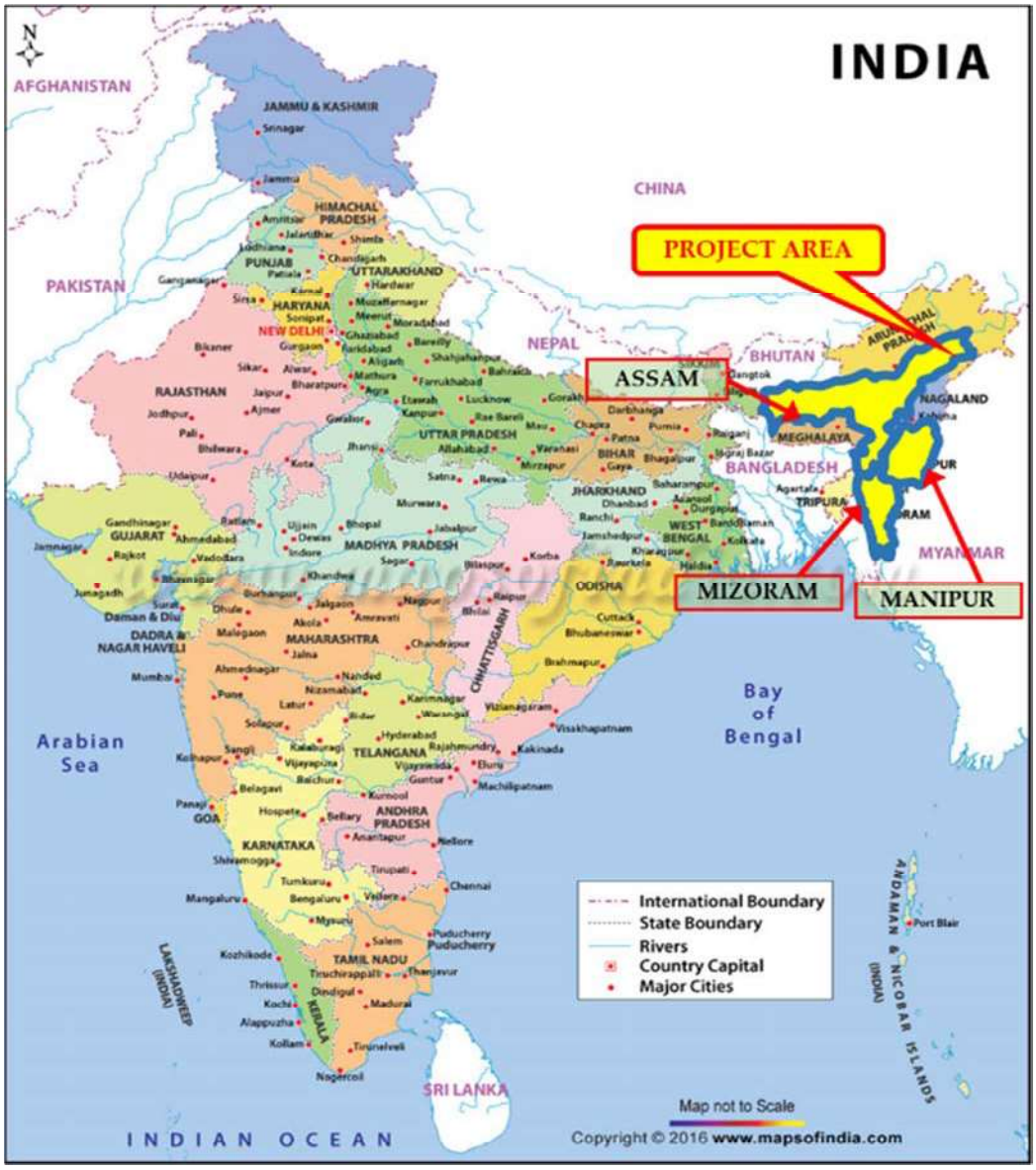
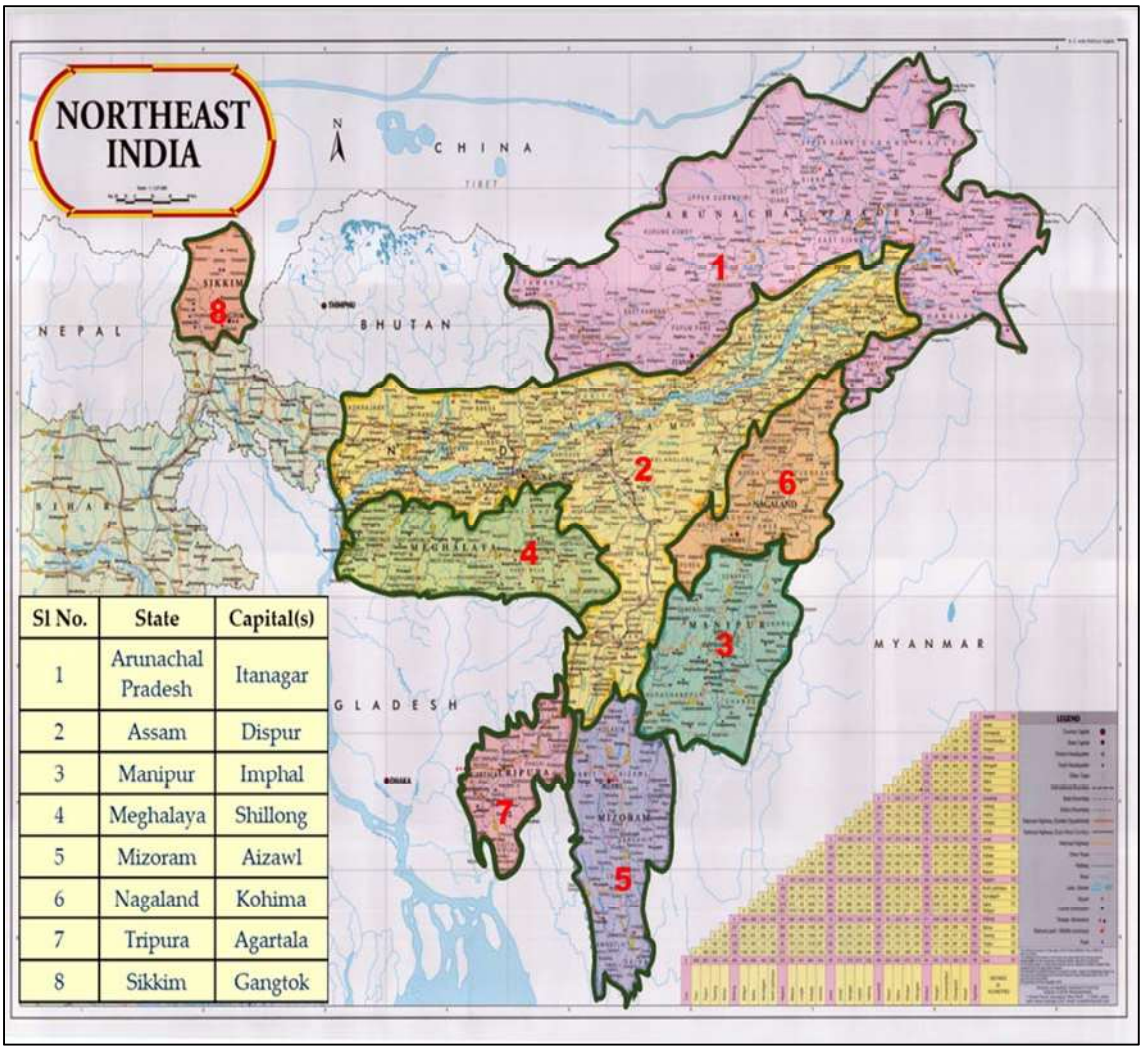


Fig 1.1 Index Map of the Project Road



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).**

Final DPR for Package: SJ-1 was submitted under R1 vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2023-24/404043 dated 24.08.2023 but collective decision was made during PATSC (25.09.2023) to modify TCS mainly modification of paved shoulder from 2.5 m to 1.5 m and earthen shoulder from 1.5 m to 2.0 m.

Whereas pavement design of the main carriageway for design traffic of 40 MSA with a minimum design period of 20 years for flexible shall be adopted.

Whereas CBR value as obtained at site shall be taken for design if less than 6%. The maximum value of CBR to be taken for design shall not exceed 6%.

PMB / CRMB shall be used for BC.

Accordingly, This Final Detailed Project Report (FDPR) is being modified and submitted under R2 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

Sl. No	Stages	Key activities	Deliverables
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 (ii) Project (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 (R2) 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) **R2** is under submission.

2

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

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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.

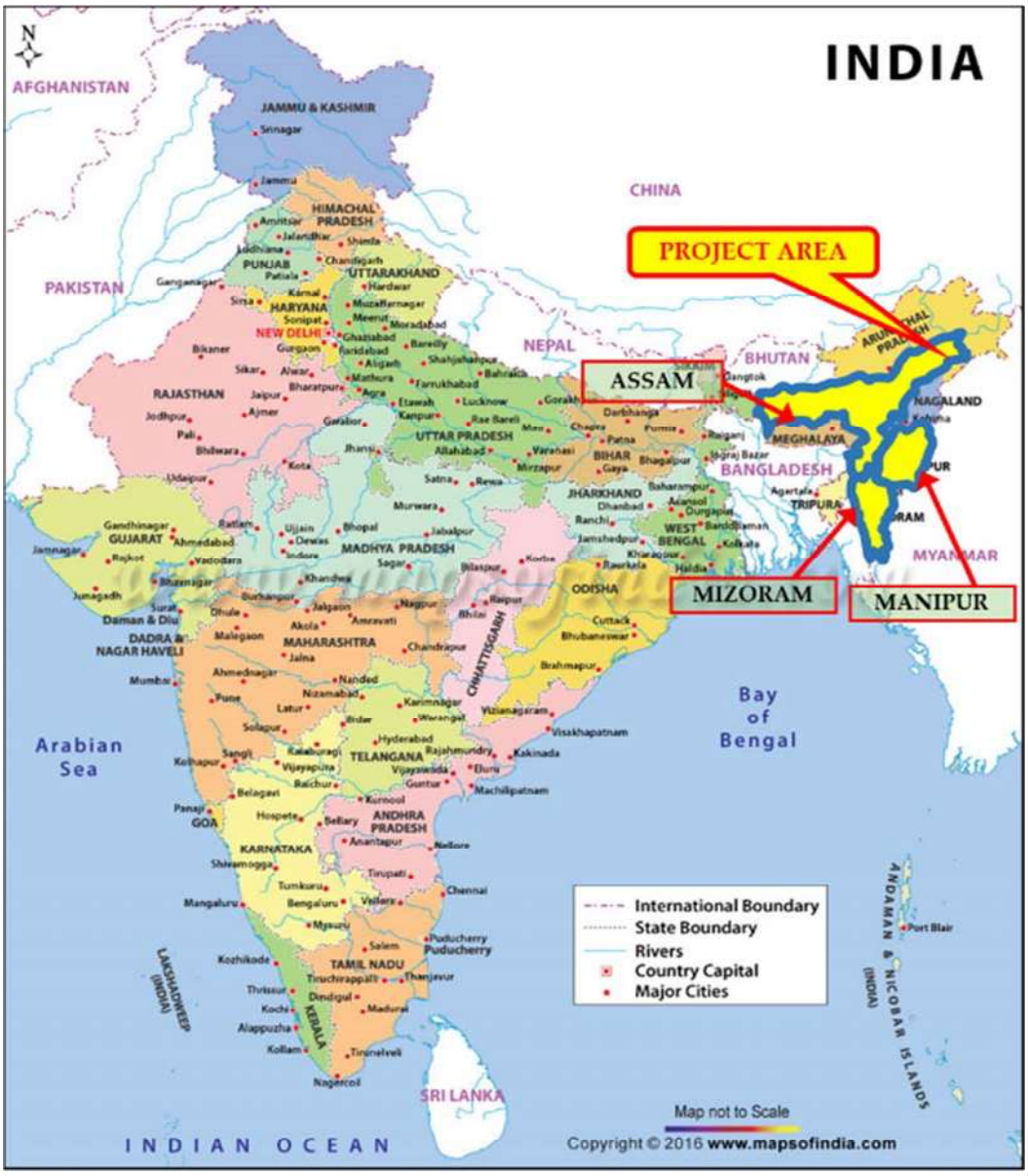
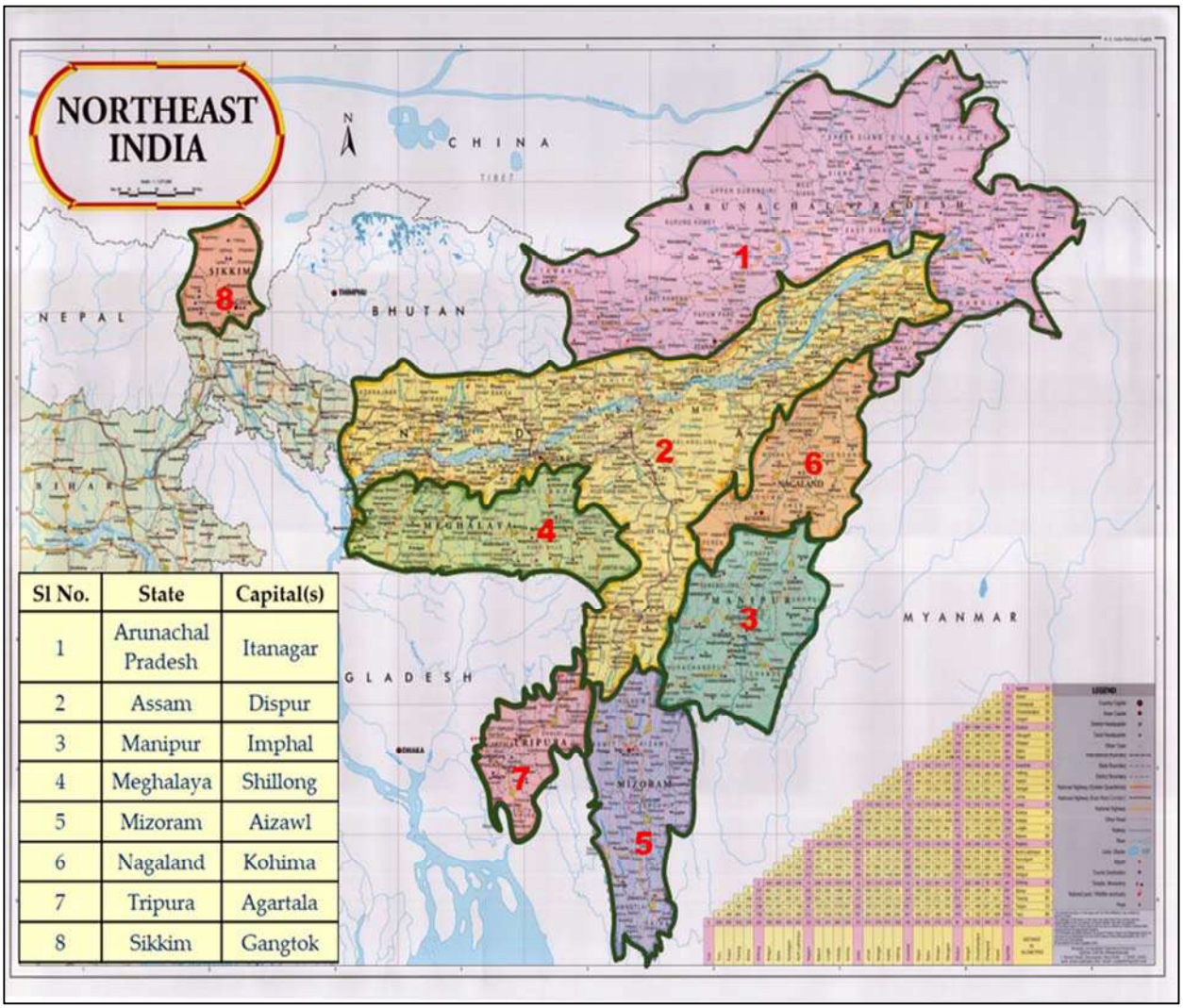


Fig 2.1 Index Map



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

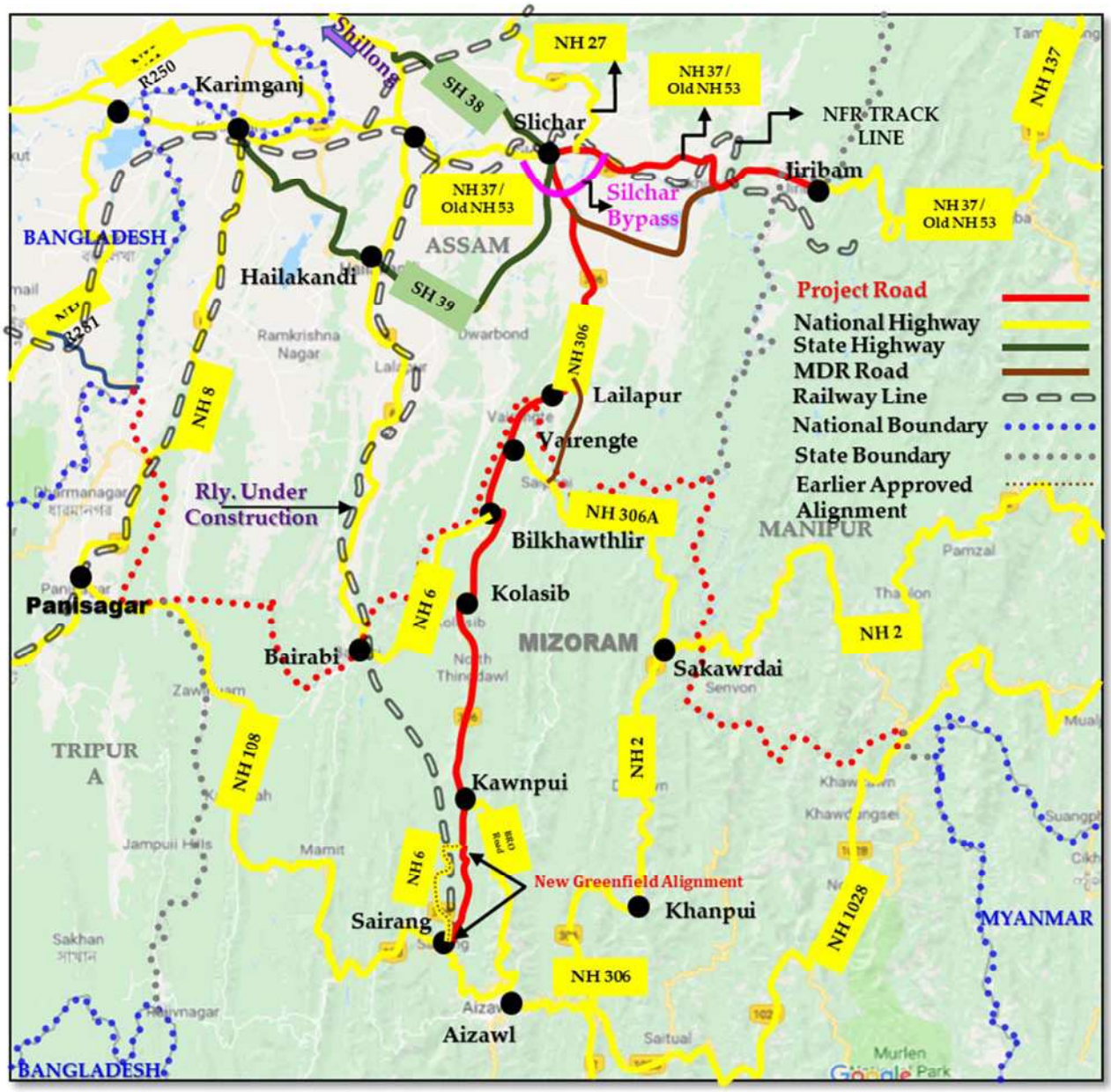


Fig 2.3 Key Map of Road Network in Assam, Mizoram and Manipur

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)

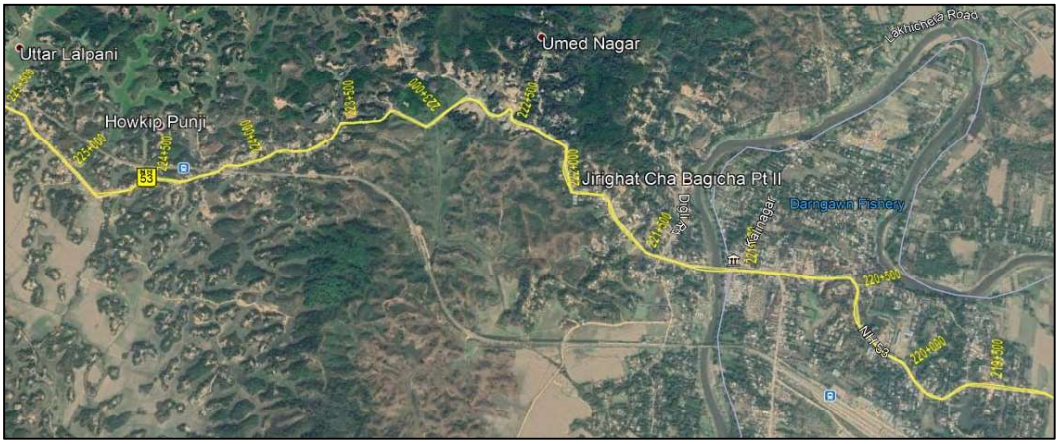
The project road from Km 254+135 to Km 249+500 passes through heavy built up of Banshkandi village (Km 251+500). The carriageway width along built up section is 10 m with side drains on both sides. The condition of road is fair with some severe edge drop at selected sections. There are many religious 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	
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	Package-2 (233+000 to 212+060)
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

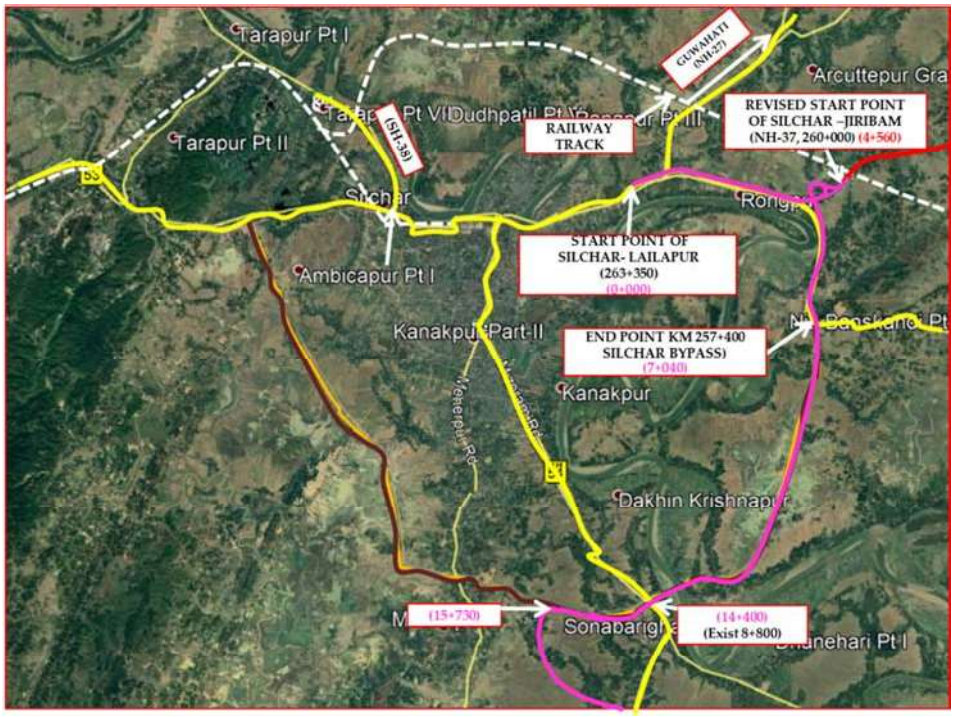
There are number of constraints for widening the existing project road. Some of them are:

- 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) 2) Ujan Tarapur near Shibpur-2 , 245+500	1) Badribasti Turning-1 (256+000) 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 2) Rongpur M.V School, km263+500 3) Ramnagar (Khelma flower Mill 4) Srikuna Daily Bazar 5) Krishnapaur, Rana MLA house, km 6+500 6) Saidpur near bridge, km 12+000	1) Kashipur T.E Road-1/2 , 258+500 2) Madhurapul Tri Junction-1/2, 262+200 3) Srikuna Army Gate- 2 4) Surtara Bridge-2 5) Sonabarighat P/Pump, 8+500 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

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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

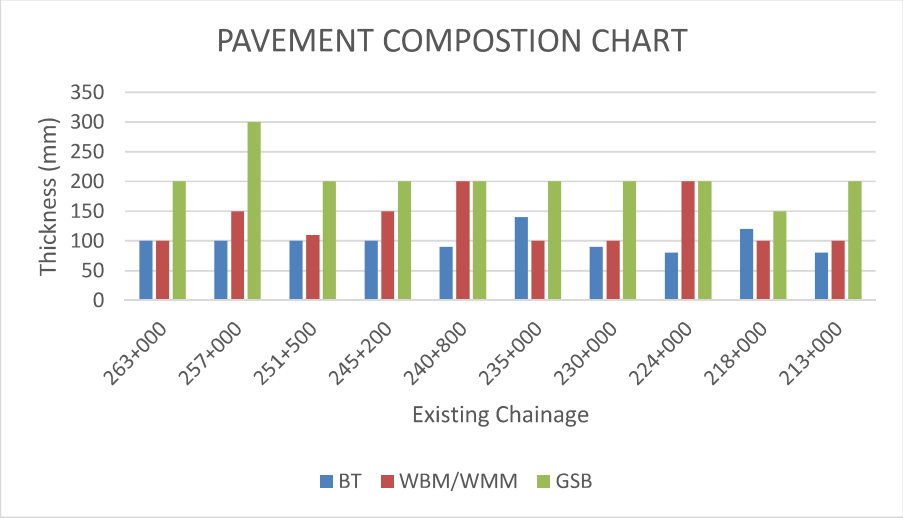
Pavement investigation of the project road as per TOR comprises of

- 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

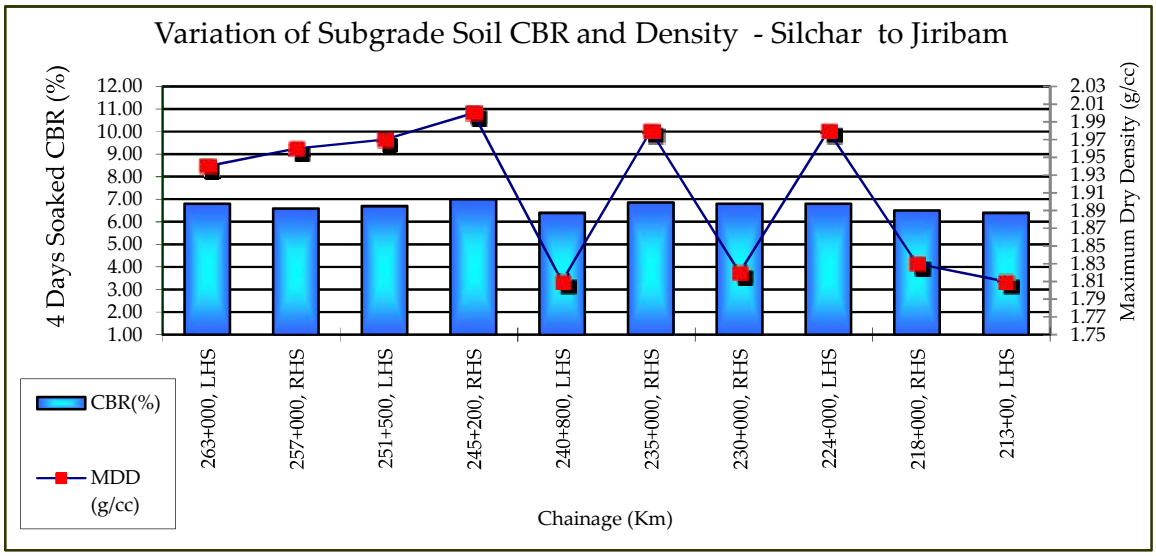


Fig 3.1 Soaked (4 Days) CBR vs MDD Graph of Subgrade Soi

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
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

3.7.8.1 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

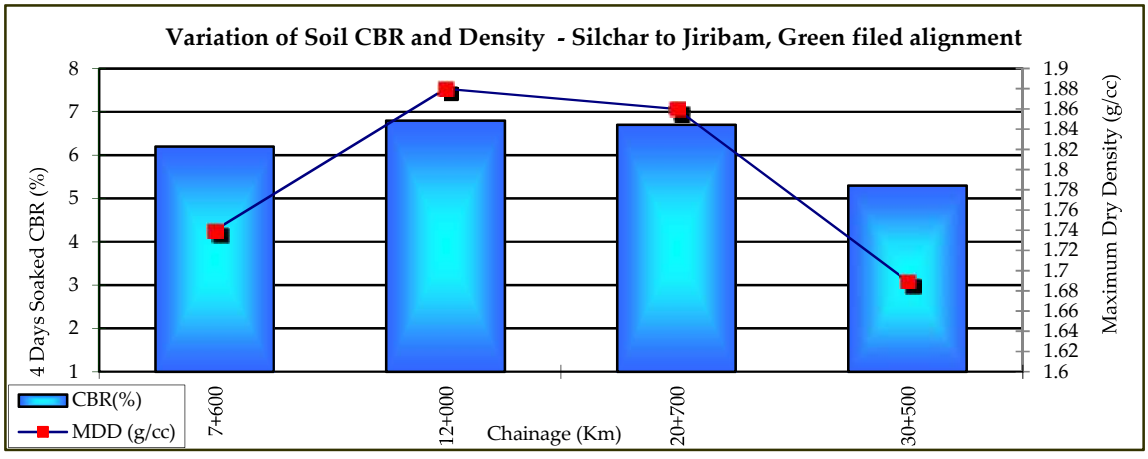


Fig 3.2 oaked (4 Days) CBR vs MDD Graph of Green filed alignment Soil

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

BA-01 at Km 214+000 (NH-37)

BA-02 at Km 225+000 (NH-37)

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

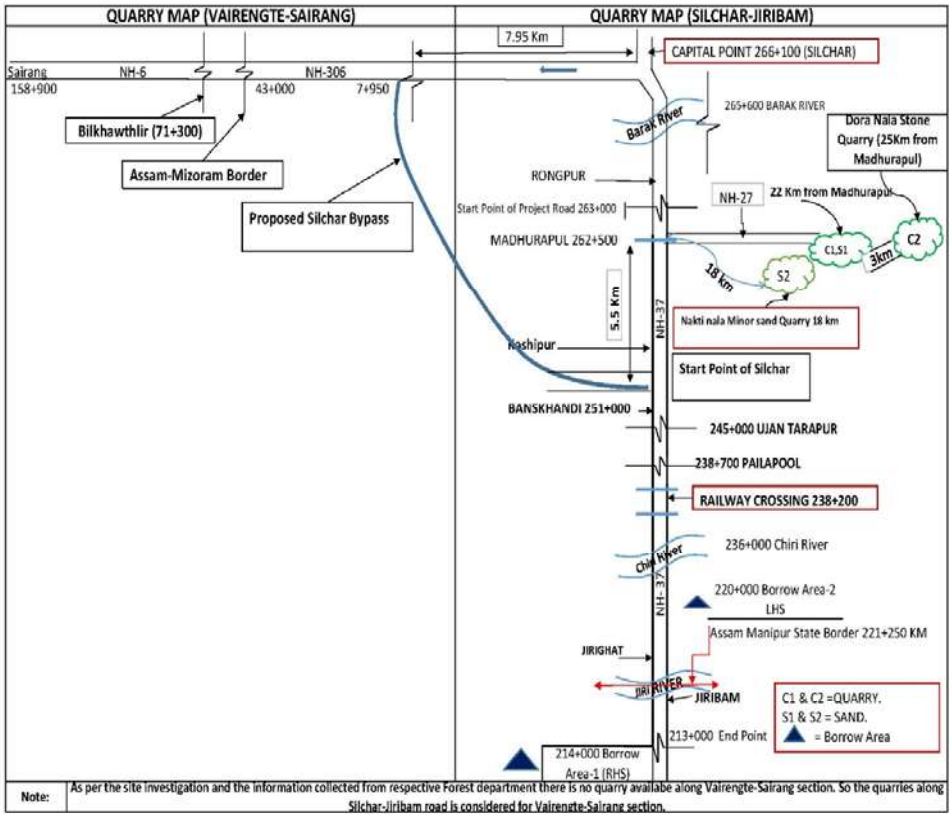
Sl. No	Chainge	Left/ Right	Name of Village/River	Lead (Km)
P 1	262+500 (NH-37)	Left	Madhura River at Udharbond Range	22.00
P 2	262+500 (NH-37)	Left	Nakti nala at Udharbond Range	18.00

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

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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;

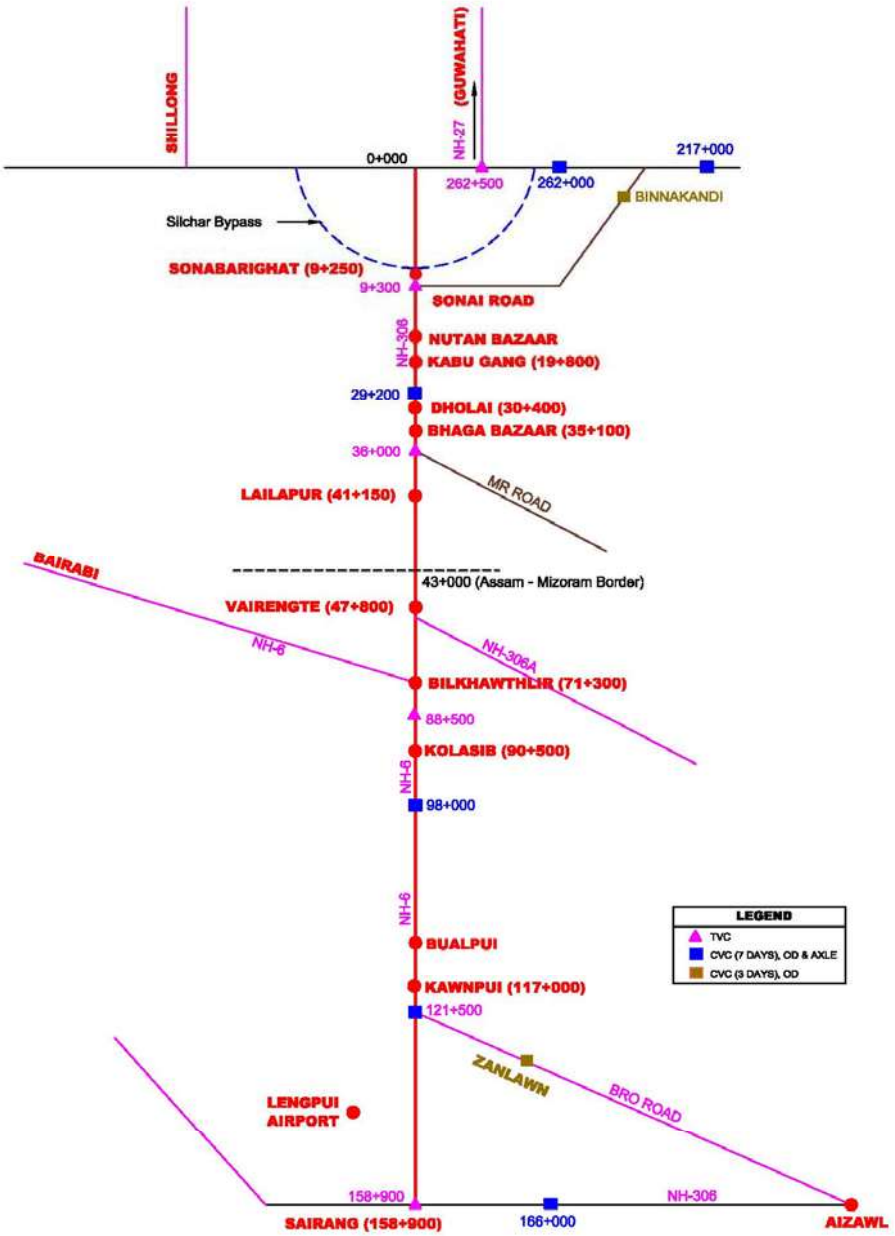

Figure 4.1 Traffic survey Linear Plan

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.

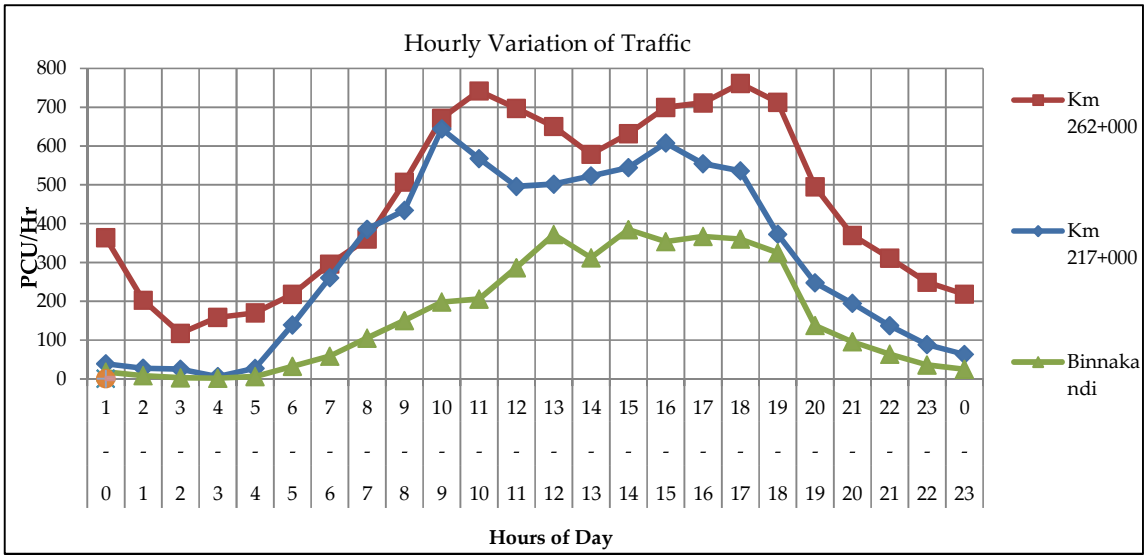

Figure 4.2 Hourly Variation of Traffic (Average of 7/3 days)

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;

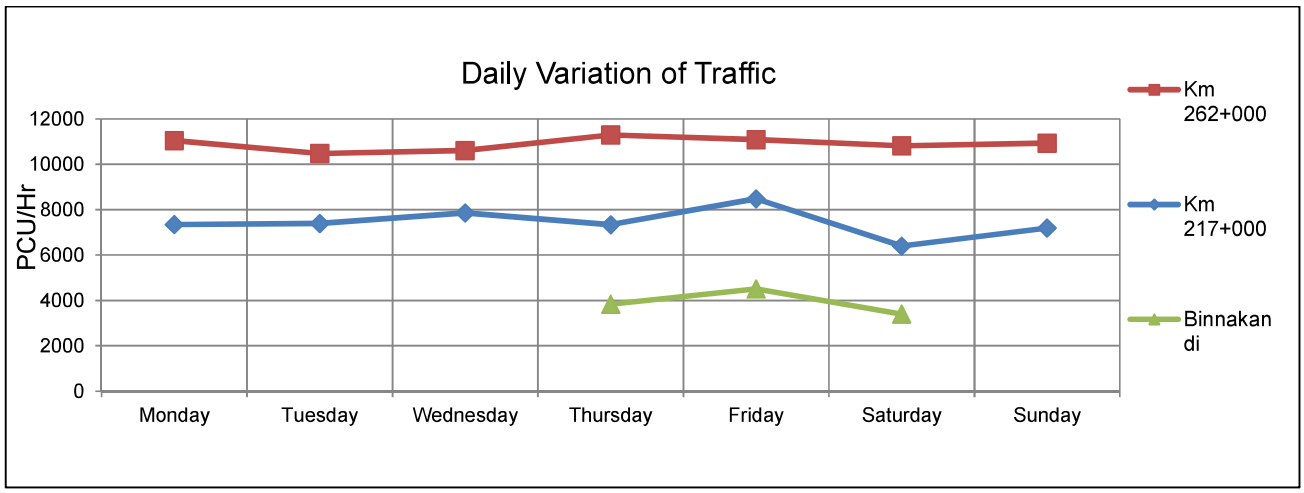

Figure 4.3 Daily Variations of traffic volume at 3 locations

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

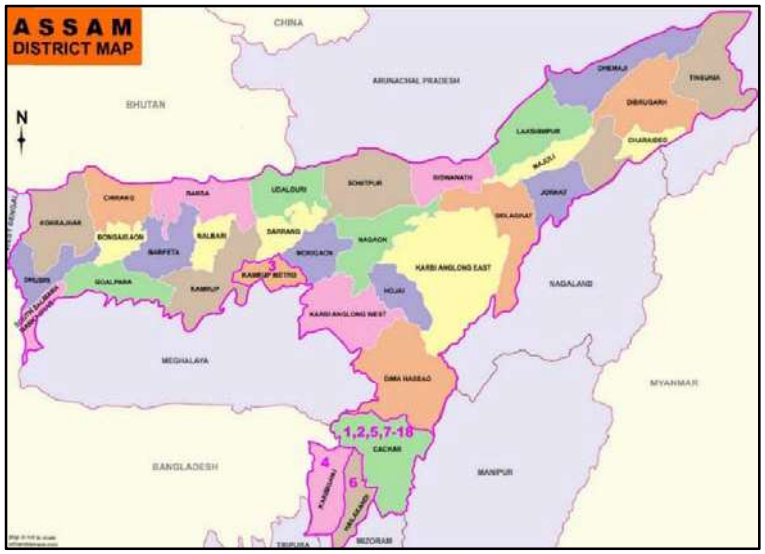

Figure 4.4 Traffic Zones for Assam (Section : Silchar to Jiribam)

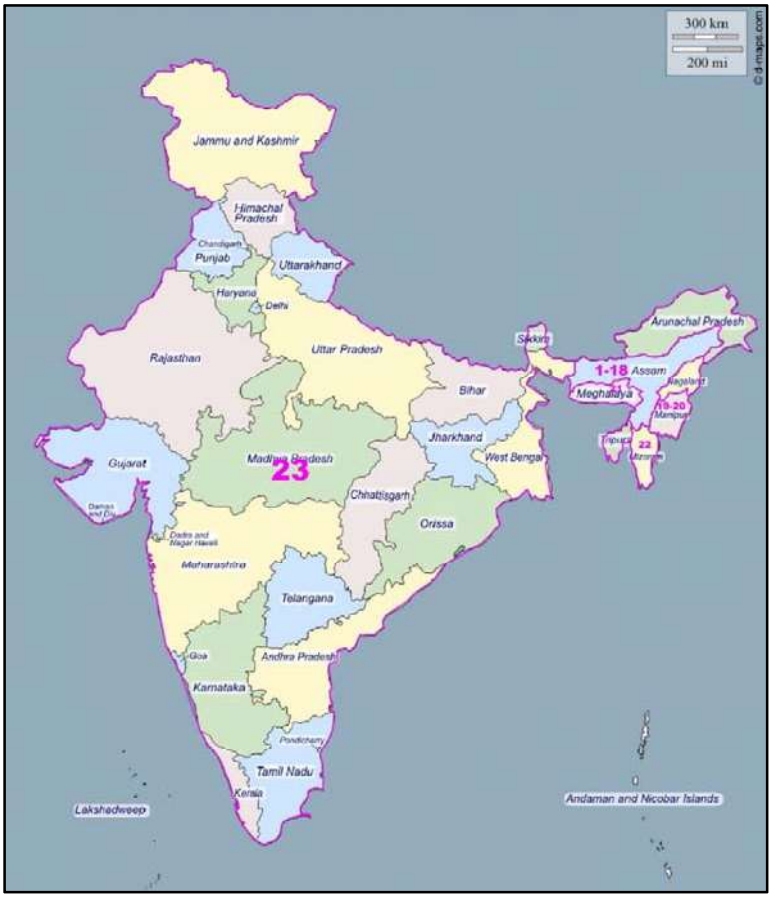

Figure 4.5 Zoning Scheme (Rest of India) for Silchar to Jiribam

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. • 90% of the traffic has origin/destination with in the Cachar district (Assam State). • 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. • 72% of the traffic has origin/destination with in the Assam State • 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). • 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). • 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

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

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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 Design capacity standards
Geometric Design	Cross-sectional elements Sight distance Horizontal curves Vertical curves
Pavement Design	CBR, Traffic, Structural Strength (Deflection value)
Cross Drainage Structures	Bridges Culverts
Intersections	At grade intersections Acceleration and deceleration lanes
Drainage system	Longitudinal, Cross drainage
Safety Measures	Guard rails & safety barriers Traffic signals Road signage & pavement markings Footpaths and sidewalks
Protection Works	Breast Walls Retaining Walls 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 1/3rd 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°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.

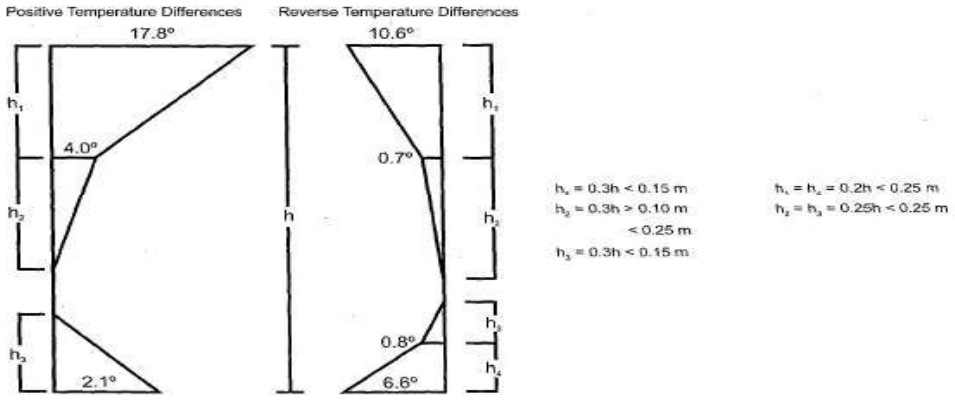

Fig. 10 (a) Design Temperature Differences for Concrete Bridge Decks

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) 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.

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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.

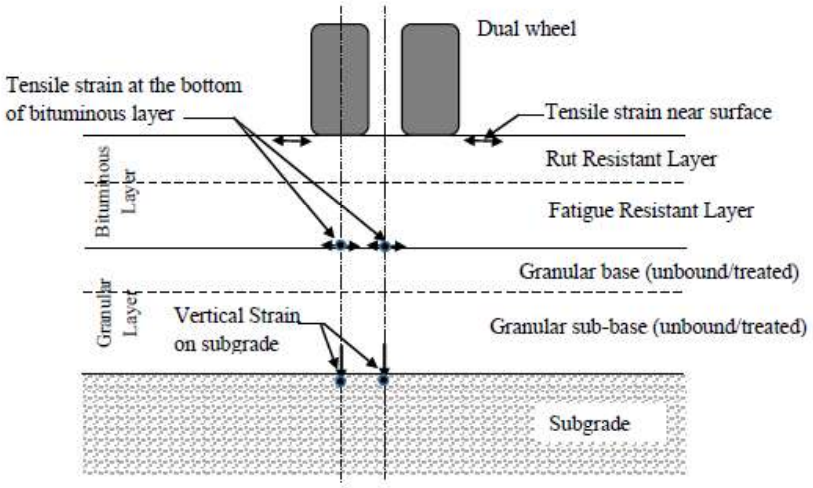


Figure 6-1: Critical locations of Stress and Strain in Flexible Pavement

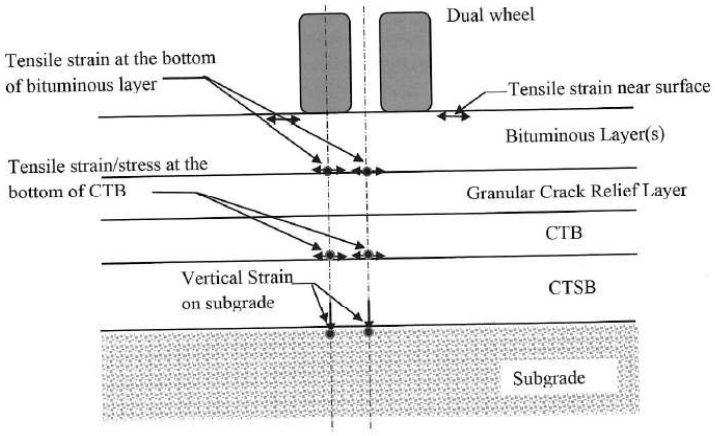


Figure 6-2: Critical locations of Stress and Strain in CTB and CTSB

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

ε_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

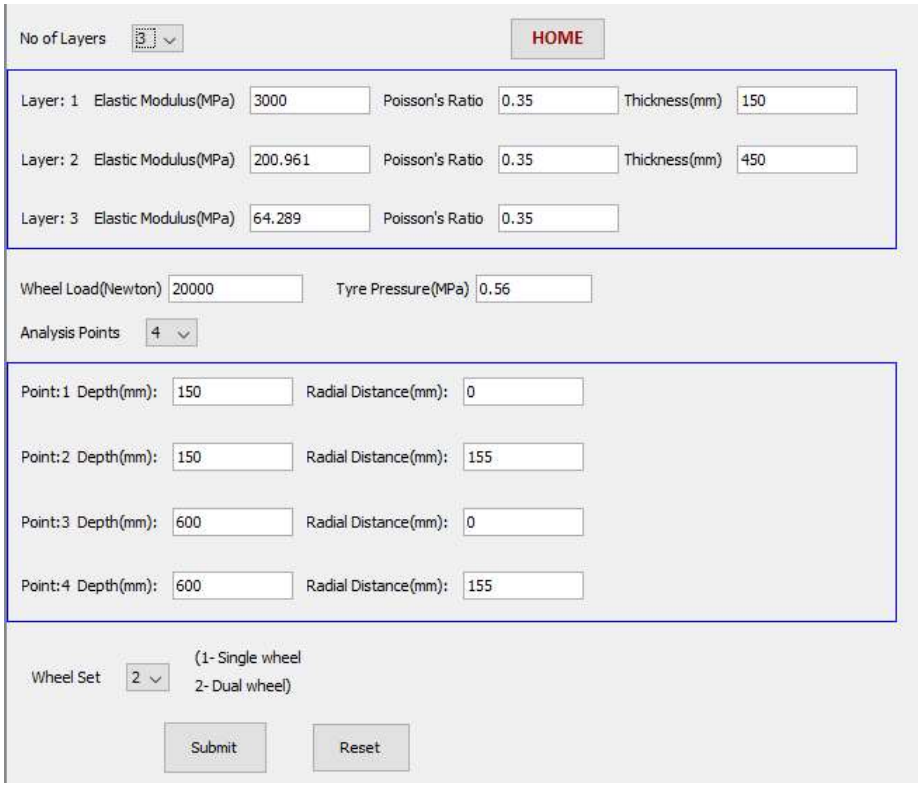
Resilient Modulus in Mpa of	
Subgrade	64.29
Granular layer (GSB+WMM)	200.96
Bituminous Layers (DBM & BC)	3000.00

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

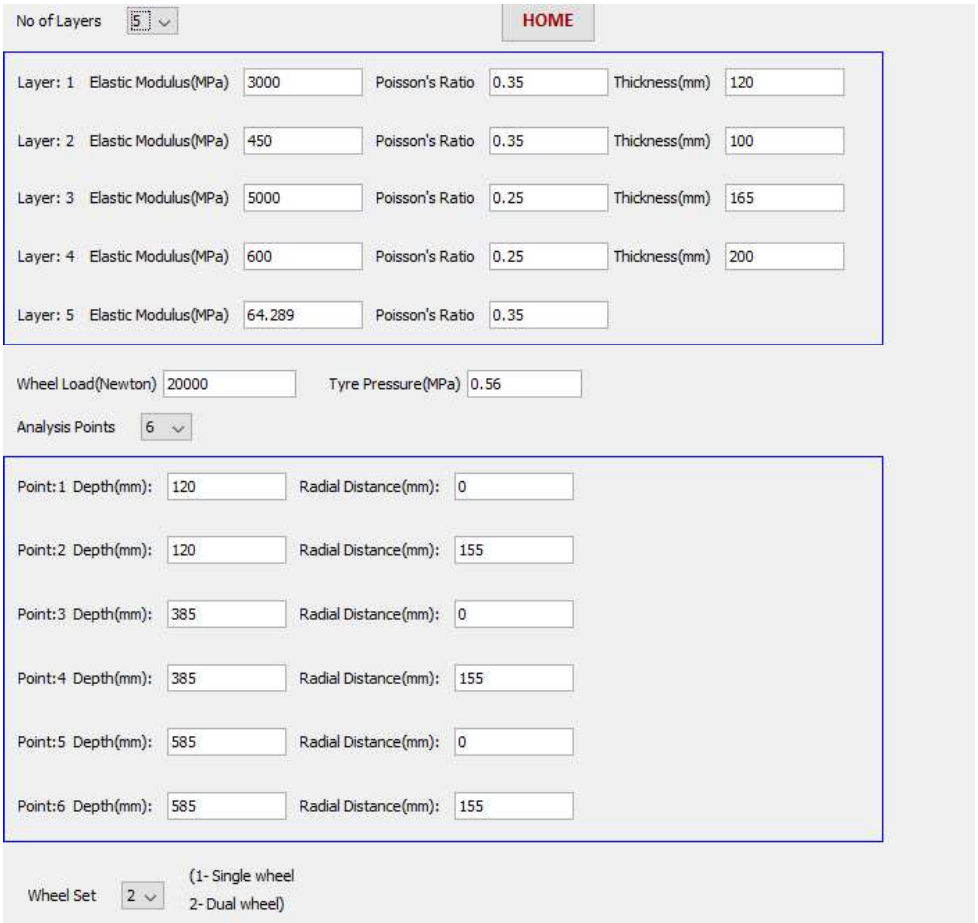
Resilient Modulus in Mpa of	
Subgrade	64.27
Cement Treated Sub-base (CTGSB)	600.00
Cement Treated Base (CTWMM)	5000.00
Crack Relief Layer (WMM)	450.00
Bituminous Layers (DBM & BC)	3000.00

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 (εt)	188.65E-06
Compressive strain at top of subgrade (ε_v)	390.45E-06
Tensile strain at the bottom of CTB layer (εt)	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

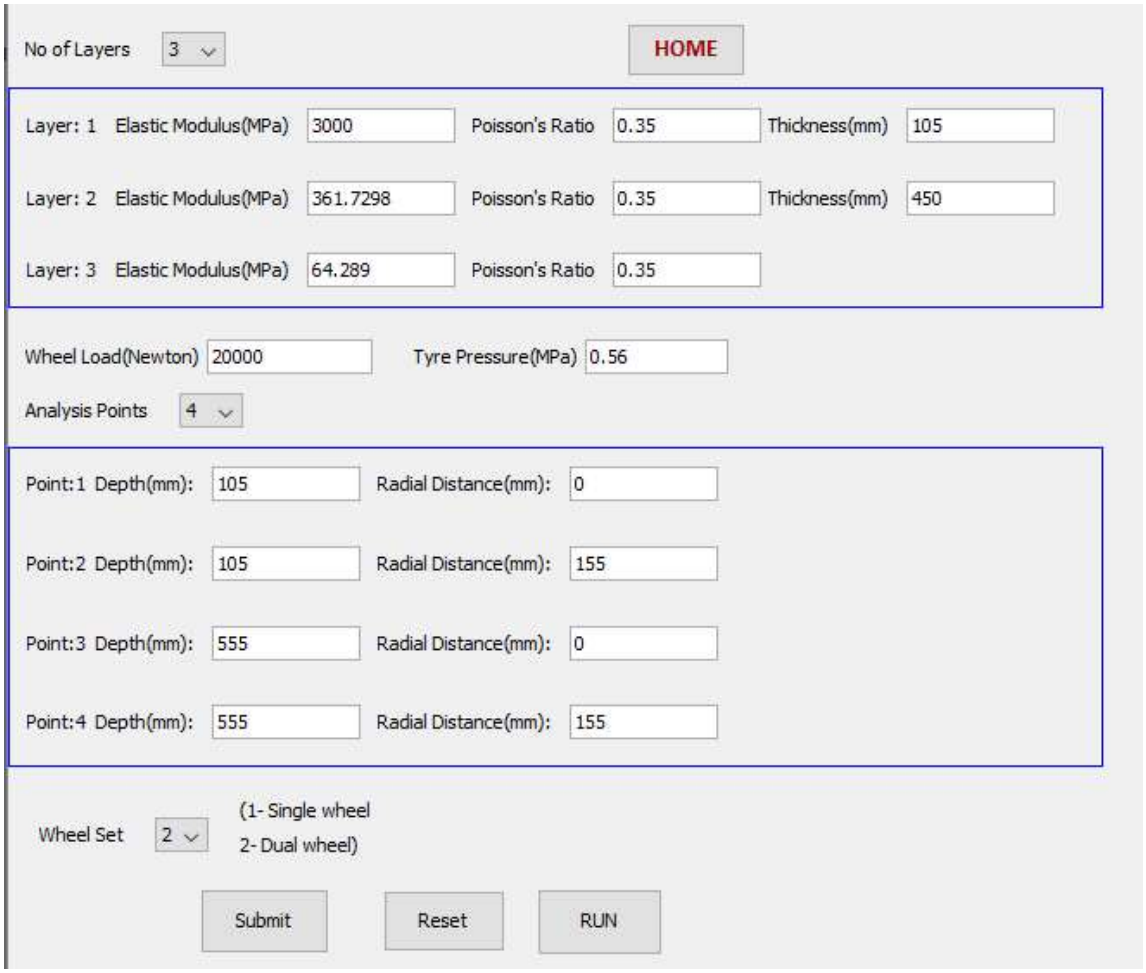
Resilient Modulus in Mpa of	
Subgrade	64.29
Granular layer (GSB+WMM)	361.73
Bituminous Layers (DBM & BC)	3000.00

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 (ε_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 (εv)	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.

$$C = \frac{365\ A\ [(1+r)n-1]}{r}\ X\ A$$

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

$$\log_{10} N = \frac{0.9718 - SR}{0.0828} \quad For\ SR > 0.55$$

$$N = \left[\frac{4.2577}{SR - 0.4325}\right]^{3.268} \quad \text{When } 0.45 <= SR <= 0.55$$

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, μ	=	0.15	
Radius of relative stiffness, l	=	0.648	
Coefficient of thermal expansion of concrete, ∝	=	10×10^{-6}	per ^{0}C
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	

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		
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
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

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		
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	-

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
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	-
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	-

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
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

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
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

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
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**

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
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**

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
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

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
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

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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 DBM = 65 mm WMM = 250 mm Geogrid (Biaxial) GSB = 200 mm Subgrade = 500 mm

*Note: * Rigid pavement is proposed at toll plaza and tunnel portion.*

However, during PATSC (25.09.2023), it has been recommended to modify pavement design of the main carriageway and service road, the CBR value as obtained at site shall be taken for design if less than 6%. The maximum value of CBR to be taken for design shall not exceed 6%.

Therefore, pavement design thickness has been modified considering 6% CBR value for design traffic of 40 MSA with a minimum design period of 20 years for flexible.

Sl. No	Sections (design Chainage)	Length (Km)	*Type of Pavement	Modified Thickness
1	From Km 4+560 to Km 37+650	33.09	Flexible with Geogrid	BC = 40 mm DBM = 75 mm WMM = 250 mm Geogrid (Biaxial) GSB = 200 mm Subgrade = 500 mm

PMB / CRMB shall be used for BC.

Based on above recommendation the BOQ and cost estimate has been estimated.

Further, as 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.

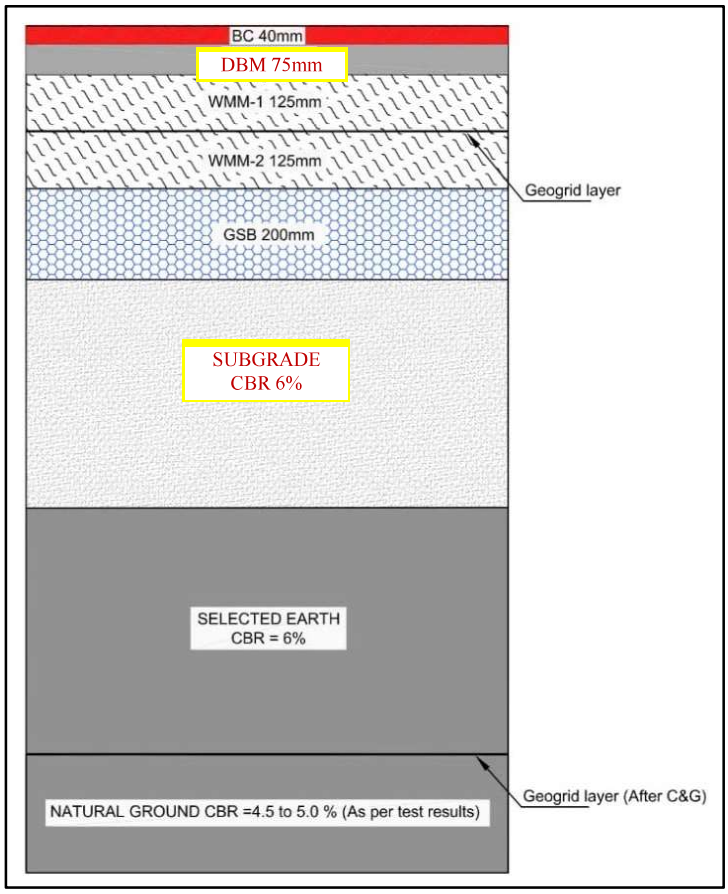


Figure 6-3: Flexible Pavement cross section with Geo grid provision

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 DLC = 150 mm GSB = 150 mm 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 6% 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 = 40 mm DBM = 70 mm WMM = 250 mm GSB = 200 mm 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**	

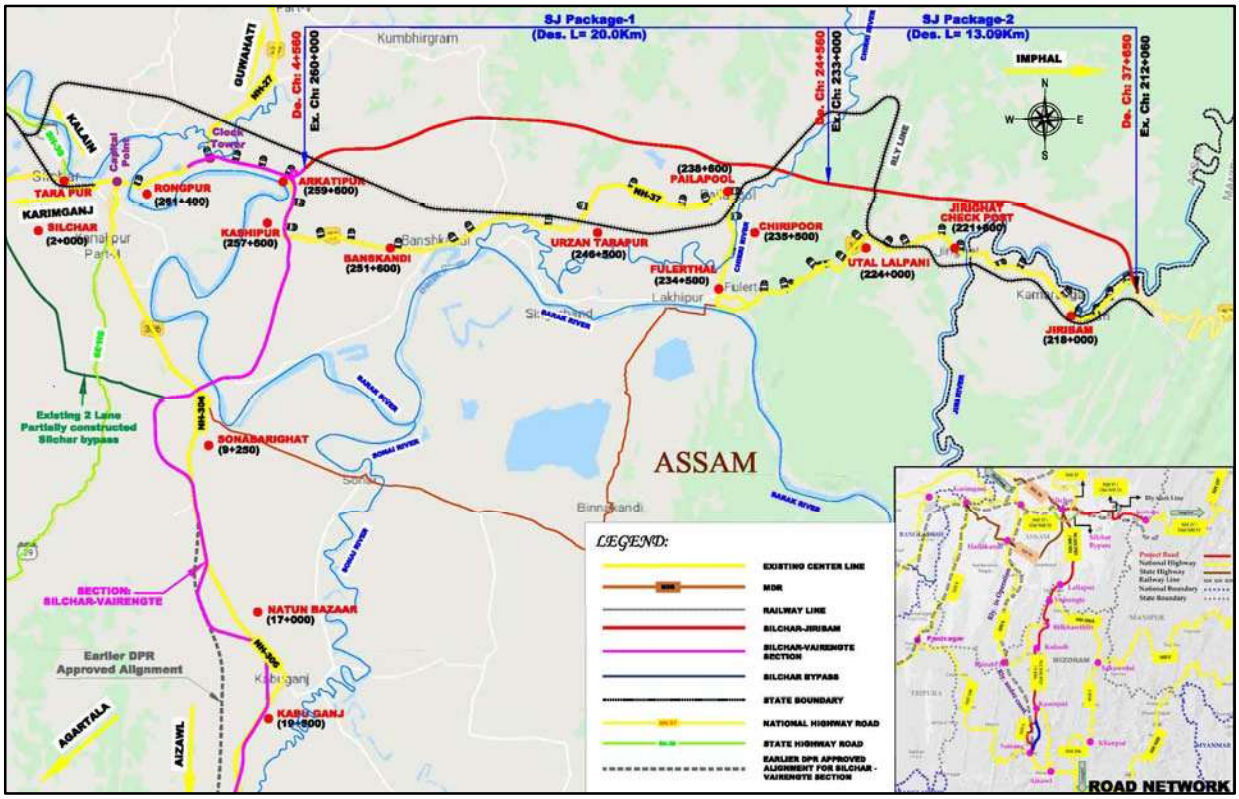


Fig 7.1 Key Plan for Proposed Construction Packages

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.

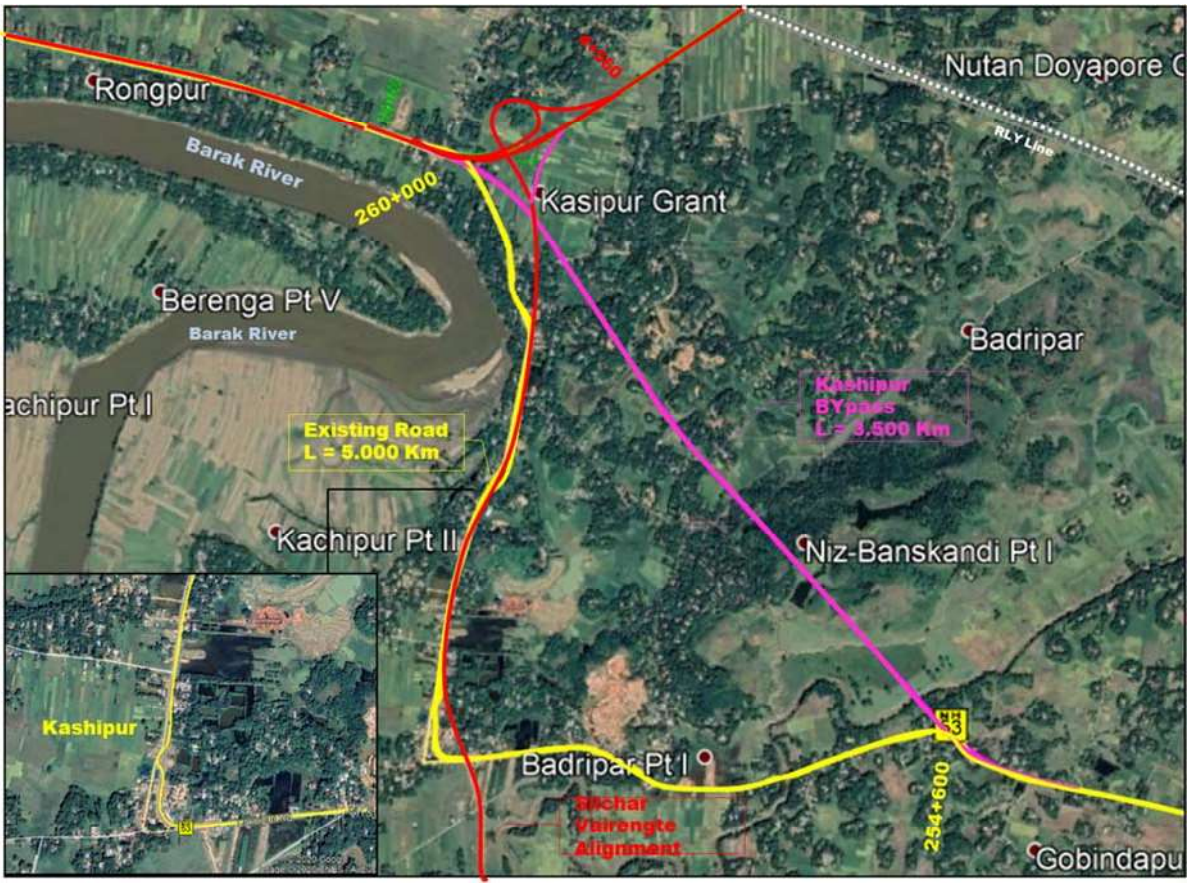


Fig 7.2 Bypass for Kashipur

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.

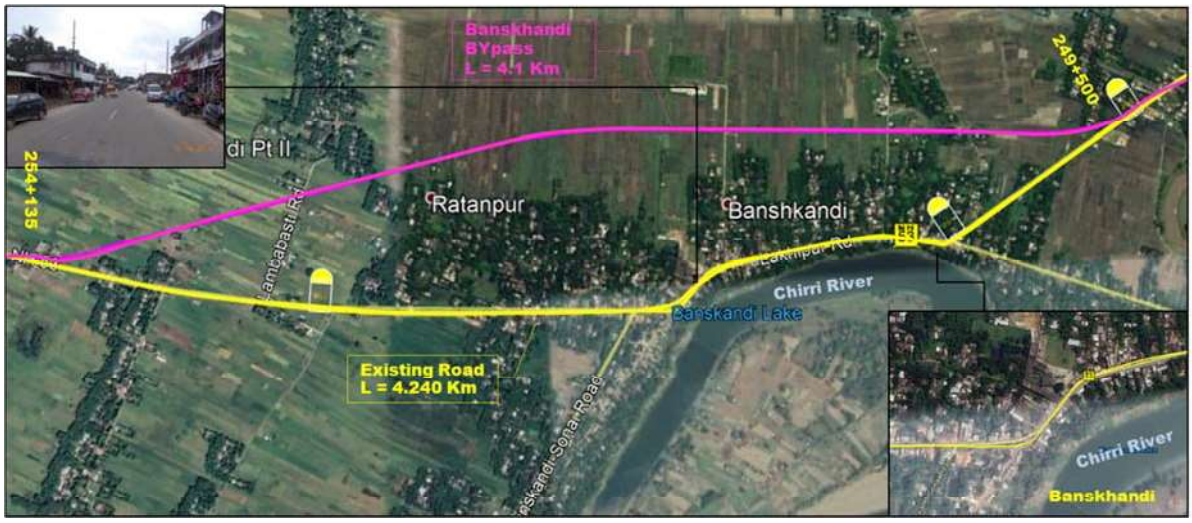


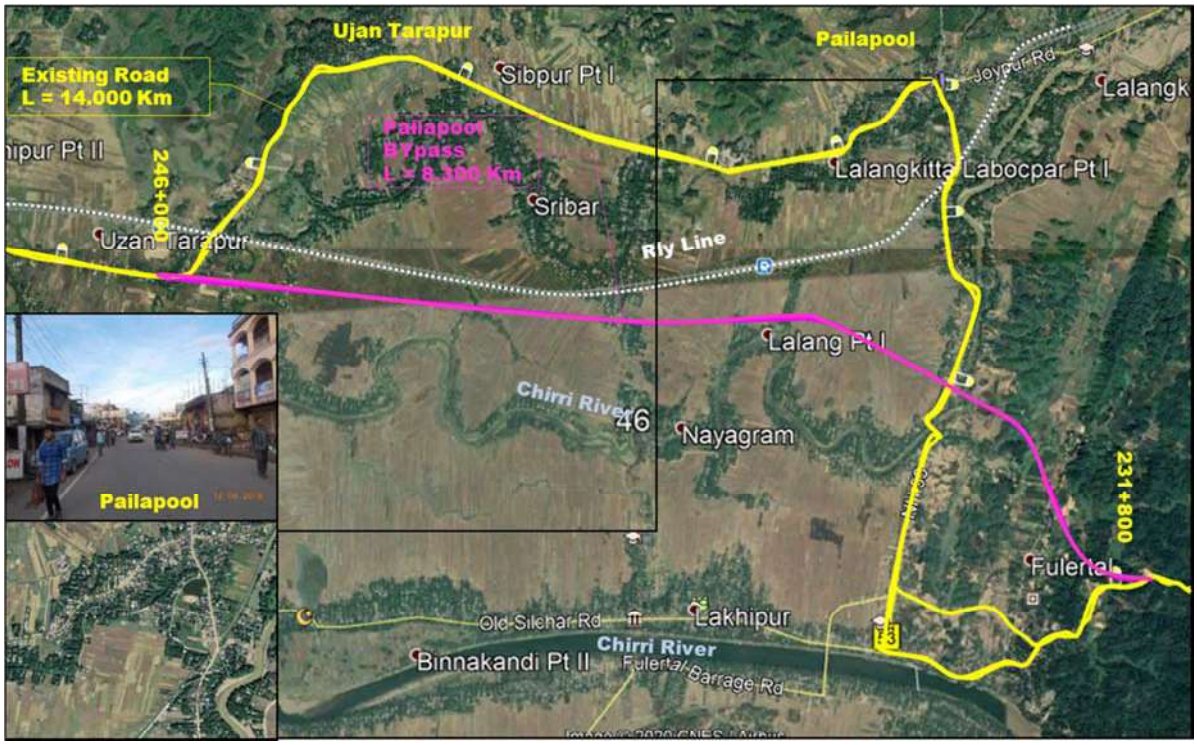
Fig 7.3 Bypass for Banskhandi

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.

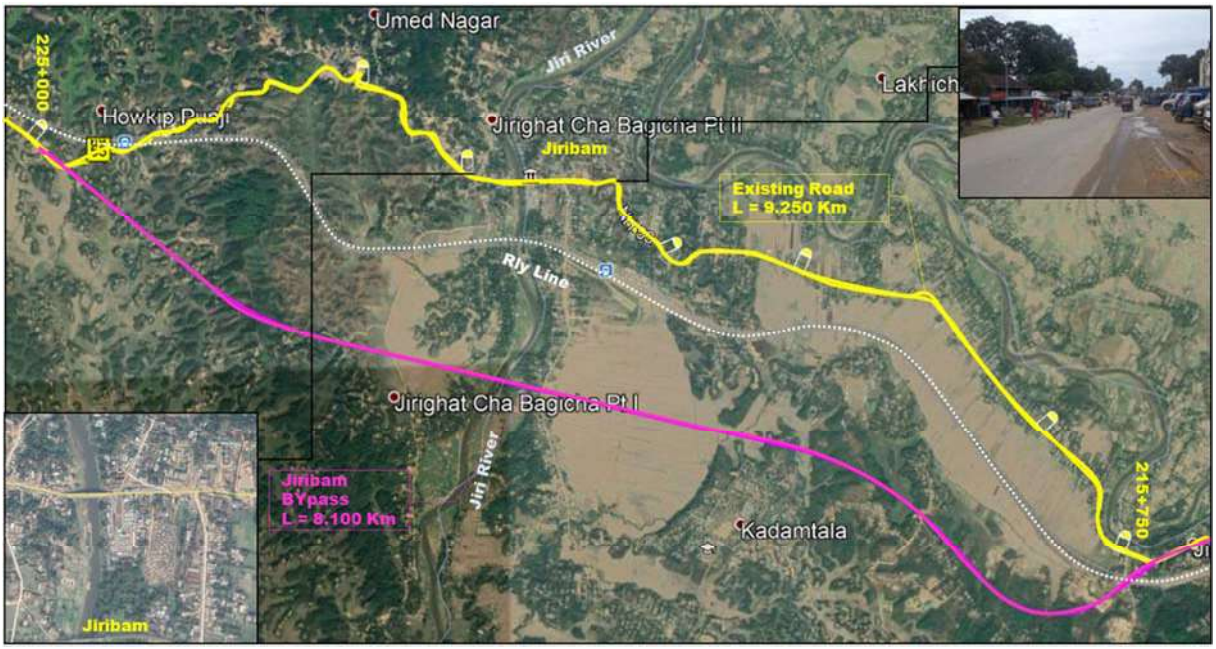


Fig 7.5 Bypass for Jiribam

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.

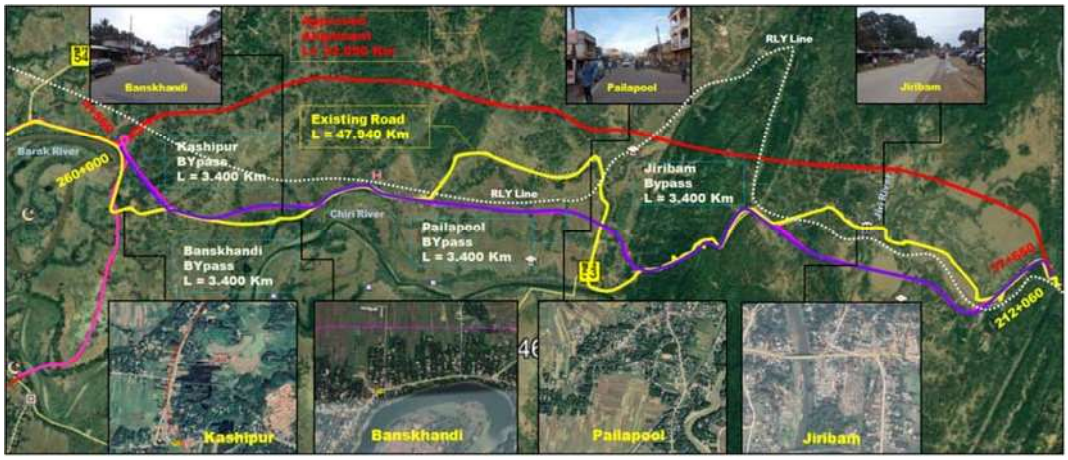


Fig 7.6 Approved Green Field Alignment

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

However, collective decision was made during PATSC (25.09.2023) to modify TCS mainly modification of paved shoulder from 2.5 m to 1.5 m and earthen shoulder from 1.5 m to 2.0 m. The revised cross-sectional element is as below,

Four-lane road (Rural area)		
Paved Carriageway		2 x 7.0 m = 14.0m
Shoulders	Paved	2 x 1.5m = 3.0m
	Unpaved	2 x 2.0m = 4.0m
Kerb shyness		2 x 0.50m = 1.00m
Median		4.00 m
Total Roadway Width		26.00 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) ES	1260	Open area (Fiil Section)

Sl. No.	Type of Cross Section		Description	Length (m)	Location/ Remarks
5	TCS 5	4 Lane Divided Highway without Service Road in Cutting on both sides	(2 x 7.00m) CW + (2 x 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) ES + (1 x 2.5m) Drain & Utility on Cut side	50	Open area (Cut & Fill Section)
10	TCS 10	4 Lane Divided Highway with Service Road on both sides	(2 x 7.00m) CW + (2 x 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) 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

Sl. No.	Type of Cross Section		Description	Length (m)	Location/ Remarks
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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) 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 1.5m) PS + 5m Median (Include 2x0.5m Kerb shyness) + (2 x 2.0m) ES including CB		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.

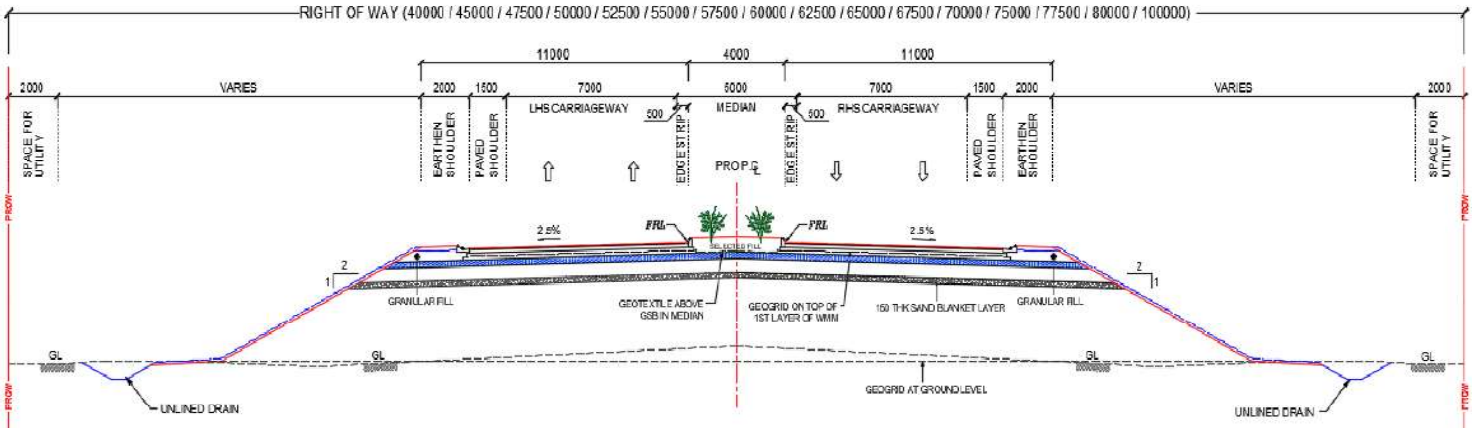


Fig 7.7 4 Lane Divided Highway without Service Road (Embankment Height ≤ 3m with Turfing treatment) (TCS-1)

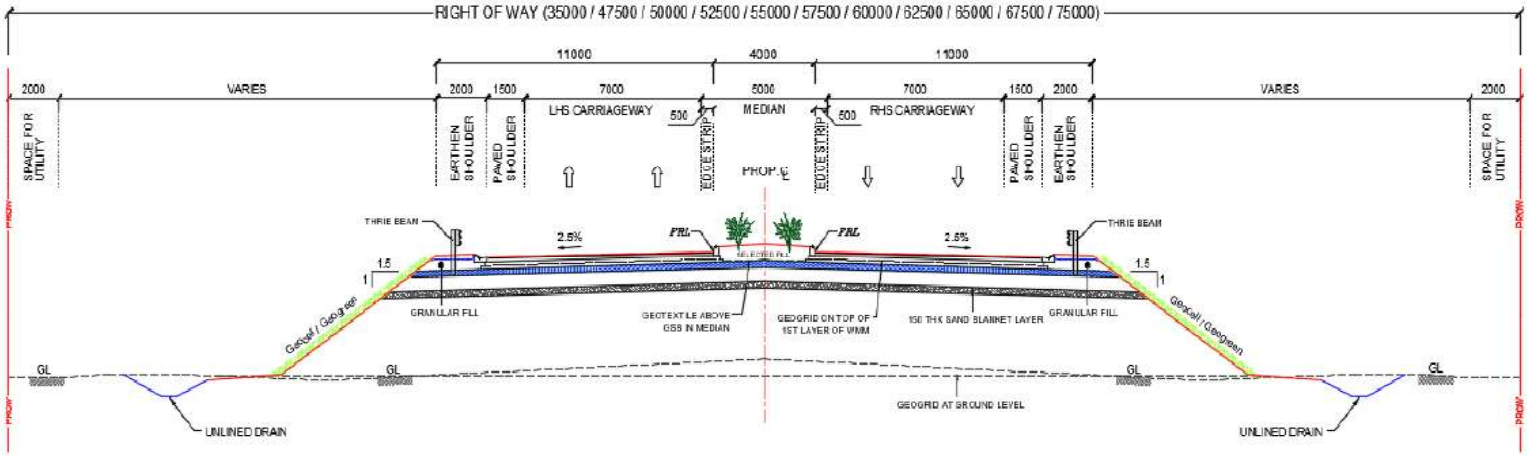


Fig 7.8 4 Lane Divided Highway without Service Road (Embankment Height > 3m and ≤ 6m with Geo-green on Embankment slope) (TCS-2)

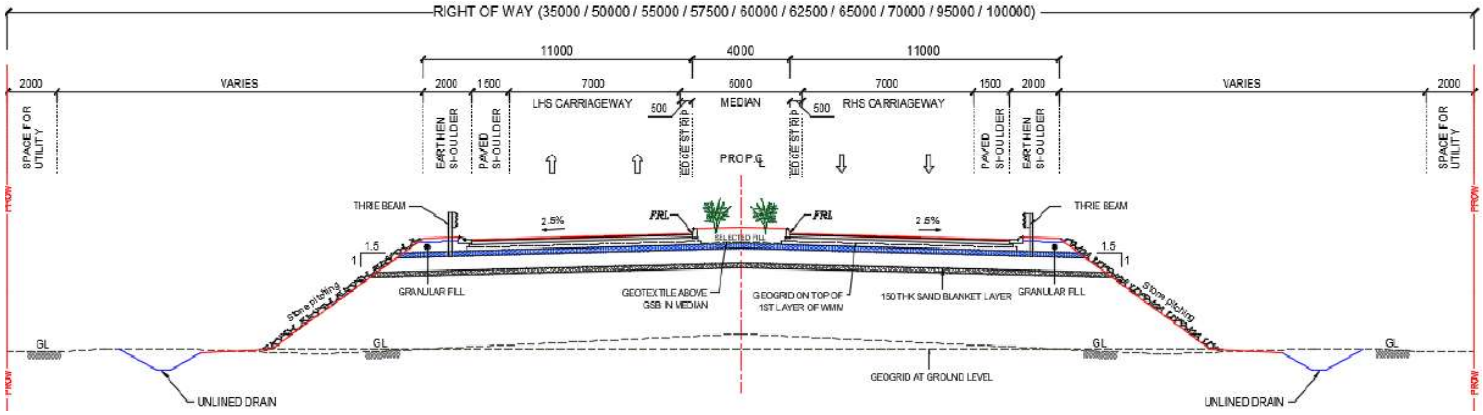


Fig 7.9 4 Lane Divided Highway without Service Road (Embankment Height > 6m with Stone pitching on Embankment slope) (TCS-3)

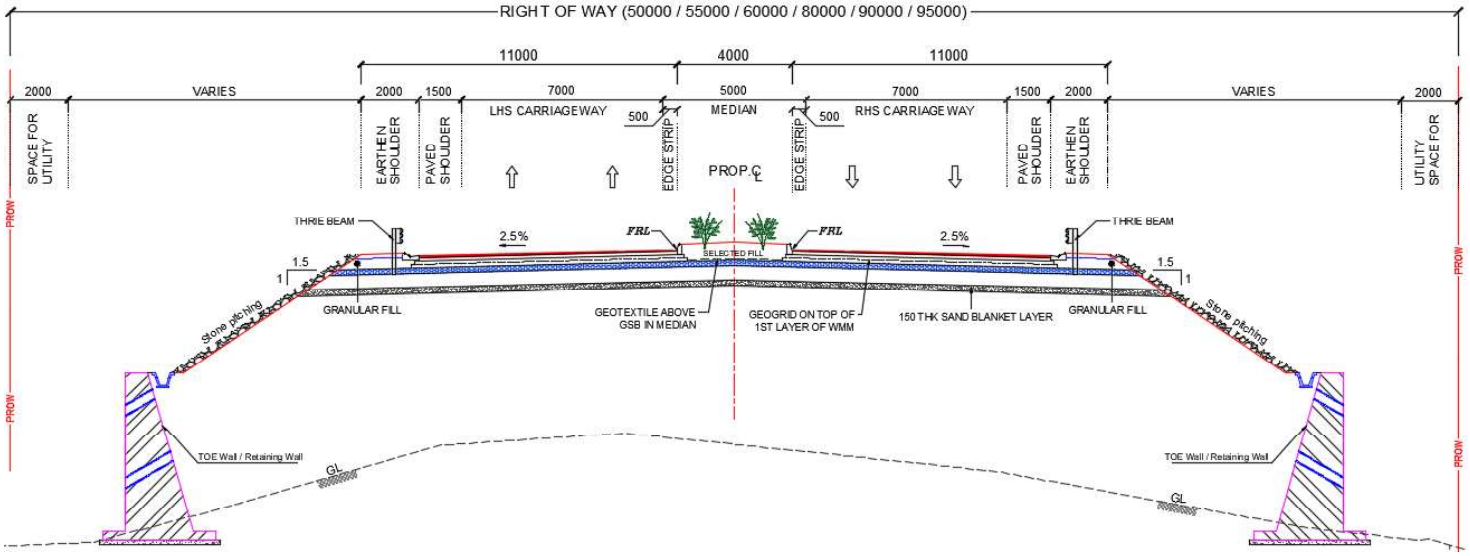


Fig 7.10 4 Lane Divided Highway without service road (Embankment Height > 6m height with Stone pitch and R/Wall or T/Wall) (TCS-4)

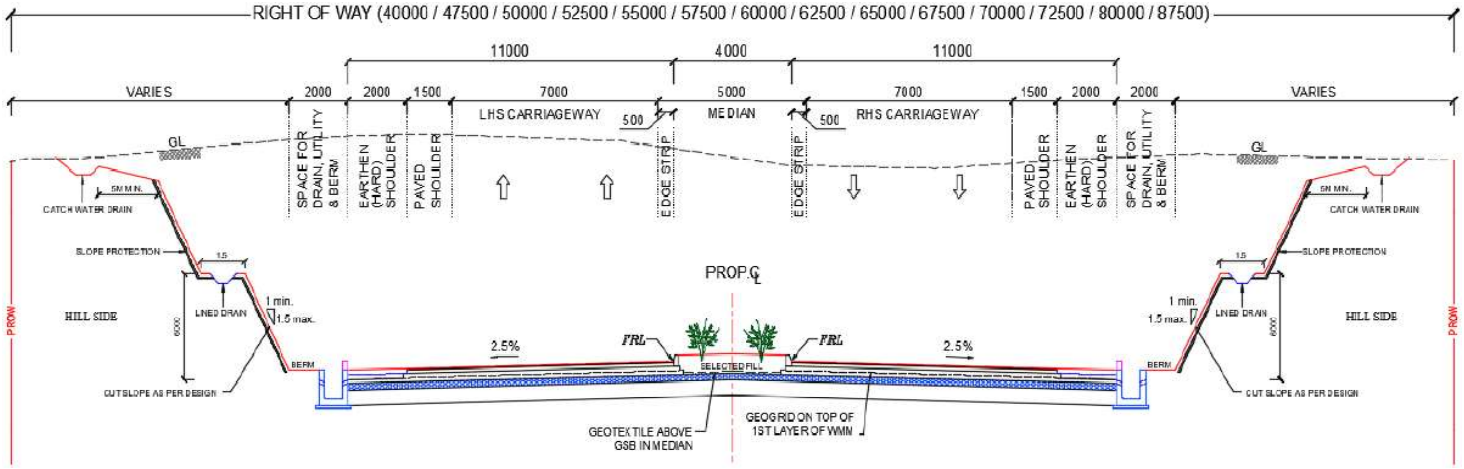


Fig 7.11 4 Lane Divided Highway without Service Road in Cutting on both sides (TCS-5)

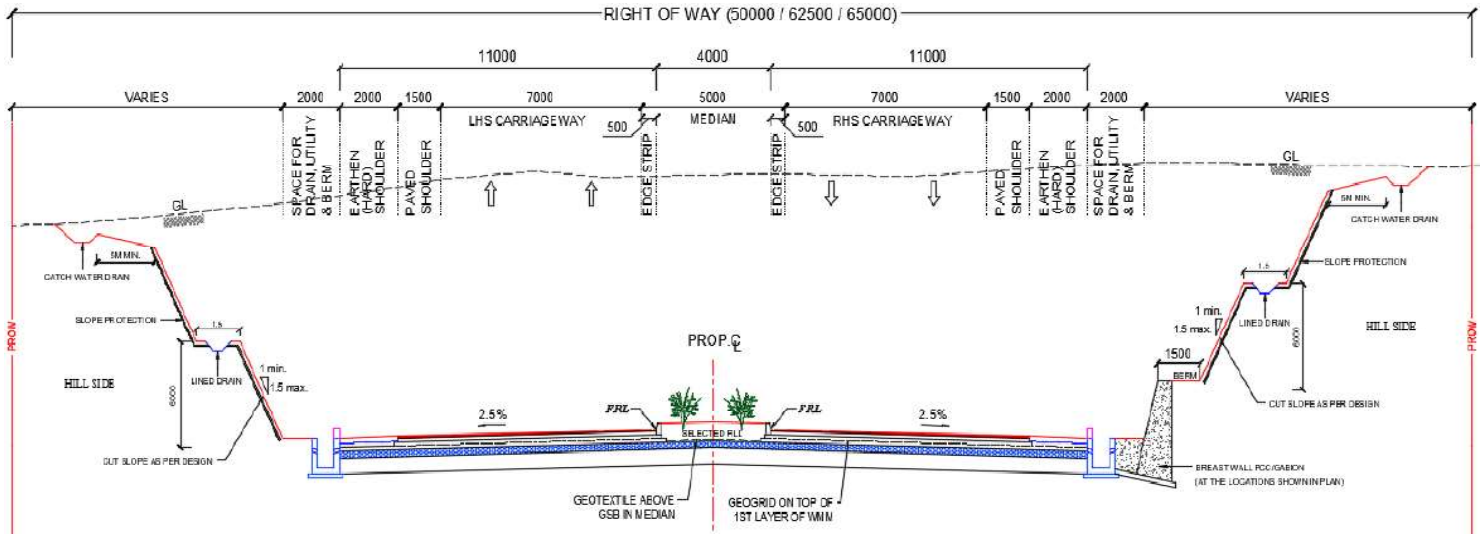


Fig 7.12 4 Lane Divided Highway without Service Road in Cutting with one side Breast Wall (TCS-6)

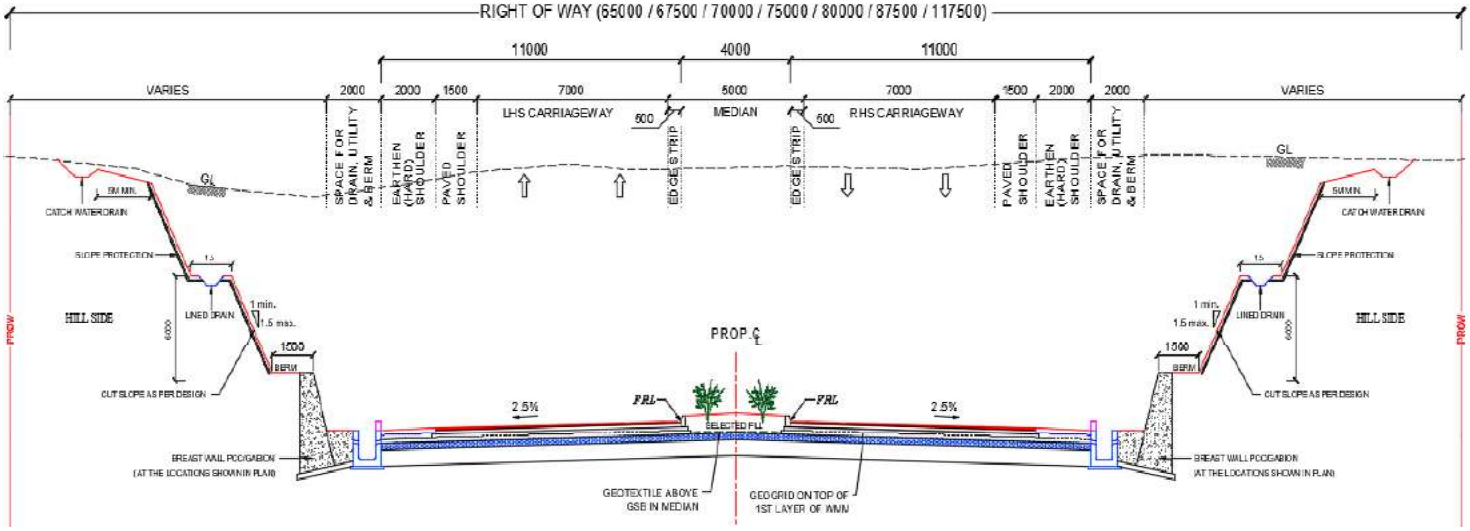


Fig 7.13 4 Lane Divided Highway without Service Road in Cutting with both side Breast Wall (TCS-7)

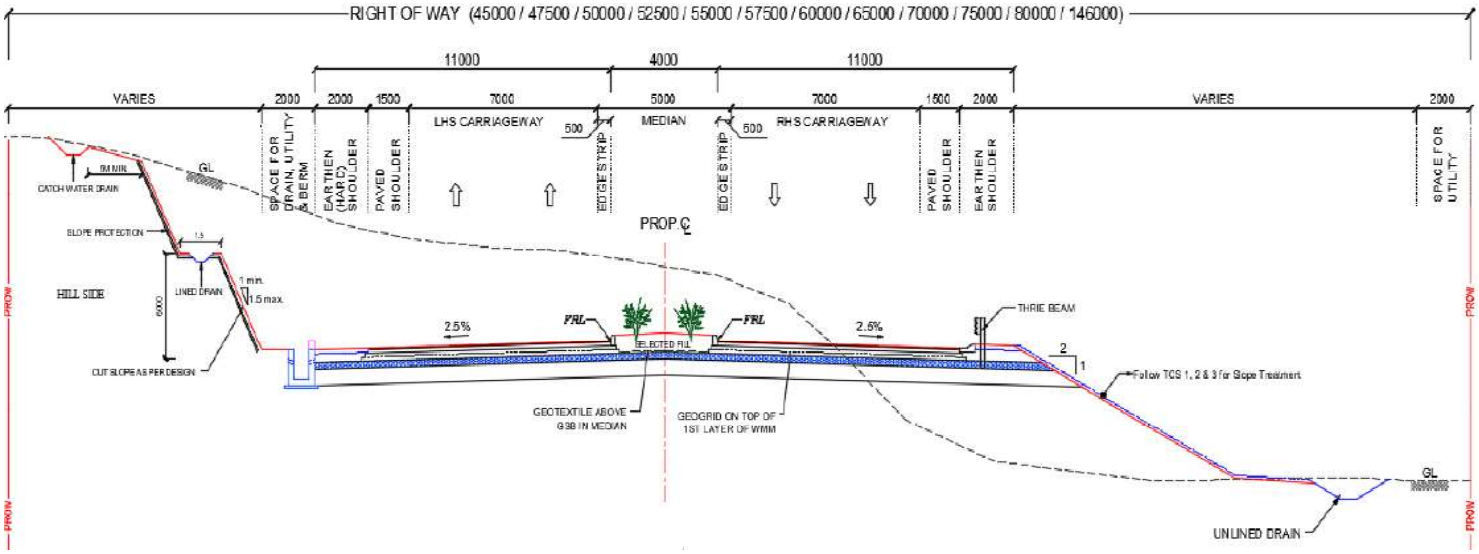


Fig 7.14 4 Lane Divided Highway without Service Road with normal Cut and Fill (TCS-8)

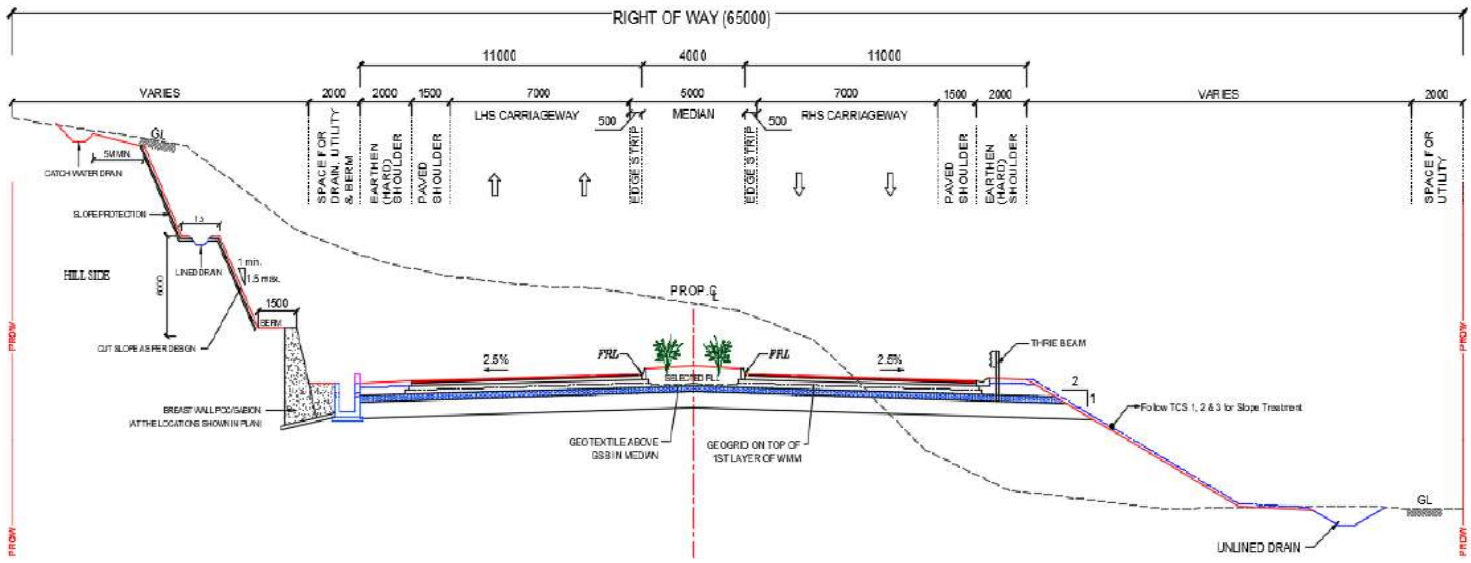


Fig 7.15 4 Lane Divided Highway without Service Road with Breast wall in High Cut and Normal Fill (TCS-9)

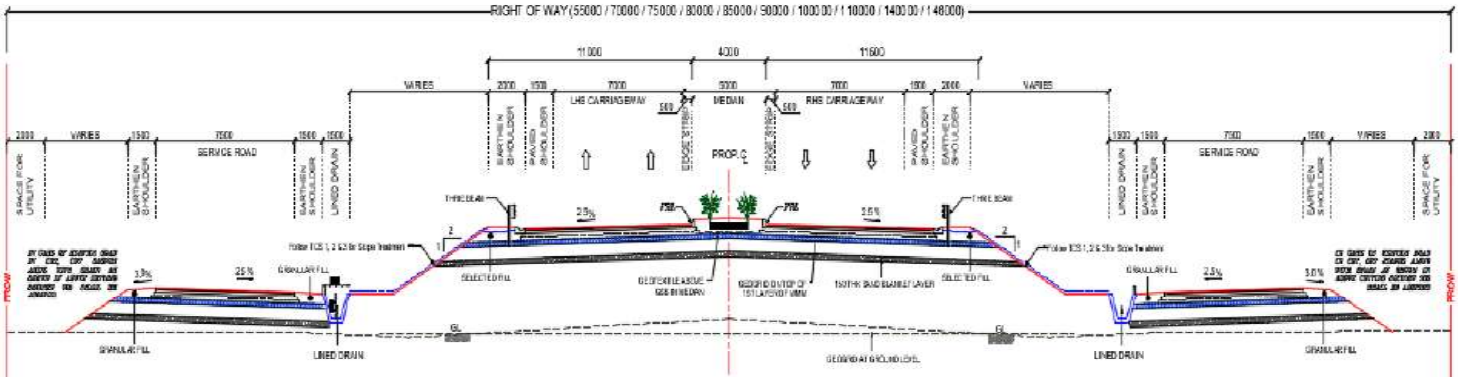


Fig 7.16 4 Lane Divided Highway with Service Road on both sides (TCS-10)

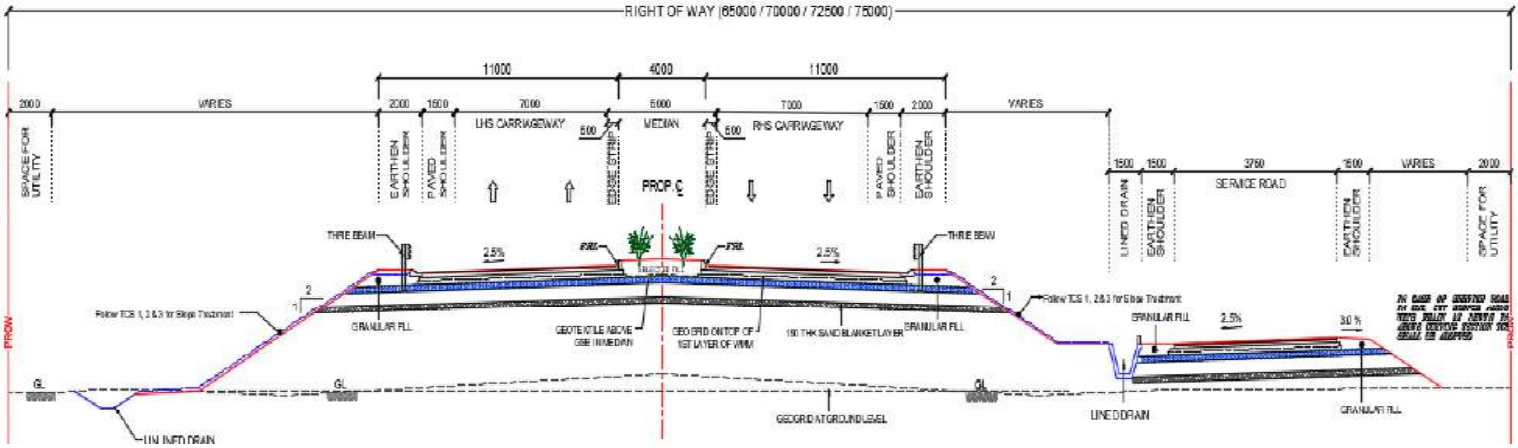


Fig 7.17 4 Lane Divided Highway with Service Road on one side (TCS-11)

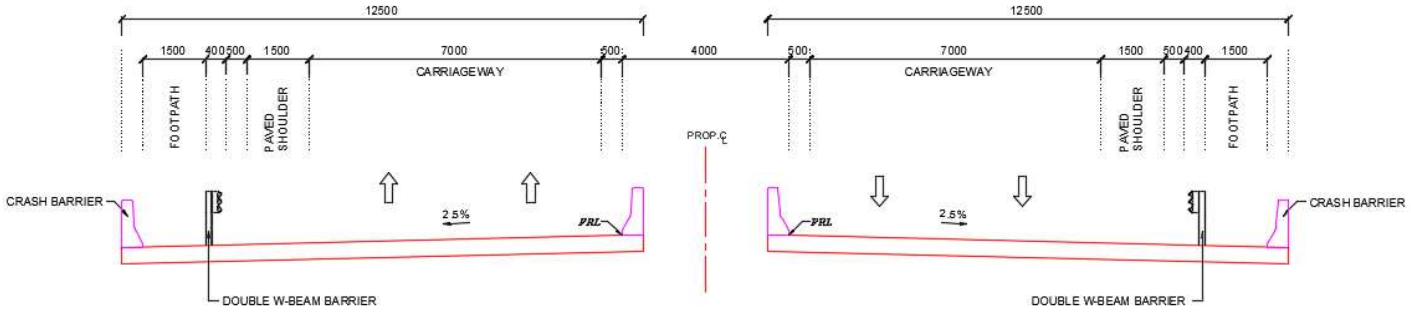


Fig 7.18 4-Lane- Bridge at Deck Level with Footpath Bridges without Service Road (TCS-12)

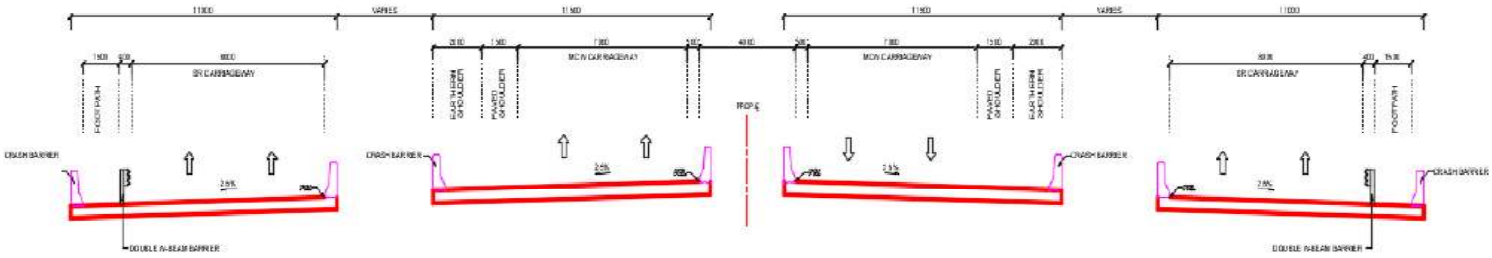


Fig 7.19 4-Lane- Bridge at Deck Level with Footpath Bridges with Service Road (TCS-13)

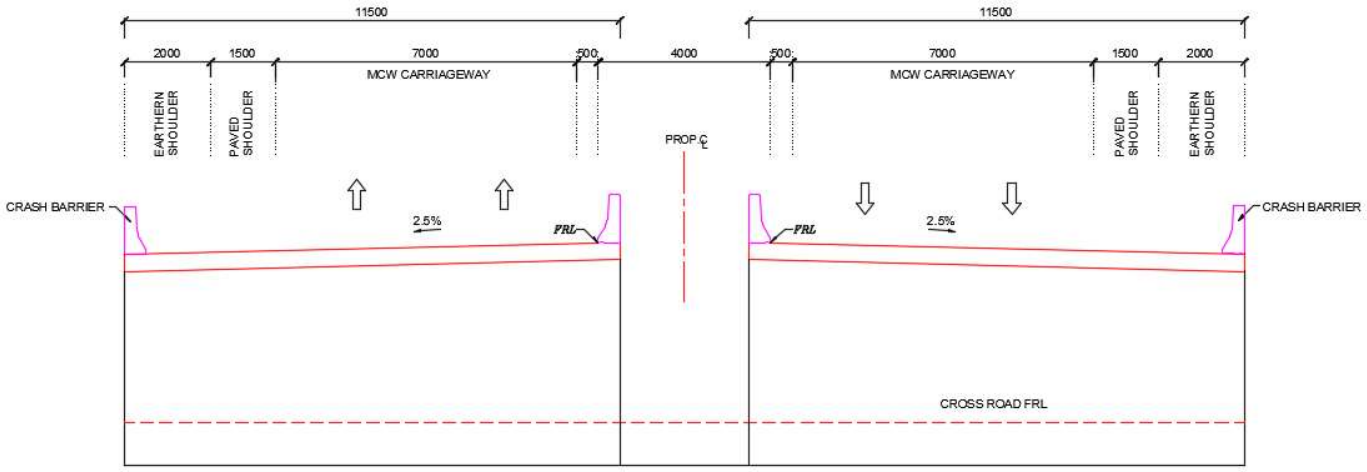


Fig 7.20 Approach of 4-Lane Grade Separated Approach (TCS-14)

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 02 nos 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 RHS - JNV Road	Village Road	1 Lane ER	With Service Road BHS
12	21+718	-	+	LHS - Lalangkitta Labocpar Pt III RHS - Lalangkitta Labocpar Pt II	Village Road	1-Lane BT	(Under SVUP)

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
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 arrangement	Total Width of Structure (m)
1	5+083	-	LHS -New Silchar Rly. Stn. RHS - oinarband Rly. Stn.	Silchar-Jiribam BG Railway Line	Single Track BG	3x36	2x12.5
2	22+542	-	LHS - Kamranga Rly. Stn. RHS - Sribar Rly. Stn.	Silchar-Jiribam BG Railway Line	Single Track BG	3x36	2x12.5

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 RHS - Kasipur Grant	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x22
2	SVUP	5+860	1- Lane ER	LHS - Arkatipur Tea Estate RHS - Nutan Doyapore	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
3	SVUP	6+820	1-Lane BT	LHS - Chappanahal Grant RHS - Banskhandi Pt IV	Village Road	Span = 1 x 7.0m Vertical Clearance = 4.0m	2x11.5
4	SVUP	8+110	1- Lane ER	LHS - Badripar RHS - Banskhandi	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
5	SVUP	9+597	1- Lane ER	LHS - Badripar RHS - Chandrapur	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
6	VUP	11+913	1-Lane BT	LHS - Udharband RHS - Alipur	Udharband Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5
7	SVUP	13+777	1- Lane ER	LHS - Monipur Kitta RHS - Alipur Cha Bagicha	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
8	SVUP	14+235	1- Lane ER	LHS - Monipur Kitta RHS - Alipur Cha Bagicha	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
9	LVUP	15+075	1-Lane BT	LHS - Monipur Kitta RHS - Tarapur Grant	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.5
10	Overpass	16+796	1-Lane BT	LHS - Sibpur Pt II 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 RHS - Laboc Grant	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
12	SVUP	19+612	1-Lane BT	LHS - Mahalthal RHS - Sibpur Pt I	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5

Sl. No.	Type / Location of Structure	Chainage	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
13	VUP	20+803	1-Lane BT	LHS - Mahalthal RHS - Pailapool	Dewan Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5
14	SVUP	21+718	1-Lane BT	LHS & RHS - Lalangkitta Labocpar Pt III	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
15	VUP	22+648	1-Lane BT	LHS - Joypur RHS - Pailapool (NH-37)	Joypur Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5

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

LHS					RHS			
Sl No	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:

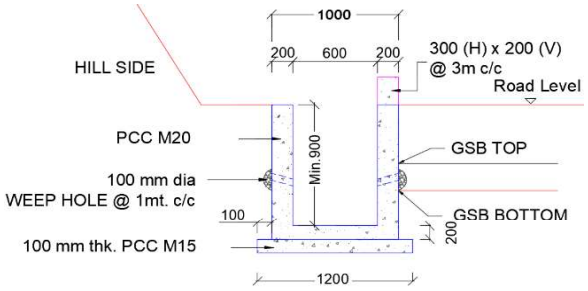
Sl. No	Design Requirements	Proposals
1.	Fast dispersal of precipitation on the road surface so as to minimize danger to moving traffic	Achieved by • Crowning the pavement • Additional Cross-slope (+0.5%) along shoulder • Minimum longitudinal gradient of 0.5%
2.	Water from road and the surrounding area need to be successfully intercepted and led away to natural outfalls.	Accomplished by provision of • 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.

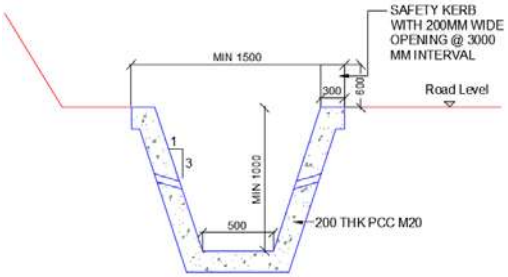
Longitudinal side drains shall be provided, on both side of road, for entire length of the project road. The type of section and size of side drain shall depend on the locations as mentioned below:

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.

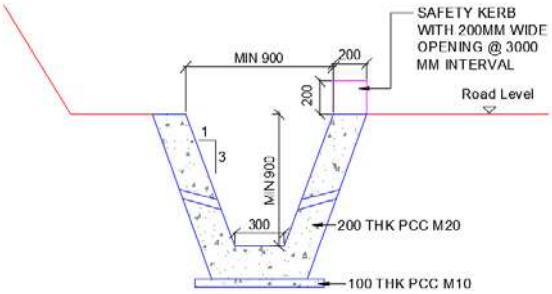
In urban areas: Lined covered drains have been proposed along the road passing through built-up areas. RCC covered drain, which shall serve as footpath also has been provided. And at the locations where the cross section is in cutting, trapezoidal type lined drains have been proposed.



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
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

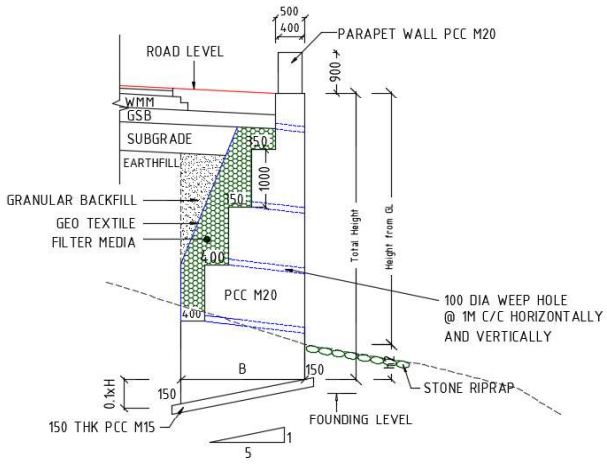
road formation. All these have to be effectively countered to obtain a stable road, to avoid instability of the slopes and landslides in future by provision of structures/slope stability arrangements to act as retaining, restraining and protective structures.

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.

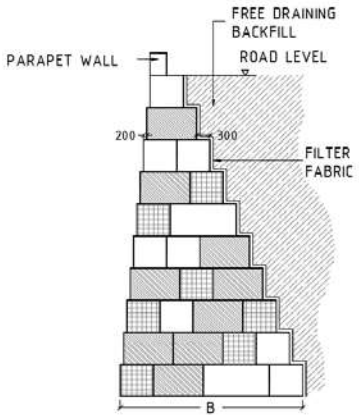
- Height of Cut/Fill
- Cross slope the existing ground/hill
- Soil properties
- Height of hill above the finished road level

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.

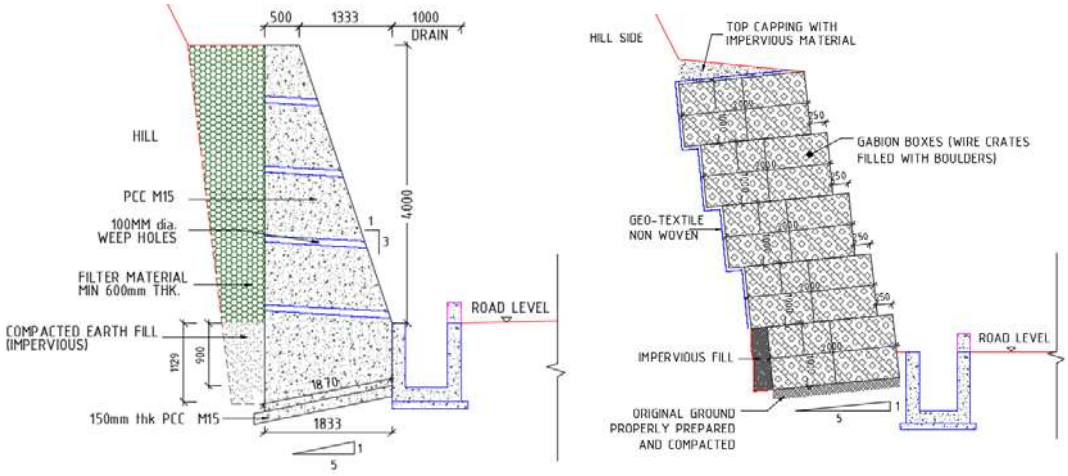
However, 24095.9 sqm of cutting area has been proposed for treatment of manmade safe designed cut slope shall be turfed with vetiver grass, seeding and mulching. Apart from that perforated PVC pipe (30 to 40mm) of desired length shall be provided at a spacing of 5m c/c.

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

LHS				RHS		
Sl No	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

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
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			
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

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
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**			

Sl. No.	Description		Unit	Total
	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 1. Km 4+560 to Km 24+560		Flexible	Flexible –4L
	Existing Type		BT	
	Proposed new 4 Lane (Main Carriageway)-6% CBR		Flexible	
	BC(PMB/CRMB)		mm	40
	DBM (VG-40)		mm	75
	WMM		mm	250
	Geogrid			Biaxial
	Granular Sub-Base (GSB)		mm	200
	Subgrade		mm	500
	Service Road (CBR 6%)		Flexible	
	BC(VG-30)		mm	40
	DBM (VG-30)		mm	70
	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: SJ-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.

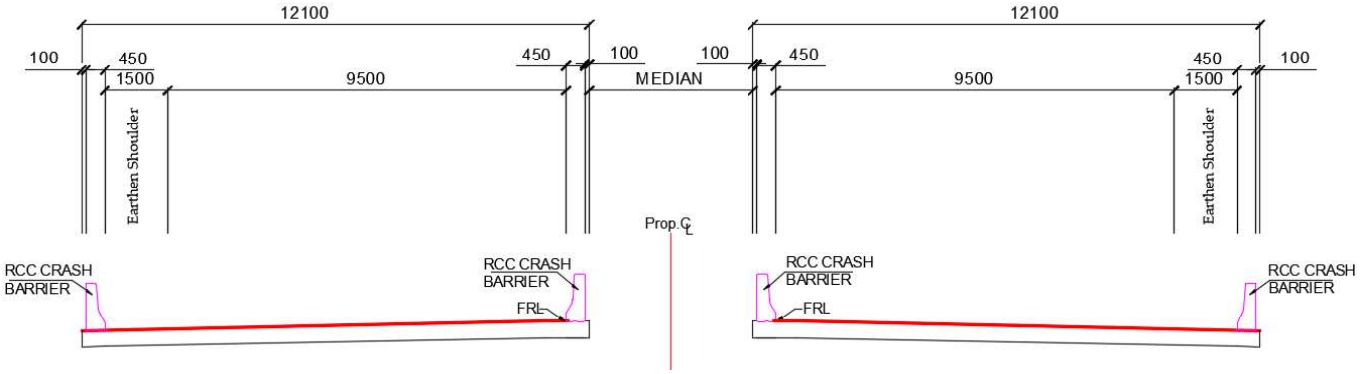

Fig 7.1 Grade Separator Structure at Deck Level

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 RHS - Kasipur Grant	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x22
2	SVUP	5+860	1- Lane ER	LHS - Arkatipur Tea Estate RHS - Nutan Doyapore	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5

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 RHS - Banskhandi Pt IV	Village Road	Span = 1 x 7.0m Vertical Clearance = 4.0m	2x11.5
4	SVUP	8+110	1- Lane ER	LHS - Badripar RHS - Banskhandi	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
5	SVUP	9+597	1- Lane ER	LHS - Badripar RHS - Chandrapur	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
6	VUP	11+913	1-Lane BT	LHS - Udharband RHS - Alipur	Udharband Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5
7	SVUP	13+777	1- Lane ER	LHS - Monipur Kitta RHS - Alipur Cha Bagicha	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
8	SVUP	14+235	1- Lane ER	LHS - Monipur Kitta RHS - Alipur Cha Bagicha	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
9	LVUP	15+075	1-Lane BT	LHS - Monipur Kitta RHS - Tarapur Grant	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.5
10	Overpass	16+796	1-Lane BT	LHS - Sibpur Pt II 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 RHS - Laboc Grant	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
12	SVUP	19+612	1-Lane BT	LHS - Mahalthal RHS - Sibpur Pt I	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
13	VUP	20+803	1-Lane BT	LHS - Mahalthal RHS - Pailapool	Dewan Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5
14	SVUP	21+718	1-Lane BT	LHS & RHS - Lalangkitta Labocpar Pt III	Village Road	Span = 1 x 7m Vertical Clearance = 4.0 m	2x11.5
15	VUP	22+648	1-Lane BT	LHS - Joypur RHS - Pailapool (NH-37)	Joypur Road	Span = 1 x 24m Vertical Clearance = 5.5 m	2x11.5

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;

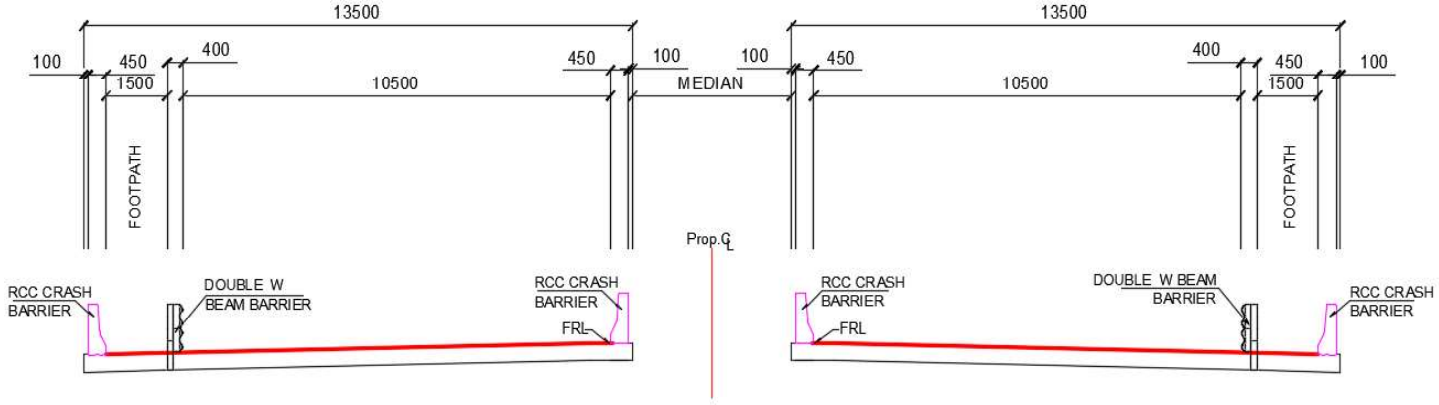

Fig 7.2 ROB Structure at Deck Level

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	2x12.5
2	ROB	22+452	Single Track BG	LHS - Kamranga Rly. Stn. RHS - Sribar Rly. Stn.	Silchar-Jiribam BG Railway Line	3 x 36m	2x12.5

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	2x12.5	Nalla (MCW)
2	-	23+138	3	36	Girder	2x12.5	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	2x12.5	MCW
4	-	7+239	3	10	Box	2x12.5	MCW
5	-	7+390	1	12	Box	2x12.5	MCW
6	-	7+771	2	25	PSC "I" Girder	2x12.5	MCW
7	-	8+980	5	10	Box	2x12.5	MCW
8	-	9+255	1	12	Box	2x12.5	MCW
9	-	9+780	5	10	Box	2x12.5	MCW
10	-	11+795	1	8	Box	2x11.5 + 1x11 + 1x14	MCW + SR
11	-	11+913	1	8	Box	2x14	Cross Road
12	-	14+355	2	12	Box	2x12.5	MCW
13	-	15+250	4	10	Box	2x12.5	MCW
14	-	21+830	1	30	PSC "I" Girder	2x12.5	MCW

7.4.1 Width of the bridges:

i. All new/ reconstructed bridges are proposed with 2 x 12.5m total deck width as per below figure for 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.

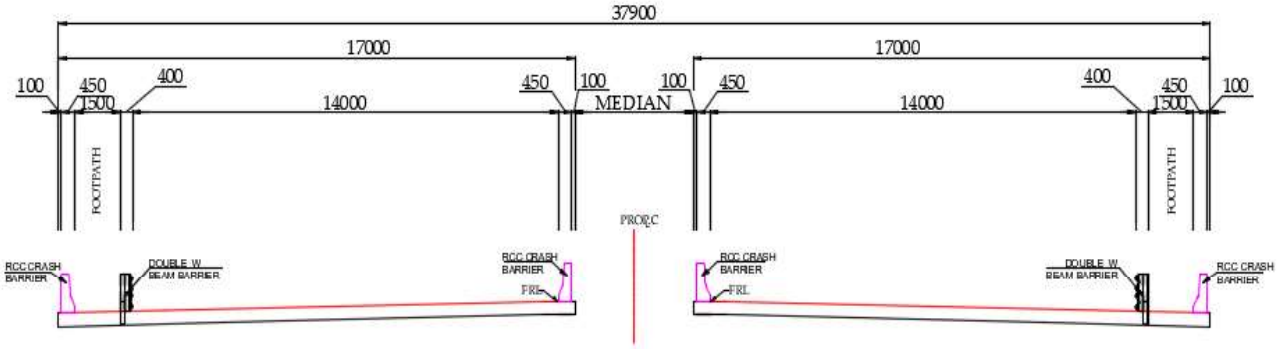

Fig 7.3 Bridge at Deck Level in 6-Lane

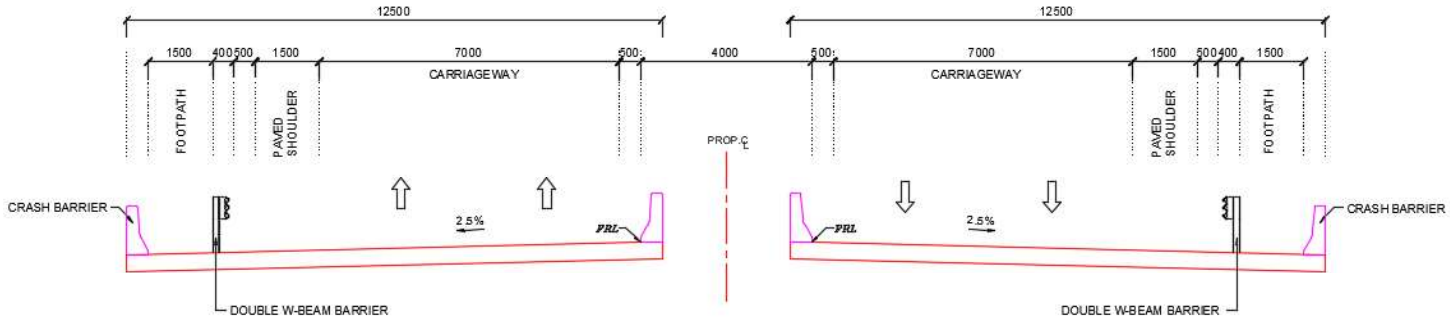

Fig 7.4 Bridge at Deck Level in 4-Lane

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

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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**	

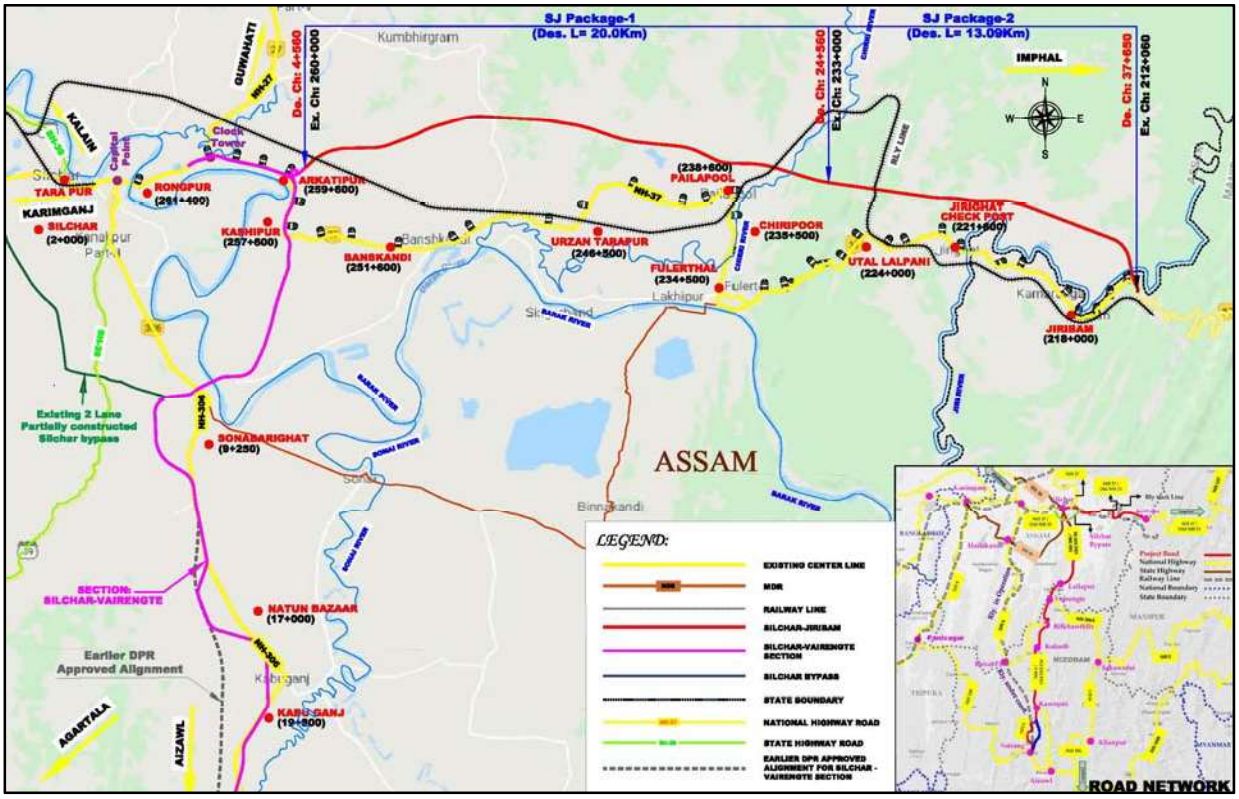

Fig 8.1 Key Plan for Proposed Construction Packages

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						
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

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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 also unit rates has been analysed using standard data book 2019 with basic rate of materials, labour and machinery has been referred from Assam SOR 2021-22. During the PATSC meeting held on NHIDCL HQ on 25.09.2023, it has been instructed to adopt minimum rates between analysed rate and SOR rate for cost estimation purpose.

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 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 (Ch: 4+560) to existing km 233+000 on NH-37 (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**

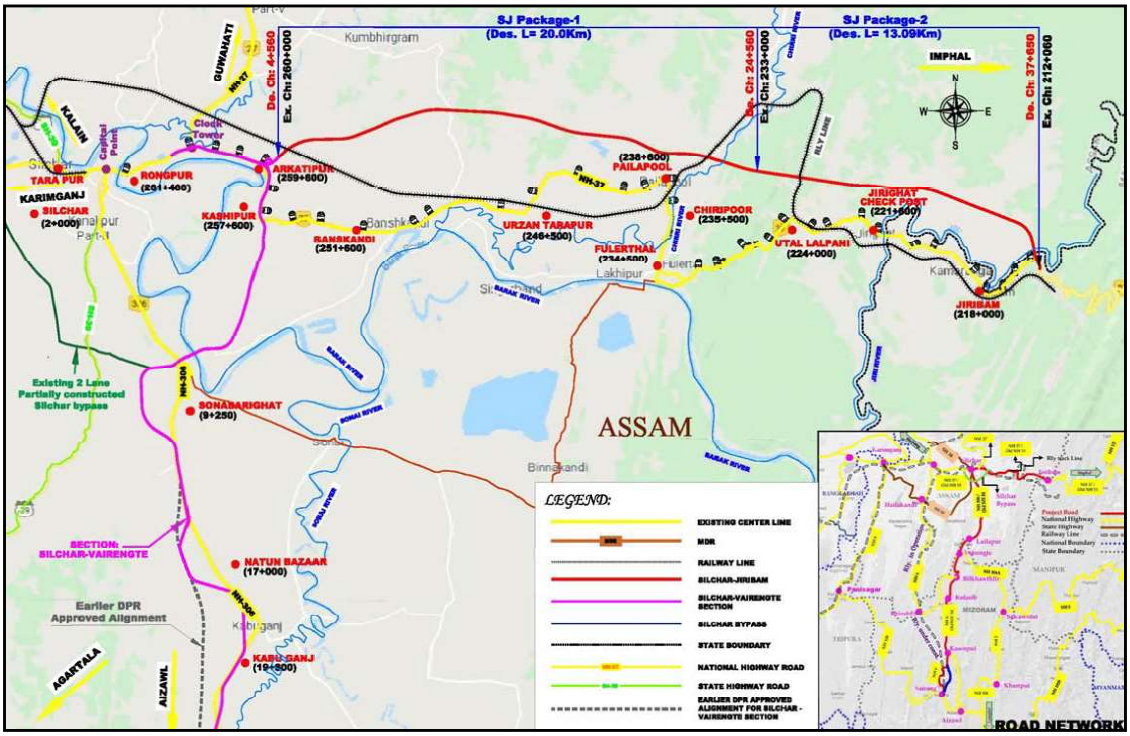


Fig 9.1 Key Plan for Proposed Construction Packages

9.3 Changes made in cost estimate during PATSC Meeting held on 25th Sept 2023 on NHIDCL HQ

Changes made in cost estimate during PATSC Meeting held on 25th Sept 2023 on NHIDCL HQ in bullet points below..

- Earlier analyzed rate was considered for the cost estimate and in this scenario estimated cost was higher than normative cost. So it has been decided to adopt minimum item rates of analyzed rate and SOR rates have been adopted for costing purpose.

- Pavement crust was designed for 8% subgrade CBR for estimation but existing ground has 6% CBR, then pavement crust has been instructed to redesign with 6% subgrade CBR and incorporate the cost estimate.

S. no.	Description	Adopted in revised cost estimate	Earlier proposed
A	**Main Carriageway**		
1	Design Traffic	40 MSA	40 MSA
2	Subgrade CBR	6%	8%
3	Pavement crust of Main Carriageway		
	BC	40 mm	40 mm
	DBM	75 mm	65 mm
	WMM + Geogrid	250 mm	250 mm
	GSB	200 mm	200 mm
	Subgrade	500 mm	500 mm
	Total crust	**1065 mm**	**1055 mm**
B	**Service road and connecting road**		
1	Design Traffic	10 MSA	10 MSA
2	Subgrade CBR	6%	8%
3	Pavement crust for service road and connecting road		
	BC	40 mm	30 mm
	DBM	70 mm	60 mm
	WMM	250 mm	250 mm
	GSB	200 mm	200 mm
	Subgrade	500 mm	500 mm
	Total crust	**1060 mm**	**1040 mm**

- Paved shoulder has been changed to 1.5m from 2.5m and earthen shoulder has been changed to 2m from 1.5m.

S. no.	Description	Adopted in revised cost estimate	Earlier proposed
1	Paved Carriageway including shyness	2x7.50 m	2x7.50 m
2	Paved Shoulder	2x1.50 m	2x2.50 m
	Earthen shoulder	2x2.0 m	2x1.50 m
	Median	4.0 m	4.0 m
	Total Roadway width	**26.0 m**	**27.0 m**

- As per observation from ITE (Sh. Marwa), in some locations profile has been lowered to optimize the cost. FRL has been lowered satisfying the HFL criteria with respect to existing ground conditions, however vertical profile will be a bit of undulating. There are in total 6 locations where FRL can be lowered in an aggregate length of 2.24 km and they are as follows:

S. no.	Chainage		Length (m.)	Average vertical height lowered from earlier (m)
	From	To		
1	8+220	8+620	400	1.250
2	10+040	10+670	630	1.500
3	10+670	11+200	530	2.000
4	11+200	11+500	300	1.000
5	16+150	16+300	150	0.750
6	16+300	16+530	230	1.000
		Sub total	**2240**	

- Incorporating above factor and Major Impact on cost has been presented in table below

Items of work	Unit	Rate	Revised crust as per 6% CBR		Change in width of PS and ES		Change due to lowering the FRL	
			Qty	Amount in Cr.	Qty	Amount in Cr.	Qty	Amount in Cr.
BC	Cum	10,115.00			-1,529.20	-1.55		
DBM	Cum	9,333.00	3,440.70	3.21	-2,867.25	-2.68		
WMM	Cum	1,690.90			-9,557.50	-1.62		
Geogrid	Sqm	250			-38230	-0.96		
Prime coat	Sqm	56			-38230	-0.21		
Tack coat	Sqm	13			-38230	-0.05		
GSB	Cum	1,471.17			-3,823.00	-0.56		
Earth work in cutting	Cum	138.50			-15,700.00	-0.22		

Items of work	Unit	Rate	Revised crust as per 6% CBR		Change in width of PS and ES		Change due to lowering the FRL	
			Qty	Amount in Cr.	Qty	Amount in Cr.	Qty	Amount in Cr.
Earth work in filling from road way cutting	Cum	106.50			-9,420.00	-0.10		
E/W in Filling from borrow	Cum	262.90			-84,300.00	-2.22	-81,835.00	-2.15
Subgrade	Cum	270.90			-8,430.00	-0.23		
Sub total				**3.21**		**-10.38**		**-2.15**

9.4 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
B	**Structures**
10	Cross Drainage Works (Box Culverts)
11	Minor Bridges
12	Major Bridges
13	SVUP
14	LVUP
15	VUP/VOP
16	ROBs

9.5 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.

9.6 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.
- 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.
- Geo grid layer was placed before proceeding with embankment filling since there is saturated soil with moisture.
- 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.

9.7 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
Total		**20000**		

Flexible pavement for main carriageway has been designed for 40 MSA and 6% subgrade CBR as per decision made during PATC meeting held on NHAI HQ dated 25.09.2023. For service road design traffic as per manual 10 MSA and 6% subgrade CBR has been considered. Adopted crust have been tabulated below:

Flexible pavement	Main Carriage Way	Service Road
BC	40	40
DBM	75	70
WMM	250	250
Geogrid	Y	
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).

9.8 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.

9.9 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 up to 3m PCC breast wall has been considered and height more than 3m gabion breast wall was been considered. PCC breast detailed locations and quantity calculations are given in **Volume-VI, VII & VIII.**

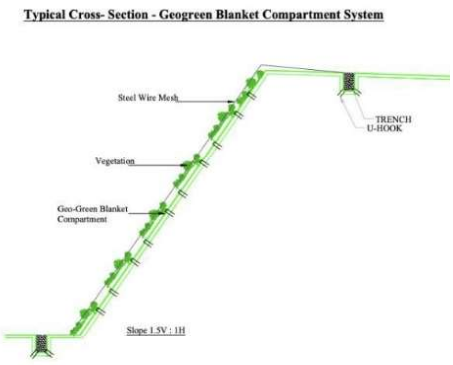
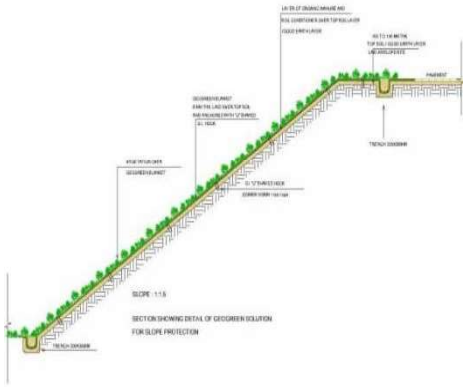
9.8.4 Retaining wall & Parapet Wall

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.**

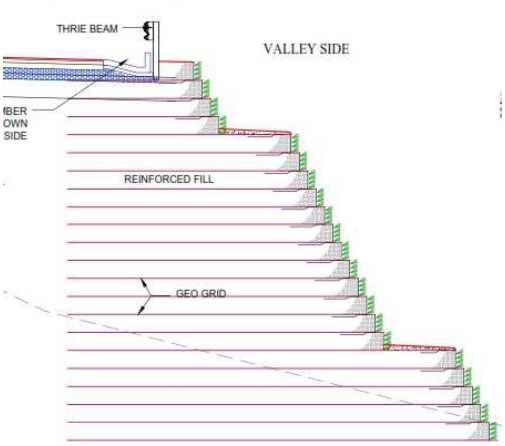
For heights up to 4m PCC and for heights more than 4m gabion retaining walls have been proposed. For PCC parapet walls over PCC & Gabion retaining wall has been proposed.

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:

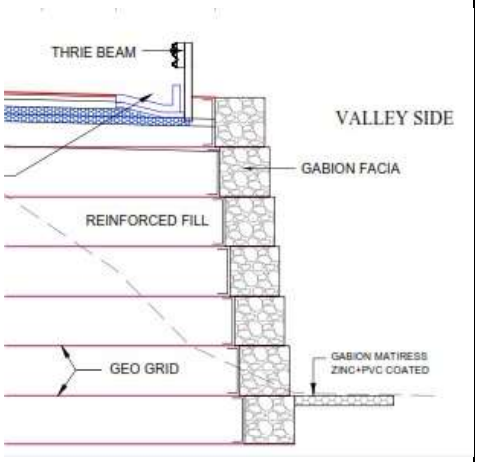
A. **Cut slope protection** - geo composite product with Soil nailing, made from natural coconut fibre reinforced with closely woven polymer nettings impregnated with seeds.	B. **Erosion control on fill Slope**- anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely 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



Reinforced soil

D. Reinforced soil wall - installation of Gabion fascia wall with geogrid with Vegetation**.**



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

9.10 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.

9.11 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.

9.12 Toll Plazas- Location and quantities are given in Volume-VI, VII & VIII.

9.13 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.

9.14 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.

9.15 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

9.16 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

9.17 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 2020-21, and items which are not listed in the SOR have been analysed on the basis of the 'Standard Data Book 2019 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.

Also 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 upto current fiscal year and considering input for analysis of rates.

During the PATSC meeting held on NHIDCL HQ on 25 Sept 2023, it has been decided to **adopt minimum rates** between Assam SOR 2020-21 and analysed rates using standard databook published on 2019 using basic rates of material from market and SOR.

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

Sl. No.	Description of Labour	Unit	SOR Assam 2020-21	Escalated by 13% for 2022-23
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
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 @ 13% 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.

9.18 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:

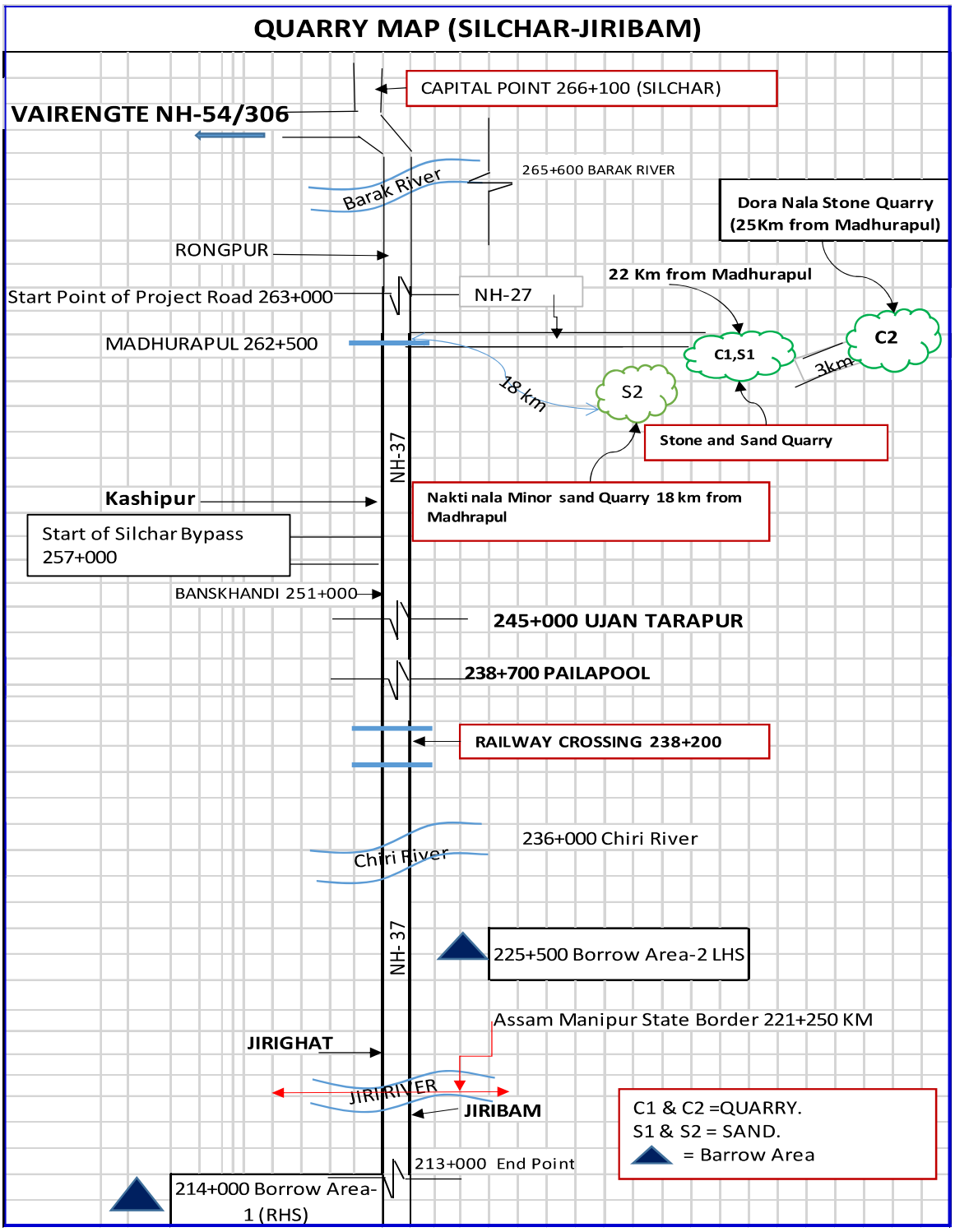


Fig 9.3 Lead Map

9.19 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%