



Ministry of Road Transport and Highways
(GOVERNMENT OF INDIA)

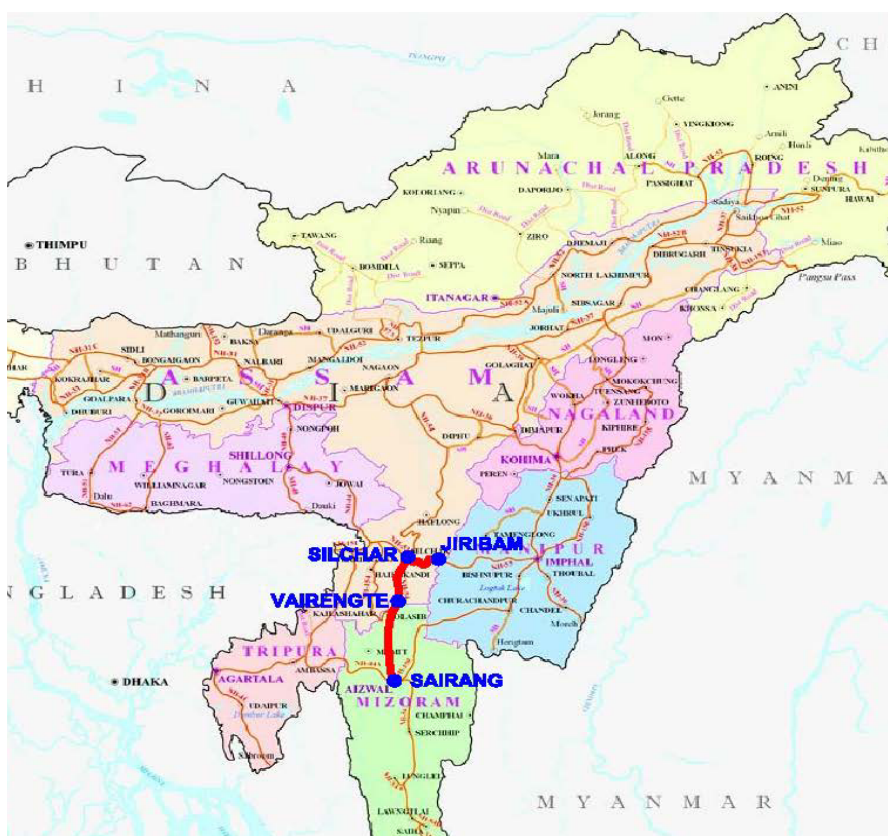


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Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km),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



**Draft Detailed Project Report (Silchar-Vairengte)
Package-2, mod. (From Km 20+000 to Km 49+360)
Volume-I (MAIN REPORT)**

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Section: Silchar to Vairengte (Package-2, mod. Km 20+000 to Km 49+360)

DRAFT DETAILED PROJECT REPORT

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Vol-I

Main Report

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

Section: Silchar to Vairengte (Package-2, mod. Km 20+000 to Km 49+360)

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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))

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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 Corporation 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.



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0.3 Project Road (Silchar to Vairengte)



Fig 0.1 Section (Silchar - Vairengte)

	<p>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)).</p>	
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- a) As per CA the second Project stretch starts from Silchar to Vairengte is the section of NH-306 (old NH-54) [or Km 266+700 of NH-37 (Old NH-53)] from the junction of capital point at Existing Km 0+000, Assam and ends at Km 49+900 of NH-306 near Phainuam junction of NH 306A at Vairengte town, Mizoram for approximate length of 49.9 Km



- b) After reconnaissance survey, it has been learnt that from Km 0+000 to Km 7+950, the project road traverses through heavily built-up with narrow ROW up to km 7+950 (Sonabarighat village). Since, said stretch couldn't warrant for 4-lane development in line with geometrics, land acquisition, environment & social perspective hence, the start point has been shifted to Clock Tower (Junction of NH-37 and NH-27) at existing km 263+800 of NH-37 and continued traversing along NH-37 up to km 257+450 via Rongpur, Arkatipur and Kashipur.

However, at the same time it has also been found that Silchar bypass (partly constructed 2-Lane, on hold) exist on RHS of project road and intersects at km 7+950 of NH-306 hence, DPR consultant has proposed to utilize partial section of Silchar bypass for the length of 7.5 Km from the junction of NH 37 at Km 257+450 and terminates at Km 7+950 of NH 306 near Sonabarighat continuing towards Vairengte up to Km 43+000 of NH-306 (old NH-54) at Lailapur /vairengte border. Hence, considering above existing scenarios, project road starts at km 263+800 of NH-37 with junction of NH-27 (Guwahati-Silchar Road).

Further, as we all know that there is dispute over border between Assam and Mizoram states. Govt. of Mizoram has put massive effort to resolve the long pending state border dispute with Union minister of home affairs (HMA) to intervene and review the state boundary based on Bengal Eastern Frontier Regulation 1873 and the inner line of the Lushai Hills Notification, 1993. The matter is still pending.

However, information obtained from different sources like Local bodies, applicable maps, and Border check-post administrative, 3 locations on existing NH-306 road have been identified viz. at existing Km 40+150, Km 42+250 and km 43+900 respectively. So, considering the existing circumstances and facts, we have fixed end chainage of "Silchar-Vairengte Section" at existing Km 43+000 of NH-306. The same may be revised once the matter resolved.



Hence, DPR consultant has considered the start point as existing Km 263+800 of NH-37 (Old NH-53) with Design Ch. 0+000 and end point at Km 43+000 with Design Ch. 49+360 at Lailapur-Vairengte state border leading towards Aizawl.

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c) Brief Information on DPR Approved Alignment:

The proposed alignment was approved on 23.10.2019 by HQ, NHIDCL (called as DPR approved alignment) and accordingly Draft DPR was submitted under package -1 (from Des. Ch. 0+000 to Des. Ch. 31+000) and package -2 (from Des. Ch. 31+000 to Des. Ch. 46+000) however, portion of approved DPR alignment from existing km 13+200 to existing km 43+000 has been suggested to modify due to obvious reasons as explained below in detailed,



- i. after awarding contract, alignment (called as DPR alignment) was done all necessary studies and presented at all stages followed by PPT presentation delivered on 15.01.2019 at conference hall, NHIDCL-HQ headed by Managing Director in presence of Director-T, ED-T, GM (T) and other NHIDCL officers and subsequently followed by site inspection between 25.01.2019 and 26.01.2019 by GM (T) however, due to obvious reasons, several meetings were conducted and eventually proposed alignment was approved on 23.10.2019 by HQ.
- ii. soon after alignment approval, PPT presentation was also delivered at respective DCs offices including DC-Cachar (Silchar) on 02.03.2020 and draft MoM was also prepared on-behalf and forwarded by NHIDCL through mail dated 03.03.2020 to DC-Cachar with an acceptance / approval of all stakeholders including DFO-Cachar but due to covid pandemic crisis followed by nationwide lockdown and subsequent transfer of existing DC-Silchar, the Minutes of meeting (MoM) could not be signed and issued.
- iii. Silchar – Vairengte section was inspected in the month of Dec.2020 by ED-(P), RO- Guwahati and refuted the alignment from existing km 13+200 (Des. Ch.21+000) to existing km 43+000 (Des. Ch. 46+000) stating “if the existing road found to be feasible for 4-lane development (under option-3) then why the proposed alignment chosen (DPR approved alignment under option-1) along greenfield as the portion of alignment (appx.12 km) falls under inner line reserve forest that could lead hurdle during forest clearance approval”. The matter was also presented during MD VC meeting however upon query, it was brought to the notice to the client that the Option-3 had mainly been studied by improving existing NH-306 but due to existence of ribbon development along the existing road followed by bypassing major settlements like Katakhal, Dholai, Bagha Bazar and Lailapur and poor geometrics (sub-standard curves) at specified locations with limited existing ROW (20m) resulting, approximately 650 additional buildings in said stretch (including temples, mosques, schools) to be bulldozed and significant utilities like electric poles, transformers, power-grids, OFCs to be relocated offering huge cost overrun. The increase in traffic growth would also lead to more traffic congestion and increase in

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road accident in the built-up section. Hence, Greenfield alignment (option-1) was chosen instead of option-3 that couldn't find to be feasible.

- iv. The matter was examined at site by GM (P)-Silchar & team along with DPR consultant and found to be appropriate as said in above para no. (iii), accordingly inspection note was sent to ED-P, RO-Guwahati dated 24.05.21 by GM-P).
- v. Further instruction was also given to the consultant through letter dated 27.07.2021 to prepare DPR along the approved alignment and submit on priority.
- vi. Later, since ED (P), Guwahati, was not fully convinced hence the matter was again addressed to NHIDCL-HQ to follow existing alignment however, after analysing the situations between approved DPR alignment (option-1) and improvement along exiting road (option-3) hence, letter dated 23.12.2021 was issued by NHIDCL-HQ stating that " forest clearance to be uploaded in PARIVESH portal based on approved alignment for seeking of necessary clearance from forest department however, any decision pertaining to change in alignment in package-2 of Silchar – Vairengte stretch to be made on the basis of comments (if any) by forest department in the said proposal for the subject stretch".
- vii. Meanwhile forest proposal was uploaded on PARIVESH portal dated 18.12.2021, based on instruction given by NHIDCL-HQ on 09.12.2021 but soon after forest department denied the proposal on various reasons and suggested to follow option-3 i.e., improvement along existing road by providing individual bypasses at needed built-up / major settlement areas.
- viii. Stakeholders meeting were also arranged in this regard 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 state govt. departments in presence of GM(P) and Manager (P) of NHIDCL and minutes of meetings (MoM) were issued dated 16.02.2022 and 26.02.2022.
- ix. As per stakeholders' meetings, preceded by Hon'ble MP and DC-cachar, it was agreeable to all stakeholders with fair compensation by developing existing road (option-3).

So, knowing facts and figures, exiting circumstances and future consequences in view of 4-lane development, it has been suggested by NHIDCL to modify / reroute the portion of "DPR approved alignment" in line with MoM issued by DC-Cachar dated 26.02.2022.

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Since the DPR approved alignment is common and had no objection up to existing km 13+200 (Des. Ch.21+000) hence, DPR package has been modified in consultation with ED (P)-RO Guwahati during VC meeting held on 13.06.2022. The revise DPR package is as mentioned below,

1. Package: P1 (Des. Ch. 0+000 to Des. Ch. 21+000) - as per earlier DPR approved Alignment.

2. Package: P2 (Des. Ch. 21+000 to Des. Ch. 46+000) - as per modified Alignment

Therefore, Draft Detailed Project Report (DDPR) for package: P-1 (Des. Ch. 0+000 to Des. Ch. 21+000) under **revision-01** was submitted on 6th July 2022 vide through letter *no Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40388.*

Later while scrutinizing the draft DPR (R-1) by GM(P) office followed by ED-P (RO, Guwahati) office meeting held on 23.09.2022 the DPR consultant has been advised for minor modification in project alignment specially **elimination of Trumpet Interchange at km 4+500 and shifting of project alignment towards right hand side at km 5+900 to avoid land acquisition of BSF area**, the project alignment has been revised as per following,

1. Package: P1 (Des. Ch. 0+000 to Des. Ch. 20+000)

2. Package: P2 (Des. Ch. 20+000 to Des. Ch. 46+360)

In addition, this report mainly deals with Package-2 that starts at existing Km 12+920 (D. Chainage 20+000) and ends at Existing Km 43+000 and (D. Chainage 49+360) however, for better comprehension DPR consultant has furnished the details from Sichear to Vairengte state border

Major built up areas along existing are Rongpur, Kashipur, Sonabharighat, Nutan Bazar, Kabuganj, Dolhai and Baga Bazar. The condition of existing pavement varies from good to fair.

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 Plain terrain and few stretches lying on hilly terrain.

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;



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Table 0.1 Summary of Land use along Project Road(Existing)

Sl. No.	Land use Description	Length (km)	% of Length
1	Built up Area	27.750	57.00
2	Semi Built up Area	5.500	11.00
3	Agricultural Land	13.650	28.00
6	Hill Cum Forest Area	2.000	04.00

Detailed land use pattern is presented in corresponding chapter.

0.6 Road Geometry and Configuration

In order to arrive at a feasible option, alternatives were decided based on both horizontal & vertical design and requirement of additional LA as well. Environmental, social perspective and safety parameter 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. New bypasses, utilisation by upgrading the under /partially constructed (non-functional) Silchar bypass for the length of 8.830km and then green field alignment has been proposed at these locations to have smooth geometry and better level of service for through traffic. The proposed locations of proposed Bypasses were critically examined/ studied for alternative improvements.

There are three options provided as below,

Option A: Utilise by upgrading the under-construction bypass and proposal of new bypass,

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

Option C: 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.



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Table 0.2 List of Bypass Proposals.

Sl. No	Location	Exist. Chainage (Km)		Exist. Length (m)	Prop. Chainage (Km)		Prop Length (m)
		Start	End		Start	End	
	Falls under Package-1						
A.	Upgrading the under constructed 2-lane Silchar Bypass to 4-lane road						
1.	Silchar Bypass	20+000	11+170	8830	6+300	13+660	7360
		Total Length (m)		8830			7360
B.	*Improvement of existing road with bypass options at Major Built up						
1	Sonabarighat Bypass (under Pkg-1)	7+950	12+500	4550	13+660	19+010	5350
		Total Length (m)		13380			12710
	Note: As per recent development the proposed alignment is to be follow as per option-B by considering the individual bypasses / short bypasses under modified / re-route alignment, shown below; Falls under Package-2						
2	Nutan Bazar Bypass (under Pkg-2)	14+620	21+270	6650	21+700	28+650	6950
3	Katakhal Bypass (under Pkg-2)	22+720	25+900	3180	30+100	33+350	3250
4	Dholai Short Bypass (Under Pkg-2)	28+150	30+120	1970	35+600	37+600	2000
5	Baga Bazar Bypass (under Pkg-2)	30+860	32+350	1490	38+350	39+600	1250
		32+960	38+110	5150	40+200	45+150	4950
		Total Length (m)		18440			18400
C	Option of Partial Green Field Alignment, falls under package-2 (now withdrawn on obvious reasons and proposed to be modified as per option-B						
1	Green Field Alignment (withdrawn)	12+920	43+000	30080	20+000	46+000	26000
		Total Length (m)		30080			26000
	Total Approval Length (m) along bypasses / Green Field Alignment			31820			31110

** The detailed discussion of the green filed alignment is given below as the green filed alignment falls under Package-2, however, the details of the other bypass is given in chapter-7.*

Bypasses to Nutan Bazar, Katakhal, Dholai and Bagha Bazar:

Nutan Bazar & Kabuganj: Project Road traverse through Nutan Bazar and Kabuganj village are situated under proximity and thickly habituated with very

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poor geometrics km 14+700 to Km 21+000. The ribbon development all along the road with government offices, educational institutions, and residential buildings on both sides throughout the stretches have given very limited opportunity to improve. Geometric correction along the existing road involves acquisition of land in built up areas which leads to demolition of buildings. Thus, to avoid the habitation in Nuthan Bazar and Kabuganj bypass options were studied. Recommended option takes-off the proposed alignment on RHS of Nutan Bazar and Kabuganj from existing Km 14+620 to Km 21+270 for a proposed length 6.950km mainly on open / agricultural field where negligible effect on buildings are accorded moreover, alignment has better scope for further town advancement with lesser LA cost as compared to other options studied.

Katakhal Village: Thereafter, project road encounters Katakhal village at Km 24+000 that found to be built up on either side with poor geometrics in terms of horizontal curves moreover, settlements were observed in linear fashion. Hence, improvement of existing road to NH standards deemed to be difficult and lead to acquisition of built-up area for entire length. Hence, bypass options have been studied. The recommended option takes-off from Km. 22+720 on LHS of Katakhal and intersects existing road at Km. 24+300 and then alignment passes on RHS of Katakhal ultimately joins at Km. 25+900. The length of this alternative is 3.250Kms. This recommended option passes through mainly agriculture filed however; marginal number of buildings conferred to be affected as compare to other options studied. Moreover, proposed alignment is away from the river which is running parallel on LHS of Katakhal built up and extends more scope for further development of Katakhal village. Land acquisition cost is also less as compared to other options.

Dholai Village: The project road further passes through Dholai village which is located on the banks of Rukini River from Km 28+500 to Km 32+000 of poor horizontal curves. Hence, existing road improvement 4-Lane NH standers attracts significant effects on residential and commercial buildings. LA cost was also concern in this matter so, bypass options were studied. The recommended option takes-off from Km 28+150 on RHS of Dholai and terminates at Km. 30+120. The length of this alternative is 2.000 Kms. This recommended alignment passes mainly through agriculture filed whereas a smaller amount of buildings needs to be acquired. Since, the recommended alignment is on RHS of existing road whereas Barak / Rukini River is on LHS, running parallel to exiting road therefore alignment option on RHS has more scope for further village growth. Land acquisition cost is also less as compared to other options.



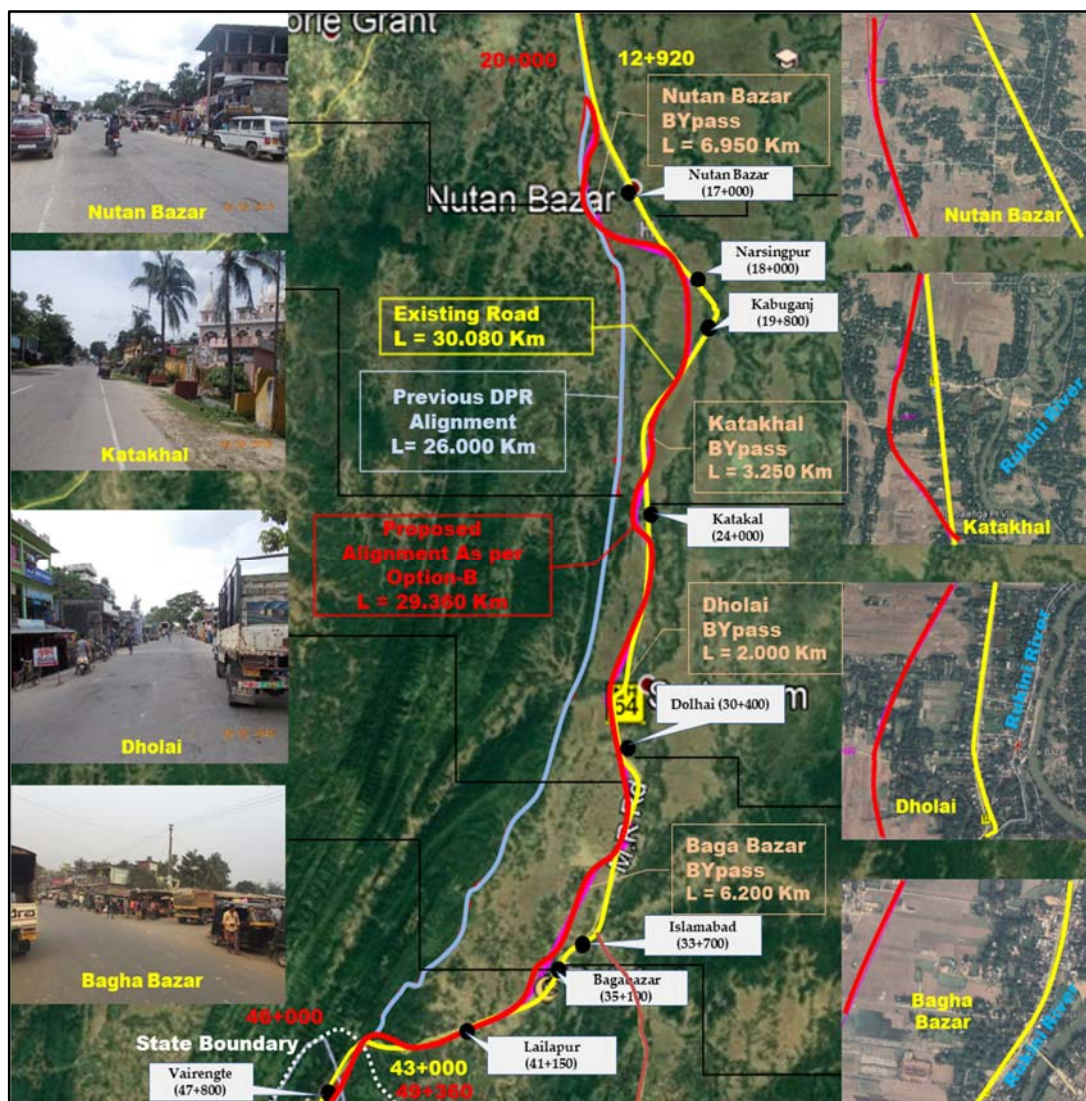
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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Baga Bazar: The cluster of 4 settlements i.e., Saptagram, Islamabad, Bagabazar and lailapur have proximity at regular intervals start at km 31+300 and ends at km 37+500. The reconnaissance found that settlements fall along existing road on either side with poor geometrics so, improvement of existing road to 4-Lane standard attracts enormous effects on commercial and residential buildings hence, bypass options were studied. The recommended alignment takes-off from Km. 30+860 on RHS of existing alignment and intersects existing road at Km. 32+350 thereafter the alignment follows the existing alignment up to Km. 32+960 and again passes on RHS of Bhaga Bazar terminates at Km. 38+110. The length of this alternative has 6.200 Kms. Moreover, this alignment passes mainly through agriculture filed and affects a smaller number of buildings but has more scope of future growth of these settlements.



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<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>		
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0.7 Pavement Condition of the Project Corridor

The existing pavement surface condition based on visual observation varies from Poor to Fair for the project road length from Km 7+950 to Km 43+000.

The pavement condition survey was conducted in the year 2018 for the section from Silchr to Vairengte, at the time of survey the condition of the pavement was fair and poor and 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 0.3 Pavement Condition on Project Road

Chainage (km)		Classification	Remarks
From	Km		
0+000	7+950	Not in the current scope	
7+950	43+000	Poor to Fair	PKG-1 and PKG-2
Refer Volume-I, Appendices to Main Report (Appendix 3.4) for more details			

Table 0.4 Summary of Distresses on Project Road

Sl. No.	Section (Existing Chainage)	Cracks (%Area)	Potholes	Ravelling (% Area)	Patching (%Area)	Rut Depth (mm)	Edge Drop (mm)
			(%Area)				
**I	0 to 7+950	Not Applicable as the proposed alignment follows Silchar bypass					
II	7+950 to 43+000 along NH-306	39%	13%	63%	26%	17	60

The soil type along the alignment is generally silty clay. This package runs mainly in plain terrain.



Total thickness of the pavement is varying between 100 mm and 520 mm. The thickness of bituminous layer is varying between 80-120 mm.

0.8 Bridges and Structures

There are 05 nos of minor bridges coming along the existing alignment, out of which 4 nos are proposed for reconstruction to minor bridge and 01 no is abandoned for proposal bypass.

0.9 Culverts

There are total 34 nos of culvert, out of which 30 nos are Pipe Culvert and 04nos Slab Culverts coming along the existing alignment, from which 17 nos are reconstructed to box culvert and 1 no to Minor bridge and 16 nos are abandoned for proposal of bypasses..

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<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>		
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0.10 Road Junctions and Intersections

There are 05 nos of Major Junction and 76 nos of Minor Junction falling under existing road.

0.11 Railway Level Crossings and ROBs

There is no. existing ROB, RUB and Level crossing along the project road.

0.12 VUP and PUP

There is no. existing VUP and PUP.

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. Five homogeneous sections tabulated below have been considered to know the traffic flow conditions as shown in the traffic report.



Table 0.5 Details of Homogeneous Sections

Section	Homogenous Section	Chainage (Existing)		Length (Km)
		From (Km)	To (Km)	
Section – 1	Intersecting point of Silchar bypass with NH-306 to Vairengte	0+000	43+000	43.00
Section – 2	Vairengte to Kolasib	43+000	86+500	43.50
Section – 3	Kolasib to Kawnpui	86+500	121+500	35.00
Section – 4	Kawnpui to Sairang	121+500	157+800	36.30
Section – 5	Sairang to Aizawl	157+800	-	20.00

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)	–	3 Locations
O-D Survey (1day)	-	3 Locations
Intersection Volume Count (12 hrs)	-	5 Locations
Axle Load Survey (2 day)	-	3 Locations

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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** 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-Sairang and Silchar-Jiribam. However, the traffic survey that is conducted for Silchar to Vairengte and Vairengte to Sairang section is represented above.*

Traffic Volume and Composition

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

Table 0.6 Details of AADT for different sections (Base year 2020)

Section	Homogenous Section	AADT (No.s)	AADT (PCUs)
Section – 1	Intersecting point of Silchar bypass with NH-306 to Vairengte	6776	80095
Section – 2	Vairengte to Kolasib	2889	4209
Section – 3	Kolasib to Kawnpui	3665	5713
Section – 4	Kawnpui to Sairang	3088	5218

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: -

$$\text{Passenger Vehicles} : Tgr = ((1+Pgr)*(1+PCI gr)-1)*100/E$$

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 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 : $Tgr = \frac{1}{2} (Agr + NSDPgr) \times E \times 100$

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 0.7 Proposed Traffic Growth rates for Silchar to Vairengte 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%



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Table 0.8 Proposed Traffic Growth rates for Vairengte to Sairang section

Vehicle Type	Upto 2025	2026-30	2031-35	2036-40	Beyond 2040
Most Likely Scenario					
Car/Van/Jeep	5.00%	8.35%	7.30%	6.50%	5.00%
Bus/Minibus	5.00%	5.00%	5.00%	5.00%	5.00%
LCV	5.00%	11.15%	9.75%	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%	9.35%	8.30%	7.50%	6.00%
Bus/Mini Bus	6.00%	6.00%	6.00%	6.00%	6.00%
LCV	6.00%	12.15%	10.75%	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%	7.35%	6.30%	5.50%	4.00%
Bus/Mini Bus	4.00%	4.00%	4.00%	4.00%	4.00%
LCV	4.00%	10.15%	8.75%	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 Sairang based on the above growth rates and the summary of projected traffic in PCUs is presented in table 0-7.

Table 0.9 Projected Traffic AADT in PCU

Homogeneous Section	Section-2 Intersecting point of Silchar bypass with NH-306 to Vairengte (Km 8+800 to Km 42+750)		
	Most Likely	Optimistic	Pessimistic
2020	8113	8113	8113
2021	8515	8596	8434
2022	8938	9109	8768
2023	9381	9652	9116
2024	9847	10227	9477



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Homogeneous Section	Section-2 Intersecting point of Silchar bypass with NH-306 to Vairengte (Km 8+800 to Km 42+750)		
	Most Likely	Optimistic	Pessimistic
2025	10336	10837	9853
2026	10849	13781	12292
2027	11543	14716	12955
2028	12287	15727	13661
2029	13084	16820	14411
2030	13941	18002	15210
2031	14860	19277	16057
2032	15788	20589	16899
2033	16778	22003	17790
2034	17836	23527	18735
2035	18967	25169	19735
2036	20176	26912	20775
2037	21204	28482	21626
2038	22284	30148	22511
2039	23420	31916	23434
2040	24614	33792	24394
2041	25869	35780	25392
2042	27157	37851	26403
2043	28510	40046	27454
2044	29931	42373	28547
2045	31422	44839	29685
2046	32988	47453	30867
2047	34632	50224	32097
2048	36358	53160	33375
2049	38170	56272	34705
2050	40073	59571	36088
2051	42071	63067	37527
2052	44169	66773	39023
2053	44191	67161	39293

Homogeneous Section	Section-2 Vairengte to Kolasib (Km 42+750 to Km 88+500)		
	Most Likely	Optimistic	Pessimistic
2020	4206	4206	4206
2021	4416	4458	4374
2022	4636	4725	4548
2023	4868	5008	4730



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Homogeneous Section	Section-2 Vairengte to Kolasib (Km 42+750 to Km 88+500)		
	Most Likely	Optimistic	Pessimistic
2024	5110	5308	4919
2025	5366	5626	5115
2026	5633	5963	5319
2027	6005	6416	5616
2028	6402	6905	5932
2029	6828	7433	6267
2030	7285	8004	6624
2031	7774	8621	7002
2032	8260	9247	7371
2033	8778	9920	7759
2034	9331	10643	8170
2035	9920	11421	8604
2036	10547	12257	9063
2037	11142	13072	9484
2038	11772	13940	9924
2039	12437	14868	10386
2040	13141	15857	10870
2041	13884	16913	11377
2042	14578	17927	11831
2043	15306	19002	12304
2044	16071	20141	12795
2045	16874	21349	13307
2046	17717	22629	13838
2047	18602	23986	14391
2048	19531	25424	14966
2049	20507	26949	15565
2050	21531	28564	16187
2051	22607	30277	16833
2052	23737	32093	17506
2053	23749	32112	17513

Homogeneous Section	Section-3 Kolasib-Kawnpui (Km 88+500 to Km 121+500)		
	Most Likely	Optimistic	Pessimistic
2020	5713	5713	5713
2021	5998	6056	5941
2022	6298	6418	6179



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Homogeneous Section	Section-3 Kolasib-Kawnpui (Km 88+500 to Km 121+500)		
	Most Likely	Optimistic	Pessimistic
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
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

Homogeneous Section	Section-4 Kawnpui to Sairang (Km 121+500 to Km 157+800)		
	Most Likely	Optimistic	Pessimistic
2020	5218	5218	5218



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Homogeneous Section	Section-4 Kawnpui to Sairang (Km 121+500 to Km 157+800)		
	Most Likely	Optimistic	Pessimistic
2021	5478	5530	5426
2022	5752	5862	5643
2023	6039	6213	5868
2024	6340	6585	6102
2025	6657	6980	6346
2026	7084	7498	6690
2027	7541	8056	7054
2028	8030	8659	7441
2029	8553	9310	7852
2030	9114	10013	8288
2031	9673	10728	8714
2032	10269	11496	9164
2033	10904	12321	9639
2034	11580	13208	10140
2035	12300	14161	10669
2036	12983	15089	11155
2037	13704	16077	11663
2038	14465	17132	12194
2039	15270	18256	12751
2040	16120	19454	13333
2041	16925	20621	13866
2042	17771	21857	14420
2043	18659	23168	14996
2044	19591	24557	15596
2045	20570	26030	16219
2046	21598	27591	16867
2047	22677	29245	17541
2048	23810	30999	18242
2049	25000	32858	18972
2050	26249	34828	19730
2051	27561	36917	20518
2052	28938	39131	21339
2053	28952	39154	21347

As per IRC SP: 73-2018 and IRC SP: 84-2019, as the project road from Silchar to Vairengte 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

As per IRC SP: 73-2018 and IRC SP: 84-2019, as the project road from Vairengte to Sairang as the project road passes through mountainous/hill terrain. The details of capacity value adopted from Vairengte to Sairang is given below.

- For 2-Lane Highway capacity (4-Lane requirement) : 6,000 PCU/day
- For 4-Lane Highway capacity (6-Lane requirement) : 30,000 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 above GSB is designed for Main carriageways, Bus bay, Truck lay bye, Rest area and Flexible pavement is designed for service road. The pavement composition is calculated for the traffic survey carried out at Km 29+200 for Package-2 and the same has been used in the calculation of pavement composition.

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	60 mm	60 mm
WMM	150 mm	250 mm
Geogrid	Biaxial	-
GSB	300 mm	200 mm
Subgrade	500 mm	500 mm

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

0.16 Improvement Proposals

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



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)).

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Table 0.11 Summary of Improvement Proposals

Sl. No.	Description (Prop)	Unit	Total
1	Alignment & Geometrics		
	Total Length	Km	29.360
	Re-alignments	Km	2.260
	Bypass / Short Bypass		
	Bypasses	Km	16.400
	Short Bypass	Km	2.000
	Total (Realignments +Bypass)	Km	20.66
2	Cross Section		
	4-Lane Road	No	29.360
	6-Lane Road (Approach of structures)	No	Nil
3	Bridges		
	Existing		
	Minor Bridges (Along Existing Road)	Nos	05
	Major Bridges (Along Existing Road)	Nos	Nil
	Proposed (Major/ Minor)		
	Minor Bridges (Reconstruction & New Construction)	Nos	12
	Major Bridges	Nos	Nil
	Rehabilitation Proposal of Existing Bridges		
	Existing Bridges reconstruction (1 no culvert & 4 nos of Minor Bridge proposed to Minor Bridge)	Nos	05
	Existing Bridges Repair/ Retain MJB	Nos	Nil
	Existing Bridges Widening	Nos	Nil
	Existing Bridges Abandoned	Nos	01
	New Bridges		
	a. Minor Bridges	Nos	07
	b. Major Bridges	Nos	Nil
4	Culverts		



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Description (Prop		Unit	Total
	Existing Culverts (Along Existing Road)		Nos	34
	Proposed Culverts (Reconstruction & New Construction)		Nos	65
	Rehabilitation Proposal of Culvert			
	Existing Culverts reconstruction (to 4-Lane)		Nos	17
	Existing Culverts Widening (to 4-Lane)		Nos	Nil
	Existing Culverts Retain (4 to Retain)		Nos	Nil
	Existing Culverts Abandon		Nos	16
	New Culvert along project road		Nos	48
	New Culvert for cross roads		Nos	25
5	Major & minor Junctions (Proposal)			
	Major Junction		Nos	15
	Minor Junctions		Nos	11
6	Toll Plaza		Nos	Nil
7	Service/Slip Road (excluding Tapper Length)		Km	21.330
8	Rest Area		Nos	Nil
9	Grade Separator			
	Overpass		Nos	01
	Vehicular Underpass (VUP)		Nos	08
	Light Vehicular Underpass (LVUP)		Nos	07
10	Bus Bay with Bus Shelter and Bus Shelter			
	Bus Bay with Bus Shelter		Nos	12
11	Truck Lay bye		Nos	Nil
12	Drain			
	RCC Cover Drain	LHS	Mts	11650
		RHS	Mts	11650
	PCC Open Drain (On Hill Side)	LHS	Mts	650
		RHS	Mts	1070



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Description (Prop)		Unit	Total
	PCC Open Drain (On Valley Side)	LHS	Mts	1490
		RHS	Mts	1120
	Un Line Drain	LHS	Mts	16430
		RHS	Mts	16430
13	Protection Work			
	Retaining Wall	LHS	Mts	2970
		RHS	Mts	3300
	RS Wall	LHS	Mts	580
		RHS	Mts	Nil
	Fill Slope protection using Erosion Control Blankets		sqm	142183
	Breast Wall	LHS	Mts	Nil
		RHS	Mts	360
	Cut Slope using Erosion Control Blankets Compartment System		sqm	9543
	Thrie Beam Crash Barrier	LHS	Mts	7840
		RHS	Mts	8310
	RE Wall	LHS	Mts	8735
		RHS	Mts	8735
14	Additional Land requirement for the project		Km.	29.360
15	% of Land Requirement for the Project (Length wise)		%	100.00
16	Pavement Design Life			
	Flexible		Year	20
	Rigid (not used in this package)		Year	30
17	Traffic in MSA : Km 20+000 to Km 49+360		MSA	40
18	Pavement Type Proposed			
	1. Km 20+000 to Km 49+360		Flexible	Flexible –4L
	Existing Type		BT	
	<u>New 4 Lane (Main Carriageway)</u>		Flexible	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Description (Prop)	Unit	Total
	BC(PMB/CRMB)	mm	40
	DBM (VG-40)	mm	60
	WMM	mm	150
	Geogrid		Biaxial
	Granular Sub-Base (GSB)	mm	300
	Subgrade	mm	500
	<u>Service Road (10 MSA)</u>	Flexible	
	BC(VG-30)	mm	30
	DBM (VG-30)	mm	60
	WMM	mm	250
	Granular Sub-Base (GSB)	mm	200
	Subgrade	mm	500

Geometric Design Standards

The entire project section passes through Mountainous /Steep terrain. The design speeds as per IRC: SP: 84-2019 and table 6.1 of IRC: SP: 48, have been proposed as under:

As per IRC SP: 84-2019 (4-Lane Manual)		As per Hill Road Manual (IRC SP: 48)			
Mountainous and Steep Terrain		Mountainous Terrain		Steep Terrain	
Cross slope of the ground more than 25%		25-60% cross slope of the ground		More than 60% cross slope of the ground	
Speed		Speed			
Ruling	Minimum	Ruling	Minimum	Ruling	Minimum
60	40	50	40	40	30

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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Table 0.12 Typical Cross Section element

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

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

Grade Separator/Underpass/Overpass

LVUP/SVUP/VOP has been proposed along major crossing. These grade separation facilities are classified and tabulated in following Table.



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Table 0.13 Proposed Grade-Separated Structures for Cross Roads

Sl. No.	Type / Location of Structure	Name	Concept	Span arrangement and Vertical clearance
1	21+900	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
2	22+950	LVUP	2 Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
3	24+325	LVUP	2 Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
4	26+610	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
5	31+610	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
6	33+860	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
7	35+810	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
8	36+513	LVUP	Intermediate Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
9	38+450	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
10	40+380	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
11	41+743	LVUP	Intermediate Lane ER	Span = 1 x 12m Vertical Clearance = 4.0 m
12	43+375	LVUP	1 Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
13	44+050	LVUP	1 Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
14	44+960	VUP	2 Lane BT	Span = 1 x 20m Vertical Clearance = 5.5 m
15	47+355	LVUP	2 Lane BT	Span = 1 x 12m Vertical Clearance = 4.0 m
16	48+820	OP	2 Lane BT	Span = 2 x 12m Vertical Clearance = 5.5 m

Summary of Grade Separated Structures:

Type	Nos.
VUP	08 No's
LVUP	07 No's
Overpass	01 No.
TOTAL	16 No's

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<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>		
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Cross drainage Structures:

57 No's of new box culverts has been proposed along green filed alignment in Package-2.

Existing				Proposed					Total
Pipe	Slab	Box	Total	New Box	Reconstruction	Widening	Retained	Abandoned (does not fall under PCL)	
30	04	-	34	48	*17	-	-	16	65

Major and Minor Bridges:

There are total 5 Nos. of minor bridges falling under this package, from which 1 no is abandoned for bypass proposal and remain 4 nos with 1 no culvert are proposed to reconstruct Minor Bridge. As per site requirement 07 nos of minor bridge have been proposed for new construction. The new bridges are proposed in standard of per IRC: SP: 84- 2019.

Existing		Proposed			Retained	Abandoned	Total
Type	No.	New	Reconstruction	Widening			
Major Bridge	-	-	-	-	-	-	-
Minor Bridge	05	7	5	-	-	01	12

Rail Over Bridge (ROB):

There is no proposal for ROB in this section.



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 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

	<p>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)).</p>	
	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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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



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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.

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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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-306 and acquisition of forest land in the reserve 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 Aizwal. The road will increase the connectivity of the project area as well as the state as a whole to the surrounding region.

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<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>		
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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.

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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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.

0.19 Task of the assignment

The tasks of this assignment include:

- 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;
- 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;
- Explore viable alternative project designs and alignments to avoid, where feasible, or minimize displacement and carry out public consultations on alternate bypass alignments.
- 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;
- Identify case of likely impact on Indigenous communities, to establish the applicability of GOI/State Government regulation;
- Carry out public consultation with the likely affected groups, NGOs, district administration and other stakeholders and document the outcomes;
- Provide a preliminary cost estimate for land acquisition, transfer and resettlement and rehabilitation and ensure inclusion in the overall project cost;
- Assets both within and outside of the right of way such structures and land will be recorded on strip maps; and

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 0: Executive Summary</p>	
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0.20 Cost Estimates

The project cost has been worked out for civil works for main carriageway, Service road, Truck lay bye, bus bays and junction improvement with Flexible pavement Project road length is considered as Packages-2, from Km 20+000 to Km 49+360. The details are presented in the Cost Estimate chapter 9.0. The item - wise abstract of cost of Civil Works package wise are given below.

Table 0.14 Abstract of Cost Estimate

Bill No.	Item of works	Cost (Rs. Crores)	Percentage
A	Site Clearance	0.83	0.11%
B	Earthwork	124.34	16.97%
C	Granular Sub-base & Base Courses	177.40	24.21%
D	Bituminous Base and Surface Courses	90.73	12.38%
E	Drains	22.03	3.01%
F	Protection Works		
	a) Reinforced earth wall	116.89	15.95%
	a) Breast wall	2.05	0.28%
	b) Retaining /Toe wall	25.21	3.44%
	c) Slope protection	7.92	1.08%
G	Traffic Signs, Markings and Other Road Appurtenances	54.13	7.39%
H	Miscellaneous works	4.03	0.55%
I	Cross Drainage Works - Box Culverts		
	a) Pipe Culverts	7.66	1.05%
	b) Box Culverts	28.30	3.86%
J	Bridges		
a	Minor Bridges	29.71	4.06%
K	Underpasses		
	a) LVUP	11.89	1.62%
	b) VUP	24.87	3.39%
L	Vehicular Overpass	4.77	0.65%
1	Cost of Civil Works (in Crores)	732.76	
2	Utility Shifting Cost	18.27	
3	Cost of Civil work i/c utility shifting	751.03	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Bill No.	Item of works	Cost (Rs. Crores)	Percentage
4	GST @18% on (3)	135.19	
5	Land Acquisition and Rehabilitation & Resettlement cost	705.08	
7	Environment and Forest clearance cost	12.76	
8	Supervision Charge 2.5% of (2) + GST @ 18%	0.54	
9	Contingency @ 1% of (1)	7.33	
10	Agency Charges @ (3% of (1) + 1% of (5)) + GST @ 18%	34.26	
11	Supervision Charge @ 3% of (1)	21.98	
12	Price Adjustment @ 5% of (1)	36.64	
13	Maintenance @ 2.5% of (1) + GST @ 18%	21.62	
14	Utility Cost of PGCIL Towers	18.16	
15	Additional compensation (Land + tree+ asset) for 540m length falls under cacher forest but physically control under Gov. of Mizoram	12.25	
16	Total Project Cost	1756.84	
17	Length of the project road (Km)	29.36	
18	Total Civil Cost per km	25.58	
19	Total Project Cost per km	59.84	

Annexure

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 0: Executive Summary</p>	
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Annexure 1. DPR Checklist – Stage 4 – Detailed Project Report

General Details	
Project Name	Vairengte to Sairang (Package-2, Km 31+000 to Km 46+000)
Consultant's Name	Transys Consulting Pvt.Ltd.
Date of Review	

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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 0: Executive Summary



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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 0: Executive Summary



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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 0: Executive Summary



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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 0: Executive Summary



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

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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))

Section: Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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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

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 1: Introduction</p>	

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.



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 1: Introduction



Fig 1.1 Index Map of the Project Road



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 1: Introduction

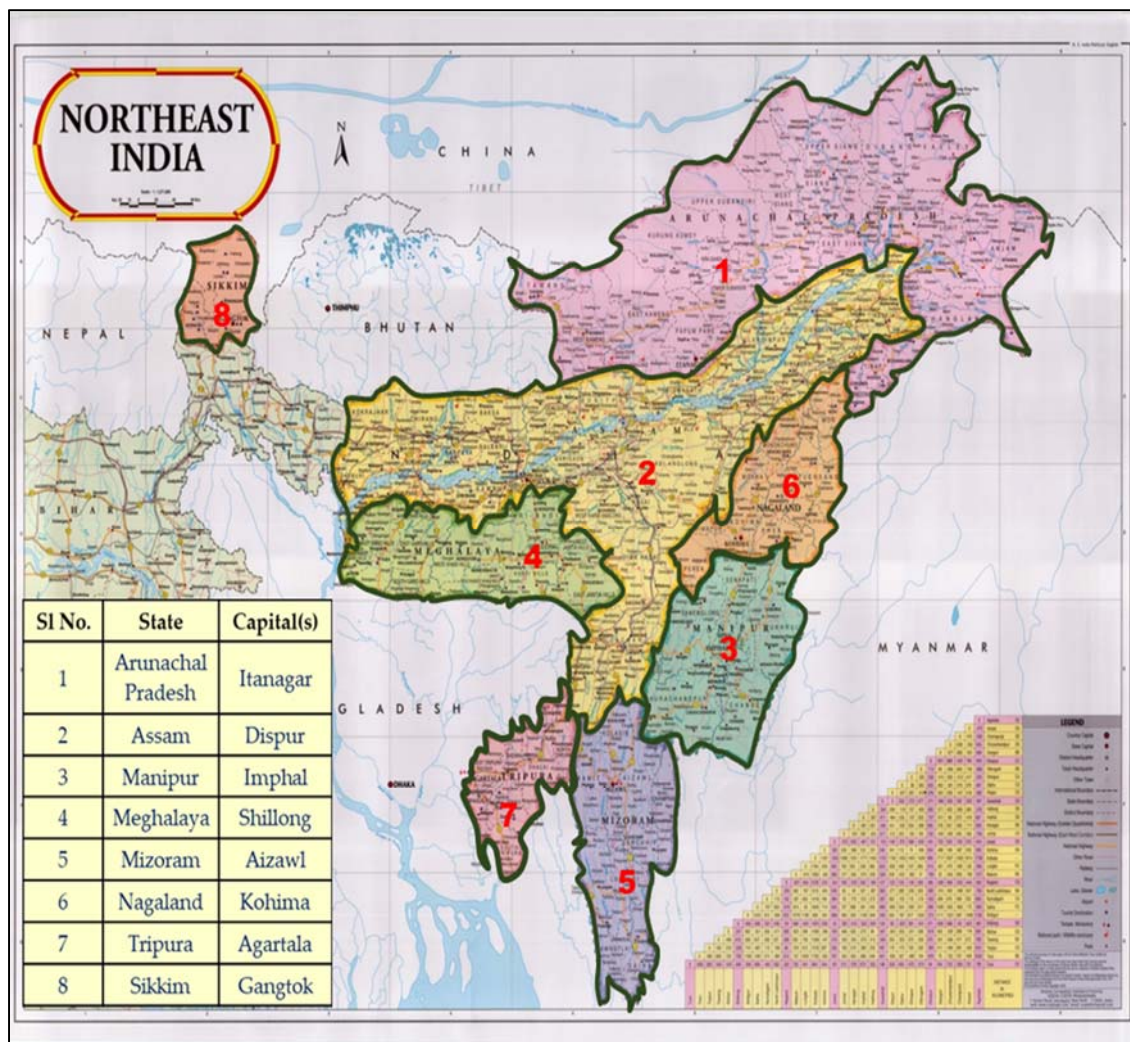


Fig 1.2 Project Influence Area



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)



Chapter 1: Introduction



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.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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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 06.06.2020 followed by last package in the month of Sep'20 i.e., on 21st September 2020 via letter no Transys/B'Lore/410/Silchar /2019-20/40301. DFR was reviewed by ED-P (RO- Guwahati) and DGM (P) - PMU Tezpur dated 06th Oct' 2020 with letter no 990012/DPR/SCH/NHIDCL/Tez/2569/228 and by ED-P (RO- Aizawl) and DGM (P)-Seling dated 19th June-20 and 21st Oct.2020 respectively with a note of an acceptance of DFR and further submission of Final Feasibility Report.

Accordingly, Final Feasibility Report (FFR) was submitted in packages SJ, SA1 & SA2 on 19.01.2021 vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2020-21/ 40319.

Draft Detailed Project Report (DDPR) was submitted for package: P-1 on 12th March 2022 vide through letter no Transys/B'Lore/410/ Silchar-Sairang/2021-22/40371 whereas Pkg-2 was submitted on 25.10.2021 vide through letter no Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40359.

Above, mentioned reports were submitted based on previous approved alignment.



However, portion of approved DPR alignment i.e., from existing km 13+200 (D. Ch. 21+000) onwards was suggested to re-route the proposed alignment as the alignment between D.Ch. 33+000 (existing km 26+750) till end of the package was proposed to be navigated through forest land keeping technical (4-lane development), social and financial viability in mind but denied by forest department at later stage with various reasons (explained in chapter - 0 under "executive summary") placed as per MoEF norms.

So further, since the DPR approved alignment was common up to existing km 13+200 (Des. Ch.21+000) and had no objection by any of the stakeholders including forest department hence, DPR package has been modified as shown below in consultation with ED(P)-RO Guwahati during VC meeting held on 13.06.2022.

1. Package: P1 (Des. Ch. 0+000 to Des. Ch. 21+000) - as per earlier DPR approved Alignment.
2. Package: P2 (Des. Ch. 21+000 to Des. Ch. 46+000) - as per modified Alignment

Accordingly, Draft Detailed Project Report (DDPR) for package: P-1 (Des. Ch. 0+000 to Des. Ch. 21+000) under **revision-01** was submitted on 6th July 2022 vide through letter no Transys / B'Lore /410/Silchar-Sairang/ 2021-22/40388.

But soon after submitting DDPR, DPR consultant has been advised for minor modification in project alignment while scrutinizing the draft DPR (R-1) by GM(P)

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 1: Introduction</p>	

office followed by ED-P (RO, Guwahati) office, meeting held on 23.09.2022 to **elimination of Trumpet Interchange at km 4+500 and shifting of project alignment towards right hand side at km 5+900 to avoid land acquisition of BSF area**, the project alignment has further been modified as per following,

1. Package: P1 (Des. Ch. 0+000 to Des. Ch. 20+000)
2. Package: P2 (Des. Ch. 20+000 to Des. Ch. 49+360)



Recently, DPR consultant has submitted revised draft DPR of Package: P-1 ((Des. Ch. 0+000 to Des. Ch. 20+000 under revision-3 and PATSC (dated 26.10.2022) followed by SFC (dated 21.12.2022) was successfully completed.

So, as per modified alignment approved by NHIDCL dated 14.07.2022 vide through letter no. NHIDCL/Assam/2021-22/SIL-VAI/TRANSYS/204315/1705, Feasibility Report (FR) was submitted for Package: P2 (mod) on 14.11.2022 vide through letter no. Transys / B'Lore /410/Silchar-Sairang/ 2022-23/401.

This Draft Detailed Project Report (DDPR) is being submitted under pkg-P2(mod) in response to the Terms of Reference Clause 10.9 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:



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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- 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;

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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- 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

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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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;



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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Table 1.1 Stage Submission Details

Sl. No	Stages	Key activities	Deliverables
1	Inception	Project planning and mobilization	Inception Report and QAP
2	Feasibility	Alignment finalization, Preliminary surveys	Alignment Options Report and Feasibility Report
3	LA and Clearances I	LA, utilities identification; creation of draft notifications and proposals	Strip Plan, LA Report (3a, 3A), Clearances and Utility Shifting proposals
4	DPR	Detailed design of highway, preparation of detailed project report with drawings	Draft DPR Report, Final DPR Report, documents and drawings
5	Technical Schedules	Preparation of bid documents and technical schedules	Civil Works Contract Agreement and Schedules
6	(i) LA II (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



Draft Detailed Project Report of Section: Silchar to Vairengte for Package-P2(mod), Km 20+000 (existing Km 12+920) to Km 49+360 (existing KM 43+000) in accordance with the accepted Feasibility 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.),

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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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



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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.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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- 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 OR after successful completion of PATSC & SFC.



1.6 Compliance to observations / comments raised during Feasibility study.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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Compliances to observations / comments raised during feasibility and common instructions for improvement in all packages during previous virtual or in-person meetings have been incorporated in this submitted DDPR

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.
- A PPT presentation with respective DCs (stake holders meeting) was held on 21.02.2020 at DC office, Kolasib, on 02.03.2020 at DC office, Cachar and on 04.03.2020 at DC office, Aizawl.
- Number of virtual and in-person meetings was also acknowledged with MD, respective EDs-P, respective GM/DGM (P), Forest department, ADC/CALA (Revenue

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 1: Introduction</p>	
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dept.), NH-PWDs and CM-Mizoram office as well to brief about development project road.

- 1.8 **Present Submission:** Draft Detailed Project Report (DDPR) is under submission.


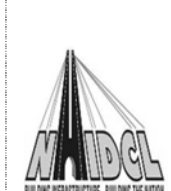
Chapter 2- Socioeconomic profile of the Project Area, Project Description and Existing Scenario

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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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 North East India is the largest State in the North East is bordering seven states (also called as 07 sisters) viz. Arunachal Pradesh, Manipur, 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 district 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 district 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 crops, 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.

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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

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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

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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 district 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 History of Road Development in Assam

Railways, which are the cheapest form of travel, have only a taken presence of some kilometers. Inland water-ways are practically non-existent even though at one time the small rivers criss-crossing the valleys were used for transporting goods and people by

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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.

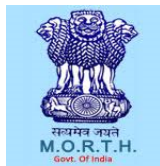
The road network construction and upgrade had received a boost with the implementation of the Special Accelerated Road Development Programme (SADRP) in 2006. The first phase envisaged a 6,500 km network for completion by 2016, but only about 1,000 km of the proposed network has been completed; a 3,723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

2.7 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



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 2: Project Appreciation

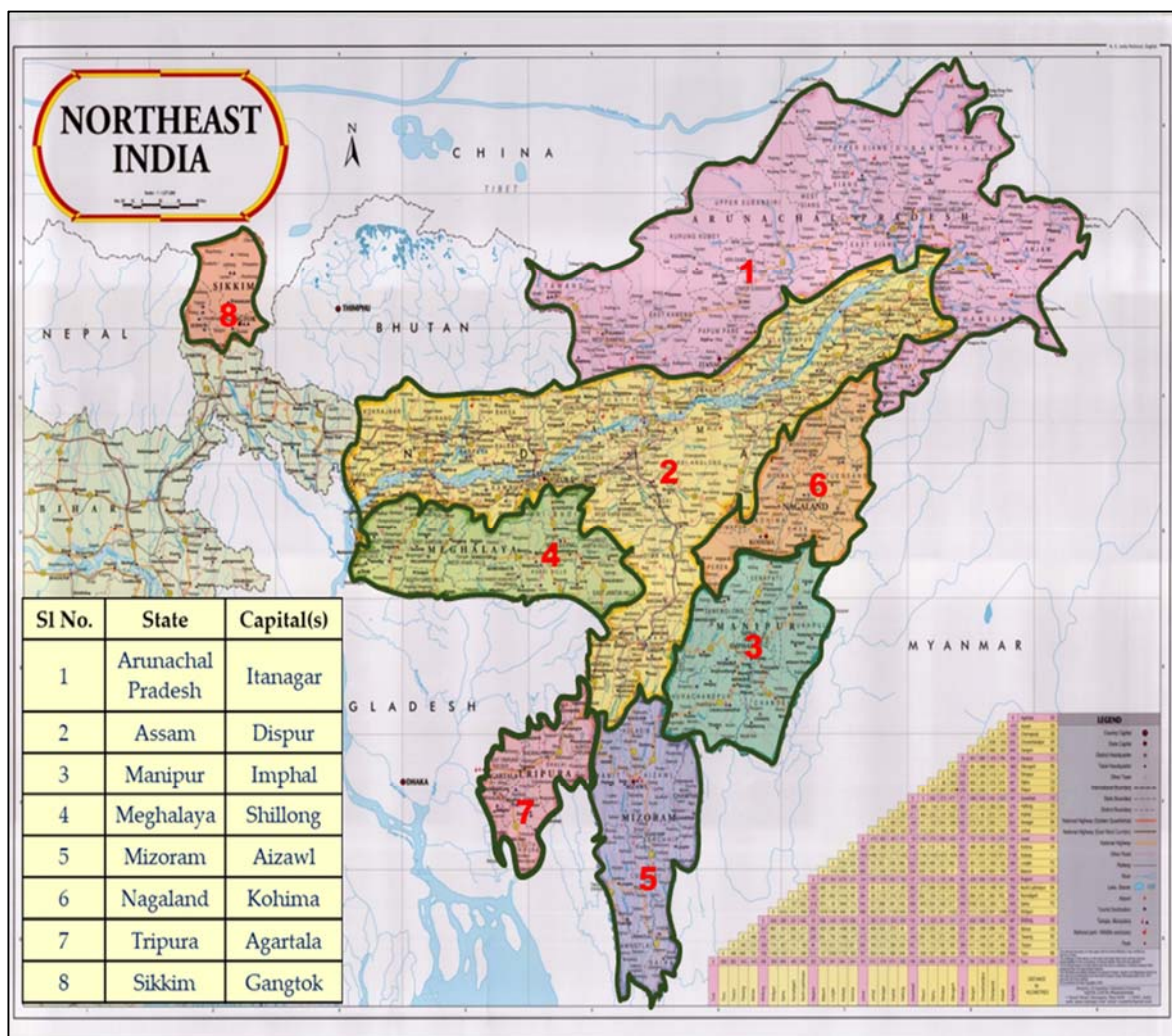


Fig 2.2 North Eastern States (7 Sisters State) : Project Influence Area

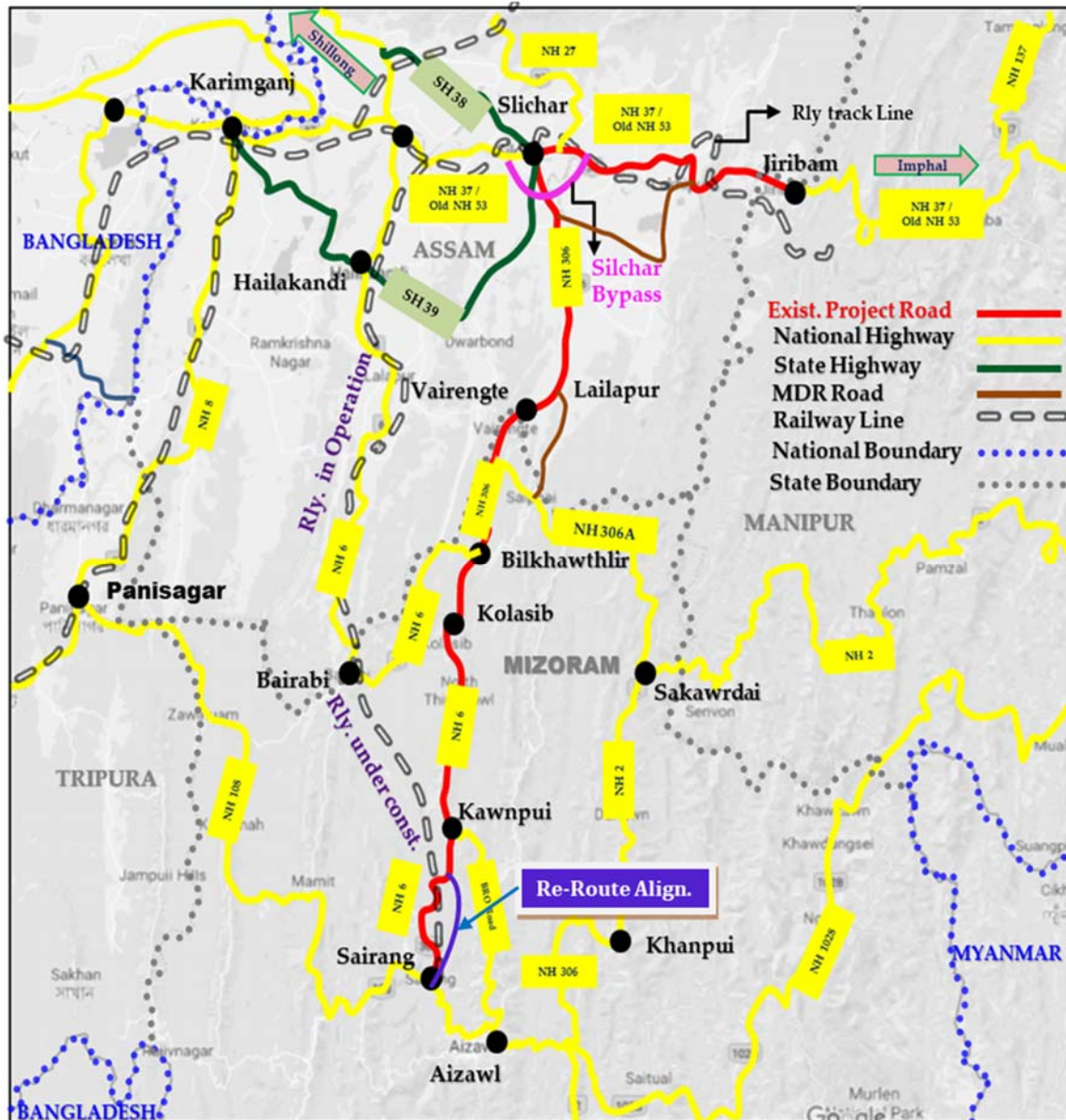




Fig 2.3 Key Map of Road Network in Assam, Mizoram and Manipur

North East (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



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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 1947, 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

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2.8 Location of Project Road

a) As per Contract Agreement (CA)

As per CA the second Project stretch starts from Silchar to Vairengte is the section of NH-306 (old NH-54) [or Km 266+700 of NH-37 (Old NH-53)] from the junction of capital point at Existing Km 0+000, Assam and ends at Km 49+900 of NH-306 near Phainuam junction of NH 306A at Vairengte town, Mizoram for approximate length of 49.9 Km.



b) After Reconnaissance survey and further discussion with NHIDCL:

After reconnaissance survey, it has been learnt that from Km 0+000 to Km 7+950, the project road traverses through heavily built-up with narrow ROW up to km 7+950 (Sonabarighat village). Since, said stretch couldn't warrant for 4-lane development in line with geometrics, land acquisition, environment & social perspective hence, the start point has been shifted to Clock Tower (Junction of NH-37 and NH-27) at existing km 263+800 of NH-37 and continued traversing along NH-37 up to km 257+450 via Rongpur, Arkatipur and Kashipur.

However, at the same time it has also been found that Silchar bypass (partly constructed 2-Lane, on hold) exist on RHS of project road and intersects at km 7+950 of NH-306 hence, DPR consultant has proposed to utilize partial section of Silchar bypass for the length of 7.5 Km from the junction of NH 37 at Km 257+450 and terminates at Km 7+950 of NH 306 near Sonabarighat continuing towards Vairengte up to Km 43+000 of NH-306 (old NH-54) at Lailapur /vairengte border. Hence, considering above existing scenarios, project road starts at km 263+800 of NH-37 with junction of NH-27 (Guwahati-Silchar Road).

Further, as we all know that there is dispute over border between Assam and Mizoram states. Govt. of Mizoram has put massive effort to resolve the long pending state border dispute with Union minister of home affairs (HMA) to intervene and review the state boundary based on Bengal Eastern Frontier Regulation 1873 and the inner line of the Lushai Hills Notification, 1993. The matter is still pending.

However, information obtained from different sources like Local bodies, applicable maps, and Border check-post administrative, 3 locations on existing NH-306 road have been identified viz. at existing Km 40+150, Km 42+250 and km 43+900 respectively. So, considering the existing circumstances and facts, we have fixed end chainage of "Silchar-Vairengte Section" at existing Km 43+000 of NH-306. The same may be revised once the matter resolved.

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Hence, DPR consultant has considered the start point as existing Km 263+800 of NH-37 (Old NH-53) with Design Ch. 0+000 and end point at Km 43+000 with Design Ch. 49+360 at Lailapur-Vairengte state border leading towards Aizawl.

Therefore, the total existing length of chosen route (along portion of NH-37 + portion of Silchar bypass + NH-306) is 48.900 kms.

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

Table 2.1 Latitude and Longitude of both ends of Project Road

Location	Latitude	Longitude	Altitude
Rongpur (NH-37)	24°50'1.50"	92°51'40.91"	23.00
Silchar-Vairengte Border	24°30'58.93"	92°46'39.72"	119.00

2.9 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. 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 136+400 from Silchar to Sairang as against 158+900 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 clarification, DPR consultant has considered the start point as existing Km 263+800 of NH-37 (Old NH-53) with Design Ch. 0+000 and end point at Km 43+000 with Design Ch. 49+360 at Lailapur-Vairengte state border leading towards Aizawl.

In addition, this report mainly deals with Package-2 that starts at existing Km 12+920 (D. Chainage 20+000) and ends at Existing Km 43+000 and (D. Chainage 49+360) however, for better comprehension DPR consultant has furnished the details from Silchar to Vairengte state border.

2.10 The Project Area

As mentioned earlier, project road lies in Cachar district of Assam and it traverse through major area like. Rongpur, kashipur, Sonabharighat, Nutan Bazar, Kabuganj,

Dolhai and Baga Bazar. The other important built-up areas are Saidpur Mukkam, Narsingpur, Katakai, Panibhora, Ramprasadpur, Saptagram, Islamabad and Lailapur.

Some portion of the project road runs through forest with constraints for geometric improvement of the alignment however, forest proposal was uploaded on PARIVESH portal dated 18.12.2021, based on instruction given by NHIDCL-HQ on 09.12.2021 but soon after proposal submission, forest department has denied the proposal on various reasons and suggested to follow option-3 i.e., improvement along existing road by providing individual bypasses at needed built-up / major settlement areas.

Later, on obvious reasons as explained in Chapter-0 under executive summary, it has been suggested by NHIDCL to modify / reroute the portion of “DPR approved alignment” in line with MoM issued by DC-Cachar dated 26.02.2022. DPR consultant has accordingly modified the alignment however, last section i.e., D. Ch 47+260 to 49+360 (L=2.1 km) encounters with IRF Cachar that requires forest clearance. DPR consultant is in process of applying FC through portal “PARIVAESH 2.0”.

Since the DPR approved alignment is common and had no objection up to existing km 12+920 (Des. Ch.20+000) hence, DPR package has been modified in consultation with ED(P)-RO Guwahati during VC meeting held on 13.06.2022 the revise DPR package is as mentioned below,

1. Package: P1 (Des. Ch. 0+000 to Des. Ch. 20+000) - as per earlier DPR approved Alignment.
2. Package: P2 (Des. Ch. 20+000 to Des. Ch. 49+360) - as per modified Alignment

2.11 Land use and Settlements along Project Road

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 2.2 Summary of Land use along project road

Sl. No.	Land use Description	Existing Length (km)	% of Length
1	Built up Area	27.750	57.00
2	Semi Built up Area	5.500	11.00
3	Agricultural Land	13.650	28.00
5	Hill Cum Forest Area	2.000	04.00

Settlements:

The existing road from Km 7+950 passes through a number of habitations. Major Builtup areas on route are Sonabharighat, Nutan Bazar, Kabuganj, Dolhai and Baga Bazar. Aggregate length of built-up areas along the Stretch is 48% 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. Numbers of Brick factories are observed along the project road. 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- Lane, improving the geometry is not possible within the available ROW wherever there is reduced EROW and it would entail for the demolition of structures within 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, three options were studied. **Option A:** Utilise by upgrading the under-construction bypass and proposal of new bypass **Option B:** Improvement of existing road with bypass options at Major built up and **Option C:** Green filed alignment. The details of the same are given below with existing Chainges;

Option A: Utilise by upgrading the under-construction Silchar bypass and proposal of new bypass



Utilize partial section of Silchar bypass for the existing length of 7.50 Km from the junction of NH 37 at Km 257+450 to Km 7+950 of NH-306. The same was agreed by concern delegates during PPT discussions and approved thereafter. PWD has also accepted the proposal and in the process of formal procedure for transferring the said stretch to NHIDCL.

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

- | | |
|-------------------------|--|
| a) Sonabarighat Bypass: | Km 7+950 to Km 12+500 |
| b) Nutan Bazar Bypass: | Km 14+620 to Km 21+270 |
| c) Katakhal Bypass: | Km 22+720 to Km 25+900 |
| d) Dholai Bypass: | Km 28+150 to Km 30+120 |
| e) Baga Bazar Bypass: | Km 30+860 to Km 32+350 &
Km 32+960 to Km 38+110 |

From all above bypasses, only the bypass to Sonabarighat was agreed by concern delegates during the presentation and remaining bypasses were overruled by opting Green field alignment option.

Off late, on obvious reasons as explained in Chapter-0 under executive summary, it has been suggested by NHIDCL to modify / reroute the portion of “DPR approved alignment” falls under greenfield (option-c) in line with MoM issued by DC-Cachar dated 26.02.2022 and follow option-B “Improvement of existing road with bypass

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options such as Nutan Bazar, Katakhal, Dholai and Bagha Bazar considered as Major Built up”.

Option C: Option of Partial Green Field Alignment: Km 12+920 to Km 43+000 (now proposed to be revised)

Option C was selected and approved during the presentation.

The detailed discussion about individual bypass under option (A), Option (B) and Option (C) is discussed in following paragraphs.

Altogether, there are total 29 villages/towns fall along existing project road. Out of 29 nos. of villages, 22 nos. of villages/towns proposed under Bypass in this project. The remaining stretches, proposed alignment follows the existing road with geometrics improvement/ Realignment. In some small villages, where existing alignment has been followed neither much of roadside activities nor any heavy local traffic coupled with pedestrian traffic exists. Following table gives list of villages along the project road.

Table 2.1 Land Use pattern and villages /Towns along Project Road

Sl. No.	Existing Chainage		Length (m)	Land Use	Side	Village Name	Remarks
	From	To					
1	263+800	259+950	3850	Built up	BHS	Rongpur	Via NH-37 Package-1 (263+800 to 12+920)
2	259+950	257+450	2500	Built up	BHS	Kashipur	
3	20+000	18+100	1900	Agricultural	BHS	Kashipur	Via Silchar Bypass Package-1 (263+800 to 12+920)
4	18+100	17+400	700	Built up	BHS	Badripar	
5	17+400	15+300	2100	Agricultural	BHS	Badripar	
6	15+300	14+500	800	Agricultural	BHS	Bagpur	
7	14+500	13+000	1500	Agricultural	BHS	Neairgram	
8	13+000	12+500	500	Built up	BHS	Sabashpur	Via NH-306 Package-1 (263+800 to 12+920)
9	7+950	9+000	1050	Built up	BHS	Saidpur	
10	9+000	10+700	1700	Built up	BHS	Sonabarighat	
11	10+700	11+500	800	Built up	BHS	Saidpur	
12	11+500	12+000	500	Built up	BHS	Dhanehari	
13	12+000	12+920	920	Semi Built up	BHS	Dhanehari	Via NH-306 Package-2 (12+920 to 43+000)
14	12+920	14+000	1080	Semi Built up	BHS	Dhanehari	
15	14+000	16+300	2300	Agricultural	BHS	Kajidahar	
16	16+300	17+000	700	Built up	BHS	Nutan Bazar	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Existing Chainage		Length (m)	Land Use	Side	Village Name	Remarks
	From	To					
17	17+000	18+200	1200	Built up	BHS	Berabak	Via NH-306 Package-2 (12+920 to 43+000)
18	18+200	19+700	1500	Semi Built up	BHS	Nagdirgram	
19	19+700	21+700	2000	Built up	BHS	Kabuganj	
20	21+700	24+000	2300	Agricultural	BHS	Narsingpur Pt I	
21	24+000	25+000	1000	Built up	BHS	Jalenga	
22	25+000	25+500	500	Agricultural	BHS	Jalenga	
23	25+500	26+000	500	Built up	BHS	Jalenga	
24	26+000	28+000	2000	Semi Built up	BHS	Jalenga	
25	28+000	29+000	1000	Built up	BHS	Ramprasadpur	
26	29+000	29+750	750	Built up	BHS	Ramprasadpur	
27	29+750	31+000	1250	Built up	BHS	Rajanikhal	
28	31+000	32+000	1000	Agricultural	BHS	Sadagram	
29	32+000	33+500	1500	Built up	BHS	Arjanpur	
30	33+500	34+500	1000	Built up	BHS	Saptagram	
31	34+500	35+000	500	Built up	BHS	Loknathpu	
32	35+000	36+000	1000	Built up	BHS	Islamabad	
33	36+000	36+500	500	Agricultural	BHS	Bhaga	
34	36+500	38+000	1500	Built up	BHS	Rajghat	
35	38+000	38+500	500	Built up	BHS	Rajghat	
36	38+500	39+500	1000	Agricultural	BHS	Howaitang	
37	39+500	41+000	1500	Built up	BHS	Joydhanpur	
38	41+000	43+000	2000	Hill cum Forest	BHS	Lailapur	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 2: Project Appreciation



Pic 2.1 Silchar Town



Pic 2.2 Sonabharighat & Saidpur



Pic 2.3 Nutan Bazar & Narsinghpur



Pic 2.4 Dolhai & Vairengte

Forest Area:

The Existing Project road passes through hill cum thickly vegetated/forest (**Inner line reserve forest / Roadside reserve forest**) from Km 41+000 to Km 43+000 for an approximate 2.00 km. The Project Highway is lying with moderate number of trees on both sides after Lailapur town from Km 41+000 to Km 43+000.

2.12 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 and hilly 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 and extends till the end of June 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 30.70 Km, 7.0 m carriageway for 8.3 Km, and 7.5km is under construction flying along silchar bypass.

The project road from Km 0+000 to Km 6+000 passes through heavy built up section of Silchar town. The carriageway (flexible) width along existing road in Silchar town

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is 10 m with Drain of 1.5m width on both sides. From Km 2+600 type of existing carriageway changes from flexible to Paver blocks which continues upto km 5+600 for a length of 3kms. From Km 6+000 to Km 7+950, the project road passes through minor built up like Uttar Krishnapur and Aulia. The type of carriage way is flexible with width of 10 m. At Km 7+950 of NH 306 project road intersects proposed Silchar bypass



Pic 2.5 Paver Block road (3kms) & Built up of Silchar Town

In general, Silchar town is completely habituated with utilities, religious structures, educational institutions and commercial activities on both side of project road. The local traffic in Silchar town is also high. Since the project road is main link between Aizawl and Silchar there is huge movement of commercial vehicle carrying different commodities to Aizawl. In addition, there is new railway construction is under progress from Bhairabhi to Sairang section. Hence considering future development there is a need for upgradation of existing road along Silchar town. During the preliminary survey it has been explored that a new bypass is already proposed to Silchar town which is under construction.



Pic 2.6 Intersect point of Silchar Bypass (km 8+500)

Hence DPR consultant has proposed to utilize partial section of bypass instead of using said stretch of NH-306 from km 0+00 to km 7+950, dense surrounded habitation of existing alignment. Utilisation of Silchar bypass is from the junction of NH 37 at Km

257+450 and terminates at Km 7+950 of NH 306 near Sonabarighat continuing towards Vairengte up to Km 43+000 of NH-306 (old NH-54) at Lailapur/Vairengte, stateborder.

From Km 7+950 to Km 9+500, the project road passes through minor built up like Saidpur and Sonabhari ghat. The type of carriage way is flexible with width of 10 m. From Km 9+500 to Km 20+000, the project road passes through villages like Saidpur (Km 10+000), Nutan bazar (Km 16+000), Narsingpur (Km 18+000) and Kabuganj (Km 19+800). The carriageway width is 10 m with condition varying from poor to fair. The width of earthen shoulder varies from 1.5 m to 2.0 m.

From Km 20+000 to Km 41+000, the project road passes through villages / towns like Katakai (Km 24+000), Panibhora (Km 26+500 or Km 27+000 of NH-54), Dolhai (Km 30+400), Saptagram (km 31+800), Islamabad (km 33+700), Bagabazar (km 35+100) and lailapur (39+500). The carriageway width varies from 9.5m to 10m and earthen shoulder varying from 1.5m to 2.0m. The embankment height along these stretches varies from 1.5 m to 2.0 m. From Km 26+000 to Km 36+000 Barak / Rukini river is flowing parallel to existing road and at Km 35+400 River flows even near to road edge (8m to 10m). At Km 39+900 the project road passes through Lailapur Military check post.

From Km 41+000 project road runs in hill terrain which continues up to end point of project at Km 43+000. The carriageway width from Km 41+000 to Km 43+000 varies from 6.8m to 7.4m. The condition of road varies from fair to poor. The width of earthen shoulder towards valley side varies from 0.5m to 1.0m.



Pic 2.7 Photographs of Existing Pavement Condition:

Table 2.2 List of Lane Configuration

Sl No	Existing Chainage		Length	Lane Configuration (as per site inventory)	Section	Remarks
	From	To				
1	263+800	263+000	800	14m	Rongpur-Kashipur	Package-1 (263+800 to 12+920) (Via NH-37)
2	263+000	257+450	5550	10m	Rongpur-Kashipur	
3	20+000	12+500	7500	-	Silchar Bypass	Package-1 (263+800 to 12+920) (Via Silchar Bypass)
4	7+950	12+100	4150	10.00 m	Uttar Krishnapur-Saidpur	Package-1 (263+800 to 12+920) (Via NH-306)
5	12+100	12+920	820	7.00 m	Saidpur-Sildubi Point	
6	12+920	13+000	80	7.00 m	Saidpur-Sildubi Point	Package-2 (12+920 to 43+000) (Via NH-306)
7	13+000	22+000	8800	10.00m	Sildubi point to Kabuganj	
8	22+000	25+500	3500	10.00 m	Kabuganj to Jalenga	
9	25+500	40+400	14900	10.00 m	Jalenga to Lailapur	
10	40+400	43+000	2600	7.00 m	Lailapur-Vairengte	

2.13 Existing Alignment

Initially during the alignment study stage many options such as widening, strengthening and improving of riding quality along with realignments, bypass and green field option were studied for the project highway. In order to avoid demolition of built up and for geometric improvements three options were studied and the details of the same is given below

The Project road proposed for Realignment and Bypass through various ancient Villages, Towns and a green field alignment also proposed for obligatory constrain along the existing road.

The details of locations are mentioned below. **(Existing Chainage)**

A. Utilise by upgrading the under-construction bypass and proposal of new bypass


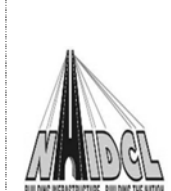
a) Silchar Bypass

B. Improvement of existing road with Bypasses

a) Sonabarighat Bypass: Km 7+950 to Km 12+500

b) Nutan Bazar Bypass: Km 14+620 to Km 21+270

c) Katakhal Bypass: Km 22+720 to Km 25+900

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	<p>Chapter 2: Project Appreciation</p>	

- d) Dholai Bypass: Km 28+150 to Km 30+120
- e) Baga Bazar Bypass: Km 30+860 to Km 32+350 &
Km 32+960 to Km 38+110

C. Proposal of Green field Alignment

- a) Green Field Alignment Option-II Km 12+920 to Km 43+000

A. Improvement of Existing road with Bypasses options

a) Silchar Bypass

Silchar town is completely habituated with utilities, religious structures, educational institutions and commercial activities on both side of project road. The local traffic in Silchar town is also comparatively high. However, at the same time it has also been extracted that Silchar bypass (partly constructed 2-Lane –on hold) exist on RHS of project road and intersects at km 7+950 of NH-306 (old NH-54). Hence, DPR consultant has proposed to utilize partial section of bypass for the existing length of 7.500 Km from the junction of NH 37 at Km 257+450 to junction of NH-306 near Sonabarighat at Km 7+950.

B. Improvement of Existing road with Bypasses options

a) Sonabarighat Bypass (Km 7+950 to Km 12+500)

The existing Project Road runs through heavy built-up section of Sonabarighat and villages like Saidpur (Km 10+000) from Km 9+000 to Km 14+000. It has also been observed that there are many religious structures which are very near to road edge like kali temple on LHS at Km 10+800, Darga at km 11+600 on LHS, etc. along both side of project road and the improvement of the existing road to NH standards will lead to demolition of buildings. Hence the bypass options were studied for Sonabarighat built a proposed length of 5.350 Km, as against existing length of 4.550 Kms.

b) Nutan Bazar Bypass (Km 14+620 to Km 21+270)

From Km 14+620 to Km 21+270, the project road passes through built up locations like Nutan Bazar (Km 16+000), Narsingpur (Km 18+000) and Kabuganj (Km 19+800). There are also government offices, educational institutions and residential buildings on both side throughout the major built up locations like Nutan bazar, Kabuganj etc. Thus, to avoid the habitation in Nuthan Bazar and Kabuganj, the bypass options was studied with a proposed length of 6.950Km, as against existing length of 6.650 Kms.

c) Katakhal Bypass (Km 22+720 to Km 25+900)

Project road enters Katakhal village from Km 23+400. The Katakhal village has built up on either side of the project road. The existing road has poor geometry with curve and pattern of development of built up is linear. To improve the existing road to 4-Lane standards would require acquisition of built up area for entire length. Hence to improve the existing geometry as per NH 4-lane standards a bypass option was

studied. The bypass option is having a length of 3.250 Kms, as against existing length of 3.180 Kms.

d) Dholai Bypass (Km 28+150 to Km 30+120)

The existing road passes through Dholai built up from Km 28+150 to Km 30+120, which has a habitation on either side of the existing road. Improving of the existing road to NH standards will lead to demolition of the greater number of buildings, so bypass options have been studied with a length of 2.000 Kms, as against existing length of 1.970 Kms

e) Baga Bazar Bypass (Km 30+860 to Km 32+350 & Km 32+960 Km 38+110)

Existing Project road traverse through Saptagram, Islamabad, Bagabazar and lailapur built up from Km 31+500 to Km 39+450. The existing road geometry is poor with substandard curves and the built up is linear on either side of the existing road, so to improving the existing alignment to 4-Lane standards will lead to demolition of buildings. . Thus, by considering above facts and future growth of town, a bypass option was studied with a design length of 6.200 Km, as against existing length of 6.640 Kms

C. Proposal of Green field Alignment (now proposed to be changed as per Green Field Alignment Km 12+920 to Km 43+000)

The proposed alignment traverses from Km.12+920 on RHS of existing alignment and passes through green field/agricultural field/forest land and terminates at Km 43+000, covering existing road length of 30.080Km as against design length of 26.000 Km. Less numbers of buildings are affected compared to other options moreover there is more scope for future widening. The portion of proposed alignment passes through hill from km 31+000 (D. Ch) to exiting km 43+000 (D. Ch. 46+000). The section of proposed alignment also encounters reserve forest. The details of same will be provided in separate chapter.

2.14 Existing Right-of-way

As per the records available with PWD, NH division, the ROW in town/built-up areas varies from 9 to 15m and in rural areas, ROW varies from 20 to 25m along the entire stretch. The existing ROW along the stretch is given in following.

Table 2.3 Details of Existing ROW/Available Land along the Project Road

SL No.	Existing Chainage		Length (m)	EROW Width (m)	Name of Villages	Remarks
	From	To				
1	263+800	262+190	1610	30	Rongpur	NH-37 Package-1 (263+800 to 12+920)
2	262+190	260+020	2170	22	Rongpur	
3	260+020	259+950	70	30	Rongpur	
4	259+950	257+450	2500	22	Kashipur	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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SL No.	Existing Chainage		Length (m)	EROW Width (m)	Name of Villages	Remarks
	From	To				
5	20+000	18+100	1900	50	Kashipur	Silchar Bypass Package-1 (263+800 to 12+920)
6	18+100	15+300	2800	50	Badripur	
7	15+300	14+500	800	50	Bagpur	
8	14+500	13+000	1500	50	Neairgram	
9	13+000	12+500	500	50	Sabashpur	
10	7+950	9+000	1050	15	Saidpur	NH-306 Package-1 (263+800 to 12+920)
11	9+000	10+700	1700	20	Sonabarighat	
12	10+700	11+500	800	20	Saidpur	
13	11+500	12+920	1420	20	Dhanehari	
14	12+920	14+000	1080	20	Dhanehari	NH-306 Package-2 (12+920 to 43+000)
15	14+000	16+300	2300	20	Kajidahar	
16	16+300	17+000	700	20	Nutan Bazar	
17	17+000	18+200	1200	20	Berabak	
18	18+200	19+700	1500	20	Nagdirgram	
19	19+700	21+700	2000	20	Kabuganj	
20	21+700	24+000	2300	20	Narsingpur Pt I	
21	24+000	27+000	3000	20	Jalenga	
23	27+000	29+000	2000	20	Ramprasadpur	
24	29+000	29+750	750	20	Rajanikhal	
25	29+750	31+000	1250	20	Sadagram	
26	31+000	32+000	1000	20	Arjanpur	
27	32+000	33+500	1500	20	Saptagram	
28	33+500	34+500	1000	20	Loknathpu	
29	34+500	35+000	500	20	Islamabad	
30	35+000	36+000	1000	20	Bhaga	
31	36+000	38+000	2000	20	Rajghat	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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SL No.	Existing Chainage		Length (m)	EROW Width (m)	Name of Villages	Remarks
	From	To				
32	38+000	38+500	500	20	Howaitang	NH-306 Package-2 (12+920 to 43+000)
33	38+500	39+500	1000	20	Joydhanpur	
34	39+500	41+000	1500	20	Lailapur	
35	41+000	43+000	2000	9	Borkhal	

2.15 Road Junctions

There are 8 major road junctions with National highway, State Highways and MDR and 91 minor junctions with village roads and State highways, which need to be designed.

Table 2.4 List of Major Road Junctions

Sl. No.	Location		At Grade	Side	Category of crossroad	Remarks
	Ex. Chainage	Name of junction				
1	262+950	Guwahati	T	LHS	NH-27	NH-37 Package-1 (263+800 to 12+920)
2	257+450	Silchar Bypass	T	RHS	Kashipur	
3	9+300	Sonai	Y	LHS	Village Road	NH-306 Package-1 (263+800 to 12+920)
4	13+300	Silkuri	T	RHS	Village Road	NH-306 Package-2 (12+920 to 43+000)
5	20+800	Kabuganj Town	Y	LHS	Village Road	
6	36+200	Bangram	Y	LHS	Village Road	
7	38+300	Howaitang Road	Y	LHS	Village Road	
8	40+600	Mizoram road, Lailapur	T	RHS	Village Road	

Table 2.5 List of Minor Road Junctions

Sl. No.	Existing Chainage	Type of Carriageway	Type of Junctions (T, Y, +)	SIDE	Type of Road (SH/ MDR/ PMGSY/ VR)	Remarks
1	259+510	ER	Y	LHS	Kashipur	NH-37 Package-1 (263+800 to 12+920)
2	259+010	BT	Y	LHS	Kashipur	
3	257+625	BT	Y	RHS	Kashipur	



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Existing Chainage	Type of Carriageway	Type of Junctions (T, Y, +)	SIDE	Type of Road (SH/ MDR/ PMGSY/ VR)	Remarks
4	14+180	BT	Y	BHS	Silchar Bypass	Silchar Bypass Package-1 (263+800 to 12+920)
5	9+285	BT	Y	LHS	Village Road	NH-306 Package-1 (263+800 to 12+920)
6	9+571	BT	Y	LHS	MBS Road	
7	9+932	BT	Y	LHS	Village Road	
8	10+200	BT	T	RHS	Village Road	
9	10+531	BT	Y	RHS	Village Road	
10	10+667	BT	T	RHS	Village Road	
11	11+016	BT	Y	RHS	Village Road	
12	11+500	BT	Y	RHS	Village Road	
13	11+610	BT	T	RHS	SAIDPUR PTV	
14	11+898	BT	Y	LHS	DHANEHARI	NH-306 Package-1 (263+800 to 12+920)
15	11+980	BT	T	RHS	Village Road	
16	12+054	BT	T	LHS	Village Road	
17	12+622	BT	Y	RHS	Village Road	
18	12+886	BT	T	RHS	Village Road	
19	12+904	BT	T	LHS	Village Road	
20	13+270	BT	T	LHS	Village Road	Package-2 (12+920 to 43+000)
21	13+332	BT	Y	RHS	Village Road	
22	13+735	BT	Y	LHS	Village Road	
23	14+035	BT	Y	LHS	Village Road	
24	14+603	BT	Y	LHS	LAMARGRAM	
25	15+265	BT	Y	RHS	Village Road	
26	15+421	BT	Y	LHS	Village Road	
27	16 827	BT	X	BOTH	Village Road	
28	17+087	BT	Y	RHS	Village Road	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 2: Project Appreciation

Sl. No.	Existing Chainage	Type of Carriageway	Type of Junctions (T, Y, +)	SIDE	Type of Road (SH/ MDR/ PMGSY/ VR)	Remarks
29	17+153	BT	Y	LHS	Village Road	Package-2 (12+920 to 43+000)
30	17+208	BT	Y	LHS	Village Road	
31	17+987	ER	Y	RHS	Village Road	
32	18+156	BT	Y	LHS	Village Road	
33	18+758	BT	Y	LHS	Village Road	
34	18+905	ER	Y	RHS	Village Road	
35	19+179	BT	Y	RHS	Village Road	
36	19+358	BT	Y	LHS	Village Road	
37	20+688	BT	T	LHS	Village Road	
38	20+838	BT	Y	LHS	Village Road	
39	21+278	BT	Y	LHS	TARUNUDOY ROAD	
40	21+595	BT	Y	LHS	Village Road	
41	21+765	BT	Y	LHS	Village Road	
42	24+181	BT	Y	RHS	B CHOWHAN ROAD	
43	24+190	BT	Y	RHS	Village Road	
44	24+606	ER	X	BOTH	Village Road	
45	25+140	BT	Y	LHS	Village Road	
46	25+545	BT	Y	RHS	Village Road	
47	25+817	BT	Y	LHS	Village Road	
48	25+986	BT	Y	RHS	Village Road	
49	27+236	BT	Y	LHS	Village Road	
50	29+050	BT	Y	LHS	Village Road	
51	29+876	BT	X	BOTH	Village Road	
52	30+000	BT	Y	LHS	Village Road	
53	30+262	BT	T	RHS	Village Road	
54	30+640	BT	Y	LHS	Village Road	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 2: Project Appreciation

Sl. No.	Existing Chainage	Type of Carriageway	Type of Junctions (T, Y, +)	SIDE	Type of Road (SH/ MDR/ PMGSY/ VR)	Remarks
55	31+012	BT	Y	RHS	Village Road	Package-2 (12+920 to 43+000)
56	31+756	BT	Y	RHS	Village Road	
57	32+092	BT	Y	LHS	Village Road	
58	32+441	BT	T	RHS	Village Road	
59	32+545	BT	Y	LHS	Village Road	
60	33+363	BT	X	BOTH	Village Road	
61	33+615	BT	T	LHS	Village Road	
62	33+802	BT	Y	RHS	Village Road	
63	33+881	BT	T	LHS	Village Road	
64	33+971	BT	Y	LHS	Village Road	
65	34+015	BT	Y	LHS	Village Road	
66	34+194	BT	Y	LHS	Village Road	
67	34+228	BT	Y	RHS	Village Road	
68	34+382	BT	Y	LHS	Village Road	
69	34+486	BT	X	BOTH	Village Road	
70	34+635	BT	Y	LHS	Village Road	
71	35+092	BT	Y	RHS	Village Road	
72	35+206	BT	X	BOTH	Village Road	
73	35+332	BT	Y	LHS	Village Road	
74	35+407	BT	Y	RHS	Village Road	
75	35+684	BT	Y	RHS	Village Road	
76	35+761	ER	Y	RHS	Village Road	
77	35+871	BT	Y	LHS	Village Road	
78	36+018	BT	Y	RHS	Village Road	
79	36+079	BT	Y	LHS	Village Road	
80	36+289	BT	Y	RHS	Village Road	
81	36+915	BT	X	BOTH	Village Road	

Sl. No.	Existing Chainage	Type of Carriageway	Type of Junctions (T, Y, +)	SIDE	Type of Road (SH/ MDR/ PMGSY/ VR)	Remarks
82	37+345	BT	Y	LHS	Village Road	Package-2 (12+920 to 43+000)
83	37+492	ER	Y	LHS	Village Road	
84	37+571	BT	Y	RHS	Village Road	
85	37+666	BT	Y	RHS	Village Road	
86	37+736	BT	Y	LHS	Village Road	
87	37+970	BT	Y	LHS	Village Road	
88	38+154	BT	Y	LHS	PANCHAYAT OFFICE ROAD	
89	38+268	BT	Y	LHS	HAWAITHAN G ROAD	
90	38+594	BT	Y	RHS	Village Road	
91	39+258	BT	Y	RHS	Village Road	
92	39+385	BT	Y	RHS	Village Road	
93	39+760	BT	Y	RHS	Village Road	
94	40+620	BT	X	BOTH	Village Road	
95	40+910	BT	Y	RHS	Village Road	

Note: The stretch between Km 0+000 to Km 7+950 of NH-306 is de-scoped from the project scope.

2.16 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 2.6 Summary of culvert & Bridges

Culverts				Bridges			Causeway	ROB	RUB	LC
Pipe	SlabArch	Box	Total	Minor	Major	Total				
Section: Silchar to Vairengte (263+800 to 43+000)										
46	05	10	61	09	01	10	-	-	-	-
Package-1 (263+800 to 12+920)										
16	01	10	27	04	01	05	-	-	-	-
Package-2 (12+920 to 43+000)										
30	04	-	34	05	-	05	-	-	-	

There are 61nos. of existing culverts, out of which 5nos are Slab on NH-306, 10nos are Box on NH-37 and 46 are Pipe culverts, Out of which 15nos are on Silchar bypass and 31 nos are on NH-306 along Silchar to Vairengte Section. However, as per Package-2 there are 04nso of Slab culvert and 30 nos of Pipe culverts on NH-306, which details are mentioned below;

Table 2.7 Summary of culvert & Bridges of Package-2


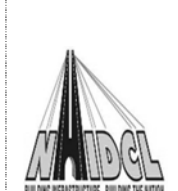
Sl No.	Existing Design Chainage (Km)	Type	Size	Formation/ Deck Width (m)	Deck Thickness (m)	Remarks
1	16+650	Pipe	2x0.9	17		Package-2 (12+920 to 43+000)
2	17+950	Pipe	2x0.9	17		
3	21+290	Pipe	2x0.9			
4	21+470	Pipe	2x0.9	17.2		
5	21+600	Pipe	2x1.2	17		
6	22+380	Pipe	2x1.2	17.3		
7	22+560	Slab	1x5	17		
8	23+260	Pipe	2x1.2	17.4		
9	26+010	Pipe	2x0.9			
10	26810	Pipe	2x1.2	17.1		
11	27+255	Pipe	2x1.2	17.2		
12	27+930	Slab	1x4	17.5	0.35	
13	30+900	Pipe	1 x 0.9			
14	32+840	Pipe	2x1.2	17.8		
15	33+300	Pipe	2x0.9	17		
16	33+600	Pipe	2x1.2	17.2		
17	34+100	Pipe	2x1.2	17.2		
18	34+300	Pipe	2x1.2	18		
19	35+650	Slab	1x5	17.2	0.35	
20	37+300	Pipe	2x1.2	17.5		
21	38+350	Pipe	1 x 0.9			
22	38+570	Pipe	2x1.2	17.5		

Sl No.	Existing Design Chainage (Km)	Type	Size	Formation/ Deck Width (m)	Deck Thickness (m)	Remarks
23	38+800	Pipe	2x1.2	18.5		Package-2 (12+920 to 43+000)
24	39+300	Pipe	2x1.2	17.8		
25	39+645	Pipe	2x1.2	18		
26	40+140	Slab	1x2.8	12.2	0.25	
27	40+300	Pipe	1x0.9	11		
28	40+550	Pipe	1x0.9	9		
29	40+700	Pipe	1x0.9	10		
30	40+900	Pipe	1x0.9	11		
31	41+000	Pipe	1x0.9	11		
32	42+200	Pipe	1x0.9	11		
33	42+600	Pipe	1x0.9	10.5		
34	42+800	Pipe	1x0.9	8		

There is 1 no of existing major bridge over Barak River falling on Silchar Bypass, at km 13+091.5 (PWD km 13+000), which is constructed up to A1, P1 and P2 in 2-Lane standard, and abandoned and 09nos. of existing Minor bridges, out of which 01 no is on Silchar bypass at PWD Km 12+270 after crossing NH-306 near Saidpur, having a span arrangement of 3 x 10.5m having a deck width of 42.0m a total length of 63m and 08 nos are on NH-306 on Silchar to Vairengte Section. Out of 08 Nos. of Minor Bridges on NH-306, 5 Nos. are RCC Slab Type 2 No. is Box type, and 1 Nos. is Steel Truss type. The details of same have been shown below.

Table 2.8 Summary of Minor Bridges

Sl. No.	Chainage	Type of Structure	Span Arrangement (m)	Length of Structure (m)	Structure Configuration	Deck Width (m)	Remarks
1	12+270	Minor Bridge	3 x 10.5	31.5	RCC Box type	42	On Silchar Bypass Package-1 (263+800 to 12+920)
2	10+250	Minor Bridge	1 x 26.50	26.50	RCC Box type	8.5	NH-306 Package-1 (263+800 to 12+920)
3	11+350	Minor Bridge	1 x 35.00	35.00	Steel Truss type	10.0	
4	12+350	Minor Bridge	1 x 26.30	26.30	RCC Bow type	9.0	

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	<p>Chapter 2: Project Appreciation</p>	

Sl. No.	Chainage	Type of Structure	Span Arrangement (m)	Length of Structure (m)	Structure Configuration	Deck Width (m)	Remarks
5	29+815	Minor Bridge	1 x 38.00	38.00	Box-Girder type	10.0	Package-2 (12+920 to 43+000)
6	30+215	Minor Bridge	1 x 38.80	38.80	Box Girder type	10.0	
7	38+490	Minor Bridge	1 x 8.50	8.50	RCC slab type	11.0	
8	39+210	Minor Bridge	2 x 5.50	11.00	RCC slab type	11.0	
9	39+990	Minor Bridge	1 x 10.00	10.00	RCC slab type	11.0	

The widening, reconstructions and New constructions of bridges are proposed as per IRC: SP: 84- 2019.

2.17 Traffic Flow Conditions



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

Table 2.9 Details of Homogenous Sections

Section	Homogenous Section	Chainage (Existing)		Length (Km)
		From (Km)	To (Km)	
Section – 1	Intersecting point of Silchar bypass with NH-306 to Vairengte	*8+800	42+750	33.95
Section – 2	Vairengte to Kolasib	42+750	86+500	43.75
Section – 3	Kolasib to Kawnpui	86+500	121+500	35.00
Section – 4	Kawnpui to Sairang	121+500	157+800	36.30
Section – 5	Sairang to Aizawl	157+800	-	20.00

Note: *The stretch between 0+000 to Km 7+950 is not in present scope of discussion.

The above homogeneous sections are considered due to settlements close to the carriageway, commercial establishments, stopping of buses, pedestrian crossing, slow moving vehicles etc.

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2.18 Railway line crossing

There are no crossings of Railway line along the project road.

2.19 VUP and PUP

There are no crossings of PUP and 1 no of VUP on Silchar Bypass to NH-306 at exist. Km 7+950 of NH-306 (PWD Km 12+500) along the project road, which is under construction.

2.20 Petrol Pumps

There are 4 Nos. of petrol / diesel pump stations present along the project road from Silchar to Vairengte. These stations are being used by vehicular traffic regularly. The location of these stations is indicated below.

Table 2.10 Petrol/Diesel Filling Stations along Project Road



Sl. No.	Existing Chainage (Km)	Direction	Near Villages	Remarks
1	263+800	RHS	Rongpur	NH-37 Package-1 (263+800 to 12+920)
2	15+849	LHS	Natun Bazar	Package-2 (12+920 to 43+000)
3	18+511	LHS	Narsipur	
4	34+497	RHS	Bhaga Bhazar	

2.21 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 2.11 Schools along Existing Project Road

Sl. No.	Existing Chainage (Km)	Side (LHS/RHS)	Near Villages	Remarks
1	263+800	LHS	Rongpur	NH-37 Package-1 (263+800 to 12+920)
2	262+900	LHS	Rongpur	
3	262+850	RHS	Rongpur	
4	259+300	LHS	Natun	
5	11+755	LHS	Saidapur	NH-306 Package-1 (263+800 to 12+920)
6	17+914	LHS	Sonai Town	NH-306 Package-2 (12+920 to 43+000)
7	18+093	RHS	Narsingpur	

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 2: Project Appreciation</p>	
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Sl. No.	Existing Chainage (Km)	Side (LHS/RHS)	Near Villages	Remarks
8	18+383	RHS	Narsingpur	NH-306 Package-2 (12+920 to 43+000)
9	19+635	RHS	Narsingpur	
10	20+698	LHS	Kabu Ganj	
11	24+412	RHS	Katakhal	
12	25+441	LHS	Pani Bhora	
13	25+815	LHS	Pani Bhora	
14	30+241	RHS	Dholai	
15	36+925	RHS	Lailapur	
16	37+332	RHS	Lailapur	
17	39+467	LHS	Lailapur	

Table 2.12 Hospitals along Existing Project Road

Sl. No.	Existing Chainage (Km)	Side (LHS/RHS)	Near Villages	Remarks
1	17+185	LHS	Sonai	NH-306 Package-2 (12+920 to 43+000)
2	20+603	RHS	Kabuganj	
3	24+610	RHS	Katakhal	
4	29+297	RHS	Dholai	
5	30+377	LHS	Dholai	NH-306 Package-2 (12+920 to 43+000)
6	34+312	RHS	Bhaga Bazaar Hbua	
7	34+555	RHS	Bhaga Bazaar Hbua	
8	43+561	RHS	Lailapur	

2.22 Constraints

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

- Bypass to Silchar town is already proposed by PWD, NH Division Silchar. The map of the Silchar bypass is given in below figure.
- Barak River is running parallel to LHS of existing road from Km 0+000 to Km 9+000. Sonai and rukuni River is also following parallel to the LHS of existing road to continuous length.

- Commercial traffic carrying different commodities from Guwahati and Karimganj (NH-27) uses the project road (NH-37) and SH-39 to reach various parts of Assam and Mizoram state. Improvement of existing road may boost to tourism sector. Improvement of existing road may boost to tourism sector.
- Inadequate existing ROW width at built-up areas,
- Settlements close to project road involving rehabilitation and resettlement action plan,
- Presence of religious structures along the project road – there are approx. 19 nos. of temples, 17 nos of masjid, 3 nos of darga and 06 nos Church along the existing 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 matured trees along the project road within EROW.
- Some stretches are flying in hilly area with plantation.
- The existing alignment is also facing so numerous blackspots, which details are provided below.

2.2.2.1 Exiting Silchar Bypass

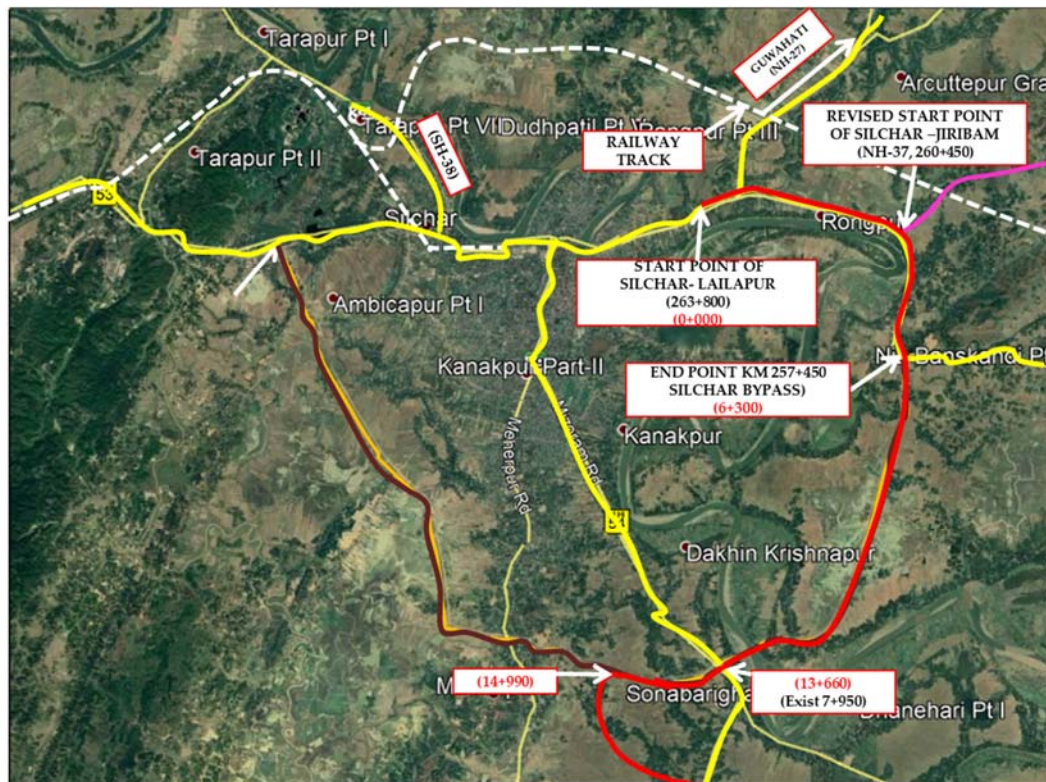

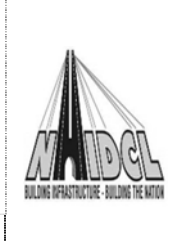


Fig 2.1 Silchar Bypass

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 2: Project Appreciation</p>	
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- Silchar bypass is 2-lane partially constructed. it is necessary to mentioned that the balance work of construction of 2-lane Silchar bypass by State PWD from km 0+000 to km 12+500 (called as ISBT leg, L=12.500 km) is still in progress and undertaken & funded by State Govt. whereas, remaining portion from State PWD km 12+500 to km 20+000 (called as Kashipur leg) is under the process of foreclosure as the same portion, turn into part of 4-lane development from Silchar to Aizawl under Bharatmala Pariyojana in order to arrive at a feasible option due to foggy situation of balance 2-lane Silchar bypass construction specially bridge over Brarak, geometrics demand, safety parameters, future traffic demand, minimizing land acquisition and environmental & social perspective.
- The Silchar 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-37 (Old NH-53) at Km 6+250.
- Traverses along RHS of Silchar town and terminates near Kashipur village at Km 257+450 of Silchar Jiribam Road NH-37 (Old NH-53).
- The proposed bypass intersects project road alignment at Km 7+950 of Silchar-Vairengte Road NH-306 (Old NH-54).
- The traffic from Guwahati and Imphal can be diverted to Silchar bypass towards Mizoram so that traffic congestion can be mitigated in Silchar town.
- Length of proposed bypass is 20.000 Km.

2.22.2 Black Spot along Existing Road

The alarming rise in road accidents is one of India's worst kept secrets. Such alarming statistics only goes to show the lack of proper road safety measures in the country. The state of Assam contributes a major part in India's alarming accident count. With the rapid growth of population in the city, the road traffic problems are also increasing at an alarming rate. The NH-37 and NH-306 passing through most of the major city are one of the most important National Highways of India as it provides the entrance to various states of North-eastern India and connects the city with other states of Eastern India. Due to the ease of connectivity, there has been an exponential growth in the number of vehicles plying through this area which has subsequently accelerated the number of road accidents. Hence, it has become important to properly analyse the stretch and locate the areas where the frequency of accidents is high. Rural areas are more prone to road accidents as compared to the urban areas in the country. In this topic, an attempt has been made to determine such accident-prone areas, called blackspots on NH-306 from Silchar to Vairengte.

Table 2.13 Details of Black Spot

Sl. No	Date	Vehicle Type	Case No	Location	Injured	Killed	Chainage
1	16-06-18	Traveler Bus	2198/18	Kashipur Turning	1	1	258+800
2	6/4/2018	Ambassador	1102/18	Kashipur B R T F Camp	-	1	259+500
3	2/5/2018	Tipper	1555/18	Rongpur (Ram Krishna Petrol Pump)	-	1	265+700
3	10/6/2018	Motor cycle	1975/18	Sonai road (2 nd link road)	-	1	3+250
4	4/5/2018	Tata sumo	1534/18	South krishnapur	1	1	6+000 to 8+000
5	1/1/2018	Maruti Car	578/18	Sonabarighat (near petrol pump)	-	1	8+800
6	8/1/2018	Truck	116/18	Sonabarighat	1	2	9+000
7	2/4/2018	Truck	1020/18	Saidpur pt II (Near Bridge)	1	4	11+700
8	5/5/2018	Auto rickshaw	1480/18	Saidpur pt iv	-	1	10+000 to 11+000
9				katagasthola			
10	15/06/2018	Motor cycle	2159/18	Saidpur pt IV	-	1	10+000 to 11+000
11	1/11/2018	Motor cycle	3452/18	Saidpur PT V	-	1	11+000
12	25/08/2018	Scotty	3427/18	Saidpur (Charkishah Mukam)	-	1	11+700
13	17/07/2018	Auto rickshaw	173/18	Panibhora SBI Atm	3	1	25+500

2.23 Utilities

Utilities like telephone cables, O.F.C. lines 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 are the part of final strip plans and are going to be submitted with this Final Feasibility Report separately. The details of the utilities and trees which are required to be shifted/ cut have been shown in the Strip Plans. Details of utilities along the existing are mentioned below,

Table 2.14 Summary of Utilities along existing

TYPES	Nos.
HT Lines	1
Electric pole	2220
Transformer	102



Pic 2.8 Utilities along existing Alignment (Silchar – Vairengte)

2.24 Environmentally Sensitive Areas

As the project road is in operation and likely to be improved / upgraded along with bypasses as discussed above. Since, the portions of alignment (2.1 km) falls under thickly vegetated/ forest hence, there would be ecological and environmental impact however; necessary measures and precaution will be ensured during construction.

2.25 Government / Private Agencies to be consulted

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

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

2.26 Recommendations concerning the alignment

Along the existing road

The project road follows the existing road for a length of 6.35 Km of NH-37 and 7.5km of existing 2-lane Silchar bypass where following suggestions are made.

- Symmetrical widening i.e. widening on both sides of existing highway for a symmetrical width has been adopted/ preferred. This would avoid acquisition of land/ buildings on a large scale as compared to eccentric widening of existing highway.
- Realignment due to curve improvement.
- Bypasses for major built-up section

Bypass/Realignments/Geometric Improvements

The project road which is presently Intermediate/2-lane shall be developed to 4-lane divided carriageway configuration in open area and built-up areas. Salient features of the proposed improvements are summarized below.

Table 2.15 Locations of Bypass for Section : Silchar to Vairengte

Sl. No.	Description	Unit	Total
1	Existing Road Alignment		
	Total exiting Road Length (from km 263+800-NH-37 to km 43+000-NH-306)	Km	48.900
2	Bypass & Green Field Alignment		
	A. Upgrading the under-construction Bypass		
	1) Silchar Bypass (Km 20+000 to Km 12+500)	Km	7.500
	B. Improvement of existing road with bypass options at Major Built up		
	1) Sonabarighat Bypass (Km 7+950 to Km 12+500, NH-306)	Km	4.550
	Note: As per recent development the proposed alignment is also to be follow the below bypass of option-B ;		
	1) Nutan Bazar Bypass	Km	6.650
	2) Katakhal Bypass	Km	3.180
	3) Dholai Bypass	Km	1.970
	4) Baga Bazar Bypass	Km	6.64
	Total Length of Bypass (under recent development)	Km	18.44
	C. Option of Partial Green Field Alignment (Now Proposed to be revised by following Option-B)		
	1) Green Field Alignment (Km 12+920 to Km 43+000, NH-306)	Km	30.080
3	Total Length (A+B))	Km	30.490

Detailed discussion on same has been dealt in Chapter: 7.



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 2: Project Appreciation</p>	
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Table 2.16 Locations of Bypass for Package-2, Km 12+920 to Km 43+000

Sl. No.	Description	Unit	Total
1	Existing Road Alignment		
	Total exiting Road Length (from km 12+920 to km 43+000)	Km	30.080
2	Improvement of existing road with bypass options at Major Built up		
	1) Nutan Bazar Bypass	Km	6.650
	2) Katakhal Bypass	Km	3.180
	3) Dholai Bypass	Km	1.970
	4) Baga Bazar Bypass	Km	6.64
3	Total Length (Bypass)	Km	18.440

The above total bypass length of 18.440 Kms is along the existing road whereas, the length as per design is 18.400 Km. So, there is difference of length comes to 0.040 Km. The same has been discussed in Chapter: 7.

3



Chapter 3 - Analysis & Interpretation of Engineering Surveys and Investigations

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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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

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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

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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



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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)	Location of Pillar w.r.t Ex. Road	Co-Ordinate		Level
				Easting	Northing	
1	GPS 12A	13+170	LHS	482820.418	2733735.051	23.414
2	GPS 12B	13+310	LHS	482844.740	2733608.967	23.443
3	GPS 14A	Bypass	RHS	483162.423	2730065.554	20.817
4	GPS 14B	Bypass	RHS	483167.630	2729922.440	21.129
5	GPS16A	21+250	LHS	485290.590	2726876.227	24.223
6	GPS16B	21+360	LHS	485223.355	2726765.010	24.366
7	GPS 18A	25+750	RHS	484400.314	2722716.699	27.361
8	GPS 18B	25+820	LHS	484421.147	2722638.945	27.386
9	GPS 20A	30+560	LHS	483673.130	2718122.006	30.068
10	GPS 20B	30+670	RHS	483691.782	2718013.573	29.841
11	GPS 22A	Bypass	RHS	482185.085	2713689.035	30.165
12	GPS 22B	Bypass	RHS	482123.147	2713591.718	30.901
13	GPS 23A	41+670	RHS	477846.378	2711476.262	93.474
14	GPS 23B	41+750	RHS	477762.799	2711460.845	97.570

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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.



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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 egomotion 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.

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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.

- Raw DGPS data for the entire highway length and adjoining areas of interest.
- Point cloud data/ Data of points captured for the entire highway length and adjoining areas of interest.
- Topographic map of scale 1:1000 of the entire highway length and adjoining areas of interest.
- Contour map of 50 cm of entire highway length and adjoining areas of interest.
- Cross section of the highway at every 1 m in *.dwg format.
- 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 has been shown graphically below.



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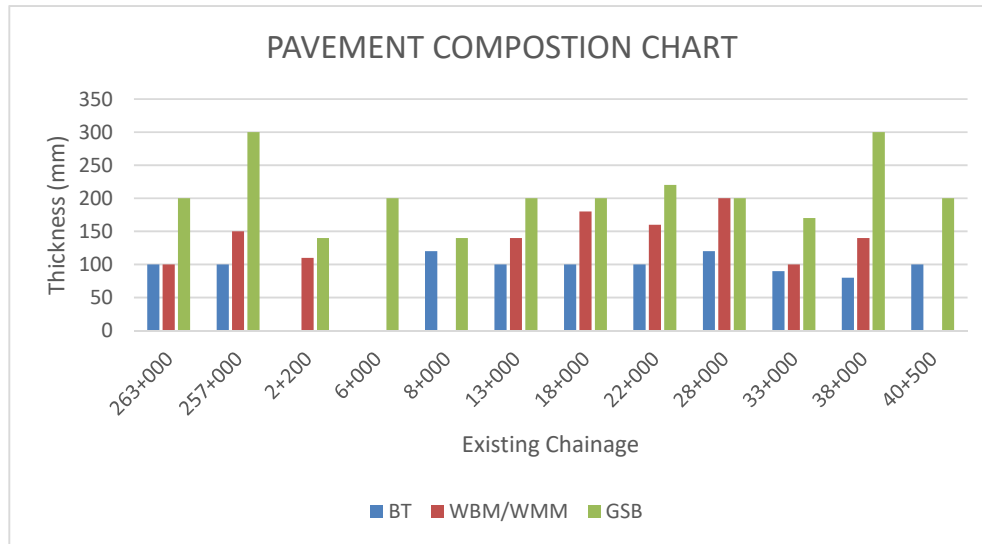


Fig 3.1 Pavement Condition Chart

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. Only GSB and WMM were observed along the partially constructed Silchar bypass. Results of the test pit survey indicate appreciably varying thickness of pavement layers for the carriageway. Total thickness of the pavement is varying between 100 mm and 520 mm. The thickness of bituminous layer is varying between 80-120 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)**. This data forms the basis for the input into economic analysis and the deterioration models that are being used for the economic analysis.

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

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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	Ravelling (% Area)	Patching (%Area)	Rut Depth (mm)	Edge Drop (mm)
			(%Area)				
**I	0 to 8+800	Not Applicable as the proposed alignment follows Silchar bypass					
II	8+800 to 43+000 along NH-306	39%	13%	63%	26%	17	60

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 stretch between Tarapur junction, Silchar to Intersection point of Silchar bypass (Km 0+000 to Km 8+8000) is de-scoped from this project work as the proposed alignment falls follows Silchar partially constructed bypass for a length of 8.5km.**

The existing pavement surface condition based on visual observation varies from Poor to Fair for the project road length from Km 8+800 to Km 43+000.

The pavement condition survey was conducted in the year 2018 for the section from Silchr to Vairengte, at the time of survey the condition of the pavement was fair and poor and 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

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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)		Classification	Remarks
From	Km		
0+000	8+800	Not in the current scope	
8+800	43+000	Poor to Fair	PKG-1 and PKG-2
Refer Volume-I, Appendices to Main Report (Appendix 3.4) for more details			

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.

- 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 canals, streams/rivers crossing the project road. The widths of these crossings vary from 0.9m to 12m. The culverts are of Pipe, Slab and Box type



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whereas most of the Minor bridges have Bridge structures with RCC slab type super structures and no 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 61 culverts and 10 Minor Bridge on the project road. A summary of cross-drainage structures are given in the following table.

Table 3.5 Summary of Culverts and Bridges

Culverts				Bridges			Causeway	ROB	RUB	LC
Pipe	Slab/Arch	Box	Total	Minor	Major	Total				
Section: Silchar to Vairengte (263+800 to 43+000)										
46	05	10	61	09	01	10	-	-	-	-
Package-1 (263+800 to 12+920)										
16	01	10	27	04	01	05	-	-	-	-
Package-2 (12+920 to 43+000)										
30	04	-	34	05	-	05	-	-	-	

There are 61nos. of existing culverts, out of which 5nos are Slab on NH-306, 10nos are Box on NH-37 and 46 are Pipe culverts, Out of which 15nos are on Silchar bypass and 31 nos are on NH-306 along Silchar to Vairengte Section. However, as per Package-2 there are 04nos of Slab culvert and 30 nos of Pipe culverts on NH-306

There is 1 no of existing major bridge over Barak River falling on Silchar Bypass, at km 13+091.5 (PWD km 13+000), which is constructed up to A1, P1 and P2 in 2-Lane standard, and abandoned and 09nos. of existing Minor bridges, out of which 01 no is on Silchar bypass at PWD Km 12+270 after crossing NH-306 near Saidpur, having a span arrangement of 3 x 10.5m having a deck width of 42.0m a total length of 63m and 08 nos are on NH-306 on Silchar to Vairengte Section. Out of 08 Nos. of Minor

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Bridges on NH-306, 5 Nos. are RCC Slab Type 2 No. is Box type, and 1 Nos. is Steel Truss type.

Most of these bridges are having open foundations at shallow depths with or without bed protection and substructures are of RCC. All the slab culverts are having RCC substructure and superstructure. In most of the Pipe culverts, the structures are of Random Rubble stone masonry only. Very few are of RCC sub structures.

Some of the pipe culverts are having too small vent of 300 mm to 600 mm and as such these structures are having insufficient vent way, most of these culverts are used for irrigation purposes. Some are having 900mm and 1000mm dia pipes, but most of these pipes are of NP2 type.

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

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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

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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. Since 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 comprehensive 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	Section	Sample Type	Remarks
1	262+000, LHS	NH-37	Subgrade	NH-306 Package-1 (263+800 to 12+920)
2	257+000, RHS	NH-337	Subgrade	
3	2+200, RHS	Silchar Bypass	Subgrade	
4	6+000, LHS	Silchar Bypass	Subgrade	
5	8+800, LHS	NH-306	Subgrade	
6	13+000, RHS	NH-306	Subgrade	
7	18+000, LHS	NH-306	Subgrade	
8	23+000, RHS	NH-306	Subgrade	
9	28+000, LHS	NH-306	Subgrade	Package-2 (12+920 to 43+000)
10	33+000, LHS	NH-306	Subgrade	
11	38+000, RHS	NH-306	Subgrade	
12	40+500, LHS	NH-306	Subgrade	

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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:** Since the Proposed alignment is passing through green filed and not following the existing NH-306(old NH-54) alignment, the subgrade samples were collected at 5 Km interval.*



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.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 3: Analysis & Interpretation of Engineering Surveys and Investigations</p>	
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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

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 %.

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 12 subgrade samples were collected from Silchar to Vairengte, out of which 2 samples collected from Km 263+000 to Km 257+000 of NH-37 and 2 samples were collected along the partially constructed Silchar bypass. All the samples collected are belongs to Silty sand SM group IS soil classification system. Liquid limit varies from NP to 41.0%, plasticity Index ranging from NP to 13.65 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 1.73gm/cc to 1.996gm/cc and



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optimum moisture content varies from 13.36% to 17.2%. 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 6.2% to 7.1%.

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 Fig 3.3.

The detailed test results (like grain size curves, compaction test curves and CBR test curves) are given table below. The images of trail pit are presented in below fig;

Table 3.7 Lab Test Results

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	262+000 (NH-37)	LHS	0.00	0.00	1.09	70.38	28.54	NP	NP	NP	32.00	2.66	1.94	13.76	6.80	SM
2	257+000 (NH-37)	RHS	0.00	0.00	7.53	50.43	42.05	NP	NP	NP	31.00	2.68	1.96	13.36	6.60	SM
3	2+200 (Silchar Bypass)	RHS	0.00	0.00	10.19	16.01	73.80	41.00	27.85	13.65	28.00	2.61	1.80	17.20	6.20	SM
4	6+000 (Silchar Bypass)	LHS	0.00	0.00	11.23	56.94	31.84	NP	NP	NP	31.00	2.65	1.92	13.50	6.90	SM
5	08+800 (NH306)	LHS	0.00	0.00	24.12	52.54	23.34	NP	NP	NP	32.00	2.72	1.90	14.20	7.10	SM
6	13+000 (NH306)	RHS	0.00	0.00	23.56	50.44	26.01	NP	NP	NP	32.00	2.64	1.92	14.00	7.00	SM
7	18+000 (NH306)	LHS	0.00	0.00	7.02	52.47	40.51	18.00	14.63	3.37	27.00	2.62	1.73	14.00	6.60	SM
8	23+000 (NH306)	RHS	0.00	0.00	28.50	41.36	30.15	21.00	19.55	1.45	26.00	2.61	1.87	14.10	6.90	SM
9	28+000 (NH306)	LHS	0.00	0.00	20.79	49.57	29.65	NP	NP	NP	33.00	2.70	1.88	14.40	6.80	SM
10	33+000 (NH306)	LHS	0.00	0.00	3.40	49.38	47.22	NP	NP	NP	31.00	2.69	1.87	14.00	6.70	SM
11	38+000 (NH306)	RHS	0.00	0.00	12.12	44.29	43.60	NP	NP	NP	32.00	2.66	1.87	13.90	6.90	SM
12	40+500 (NH306)	LHS	0.00	0.00	6.62	50.77	42.61	NP	NP	NP	31.00	2.65	1.85	14.10	6.80	SM

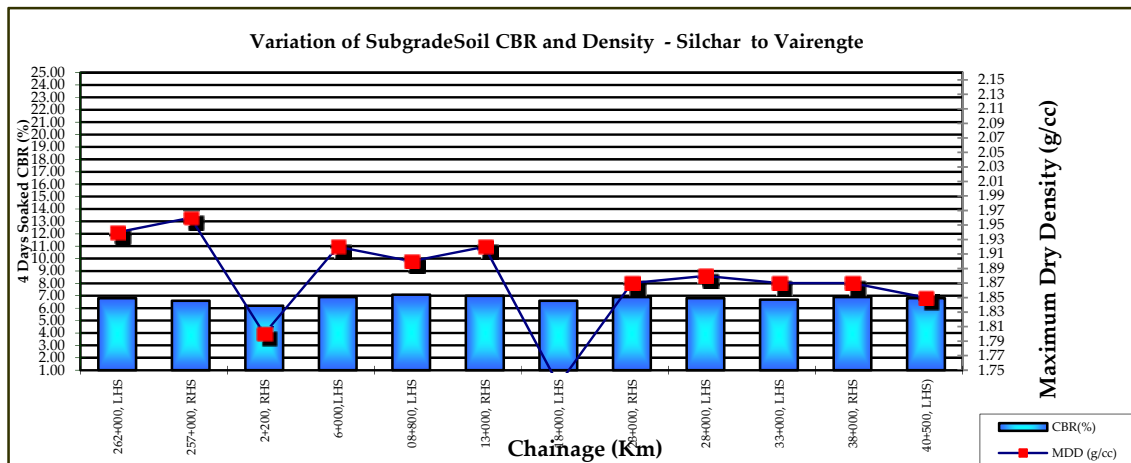


Fig 3.2 Soaked (4 Days) CBR vs MDD Graph of Subgrade Soil



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Trial Pit at Silchar bypass (LHS)



Trial Pit at Silchar bypass



Trial Pit at Km 8+800 (LHS)



Trial Pit at Km 13+000 (RHS)



Trial Pit at Km 18+000 (LHS)



Trial Pit at Km 23+000 (RHS)



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Trial Pit at Km 28+000 (LHS)



Trial Pit at Km 33+000 (LHS)



Trial Pit at Km 38+000 (RHS)



Trial Pit at Km 40+500 (LHS)



Pic 3.1 Photographs Showing Trial Pit

3.7.6 Green filed alignment Section Soil Sample

A total of 5 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	15+700	Bypass	Package-1 (263+800 to 12+920)
2	22+000	Bypass	Package-2 (12+920 to 43+000)
3	23+500	Bypass	
4	31+200	Bypass	
5	36+900	Bypass	

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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.

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

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

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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 %.

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 5 Soil samples were collected along green filed alignment. All the samples collected are belongs to belongs to Silty with low compressibility ML IS soil classification system. Liquid limit varies from 20% to 50.5%, plasticity Index ranging from 11.37 to 16.36 and free swelling index varies from 25% to 28%. 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 1.65gm/cc to 1.92gm/cc and optimum moisture content varies from 14.00%to 21.80%. 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 4.5% to 5.5%.

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 **Fig 3.2**.

The detailed test results (like grain size curves, compaction test curves and CBR test curves) are given in table below. The images of trail pit are presented in below fig;



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 3: Analysis & Interpretation of Engineering Surveys and Investigations</p>	
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Table 3.9 Soil test results

Sl. No	Design Chainage	Location	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	15+700	Bypass	0	0	0	11	89	47.5	31.76	15.74	25	2.53	1.67	21.8	4.8	ML
2	22+000	Bypass	0	0	0	7.2	92	50.5	34.14	16.36	27	2.51	1.68	21.1	4.7	ML
3	23+500	Bypass	0	0	0	9.3	90	47	31.64	15.36	26	2.58	1.67	21	4.9	ML
4	31+200	Bypass	0	0	0	3	97	49	35.46	13.54	28	2.56	1.65	21.3	4.5	ML
5	36+900	Bypass	0	0	2.34	402	57	20	8.63	11.37	26	2.62	1.92	14	5.5	ML

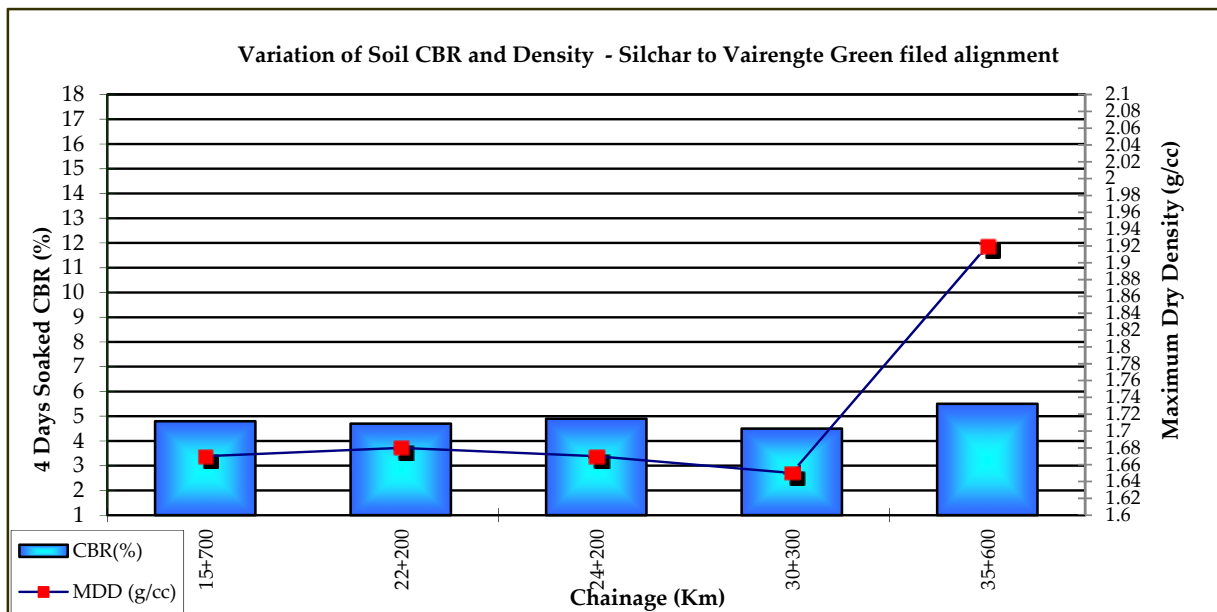


Fig 3.3 Soaked (4 Days) CBR vs MDD Graph of Green filed alignment Soil



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Soil sample at Dch 15+700 (Bypass)



Soil sample at Dch 22+000 (Bypass)



Soil sample at Dch 23+500 (Bypass)





Soil sample at Dch 31+200 (Bypass)



Soil sample at Dch 36+900 (Bypass)

Pic 3.2 Photographs Showing Soil samples

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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

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 3: Analysis & Interpretation of Engineering Surveys and Investigations</p>	
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- 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 were no borrow area observed along the project road from Silchar to Vairengte , so the Borrow 2 borrow areas that are located along Silchar to Jiribam is considered for Silchar to Vairengte 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

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
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Pic 3.3 Photographs of 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.



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Table 3.11 Details of Stone Quarries

Quarry No.	Name of the Quarry / Address / Location	Material Supplying	Existing Chainage	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	Chainage	Left/ Right	Name of Village/River	Lead (Km)
PKG-1	262+500 (NH-37)	Left	Madhura River at Udharbond Range	22.00
PKG-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



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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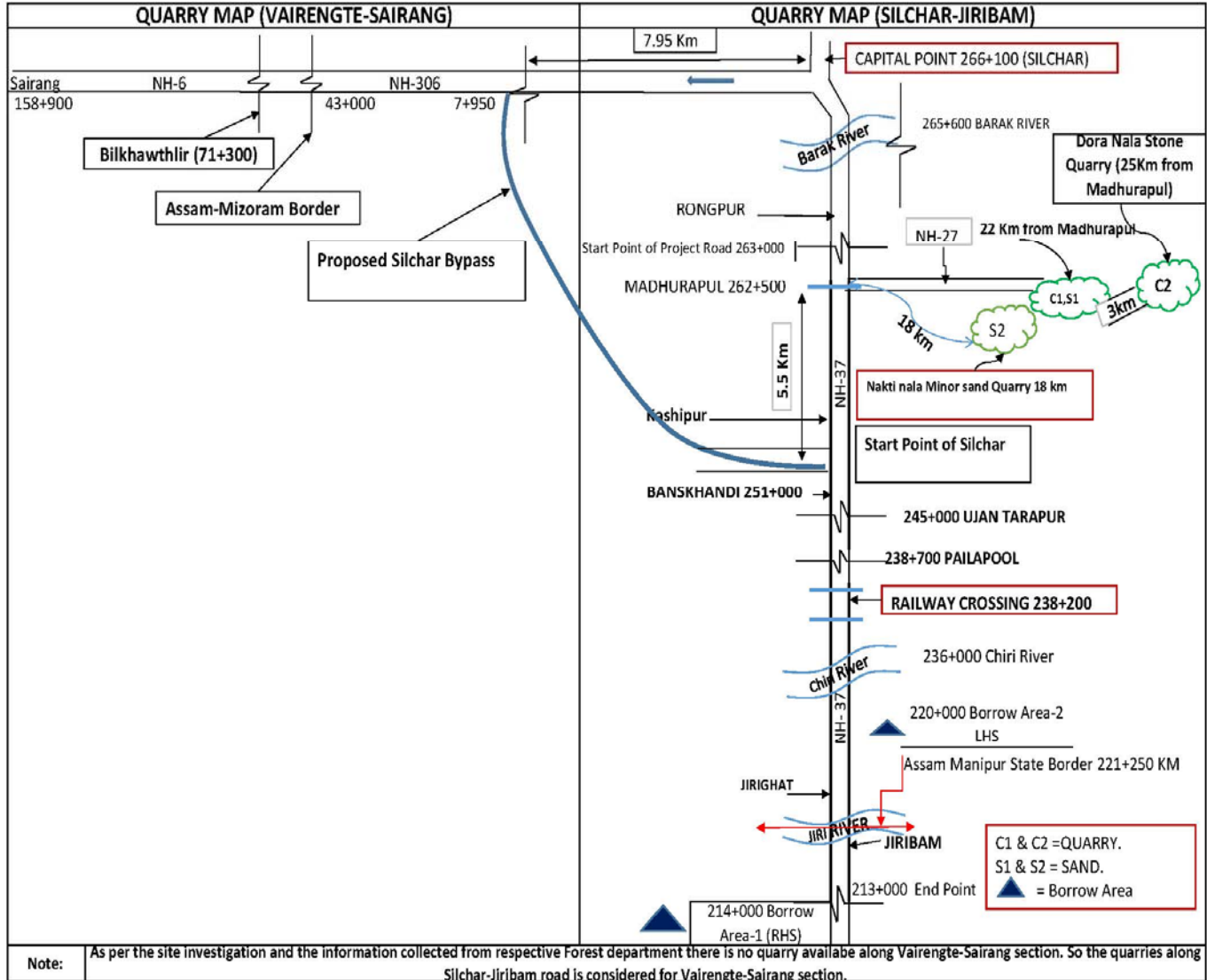




Fig 3.4 Lead Map

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.

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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 Schar 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


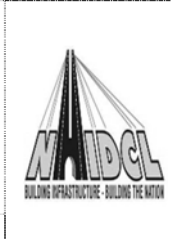
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4 Chapter 4 – Traffic Studies & Demand Forecast

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 devise 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 Sairang is a part of Silchar-Aizawl corridor, which is considered as an important connecting road between Assam, Manipur, Meghalaya and Mizoram. The project road attracts the traffic from Shillong, Karimganj, Dawki, Imphal, Guwhathi, Silchar and other parts of Assam. The project road is the single source of trade for Mizoram and International trade like Myanmar and Bangladesh. 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 Sairang is characterized by different level of traffic at individual sections falls within the State of Assam & Mizoram and taking into account of the traffic in terms of volume and character, it can be divided in five homogeneous section. Further addition to that in order to observe the traffic movement between Sairang and Aizwal, an additional homogeneous section from Sairang to Aizwal is also considered. The section details are indicated in below table;

Table 4.1 Details of homogeneous sections



Section	Homogenous Section	Chainage (Existing)		Length (Km)
		From (Km)	To (Km)	
Section – 1	Silchar to Vairengte	0+000	42+750	42.75
Section – 2	Vairengte to Kolasib	42+750	86+500	43.75
Section – 3	Kolasib to Kawnpui	86+500	121+500	35.00
Section – 4	Kawnpui to Sairang	121+500	158+900	37.40
Section – 5*	Sairang to Aizawl	158+900	178+000	19.01

Note:

The stretch between Km 0+000 to Km 8+000 (at intersection point of Silchar bypass) is de-scoped from the project road as the proposed alignment follows partially constructed Silchar bypass.

*The section between Sairang to Aizwal is not part of the project road. However, **since** majority of the traffic is originating/ destination from Aizwal and in order to observe the traffic movement between Sairang and Aizwal, this homogeneous section has been considered.

Further since, the project road from Silchar to Sairang lies in two different states ie. Assam and Mizoram, hence the Project Influence area (PIA) will be different for the Assam state and

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Mizoram state, hence the traffic analysis is represented for Silchar to Vairengte and Vairengte to Sairang separately.

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 gives details of various traffic surveys conducted with location and period of survey from Silchar to Vairengte and Vairengte to Sairang.

Table 4.2 Details of traffic Survey locations

Sl. No.	Type of Survey	Duration	Location (Existing Km)	Period	
				From	To
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 (BRO Road))	12-02-2020	15-02-2020

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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Sl. No.	Type of Survey	Duration	Location (Existing Km)	Period	
				From	To
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 Survey 4	1 Day	Zanlawn (BRO Road)	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-6 and Bairabi Road at Km 88+500 (Rengtekawn)	12-02-2020	12-02-2020
	Intersection Volume Count-04	Peak Hours	Jn of NH-6 and BRO Road at Km 121+500 (Kawnpui)	12-02-2020	12-02-2020
	Intersection Volume Count-05	Peak Hours	Jn of NH-6 and NH-108 at Km 158+900 (Sairang)	10-02-2020	10-02-2020
*Traffic survey locations for Silchar to Jiribam section					
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

**The detailed traffic study for Silchar-Jiribam corridor will done separately under different package.*

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-Sairnaga and Silchar-Jiribam.

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

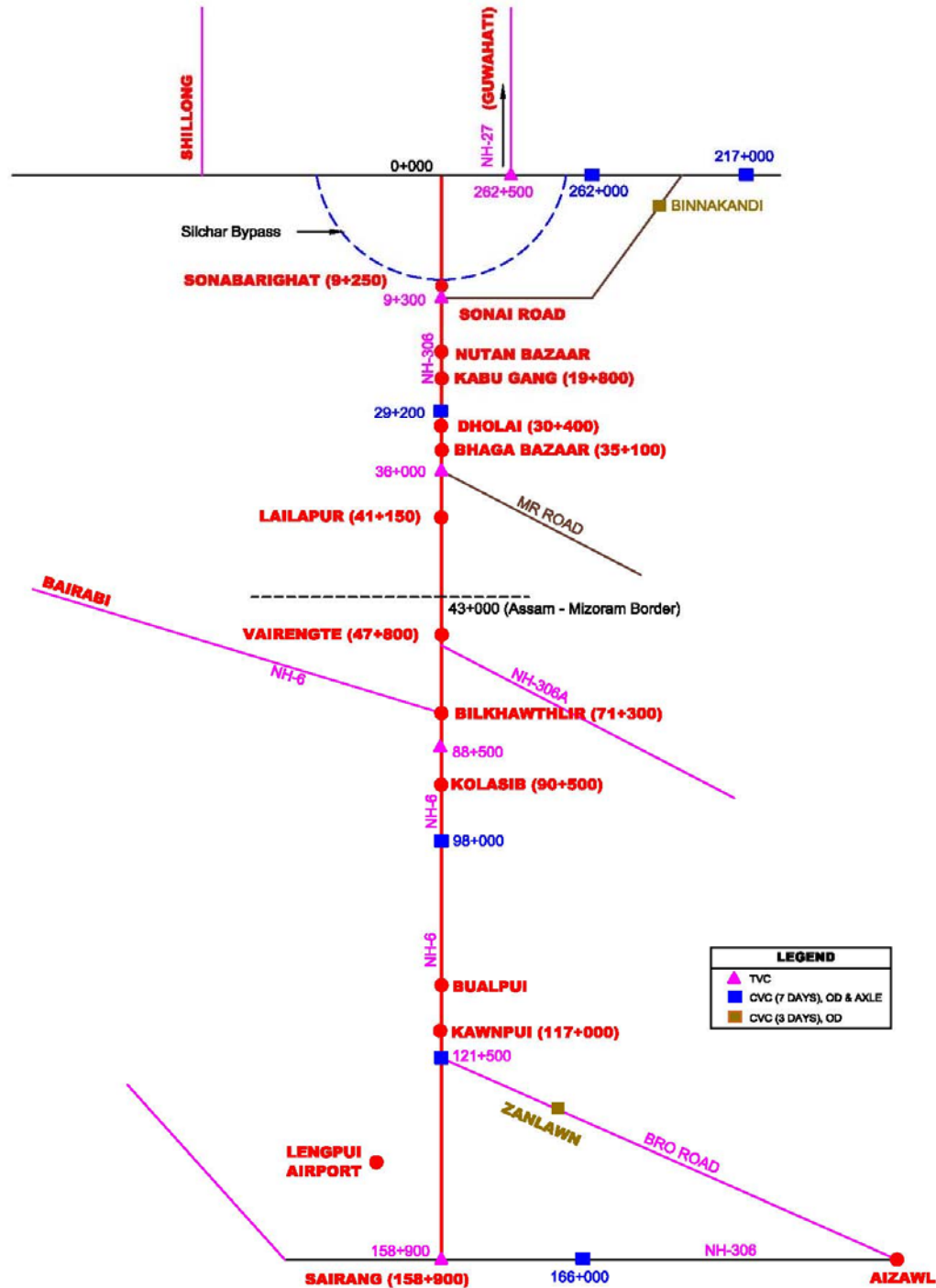


Figure 4.1 Traffic survey Linear Plan

In present report, DPR consultant has discussed and presented traffic study and analysis for Silchar – Aizawl as “ONE” through corridor which has further bifurcated in 02 sections i.e.

- 1) Silchar-Vairengte (State border) and
- 2) Vairengte-Sairang /Aizawl.

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 is 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 below table3. 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

Sl. No.	Vehicle Category	PCU Factors
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 Sairang is a part of Silchar-Aizawl road and is divided into 05 homogeneous sections as the project road falls in two different states. 1 homogeneous section has been considered in Assam state for a length of 42.75 up to border, near Variegate.

Whereas, 03 homogeneous sections have been considered between Vairengte and Sairang due to potential traffic diversion at Kawnpui towards Aizawl via Sharkhan, Sentlang, Durtlang leitan on NH-6 i.e., 1) from km 42+750 to km 86+500 at Kolasib start point 2) km 88+500 to 121+500 near Kawnpui and 3) from km 121+500 to km 158+900 at Sairang.

For obvious reasons as explained above, one more homogenous section has been considered at Km 166+00 towards Aizawl via Sairang on NH 6.

Project road shares total length of 115.900 Km till Sairang out of 137 Km of total length from Vairengte to Aizawl.

07 days classified volume count (CVC) was conducted at Km 29+200 for homogenous section (HS) 1, whereas, CVC was conducted at Km 98+000 for HS-2, HS-3 and HS-4. Additional CVC was conducted at km 166+000 for HS-5.



Apart from that an additional 3-days CVC was also conducted on BRO Road (Zanlawn Road) in order to determine traffic diversion towards Aizawl from our project road 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 29+200**



**Traffic Study using ATCC on
Project Road at Km 98+000**

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Traffic Study using ATCC on Sairang-Aizwal road at Km: 166+000



Traffic Study using Videography on Kolasib-Aizawl Road at Zanlawn (BRO Road)

Brief description of traffic count location is given below:

Silchar-Vairengte section:

(Km 29+200) near Dholai – 7 days

This count station is non-urban stretch of NH-306. This station represents the traffic for section from Silchar to Vairengte via Sonabarighat, Nuthan Bazar, Kabuganj, Narsipur, Dholai, Bhaga Bazar and Lailapur and will account for through traffic that is diverted towards Sonai road from NH-306 and diversion of traffic at Bhaga Bazar (through MR Road).



Vairengte-Sairang section

(i) (Km 98+000) near North Thingdawl – 7 days



This count station is non-urban stretch of NH-306. This station represents the traffic for section from Vairengte to Sairang via Bilkhawthlir, Kolasib, North Thingdawl, Bualpui, Kawnpui, Khamrang and will account all the traffic including traffic coming from Bairabi via NH-6 & traffic from NH-6 (BRO road) via Serkhan, Sentlang, Lungdai, Siphir, Durtlang.



(ii) (Km 166+00) near Sairang on Sairang-Aizawl road – 7 days

This count station is non-urban stretch of NH-6 which falls between Sairang and Aizawl that does not fall under project corridor however, this counting station will observe the traffic pattern of commercial / Passenger vehicles between Sairang & Aizawl. This will be accounted for originating/destination



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traffic from Aizawl city and other potential traffic such as Lunglei, Lawngtlai, Seling and international cross border corridor.

(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.



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast



Origin & Destination Study on Project Road at Km 29+200



Origin & Destination Study on Project Road at Km 98+000



Origin & Destination Study on Sairang-Aizwal Road at Km: 166+000



Origin & Destination Study on Kolasib-Aizawl Road at Zanzawl

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: 29+200



Axle Load Survey is on Project Road at Km: 98+000



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast



Axle Load Survey is on Sairang-Aizwal Road at Km: 166+000

4.7.5 Turning Movement Surveys

Manual turning volume counts for 16-hour duration were conducted at 5 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.



Turning Movement Survey on Project Road at Km 9+500



Turning Movement on Project Road at Km 36+000



Turning Movement Survey on Project road at Km 88+500



Turning Movement Survey is on Project Road at Km 121+500



Turning Movement Survey at Km 158+900

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.

Silchar-Vairengte Section

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

Sl. No	Vehicle Type	ADT (In nos.)
		Km 29+200
Tollable Traffic		
1	Car	1634
2	Mini-Bus	86
3	Pvt. Bus	31
4	Govt. Bus	0
5	LCV	236
6	2 Axle	742
7	3 Axle	284
8	4-6 Axle	12
9	>=7 Axle	0



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)



Chapter 4: Traffic Studies & Demand Forecast



Sl. No	Vehicle Type	ADT (In nos.)
		Km 29+200
Non-Tollable Traffic		
10	2W	1980
11	3W	1848
12	Tractor with Trailer	6
13	Tractor without Trailer	0
14	Cycle	175
15	Rickshaw	1
16	Animal Drawn	0
ADT in Nos.		
Tollable		3025
Non - Tollable		4010
Total		7035

Table 4.5 Average Daily Traffic (ADT – in PCU)

Sl. No	Vehicle Type	ADT (In PCU)
		Km 29+200
Tollable Traffic		
1	Car	1634
2	Mini-Bus	129
3	Pvt. Bus	93
4	Govt. Bus	0
5	LCV	354
6	2 Axle	2226
7	3 Axle	852
8	4-6 Axle	54
9	>=7 Axle	0
Non-Tollable Traffic		
10	2W	990
11	3W	1848
12	Tractor with Trailer	27
13	Tractor without Trailer	0
14	Cycle	88
15	Rickshaw	2
16	Animal Drawn	0
ADT in PCU.		
Tollable		5342
Non - Tollable		2955
Total		8297

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Chapter 4: Traffic Studies & Demand Forecast		

Vairengte-Sairang section

Table 4.6 Average Daily Traffic (ADT – in nos.)

Sl. No	Vehicle Type	ADT (In nos.)		
		Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Tollable Traffic				
1	Car	1372	1859	519
2	Mini-Bus	10	21	8
3	Pvt. Bus	26	7	0
4	Govt. Bus	9	13	5
5	LCV	245	386	98
6	2 Axle	887	361	75
7	3 Axle	171	104	20
8	4-6 Axle	64	36	6
9	>=7 Axle	0	0	0
Non-Tollable Traffic				
10	2W	801	949	425
11	3W	81	498	156
12	Tractor with Trailer	0	3	0
13	Tractor without Trailer	0	4	0
14	Cycle	29	0	0
15	Rickshaw	0	0	0
16	Animal Drawn	0	0	0
ADT in Nos.				
Tollable		2784	2787	731
Non - Tollable		911	1454	581
Total		3695	4241	1312

Table 4.7 Average Daily Traffic (ADT – in PCU)

Sl. No	Vehicle Type	ADT (In PCU)		
		Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Tollable Traffic				
1	Car	1372	1859	519
2	Mini-Bus	15	32	12
3	Pvt. Bus	78	21	0
4	Govt. Bus	27	39	15
5	LCV	368	579	147
6	2 Axle	2661	1083	225
7	3 Axle	513	312	60
8	4-6 Axle	288	162	27
9	>=7 Axle	0	0	0

Sl. No	Vehicle Type	ADT (In PCU)		
		Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Non-Tollable Traffic				
10	2W	401	475	213
11	3W	81	498	156
12	Tractor with Trailer	0	14	0
13	Tractor without Trailer	0	6	0
14	Cycle	15	0	0
15	Rickshaw	0	0	0
16	Animal Drawn	0	0	0
ADT in PCU.				
Tollable		5322	4087	1005
Non - Tollable		496	992	369
Total		5818	5079	1374

4.8.1 Traffic Composition

Composition of traffic as observed at Km 29+200 is presented in the following table. It can be seen, the proportion of non-motorized vehicle using this section of road is very less. The combined share of freight traffic is 42% in terms of Nos. (65% in terms of PCU) of Tollable Traffic. Passenger traffic is also in considerable volume – 58% in terms of Nos. and 35% in terms of PCU.

Further at Km 98+000 and Km 166+000 the proportion of non-motorized vehicle using this section of road is very less. The combined share of freight traffic is 40.46% in terms of Nos. (62.12% in terms of PCU) of Tollable Traffic. Passenger traffic is also in considerable volume – 59.54% in terms of Nos. and 37.88% in terms of PCU.

Table 4.8 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. %)											
Silchar-Vairengte											
Km 29+200	54.02	2.84	1.02	0.00	7.80	24.53	9.39	0.40	0.00	58	42
Vairengte to Sairang											
Km 98+000	49.28	0.36	0.93	0.32	8.80	31.86	6.14	2.30	0.00	51	49
Km 166+000 (Sairang-Aizwal Rd)	66.70	0.75	0.25	0.47	13.85	12.95	3.73	1.29	0.00	68	32
Zanlawn (BRO Road)	71.00	1.09	0.00	0.68	13.41	10.26	2.74	0.82	0.00	73	27

Location	Car	Mini Bus	Pvt. Bus	Govt. Bus	LCV	2-Axle	3-Axle	4-6 Axle	>7 Axle	Pass.	Comm.
Traffic Composition (PCU %)											
Silchar-Vairengte											
Km 29+200	30.59	2.41	1.74	0.00	6.63	41.67	15.95	1.01	0.00	35	65
Vairengte to Sairang											
Km 98+000	25.78	0.28	1.47	0.51	6.91	50.00	9.64	5.41	0.00	28	72
Km 166+000 (Sairang-Aizwal Rd)	45.49	0.77	0.51	0.95	14.17	26.50	7.63	3.96	0.00	48	52
Zanlawn (BRO Road)	51.64	1.19	0.00	1.49	14.63	22.39	5.97	2.69	0.00	54	46

Table 4.9 Percentage Composition of Traffic

Location	Nos.		PCU	
	Tollable	Non-Tollable	Tollable	Non-Tollable
Silchar-Vairengte				
Km 29+200	43.00	57.00	64.39	35.61
Vairengte to Sairang				
Km 98+000	75.35	24.65	91.47	80.47
Km 166+000 (Sairang-Aizwal Rd)	80.47	44.28	80.47	19.53
Zanlawn (BRO Road)	55.72	44.28	73.17	26.83

From the above table it can be observed that at Km 29+200 considerable volume of tollable traffic is flowing on the project road. It can also be observed that the tollable traffic is approx. 64% to total traffic PCU. Further at Km 98+000 and at Km 166+000 was observed that the tollable traffic is approx. 85% to total traffic PCU along project road.

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

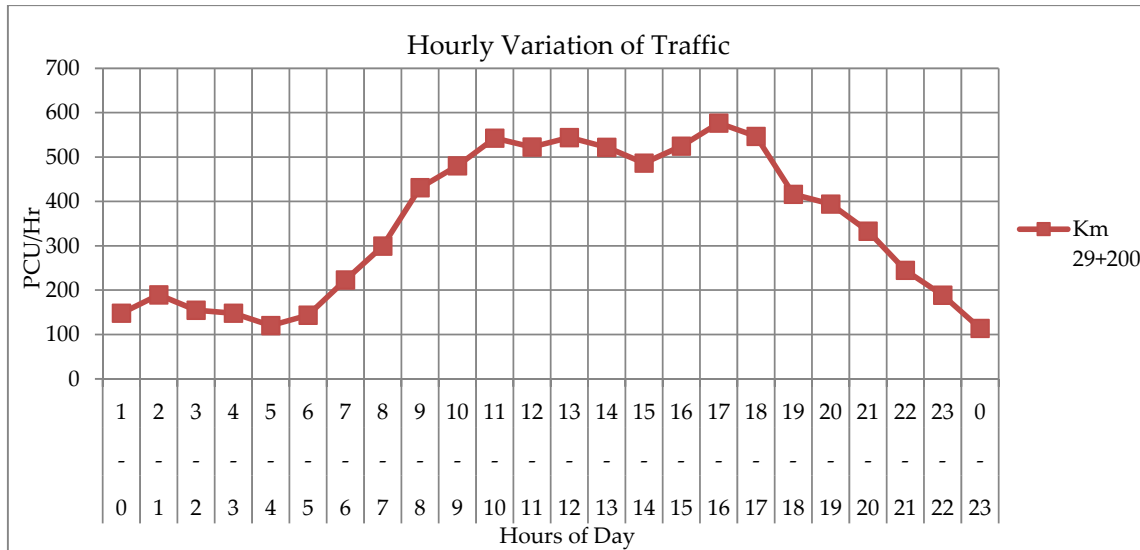


Figure 4.2 Hourly Variation of Traffic (Average of 7/3 days) for Silchar to Vairengte

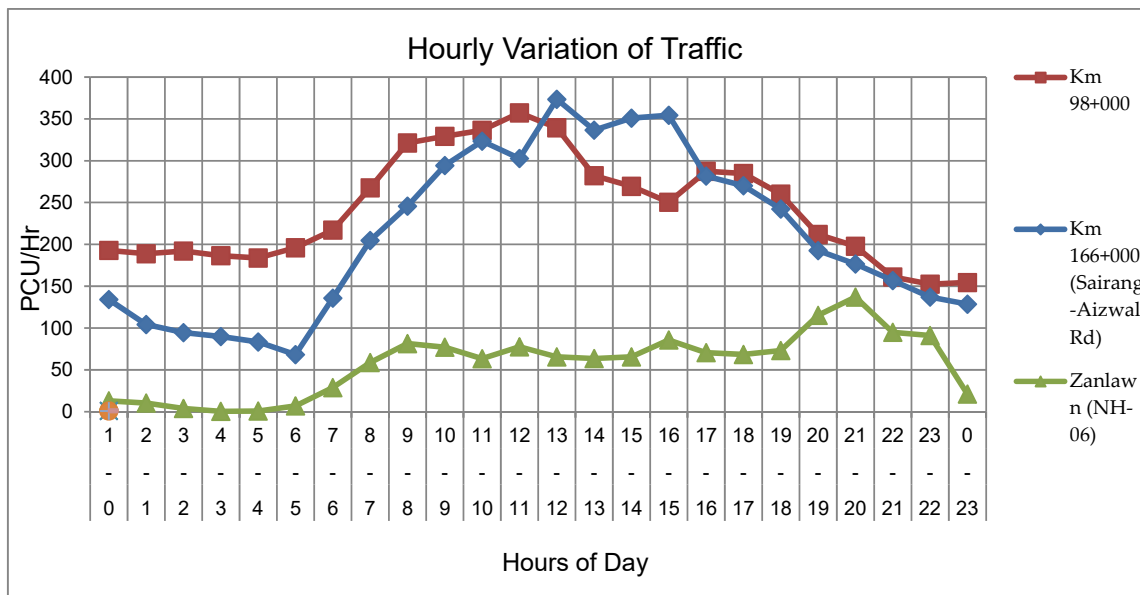


Figure 4.3 Hourly Variation of Traffic (Average of 7/3 days) for Vairengte to Sairang

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 peak period at Km 29+200 is between 16:00 hours – 17:00 hours. Further at Km 98+000 peak hour is between 11:00 hours - 12:00 hours, at

Km 166+000 the peak period is between 12:00 hours - 13:00 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 290 PCU - 467 PCU.

Table 4.10 Peak hour factor

Location	Peak Hour	Peak Hour Flow (PCU)	Peak Hour Factor (PHF)
Silchar to Vairengte			
Km 29+200	16 - 17	577	6.95
Vairengte to Sairang			
Km 98+000	11 - 12	357	6.14
Km 166+000 (Sairang-Aizwal Rd)	12 - 13	373	7.35
Zanlawn (BRO Road)	20 - 21	137	9.97

4.8.3 Daily variation of traffic volume

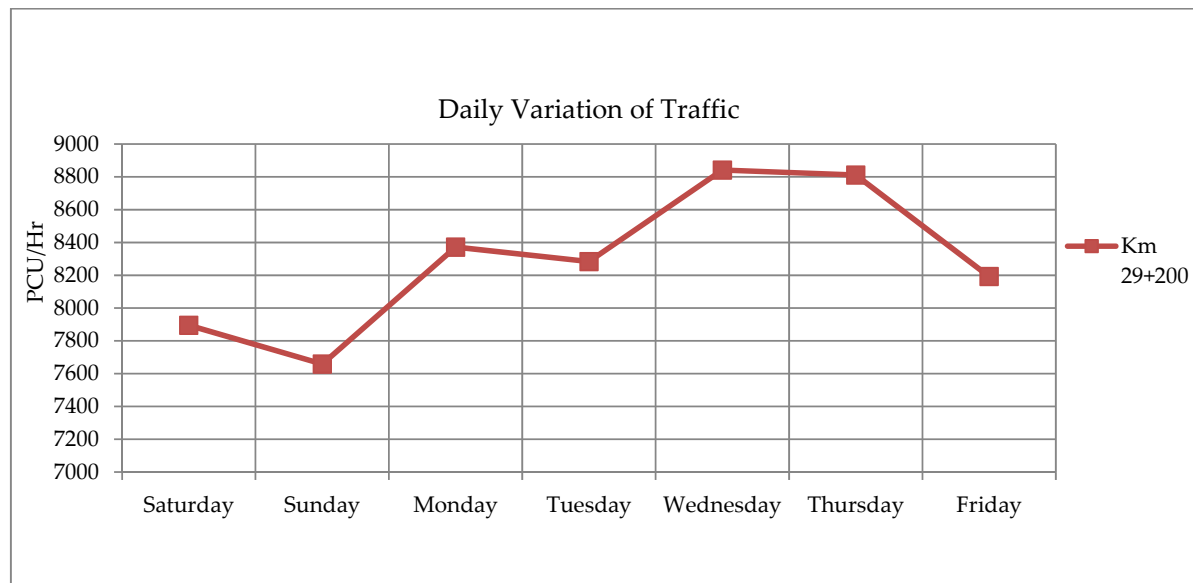


Figure 4.4 Daily Variations of traffic volume at 1 location for Silchar to Vairengte section

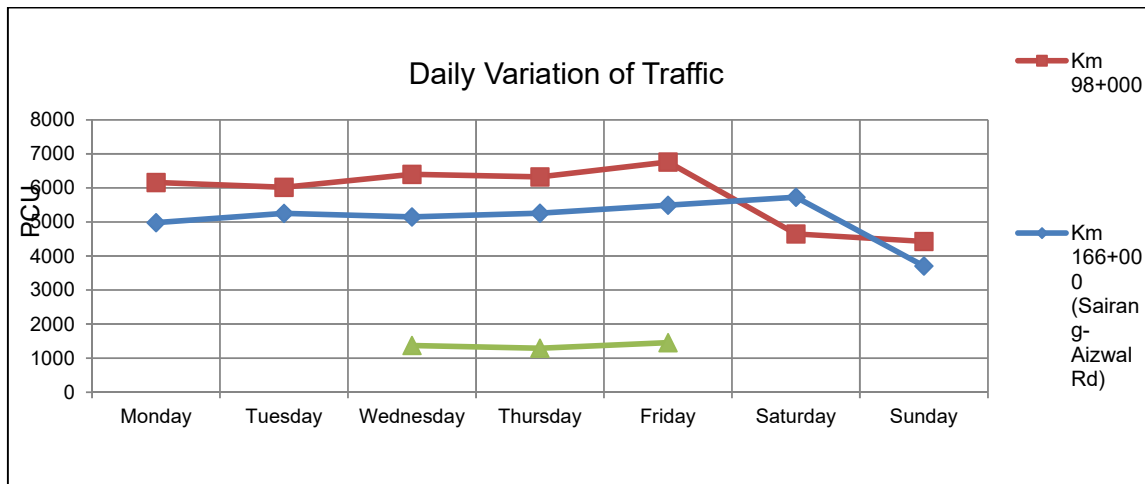


Figure 4.5 Daily Variations of traffic volume at 3 locations – 7/3 Days for Vairengte to Sairang sections

Daily variation of traffic for all the locations is shown in **Figure 4.4** and **Figure 4.5**. From the analysis it is found that, at Km 29+200 the traffic values are Wednesday, and Thursday compare to other days within the week and at Km 98+000, traffic levels are higher on Friday and at Km 166+000, traffic levels are higher on Friday as compared to the other days within in a week. The daily variations of observed traffic volumes at five counting stations are given in below table;

Table 4.11 Daily Variations of traffic volume in PCUs

Day	Km 29+200	Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Monday	8371	6162	4981	Additional Survey Point
Tuesday	8284	6020	5256	
Wednesday	8842	6399	5150	
Thursday	8812	6324	5259	
Friday	8193	6763	5493	
Saturday	7895	4646	5727	
Sunday	7658	4427	3706	

4.8.4 Directional distribution of traffic

Directional split at each of the location is shown in following table. This is a useful input for capacity analysis and pavement design. As seen, from below table that the traffic flow is evenly distributed (almost 50:50 in each direction, at Zalawn 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.



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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Table 4.12 Directional Split in %

Location	Silchar to Vairengte	Vairengte to Silchar
Km 29+200	49.74	50.26
Location	Vairengte to Sairang	Sairang to Vairengte
Km 98+000	50.22	49.78
Location	Sairang to Aizawl	Aizawl to Sairang
Km 166+000 (Sairang-Aizwal Rd)	48.31	51.96
Location	Kawnpui to Aizawl	Aizawl to Kawnpui
Zanlawn (BRO Road)	51.86	48.15

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 4.13**. 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 4.13**. It can be observed that at Km 29+200 the share of 2 wheelers traffic is very high about 29% of total traffic. Beside this car 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 80% when compared to commercial traffic of 17%. The composition of goods vehicles is observed to be in the range of 2-14%, the majority of them being two/three 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 of 3.0 %, where more number of cycles are observed.

Further at Km 98+000 and at Km 166+000 it can be observed that the share of car and 3 wheeler traffic is high about 48% of total traffic. Beside this 2-wheeler constitute moderate percentage of the ADT on all along the road accounting to about 23% 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 78% when compared to commercial traffic of 29%. The composition of goods vehicles is observed to be in the range of 2-30%, the majority of them being two/three 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 of 0.9 %.



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Table 4.13 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.	
Silchar to Vairengte										
Km 29+200	28.14	49.50	1.66	3.35	14.58	0.17	0.09	79.30	18.19	2.50
Vairengte to Sairang										
Km 98+000	21.68	39.32	1.22	6.63	28.63	1.73	0.00	62.22	37.00	0.78
Km 166+000 (Sairang- Aizwal Rd)	22.38	55.58	0.97	9.10	10.96	0.85	0.17	78.92	21.08	0.00
Zanlawn (BRO Road)	32.39	51.45	0.99	7.47	7.24	0.46	0.00	84.83	15.17	0.00

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. Fuel sale data was collected at 1 location in Silchar to Vairengte and at 3 locations from Vairengte to Aizawl however, for analysis seasonal correction factor for Silchar to Vairengte and Vairengte to Aizawl is taken separately and the same is used for arriving AADT.

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

Table 4.14 Monthly Fuel Sales (in KL) in the Project Influence Area for Silchar to Vairengte section

Section: Silchar to Vairengte		
Month	Km 18+000	
	Diesel (KL)	Petrol (KL)
Jan-19	144.0	96.0
Feb-19	126.0	99.0
Mar-19	144.0	120.0
Apr-19	108.0	96.0
May-19	120.0	84.0
Jun-19	96.0	84.0
Jul-19	144.0	84.0

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	



Section: Silchar to Vairengte		
Month	Km 18+000	
	Diesel (KL)	Petrol (KL)
Aug-19	132.0	84.0
Sep-19	84.0	84.0
Oct-19	96.0	96.0
Nov-19	132.0	96.0
Dec-19	180.0	84.0
Average	126	92

Table 4.15 Monthly Fuel Sales (in KL) in the Project Influence Area for Vairengte to Sairang section

Section: Vairengte to Sairang						
Month	Kolasib (Km 94+000)		Aizawl		Aizawl	
	Diesel (KL)	Petrol (KL)	Diesel (KL)	Petrol (KL)	Diesel (KL)	Petrol (KL)
Jan-19	102.0	72.0	148.0	60.0	144.0	144.0
Feb-19	96.0	70.0	196.0	60.0	156.0	144.0
Mar-19	94.0	74.0	248.0	72.0	168.0	156.0
Apr-19	96.0	70.0	196.0	72.0	192.0	156.0
May-19	92.0	70.0	192.0	24.0	168.0	144.0
Jun-19	88.0	72.0	188.0	72.0	168.0	132.0
Jul-19	116.0	70.0	132.0	48.0	192.0	132.0
Aug-19	96.0	72.0	152.0	60.0	156.0	132.0
Sep-19	96.0	72.0	140.0	72.0	192.0	108.0
Oct-19	104.0	84.0	156.0	72.0	168.0	120.0
Nov-19	104.0	72.0	144.0	72.0	180.0	132.0
Dec-19	104.0	96.0	92.0	72.0	168.0	156.0
Average: :	99.0	74.5	165.3	63.0	171.0	138.0

Table 4.16 Seasonal Variation and Correction Factors for Silchar to Vairengte section

Section: Silchar to Vairengte				
Month	Seasonal Variation		Seasonality Factor	
	Diesel	Petrol	Diesel	Petrol
Jan-19	1.147	1.041	0.872	0.961
Feb-19	1.004	1.073	0.996	0.932
Mar-19	1.147	1.301	0.872	0.769
Apr-19	0.861	1.041	1.162	0.961
May-19	0.956	0.911	1.046	1.098
Jun-19	0.765	0.911	1.307	1.098
Jul-19	1.147	0.911	0.872	1.098
Aug-19	1.052	0.911	0.951	1.098
Sep-19	0.669	0.911	1.494	1.098
Oct-19	0.765	1.041	1.307	0.961

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Section: Silchar to Vairengte				
Month	Seasonal Variation		Seasonality Factor	
	Diesel	Petrol	Diesel	Petrol
Nov-19	1.052	1.041	0.951	0.961
Dec-19	1.434	0.911	0.697	1.098

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	:	0.9960
For Diesel Driven Vehicles	:	0.9679

Table 4.17 Average Annual Daily traffic (AADT) on Project road for 2020

Section: Silchar to Vairengte		
Sl. No	Vehicle Type	AADT (In nos.)
		Km 29+200
Tollable Traffic		
1	Car	1523
2	Mini-Bus	86
3	Pvt. Bus	31
4	Govt. Bus	0
5	LCV	235
6	2 Axle	739
7	3 Axle	283
8	4-6 Axle	12
9	>=7 Axle	0
Non-Tollable Traffic		
10	2W	1845
11	3W	1841
12	Tractor with Trailer	6
13	Tractor without Trailer	0
14	Cycle	175
15	Rickshaw	1
16	Animal Drawn	0
AADT in Nos.		
Tollable		2908
Non - Tollable		3868
Total		6776



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Table 4.18 Average Annual Daily Traffic (AADT in PCU)

Section: Silchar to Vairengte		
Sl. No	Vehicle Type	AADT (PCU.)
		Km 29+200
Tollable Traffic		
1	Car	1523
2	Mini-Bus	128
3	Pvt. Bus	93
4	Govt. Bus	0
5	LCV	353
6	2 Axle	2217
7	3 Axle	849
8	4-6 Axle	54
9	>=7 Axle	0
Non-Tollable Traffic		
10	2W	922
11	3W	1841
12	Tractor with Trailer	27
13	Tractor without Trailer	0
14	Cycle	88
15	Rickshaw	2
16	Animal Drawn	0
AADT in Nos.		
Tollable		5216
Non - Tollable		2879
Total		8095

Table 4.19 Seasonal Variation and Correction Factors for Vairengte to Sairang section

Section : Vairengte to Sairang				
Month	Seasonal Variation		Seasonality Factor	
	Diesel	Petrol	Diesel	Petrol
Jan-19	0.905	1.002	1.105	0.998
Feb-19	1.029	0.995	0.972	1.005
Mar-19	1.172	1.096	0.854	0.912
Apr-19	1.112	1.082	0.899	0.924
May-19	1.038	0.864	0.963	1.158
Jun-19	1.020	1.002	0.980	0.998
Jul-19	1.011	0.907	0.989	1.102
Aug-19	0.928	0.958	1.078	1.044
Sep-19	0.983	0.915	1.017	1.093
Oct-19	0.983	1.002	1.017	0.998
Nov-19	0.983	1.002	1.017	0.998
Dec-19	0.836	1.176	1.196	0.850

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 : 1.0055
For Diesel Driven Vehicles : 0.9717

Table 4.20 Average Annual Daily traffic (AADT) on Project road for 2020

Section : Vairengte to Sairang				
Sl. No	Vehicle Type	AADT (In nos.)		
		Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Tollable Traffic				
1	Car	1380	1869	522
2	Mini-Bus	10	20	8
3	Pvt. Bus	25	7	0
4	Govt. Bus	9	13	5
5	LCV	238	375	95
6	2 Axle	862	351	73
7	3 Axle	166	101	19
8	4-6 Axle	62	35	6
9	>=7 Axle	0	0	0
Non-Tollable Traffic				
10	2W	805	954	427
11	3W	79	484	152
12	Tractor with Trailer	0	3	0
13	Tractor without Trailer	0	4	0
14	Cycle	29	0	0
15	Rickshaw	0	0	0
16	Animal Drawn	0	0	0
AADT in Nos.				
Tollable		2752	2771	728
Non - Tollable		913	1445	579
Total		3665	4216	1307



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Table 4.21 Average Annual Daily Traffic (AADT in PCU)

Section : Vairengte to Sairang				
Sl. No	Vehicle Type	AADT (In PCU)		
		Km 98+000	Km 166+000 (Sairang-Aizwal Rd)	Zanlawn (NH-06)
Tollable Traffic				
1	Car	1380	1869	522
2	Mini-Bus	15	31	12
3	Pvt. Bus	76	20	0
4	Govt. Bus	26	38	15
5	LCV	357	563	143
6	2 Axle	2586	1052	219
7	3 Axle	498	303	58
8	4-6 Axle	280	157	26
9	>=7 Axle	0	0	0
Non-Tollable Traffic				
10	2W	403	477	214
11	3W	79	484	152
12	Tractor with Trailer	0	13	0
13	Tractor without Trailer	0	6	0
14	Cycle	15	0	0
15	Rickshaw	0	0	0
16	Animal Drawn	0	0	0
AADT in PCU.				
Tollable		5217	4034	994
Non - Tollable		496	980	365
Total		5713	5014	1359

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 4 locations (at Km 29+200, Km 98+000, Km 166+000 and at Zanlawn). The location of O-D survey station is 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 4.22** 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 4.22 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 29+200					
Car	607	1812	33.50%	1812	2.99
Bus	47	126	37.23%	126	2.69
LCV	82	620	13.23%	620	7.56
2A Truck	390	1126	34.64%	1126	2.89
3A Truck	157	540	29.07%	540	3.44
MAV	55	80	68.75%	80	1.45
Total =	1338	4304	31.09%		

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 98+000					
Car	488	1583	30.83%	1583	3.24
Bus	18	49	36.73%	49	2.72
LCV	63	554	11.37%	554	8.79
2A Truck	568	1840	30.87%	1840	3.24
3A Truck	129	380	33.95%	380	2.95
MAV	65	148	43.92%	148	2.28
Total =	1331	4554	29.23%		

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 166+000					
Car	550	1661	33.11%	1661	3.02
Bus	12	30	40.00%	30	2.50
LCV	48	789	6.08%	789	16.44
2A Truck	262	755	34.70%	755	2.88
3A Truck	81	226	35.84%	226	2.79
MAV	27	91	29.67%	91	3.37
Total =	980	3552	27.59%		



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 23/20/19 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 in the **Figure 4.6 to Figure 11**.

Table 4.23 Zone list for the study area for Silchar-Vairengte section



Zone No.	Zone	Location
1	Silchar	Assam
2	Badarpur, Kalain, Katakhal	Assam
3	Guwhathi	Assam
4	Rongpur, Salgana, Silchar airport	Assam
5	Nagathilla, Saidpur	Assam
6	Sonbarighat	Assam
7	Sonai	Assam
8	Kabuganj, Nuthan Bazar, Painbhora	Assam
9	Dholai, Sadagram, Ramprasadpur, Saptagram	Assam
10	Bhaga, Bhaga Bazar	Assam

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Zone No.	Zone	Location
11	Bhaga, Bhaga Bazar, Hawaithang, Narsipur	Assam
12	Amarghat, Jamalpur, Krishnapur, Mothi Nagar	Assam
13	Lailapur	Assam
14	Banskandi	Assam
15	Lakhipur, Pailapool	Assam
16	Joypur	Assam
17	Jiribam, Manipur	Manipur
18	Vairengte	Mizoram
19	Kolasib	Mizoram
20	Kawnpui	Mizoram
21	Aizawl, Lunglei, Siaha, Tlungvel, Champai, Mizoram	Mizoram
23	Meghalaya	Meghalaya
24	Rest of India (Jaipur, Vijawada)	Rest of India

Table 4.24 Zone list for the study area for Vairengte to Sairang section

Zone No.	Zone	Location
1	Vairengte	Mizoram
2	Bilkthawthir	Mizoram
3	Bairabi	Mizoram
4	Kolasib	Mizoram
5	North Thingdawl	Mizoram
6	Bualpui	Mizoram
7	Kawnpui	Mizoram
8	Khamrang	Mizoram
9	Sairang	Mizoram
10	Lengpui	Mizoram
11	Aizawl	Mizoram
12	Seling, Serchhip, Tuipang, Champai	Mizoram
13	Lunglei	Mizoram
14	Lailapur	Assam
15	Bhaga, Kabuganj	Assam
16	Silchar, Badarpur	Assam
17	Guwahati, Madanpur, Barpet	Assam

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Zone No.	Zone	Location
18	Manipur	Manipur
19	Shilong, Meghalaya	Meghalaya
20	Delhi, Gujarat, Rajasthan, Kolkata	Rest of India

Table 4.25 Zone list for the study area for Sairang-Aizawl

Zone No.	Zone	Location
1	Bairabi	Mizoram
2	Kolasib	Mizoram
3	Bualpui, Zanlawn	Mizoram
4	Lengpui, Lengpui Airport	Mizoram
5	Darlak, W Phaileng	Mizoram
6	Mamit	Mizoram
7	Sairang	Mizoram
8	Aizawl	Mizoram
9	Champai	Mizoram
10	Lunglei	Mizoram
11	Seling	Mizoram
12	Serchip	Mizoram
13	Bhaga	Assam
14	Silchar	Assam
15	Karimganj	Assam
16	Guwahati, Assam	Assam
17	Shillong	Meghalaya
18	Kolkata, West bengal	West Bengal
19	Delhi, Gujrat, Himachal Pradesh, Nagaland, Punjab, Rajasthan, Uttar Pradesh	Res of India

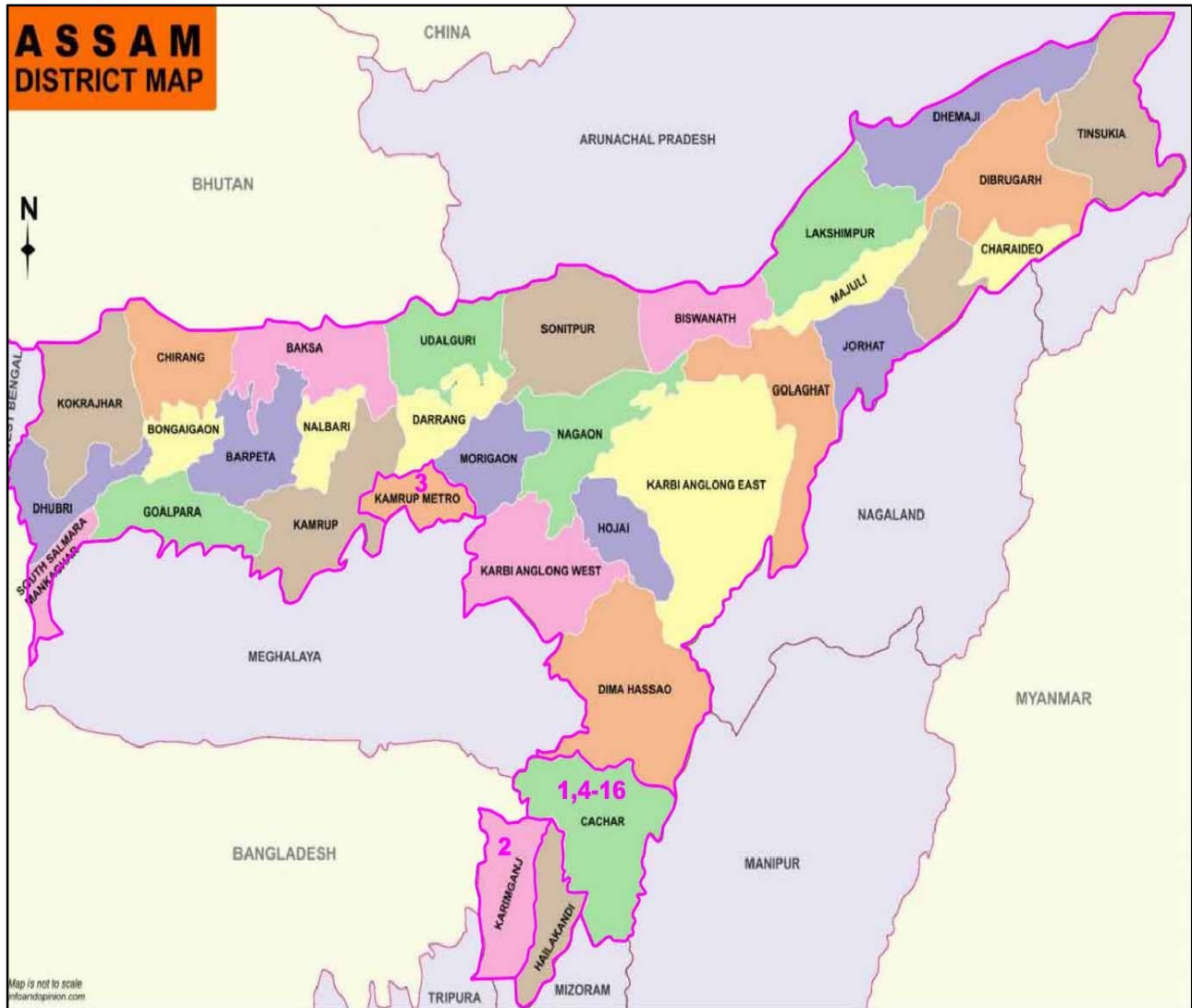


Figure 4.6 Traffic Zones for Assam (Section : Silchar to Vairengte)



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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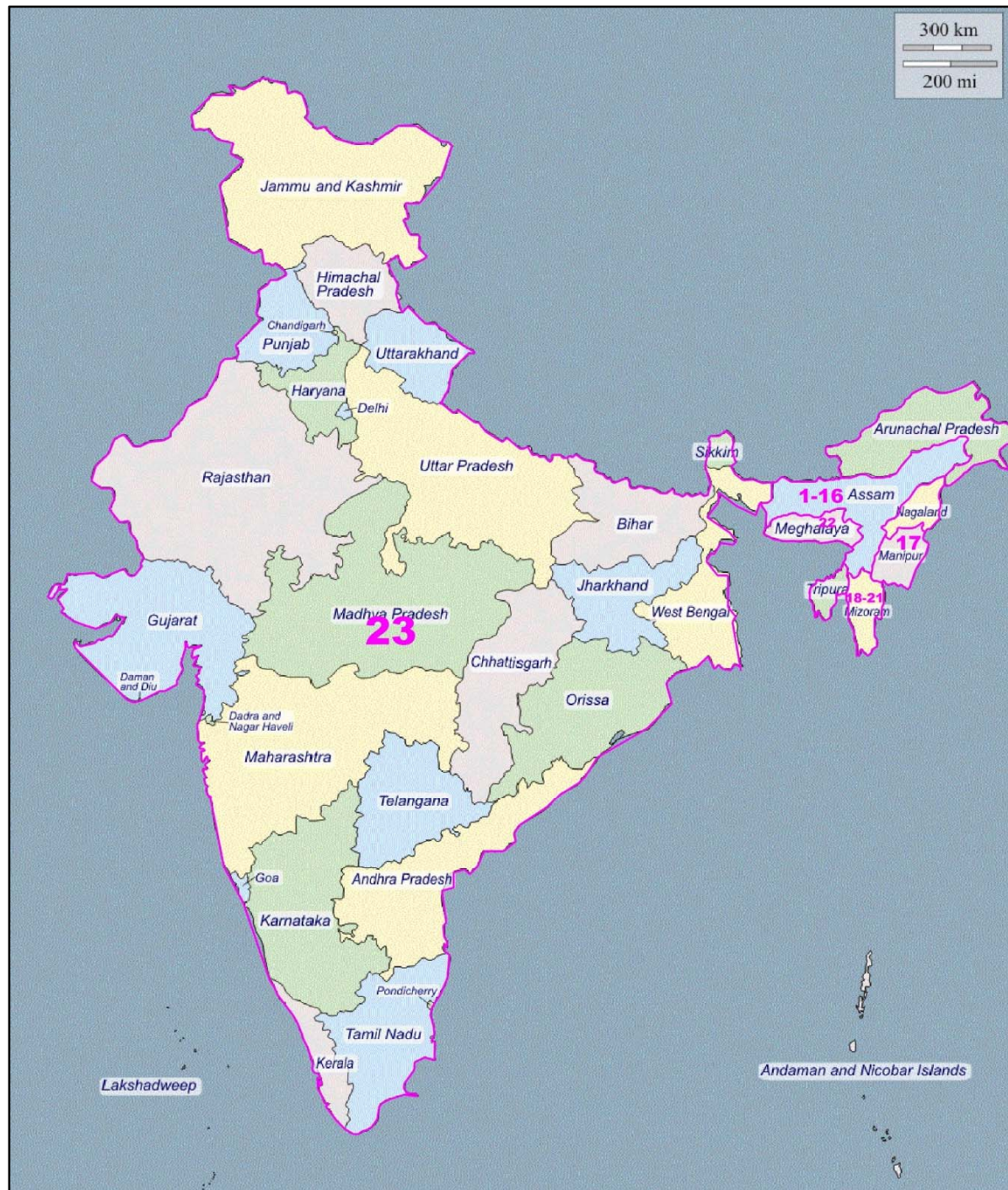


Figure 4.7 Zoning Scheme (Rest of India) for Silchar to Vairengte

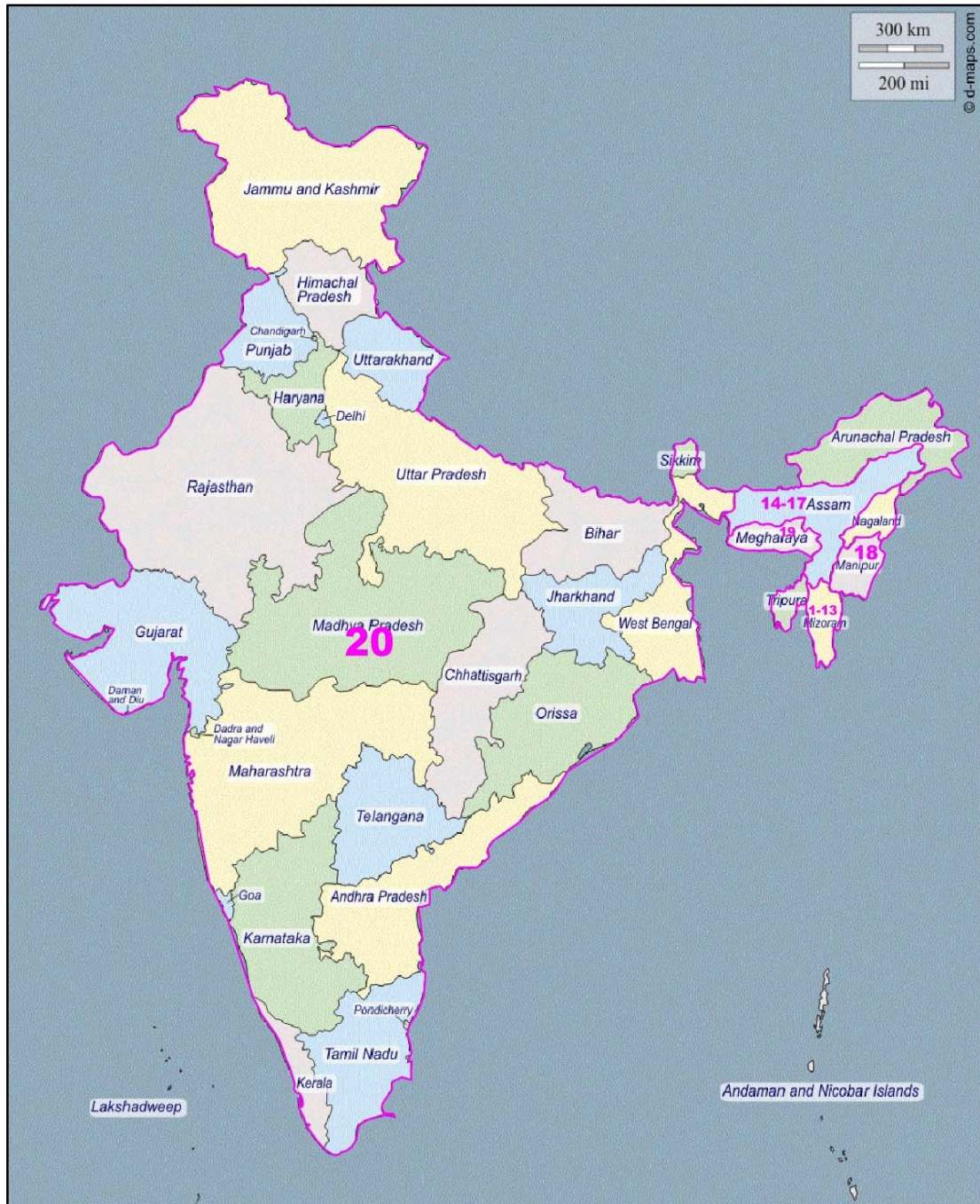


Figure 4.8 Traffic Zones (Mizoram) for Vairengte to Sairang



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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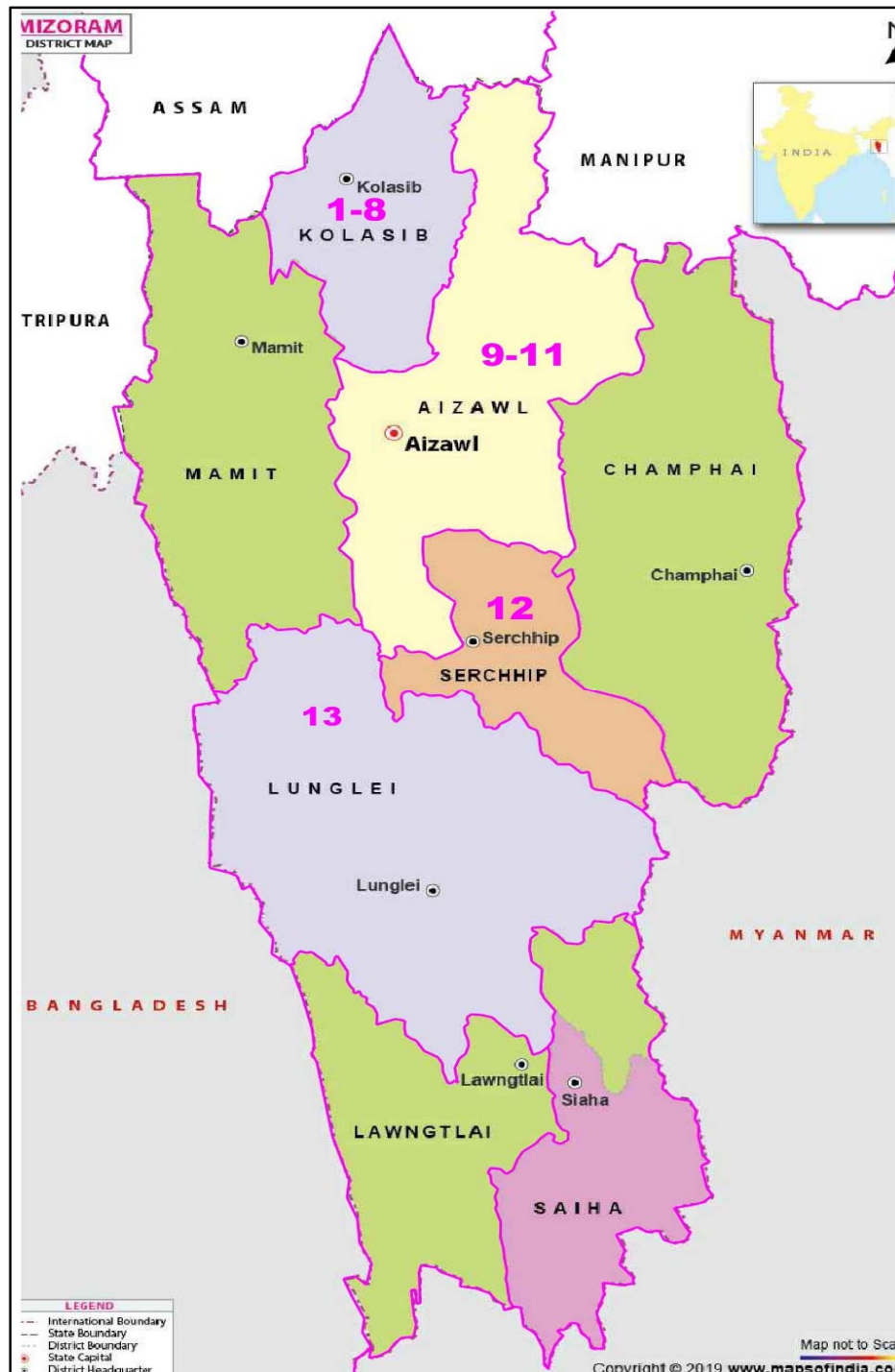


Figure 4.9 Zoning Scheme (Rest of India) for Vairengte to Sairang



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast

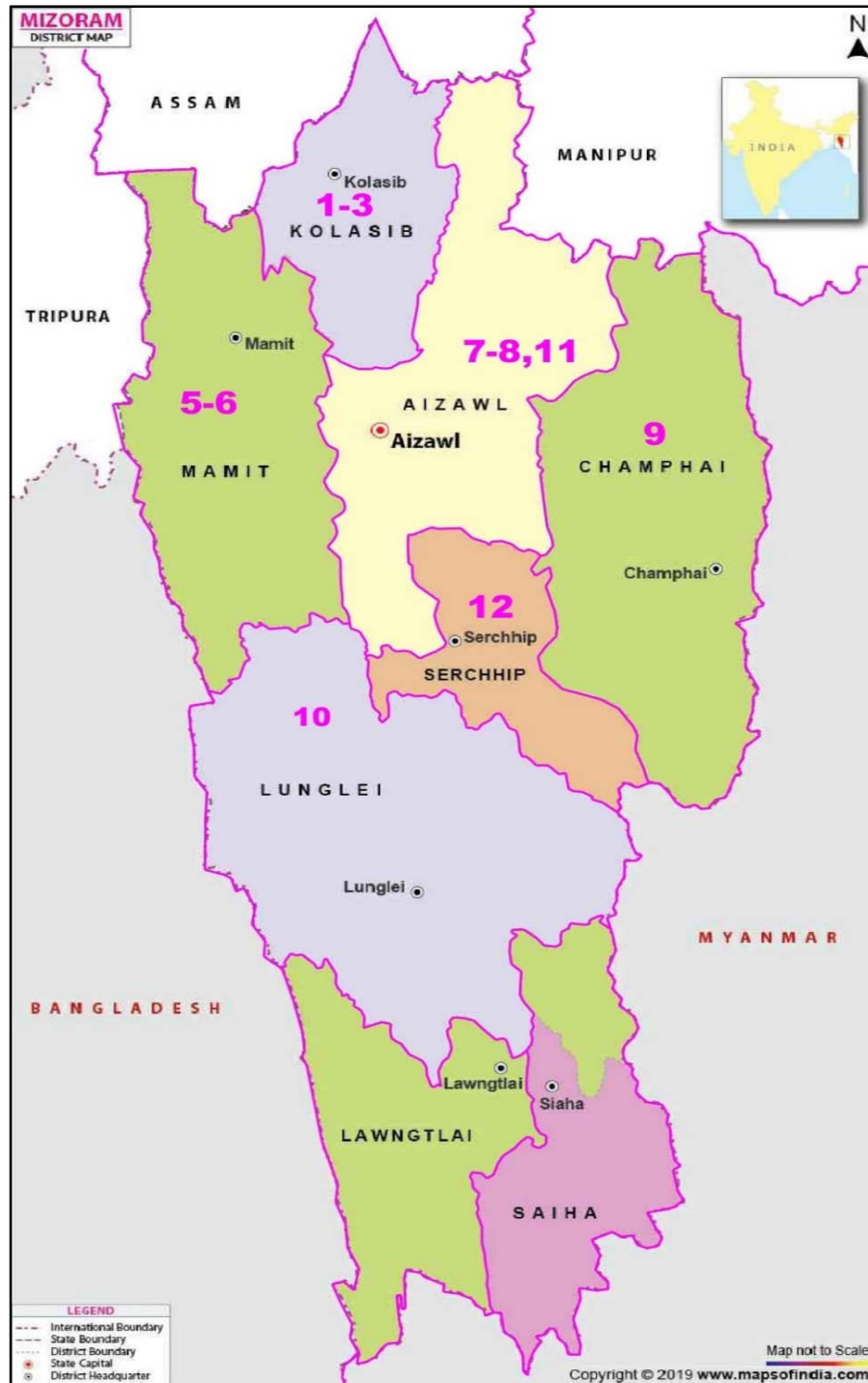


Figure 4.10 Traffic Zones (Mizoram) for Sairang to Aizawl



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast

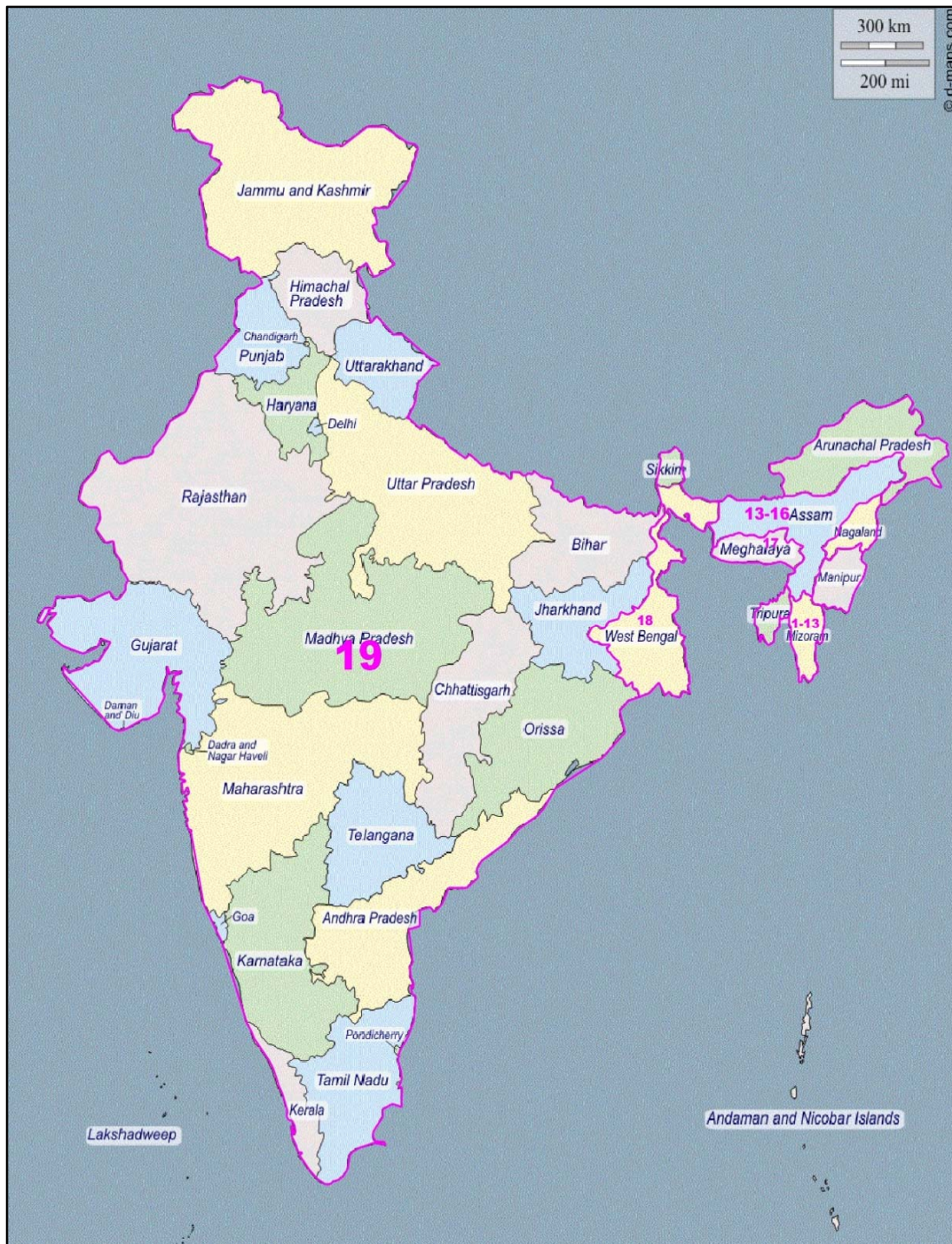


Figure 4.11 Zoning Scheme (Rest of India) for Sairang to Aizawl

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 29+200	<ul style="list-style-type: none"> Major OD pairs are zone 1(Silchar) to zone 8, 9, 10, 11 and 12 (Dholai, Bhaga, Bhag Bazar) and 1(Silchar) to zone 18, 19, 20 and 21 (Vairengte, Kolasib, Kawnpui, Aizwal) and zone 1 (Silchar) to other part of Assam and Mizoram. 87% of the traffic has origin/destination with in the Cachar district. About 84% of the traffic distributes with in the zones- 1 to 10 (within Assam). 	<ul style="list-style-type: none"> Major OD pairs are zone 1 (Silchar) to zone 21 (Aizwal) and Mizoram. 58% 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 98+000	<ul style="list-style-type: none"> Major OD pairs are zone 11 (Aizawl) to zone 15, 16, and 17 (Bhga, Silchar and Guwhathi) and 4 (Kolasib) to zone 11 (Aizawl) and zone 4 (Kolasib) to other 5, 7 and 9 (N Thingdawl, Balpuni, Kawnpiu and Sairang). 82% of the traffic has origin/destination with in the Aizawl/Kolasib district. 	<ul style="list-style-type: none"> Major OD pairs are zone 11 (Aizawl) to zone 15, 16, and 17 (Bhga, Silchar and Guwhathi). 58% of the traffic has origin/destination with in the Mizoram State
3	Km 166+000	<ul style="list-style-type: none"> Major OD pairs are zone 8 (Aizawl) to zone 2, 14, 15, 16, and 17 (Bhga, Silchar and Guwhathi, Kolasib, Kolkata) and zone 8 (Aizawl) to zone 2, 3 and 4 (Kolasib, Balpui, Kawnpui and Lengpiu airport) 82% of the traffic has origin/destination with in the Aizawl/Kolasib district. 	<ul style="list-style-type: none"> Major OD pairs are zone 8 (Aizawl) to zone 2, 14, 15, 16, and 17 (Bhga, Silchar and Guwhathi, Kolasib, Kolkata). 66% of the traffic has origin/destination with in the Mizoram 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 17 categories as presented in the following table. Due consideration has been given to include a possible commodity and to categorize them into homogeneous groups. The summary of the commodity analysis is presented in the table below:

Table 4.26 Commodity Movement Pattern

Km 29+200 (Numbers)

Sl. No.	Commodity	No. of Vehicles					
		Towards Vairengte			Towards Silchar		
		2 Axle	3 Axle	M Axle	2 Axle	3 Axle	M Axle
1	Empty	29	14	10	175	70	5
2	Misc & Provision	2	0	0	0	1	0
3	Grains & Pulses	11	0	1	0	3	0
4	Fruits & Vegetables	9	0	0	0	0	0
5	Coal	0	0	0	0	0	0
6	CEMENT	31	25	27	3	0	0
7	HOUSE MATERIAL	0	0	0	0	3	0
8	Other Construction Material	22	1	1	2	4	0
9	Petroleum Products	35	23	0	12	2	0
10	Chemical and Fertilizers	1	0	0	0	0	0
11	Metals	7	0	0	0	0	0
12	Cotton & Wooden Products	0	0	0	0	0	0
13	Machinery & Equipment's	1	0	0	1	1	0
14	Other industrial products & parcel	40	2	10	2	4	1
15	Perishable goods (milk, eggs, animal, animal food)	3	0	0	1	4	0
16	Automobile & Parts	3	0	0	0	0	0
Total		194	65	49	196	92	6



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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Km 29+200 (Percentage)

Sl. No.	Commodity	% of Vehicles					
		Towards Vairengte			Towards Silchar		
		2-Axle	3-Axle	MAV	2-Axle	3-Axle	MAV
1	Empty	14.95%	21.54%	20.41%	89.29%	76.09%	83.33%
2	Misc. & Provision	1.03%	0.00%	0.00%	0.00%	1.09%	0.00%
3	Grains & Pulses	5.67%	0.00%	2.04%	0.00%	3.26%	0.00%
4	Fruits & Vegetables	4.64%	0.00%	0.00%	0.00%	0.00%	0.00%
5	Coal	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	CEMENT	15.98%	38.46%	55.10%	1.53%	0.00%	0.00%
7	HOUSE MATERIAL	0.00%	0.00%	0.00%	0.00%	3.26%	0.00%
8	Other Construction Material	11.34%	1.54%	2.04%	1.02%	4.35%	0.00%
9	Petroleum Products	18.04%	35.38%	0.00%	6.12%	2.17%	0.00%
10	Chemical and Fertilizers	0.52%	0.00%	0.00%	0.00%	0.00%	0.00%
11	Metals	3.61%	0.00%	0.00%	0.00%	0.00%	0.00%
12	Cotton & Wooden Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
13	Machinery & Equipment's	0.52%	0.00%	0.00%	0.51%	1.09%	0.00%
14	Other industrial products & parcel	20.62%	3.08%	20.41%	1.02%	4.35%	16.67%
15	Perishable goods (milk, eggs, animal, animal food)	1.55%	0.00%	0.00%	0.51%	4.35%	0.00%
16	Automobile & Parts	1.55%	0.00%	0.00%	0.00%	0.00%	0.00%
Total		100.0%	100.00%	100.00%	100.00%	100.00%	100.00%

Km 98+000 (Numbers)



Sl. No.	Commodity	No. of Vehicles					
		Towards Sairang			Towards Vairengte		
		2 Axle	3 Axle	M Axle	2 Axle	3 Axle	M Axle
1	Empty	56	10	0	52	5	2
2	Misc. & Provision	10	0	0	7	1	2
3	Grains & Pulses	7	5	8	15	6	3
4	Fruits & Vegetables	7	1	3	14	3	0

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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Sl. No.	Commodity	No. of Vehicles					
		Towards Sairang			Towards Vairengte		
		2 Axle	3 Axle	M Axle	2 Axle	3 Axle	M Axle
5	Coal	0	0	0	0	0	0
6	CEMENT	20	11	11	27	0	2
7	HOUSE MATERIAL	0	0	0	12	3	0
8	Other Construction Material	70	15	6	24	1	0
9	Petroleum Products	37	16	4	15	1	0
10	Chemical and Fertilizers	1	1	0	5	1	0
11	Metals	5	1	3	21	15	1
12	Cotton & Wooden Products	11	3	1	3	0	0
13	Machinery & Equipment's	20	0	1	2	1	0
14	Other industrial products & parcel	30	1	8	38	17	6
15	Perishable goods (milk, eggs, animal, animal food)	5	6	1	43	5	1
16	Automobile & Parts	4	0	1	5	0	0
Total		283	70	47	283	59	17

Km 98+000 (Percentage)

Sl. No.	Commodity	% of Vehicles					
		Towards Vairengte			Towards Silchar		
		2-Axle	3-Axle	MAV	2-Axle	3-Axle	MAV
1	Empty	19.79%	14.29%	0.00%	18.37%	8.47%	11.76%
2	Misc. & Provision	3.53%	0.00%	0.00%	2.47%	1.69%	11.76%
3	Grains & Pulses	2.47%	7.14%	17.02%	5.30%	10.17%	17.65%
4	Fruits & Vegetables	2.47%	1.43%	6.38%	4.95%	5.08%	0.00%
5	Coal	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	CEMENT	7.07%	15.71%	23.40%	9.54%	0.00%	11.76%
7	HOUSE MATERIAL	0.00%	0.00%	0.00%	4.24%	5.08%	0.00%
8	Other Construction Material	24.73%	21.43%	12.77%	8.48%	1.69%	0.00%
9	Petroleum Products	13.07%	22.86%	8.51%	5.30%	1.69%	0.00%
10	Chemical and Fertilizers	0.35%	1.43%	0.00%	1.77%	1.69%	0.00%
11	Metals	1.77%	1.43%	6.38%	7.42%	25.42%	5.88%

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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Sl. No.	Commodity	% of Vehicles					
		Towards Vairengte			Towards Silchar		
		2-Axle	3-Axle	MAV	2-Axle	3-Axle	MAV
12	Cotton & Wooden Products	3.89%	4.29%	2.13%	1.06%	0.00%	0.00%
13	Machinery & Equipment's	7.07%	0.00%	2.13%	0.71%	1.69%	0.00%
14	Other industrial products & parcel	10.60%	1.43%	17.02%	13.43%	28.81%	35.29%
15	Perishable goods (milk, eggs, animal, animal food)	1.77%	8.57%	2.13%	15.19%	8.47%	5.88%
16	Automobile & Parts	1.41%	0.00%	2.13%	1.77%	0.00%	0.00%
Total		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Km 166+000 (Numbers)

Sl. No.	Commodity	No. of Vehicles					
		Towards Aizawl			Towards Sairang		
		2 Axle	3 Axle	M Axle	2 Axle	3 Axle	M Axle
1	Empty	15	5	1	28	2	1
2	Misc. & Provision	12	0	0	3	2	0
3	Grains & Pulses	3	2	4	6	2	0
4	Fruits & Vegetables	0	1	0	9	2	0
5	Coal	1	0	0	0	0	0
6	CEMENT	12	7	7	4	2	1
7	HOUSE MATERIAL	10	2	0	15	6	0
8	Other Construction Material	24	1	1	8	7	0
9	Petroleum Products	7	2	0	14	0	0
10	Chemical and Fertilizers	1	1	0	0	0	0
11	Metals	5	0	1	5	2	1
12	Cotton & Wooden Products	6	0	0	2	2	0
13	Machinery & Equipment's	1	0	0	1	2	0
14	Other industrial products & parcel	23	10	9	28	12	0
15	Perishable goods (milk, eggs, animal, animal food)	7	0	1	10	8	0
16	Automobile & Parts	0	0	0	2	1	0
Total		127	31	24	135	50	3

Km 166+000 (Percentage)

Sl. No.	Commodity	% of Vehicles					
		Towards Aizawl			Towards Sairang		
		2-Axle	3-Axle	MAV	2-Axle	3-Axle	MAV
1	Empty	11.81%	16.13%	4.17%	20.74%	4.00%	33.33%
2	Misc. & Provision	9.45%	0.00%	0.00%	2.22%	4.00%	0.00%
3	Grains & Pulses	2.36%	6.45%	16.67%	4.44%	4.00%	0.00%
4	Fruits & Vegetables	0.00%	3.23%	0.00%	6.67%	4.00%	0.00%
5	Coal	0.79%	0.00%	0.00%	0.00%	0.00%	0.00%
6	CEMENT	9.45%	22.58%	29.17%	2.96%	4.00%	33.33%
7	HOUSE MATERIAL	7.87%	6.45%	0.00%	11.11%	12.00%	0.00%
8	Other Construction Material	18.90%	3.23%	4.17%	5.93%	14.00%	0.00%
9	Petroleum Products	5.51%	6.45%	0.00%	10.37%	0.00%	0.00%
10	Chemical and Fertilizers	0.79%	3.23%	0.00%	0.00%	0.00%	0.00%
11	Metals	3.94%	0.00%	4.17%	3.70%	4.00%	33.33%
12	Cotton & Wooden Products	4.72%	0.00%	0.00%	1.48%	4.00%	0.00%
13	Machinery & Equipment's	0.79%	0.00%	0.00%	0.74%	4.00%	0.00%
14	Other industrial products & parcel	18.11%	32.26%	37.50%	20.74%	24.00%	0.00%
15	Perishable goods (milk, eggs, animal, animal food)	5.51%	0.00%	4.17%	7.41%	16.00%	0.00%
16	Automobile & Parts	0.00%	0.00%	0.00%	1.48%	2.00%	0.00%
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.





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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Table 4.27 Trip Length Distribution



Km 29+200 (Percentage)

Trip Length (Kms)			Car	Bus	LCV	2 Axle	3Axle	MAV
Towards Vairengte								
0	-	5	3.31%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	7.62%	6.67%	0.00%	0.00%	0.00%	0.00%
21	-	30	1.99%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	64.57%	66.67%	5.56%	17.01%	7.69%	8.16%
51	-	100	5.63%	6.67%	61.11%	0.00%	10.77%	0.00%
101	-	200	16.56%	13.33%	33.33%	63.40%	49.23%	75.51%
201	-	500	0.00%	0.00%	0.00%	12.37%	29.23%	10.20%
501	-	1000	0.33%	6.67%	0.00%	7.22%	1.54%	6.12%
1001	-	10000	0.00%	0.00%	0.00%	0.00%	1.54%	0.00%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Towards Silchar								
0	-	5	1.64%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	11.48%	5.88%	2.17%	0.00%	0.00%	0.00%
21	-	30	1.31%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	57.38%	64.71%	45.65%	32.14%	16.30%	16.67%
51	-	100	8.20%	5.88%	2.17%	5.10%	11.96%	0.00%
101	-	200	19.67%	23.53%	19.57%	39.80%	38.04%	33.33%
201	-	500	0.00%	0.00%	26.09%	15.31%	31.52%	33.33%
501	-	1000	0.33%	0.00%	4.35%	7.65%	2.17%	16.67%
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	2.47%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	9.56%	6.38%	1.22%	0.00%	0.00%	0.00%
21	-	30	1.65%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	60.96%	65.96%	28.05%	24.62%	12.74%	9.09%
51	-	100	6.92%	6.38%	28.05%	2.56%	11.46%	0.00%
101	-	200	18.12%	17.02%	25.61%	51.54%	42.68%	70.91%
201	-	500	0.00%	0.00%	14.63%	13.85%	30.57%	12.73%
501	-	1000	0.33%	4.26%	2.44%	7.44%	1.91%	7.27%
1001	-	10000	0.00%	0.00%	0.00%	0.00%	0.64%	0.00%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	



Km 98+000 (Percentage)

Trip Length (Kms)			Car	Bus	LCV	2 Axle	3Axle	MAV
Towards Sairang								
0	-	5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	28.07%	50.00%	0.00%	0.35%	0.00%	0.00%
21	-	30	7.46%	0.00%	0.00%	0.35%	0.00%	0.00%
31	-	50	0.00%	0.00%	0.00%	0.71%	0.00%	0.00%
51	-	100	39.04%	0.00%	50.00%	9.89%	30.00%	4.26%
101	-	200	23.25%	8.33%	25.00%	51.94%	34.29%	48.94%
201	-	500	2.19%	41.67%	25.00%	34.98%	32.86%	38.30%
501	-	1000	0.00%	0.00%	0.00%	0.35%	0.00%	2.13%
1001	-	10000	0.00%	0.00%	0.00%	1.41%	2.86%	6.38%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Towards Vairengte								
0	-	5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	16.92%	0.00%	0.00%	0.35%	0.00%	0.00%
21	-	30	3.08%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
51	-	100	50.77%	33.33%	25.64%	5.61%	5.08%	0.00%
101	-	200	26.92%	33.33%	64.10%	66.32%	44.07%	61.11%
201	-	500	2.31%	33.33%	10.26%	27.02%	50.85%	38.89%
501	-	1000	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%
1001	-	10000	0.00%	0.00%	0.00%	0.35%	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	22.13%	33.33%	0.00%	0.35%	0.00%	0.00%
21	-	30	5.12%	0.00%	0.00%	0.18%	0.00%	0.00%
31	-	50	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%
51	-	100	45.29%	11.11%	34.92%	7.75%	18.60%	3.08%
101	-	200	25.20%	16.67%	49.21%	59.15%	38.76%	52.31%
201	-	500	2.25%	38.89%	15.87%	30.99%	41.09%	38.46%
501	-	1000	0.00%	0.00%	0.00%	0.35%	0.00%	1.54%
1001	-	10000	0.00%	0.00%	0.00%	0.88%	1.55%	4.62%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Km 166+000 (Percentage)

Trip Length (Kms)			Car	Bus	LCV	2 Axle	3Axle	MAV
Towards Aizawl								
0	-	5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	17.01%	25.00%	70.00%	22.66%	16.13%	16.67%
21	-	30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	73.96%	12.50%	0.00%	1.56%	0.00%	0.00%
51	-	100	3.47%	0.00%	15.00%	8.59%	6.45%	0.00%
101	-	200	2.43%	50.00%	5.00%	39.06%	38.71%	25.00%
201	-	500	2.08%	12.50%	10.00%	25.00%	16.13%	29.17%
501	-	1000	0.00%	0.00%	0.00%	0.78%	3.23%	0.00%
1001	-	10000	1.04%	0.00%	0.00%	2.34%	19.35%	29.17%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Towards Sairang								
0	-	5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	-	20	21.37%	0.00%	17.86%	21.48%	12.00%	33.33%
21	-	30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	72.52%	0.00%	0.00%	0.74%	0.00%	0.00%
51	-	100	3.44%	0.00%	7.14%	0.00%	4.00%	0.00%
101	-	200	2.67%	50.00%	64.29%	59.26%	50.00%	33.33%
201	-	500	0.00%	50.00%	10.71%	17.78%	30.00%	33.33%
501	-	1000	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1001	-	10000	0.00%	0.00%	0.00%	0.74%	4.00%	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	19.09%	16.67%	39.58%	22.05%	13.58%	18.52%
21	-	30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	-	50	73.27%	8.33%	0.00%	1.14%	0.00%	0.00%
51	-	100	3.45%	0.00%	10.42%	4.18%	4.94%	0.00%
101	-	200	2.55%	50.00%	39.58%	49.43%	45.68%	25.93%
201	-	500	1.09%	25.00%	10.42%	21.29%	24.69%	29.63%
501	-	1000	0.00%	0.00%	0.00%	0.38%	1.23%	0.00%
1001	-	10000	0.55%	0.00%	0.00%	1.52%	9.88%	25.93%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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4.9.6 Summary of Results (OD)

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

Silchar to Vairengte section

- Maximum share of the trips for passenger vehicles are originated from or destined to the state of Assam with its share being approx. 87%.
- For Goods vehicles share of Assam is approx. 60%. The share of the trips for goods vehicles originated from or destined to the state of Mizoram is around 40%. This is mainly due to the fact that all the construction material and other food products is transported to Mizoram from Assam. It is also observed that approx. 38%-40% of multi axle vehicles are originated from or destined to the state of Mizoram carrying Construction materials like Cement and Stone Slabs.
- Commodity movement pattern on this corridor shows that there is considerable movement of Construction materials like Cement, Stone Slabs, steel, industrial products & products, in addition to other miscellaneous goods like perishable items, petroleum products and miscellaneous goods etc. On the other hand, at Km 29+200, the share of goods vehicle carrying grains & pulses and construction materials as many surrounding area are large producer of pulses and also many quarries are present in the project influence area.
- On the corridor, most of the 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 100km to 200 Km, the percentage being approx. 15% to 70%, which clearly shows all this traffic is coming from Mizoram state. Amongst the passenger vehicles, buses having lead of more than 200 km is less than 6% and cars having a lead of more than 200km is approx. 17% only. This shows that the majority of passenger traffic movement is within the state only and some traffic movement from other state is observed.

Vairengte to Sairang section

- Maximum share of the trips for passenger vehicles are originated from or destined to Aizwal in the state of Mizoram with its share being approx. 85%.
- For Goods vehicles share of Mizoram is approx. 72%. The share of the trips for goods vehicles originated from or destined to the state of Mizoram is around 72%. This is mainly due to the fact that all the construction material and other food products is transported to Mizoram from Assam. It is also observed that approx. 58%-61% of multi axle vehicles are originated from or destined to the state of Mizoram carrying Construction materials like Cement and Stone Slabs.

- Commodity movement pattern on this corridor shows that there is considerable movement of Construction materials like Cement, Stone Slabs, steel, industrial products & products, in addition to other miscellaneous goods like perishable items, petroleum products and miscellaneous goods etc. On the other hand, the share of goods vehicle carrying grains & pulses and construction materials as there is no major quarry situated along the project road. Since the Railway construction work is progress, many construction materials movement were observed.
- On the corridor, most of the 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 100km to 500 Km, the percentage being approx. 15% to 60%, which clearly shows all this traffic is coming from Assam state. Amongst the passenger vehicles, buses having lead of more than 200 km is less than 41% and cars having a lead of more than 200km is approx. 3% only. This shows that the majority of passenger car movement is within the state only and bus movement is within interstate.

4.9.7 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. The assessment for expected tollable traffic on the proposed bypass has been done on the basis of analysis of the OD studies done at Km 29+200 along existing road; 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

Further Silchar to Vairengte section there is a link road between Sonbarighat on NH-306 and Fulertheal on NH-37 which will divert that traffic from NH-306 to NH-37 via Sonai. This rote is the shortest route and will save the travel time, currently the traffic that is travelling from Mizoram towards Manipur is using this route. Once the project road is developed to 4-lane divided carriageway all the traffic that are using this route will be diverted to NH-306.



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

Table 4.28 Percentage diversion of tollable traffic on proposed Green Filed alignment

Car	Bus	LCV	2A Trucks	3A Trucks	4-6 Axle Trucks
90%	90%	70%	100%	100%	100%

Table 4.29 Assumed % diversion of non-tollable traffic on Green Filed alignment

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

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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 4.30 Average Daily Traffic on proposed green filed alignment (ADT – in nos.)

Sl. No	Vehicle Type	ADT (In nos.)	
		Actual traffic on existing road (km 29+200)	Diverted traffic on Green filed alignment
Tollable Traffic			
1	Car	1523	1370
2	Mini-Bus	86	77
3	Pvt. Bus	31	28
4	Govt. Bus	0	0
5	LCV	235	165
6	2 Axle	739	739
7	3 Axle	283	283
8	4-6 Axle	12	12
9	>=7 Axle	0	0
Non-Tollable Traffic			
10	2W	1845	738
11	3W	1841	552
12	Tractor with Trailer	6	4
13	Tractor without Trailer	0	0
14	Cycle	175	123
15	Rickshaw	1	1
16	Animal Drawn	0	0
ADT in Nos.			
Tollable		2908	2674
Non - Tollable		3868	1418
Total		6776	4091

Table 4.31 Average Daily Traffic on proposed green filed alignment (ADT – in PCU)

Sl. No	Vehicle Type	ADT (In PCU)	
		Actual traffic on existing road (km 29+200)	Diverted traffic on Green filed alignment
Tollable Traffic			
1	Car	1523	1370
2	Mini-Bus	128	116
3	Pvt. Bus	93	83
4	Govt. Bus	0	0
5	LCV	353	247
6	2 Axle	2217	2217

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<p>Chapter 4: Traffic Studies & Demand Forecast</p>		

Sl. No	Vehicle Type	ADT (In PCU)	
		Actual traffic on existing road (km 29+200)	Diverted traffic on Green filed alignment
7	3 Axle	849	849
8	4-6 Axle	54	54
9	>=7 Axle	0	0
Non-Tollable Traffic			
10	2W	922	369
11	3W	1841	552
12	Tractor with Trailer	27	19
13	Tractor without Trailer	0	0
14	Cycle	88	61
15	Rickshaw	2	1
16	Animal Drawn	0	0
ADT in PCU.			
Tollable		5216	4936
Non - Tollable		2879	1003
Total		8095	5938

4.10 Traffic in terms of AADT for Section 2 (From Km 42+750 to Km 88+500)

Base on the traffic survey and OD survey conducted at Km 29+200 and at Km 98+000, the traffic in terms of AAST is determined for section 3 i.e. from Km 42+750 to Km 88+500. Most of the traffic at Km 98+000 is originated/designated to Kolasib, hence the traffic is less compared to the traffic of section 4 from Km 88+5000 to Km 121+500. The summary of traffic in terms of AADT is given in below table.

Table 4.32 Annual Average Daily Traffic (AADT) for Section 2 (From Km 42+750 to Km 88+500)

Sl. No	Vehicle Type	AADT (In nos.)	AADT (In PCUs.)
		Section 2 (From Km 42+750 to Km 88+500)	Section 2 (From Km 42+750 to Km 88+500)
Tollable Traffic			
1	Car	1104	1104
2	Mini-Bus	25	37
3	Pvt. Bus	9	27
4	Govt. Bus	0	0
5	LCV	148	223
6	2 Axle	505	1516
7	3 Axle	193	580
8	4-6 Axle	55	248
9	>=7 Axle	0	0
Non-Tollable Traffic			
10	2W	738	369
11	3W	80	80

Sl. No	Vehicle Type	AADT (In nos.)	AADT (In PCUs.)
		Section 2 (From Km 42+750 to Km 88+500)	Section 2 (From Km 42+750 to Km 88+500)
12	Tractor with Trailer	2	10
13	Tractor without Trailer	0	0
14	Cycle	28	14
15	Rickshaw	0	1
16	Animal Drawn	0	0
ADT in Nos.			
Tollable		2040	3734
Non - Tollable		849	474
Total		2889	4209

4.11 Traffic in terms of AADT for Section 4 (From Km 121+500 to Km 158+900)

Presently the passenger traffic using NH-6 (BRO) after Kawnpui towards Aizawl via Sherkhan, Sentlang, Lungdai, Siphir, Durtlang instead of our project road i.e., NH-306. This NH-6 (BRO road) has only 3.5m road width (Single carriageway) with 10km shorter as compared to our project road however, since the road falls under single carriageway, it cannot be utilized for longer period and commercial goods vehicle as well in view of safety aspect.

As per recent site visit, it has been accorded that NH-PWD has started repairing the project road under exclusive fund as the commercial vehicles are forced to use the same road resulting significant vehicle damage and enormous fuel cost. The repair works are estimated to be completed by this financial year. As a result, diverted passenger vehicles would be brought back to main road i.e., on NH-306

Based on above assessment, OD studies being done at Zalawn of NH-6 for the purpose of determining the expected diverted tollable traffic. Further, the percentages of likely diversions of non-tollable vehicles have been assessed on the basis of consultant's experience in line with traffic network in the project influence area.

Hence, the details of the summarized diverted traffic are presented in the table below.

Table 4.33 Percentage diversion of tollable traffic on project road

From section	Likely percentage of diverted traffic on project road					
	Car	Bus	LCV	2A Trucks	3A Trucks	4-6 Axle Trucks
From NH-6 (Kawnpui-Aizawl Rd)	70%	100%	60%	80%	70%	60%



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	<p>Chapter 4: Traffic Studies & Demand Forecast</p>	

Table 4.34 Assumed % diversion of non-tollable traffic on project road



3W	2W	Tractors	Non-motorised
60%	30%	70%	70%

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

Table 4.35 Diverted Annual Average Daily Traffic (AADT)

I. No.	Vehicle Type	AADT (In Nos.)	AADT (In Nos.)	AADT (In PCU)
		On NH-6 (As per CVC)	Diverted traffic	Diverted traffic
Tollable Traffic				
1	Car	522	365	365
2	Mini-Bus	8	8	12
3	Pvt. Bus	0	0	0
4	Govt. Bus	5	5	15
5	LCV	95	57	86
6	2 Axle	73	58	175
7	3 Axle	19	14	41
8	4-6 Axle	6	3	16
9	>=7 Axle	0	0	0
Non-Tollable Traffic				
10	2W	427	128	64
11	3W	152	91	91
12	Tractor with Trailer	0	0	0
13	Tractor without Trailer	0	0	0
14	Cycle	0	0	0
15	Rickshaw	0	0	0
16	Animal Drawn	0	0	0
AADT in Nos.				
Tollable		728	510	709
Non - Tollable		579	219	155
Total		1307	730	864

As per the OD studies there is no leakage of the traffic between Kawnpui and Sairang hence, in order to determine the traffic on Section-4 (From Km 121+000 to Km 158+900) the percentage of the traffic that are travelling towards Serkhan, Lungdai, Siphir via NH-6 is deducted from the AADT values at Km 98+000 and the same values is

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considered as AADT values for Section-4. The details of the AADT values are given in below table;

Table 4.36 Annual Average Daily Traffic (AADT) for Section 4

Sl. No	Vehicle Type	AADT (In nos.)	AADT (In PCUs.)
		Section-4 (From Km 121+500 to Km 158+900)	Section-4 (From Km 121+500 to Km 158+900)
Tollable Traffic			
1	Car	1223	1223
2	Mini-Bus	10	15
3	Pvt. Bus	25	76
4	Govt. Bus	9	26
5	LCV	200	300
6	2 Axle	847	2542
7	3 Axle	160	481
8	4-6 Axle	60	269
9	>=7 Axle	0	0
Non-Tollable Traffic			
10	2W	506	253
11	3W	18	18
12	Tractor with Trailer	0	0
13	Tractor without Trailer	0	0
14	Cycle	29	15
15	Rickshaw	0	0
16	Animal Drawn	0	0
ADT in Nos.			
Tollable		2534	4932
Non - Tollable		553	286
Total		3088	5218

4.12 Turning Movement Surveys

Turning movement survey has been carried out at the following 3 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, since the proposed alignment is passing through green filed and will not encounter those junctions along the existing road.

Details of junctions are given below in below table;



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Table 4.37 Junction Details

Sl. No	Location	Chainage	Type	Classification of Road	X-Road leading to
Silchar to Vairengte					
1	Sonbarighat	9+500	3-Legged	MDR	Sonai Towards NH-37
2	Bhaga Bazar	36+000	3-Legged	NH-306A	Aizwal
Vairengte to Sairang					
1	Rengtekawn	88+500	3-Legged	NH-6	Bairabi Road
2	Kawnpui	121+500	3-Legged	NH-6	BRO Road(Zanlawn Rd)
3	Sairang	158+900	3-Legged	NH-6	Lengpui Airport Road

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 4.38 Details of Turning Movement Survey



Sl. No	Location	Chainage, Km	Type of Junction	Peak Hour	Peak Hour PCU
Silchar to Vairengte					
1	Sonbarighat	9+500	3-Legged	13.00 – 14.00	2367
2	Bhaga Bazar	36+000	3-Legged	12.00 – 13.00	1146
Vairengte to Sairang					
3	Rengtekawn	88+500	3-Legged	17.00-18.00	393
5	Kawnpui	121+500	3-Legged	17.00-18.00	354
6	Sairang	158+900	3-Legged	14.00-15.00	521

4.12.1 Sonbarighat Junction (Km 9+500)

The Peak hour traffic at this junction is 2367 PCU and the peak hour timing is 13.00 to 14.00 hrs. The total traffic for 16 hrs at this junction is 19356 PCU. The major movement of traffic is observed between Silchar & Vairengte vice versa. This is due to movement of the commercial traffic from silchar and Mizoram The turning traffic means the traffic coming from or going to Sonbarighat junction at this junction is 2094.

4.12.2 Bhaga Bazar Junction (Km 36+000)

The Peak hour traffic at this junction is 1146 PCU and the peak hour timing is 12.00 to 13.00 hrs. The total traffic for 16 hrs at this junction is 13711 PCU. The major movement

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of traffic is observed between Silchar & Vairengte vice versa. This is due to movement of construction material. The turning traffic means the traffic coming from or going to Bhaga Bazar at this junction is 928.

4.12.3 Bairabi Rd Junction (Km 88+500)

The Peak hour traffic at this junction is 393 PCU and the peak hour timing is 17.00 to 18.00 hrs. The total traffic for 16 hrs at this junction is 4412 PCU. The major movement of traffic is observed between Vairengte & Kolasib vice versa. This is due to movement of the commercial traffic from silchar and Mizoram The turning traffic means the traffic coming from or going to at this junction is 393.

4.12.4 Aizawl Rd Junction (Km 121+500)

The Peak hour traffic at this junction is 354PCU and the peak hour timing is 17.00 to 18.00 hrs. The total traffic for 16 hrs at this junction is 3221 PCU. The major movement of traffic is observed between Kolasib & Sairang vice versa. This is due to movement of construction material. The turning traffic means the traffic coming from or going to at this junction is 354.

4.12.5 Aizawl Rd Junction (Km 158+900)

The Peak hour traffic at this junction is 521 PCU and the peak hour timing is 14.00 to 15.00 hrs. The total traffic for 16 hrs at this junction is 4957 PCU. The major movement of traffic is observed between Sairang & Aizawl vice versa. This is due to movement of construction material. The turning traffic means the traffic coming from or going to at this junction is 521.



4.13 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 one location (km 29+200, 98+000 and 166+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.

4.13.1 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:

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- 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.



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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Table 4.39 Vehicle Damage Factor (VDF) for Commercial Vehicles

Km 29+200

Type of Vehicle	Sample (%)	Silchar - Vairengte		Vairengte to Silchar		Adopted VDF
		No. of Vehicle	VDF	No. of Vehicle	VDF	
LCV	16.0%	42	0.63	57	0.03	0.63
2-Axle Truck	31.7%	194	5.31	194	0.54	5.31
3-Axle Truck	29.1%	65	5.49	92	3.06	5.49
Multi-Axle Truck	69.1%	49	7.88	6	1.52	7.88
Bus	51.7%	20	0.79	16	0.78	0.79

Km 98+000

Type of Vehicle	Sample (%)	Vairengte-Sairang		Sairang-Vairengte		Adopted VDF
		No. of Vehicle	VDF	No. of Vehicle	VDF	
LCV	13.5%	36	0.98	39	0.76	0.98
2-Axle Truck	33.0%	269	4.29	275	1.35	4.29
3-Axle Truck	35.1%	68	5.58	65	2.07	5.58
Multi-Axle Truck	45.3%	47	7.94	20	1.52	7.94
Bus	32.7%	12	0.12	4	0.98	0.98

Km 166+000



Type of Vehicle	Sample (%)	Sairang-Aizawl		Aizawl-Sairang		Adopted VDF
		No. of Vehicle	VDF	No. of Vehicle	VDF	
LCV	6.1%	20	0.58	28	0.04	0.58
2-Axle Truck	34.6%	127	6.06	134	1.98	6.06
3-Axle Truck	36.7%	33	4.55	50	1.47	4.55
Multi-Axle Truck	29.7%	23	4.16	4	6.35	6.35
Bus	40.0%	6	1.20	6	3.08	3.08

4.14 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:

4.14.1 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.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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4.14.2 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

4.14.3 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.

4.14.4 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)

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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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 Manipur as collected from different statistical handbooks are presented in below table . 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 4.40 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%

4.14.5 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,

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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

4.14.6 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 : $Tgr = ((1 + Pgr) \times (1 + PCI\ gr) - 1) \times 100 \times E$

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 : $Tgr = \frac{1}{2} (Agr + NSDPgr) \times E \times 100$

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 4.41 Proposed Traffic Growth rates for Silchar to Vairengte 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%

Table 4.42 Proposed Traffic Growth rates for Vairengte to Sairang section

Vehicle Type	Upto 2025	2026-30	2031-35	2036-40	Beyond 2040
Most Likely Scenario					
Car/Van/Jeep	5.00%	8.35%	7.30%	6.50%	5.00%
Bus/Minibus	5.00%	5.00%	5.00%	5.00%	5.00%

Vehicle Type	Upto 2025	2026-30	2031-35	2036-40	Beyond 2040
LCV	5.00%	11.15%	9.75%	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%	9.35%	8.30%	7.50%	6.00%
Bus/Mini Bus	6.00%	6.00%	6.00%	6.00%	6.00%
LCV	6.00%	12.15%	10.75%	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%	7.35%	6.30%	5.50%	4.00%
Bus/Mini Bus	4.00%	4.00%	4.00%	4.00%	4.00%
LCV	4.00%	10.15%	8.75%	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 is given below in table.

Table 4.43 Proposed yearly Traffic Growth rates (Most Likely Scenario) for Silchar to Vairengte 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%



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Year	Car	Mini-Bus	Full Bus	LCV	TRUCKS				2W	3W	Tractor	Cycle	Rickshaw	Animal drawn
					2A	3A	4-6A	≥7A						
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%
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%



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Year	Car	Mini-Bus	Full Bus	LCV	TRUCKS				2W	3W	Tractor	Cycle	Rickshaw	Animal drawn
					2A	3A	4-6A	≥7A						
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%

Table 4.44 Proposed yearly Traffic Growth rates (Most Likely Scenario) for Vairengte to Sairang 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	8.35%	5.00%	5.00%	11.15%	5.00%	7.00%	7.00%	7.00%	5.00%	5.00%	2.00%	2.00%	2.00%	8.35%
2027	8.35%	5.00%	5.00%	11.15%	5.00%	7.00%	7.00%	7.00%	5.00%	5.00%	2.00%	2.00%	2.00%	8.35%
2028	8.35%	5.00%	5.00%	11.15%	5.00%	7.00%	7.00%	7.00%	5.00%	5.00%	2.00%	2.00%	2.00%	8.35%
2029	8.35%	5.00%	5.00%	11.15%	5.00%	7.00%	7.00%	7.00%	5.00%	5.00%	2.00%	2.00%	2.00%	8.35%
2030	8.35%	5.00%	5.00%	11.15%	5.00%	7.00%	7.00%	7.00%	5.00%	5.00%	2.00%	2.00%	2.00%	8.35%
2031	7.30%	5.00%	5.00%	9.75%	5.00%	6.50%	6.50%	6.50%	5.00%	5.00%	2.00%	2.00%	2.00%	7.30%
2032	7.30%	5.00%	5.00%	9.75%	5.00%	6.50%	6.50%	6.50%	5.00%	5.00%	2.00%	2.00%	2.00%	7.30%
2033	7.30%	5.00%	5.00%	9.75%	5.00%	6.50%	6.50%	6.50%	5.00%	5.00%	2.00%	2.00%	2.00%	7.30%
2034	7.30%	5.00%	5.00%	9.75%	5.00%	6.50%	6.50%	6.50%	5.00%	5.00%	2.00%	2.00%	2.00%	7.30%
2035	7.30%	5.00%	5.00%	9.75%	5.00%	6.50%	6.50%	6.50%	5.00%	5.00%	2.00%	2.00%	2.00%	7.30%





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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast



Year	Car	Mini-Bus	Full Bus	LCV	TRUCKS				2W	3W	Tractor	Cycle	Rickshaw	Animal drawn
					2A	3A	4-6A	>=7A						
2036	6.50%	5.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.00%	5.00%	2.00%	2.00%	2.00%	6.50%
2037	6.50%	5.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.00%	5.00%	2.00%	2.00%	2.00%	6.50%
2038	6.50%	5.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.00%	5.00%	2.00%	2.00%	2.00%	6.50%
2039	6.50%	5.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.00%	5.00%	2.00%	2.00%	2.00%	6.50%
2040	6.50%	5.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.00%	5.00%	2.00%	2.00%	2.00%	6.50%
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%
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%

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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4.14.7 Projected Traffic

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

Table 4.45 Projected Traffic (PCU) - Section 1 From Km 0+000 to Km 42+750 (Silchar to Vairengte)

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal Drawn	Volume	PCU
2020	1523	86	31	235	739	283	12	1845	1841	6	0	210	1	0	6811	8113
2021	1599	90	32	247	776	297	13	1937	1933	6	0	214	1	0	7145	8515
2022	1679	94	34	259	815	312	13	2034	2029	7	0	218	1	0	7496	8938
2023	1763	99	36	272	856	327	14	2136	2131	7	0	223	1	0	7864	9381
2024	1851	104	38	286	898	344	15	2243	2237	7	0	227	1	0	8250	9847
2025	1943	109	39	300	943	361	15	2355	2349	8	0	232	1	0	8656	10336
2026	2040	115	41	315	990	379	16	2472	2467	8	0	236	1	0	9082	10849
2027	2238	121	43	354	1040	406	17	2596	2590	8	0	241	1	0	9656	11543
2028	2455	127	46	398	1092	434	18	2726	2719	9	0	246	1	0	10271	12287
2029	2694	133	48	447	1146	464	20	2862	2855	9	0	251	1	0	10931	13084
2030	2955	140	50	503	1204	497	21	3005	2998	10	0	256	1	0	11639	13941
2031	3241	147	53	565	1264	532	22	3156	3148	10	0	261	1	0	12400	14860
2032	3517	154	55	626	1327	566	24	3313	3305	11	0	266	1	0	13167	15788
2033	3816	162	58	694	1394	603	25	3479	3471	11	0	272	1	0	13986	16778
2034	4140	170	61	770	1463	642	27	3653	3644	12	0	277	1	0	14861	17836
2035	4492	178	64	853	1536	684	29	3836	3826	12	0	283	1	0	15795	18967
2036	4874	187	67	946	1613	728	31	4027	4018	13	0	288	1	0	16795	20176
2037	5118	196	71	993	1694	772	33	4229	4219	14	0	294	1	0	17633	21204
2038	5374	206	74	1043	1779	818	35	4440	4430	14	0	300	1	0	18514	22284
2039	5642	216	78	1095	1867	868	37	4662	4651	15	0	306	1	0	19439	23420
2040	5924	227	82	1150	1961	920	39	4895	4884	16	0	312	1	0	20411	24614
2041	6221	239	86	1207	2059	975	41	5140	5128	17	0	318	2	0	21432	25869
2042	6532	251	90	1268	2162	1024	43	5397	5384	17	0	325	2	0	22494	27157
2043	6858	263	95	1331	2270	1075	45	5667	5653	18	0	331	2	0	23609	28510



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)



Chapter 4: Traffic Studies & Demand Forecast



Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal Drawn	Volume	PCU
2044	7201	276	100	1397	2383	1128	48	5950	5936	19	0	338	2	0	24779	29931
2045	7561	290	105	1467	2503	1185	50	6248	6233	20	0	345	2	0	26008	31422
2046	7939	305	110	1541	2628	1244	53	6560	6545	21	0	351	2	0	27298	32988
2047	8336	320	115	1618	2759	1306	55	6888	6872	22	0	358	2	0	28652	34632
2048	8753	336	121	1699	2897	1372	58	7232	7215	23	0	366	2	0	30074	36358
2049	9191	353	127	1784	3042	1440	61	7594	7576	25	0	373	2	0	31567	38170
2050	9650	370	133	1873	3194	1512	64	7974	7955	26	0	380	2	0	33134	40073
2051	10133	389	140	1966	3354	1588	67	8373	8353	27	0	388	2	0	34779	42071
2052	10639	408	147	2065	3521	1667	70	8791	8770	28	0	396	2	0	36506	44169
2053	10645	408	147	2066	3523	1668	70	8796	8775	28	0	396	2	0	36524	44191

Table 4.46 Projected Traffic (PCU) – Section 2 From Km 42+750 to Km 88+500 (Vairengte -Kolasib)

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 Drawn	Volume	PCU
2020	1104	25	8	149	506	193	55	738	80	2	0	29	0	0	2889	4206
2021	1159	26	8	156	531	203	58	775	84	2	0	30	0	0	3033	4416
2022	1217	28	9	164	558	213	61	814	88	2	0	30	0	0	3183	4636
2023	1278	29	9	172	586	223	64	854	93	2	0	31	0	0	3342	4868
2024	1342	30	10	181	615	235	67	897	97	2	0	31	0	0	3508	5110
2025	1409	32	10	190	646	246	70	942	102	3	0	32	0	0	3682	5366
2026	1479	34	11	200	678	259	74	989	107	3	0	33	0	0	3865	5633
2027	1603	35	11	222	712	277	79	1038	113	3	0	33	0	0	4126	6005
2028	1737	37	12	247	748	296	84	1090	118	3	0	34	0	0	4406	6402
2029	1882	39	12	274	785	317	90	1145	124	3	0	35	0	0	4706	6828

 <p>संयोजित नवते M.O.R.T.H. एम्. ओ. आर. टी. एच.</p>	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	 <p>BUILDING INFRASTRUCTURE - BUILDING THE NATION</p>
<p>Chapter 4: Traffic Studies & Demand Forecast</p>		

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 Drawn	Volume	PCU
2030	2039	41	13	305	824	339	97	1202	130	3	0	35	0	0	5028	7285
2031	2209	43	14	339	865	363	103	1262	137	3	0	36	0	0	5375	7774
2032	2371	45	14	372	909	386	110	1325	144	4	0	37	0	0	5716	8260
2033	2544	47	15	408	954	411	117	1392	151	4	0	38	0	0	6080	8778
2034	2729	49	16	448	1002	438	125	1461	158	4	0	38	0	0	6469	9331
2035	2929	52	17	491	1052	467	133	1534	166	4	0	39	0	0	6884	9920
2036	3142	55	17	539	1105	497	142	1611	175	4	0	40	0	0	7327	10547
2037	3347	57	18	566	1160	527	150	1692	183	5	0	41	0	0	7745	11142
2038	3564	60	19	595	1218	558	159	1776	193	5	0	41	0	0	8188	11772
2039	3796	63	20	624	1279	592	169	1865	202	5	0	42	0	0	8657	12437
2040	4042	66	21	656	1343	627	179	1958	212	5	0	43	0	0	9153	13141
2041	4305	70	22	688	1410	665	190	2056	223	6	0	44	0	0	9678	13884
2042	4520	73	23	723	1480	698	199	2159	234	6	0	45	0	0	10161	14578
2043	4747	77	25	759	1554	733	209	2267	246	6	0	46	0	0	10668	15306
2044	4984	81	26	797	1632	770	219	2380	258	6	0	47	0	0	11200	16071
2045	5233	85	27	837	1713	808	230	2499	271	7	0	48	0	0	11758	16874
2046	5495	89	28	879	1799	849	242	2624	284	7	0	49	0	0	12345	17717
2047	5769	93	30	923	1889	891	254	2755	299	7	0	49	0	0	12961	18602
2048	6058	98	31	969	1984	936	267	2893	314	8	0	50	0	0	13607	19531
2049	6361	103	33	1017	2083	983	280	3038	329	8	0	51	0	0	14286	20507
2050	6679	108	35	1068	2187	1032	294	3190	346	9	0	53	0	0	14999	21531
2051	7013	113	36	1121	2296	1083	309	3349	363	9	0	54	0	0	15747	22607
2052	7363	119	38	1177	2411	1138	324	3517	381	10	0	55	0	0	16533	23737
2053	7367	119	38	1178	2412	1138	324	3518	381	10	0	55	0	0	16541	23749





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Table 4.47 Projected Traffic (PCU) - Section 3 From Km 88+500 to Km 121+500(Kolasib-Kawnpui)

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Ricksha	Animal	Volume	PCU
2020	1380	10	34	238	862	166	62	805	79	0	0	29	0	0	3665	5713
2021	1448	10	36	250	905	174	65	846	83	0	0	30	0	0	3847	5998
2022	1521	11	37	262	950	183	69	888	87	0	0	30	0	0	4039	6298
2023	1597	11	39	276	998	192	72	932	91	0	0	31	0	0	4240	6612
2024	1677	12	41	289	1048	202	76	979	96	0	0	31	0	0	4451	6943
2025	1761	12	43	304	1100	212	79	1028	100	0	0	32	0	0	4672	7289
2026	1849	13	46	319	1155	223	83	1079	105	0	0	33	0	0	4905	7653
2027	2003	14	48	355	1213	238	89	1133	111	0	0	33	0	0	5237	8148
2028	2170	14	50	394	1273	255	95	1190	116	0	0	34	0	0	5593	8677
2029	2352	15	53	438	1337	273	102	1249	122	0	0	35	0	0	5976	9243
2030	2548	16	55	487	1404	292	109	1312	128	0	0	35	0	0	6387	9849
2031	2761	17	58	541	1474	312	117	1377	135	0	0	36	0	0	6828	10499
2032	2962	17	61	594	1548	333	124	1446	141	0	0	37	0	0	7264	11147
2033	3178	18	64	652	1625	354	133	1519	148	0	0	38	0	0	7729	11838
2034	3410	19	67	715	1707	377	141	1595	156	0	0	38	0	0	8226	12574
2035	3659	20	71	785	1792	402	150	1674	164	0	0	39	0	0	8757	13358
2036	3926	21	74	862	1881	428	160	1758	172	0	0	40	0	0	9323	14193
2037	4182	22	78	905	1976	454	170	1846	180	0	0	41	0	0	9853	14981
2038	4454	23	82	950	2074	481	180	1938	189	0	0	41	0	0	10413	15814
2039	4743	25	86	998	2178	510	191	2035	199	0	0	42	0	0	11006	16693
2040	5051	26	90	1048	2287	540	202	2137	209	0	0	43	0	0	11633	17622
2041	5380	27	95	1100	2401	573	214	2244	219	0	0	44	0	0	12297	18604
2042	5649	28	99	1155	2521	601	225	2356	230	0	0	45	0	0	12910	19533
2043	5931	30	104	1213	2647	631	236	2474	242	0	0	46	0	0	13554	20509
2044	6228	31	110	1273	2780	663	248	2597	254	0	0	47	0	0	14231	21534
2045	6539	33	115	1337	2919	696	261	2727	267	0	0	48	0	0	14941	22610
2046	6866	35	121	1404	3065	731	274	2864	280	0	0	49	0	0	15686	23740
2047	7209	36	127	1474	3218	767	287	3007	294	0	0	49	0	0	16469	24926

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<p>Chapter 4: Traffic Studies & Demand Forecast</p>		

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Ricksha	Animal	Volume	PCU
2048	7570	38	133	1548	3379	806	302	3157	309	0	0	50	0	0	17291	26172
2049	7948	40	140	1625	3548	846	317	3315	324	0	0	51	0	0	18154	27479
2050	8346	42	147	1706	3725	888	332	3481	340	0	0	53	0	0	19060	28853
2051	8763	44	154	1792	3911	933	349	3655	357	0	0	54	0	0	20012	30294
2052	9201	46	162	1881	4107	979	367	3838	375	0	0	55	0	0	21011	31808
2053	9206	46	162	1882	4109	980	367	3840	375	0	0	55	0	0	21021	31824

Table 4.48 Projected Traffic (PCU) - Section 4 From Km 121+500 to Km 158+900(Kawnpui-Sairang)

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal	Volume	PCU
2020	1223	10	34	200	847	160	60	506	18	0	0	29	0	0	3088	5218
2021	1284	10	36	210	890	168	63	532	19	0	0	30	0	0	3241	5478
2022	1348	11	37	220	934	177	66	558	20	0	0	30	0	0	3402	5752
2023	1416	11	39	232	981	186	69	586	21	0	0	31	0	0	3571	6039
2024	1487	12	41	243	1030	195	73	615	22	0	0	31	0	0	3749	6340
2025	1561	12	43	255	1081	205	76	646	23	0	0	32	0	0	3936	6657
2026	1691	13	46	284	1136	219	82	678	24	0	0	33	0	0	4205	7084
2027	1832	14	48	315	1192	234	87	712	25	0	0	33	0	0	4494	7541
2028	1985	14	50	350	1252	251	94	748	27	0	0	34	0	0	4805	8030
2029	2151	15	53	390	1315	268	100	785	28	0	0	35	0	0	5140	8553
2030	2331	16	55	433	1380	287	107	825	29	0	0	35	0	0	5499	9114
2031	2501	17	58	475	1449	306	114	866	31	0	0	36	0	0	5853	9673
2032	2684	17	61	522	1522	326	122	909	32	0	0	37	0	0	6231	10269
2033	2879	18	64	572	1598	347	129	955	34	0	0	38	0	0	6634	10904
2034	3090	19	67	628	1678	369	138	1002	36	0	0	38	0	0	7066	11580

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal	Volume	PCU
2035	3315	20	71	689	1762	393	147	1052	38	0	0	39	0	0	7526	12300
2036	3531	21	74	724	1850	417	156	1105	39	0	0	40	0	0	7956	12983
2037	3760	22	78	760	1942	442	165	1160	41	0	0	41	0	0	8412	13704
2038	4005	23	82	798	2039	468	175	1218	43	0	0	41	0	0	8894	14465
2039	4265	25	86	838	2141	496	185	1279	46	0	0	42	0	0	9404	15270
2040	4542	26	90	880	2248	526	196	1343	48	0	0	43	0	0	9943	16120
2041	4769	27	95	924	2361	553	206	1410	50	0	0	44	0	0	10439	16925
2042	5008	28	99	970	2479	580	217	1481	53	0	0	45	0	0	10960	17771
2043	5258	30	104	1019	2603	609	227	1555	56	0	0	46	0	0	11506	18659
2044	5521	31	110	1070	2733	640	239	1633	58	0	0	47	0	0	12080	19591
2045	5797	33	115	1123	2869	672	251	1714	61	0	0	48	0	0	12683	20570
2046	6087	35	121	1179	3013	705	263	1800	64	0	0	49	0	0	13316	21598
2047	6391	36	127	1238	3164	740	276	1890	67	0	0	49	0	0	13980	22677
2048	6711	38	133	1300	3322	777	290	1985	71	0	0	50	0	0	14677	23810
2049	7046	40	140	1365	3488	816	305	2084	74	0	0	51	0	0	15410	25000
2050	7398	42	147	1433	3662	857	320	2188	78	0	0	53	0	0	16179	26249
2051	7768	44	154	1505	3845	900	336	2297	82	0	0	54	0	0	16986	27561
2052	8157	46	162	1580	4038	945	353	2412	86	0	0	55	0	0	17834	28938
2053	8161	46	162	1581	4040	945	353	2413	86	0	0	55	0	0	17843	28952

Table 4.49 Projected Traffic (PCU) - Section 5 (Sairang-Aizawl)

Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal Drawn	Volume	PCU
2020	1869	20	19	375	351	101	35	427	152	0	0	0	0	0	3350	4399
2021	1963	21	20	394	368	106	37	449	159	0	0	0	0	0	3517	4619
2022	2061	22	21	414	387	111	39	471	167	0	0	0	0	0	3693	4850
2023	2164	24	22	434	406	117	40	495	175	0	0	0	0	0	3878	5092
2024	2272	25	24	456	426	123	43	519	184	0	0	0	0	0	4072	5347
2025	2386	26	25	479	448	129	45	545	193	0	0	0	0	0	4275	5614
2026	2585	27	26	532	470	138	48	573	203	0	0	0	0	0	4602	6031
2027	2801	29	27	591	494	148	51	601	213	0	0	0	0	0	4955	6481
2028	3034	30	29	657	518	158	55	631	224	0	0	0	0	0	5337	6967
2029	3288	32	30	731	544	169	59	663	235	0	0	0	0	0	5750	7492
2030	3562	33	32	812	571	181	63	696	247	0	0	0	0	0	6197	8059
2031	3822	35	33	891	600	193	67	731	259	0	0	0	0	0	6631	8614
2032	4101	37	35	978	630	205	71	767	272	0	0	0	0	0	7097	9210
2033	4401	38	37	1074	661	219	76	806	286	0	0	0	0	0	7597	9848
2034	4722	40	38	1178	695	233	81	846	300	0	0	0	0	0	8133	10533
2035	5067	42	40	1293	729	248	86	888	315	0	0	0	0	0	8709	11268
2036	5396	45	42	1358	766	263	91	933	331	0	0	0	0	0	9224	11919
2037	5747	47	45	1426	804	278	96	979	347	0	0	0	0	0	9770	12608
2038	6121	49	47	1497	844	295	102	1028	365	0	0	0	0	0	10348	13337
2039	6518	52	49	1572	886	313	108	1080	383	0	0	0	0	0	10961	14109
2040	6942	54	52	1650	931	332	115	1134	402	0	0	0	0	0	11611	14927
2041	7289	57	54	1733	977	348	121	1191	422	0	0	0	0	0	12192	15673
2042	7654	60	57	1820	1026	366	127	1250	443	0	0	0	0	0	12802	16457
2043	8036	63	60	1911	1077	384	133	1313	466	0	0	0	0	0	13442	17280
2044	8438	66	63	2006	1131	403	140	1378	489	0	0	0	0	0	14114	18143
2045	8860	69	66	2106	1188	423	147	1447	513	0	0	0	0	0	14820	19051



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast



Years	Motorized Vehicles											Non-Motorized Vehicles			Total	
	Car	Mini Bus	Bus	LCV	2-Axle	3 Axle	M Axle	2W	3W	Tractor	Tractor without	Cycle	Rickshaw	Animal Drawn	Volume	PCU
2046	9303	73	69	2212	1247	444	154	1519	539	0	0	0	0	0	15560	20003
2047	9768	76	73	2322	1310	467	162	1595	566	0	0	0	0	0	16339	21003
2048	10257	80	76	2438	1375	490	170	1675	594	0	0	0	0	0	17155	22054
2049	10769	84	80	2560	1444	515	178	1759	624	0	0	0	0	0	18013	23156
2050	11308	88	84	2688	1516	540	187	1847	655	0	0	0	0	0	18914	24314
2051	11873	93	88	2823	1592	567	196	1939	688	0	0	0	0	0	19860	25530
2052	12467	97	93	2964	1672	596	206	2036	722	0	0	0	0	0	20853	26806
2053	12473	97	93	2965	1672	596	206	2037	723	0	0	0	0	0	20863	26820

4.15 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 4.50 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 up gradation from two lane to four lane will trigger, as indicated in below table;



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Table 4.51 Design Capacity for up gradation from Two Lane to Four Lane

Nature of Terrain	Traffic at which up gradation 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 Vairente is passing through plain terrain the following capacity values has been adopted.

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

Hence, based on above table the design service volume for different LOS has been adopted for capacity analysis of the project road from Vairengte to Sairang as the project road passes through mountainous/hill terrain. The details of capacity value adopted from Vairengte to Sairang is given below.



- For 2-Lane Highway capacity (4-Lane requirement) : 6,000 PCU/day
 - *For 4-Lane Highway capacity (6-Lane requirement) : 30,000 PCU/day
- *Threshold level for 4-laning capacity, if traffic volume exceeds LOS-B (20,000 PCU/ Day). [For LOS C, design service volume is 40% higher than those values for LOS B, given above]

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 4.52 Projected sectional traffic (AADT) in PCUs

Homogeneous Section	Section-1 Silchar to Vairengte (Km 0+000 to Km 42+750)		
	Most Likely	Optimistic	Pessimistic
2020	8113	8113	8113
2021	8515	8596	8434
2022	8938	9109	8768
2023	9381	9652	9116

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Homogeneous Section	Section-1 Silchar to Vairengte (Km 0+000 to Km 42+750)		
	Most Likely	Optimistic	Pessimistic
2024	9847	10227	9477
2025	10336	10837	9853
2026	10849	13781	12292
2027	11543	14716	12955
2028	12287	15727	13661
2029	13084	16820	14411
2030	13941	18002	15210
2031	14860	19277	16057
2032	15788	20589	16899
2033	16778	22003	17790
2034	17836	23527	18735
2035	18967	25169	19735
2036	20176	26912	20775
2037	21204	28482	21626
2038	22284	30148	22511
2039	23420	31916	23434
2040	24614	33792	24394
2041	25869	35780	25392
2042	27157	37851	26403
2043	28510	40046	27454
2044	29931	42373	28547
2045	31422	44839	29685
2046	32988	47453	30867
2047	34632	50224	32097
2048	36358	53160	33375
2049	38170	56272	34705
2050	40073	59571	36088
2051	42071	63067	37527
2052	44169	66773	39023
2053	44191	67161	39293

Homogeneous Section	Section-2 Vairengte to Kolasib (Km 42+750 to Km 88+500)		
	Most Likely	Optimistic	Pessimistic
2020	4206	4206	4206
2021	4416	4458	4374
2022	4636	4725	4548
2023	4868	5008	4730
2024	5110	5308	4919



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 4: Traffic Studies & Demand Forecast



Homogeneous Section	Section-2 Vairengte to Kolasib (Km 42+750 to Km 88+500)		
	Most Likely	Optimistic	Pessimistic
2025	5366	5626	5115
2026	5633	5963	5319
2027	6005	6416	5616
2028	6402	6905	5932
2029	6828	7433	6267
2030	7285	8004	6624
2031	7774	8621	7002
2032	8260	9247	7371
2033	8778	9920	7759
2034	9331	10643	8170
2035	9920	11421	8604
2036	10547	12257	9063
2037	11142	13072	9484
2038	11772	13940	9924
2039	12437	14868	10386
2040	13141	15857	10870
2041	13884	16913	11377
2042	14578	17927	11831
2043	15306	19002	12304
2044	16071	20141	12795
2045	16874	21349	13307
2046	17717	22629	13838
2047	18602	23986	14391
2048	19531	25424	14966
2049	20507	26949	15565
2050	21531	28564	16187
2051	22607	30277	16833
2052	23737	32093	17506
2053	23749	32112	17513

Homogeneous Section	Section-3 Kolasib-Kawnpui (Km 88+500 to Km 121+500)		
	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

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Homogeneous Section	Section-3 Kolasib-Kawnpui (Km 88+500 to Km 121+500)		
	Most Likely	Optimistic	Pessimistic
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
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

Homogeneous Section	Section-4 Kawnpui to Sairang (Km 121+500 to Km 158+900)		
	Most Likely	Optimistic	Pessimistic
2020	5218	5218	5218
2021	5478	5530	5426
2022	5752	5862	5643
2023	6039	6213	5868
2024	6340	6585	6102
2025	6657	6980	6346
2026	7084	7498	6690
2027	7541	8056	7054
2028	8030	8659	7441
2029	8553	9310	7852

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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Homogeneous Section	Section-4 Kawnpui to Sairang (Km 121+500 to Km 158+900)		
	Most Likely	Optimistic	Pessimistic
2030	9114	10013	8288
2031	9673	10728	8714
2032	10269	11496	9164
2033	10904	12321	9639
2034	11580	13208	10140
2035	12300	14161	10669
2036	12983	15089	11155
2037	13704	16077	11663
2038	14465	17132	12194
2039	15270	18256	12751
2040	16120	19454	13333
2041	16925	20621	13866
2042	17771	21857	14420
2043	18659	23168	14996
2044	19591	24557	15596
2045	20570	26030	16219
2046	21598	27591	16867
2047	22677	29245	17541
2048	23810	30999	18242
2049	25000	32858	18972
2050	26249	34828	19730
2051	27561	36917	20518
2052	28938	39131	21339
2053	28952	39154	21347

Homogeneous Section	Section-5 (Sairang-Aizawl)		
	Most Likely	Optimistic	Pessimistic
2020	4399	4399	4399
2021	4619	4663	4575
2022	4850	4943	4758
2023	5092	5239	4948
2024	5347	5554	5146
2025	5614	5887	5352
2026	6031	7021	6265
2027	6481	7561	6670
2028	6967	8150	7103
2029	7492	8791	7568
2030	8059	9491	8065
2031	8614	10189	8546



Homogeneous Section	Section-5 (Sairang-Aizawl)		
	Most Likely	Optimistic	Pessimistic
2032	9210	10945	9051
2033	9848	11763	9588
2034	10533	12648	10160
2035	11268	13606	10767
2036	11919	14485	11294
2037	12608	15423	11833
2038	13337	16427	12400
2039	14109	17498	12993
2040	14927	18644	13616
2041	15673	19724	14171
2042	16457	20869	14738
2043	17280	22083	15327
2044	18143	23370	15941
2045	19051	24733	16578
2046	20003	26179	17241
2047	21003	27711	17931
2048	22054	29335	18648
2049	23156	31057	19394
2050	24314	32882	20170
2051	25530	34816	20977
2052	26806	36867	21816
2053	26820	39040	22688

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 and mountainous terrain

Table 4.53 Capacity Augmentation

Sl. No	Section	Scenario	2 Lane with Paved Shoulder (warranting for 4-Lane)	4 Lane divided Carriageway (warranting for 6-Lane)
Silchar to Vairengte				
1	Section – 01 (From Km 0+000 to Km 42+750)	Most Likely Scenario	2025	➤ 2053
		Optimistic Scenario	2024	2052
		Pessimistic Scenario	2026	➤ 2053

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Sl. No	Section	Scenario	2 Lane with Paved Shoulder (warranting for 4-Lane)	4 Lane divided Carriageway (warranting for 6-Lane)
Vairengte to Sairang				
2	Section – 02 (From Km 42+750 to Km 88+500)	Most Likely Scenario	2027	➤ 2053
		Optimistic Scenario	2027	2051
		Pessimistic Scenario	2029	➤ 2053
3	Section – 03 (From Km 88+500 to Km 121+500)	Most Likely Scenario	2022	2051
		Optimistic Scenario	2021	2046
		Pessimistic Scenario	2022	➤ 2053
4	Section – 04 (From Km 121+500 to Km 158+900)	Most Likely Scenario	2023	➤ 2053
		Optimistic Scenario	2023	2048
		Pessimistic Scenario	2024	➤ 2053

4.16 Recommendations:



Silchar to Vairengte section

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 Aizawl and other part of Mizoram State. This road also caters for the passenger vehicles, commercial vehicle that are coming from NH-37 and NH-27. Same has been observed during the traffic surveys also.

The Section between Silchar to Vairengte via Silchar, Sonbarighat, Dholai, Baga and Lailapur is the part of Silchar-Aizawl road, which observes more commercial vehicle that are coming from Shillong, Karimganj, Dawki, Imphal 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 0+000 to Km 42+750 as the design capacity of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2025 which is after the completion of construction period.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 4: Traffic Studies & Demand Forecast</p>	
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Vairengte to Sairang section

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 Assam, Meghalaya and Manipur to Mizoram. This road also caters for the passenger vehicles, commercial vehicle that are coming from NH-6 from Birabi and travelling towards Aizawl. Same has been observed during the traffic surveys also.

The Section between Vairengte to Sairang via Bilkthwir, Kolasib, N Thingdawl, Kawnpui, Balpui, Kamrang is the part of Silchar-Aizawl road, which observes more commercial vehicle that are coming from Shillong, Karimganj, Dawki, Manipur Guwhathi and Silchar travelling towards Aizawl.

This project road is essential to provide connectivity for the traffic between Assam and Mizoram. Development of this road will help in social and economic growth region surrounding this corridor.

Four lane Divided carriage is recommended for the section 02 from Km 42+750 to 88+500 Km as the design capacity (6,000 PCU/day) for mountainous terrain of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2027, after 3 years of construction of road.

Four lane Divided carriage is recommended for the section 03 from Km 88+50 to 121+500 Km as the design capacity (6,000 PCU/day) for mountainous terrain of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2022, which is within the construction period.

Four lane Divided carriage is recommended for the section 04 from Km 121+500 to 158+900 Km as the design capacity (6,000 PCU/day) for mountainous terrain of the section exceeds the design capacity of Two Lane with Paved Shoulder in the year 2023, which is within the construction period is completed and the road is open for traffic.

5

Chapter 5 – Design Standards

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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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5 Chapter 5 – Design Standards

5.1 General

The project road traverses through hilly terrain, which must negotiate geometries through difficult topography, inhospitable terrain. As such, design of hill roads to predetermined standards, considering importance of safety and free flow, is necessary so that travel is safe and comfortable.

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



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The basic design philosophy is based on the consideration of providing suitable alignment, cross-sectional layout, geometric, safety and access control to cater to the fast and uninterrupted movement of through traffic.

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
- Satisfy traffic carrying capacity for 30 years
- 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 in 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

Category	Design element
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 (warranting to 6-lane)

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 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

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 5: Design Standards</p>	

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 (warranting to 4-lane)

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, based on above table the design service volume has been adopted for capacity analysis of the project road for different LOC as follows;

- For 2-Lane Highway capacity (4-Lane requirement) : 10,000 PCU/day
- For 4-Lane Highway capacity (6-Lane requirement) : 40,000 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)

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- 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: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 divided and 4-Lane with paved shoulder 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 gives the terrain classification adopted for the project road as per IRC 73-1980.

Table 5.4 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 fully through Rolling and Mountainous terrain. Thus, design standards for design of alignment Rolling and Mountainous 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 table 6.1 of IRC: SP: 48, the following design speeds has been adopted for the project road.



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Table 5.5 Design Speed (Km/h)

As per IRC SP: 84-2019				As per Hill Road Manual (IRC SP: 48)			
Plain and Rolling Terrain		Mountainous and Steep Terrain		Mountainous Terrain		Steep Terrain	
Up to 25% cross slope of the ground		Cross slope of the ground more than 25%		25-60% cross slope of the ground		More than 60% cross slope of the ground	
Ruling	Minimum	Ruling	Minimum	Ruling	Minimum	Ruling	Minimum
100	80	60	40	50	40	40	30

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. As per clause no. 2.3 of IRC: SP: 84-2019, a minimum RoW of 60m should be available for development of a 4-Lane Highway.

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.

However, in present case, the project requirement is to provide 4-lane carriageway configurations and service road provisions at specific locations. 4-Lane carriageway would be designed and accommodated with a Row of 60m however the proposed improvement would need minimal height/depth of construction of banks/cuts on the terrain which requires more than 60 m ROW and at junction improvement as well.

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;



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Table 5.6 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

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

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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. Further 0.5m Shy off on either side is proposed.

5.9 Horizontal Alignment

The horizontal curves for this project will be designed in accordance with the requirements stipulated in IRC: 73-1980. In this context of proposed geometric improvement, it may be mentioned here that unless otherwise absolutely essential from economic and safety considerations with 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 given below:

Table 5.7 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

Table 5.8 Minimum Radii of Horizontal Curves: IRC: SP: 48-1998

Nature of Terrain	Desirable Minimum Radius (m)	Absolute Minimum Radius (m)
Mountainous	80	50
Steep	50	30

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%. Below table indicates the radius of horizontal curves for different rates of camber beyond which super elevation will not be required.

Table 5.9 Radius beyond which super elevation is not required

Design Speed (Kmph)	Radius (m)
100	1800
80	1100
65	750
50	450
40	280

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:

- $L_s = 0.0215V^3/CR$
- $L_s = 2.7 V^2/R$ (for plain & rolling terrain) and $1.0V^2/R$ (for mountainous and steep terrain)
- $L_s = e \times w \times 60$ considering rate of change of SE

Where:

- L_s = 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



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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 5.10 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 5.11 Sight Distance

Design Speed (Kmph)	Intermediate Sight Distance (m)	Stopping Sight Distance (m)
100	360	180
80	260	130
60	180	90
50	120	60
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 5.12 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 5.13 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.



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The cumulative rise/fall in elevation over 2 Km length shall not exceed 100 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:

$$\text{Grade Compensation (per cent)} = (30 + R) / R$$

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 Km/h 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



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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 5.14 "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



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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 5.15 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 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 5.16 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 than the values given below;

Table 5.17 Clearance at Grade separated Structure

Sl. No.	Types of Underpass	Vertical Clearance	Horizontal Clearance
1	Vehicular Underpass (VUP)	5.5 m	20.0 m
2	Light Vehicular Underpass (LVUP)	4.0 m	12.0 m
3	Smaller Vehicular Underpass (SVUP)	4.0 m	7.0 m

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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


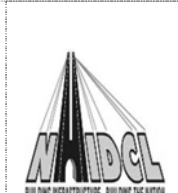
For safety and operational reasons it will be necessary to provide suitable safety features, road furniture and other facilities along the project road. These features will include safety barriers, road signs, road markings, road lighting, route markers, kilometre and hectometre stones, road delineators, 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 conform 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.

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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.



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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.

5.13 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: 41 considering 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 5.18 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

Inner Radius (m)	Design Speed (km/h)	Single lane width (m)	Two lane width (m)
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 5.19 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



5.14 Pavement Design

As per section 5.4 of IRC:84:2019 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.

Depending upon the available CBR and Cumulative Million Standard axles on the road, new flexible pavement may comprise of Bituminous Concrete (BC) wearing

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course over laid on 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 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. A geogrid layer shall be provided above GSB layer in hill regions.

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.

For the present project road, new Rigid Pavement is proposed.

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.

5.15 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.



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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.

5.16 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)

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Slope shall be designed for embankment height greater than 6.0m using MoRT&H software for High Embankment design.

As per IRC: SP: 84-2019, side slope shall not steeper than 2H :1V.

As per IRC: SP: 48-1998, in hill roads heavy embankment work is very limited. The ratio of cut and fill method can vary with the slope and terrain of hill. However there is scope / requirement for adopting cut and fill method at few places in mountainous region except where valleys are to be negotiated between hill features or mountain ranges.

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.

5.17 Road way 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 varieties 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

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5.18 Design Parameters for Bridges

5.18.1 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 cross roads above the project road are termed as overpasses and the structures carrying the cross roads below the project road are called underpasses.

5.18.2 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.

5.18.3 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.

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5.18.4 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

- 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.
- 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.
- For combination of different class of vehicle, reference to Table 6 & 6A of IRC:6 shall be made
- SV loading shall be considered in accordance with clause 204.5 for structural design verification under Ultimate Limit State and Serviceability Limit State.
- 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.
- 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.
- 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 restrainers 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 %



5.18.5 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.

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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.

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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.

5.18.6 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



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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

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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:

- 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 Geotech
- 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).
- 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.
- 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

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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 d_{eff} 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.

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5.18.7 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.

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- 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.

5.18.8 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 S_a/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.

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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.


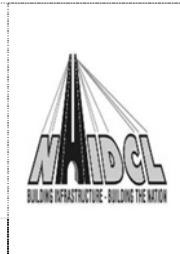
Bearings & connections shall be designed to resist the lesser of the following forces, i.e.

- Design seismic forces obtained by using the response reduction factors.
- Forces developed due to over strength moment when hinge is formed in the substructure.
- 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

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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 ($f_{ck} = 25$ MPa) and M15 for PCC works.

Steel reinforcement of grade Fe 500D (see IS 1786: 1985) will be used.

5.18.9 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


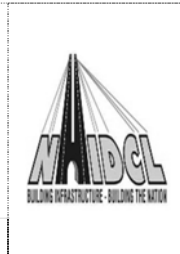
Elastomeric bearing can accommodate translation movements in any direction and rotational movements in any axis by elastic deformation. They should not be used in tension or when rotation is high and vertical load small. The basis of design is that the elastomer is an elastic material, the deflection 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 table 2 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,

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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.

5.18.10 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 12.0×10^{-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° 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.



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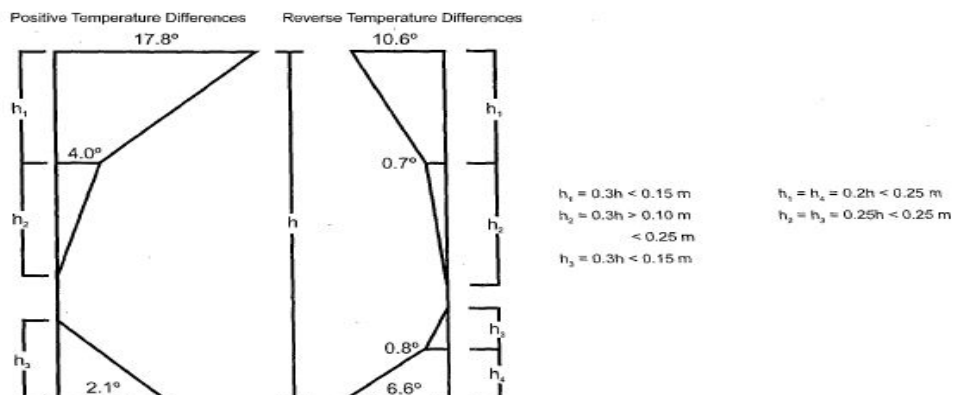


Fig. 10 (a) Design Temperature Differences for Concrete Bridge Decks

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 table 14.1 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 $0.48 f_{cj}$. Maximum tensile stress in steel is restricted to $0.8 f_{yk}$ in rare combinations.

The section is checked for flexure, shear & torsion under ULS condition.



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5.18.11 Deflection Limitations

For RCC/PSC structures, deflection criteria shall be checked as per clause 12.4 of IRC: 112.

- For vehicular live load: $\text{Span}/800$
- For vehicular LL on cantilever: $\text{cantilever span}/300$

5.18.12 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.

<u>Component</u>	<u>Minimum Cover in mm</u>
Superstructure	40
Substructure	40/50
Foundation	75
Pre-stressing cable duct	75 (Post Tensioning) 65 (Pre-Tensioning)
Pre-cast elements	35

5.18.13 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.

5.18.14 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:

<u>Sr. No.</u>	<u>Span</u>	<u>Expansion Joints</u>
(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

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5.18.15 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.

5.18.16 Drainage Spouts

Drainage spouts will be provided in accordance with MOST standard plans. The minimum spacing will be kept preferably as 5.0m c/c which may be adjusted to suit span length.

6

Chapter 6 – Pavement Design

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Section: Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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 of up-gradation of existing two-lane carriageway from Silchar to Vairengte new 4 lane divided carriageway configuration.

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 and economy of the design should be evaluated based on life cycle cost analysis.

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 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.

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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

For the design purpose based on the traffic along the project road, the proposed alignment from Silchar to Vairengte is divided into 1-homogenous section and the details of the homogeneous section is given in below table.

Table 6.1 Details of Homogenous Section

Section	Homogenous Section	Chainage		Design Length (Km)
		Existing	Design	
Section – 1	Start point of SA-1 to Vairengte	From Km 263+000 (NH-37) to 42+750 (NH-306)	From Km 0+000 to Km 49+360	49.360

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



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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.

$$\begin{aligned} \text{Single axle with single wheel on either side} &= \left(\frac{\text{axle load in KN}}{65} \right)^4 \\ \text{Single axle with dual wheels on either side} &= \left(\frac{\text{axle load in KN}}{80} \right)^4 \\ \text{Tandem axle with dual wheels on either side} &= \left(\frac{\text{axle load in KN}}{148} \right)^4 \\ \text{Tridem axle with dual wheels on either side} &= \left(\frac{\text{axle load in KN}}{224} \right)^4 \end{aligned}$$

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 0+000 to Km 49+360	Silchar to Vairengte	0.63	0.79	6.44	5.31	7.88
			Vairengte to Silchar	0.03	0.78	0.54	3.06	1.52
			Adopted VDF	0.63	0.79	6.44	5.31	7.88



Axle load survey was carried at Km 29+200 (Ext. Chainage) and for section from 0+000 to 49+360 (Design Chainage) the VDF values/ axle load spectrum at Km 29+200 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".

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Since, the section from Silchar to Vairengte, the proposed alignment follows mostly green filed and partially Silchar bypass, the commercial traffic along the existing road has been considered at km 29+200 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 0+000 to Km 49+360	31	235	739	283	12

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 Vairengte

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

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n = Design life in years (20 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 in **Table 6.6**.

Table 6.5 Design Traffic in Million Standard Axles (MSA)

Sl. No	Section (Design Chainage)	Million Standard Axles (For both side Carriageway)				Remark
		5 Year	10 Year	15 Year	20 Year	
1	Km 0+000 to Km 49+360	9.16	16.57	26.29	38.86	Annex.6.1A

The copy of the Annexure 6.1 is attached along with **Volume II – Appendices to Main Report**.

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 (ϵ_t) at the bottom of the bituminous layer and the vertical subgrade strain (ϵ_v) 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.

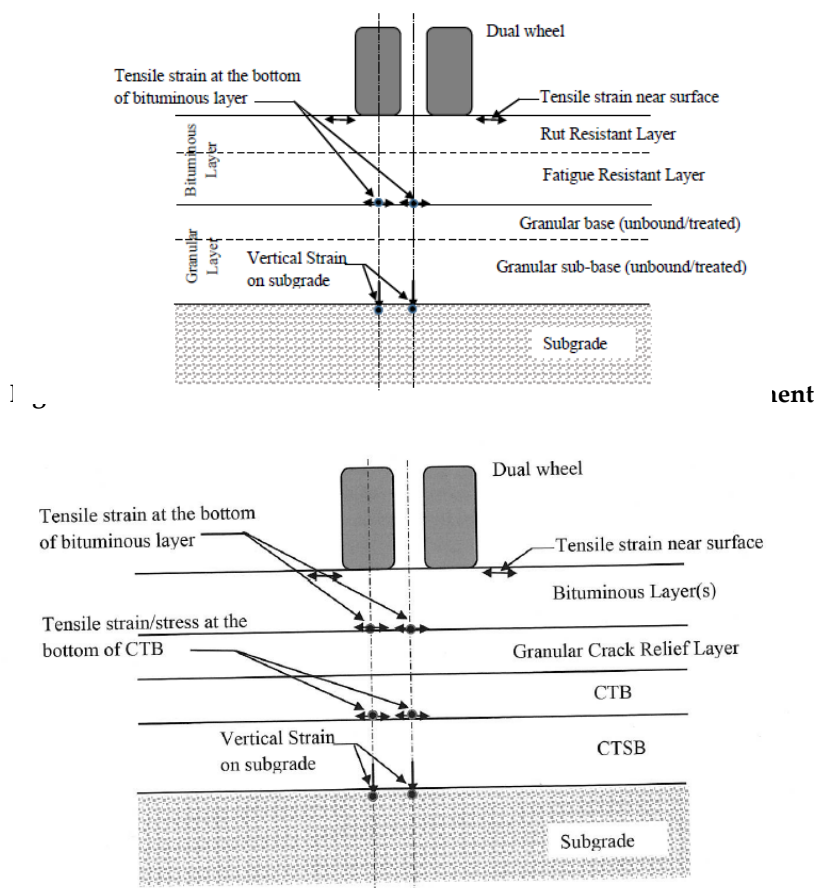




Figure 6-2: Critical locations of Stress and Strain in CTB and CTSB

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

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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 in below table;

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 0+000 to Km 49+360	40	

*Note: * Since, proposed road from Km 0+000 to Km 16+000 is the part of Silchar bypass and acts as common connecting road for all traffic that are coming from Meghalaya via NH-37, from Guwahati via NH-27, from Mizoram via NH-306 (oldNH-54), from Manipur via NH-37 including Silchar local traffic hence, on the safer side and sudden commercial traffic growth after COD, the DPR consultant has considered the design traffic as 40MSA for above said section.*

***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 in 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:

$$M_R \text{ (MPa)} = 10 \times \text{CBR} \quad \text{for CBR} < 5$$

$$M_R \text{ (MPa)} = 17.6 \times (\text{CBR})^{0.64} \quad \text{for CBR} \geq 5$$

M_R = Resilient modulus of subgrade soil.

The proposed effective CBR value adopted for different sections of the road is given in below table.



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Table 6.7 Properties of proposed Subgrade Material

Sl No	Section (Design Chainage)	Effective CBR value in %	Mr (MPa) Resilient Modulus	μ Poisson's Ratio
1	From Km 0+000 to Km 49+360	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 in below table;

Table 6.8 Rutting Model equations

Design MSA	Reliability Factor	Equation
Less than equal to 30 MSA	80 %	$N = 4.1656 \times 10^{-08} \times [1/\epsilon_v]^{4.5337}$
Greater than 30 MSA	90 %	$N = 1.41 \times 10^{-08} \times [1/\epsilon_v]^{4.5337}$

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



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Properties	Requirement as per MoRT&H
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:

$$M_{R_Granular} = 0.2 \cdot h^{0.45} \times M_{R_Subgrade}$$

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 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 %	$N = 0.516 \times C \times 10^{-04} \times [1/\epsilon_t]^{3.89} \times [1/M_R]^{0.854}$

$$C = 10^M$$

$$M = (V_{be} / (V_a + V_{be}))$$

$V_a = 3.5$ % (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:

$$N = RF [(113000/E^{0.804} + 191) / \epsilon_t]^{12}$$

N : Fatigue life of cemented layer in number of standard axles

RF : Reliability factor (1)

E : Elastic modulus of cemented layer

ϵ_t : Allowable tensile strain at the bottom cement treated base layer

6.3.3 Flexible pavement design – Option 1

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.



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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 (V_a)	3.50
Volume of Bitumen (V_b)	11.50
"C" Value	2.35
Horizontal tensile strain at the bottom of DBM layer (ϵ_t)	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 (ϵ_t)	185.500E-06
Vertical strain at top of subgrade (ϵ_v)	311.90E-06



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Input Screen

No of Layers [HOME](#)

Layer: 1 Elastic Modulus(MPa) Poisson's Ratio Thickness(mm)

Layer: 2 Elastic Modulus(MPa) Poisson's Ratio Thickness(mm)

Layer: 3 Elastic Modulus(MPa) Poisson's Ratio

Wheel Load(Newton) Tyre Pressure(MPa)

Analysis Points

Point:1 Depth(mm): Radial Distance(mm):

Point:2 Depth(mm): Radial Distance(mm):

Point:3 Depth(mm): Radial Distance(mm):

Point:4 Depth(mm): Radial Distance(mm):

Wheel Set (1- Single wheel
2- Dual wheel)

[Submit](#) [Reset](#)

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
```



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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6.3.4 Flexible pavement design – Option 2

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 (%) V _{be}	11.50
Volume of Air Voids (%) V _a	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



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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 (%) V_a	3.50
Volume of Bitumen (%) V_{be}	11.50
"C" Value	2.35
Tensile strain at the bottom of DBM layer (ϵ_t)	188.65E-06
Compressive strain at top of subgrade (ϵ_v)	390.45E-06
Tensile strain at the bottom of CTB layer (ϵ_t)	072.31E-06

Computed strains	
Horizontal tensile strain at the bottom of DBM layer (ϵ_t)	113.2 E-06
Vertical strain at top of subgrade (ϵ_v)	182.8 E-06
Tensile strain at the bottom of CTB layer (ϵ_t) with 0.80 Mpa tyre contact pressure	045..4 E-06



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design



Input Screen

No of Layers HOME

Layer	Elastic Modulus(MPa)	Poisson's Ratio	Thickness(mm)
Layer: 1	<input type="text" value="3000"/>	<input type="text" value="0.35"/>	<input type="text" value="120"/>
Layer: 2	<input type="text" value="450"/>	<input type="text" value="0.35"/>	<input type="text" value="100"/>
Layer: 3	<input type="text" value="5000"/>	<input type="text" value="0.25"/>	<input type="text" value="165"/>
Layer: 4	<input type="text" value="600"/>	<input type="text" value="0.25"/>	<input type="text" value="200"/>
Layer: 5	<input type="text" value="64.289"/>	<input type="text" value="0.35"/>	

Wheel Load(Newton) Tyre Pressure(MPa)

Analysis Points

Point	Depth(mm)	Radial Distance(mm)
Point:1	<input type="text" value="120"/>	<input type="text" value="0"/>
Point:2	<input type="text" value="120"/>	<input type="text" value="155"/>
Point:3	<input type="text" value="385"/>	<input type="text" value="0"/>
Point:4	<input type="text" value="385"/>	<input type="text" value="155"/>
Point:5	<input type="text" value="585"/>	<input type="text" value="0"/>
Point:6	<input type="text" value="585"/>	<input type="text" value="155"/>

Wheel Set (1- Single wheel
2- Dual wheel)

Output Screen

```
No. of layers          5
E values (MPa)        3000.00  450.00  5000.00  600.00  64.29
Mu values              0.350  0.350  0.250  0.250  0.35
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
```



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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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.

$$\text{Where,} \quad \text{Log } N_{fi} = \frac{0.972 - (\sigma_t / M_{Rup})}{0.0825}$$

N_{fi} : Fatigue life in terms of cumulative number of axle load of class i

σ_t : tensile stress under cement treated base layer.

M_{Rup} : 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	34	238	862	166	62	497261	
2021	36	250	905	174	65	522125	
2022	37	262	950	183	69	548231	
2023	39	276	998	192	72	575642	
2024	41	289	1048	202	76	604424	
2025	43	304	1100	212	79	634646	634646
2026	46	319	1155	223	83	666378	1301024
2027	48	355	1213	238	89	709092	2010116
2028	50	394	1273	255	95	754897	2765013



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Year	in both directions					Total Veh. in one direction per year	Cumulative Comm Veh.
	Bus	LCV	2A Truck	3A Truck	M Axle Truck		
2029	53	438	1337	273	102	804048	3569061
2030	55	487	1404	292	109	856821	4425882
2031	58	541	1474	312	117	913521	5339403
2032	61	594	1548	333	124	970931	6310334
2033	64	652	1625	354	133	1032279	7342613
2034	67	715	1707	377	141	1097861	8440474
2035	71	785	1792	402	150	1167998	9608472
2036	74	862	1881	428	160	1243035	10851507
2037	78	905	1976	454	170	1307333	12158840
2038	82	950	2074	481	180	1374975	13533814
2039	86	998	2178	510	191	1446135	14979950
2040	90	1048	2287	540	202	1520998	16500948
2041	95	1100	2401	573	214	1599758	18100706
2042	99	1155	2521	601	225	1679746	19780452
2043	104	1213	2647	631	236	1763733	21544185
2044	110	1273	2780	663	248	1851920	23396105

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 σ_t , in Mpa	Stress Ratio (σ_t/M_{rup})	Fatigue life (Nf)	Fatigue life consumed (ni/Nf)
Single Axles					
190	188787	0.63	0.45	2.35E+06	0.080
180	283181	0.59	0.42	4.52E+06	0.063
170	283181	0.56	0.40	8.71E+06	0.033
160	943935	0.53	0.38	1.68E+07	0.056
150	1038329	0.49	0.35	3.23E+07	0.032
140	1415903	0.46	0.33	6.23E+07	0.023
130	1793477	0.43	0.31	1.20E+08	0.015



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Axle load in KN	Expected single axle repetitions (ni)	Tensile Stress at the bottom of CTB σ_t , in Mpa	Stress Ratio (σ_t/M_{rup})	Fatigue life (Nf)	Fatigue life consumed (ni/Nf)
120	1510296	0.39	0.28	2.31E+08	0.007
110	1415903	0.36	0.26	4.46E+08	0.003
100	1038329	0.33	0.23	8.59E+08	0.001
90	1887870	0.30	0.21	1.65E+09	0.001
85	19917030	0.28	0.20	2.30E+09	0.009
Cumulative Fatigue Damage in CTB due to Single Axles					0.322
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	579726	0.56	0.40	8.71E+06	0.067
320	0	0.53	0.38	1.68E+07	0.000
300	1159453	0.49	0.35	3.23E+07	0.036
280	2318906	0.46	0.33	6.23E+07	0.037
260	3478359	0.43	0.31	1.20E+08	0.029
240	7536444	0.39	0.28	2.31E+08	0.033
220	3478359	0.36	0.26	4.46E+08	0.008
200	9275624	0.33	0.23	8.59E+08	0.011
180	11594530	0.30	0.21	1.65E+09	0.007
170	26087692	0.28	0.20	2.30E+09	0.011
Cumulative Fatigue Damage in CTB due to Tandem Axles					0.238
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



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Axle load in KN	Expected single axle repetitions (ni)	Tensile Stress at the bottom of CTB σ_t , in Mpa	Stress Ratio (σ_t/M_{rup})	Fatigue life (Nf)	Fatigue life consumed (ni/Nf)
360	0	0.39	0.28	2.31E+08	0.000
330	0	0.36	0.26	4.46E+08	0.000
300	0	0.33	0.23	8.59E+08	0.000
270	14037663	0.30	0.21	1.65E+09	0.008
255	84225978	0.28	0.20	2.30E+09	0.037
Cumulative Fatigue Damage in CTB due to Tridem Axles					0.045

Cumulative Fatigue Damage			
Due to Single Axles	Due to Tandem Axles	Due to Tridem Axles	Total CFD
0.322	0.238	0.045	0.606

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:

6.4 Option 03: Flexible Pavement Design with Geo grid provision

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



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Volume of air voids (%)	3.50
-------------------------	------

Pavement Crust (mm)	
Granular Sub-base (GSB)	300
Wet Mix Macadam (WMM)	150
Geo-Grid	Biaxial
Dense Bituminous Macadam (DBM)	60
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 (V_a)	3.50
Volume of Bitumen (V_b)	11.50
"C" Value	2.35
Horizontal tensile strain at the bottom of DBM layer (ϵ_t)	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 (ϵ_t)	186.900E-06
Vertical strain at top of subgrade (ϵ_v)	327.40E-06



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Input Screen

No of Layers	<input type="text" value="3"/>	<input type="button" value="HOME"/>				
Layer: 1	Elastic Modulus(MPa)	<input type="text" value="3000"/>	Poisson's Ratio	<input type="text" value="0.35"/>	Thickness(mm)	<input type="text" value="100"/>
Layer: 2	Elastic Modulus(MPa)	<input type="text" value="361.7298"/>	Poisson's Ratio	<input type="text" value="0.35"/>	Thickness(mm)	<input type="text" value="450"/>
Layer: 3	Elastic Modulus(MPa)	<input type="text" value="64.289"/>	Poisson's Ratio	<input type="text" value="0.35"/>		
Wheel Load(Newton)		<input type="text" value="20000"/>	Tyre Pressure(MPa)		<input type="text" value="0.56"/>	
Analysis Points		<input type="text" value="4"/>				
Point:1 Depth(mm):		<input type="text" value="100"/>	Radial Distance(mm):		<input type="text" value="0"/>	
Point:2 Depth(mm):		<input type="text" value="100"/>	Radial Distance(mm):		<input type="text" value="155"/>	
Point:3 Depth(mm):		<input type="text" value="550"/>	Radial Distance(mm):		<input type="text" value="0"/>	
Point:4 Depth(mm):		<input type="text" value="550"/>	Radial Distance(mm):		<input type="text" value="155"/>	
Wheel Set	<input type="text" value="2"/>	(1- Single wheel 2- Dual wheel)				
<input type="button" value="Submit"/>		<input type="button" value="Reset"/>				

Output screen

```
No. of layers          3
E values (MPa)        3000.00  361.73  64.29
Mu values             0.350.350.35
thicknesses (mm)      100.00  450.00
single wheel load (N) 20000.00
tyre pressure (MPa)   0.56
Dual Wheel
  Z      R      SigmaZ      SigmaT      SigmaR      TacRZ      DispZ      epZ      epT      epR
100.00   0.00-0.2119E+00  0.6754E+00  0.5392E+00-0.2063E-01  0.3943E+00-0.2123E-03  0.1869E-03  0.1257E-03
100.00L  0.00-0.2119E+00-0.1891E-01-0.3533E-01-0.2063E-01  0.3943E+00-0.5333E-03  0.1869E-03  0.1257E-03
100.00  155.00-0.1489E+00  0.4523E+00-0.3536E-01-0.1000E+00  0.3969E+00-0.9829E-04  0.1723E-03-0.4718E-04
100.00L 155.00-0.1489E+00-0.1598E-01-0.7479E-01-0.1000E+00  0.3969E+00-0.3239E-03  0.1723E-03-0.4718E-04
550.00   0.00-0.1848E-01  0.5690E-01  0.4970E-01-0.3083E-02  0.2891E+00-0.1542E-03  0.1271E-03  0.1002E-03
550.00L  0.00-0.1860E-01  0.1856E-02  0.5722E-03-0.3091E-02  0.2891E+00-0.3025E-03  0.1270E-03  0.1001E-03
550.00  155.00-0.1995E-01  0.6099E-01  0.5601E-01-0.4223E-02  0.2963E+00-0.1684E-03  0.1337E-03  0.1151E-03
550.00L 155.00-0.1995E-01  0.2005E-02  0.1119E-02-0.4302E-02  0.2963E+00-0.3274E-03  0.1337E-03  0.1151E-03
```


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As shown in above table it is observed that by introducing geo-grid over GSB layer will reduce the thickness of WBM by 45mm and WMM by 100mm. The cost difference per Km between conventional flexible pavement and Flexible pavement with geo-grid provision is App. 50 lack per km i.e. Flexible pavement is costlier that reinforced geo-grid pavement. Flexible pavement works out to be cheaper by 10 lack per km compared to Flexible pavement with cement treated base and sub base. Moreover, the CBR of existing soil is less and the availability of aggregate material along the project road is less due to lack of availability of Stone aggregate.

Hence, DPR consultant has recommended Reinforced geogrid flexible pavement.

6.5 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.

6.5.1 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.

6.5.2 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



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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.

6.5.3 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.

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

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.

6.5.4 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 °C /14.3 °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
I	Hilly Region	12.5	13.1	14.3	15.8

6.5.5 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 Silchar to Vairengte section and 8 is considered for Vairengte to Sairang section, k value corresponding 8% CBR is 50.3 MPa/m and effective k over 150mm DLC is 285 MPa/m.



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6.5.6 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/m ³	24
28 days flexural strength, MPa	4.5
Grade of Concrete	M40

6.5.7 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

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

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

6.5.8 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.

6.5.9 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.



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$$\sigma_{\max} = \frac{K P_t}{4\beta^3 EI} (2 + \beta z) \quad \beta = \sqrt[4]{\frac{kb}{4EI}}$$

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 = 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, f_{ck} = 40 MPa (28 days) and 48 MPa (90 days)

6.5.10 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:

$$A_s = \frac{b f w}{S}$$

Where;

A = Area of steel in mm² 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 mm²

B = Maximum permissible bond stress, MPa

6.6 Design of Rigid Pavement

6.6.1 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.

6.6.2 Design of Slab Thickness for Section from Km 0+000 to Km 45+750 (Design Chainage)

The pavement composition is calculated for the traffic survey carried out at Km 29+200 (Existing chainage). The loading pattern between Silchar to vairengte is more critical as compared to the loading pattern between Vairengte 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/m ³



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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	=	0.684	
Coefficient of thermal expansion of concrete, α	=	10×10^{-6}	per $^{\circ}\text{C}$
Maximum day-time temperature differential in slab (for bottom-up cracking)	=	16.6	$^{\circ}\text{C}$
Night-time temperature differential in slab (for top-down cracking)	=	13.3	$^{\circ}\text{C}$
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

6.6.3 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	@ Km 29+200 (Existing Chainage)					Total Vehicle in both directions per year	Cumulative Vehicle in both directions
	Bus	LCV	2A Truck	3A Truck	Multi Axle Truck		
2020	31	235	739	283	12	474420	Design, Land acquisition and Construction period
2021	32	247	776	297	13	498141	
2022	34	259	815	312	13	523048	
2023	36	272	856	327	14	549200	





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Year	@ Km 29+200 (Existing Chainage)					Total Vehicle in both directions per year	Cumulative Vehicle in both directions
	Bus	LCV	2A Truck	3A Truck	Multi Axle Truck		
2024	38	286	898	344	15	576660	
2025	39	300	943	361	15	605493	605493
2026	41	315	990	379	16	635768	1241261
2027	43	354	1040	406	17	678948	1920209
2028	46	398	1092	434	18	725545	2645754
2029	48	447	1146	464	20	775873	3421627
2030	50	503	1204	497	21	830282	4251909
2031	53	565	1264	532	22	889156	5141065
2032	55	626	1327	566	24	948714	6089779
2033	58	694	1394	603	25	1012757	7102536
2034	61	770	1463	642	27	1081663	8184199
2035	64	853	1536	684	29	1155847	9340045
2036	67	946	1613	728	31	1235761	10575807
2037	71	993	1694	772	33	1300320	11876127
2038	74	1043	1779	818	35	1368274	13244401
2039	78	1095	1867	868	37	1439801	14684202
2040	82	1150	1961	920	39	1515091	16199293
2041	86	1207	2059	975	41	1594344	17793638
2042	90	1268	2162	1024	43	1674062	19467699
2043	95	1331	2270	1075	45	1757765	21225464
2044	100	1397	2383	1128	48	1845653	23071117
2045	105	1467	2503	1185	50	1937936	25009052
2046	110	1541	2628	1244	53	2034832	27043885
2047	115	1618	2759	1306	55	2136574	29180459
2048	121	1699	2897	1372	58	2243403	31423861
2049	127	1784	3042	1440	61	2355573	33779434
2050	133	1873	3194	1512	64	2473351	36252786
2051	140	1966	3354	1588	67	2597019	38849805
2052	147	2065	3521	1667	70	2726870	41576675
2053	147	2066	3523	1668	70	2728233	44304908
2054	147	2067	3525	1669	71	2729598	47034506

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6.6.4 Design Traffic Estimation

i. at Km 29+200 (Ext. Chainage)

Design Period (years)	30
Cumulative No of Commercial vehicles during design period (two-way), A	43290066
% of Day Traffic (8 AM to 8 PM)	46%
% of Night Traffic (8 PM to 8 AM)	54%
Average No of axles per commercial vehicle, B	2.00
Cumulative No of Commercial Axles during design period (two-way), C = A*B	86580132
Proportion of traffic in predominant direction, D	49%
Lateral Placement factor, E = 0.25*D	10606066
Factor for selection of traffic for BUC analysis (for six-hour period during day), F	0.23
Factor for selection of traffic for TDC analysis (for six-hour period during day), G	0.27
Design axle repetitions for BUC analysis (for 6 hour day time traffic), H = C*E*F	2437580
Proportion of vehicles with spacing between front and the first rear axle less than the spacing of transverse joints, I	19.15%
Design axle repetitions for TDC analysis (for 6-hour night time traffic), J = C*E*G*I	548803
Proportion of Front single (steering) Axles, K1	0.502
Proportion of Rear single Axles, K2	0.180
Proportion of Tandem Axles, K3	0.316
Proportion of Tridem Axles, K4 = (1-K1-K2-K3)	0.002

As per Axle
load surveys

Design Axle Load Repetitions for Fatigue Analysis

For Bottom-up Cracking Analysis

Front single (steering) Axles = H * K1	1223665
Rear single Axles = H * K2	438764



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Tandem Axles = $H * K3$ 770275

Tridem Axles = $H * K4$ 4875

For Top-Down Cracking Analysis

Front single (steering) Axles = $J * K1$ 275499

Rear single Axles = $J * K2$ 98785

Tandem Axles = $J * K3$ 173422

Tridem Axles = $J * K4$ 1098

6.6.5 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 Vairengte is more critical than between Vairengte to Silchar. The axle load spectrum corresponding to Km 29+200 (existing Chainage) is considered and is given below:

Table 6.19 Axle load spectrum

Load (KN)	% of Vehicles at Ch 29+200 Km (Existing Chainage)					
	Silchar To Vairengte			Vairengte To Silchar		
	Single Axle	Tandem Axle	Tridem Axle	Single Axle	Tandem Axle	Tridem Axle
0-85	52.98	9.65	0.00	97.67	69.79	50.00
85-95	14.39	11.40	0.00	0.78	13.54	0.00
95-105	5.61	0.00	0.00	0.39	3.13	0.00
105-115	3.51	0.00	0.00	0.39	5.21	50.00
115-125	4.56	0.88	0.00	0.39	1.04	0.00
125-135	5.96	8.77	0.00	0.00	0.00	0.00
135-145	3.16	0.88	0.00	0.00	1.04	0.00
145-155	3.86	4.39	0.00	0.00	0.00	0.00
155-165	1.40	0.88	0.00	0.00	1.04	0.00
165-175	1.40	7.89	0.00	0.00	0.00	0.00
175-185	1.05	3.51	0.00	0.00	0.00	0.00
185-195	1.40	0.88	0.00	0.39	2.08	0.00
195-205	0.70	7.02	0.00	0.00	0.00	0.00



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Load (KN)	% of Vehicles at Ch 29+200 Km (Existing Chainage)					
	Silchar To Vairengte			Vairengte To Silchar		
	Single Axle	Tandem Axle	Tridem Axle	Single Axle	Tandem Axle	Tridem Axle
205-215	0.00	7.02	0.00	0.00	0.00	0.00
215-225	0.00	1.75	0.00	0.00	1.04	0.00
225-235	0.00	0.88	0.00	0.00	0.00	0.00
235-245	0.00	10.53	0.00	0.00	0.00	0.00
245-255	0.00	10.53	0.00	0.00	0.00	0.00
255-265	0.00	0.88	0.00	0.00	0.00	0.00
265-275	0.00	6.14	0.00	0.00	0.00	0.00
275-285	0.00	3.51	0.00	0.00	0.00	0.00
285-295	0.00	0.88	0.00	0.00	0.00	0.00
295-305	0.00	0.88	0.00	0.00	0.00	0.00
305-315	0.00	0.88	0.00	0.00	0.00	0.00
315-325	0.00	0.00	0.00	0.00	0.00	0.00
325-335	0.00	0.00	0.00	0.00	0.00	0.00
335-345	0.00	0.00	0.00	0.00	0.00	0.00
345-355	0.00	0.00	0.00	0.00	0.00	0.00
355-365	0.00	0.00	0.00	0.00	0.00	0.00
365-375	0.00	0.00	0.00	0.00	0.00	0.00
375-385	0.00	0.00	0.00	0.00	0.00	0.00
385-395	0.00	0.00	0.00	0.00	0.00	0.00
395-405	0.00	0.00	0.00	0.00	0.00	0.00
405-415	0.00	0.00	0.00	0.00	0.00	0.00
415-425	0.00	0.00	0.00	0.00	0.00	0.00
	100.00	100.00	100.00	100.00	100.00	100.00

6.6.6 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.

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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: - At Km 29+200 Km (Existing Chainage)

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	52.98	232468	256613.486	0.906
85-95	90	1.74	0.351	14.39	63120	Infinite	0.000
95-105	100	1.83	0.369	5.61	24632	Infinite	0.000
105-115	110	1.91	0.386	3.51	15395	Infinite	0.000
115-125	120	2.00	0.404	4.56	20014	Infinite	0.000
125-135	130	2.09	0.421	5.96	26172	Infinite	0.000
135-145	140	2.17	0.439	3.16	13856	Infinite	0.000
145-155	150	2.26	0.456	3.86	16935	22475442.1	0.001
155-165	160	2.35	0.474	1.40	6158	3730355.49	0.002
165-175	170	2.43	0.492	1.40	6158	1178385.19	0.005
175-185	180	2.52	0.509	1.05	4619	503535.205	0.009
185-195	190	2.61	0.527	1.40	6158	256613.486	0.024
195-205	200	2.69	0.544	0.70	3079	146794.714	0.021
205-215	210	2.78	0.562	0.00	0	89511.3979	0.000
215-225	220	2.87	0.579	0.00	0	54939.1368	0.000
225-235	230	2.95	0.597	0.00	0	33719.8259	0.000
235-245	240	3.04	0.614	0.00	0	20696.1143	0.000
245-255	250	3.13	0.632	0.00	0	12702.5908	0.000
255-265	260	3.22	0.650	0.00	0	7796.43026	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	2936.99212	0.000
285-295	290	3.48	0.702	0.00	0	1802.62867	0.000
295-305	300	3.56	0.720	0.00	0	1106.39388	0.000



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
Fatigue Damage from Rear Single Axles							0.968
Rear Tandem Axles							
<=205	200	1.47	0.297	56.14	432435	Infinite	0.000
205-215	210	1.51	0.305	7.02	54054	Infinite	0.000
215-225	220	1.55	0.313	1.75	13514	Infinite	0.000
225-235	230	1.59	0.321	0.88	6757	Infinite	0.000
235-245	240	1.63	0.329	10.53	81082	Infinite	0.000
245-255	250	1.67	0.336	10.53	81082	Infinite	0.000
255-265	260	1.70	0.344	0.88	6757	Infinite	0.000
265-275	270	1.74	0.352	6.14	47298	Infinite	0.000
275-285	280	1.78	0.360	3.51	27027	Infinite	0.000
285-295	290	1.82	0.368	0.88	6757	Infinite	0.000
295-305	300	1.86	0.376	0.88	6757	Infinite	0.000
305-315	310	1.90	0.384	0.88	6757	Infinite	0.000
315-325	320	1.94	0.392	0.00	0	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	27167467.8	0.000
405-415	410	2.29	0.463	0.00	0	10194165	0.000
415-425	420	2.33	0.471	0.00	0	4800788.39	0.000
425-435	430	2.37	0.479	0.00	0	2604344.28	0.000
435-445	440	2.41	0.487	0.00	0	1556122.19	0.000
445-455	450	2.45	0.495	0.00	0	997430.201	0.000
455-465	460	2.49	0.503	0.00	0	674355.171	0.000
465-475	470	2.53	0.510	0.00	0	475439.607	0.000
475-485	480	2.57	0.518	0.00	0	346720.4	0.000



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
Fatigue Damage from Rear Tandem Axles							0.000
ii) Cumulative Fatigue Damage Analysis for Top-down Cracking (TDC)							
Single Axle							
<=85	80	1.81	0.366	52.98	52338	Infinite	0.000
85-95	90	1.87	0.378	14.39	14211	Infinite	0.000
95-105	100	1.93	0.390	5.61	5546	Infinite	0.000
105-115	110	1.99	0.402	3.51	3466	Infinite	0.000
115-125	120	2.05	0.414	4.56	4506	Infinite	0.000
125-135	130	2.11	0.426	5.96	5892	Infinite	0.000
135-145	140	2.17	0.438	3.16	3120	Infinite	0.000
145-155	150	2.23	0.450	3.86	3813	Infinite	0.000
155-165	160	2.29	0.462	1.40	1386	11396631.2	0.000
165-175	170	2.35	0.474	1.40	1386	3718917.68	0.000
175-185	180	2.41	0.486	1.05	1040	1617556.99	0.001
185-195	190	2.47	0.498	1.40	1386	833605.56	0.002
195-205	200	2.53	0.510	0.70	693	480538.511	0.001
205-215	210	2.59	0.522	0.00	0	299960.367	0.000
215-225	220	2.64	0.534	0.00	0	198713.541	0.000
225-235	230	2.70	0.546	0.00	0	137855.662	0.000
235-245	240	2.76	0.558	0.00	0	98189.0736	0.000
245-255	250	2.82	0.571	0.00	0	70217.4601	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	25679.7611	0.000
285-295	290	3.06	0.619	0.00	0	18364.2388	0.000
295-305	300	3.12	0.631	0.00	0	13132.7261	0.000
305-315	310	3.18	0.643	0.00	0	9391.5406	0.000
Fatigue Damage from Single Axles							0.004



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

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	56.14	97360	Infinite	0.000
205-215	210	1.96	0.396	7.02	12170	Infinite	0.000
215-225	220	1.99	0.402	1.75	3042	Infinite	0.000
225-235	230	2.02	0.408	0.88	1521	Infinite	0.000
235-245	240	2.05	0.414	10.53	18255	Infinite	0.000
245-255	250	2.08	0.420	10.53	18255	Infinite	0.000
255-265	260	2.11	0.426	0.88	1521	Infinite	0.000
265-275	270	2.14	0.432	6.14	10649	Infinite	0.000
275-285	280	2.17	0.438	3.51	6085	Infinite	0.000
285-295	290	2.20	0.444	0.88	1521	Infinite	0.000
295-305	300	2.23	0.450	0.88	1521	Infinite	0.000
305-315	310	2.26	0.456	0.88	1521	24056663.3	0.000
315-325	320	2.29	0.462	0.00	0	11396631.2	0.000
325-335	330	2.32	0.468	0.00	0	6206750.96	0.000
335-345	340	2.35	0.474	0.00	0	3718917.68	0.000
345-355	350	2.38	0.480	0.00	0	2388668.31	0.000
355-365	360	2.41	0.486	0.00	0	1617556.99	0.000
365-375	370	2.44	0.492	0.00	0	1141885.51	0.000
375-385	380	2.47	0.498	0.00	0	833605.56	0.000
385-395	390	2.50	0.504	0.00	0	625618.727	0.000
395-405	400	2.53	0.510	0.00	0	480538.511	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	299960.367	0.000
425-435	430	2.62	0.528	0.00	0	242566.451	0.000
435-445	440	2.64	0.534	0.00	0	198713.541	0.000
445-455	450	2.67	0.540	0.00	0	164666.833	0.000
455-465	460	2.70	0.546	0.00	0	137855.662	0.000
465-475	470	2.73	0.552	0.00	0	116110.685	0.000





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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
475-485	480	2.76	0.558	0.00	0	98189.0736	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	0.00	0	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
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	Infinite	0.000
465-475	470	2.27	0.458	0.00	0	Infinite	0.000
475-485	480	2.29	0.462	0.00	0	Infinite	0.000
Fatigue Damage from Rear Tridem Axles							0.000

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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	
0.968	0.000	0.004	0.000	0.000	0.972

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.

6.6.7 Design of Dowel Bars

i. At Km 29+200 (Existing Chainage)

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	=	300	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, f_{ck}	=	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



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

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

6.6.8 Design of Tie Bars

i. at Km 29+200 (Existing Chainage)

Design Parameters

Slab thickness, h	=	0.30	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	=	243	mm ² /m
Cross sectional area of tie bar, A	=	113.10	mm ²



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Perimeter of tie bar , P = 37.70 mm

Spacing of tie bars , A/As = 465.0 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

6.7 Recommendation

The current policy directives from MoRT&H stipulate that consultant shall consider rigid pavement for the Bypasses and wherever there is eccentric widening for more than 3 km length. However, consultant has considered the following while deciding on pavement type.

- IRC: SP:48 -1998 (Hill Road Manual) Page 111 Clause 10.2.1 and page 139 Clause 10.23.1 which clearly state that rigid pavement is generally not recommended for hill roads.
- Achieving a high level of smoothness in concrete pavements without sacrificing long-term performance for the curvilinear alignment require special adjustment at time of construction.
- It is more difficult to construct a smooth surface for PCC pavements along horizontal curves than those on tangents because of the transitions for super elevation. Generally, roughness is more prevalent in transitions and super elevated portions of a horizontal curve than on tangents. In the transition sections, the profile pan must adjust to meet the varied cross slope requirements of the curve. As with an uneven track line, the constant adjustments of the paving machine can adversely affect the smoothness of the pavement.
- As the horizontal curvature increases, the potential for roughness within the curve increases. When the degree of curvature exceeds 6 degrees (or the radius of curvature falls below 300 m) increased attention to the machine operation and the string line-staking interval is required and it is virtually impossible to construct the surface to the same specified tolerance desirable for a tangent section because of the significant corrective adjustments necessary by the equipment.
- In majority of curves along the project section which occur in quick succession with very little straight tangents in between and the radii are much less than 300m.

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Thus, it will be very difficult and time consuming to achieve the surface finish to the desired levels.

- f. As far as option-2 using CTB/CTSB is concern, we have shown in above table that by introducing geo-grid over GSB layer will reduce the thickness of WBM by 45mm and WMM by 100mm. The cost difference per Km between conventional flexible pavement and Flexible pavement with geo-grid provision is App. 50 lack per km i.e., Flexible pavement is costlier than reinforced geo-grid pavement. **Further, flexible pavement with geo-grid provision also works out to be cheaper by 10 lack per km compared to Flexible pavement with cement treated base and subbase.** Moreover, the CBR of existing soil is less and the availability of aggregate material along the project road is extremely limited so, introducing geogrid would be most suitable option in Plain / Hilly terrain condition.
- g. **Hence, considering all the above facts the consultant has recommended flexible pavement with geogrid for project road.**

The summary of proposed pavement type is shown below.

Table 6.21 Summary of Pavement Type

Sl No	Sections	Length (Km)	Type of Pavement	Thickness
1	From Km 0+000 to Km 45+750	45.75	Flexible with Geogrid	BC = 40 mm DBM = 60 mm WMM = 150 mm Geogrid = Biaxial GSB = 300 mm Subgrade = 500 mm

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

As the proposed alignment is passing through high embankment and falls under submerged area where the CBR value varies from 4.5 % to 4.8 % hence, an additional geogrid layer has been introduced between natural ground (after clearing and grubbing) and selected earth (Embankment). The typical figure of the pavement cross section is given below.

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



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Chapter 6: Pavement Design

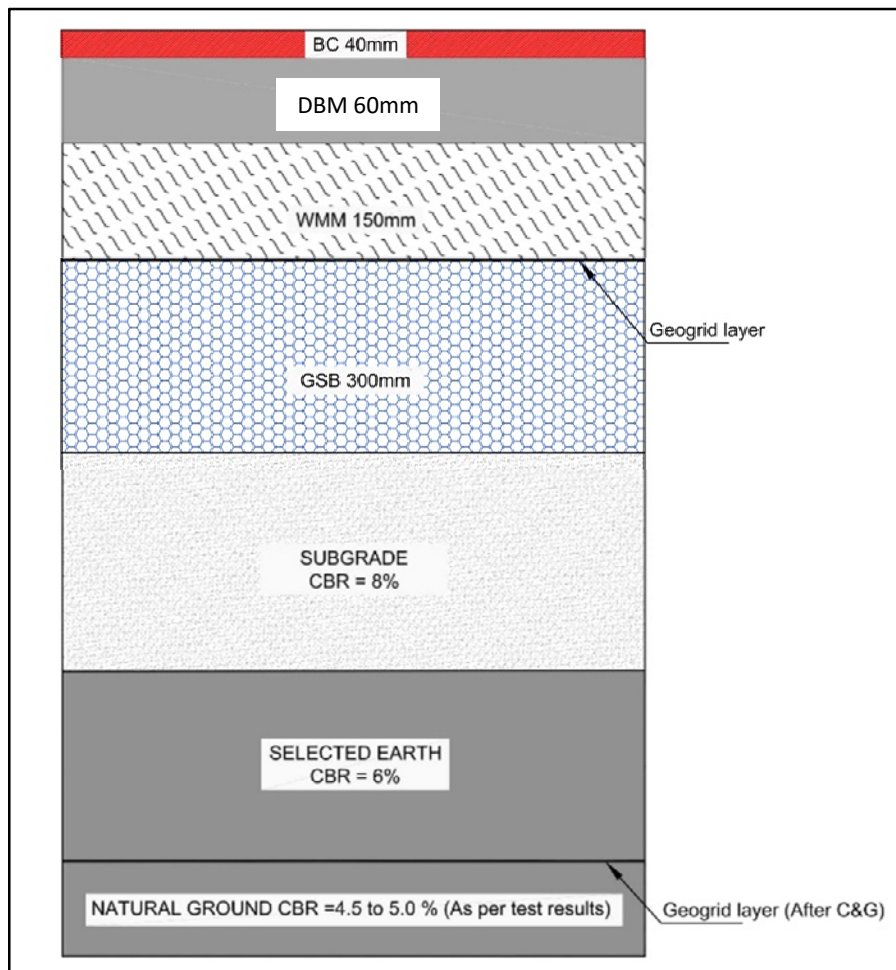


Figure 6-3: Flexible Pavement cross section with Geo grid provision

6.8 Design thickness for service road

As per the Clause 5.5.4 of IRC SP: 84-2019 service roads shall be designed for 10 MSA. The pavement layer thickness for design traffic of 10 MSA and 8% CBR is given in below table:



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Section : Silchar-Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 6: Pavement Design

Table 6.22 Summary of Pavement thickness for Service road

Sl. No	Section (Design Chainage)	Layers	CBR (%)	Thickness in mm	Resilient Modulus	Poisson's Ratio	MSA
1	Km 0+000 to Km 45+750	BC (VG-30)	8	30	2000	0.35	Adopted 10 MSA
		DBM (VG-30)		60		0.35	
		WMM		250	208.19	0.35	
		GSB		200		0.35	
		Sub-Grade		500	CBR 8%	0.35	

6.9 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.

6.10 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.

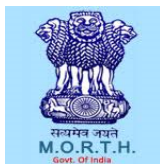
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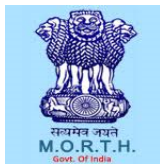
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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



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–Vairengte 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 Aizawl under national highway NH-306 with total length of 185.00 Km. The corridor further bifurcated in to two Section as below.

- Silchar to Vairengte (Assam State)
- Vairengte to Aizawl (Mizoram State)

Since, DPR consultant has been assigned for DPR preparation from Silchar to Sairang hence, based on assessment in line with construction packages the project Corridor from Silchar to Sairang has been divided in to 8-Packages as shown in below table with key Plan.

This Report mainly contains Improvement proposal pertaining to Package-2.

Table 7.1 Package Distribution

Sl. No.	Construction Packages	Design Chainage (Tentative)			Existing Chainage (Tentative)			Bypassing to
		From	To	Length (km)	From	To	Length (km)	
1	Package-1	0+000	20+000	20.000	263+800 (Of NH-37)	12+920 of NH-306	18.820	Kasipur, Sonabarighat via Silchar bypass, Saidpur, Nutan Bazar, Narsingpur.
2	Package -2	20+000	*49+360	29.360	12+920	43+000	30.080	Bagha Bazar, Lailapur
3	Package-3	46+000	**60+850	14.850	43+000	59+700	16.700	Vairengte
4	Package -4	61+000	77+500	16.500	59+700	86+000	26.300	Bilkhawthlir
5	Package -5	77+500	95+500	18.000	86+000	107+850	21.850	Kolasib and N.Thingdwal
6	Package -6	95+500	111+850	16.350	107+850	126+315	18.465	Balpui and Kawnpui
7	Package -7	111+850	125+500	13.650	126+315	142+060	15.745	-
8	Package -8	125+500	136+400	10.900	142+060	158+900	16.840	Sairang
	Total Design Length			139.610	Total Existing Length		164.800	

* EQ (km 49+360 = km 46+000) ** EQ (km 60+850 = km 61+000)

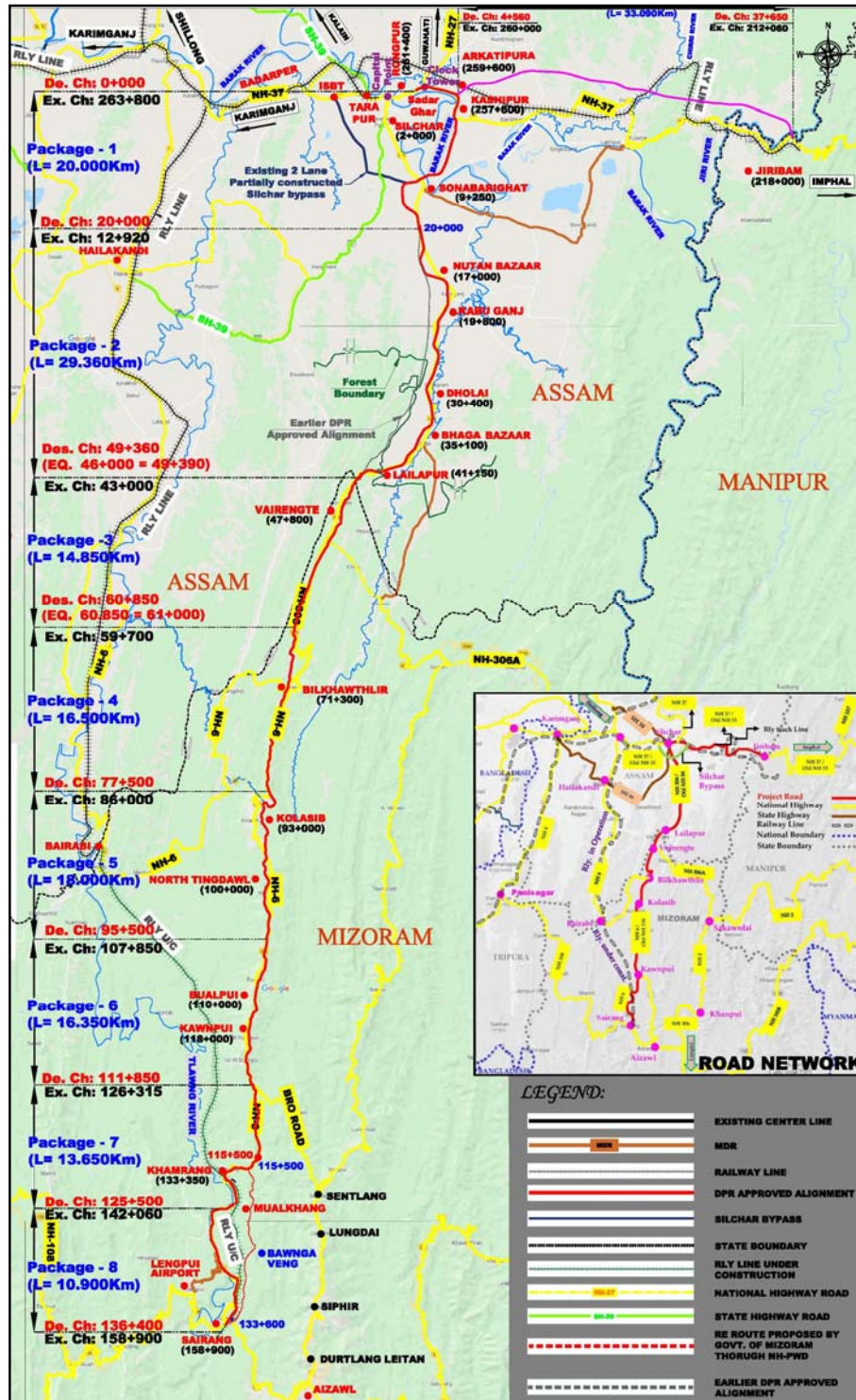




Fig 7.1 Key Plan for Proposed Construction Packages

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

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 has 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,

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	

- 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.
- ◆ Realignment 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.

Generally, the widening of the existing road is proposed on hill side and the centreline of the proposed alignment is designed such that, the proposed outer/valley side shoulder edge matches with the existing shoulder edge. Widening of the road on the valley side is generally not possible, which will require high retaining walls for the widening. However, the most optimal rehabilitation method is not necessarily to widen the road entirely on one side. At some locations, where too high cutting is involved, alignment is shifted to valley side, to minimize the cutting on hill side thus



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achieving the most optimum alignment, duly keeping in mind the stability and steepness of the valley side slopes.


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 Realignments

There are some locations along the project road, where the existing geometrics would not permit design speed of 100 Kmph. The consultants have exercised various possible alternatives to improve the existing geometrics. However, length of major geometric improvements pertaining to this Package-2 is 2.260m. Planimetry of the geometric improvements is given in **Vol IX - Drawings**. Locations of these improvements are given below.

Table 7.2 List of Geometric Improvements

Sl. No	Location	Exist. Chainage (Km)		Exist. Length (m)	Prop. Chainage (Km)		Prop. Length (m)
		Start	End		Start	End	
1							
	The section has been improved by providing smooth horizontal curvature to avoid substandard existing road geometry. Moreover, existing road has unexpected vertical gradient of more than 15% (35 m to 140 m) in short span of 1.2 km. So, to avoid substandard existing design in view of safety aspect, proposed alignment has been shifted towards left side of existing road to match with smooth gradients within permissible limit as per IRC SP-84, 2019.	40+060	43+000	2940	47+100	49+360	2260
Total Length (m)				2940			2260

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

7.4.2 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 proposed as it would not be possible to accommodate the proposed cross section through these settlements within the available ROW.

Bypasses have been proposed by keeping the geometry in view to improve the gradient or curvature or both when crossing high and steep mountain ranges. New bypasses, utilisation by upgrading the under /partially constructed Silchar bypass for the length of 8.25km and then green field alignment has been proposed at these locations to have smooth geometry and better level of service for through traffic. The proposed locations of proposed Bypasses were critically examined/ studied for alternative improvements. The most economical with minimum disturbance has been considered.

Details of these improvements are given for Silchar to Vairengte and summary of subsequent package is presented below:

There are three options provided as below,

Option A: Utilise by upgrading the under-construction bypass and proposal of new bypass,

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

Option C: 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.



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Table 7.3 List of Bypass Proposals.

Sl. No	Location	Exist. Chainage (Km)		Exist. Length (m)	Prop. Chainage (Km)		Prop Length (m)
		Start	End		Start	End	
	Falls under Package-1						
A.	Upgrading the under constructed 2-lane Silchar Bypass to 4-lane road						
1.	Silchar Bypass	20+000	11+170	8830	6+300	13+660	7360
		Total Length (m)		8830			7360
B.	*Improvement of existing road with bypass options at Major Built up						
1	Sonabarighat Bypass (under Pkg-1)	7+950	12+500	4550	13+660	19+010	5350
		Total Length (m)		13380			12710
	Note: As per recent development the proposed alignment is to be follow as per option-B by considering the individual bypasses / short bypasses under modified / re-route alignment, shown below; Falls under Package-2						
2	Nutan Bazar Bypass (under Pkg-2)	14+620	21+270	6650	21+700	28+650	6950
3	Katakhal Bypass (under Pkg-2)	22+720	25+900	3180	30+100	33+350	3250
4	Dholai Short Bypass (Under Pkg-2)	28+150	30+120	1970	35+600	37+600	2000
5	Baga Bazar Bypass (under Pkg-2)	30+860	32+350	1490	38+350	39+600	1250
		32+960	38+110	5150	40+200	45+150	4950
		Total Length (m)		18440			18400
C	Option of Partial Green Field Alignment, falls under package-2 (now withdrawn on obvious reasons and proposed to be modified as per option-B						
1	Green Field Alignment (withdrawn)	12+920	43+000	30080	20+000	46+000	26000
		Total Length (m)		30080			26000
	Total Approval Length (m) along bypasses / Green Field Alignment			31820			31110



A. Upgrading under constructed 2-lane Silchar Bypass to 4-Lane configuration

A.1 Silchar Bypass

Silchar town is completely habituated with utilities, religious structures, educational institutions and commercial activities on both side of project road. The local traffic in Silchar town is also comparatively high. Since the project road is main link between Silchar and Aizawl, there is huge movement of commercial vehicle carrying different commodities to Aizawl.

During the preliminary survey it has been explored that a 2-Lane bypass is already proposed to Silchar town which is under construction /partially constructed.

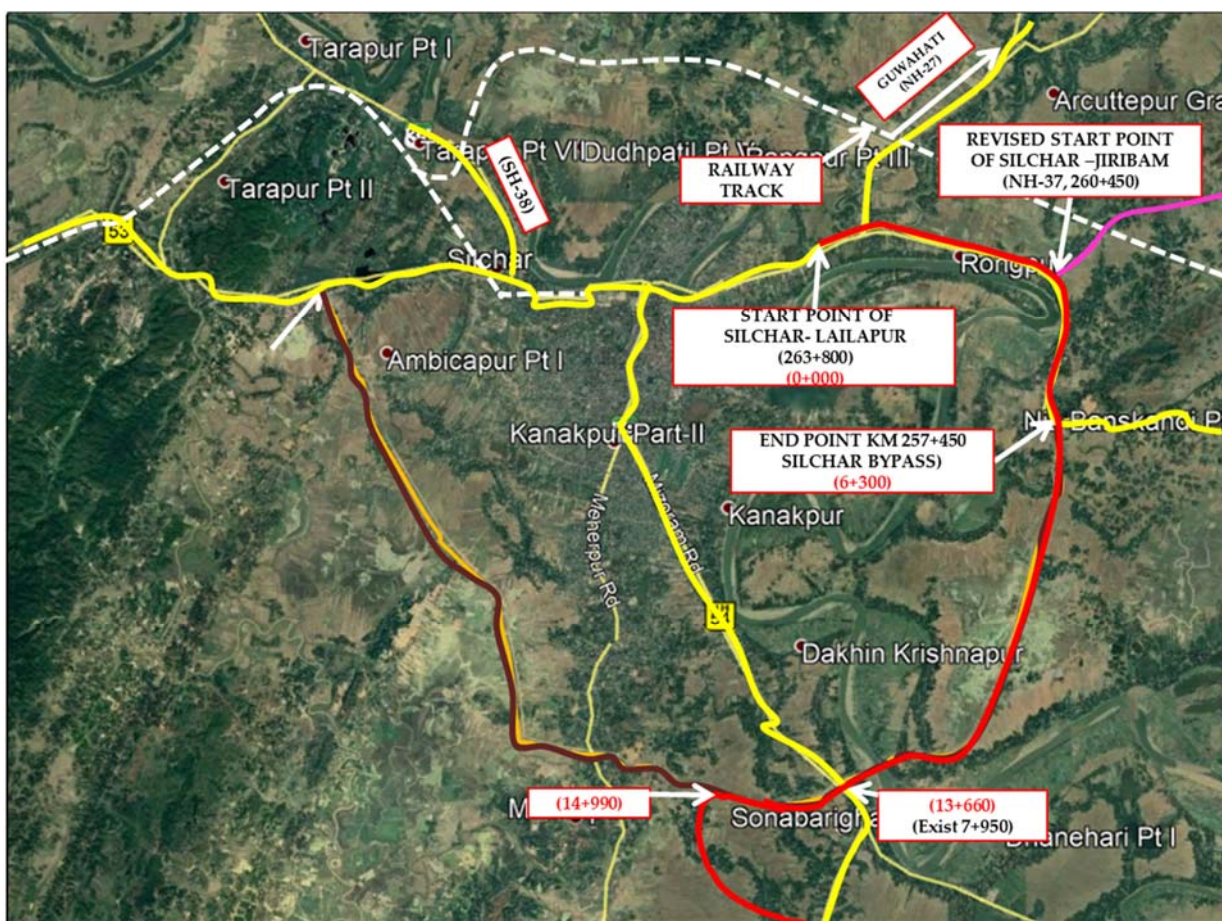


Fig 7.2 Partial use of Silchar Bypass

After detailed reconnaissance survey, it has been learnt that the project road from Km 0+000 to Km 7+950 of NH306 (old NH-54) traverses through heavily built-up with narrow ROW and falls under Silchar municipality whereas, at the same time it has also been extracted that Silchar bypass (partly constructed 2-Lane – on hold, non-



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fuctional) exist on RHS of project road and intersects at km 7+950 of NH-306 (old NH-54).

Hence, DPR consultant has proposed to utilize partial section of bypass for the existing length of 7.500 Km (Design Ch: 6+300 to 13+660, L= 7.360) from the junction of NH 37 at Km 257+450 and terminates at design Km 14+400, intersecting of NH 306 near Sonabarighat at Km 7+950 of NH-306.

B. Improvement of existing road with bypass options at Major Built up

B.1 Sonabarighat Bypass:

The project road passes through heavy built-up section of Sonabarighat from Km 9+000 to Km 14+000 with substandard geometrics. It has also been observed that there are many religious structures which are very near to road edge like kali temple on LHS at Km 10+800, Darga at km 11+600 on LHS whereas existing / available ROW varies from 10m to 15m and the improvement of the existing road to 4-Lane standards will lead to demolition of buildings. Thus, to avoid the thickly habituated Sonabarighat town, for bypass options have been studied and proposed length of 5.350 Km, as against existing length of 4.550 Kms. The detailed study may be referred from earlier submitted Alignment Report however, brief information on final options is presented here under.

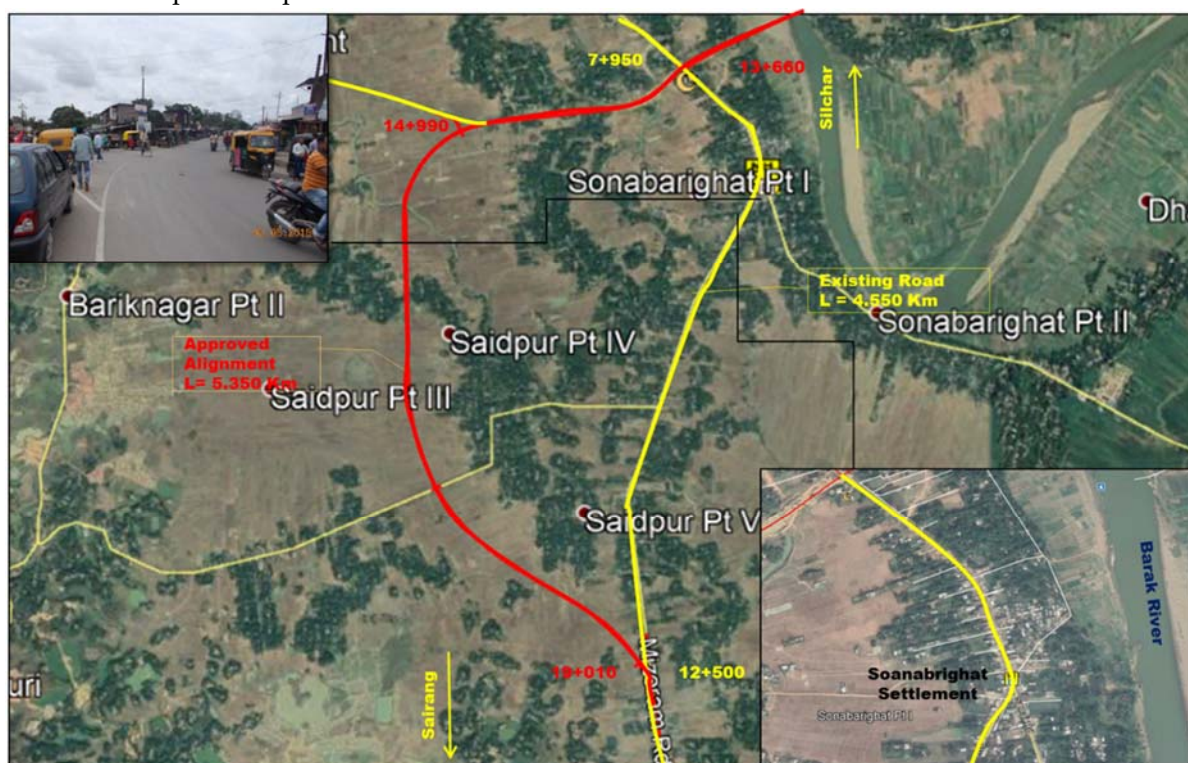
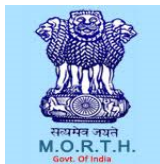


Fig 7.3 Proposed Bypass options for Sonabarighat



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The selected alignment for bypassing Sonabarighat takes off from proposed Silchar bypass on RHS of Sonabarighat and ends at existing Km.12+500. This proposal detours all the settlements including religious structures falling along existing road with substandard curves. The proposed mainly traverses on open field with negligible habitation and found to be most feasible option as compared to other studied options.

B.2 Bypasses to Nutan Bazar, Katakhal, Dholai and Bagha Bazar:

Nutan Bazar & Kabuganj: Project Road traverse through Nutan Bazar and Kabuganj village are situated under proximity and thickly habituated with very poor geometrics km 14+700 to Km 21+000. The ribbon development all along the road with government offices, educational institutions, and residential buildings on both sides throughout the stretches have given very limited opportunity to improve. Geometric correction along the existing road involves acquisition of land in built up areas which leads to demolition of buildings. Thus, to avoid the habitation in Nuthan Bazar and Kabuganj bypass options were studied. Recommended option takes-off the proposed alignment on RHS of Nutan Bazar and Kabuganj from existing Km 14+620 to Km 21+270 for a proposed length 6.950km mainly on open / agricultural field where negligible effect on buildings are accorded moreover, alignment has better scope for further town advancement with lesser LA cost as compared to other options studied.

Katakhal Village: Thereafter, project road encounters Katakhal village at Km 24+000 that found to be built up on either side with poor geometrics in terms of horizontal curves moreover, settlements were observed in linear fashion. Hence, improvement of existing road to NH standards deemed to be difficult and lead to acquisition of built-up area for entire length. Hence, bypass options have been studied. The recommended option takes-off from Km. 22+720 on LHS of Katakhal and intersects existing road at Km. 24+300 and then alignment passes on RHS of Katakhal ultimately joins at Km. 25+900. The length of this alternative is 3.250Kms. This recommended option passes through mainly agriculture filed however; marginal number of buildings conferred to be affected as compare to other options studied. Moreover, proposed alignment is away from the river which is running parallel on LHS of Katakhal built up and extends more scope for further development of Katakhal village. Land acquisition cost is also less as compared to other options.

Dholai Village: The project road further passes through Dholai village which is located on the banks of Rukini River from Km 28+500 to Km 32+000 of poor horizontal curves. Hence, existing road improvement 4-Lane NH standers attracts significant effects on residential and commercial buildings. LA cost was also concern in this matter so, bypass options were studied. The recommended option takes-off from Km 28+150 on RHS of Dholai and terminates at Km. 30+120. The



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length of this alternative is 2.000 Kms. This recommended alignment passes mainly through agriculture filed whereas a smaller amount of buildings needs to be acquired. Since, the recommended alignment is on RHS of existing road whereas Barak / Rukini River is on LHS, running parallel to exiting road therefore alignment option on RHS has more scope for further village growth. Land acquisition cost is also less as compared to other options.

Baga Bazar: The cluster of 4 settlements i.e., Saptagram, Islamabad, Bagabazar and lailapur have proximity at regular intervals start at km 31+300 and ends at km 37+500. The reconnaissance found that settlements fall along existing road on either side with poor geometrics so, improvement of existing road to 4-Lane standard attracts enormous effects on commercial and residential buildings hence, bypass options were studied. The recommended alignment takes-off from Km. 30+860 on RHS of existing alignment and intersects existing road at Km. 32+350 thereafter the alignment follows the existing alignment up to Km. 32+960 and again passes on RHS of Bhaga Bazar terminates at Km. 38+110. The length of this alternative has 6.200 Kms. Moreover, this alignment passes mainly through agriculture filed and affects a smaller number of buildings but has more scope of future growth of these settlements.

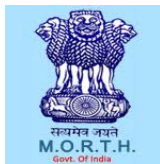
B.3 Option of Green Field alignment (km 12+920 to km 43+000)

The existing road passes through many built up locations such as Nuthan Bazar, Kabuganj, Katakhal, Dholai and Baga bazar from Km 12+920 to Km 43+000. As discussed above options are studied for improving the existing road along with the several bypass proposals at built up locations.

Thus, In this specific segment (with so many bypass options), the effort has also been made to study the green filed alignment option from Km 12+920 to Km 43+000 under option-V and option-VI that passes through green filed/agriculture land/forest land. However, Option-VI were recommended and brief information of same has been presented hereunder. Please refer Alignment report for details information.

In recommended **Option-VI**, the proposed alignment takes-off from Km. 12+920 on RHS of existing alignment and passes through green field/agricultural filed/forest land and terminates at Km 43+000, the approximate length of the alignment is 30.080 Kms. A smaller amount of buildings is affected as compared to other option however; it has more scope for future development of these settlements as the alignment fairly away from existing road. Since, the proposed alignment ultimately needs to be merge at Variegate town surrounded with thickly vegetated / forest area, few portions of this recommended alignment fall under reserve forest.

After, detailed assessment and discussions in consultation with stakeholders, NHDCL- HQ has approved Option-VI during presentation furnished at HQ on



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23.10.2019 followed by approval letter vide no letter no NHIDCL/Bharatmala/V-S/ DPR/ Mizoram/2019-20//353.

However, as per recent development and as discussed in chapter-01 under executive summary, the proposed alignment to be followed as per above option B-2 (Bypasses to Nutan Bazar, Katakhal, Dholai and Bagha Bazar)

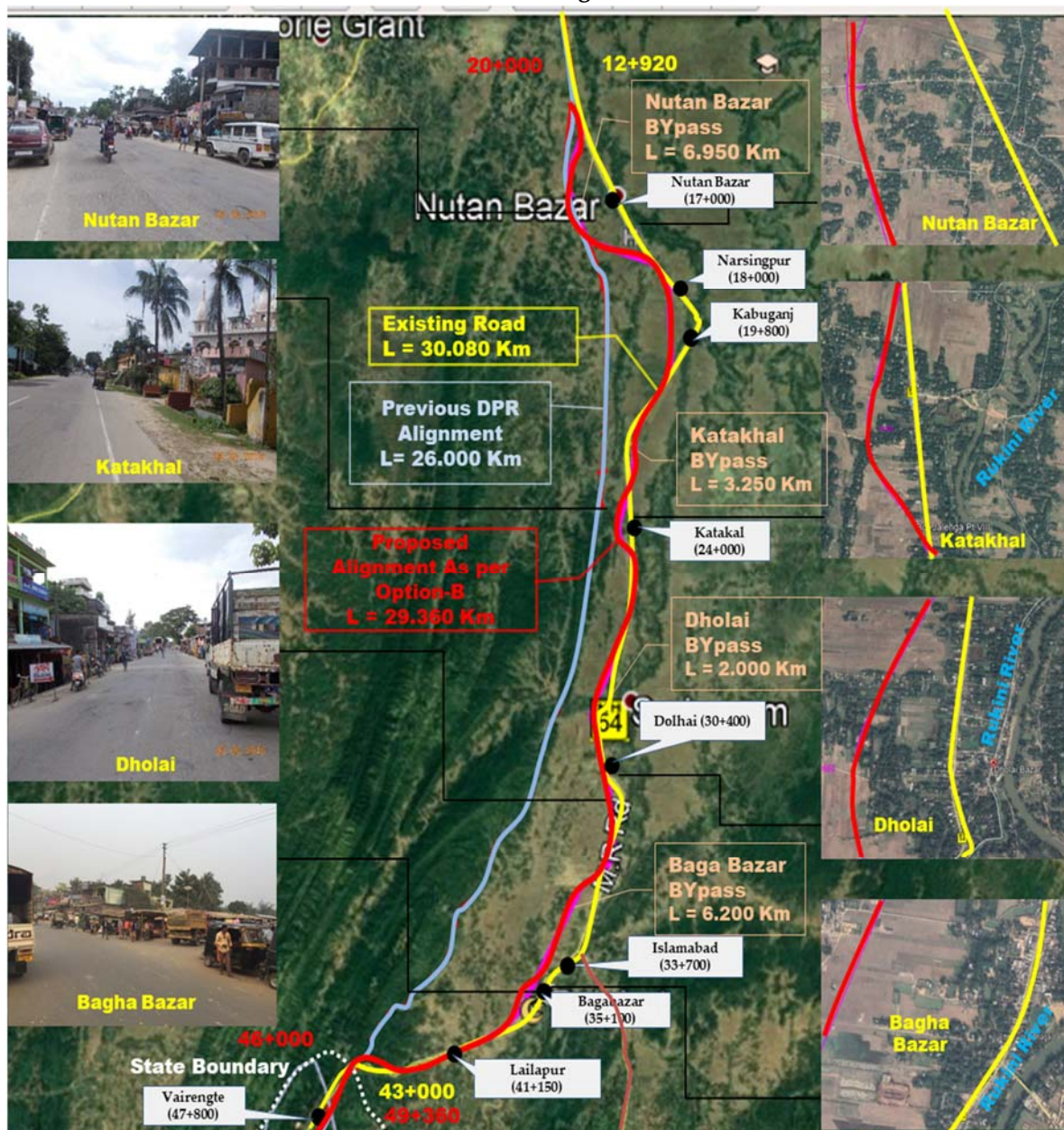
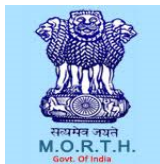


Fig 7.4 Approved Green Field Alignment



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7.4.3 Villages / Towns along Approved Alignment

There are 24 Nos. of villages with major settlement side of proposed alignment under this package, where the proposed alignment is taken through the villages. The proposed alignment is passing through open area of villages with no habitation. The consultant has exercised various possible alternatives to improve the existing geometrics to be within proposed geometric standards.

Table 7.4 List of Villages along Proposed Alignment

Sl.no	State	District	Block	Village Name	Proposed Chainage		Length	Side
					From	To		
1	Assam	Cachar	Sonai	Dhanehari Pt III	20+000	20+120	120	Both
2			Sonai	Kajidahar Pt III	20+120	22+255	2135	Both
3			Silchar	Menipur Pt II	22+255	22+875	620	Both
4			Silchar	Clever House Cha Bagicha	22+875	24+470	1595	Both
5			Silchar	Clever House Pt IV	24+470	26+380	1910	Both
6			Sonai	Narsingpur Pt I	26+380	26+880	500	Both
7			Sonai	Narsingpur Pt II	26+880	28+015	1135	Both
8			Sonai	Narsingpur Pt III	28+015	28+270	255	Both
9			Sonai	Narsingpur Pt IV	28+270	29+150	880	Both
10			Sonai	Narsingpur Pt V	29+150	30+030	880	Both
11			Sonai	Narsingpur Pt VI	30+030	31+400	1370	Both
12			Silchar	Borjalenga VII	31+400	32+220	820	Both
13			Silchar	Borjalenga VIII	32+220	33+780	1560	Both
14			Sonai	Rampradpur	33+780	34+860	1080	Both
15			Sonai	Lantugram	34+860	35+710	850	Both
16			Sonai	Sadagram	35+710	37+830	2120	Both
17			Sonai	Saptagram	37+830	39+610	1780	Both
18			Sonai	Islamabad	39+610	41+760	2150	Both
19			Sonai	Bangram	41+760	43+200	1440	Both
20			Sonai	Rajghat	43+200	44+420	1220	Both
21			Sonai	Channighat	44+420	45+400	980	Both
22			Sonai	Hawaitang	45+400	46+760	1360	Both
23			Sonai	Lailapura	46+760	47+330	570	Both
24			Sonai	French Nagar FV	47+330	49+360	2030	Both

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

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, particularly in mountainous sections. 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.



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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;



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Table 7.5 Summary of Proposed Horizontal Curves

Curve No.	HIP			Deflection Angle			Speed (Kmph)	Radius (m)	Transition Length (m)	Length of Curve (m)	Tangent Length	Direction of Curve	Super-elevation	BS-Start of Transition (Ch)	BC-Start of Curve (Ch)	EC-End of Curve (Ch)	ES-End of Transition (Ch)
	Chainage	Easting	Northing	Deg	Min	Sec											
Start	19600.000	482692.472	2734385.659														19600
1	21818.314	483108.650	2732202.516	6	25	54.9	100	600	100.000	221.600	214.943	Right	5.000%	21607.514	21707.514	21929.114	22029.114
2	22960.924	482714.553	2731114.883	1	21	51.5	100	-600	100.000	331.829	275.994	Left	5.000%	22695.009	22795.009	23126.838	23226.838
3	24325.457	483222.039	2729814.517	23	44	17.2	100	-600	100.000	449.317	345.931	Left	5.000%	24000.798	24100.798	24550.115	24650.115
4	26063.233	484915.407	2729321.740	339	49	59.9	100	600	100.000	232.180	220.652	Right	5.000%	25847.143	25947.143	26179.323	26279.323
5	26579.522	485270.564	2728928.044	33	32	11.5	100	600	100.000	321.629	270.183	Right	5.000%	26318.707	26418.707	26740.336	26840.336
6	28542.154	485332.366	2726951.880	323	18	13.4	100	600	100.000	245.451	227.855	Right	5.000%	28319.428	28419.428	28664.879	28764.879
7	29613.921	484774.542	2726030.692	40	58	37.0	100	4000	0.000	207.941	103.993	Right	NORMAL	29509.950	29509.950	29717.891	29717.891
8	30236.511	484421.895	2725511.307	313	11	51.5	100	-600	100.000	246.513	228.433	Left	5.000%	30013.254	30113.254	30359.767	30459.767
9	30976.451	484407.745	2724764.759	16	45	47.1	100	2000	0.000	530.413	266.772	Right	NORMAL	30711.244	30711.244	31241.657	31241.657
10	32573.073	483950.839	2723200.336	34	15	43.9	100	-600	100.000	521.982	392.583	Left	5.000%	32212.082	32312.082	32834.064	32934.064
11	33202.981	484407.417	2722712.663	346	47	41.3	100	600	100.000	274.714	243.906	Right	5.000%	32965.624	33065.624	33340.338	33440.338
12	33774.141	484481.379	2722137.790	36	30	21.4	100	500	100.000	116.975	160.390	Right	5.000%	33615.653	33715.653	33832.628	33932.628
13	35485.935	483964.994	2720503.227	314	48	30.2	100	2000	0.000	361.562	181.275	Right	NORMAL	35305.154	35305.154	35666.716	35666.716
14	36894.408	483299.377	2719245.573	350	2	42.8	100	-600	100.000	380.096	304.015	Left	5.000%	36604.360	36704.360	37084.456	37184.456
15	38328.254	483745.784	2717868.048	9	15	44.2	100	600	100.000	16.560	108.520	Right	5.000%	38219.974	38319.974	38336.534	38436.534
16	39652.880	483903.350	2716551.551	20	35	12.9	100	2000	0.000	461.083	231.569	Right	NORMAL	39422.338	39422.338	39883.421	39883.421
17	40385.730	483819.467	2715801.830	333	33	23.2	100	500	100.000	378.527	309.786	Right	5.000%	40096.466	40196.466	40574.993	40674.993
18	41148.602	483128.571	2715422.308	19	13	34.6	100	-600	100.000	239.735	224.748	Left	5.000%	40928.734	41028.734	41268.469	41368.469
19	42288.807	482577.224	2714418.451	349	35	9.5	100	-2000	0.000	274.931	137.682	Left	NORMAL	42151.341	42151.341	42426.272	42426.272



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Curve No.	HIP			Deflection Angle			Speed (Kmph)	Radius (m)	Transition Length (m)	Length of Curve (m)	Tangent Length	Direction of Curve	Super-elevation	BS-Start of Transition (Ch)	BC-Start of Curve (Ch)	EC-End of Curve (Ch)	ES-End of Transition (Ch)
	Chainage	Easting	Northing	Deg	Min	Sec											
20	43155.270	482266.934	2713605.910	348	36	17.9	100	700	100.000	224.145	215.164	Right	5.000%	42943.197	43043.197	43267.342	43367.342
21	44019.171	481626.211	2713017.401	10	58	27.3	100	-800	100.000	251.342	228.660	Left	5.000%	43793.500	43893.500	44144.842	44244.842
22	44946.299	481263.139	2712130.791	331	29	10.6	100	800	100.000	630.628	443.268	Right	5.000%	44530.985	44630.985	45261.613	45361.613
23	46344.119	479888.534	2711752.077	20	58	49.9	100	-2000	0.000	163.548	81.819	Left	NORMAL	46262.345	46262.345	46425.893	46425.893
24	47303.929	478981.113	2711420.213	339	7	24.1	100	600	80.000	292.250	232.471	Right	5.000%	47077.804	47157.804	47450.054	47530.054
25	48299.459	477997.150	2711692.325	48	17	19.3	100	-600	80.000	451.112	324.576	Left	5.000%	47993.903	48073.903	48525.015	48605.015
26	49044.174	477372.050	2711250.404	326	34	12.1	80	-400	75.000	109.611	131.607	Left	5.000%	48914.368	48989.368	49098.979	49173.979
27	49411.275	477196.686	2710924.684	346	27	24.6	100	600	80.000	121.337	141.694	Right	5.000%	49270.606	49350.606	49471.943	49551.943
END	49560.357	477085.973	2710823.320														

The summaries of proposed horizontal curves are given below;

Table 7.6 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
27	-	-	-	27	-	-	-	1	26

Length (m)			% Length	
Total	In Straight	In Curve	In Straight	In Curve
29360	19288	10072	66%	34%



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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 7.7 Summary of Vertical Curves

Sl. No.	Vertical Intersection Points			Element	Vertical Tangent Points				Grade (%)	K Value	Length of Element
	Chainage	Level	%Grade Diff.		Start Chainage	Level	End Chainage	Level			
1				Grade	19600.000	24.264	20057.884	25.062	0.174		
2	20157.884	25.236	-0.225	Hog Curve	20057.884	25.062	20257.884	25.185		-89014	-0.112
3				Grade	20257.884	25.185	21388.600	24.615	-0.050		
4	21448.601	24.584	2.550	Sag Curve	21388.600	24.615	21508.600	26.084		4705	2.125
5				Grade	21508.600	26.084	21560.000	27.369	2.500		
6	21900.000	35.869	-5.000	Hog Curve	21560.000	27.369	22240.000	27.369		-13600	-0.735
7				Grade	22240.000	27.369	22318.802	25.399	-2.500		
8	22378.802	23.899	2.508	Sag Curve	22318.802	25.399	22438.802	23.904		4784	2.090
9				Grade	22438.802	23.904	22559.039	23.914	0.008		
10	22619.039	23.919	1.492	Sag Curve	22559.039	23.914	22679.039	24.819		8044	1.243
11				Grade	22679.039	24.819	22745.000	25.808	1.500		
12	22950.000	28.883	-3.000	Hog Curve	22745.000	25.808	23155.000	25.808		-13667	-0.732



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Sl. No.	Vertical Intersection Points			Element	Vertical Tangent Points				Grade (%)	K Value	Length of Element
	Chainage	Level	%Grade Diff.		Start Chainage	Level	End Chainage	Level			
13				Grade	23155.000	25.808	23217.378	24.873	-1.500		
14	23277.378	23.973	1.508	Sag Curve	23217.378	24.873	23337.378	23.978		7957	1.257
15				Grade	23337.378	23.978	23952.732	24.028	0.008		
16	24012.732	24.033	1.492	Sag Curve	23952.732	24.028	24072.732	24.933		8044	1.243
17				Grade	24072.732	24.933	24120.008	25.642	1.500		
18	24325.008	28.717	-3.000	Hog Curve	24120.008	25.642	24530.008	25.642		-13667	-0.732
19				Grade	24530.008	25.642	24576.309	24.947	-1.500		
20	24636.309	24.047	1.699	Sag Curve	24576.309	24.947	24696.309	24.167		7065	1.415
21				Grade	24696.309	24.167	25160.321	25.088	0.199		
22	25260.321	25.286	-0.199	Hog Curve	25160.321	25.088	25360.321	25.286		-100725	-0.099
23				Grade	25360.321	25.286	26063.737	25.286	0.000		
24	26123.738	25.286	2.500	Sag Curve	26063.737	25.286	26183.737	26.786		4800	2.083
25				Grade	26183.737	26.786	26270.000	28.943	2.500		
26	26610.000	37.443	-5.000	Hog Curve	26270.000	28.943	26950.000	28.943		-13600	-0.735
27				Grade	26950.000	28.943	27039.950	26.694	-2.500		
28	27114.950	24.819	2.747	Sag Curve	27039.950	26.694	27189.950	25.004		5461	1.831
29				Grade	27189.950	25.004	27474.114	25.706	0.247		
30	27574.114	25.952	-0.320	Hog Curve	27474.114	25.706	27674.114	25.880		-62592	-0.160
31				Grade	27674.114	25.880	28345.170	25.392	-0.073		
32	28405.170	25.348	0.177	Sag Curve	28345.170	25.392	28465.170	25.411		67648	0.148
33				Grade	28465.170	25.411	29146.600	26.124	0.105		
34	29221.600	26.203	-0.128	Hog Curve	29146.600	26.124	29296.600	26.185		-116812	-0.086
35				Grade	29296.600	26.185	30592.709	25.878	-0.024		
36	30667.709	25.860	0.222	Sag Curve	30592.709	25.878	30742.709	26.008		67577	0.148
37				Grade	30742.709	26.008	31075.858	26.669	0.198		
38	31135.858	26.788	2.302	Sag Curve	31075.858	26.669	31195.858	28.288		5213	1.918



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No.	Vertical Intersection Points			Element	Vertical Tangent Points				Grade (%)	K Value	Length of Element
	Chainage	Level	%Grade Diff.		Start Chainage	Level	End Chainage	Level			
39				Grade	31195.858	28.288	31270.000	30.141	2.500		
40	31610.000	38.641	-5.000	Hog Curve	31270.000	30.141	31950.000	30.141		-13600	-0.735
41				Grade	31950.000	30.141	31978.800	29.421	-2.500		
42	32038.800	27.921	2.590	Sag Curve	31978.800	29.421	32098.800	27.975		4634	2.158
43				Grade	32098.800	27.975	32436.570	28.279	0.090		
44	32536.570	28.368	-0.090	Hog Curve	32436.570	28.279	32636.570	28.368		-222670	-0.045
45				Grade	32636.570	28.368	33291.006	28.369	0.000		
46	33351.006	28.369	2.500	Sag Curve	33291.006	28.369	33411.006	29.869		4800	2.083
47				Grade	33411.006	29.869	33520.000	32.593	2.500		
48	33860.000	41.093	-5.000	Hog Curve	33520.000	32.593	34200.000	32.593		-13600	-0.735
49				Grade	34200.000	32.593	34266.932	30.920	-2.500		
50	34326.932	29.420	2.548	Sag Curve	34266.932	30.920	34386.932	29.449		4710	2.123
51				Grade	34386.932	29.449	35253.466	29.861	0.048		
52	35328.466	29.897	2.152	Sag Curve	35253.466	29.861	35403.466	31.547		6969	1.435
53				Grade	35403.466	31.547	35510.000	33.891	2.200		
54	35810.000	40.491	-4.400	Hog Curve	35510.000	33.891	36110.000	33.891		-13636	-0.733
55				Grade	36110.000	33.891	36138.305	33.268	-2.200		
56	36223.305	31.398	3.700	Sag Curve	36138.305	33.268	36308.305	32.673		4595	2.176
57				Grade	36308.305	32.673	36310.000	32.698	1.500		
58	36515.000	35.773	-3.000	Hog Curve	36310.000	32.698	36720.000	32.698		-13667	-0.732
59				Grade	36720.000	32.698	36800.014	31.498	-1.500		
60	36860.014	30.598	1.606	Sag Curve	36800.014	31.498	36920.014	30.662		7473	1.338
61				Grade	36920.014	30.662	37354.281	31.121	0.106		
62	37414.281	31.185	0.503	Sag Curve	37354.281	31.121	37474.281	31.550		23873	0.419
63				Grade	37474.281	31.550	37627.355	32.482	0.609		
64	37687.355	32.847	-0.827	Hog Curve	37627.355	32.482	37747.355	32.716		-14518	-0.689



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Sl. No.	Vertical Intersection Points			Element	Vertical Tangent Points				Grade (%)	K Value	Length of Element
	Chainage	Level	%Grade Diff.		Start Chainage	Level	End Chainage	Level			
65				Grade	37747.355	32.716	37982.203	32.204	-0.218		
66	38042.203	32.073	2.718	Sag Curve	37982.203	32.204	38102.203	33.573		4415	2.265
67				Grade	38102.203	33.573	38110.010	33.768	2.500		
68	38450.010	42.268	-5.000	Hog Curve	38110.010	33.768	38790.010	33.768		-13600	-0.735
69				Grade	38790.010	33.768	38853.409	32.183	-2.500		
70	38928.409	30.308	2.733	Sag Curve	38853.409	32.183	39003.409	30.483		5488	1.822
71				Grade	39003.409	30.483	39599.499	31.874	0.233		
72	39659.499	32.014	-0.161	Hog Curve	39599.499	31.874	39719.499	32.058		-74571	-0.134
73				Grade	39719.499	32.058	39833.160	32.140	0.072		
74	39893.160	32.184	2.428	Sag Curve	39833.160	32.140	39953.160	33.684		4943	2.023
75				Grade	39953.160	33.684	40040.000	35.855	2.500		
76	40380.000	44.355	-5.000	Hog Curve	40040.000	35.855	40720.000	35.855		-13600	-0.735
77				Grade	40720.000	35.855	40850.389	32.595	-2.500		
78	40915.389	30.970	2.357	Sag Curve	40850.389	32.595	40980.389	30.877		5516	1.813
79				Grade	40980.389	30.877	41267.465	30.465	-0.143		
80	41367.465	30.321	1.643	Sag Curve	41267.465	30.465	41467.465	31.821		12170	0.822
81				Grade	41467.465	31.821	41558.000	33.179	1.500		
82	41743.000	35.954	-2.700	Hog Curve	41558.000	33.179	41928.000	33.734		-13704	-0.730
83				Grade	41928.000	33.734	41959.421	33.357	-1.200		
84	42019.421	32.637	1.340	Sag Curve	41959.421	33.357	42079.421	32.721		8958	1.116
85				Grade	42079.421	32.721	42356.628	33.108	0.140		
86	42456.628	33.248	-0.143	Hog Curve	42356.628	33.108	42556.628	33.244		-140084	-0.071
87				Grade	42556.628	33.244	43021.733	33.229	-0.003		
88	43081.733	33.227	1.003	Sag Curve	43021.733	33.229	43141.733	33.827		11961	0.836
89				Grade	43141.733	33.827	43255.003	34.960	1.000		
90	43375.002	36.160	-2.000	Hog Curve	43255.003	34.960	43495.003	34.960		-12000	-0.833



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Sl. No.	Vertical Intersection Points			Element	Vertical Tangent Points				Grade (%)	K Value	Length of Element
	Chainage	Level	%Grade Diff.		Start Chainage	Level	End Chainage	Level			
91				Grade	43495.003	34.960	43640.002	33.510	-1.000		
92	43715.001	32.760	2.700	Sag Curve	43640.002	33.510	43790.002	34.035		5556	1.800
93				Grade	43790.002	34.035	43820.000	34.545	1.700		
94	44050.000	38.455	-3.400	Hog Curve	43820.000	34.545	44280.000	34.545		-13529	-0.739
95				Grade	44280.000	34.545	44309.629	34.041	-1.700		
96	44434.629	31.916	4.200	Sag Curve	44309.629	34.041	44559.629	35.041		5952	1.680
97				Grade	44559.629	35.041	44620.000	36.551	2.500		
98	44960.000	45.051	-5.000	Hog Curve	44620.000	36.551	45300.000	36.551		-13600	-0.735
99				Grade	45300.000	36.551	45353.605	35.210	-2.500		
100	45418.605	33.585	2.627	Sag Curve	45353.605	35.210	45483.605	33.668		4948	2.021
101				Grade	45483.605	33.668	46296.378	34.702	0.127		
102	46356.378	34.778	0.399	Sag Curve	46296.378	34.702	46416.378	35.094		30110	0.332
103				Grade	46416.378	35.094	47066.948	38.514	0.526		
104	47166.948	39.040	3.974	Sag Curve	47066.948	38.514	47266.948	43.540		5032	1.987
105				Grade	47266.948	43.540	47683.881	62.302	4.500		
106	47803.881	67.702	-1.170	Hog Curve	47683.881	62.302	47923.881	71.698		-20513	-0.488
107				Grade	47923.881	71.698	49163.453	112.976	3.330		
108	49343.453	118.970	-2.620	Hog Curve	49163.453	112.976	49523.453	120.247		-13738	-0.728
109				Grade	49523.453	120.247	49549.749	120.434	0.710		

Summary of proposed alignment length as per gradient is given below;

Table 7.8

Table 6.8 - Distribution of proposed vertical grades

Gradient -->>	<=4	>4 & <=5	>5 & <=6	>6 & <=7	>7
Length (m)	29009	351	-	-	-
% of Length	99%	1%	-	-	-

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7.5.4 Speed Zoning

As given in Chapter 5 - Design Standards, the ruling and minimum design speeds for Plain and Rolling terrain are 100 Km/h and 80 Km/h 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 7.9 Speed Zoning

From	To	Length (m)	Des Speed (Km/h)
20+000	48+914	28914.000	100
48+914	49+174	260.000	80
49+174	49+360	186.000	100

Speed (Kmph) -->	40	50	60	80	100
Length (m)	-	-	-	260	29100
% Length	-	-	-	1%	99%

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 7.10 Table 6.9 - Proposed Lane Configuration

Existing Chainage		Proposed Chainage			Lane Configuration
From	To	From	To	Length (km)	
12+920	43+000	20+000	49+360	29.360	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.

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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

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 7.11 Design Standards for Cross Sectional Elements

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

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

7.7.1 Typical Cross-sections

In accordance with 4-lane manual, various cross-sectional elements discussed earlier and 10 types of typical cross sections have been proposed for the project road for various conditions expected to meet with during execution. These are shown in drawing **Volume-IX** of this report. However, same drawings are enclosed in this section for ready reference. Following table gives detailed description of each type of cross section.





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	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

Table 7.12 List of Typical Cross Sections

Sl. No.	Type of Cross Section		Description	Length (m)	Location/Remarks
1	TCS-1	4-Lane Road with Paved and Earthen Shoulder with 2.5m raised median	(2 x 7.00m) CW + (2x2.5m) PS+ + 2.5m Median (Include 2x0.5m Kerb shyness) + 2 x 1.5 ES	1525	Open Area
2	TCS-2	4-Lane Road with Paved and Earthen Shoulder in Rural Area with 5.0m raised median	(2 x 7.00m) CW + (2x2.5m) PS+ + 5.0m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) ES	14905	Open Area
3	TCS-3	4 Lane with Paved Shoulder and RCC Drain on Both Side in Built-up Area along the Existing Road with 2.5 m Median	(2 x 7.00m) CW + (2x2.5m) PS + 2.5m Median (Include 2x0.5m Kerb shyness) + 2 x 1.5 Footpath cum Drain	905	Built up
4	TCS-4	4-Lane with Paved Shoulder and 7.5m wide Service Road and RCC Drain on both side in Built-up Area along the Existing Road with 2.5m median	(2x7.0 m) CW+ Median (Include 2x0.5m Kerb shyness) + (2 x 1.5 m) PS + 2 x 1.5m Cover Drain + (1 x 1.5m Footpath Including railing + 2 x 7.5m SR Include 2x0.25m Kerb shyness + 2x1.5m Footpath Drain	1640	Built up
5	TCS-5	4-Lane divided highway with Cut on Hill Side and Cut/Fill on Valley Side	(2 x 7.00m) CW + (2x1.5m) PS+ + 2.5m Median (Include 2x0.5m Kerb shyness) + 1 x 1.0m Open Drain on Hill Side + 1 x 2.0m ES(Include CB & Drain) on Valley Side	100	Hilly Area
6	TCS-6	4-Lane divided highway with Breast Wall on Hill Side and Cut/Fill on Valley Side	(2 x 7.00m) CW + (2x1.5m) PS + 2.5m Median (Include 2x0.5m Kerb shyness) + 1 x 1.0m Open Drain on Hill Side with Breast Wall Protection + 1 x 2.0m ES (Include CB & Drain) on Valley Side	600	Open Area
7	TCS-7	4-Lane divided highway with Breast Wall on Hill Side and Retaining Wall on Valley Side	(2 x 7.00m) CW + (2x1.5m) PS+ 2.5m Median (Include 2x0.5m Kerb shyness) + 1 x 1.0m Open Drain on Hill Side with Breast Wall Protection + 1 x 2.0m ES(Include CB & Drain) on	230	Open Area

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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Sl. No.	Type of Cross Section		Description	Length (m)	Location/Remarks
			Valley Side with retaining wall		
8	TCS-8	4-Lane divided highway with Breast Wall on Hill Side and Reinforced Soil Wall on Valley Side	(2 x 7.00m) CW + (2x1.5m) PS+ 2.5m Median (Include 2x0.5m Kerb shyness) + 1 x 1.0m Open Drain on Hill Side with Breast Wall Protection + 1 x 2.0m ES(Include CB & drain) on Valley Side with Gabion Facia	350	Open Area
9	TCS-9	4-Lane Approaches of Grade separated structure with 7.5m wide Service Road and RCC Drain on both side with 2.5 m median	(2 x 7.00m) CW + (2x3.0 m) PS + 2.5m Median (Include 2x0.5m Kerb shyness) + (2 x 0.550m) RCC CB + (2 x 1.5m) Footpath + (2x7.5) m SR including (Include 2x0.25m Kerb shyness) + (2x1.5m) Footpath cum Drain	2155	
10	TCS-10	4-Lane Approaches of Grade separated structure with 7.5m wide Service Road and RCC Drain on both side with 5.0 m median	(2 x 7.00m) CW + (2x3.0 m) PS + 5.0m Median (Include 2x0.5m Kerb shyness) + (2 x 0.550m) RCC CB + (2 x 1.5m) Footpath + (2x7.5) m SR including (Include 2x0.25m Kerb shyness) + (2x1.5m) Footpath cum Drain	4390	
11	TCS-11	4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both sides along Existing Road with 5.0 m Median	(2 x 7.00m) CW + (2x3.0 m) PS + 5.0m Median (Include 2x0.5m Kerb shyness) + (x 0.550m) RCC CB + (2 x 1.5m) Footpath + (1x11.0) m SR including (Include 2x0.25m Kerb shyness) on LHS + (1x7.5)m SR including (Include 2x0.25m Kerb shyness) on RHS + (2x1.5m) Footpath cum Drain	500	
12	TCS-12	4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both sides along Existing Road with 2.5 m Median	(2 x 7.00m) CW + (2x3.0 m) PS + 2.5m Median (Include 2x0.5m Kerb shyness) + (x 0.550m) RCC CB + (2 x 1.5m) Footpath + (1x11.0)m SR including (Include 2x0.25m Kerb shyness) on LHS + (1x7.5)m SR including (Include 2x0.25m Kerb shyness) on RHS + (2x1.5m) Footpath cum Drain	1340	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Type of Cross Section		Description	Length (m)	Location/Remarks
13	TCS-13	4-Lane divided highway at VOP approaches	(2 x 7.00m) CW + (2x1.5 m) PS + 2.5m Median (Include 2x0.5m Kerb shyness) + (2 x 1.5m) Footpath cum Drain + (2 x 1.5m) Footpath + (2x7.5) m SR including (Include 2x0.25m Kerb shyness) + (1x1.0m) Drain on Cutting side + (1x2.0m) Drain on Valley Side	720	
14	TCS-14	4-Lane- Buried Culvert (Pipe and Slab) at road level	(2 x 7.00m) CW + (2x2.5m) PS + Median + 2x0.5m Kerb shyness + (2x1.5m) ES		Buried Culvert
15	TCS-15	4-Lane Slab & Box culvert at Road Level	(2 x 9.45m) CW + (2 x 1.50m) ES + (4x0.45m) RCC CB + Median + (4x0.1m)		GS/Box/Slab culvert
16	TCS-16	4-Lane Separated Bridge at Deck Level with Footpath	(2 x 10.5m) CW + (4x0.45m) RCC CB + Median + (2x1.5m) Footpath + (2x0.4m) Double Beam Barrier + (4x0.1m)		Bridge
17	TCS-17	4-Lane Separated Bridge at Deck Level with Footpath	(2 x 10.5m) CW + (4x0.45m) RCC CB + Median + (4x0.1m) on MCW (2 x 8.0m) CW + (4x0.45m) RCC CB + (2x1.5m) Footpath + (2x0.4m) Double Beam Barrier + (4x0.1m) on SR		Bridge with SR
18	TCS-18	4-Lane Separated Structure	(2 x 10.50m) CW + (4x0.45m) RCC CB + Median + (2x0.4m) Double Beam Barrier + (4x0.1m)		GS
Total Length				29360	

The above listed typical cross sections are depicted in TCS-1 and TCS-16 on subsequent pages.

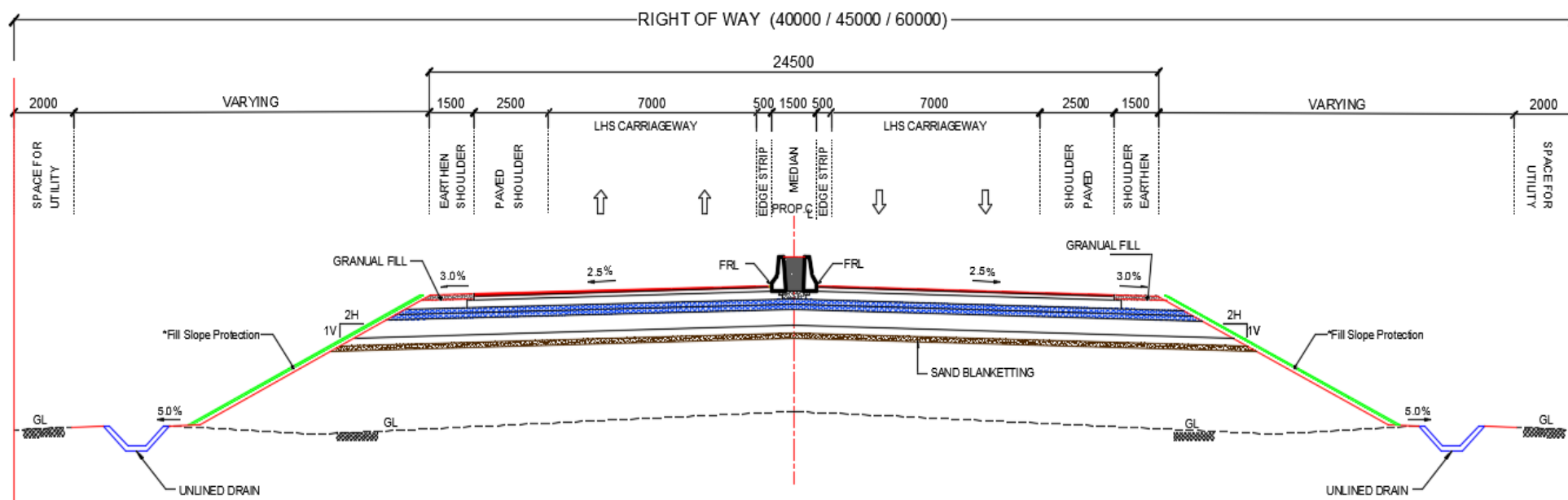


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).

Section : Silchar to Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)



*Note: Anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely woven polymer nettings and seeds broadcasting on the treated site. For details refer standard drawing

Fig 7.5 4-Lane Road with Paved and Earthen Shoulder with 2.5m raised median (TCS-1)

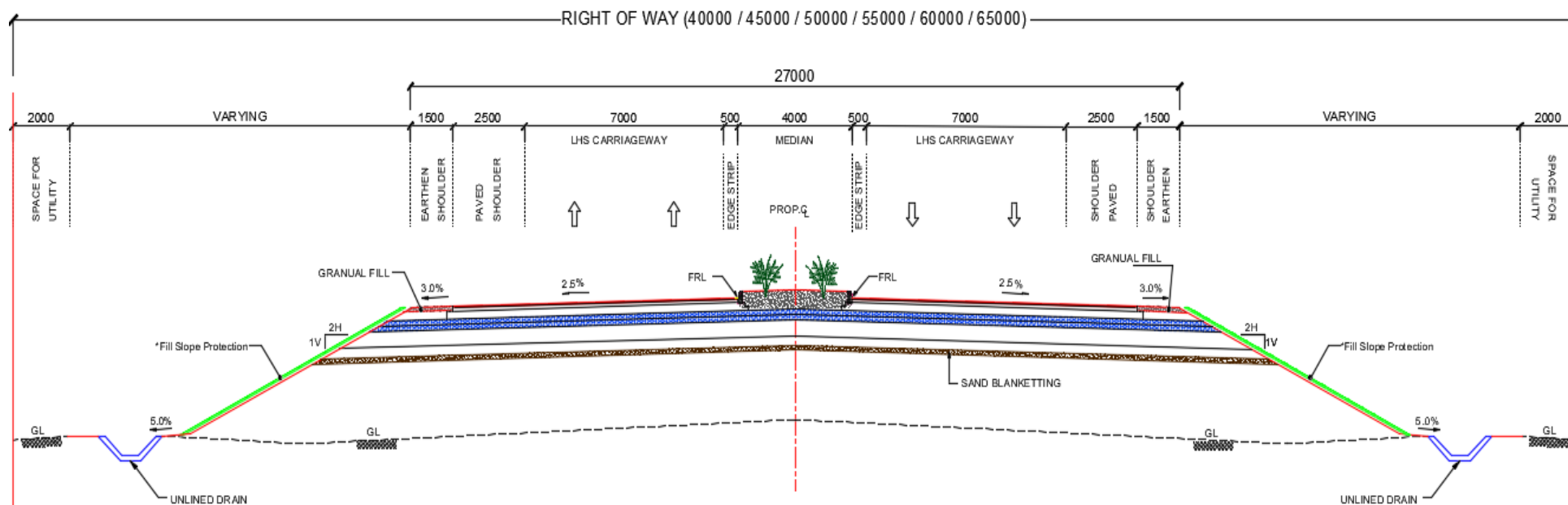


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).

Section : Silchar to Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)



*Note: Anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely woven polymer nettings and seeds broadcasting on the treated site. For details refer standard drawing

Fig 7.6 4-Lane Road with Paved and Earthen Shoulder in Rural Area with 5.0m raised median (TCS-2)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

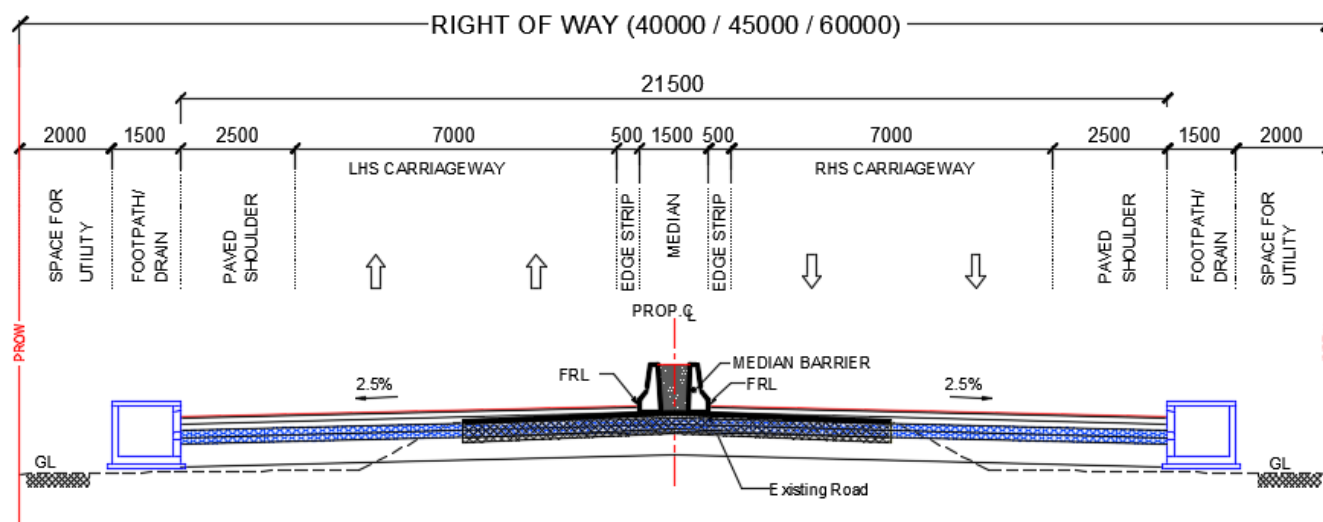


Fig 7.7 4-Lane with Paved Shoulder and RCC Drain on Both Side in Built-up Area along the Existing Road with 2.5m median (TCS-3)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

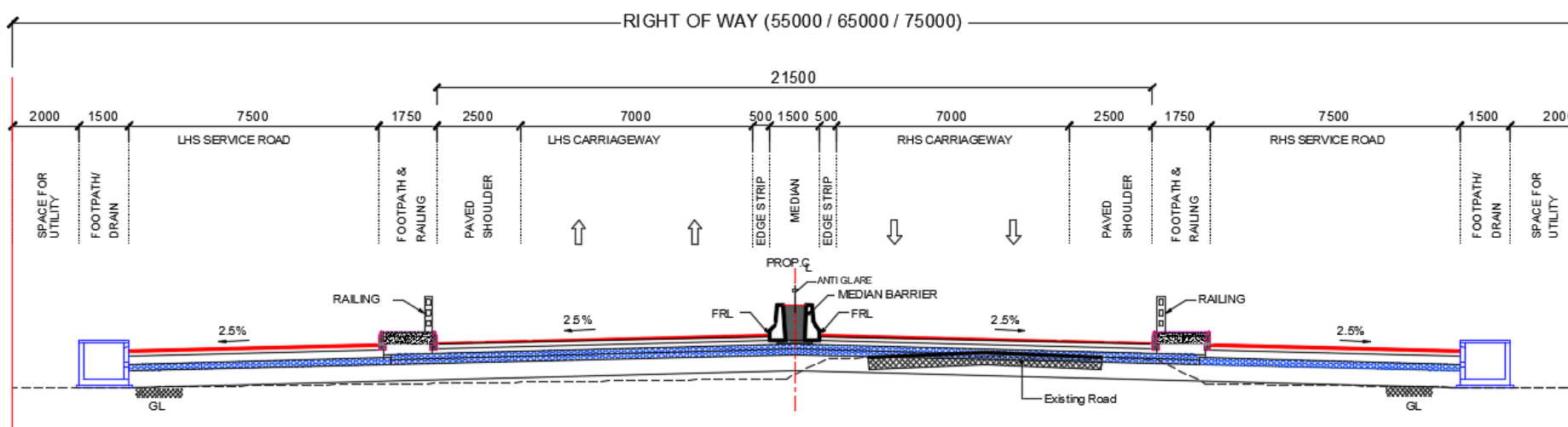


Fig 7.8 4-Lane with Paved Shoulder and 7.5m wide Service Road and RCC Drain on both side in Built-up Area along the Existing Road with 2.5m median (TCS-4)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

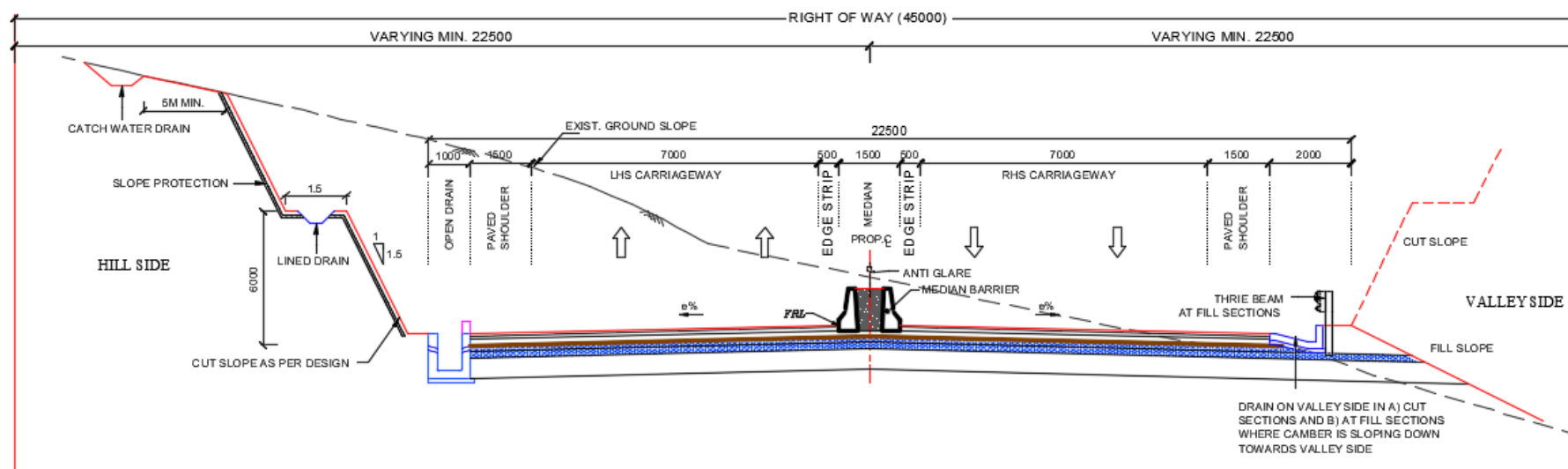


Fig 7.9 4-lane divided highway with Cut on Hill Side and Cut/Fill on Valley Side (TCS-5)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

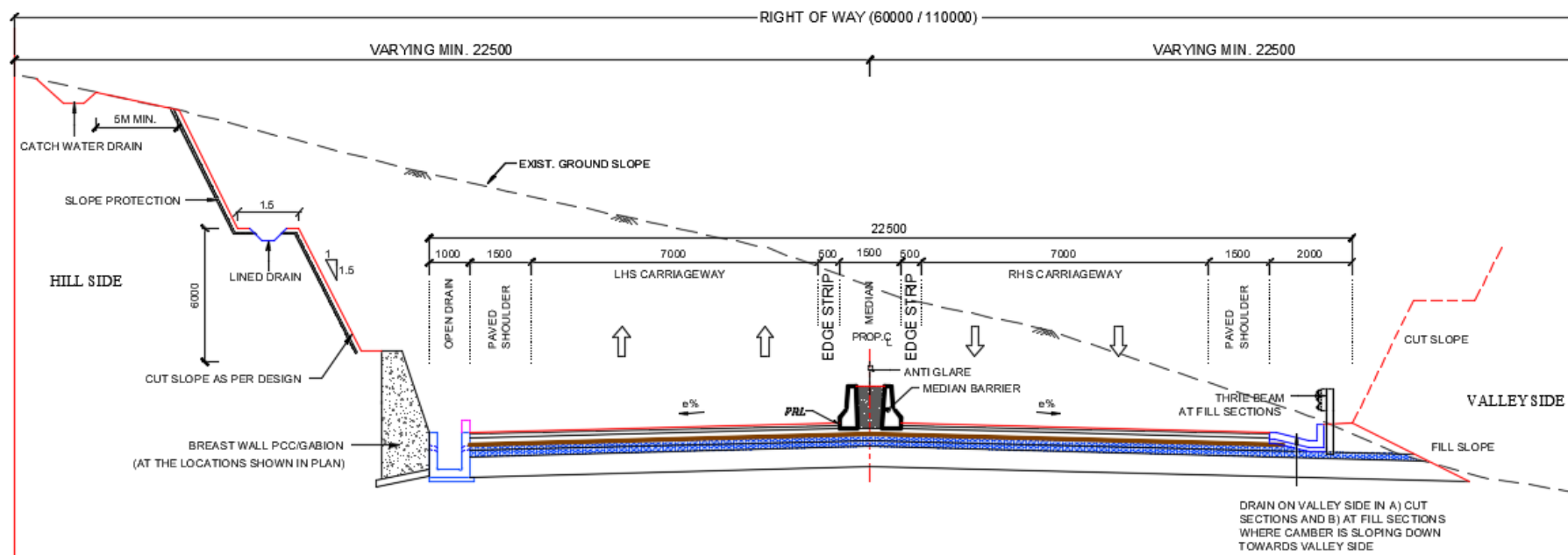


Fig 7.10 4-Lane divided highway with Breast Wall on Hill Side and Fill on Valley Side (TCS-6)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

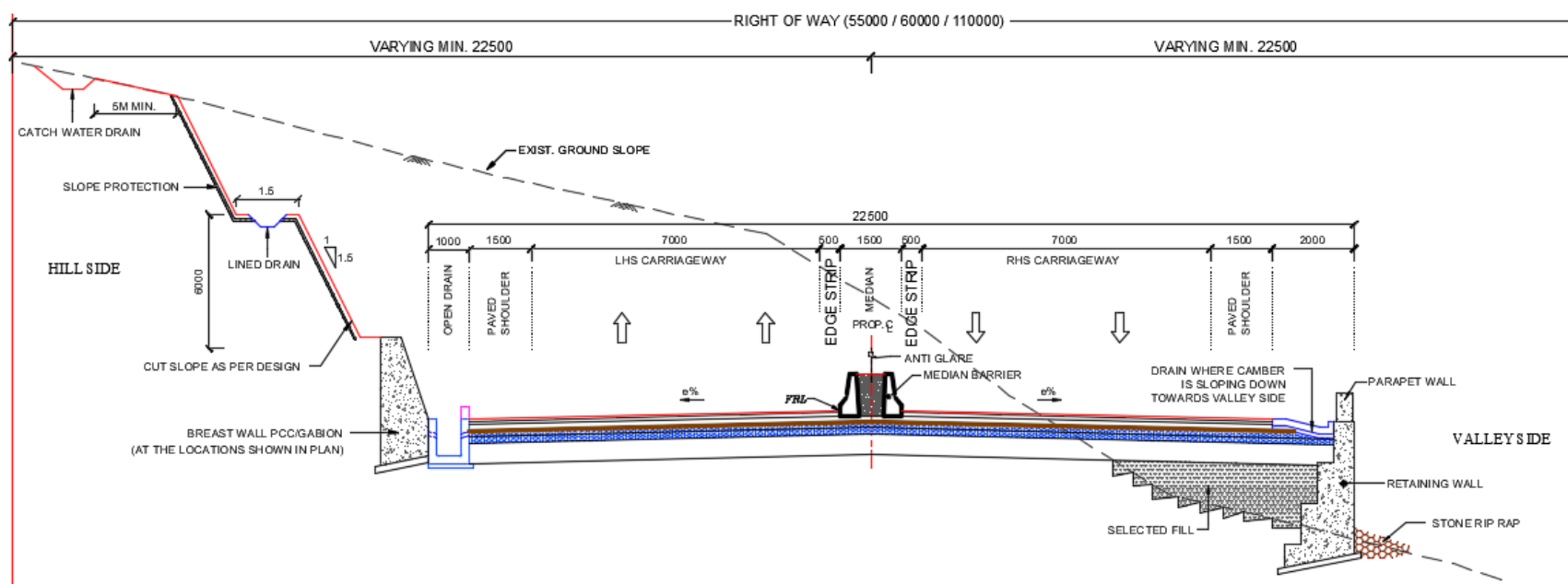


Fig 7.11 4-Lane divided highway with Breast Wall on Hill Side and Realignment wall on Valley Side (TCS-7)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

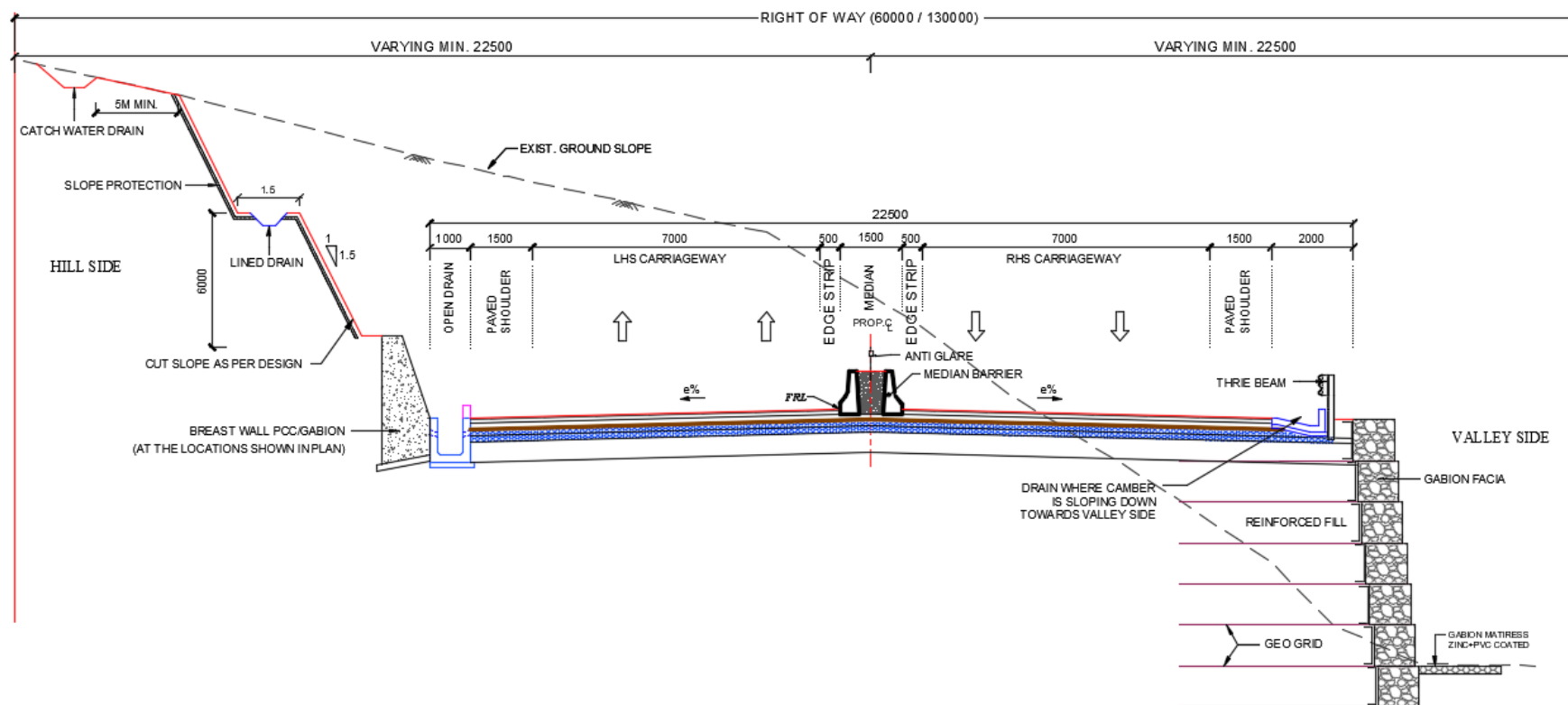


Fig 7.12 4-Lane divided highway with Breast Wall on Hill Side and Reinforcement Soil Wall on Valley Side (TCS-8)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

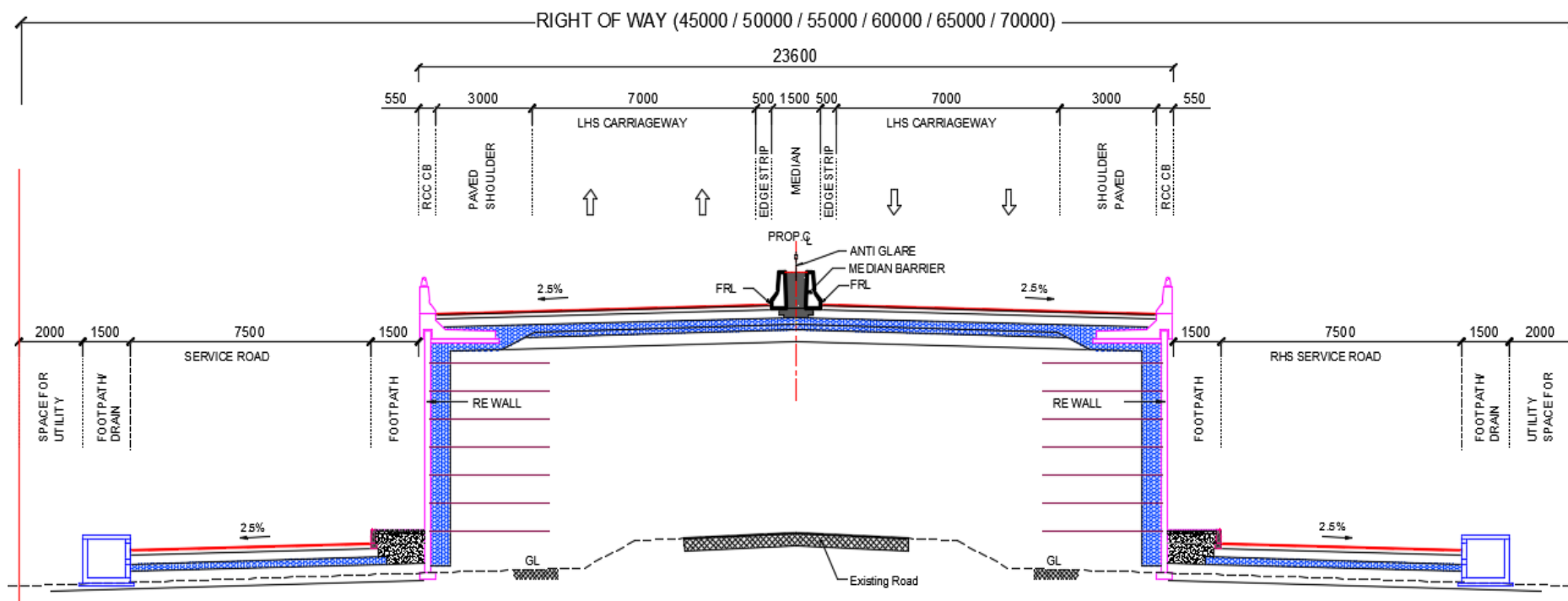


Fig 7.13 4-Lane Approaches of Grade separated structure with 7.5m wide Service Road and RCC Drain on both side with 2.5 m median (TCS-9)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

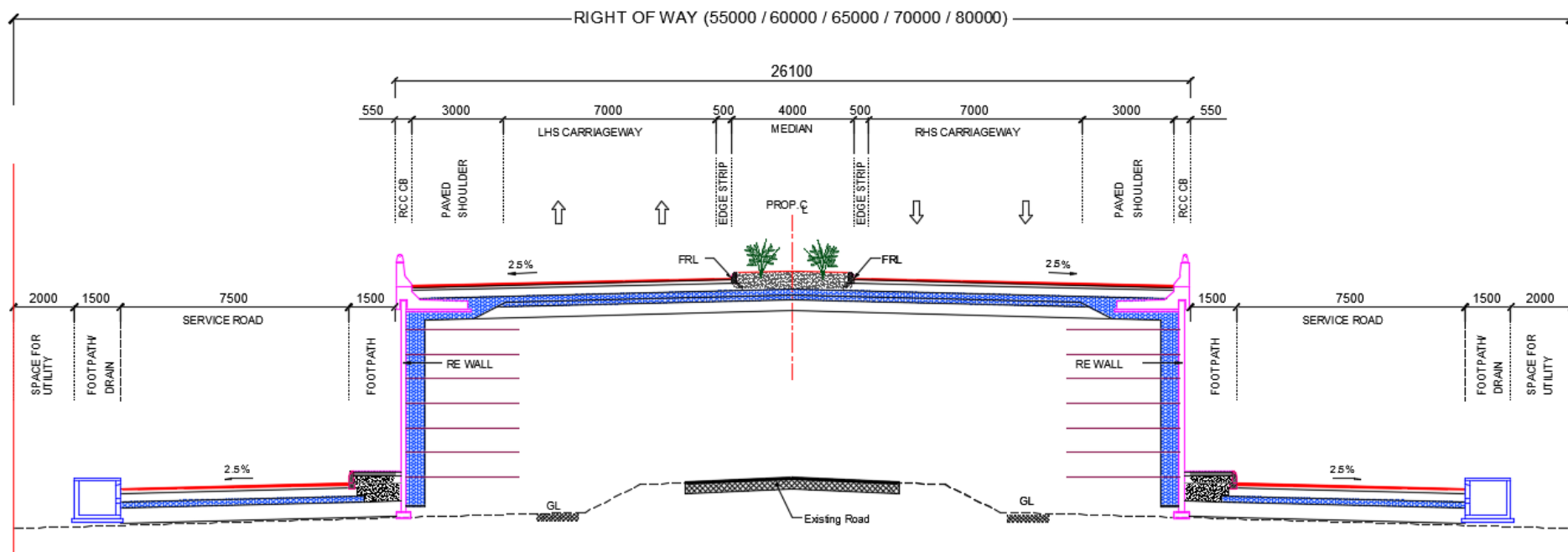


Fig 7.14 4-Lane Approaches of Grade separated structure with 7.5m wide Service Road and RCC Drain on both side with 5.0 m median (TCS-10)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

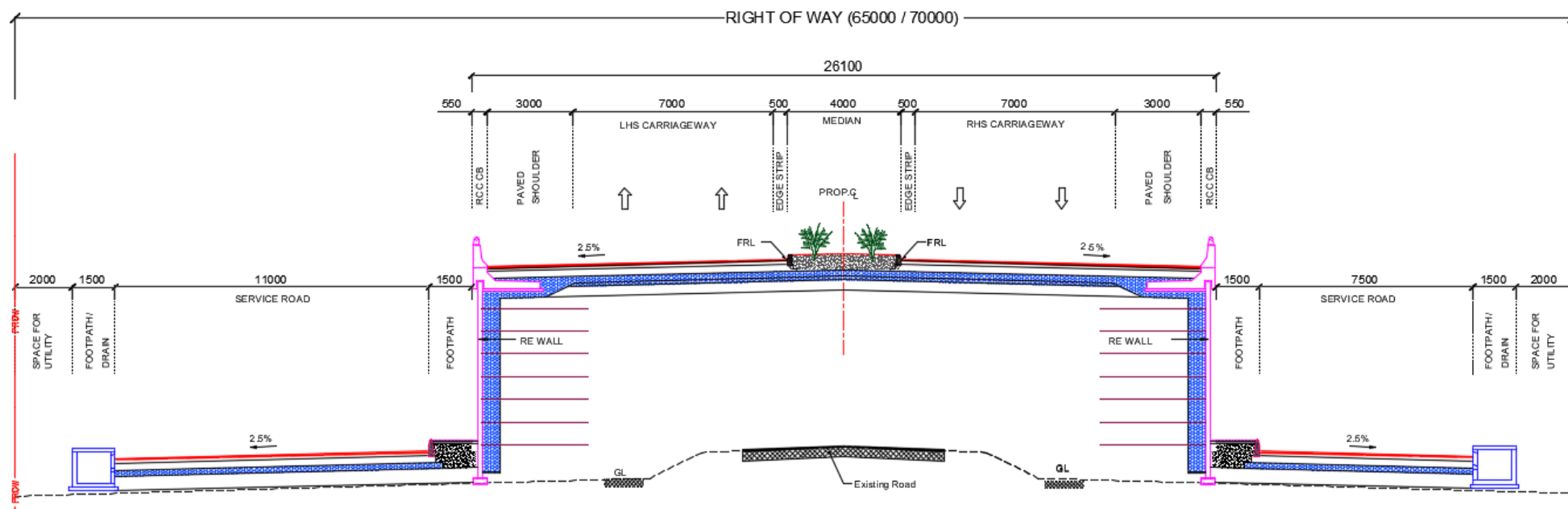


Fig 7.15 4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both side along Existing Road with 5.0 m Median (TCS-11)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

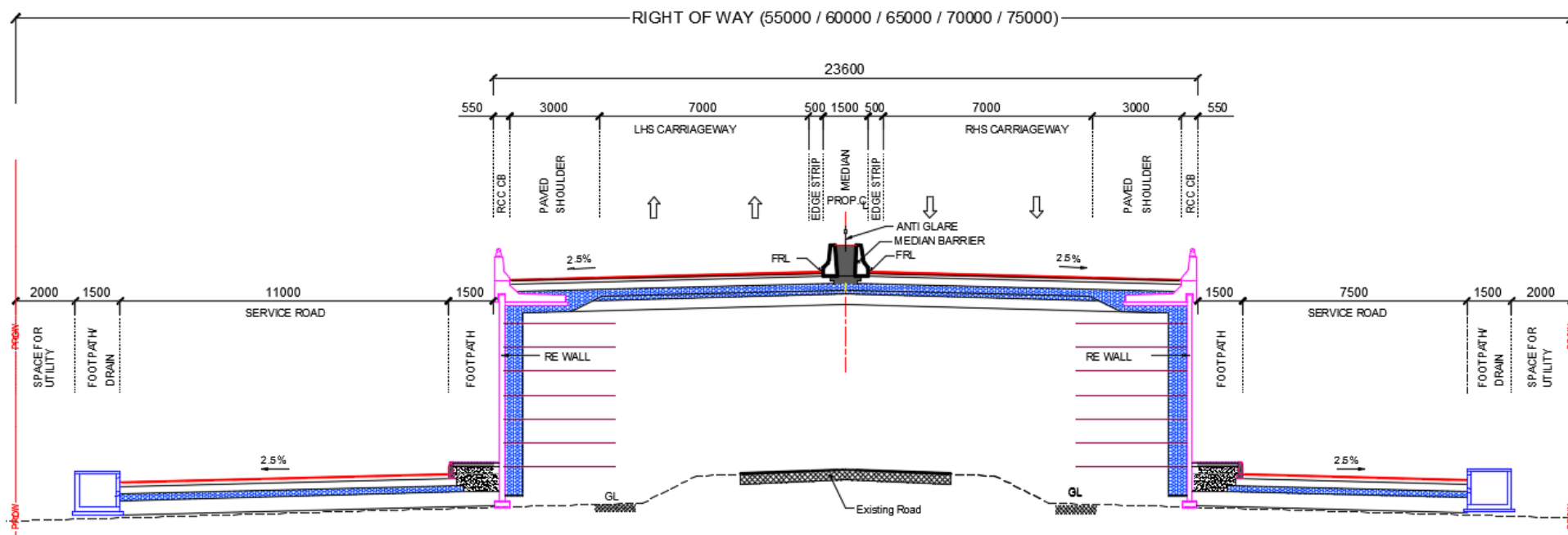


Fig 7.16 4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both side along Existing Road with 2.5 m Median (TCS-12)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

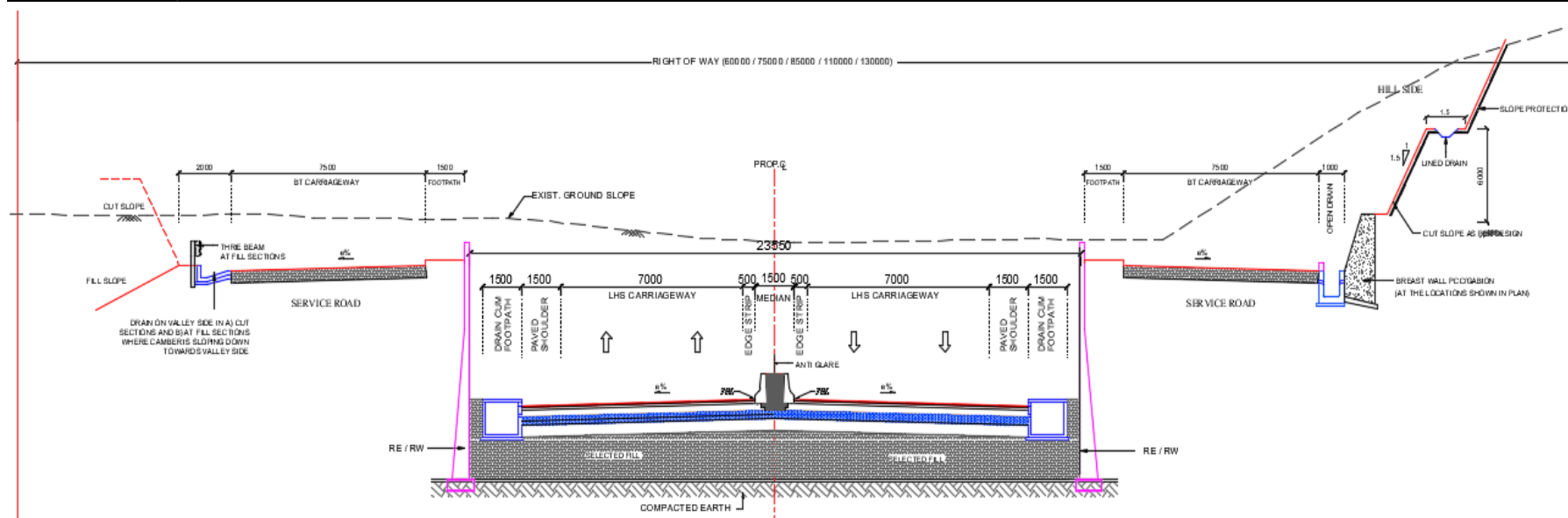


Fig 7.17 4-Lane divided highway at VOP approaches (TCS-13)

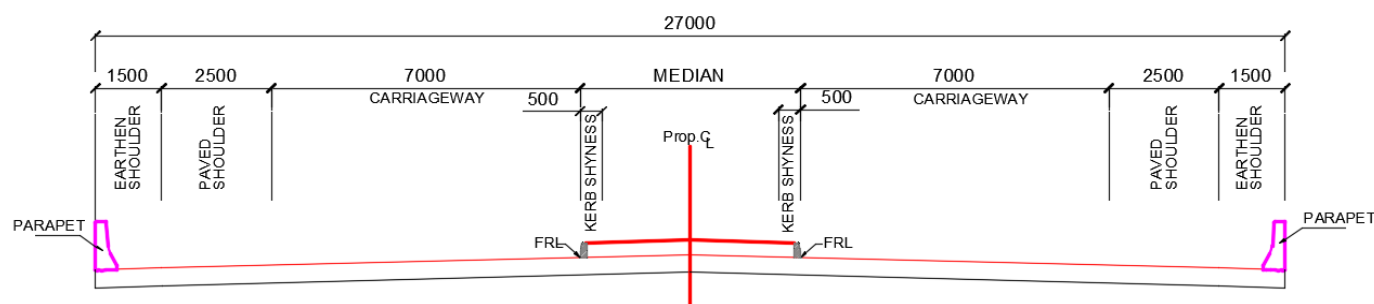


Fig 7.18 4-Lane Buried Culvert (Pipe/Slab/ Box) at Road Level (TCS-14)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

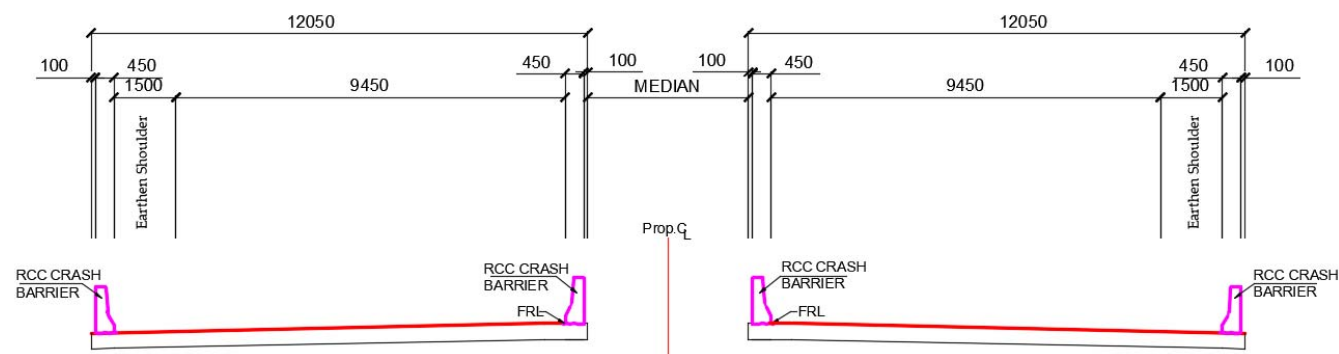


Fig 7.19 4-Lane Slab/ Box Culvert at Road Level (TCS-15)

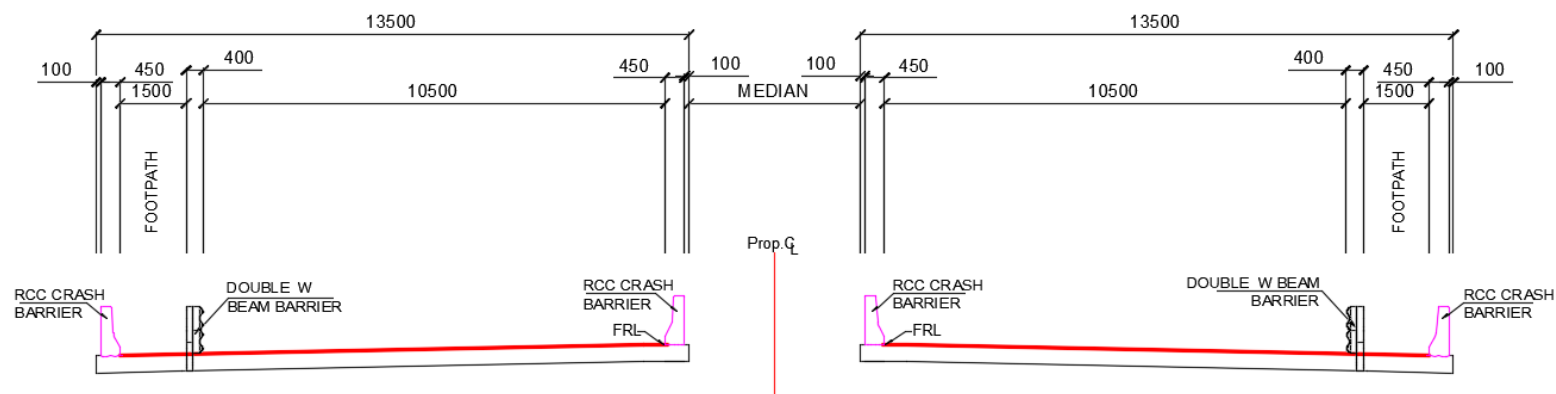


Fig 7.20 4-Lane Bridge at Deck Level without Footpath (TCS-16)



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 Vairengte (Package-2, mod. from Km 31+000 to Km 46+000)



Chapter 7: Improvement Proposals (Highways)

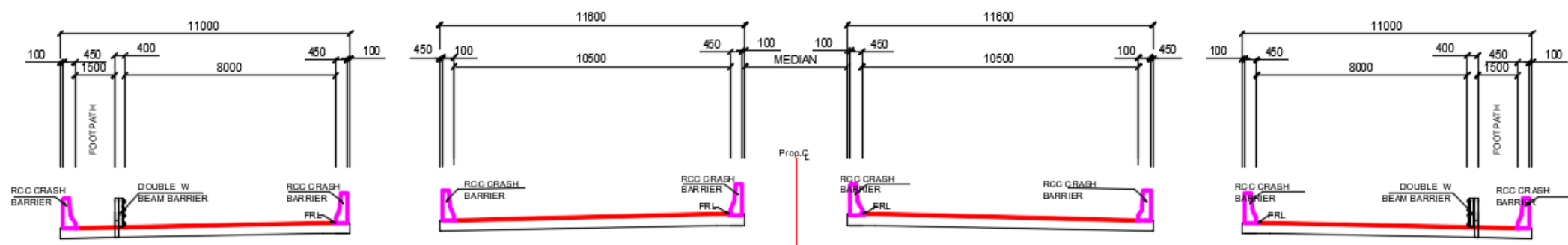


Fig 7.21 4-Lane Bridge at Deck Level with Service Road and Footpath (TCS-17)

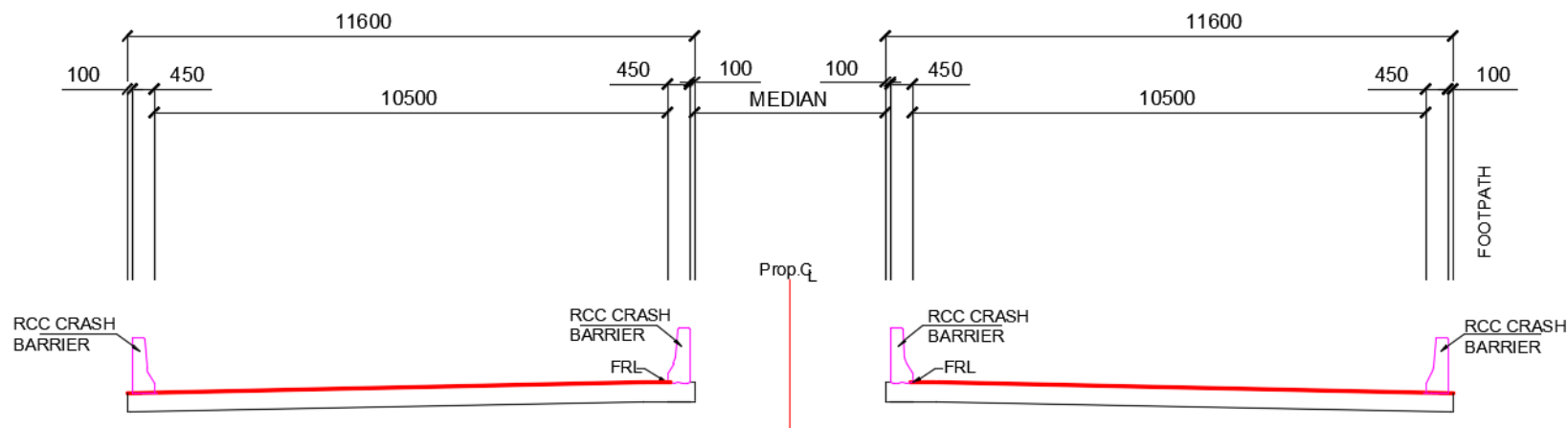


Fig 7.22 4-Lane Grade separated Structures at Deck level (TCS-18)



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

As mentioned earlier in this report, 100.0% length of road follows the Green field Alignment. Schedule of cross-sections are given below:

Table 7.13 Schedule of Typical Cross Sections

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
1	20+000	20+180	180	10	Follow Existing	TCS 3	45	
2	20+180	20+300	120	10	Follow Existing	TCS 3	40	
3	20+300	21+220	920	10	Follow Existing	TCS 1	40	
4	21+220	21+360	140	10	Follow Existing	TCS 1	45	
5	21+360	21+420	60	10	Follow Existing	TCS 1	60	
6	21+420	21+830	410	-	New Alignment	TCS 10	60	Nutan Bazar Bypass
7	21+830	21+980	150	-	New Alignment	TCS 10	70	Nutan Bazar Bypass
8	21+980	22+375	395	-	New Alignment	TCS 10	60	Nutan Bazar Bypass
9	22+375	22+450	75	-	New Alignment	TCS 2	60	Nutan Bazar Bypass
10	22+450	22+790	340	-	New Alignment	TCS 2	50	Nutan Bazar Bypass
11	22+790	23+190	400	-	New Alignment	TCS 2	55	Nutan Bazar Bypass
12	23+190	24+070	880	-	New Alignment	TCS 2	45	Nutan Bazar Bypass
13	24+070	24+140	70	-	New Alignment	TCS 2	55	Nutan Bazar Bypass



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
14	24+140	24+540	400	-	New Alignment	TCS 2	60	Nutan Bazar Bypass
15	24+540	26+000	1460	-	New Alignment	TCS 2	45	Nutan Bazar Bypass
16	26+000	26+110	110	-	New Alignment	TCS 2	55	Nutan Bazar Bypass
17	26+110	26+160	50	-	New Alignment	TCS 2	65	Nutan Bazar Bypass
18	26+160	26+570	410	10	Follow Existing	TCS 11	65	
19	26+570	26+660	90	10	Follow Existing	TCS 11	70	
20	26+660	26+670	10	-	New Alignment	TCS 10	70	Nutan Bazar Bypass
21	26+670	26+760	90	-	New Alignment	TCS 10	65	Nutan Bazar Bypass
22	26+760	26+800	40	-	New Alignment	TCS 10	70	Nutan Bazar Bypass
23	26+800	26+920	120	-	New Alignment	TCS 10	80	Nutan Bazar Bypass
24	26+920	27+010	90	-	New Alignment	TCS 10	70	Nutan Bazar Bypass
25	27+010	27+140	130	-	New Alignment	TCS 10	60	Nutan Bazar Bypass
26	27+140	27+210	70	10	Follow Existing	TCS 2	60	
27	27+210	27+340	130	10	Follow Existing	TCS 2	50	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
28	27+340	27+430	90	10	Follow Existing	TCS 2	45	
29	27+430	29+630	2200	10	Follow Existing	TCS 2	40	
30	29+630	29+750	120	10	Follow Existing	TCS 2	45	
31	29+750	30+750	1000	10	Follow Existing	TCS 2	40	
32	30+750	30+910	160	10	Follow Existing	TCS 2	45	
33	30+910	30+970	60	10	Follow Existing	TCS 2	60	
34	30+970	31+270	300	-	New Alignment	TCS 10	60	Katakhal Bypass
35	31+270	31+350	80	-	New Alignment	TCS 10	65	Katakhal Bypass
36	31+350	31+460	110	-	New Alignment	TCS 10	70	Katakhal Bypass
37	31+460	31+510	50	-	New Alignment	TCS 10	65	Katakhal Bypass
38	31+510	31+830	320	-	New Alignment	TCS 10	70	Katakhal Bypass
39	31+830	31+880	50	-	New Alignment	TCS 10	65	Katakhal Bypass
40	31+880	31+930	50	-	New Alignment	TCS 10	60	Katakhal Bypass
41	31+930	32+060	130	-	New Alignment	TCS 10	55	Katakhal Bypass
42	32+060	32+110	50	-	New Alignment	TCS 2	55	Katakhal Bypass
43	32+110	32+280	170	-	New Alignment	TCS 2	50	Katakhal Bypass
44	32+280	33+240	960	-	New Alignment	TCS 2	45	Katakhal Bypass
45	33+240	33+300	60	-	New Alignment	TCS 2	60	Katakhal Bypass



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
46	33+300	33+680	380	10	Follow Existing	TCS 12	60	
47	33+680	33+780	100	10	Follow Existing	TCS 12	55	
48	33+780	33+860	80	10	Follow Existing	TCS 12	70	
49	33+860	33+940	80	10	Follow Existing	TCS 9	70	
50	33+940	34+295	355	10	Follow Existing	TCS 9	60	
51	34+295	34+340	45	10	Follow Existing	TCS 3	60	
52	34+340	34+490	150	10	Follow Existing	TCS 3	45	
53	34+490	34+900	410	10	Follow Existing	TCS 3	40	
54	34+900	34+990	90	10	Follow Existing	TCS 1	40	
55	34+990	35+230	240	10	Follow Existing	TCS 1	45	
56	35+230	35+305	75	10	Follow Existing	TCS 1	60	
57	35+305	35+360	55	-	New Alignment	TCS 10	60	Dholai Bypass
58	35+360	35+600	240	-	New Alignment	TCS 10	65	Dholai Bypass
59	35+600	36+190	590	-	New Alignment	TCS 10	55	Dholai Bypass
60	36+190	36+090	-100	-	New Alignment	TCS 2	65	Dholai Bypass
61	36+090	36+230	140	-	New Alignment	TCS 2	60	Dholai Bypass
62	36+230	36+540	310	-	New Alignment	TCS 2	55	Dholai Bypass
63	36+540	36+630	90	-	New Alignment	TCS 2	50	Dholai Bypass
64	36+630	37+610	980	-	New Alignment	TCS 2	45	Dholai Bypass



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
65	37+610	37+750	140	-	New Alignment	TCS 2	40	Dholai Bypass
66	37+750	37+930	180	-	New Alignment	TCS 2	55	Dholai Bypass
67	37+930	37+985	55	-	New Alignment	TCS 2	60	Dholai Bypass
68	37+985	38+160	175	10	Follow Existing	TCS 10	60	
69	38+160	38+350	190	10	Follow Existing	TCS 10	55	
70	38+350	38+530	180	10	Follow Existing	TCS 10	65	
71	38+530	38+965	435	10	Follow Existing	TCS 10	60	
72	38+965	39+010	45	-	New Alignment	TCS 2	60	Baga Bazar Bypass
73	39+010	39+150	140	-	New Alignment	TCS 2	55	Baga Bazar Bypass
74	39+150	39+380	230	-	New Alignment	TCS 2	45	Baga Bazar Bypass
75	39+380	39+530	150	-	New Alignment	TCS 2	50	Baga Bazar Bypass
76	39+530	39+600	70	-	New Alignment	TCS 2	60	Baga Bazar Bypass
77	39+600	40+040	440	10	Follow Existing	TCS 12	60	
78	40+040	40+100	60	10	Follow Existing	TCS 12	70	
79	40+100	40+180	80	10	Follow Existing	TCS 12	75	
80	40+180	40+240	60	10	Follow Existing	TCS 12	65	
81	40+240	40+330	90	10	Follow Existing	TCS 12	60	
82	40+330	40+380	50	10	Follow Existing	TCS 12	65	
83	40+380	40+460	80	-	New Alignment	TCS 9	65	Baga Bazar Bypass



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
84	40+460	40+910	450	-	New Alignment	TCS 9	55	Baga Bazar Bypass
85	40+910	41+060	150	-	New Alignment	TCS 2	55	Baga Bazar Bypass
86	41+060	41+120	60	-	New Alignment	TCS 2	50	Baga Bazar Bypass
87	41+120	41+510	390	-	New Alignment	TCS 2	45	Baga Bazar Bypass
88	41+510	41+940	430	-	New Alignment	TCS 2	55	Baga Bazar Bypass
89	41+940	43+230	1290	-	New Alignment	TCS 2	45	Baga Bazar Bypass
90	43+230	43+490	260	-	New Alignment	TCS 2	50	Baga Bazar Bypass
91	43+490	43+830	340	-	New Alignment	TCS 2	45	Baga Bazar Bypass
92	43+830	44+250	420	-	New Alignment	TCS 2	55	Baga Bazar Bypass
93	44+250	44+350	100	-	New Alignment	TCS 2	45	Baga Bazar Bypass
94	44+350	44+480	130	-	New Alignment	TCS 2	50	Baga Bazar Bypass
95	44+480	44+530	50	-	New Alignment	TCS 2	60	Baga Bazar Bypass
96	44+530	44+900	370	-	New Alignment	TCS 9	60	Baga Bazar Bypass
97	44+900	45+020	120	-	New Alignment	TCS 9	70	Baga Bazar Bypass
98	45+020	45+430	410	-	New Alignment	TCS 9	55	Baga Bazar Bypass
99	45+430	45+640	210	10	Follow Existing	TCS 4	55	
100	45+640	45+770	130	10	Follow Existing	TCS 4	65	
101	45+770	45+850	80	10	Follow Existing	TCS 4	75	
102	45+850	45+970	120	10	Follow Existing	TCS 4	65	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
103	45+970	47+070	1100	10	Follow Existing	TCS 4	55	
104	47+070	47+180	110	-	New Alignment	TCS 9	55	Realignment
105	47+180	47+350	170	-	New Alignment	TCS 9	50	Realignment
106	47+350	47+360	10	-	New Alignment	TCS 9	45	Realignment
107	47+360	47+460	100	-	New Alignment	TCS 5	45	Realignment
108	47+460	47+540	80	-	New Alignment	TCS 7	60	Realignment
109	47+540	47+620	80	-	New Alignment	TCS 7	55	Realignment
110	47+620	47+780	160	-	New Alignment	TCS 6	110	Realignment
111	47+780	47+850	70	-	New Alignment	TCS 7	110	Realignment
112	47+850	47+970	120	-	New Alignment	TCS 6	110	Realignment
113	47+970	48+310	340	-	New Alignment	TCS 8	130	Realignment
114	48+310	48+320	10	-	New Alignment	TCS 8	60	Realignment
115	48+320	48+580	260	-	New Alignment	TCS 13	60	Realignment
116	48+580	48+700	120	-	New Alignment	TCS 13	110	Realignment
117	48+700	48+820	120	-	New Alignment	TCS 13	130	Realignment
118	48+820	49+010	190	-	New Alignment	TCS 13	85	Realignment
119	49+010	49+040	30	-	New Alignment	TCS 13	75	Realignment
120	49+040	49+130	90	-	New Alignment	TCS 6	75	Realignment
121	49+130	49+360	230	-	New Alignment	TCS 6	60	Realignment
	Total Length		29360					



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



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 7.14 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	20+000	20+180	180	20	22.5	22.5	45
2	20+180	20+720	540	20	20	20	40
3	20+720	21+220	500		20	20	40
4	21+220	21+360	140		22.5	22.5	45
5	21+360	21+830	470		30	30	60
6	21+830	21+980	150		35	35	70
7	21+980	22+450	470		30	30	60
8	22+450	22+790	340		25	25	50
9	22+790	23+190	400		25	30	55
10	23+190	24+070	880		22.5	22.5	45
11	24+070	24+140	70		25	30	55
12	24+140	24+540	400		30	30	60
13	24+540	26+000	1460		22.5	22.5	45
14	26+000	26+100	100		32.5	22.5	55
15	26+100	26+110	10	20	32.5	22.5	55
16	26+110	26+170	60	20	35	30	65
17	26+170	26+570	400	20	33	32	65
18	26+570	26+670	100		35	35	70
19	26+670	26+760	90		32.5	32.5	65
20	26+760	26+800	40		40	30	70



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Design Chainage (m)		Length (m)	Ex. ROW (m)	Proposed ROW (m)	Additional ROW (m)	Area of additional land to be acquired (Sq.m)
	From	To					
21	26+800	26+920	120		40	40	80
22	26+920	27+010	90		30	40	70
23	27+010	27+210	200		30	30	60
24	27+210	27+340	130		25	25	50
25	27+340	27+430	90		22.5	22.5	45
26	27+430	28+540	1110		20	20	40
27	28+540	29+630	1090	20	20	20	40
28	29+630	29+750	120	20	22.5	22.5	45
29	29+750	29+860	110	20	20	20	40
30	29+860	30+030	170	20	22.5	17.5	40
31	30+030	30+160	130	20	20	20	40
32	30+160	30+750	590		20	20	40
33	30+750	30+910	160		22.5	22.5	45
34	30+910	31+270	360		30	30	60
35	31+270	31+350	80		35	30	65
36	31+350	31+460	110		40	30	70
37	31+460	31+510	50		35	30	65
38	31+510	31+660	150		35	35	70
39	31+660	31+830	170		32.5	37.5	70
40	31+830	31+880	50		27.5	37.5	65
41	31+880	31+930	50		27.5	32.5	60
42	31+930	32+110	180		27.5	27.5	55
43	32+110	32+280	170		25	25	50
44	32+280	33+240	960		22.5	22.5	45
45	33+240	33+250	10		35	25	60
46	33+250	33+340	90	20	35	25	60



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Design Chainage (m)		Length (m)	Ex. ROW (m)	Proposed ROW (m)	Additional ROW (m)	Area of additional land to be acquired (Sq.m)
	From	To					
47	33+340	33+500	160	20	32.5	27.5	60
48	33+500	33+680	180	20	30	30	60
49	33+680	33+780	100	20	30	25	55
50	33+780	33+940	160	20	35	35	70
51	33+940	34+340	400	20	30	30	60
52	34+340	34+490	150	20	22.5	22.5	45
53	34+490	34+990	500	20	20	20	40
54	34+990	35+230	240	20	22.5	22.5	45
55	35+230	35+360	130	20	30	30	60
56	35+360	35+600	240	20	35	30	65
57	35+600	35+680	80	20	25	30	55
58	35+680	35+730	50		25	30	55
59	35+730	35+890	160		25	40	65
60	35+890	36+090	200		27.5	37.5	65
61	36+090	36+230	140		27.5	32.5	60
62	36+230	36+540	310		27.5	27.5	55
63	36+540	36+630	90		25	25	50
64	36+630	37+610	980		22.5	22.5	45
65	37+610	37+750	140	20	22.5	17.5	40
66	37+750	37+930	180	20	27.5	27.5	55
67	37+930	38+160	230	20	27.5	32.5	60
68	38+160	38+160	0	20	27.5	32.5	60
69	38+160	38+350	190	20	27.5	27.5	55
70	38+350	38+360	10	20	27.5	37.5	65
71	38+360	38+530	170		27.5	37.5	65
72	38+530	39+010	480		30	30	60



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



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					
73	39+010	39+150	140		27.5	27.5	55
74	39+150	39+380	230		22.5	22.5	45
75	39+380	39+530	150		25	25	50
76	39+530	39+770	240	20	32.5	27.5	60
77	39+770	40+040	270	20	30	30	60
78	40+040	40+100	60	20	35	35	70
79	40+100	40+180	80	20	40	35	75
80	40+180	40+240	60	20	35	30	65
81	40+240	40+300	60	20	30	30	60
82	40+300	40+330	30		30	30	60
83	40+330	40+460	130		30	35	65
84	40+460	41+060	600		27.5	27.5	55
85	41+060	41+120	60		22.5	27.5	50
86	41+120	41+510	390		22.5	22.5	45
87	41+510	41+940	430		27.5	27.5	55
88	41+940	43+230	1290		22.5	22.5	45
89	43+230	43+490	260		25	25	50
90	43+490	43+830	340		22.5	22.5	45
91	43+830	44+250	420		27.5	27.5	55
92	44+250	44+350	100		22.5	22.5	45
93	44+350	44+480	130		25	25	50
94	44+480	44+900	420		30	30	60
95	44+900	45+020	120		32.5	37.5	70
96	45+020	45+100	80		27.5	27.5	55
97	45+100	45+640	540	20	27.5	27.5	55
98	45+640	45+770	130	20	27.5	37.5	65



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

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					
99	45+770	45+850	80	20	37.5	37.5	75
100	45+850	45+970	120	20	37.5	27.5	65
101	45+970	47+160	1190	20	27.5	27.5	55
102	47+160	47+180	20		27.5	27.5	55
103	47+180	47+350	170		35	15	50
104	47+350	47+460	110		22.5	22.5	45
105	47+460	47+540	80		32.5	27.5	60
106	47+540	47+620	80		32.5	22.5	55
107	47+620	47+970	350		22.5	22.5	110
108	47+970	48+310	340		37.5	22.5	130
109	48+310	48+580	270		30	30	60
110	48+580	48+700	120	12	80	30	110
111	48+700	48+820	120	12	80	50	130
112	48+820	49+010	190		45	40	85
113	49+010	49+130	120		45	30	75
114	49+130	49+360	230		30	30	60
115	at minor junction	21+455		199.188	793.687	594.500	594.500
116	at minor junction	21+615		184.453	798.805	614.352	614.352
117	at major junction	21+900		999.740	7711.594	6711.854	6711.854
118	at minor junction	26+000		1157.053	2248.089	1091.036	1091.036
119	at minor junction	26+200		260.775	1654.580	1393.805	1393.805
120	at minor junction	26+350		228.402	1062.630	834.228	834.228
121	at major junction	26+680		1926.847	4620.388	2693.541	2693.541
122	at minor junction	28+450		2797.222	5058.814	2261.592	2261.592
123	at minor junction	30+310		1743.679	3320.356	1576.677	1576.677
124	at minor junction	31+040		302.918	1380.045	1077.127	1077.127



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

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					
125	at major junction	31+600		3914.703	26524.990	22610.287	22610.287
126	at minor junction	31+955		81.970	852.036	770.066	770.066
127	at minor junction	33+140		1174.843	2674.532	1499.689	1499.689
128	at major junction	33+860		673.703	6159.329	5485.626	5485.626
129	at minor junction	35+620		166.867	466.620	299.753	299.753
130	at major junction	35+810		1157.766	5978.497	4820.731	4820.731
131	at minor junction	37+530		1127.454	3298.027	2170.574	2170.574
132	at minor junction	37+620		137.418	396.775	259.357	259.357
133	at major junction	38+450		1634.688	6426.692	4792.004	4792.004
134	at minor junction	39+450		2335.526	3973.877	1638.351	1638.351
135	at major junction	40+400		1389.379	4531.859	3142.480	3142.480
136	at major junction	44+960		727.854	3405.763	2677.909	2677.909
137	at minor junction	45+355		162.042	911.396	749.355	749.355
138	at minor junction	46+768		370.088	2306.836	1936.748	1936.748
139	at minor junction	47+355		388.928	2632.336	2243.408	2243.408
140	at major junction	48+820		865.570	5389.798	4524.229	4524.229
Total 1493339.3 Sqm							
369.012 Acres							
149.334 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 an 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, and designed entry/exits.etc. In depth discussion of these facilities along with their locations has been given in structural part of this chapter.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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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 is no proposal of major junction and provision 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 affected due to the proposed improvements needs to be re-established.

The Major Junction facilities are classified and tabulated in following Table.

Table 7.15 List of Major Road Junctions

Sl. No.	Location			At Grade / Grade Separator	Side	Type of Road (SH/MDR/ODR/VR)	Types of C/W	Remarks
	Design Chainage	Ex. Chainage	Name of junction					
1	21+900	14+800	Nutan Bazar	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	Refer Plan metric drawing for ready reference.
2	26+000	18+100	Nutan Bazar	Y (Free Left)	LHS	NH-306 (Exist. Road)	2 Lane BT	
3	26+680	18+720	Kabuganj	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	
4	28+450	21+060	Kabuganj	Y (Free Left)	LHS	NH-306 (Exist. Road)	2 Lane BT	
5	30+310	22+920	Narsingpur	Y (Free Left)	RHS	NH-306 (Exist. Road)	2 Lane BT	





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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

Sl. No.	Location			At Grade / Grade Separator	Side	Type of Road (SH/MDR/ODR/VR)	Types of C/W	Remarks
	Design Chainage	Ex. Chainage	Name of junction					
6	31+610	24+990	Narsingpur - Bor Jalenga	4 Legged (Below Underpass)	BHS	NH-306 (Exist. Road)	2 Lane BT	Refer Plan metric drawing for ready reference.
7	33+140	25+700	Narsingpur	Y (Free Left)	LHS	NH-306 (Exist. Road)	2 Lane BT	
8	33+860	26+410	Ramprasadpur	T (Below Underpass)	LHS	VR	1 Lane BT	
9	35+810	28+400	Dholai Bazar	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	
10	37+530	30+040	Dholai Bazar	Y (Free Left)	LHS	NH-306 (Exist. Road)	2 Lane BT	
11	38+450	31+000	Bagha Bazar	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	
12	39+450	32+210	Bagha Bazar	Y (Free Left)	LHS	NH-306 (Exist. Road)	2 Lane BT	
13	40+400	33+170	Bagha Bazar	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	
14	44+960	37+900	Bagha Bazar	T (Below Underpass)	LHS	NH-306 (Exist. Road)	2 Lane BT	
15	48+820	42+000	Lailapur - Vairengte	4 Legged (Below Underpass)	BHS	NH-306 (Exist. Road)	2 Lane BT	

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These Minor Junction facilities are classified and tabulated in following Table.

Table 7.16 List of Minor Road Junctions

Sl. No.	Design Chainage	Existing Chainage	Type of Road (BT, CC, Gr.)	Type of Junctions (T, Y, +)	Side	Remarks
1	21+455	14+375	1-Lane BT	T	RHS	Refer Plan metric drawing for ready reference
2	21+615	14+535	1-Lane BT	T	LHS	
3	26+200	18+300	1-Lane BT	T	RHS	
4	26+350	18+470	1-Lane BT	T	LHS	
5	31+040	Bypass	1-Lane BT	+	LHS	
6	31+955	Bypass	1-Lane BT	T	RHS	
7	35+620	28+180	Intermediate Lane-BT	T	LHS	
8	37+620	30+135	Intermediate Lane-BT	T	RHS	
9	45+355	38+260	1-Lane ER	T	RHS	
10	46+768	39+720	2 Lane BT	+	BHS	
11	47+355	40+350	2 Lane BT	+	BHS	

7.9 Railway crossings/ROB/RUB

The project road does not cross any Railway line or ROB or RUB.

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. All other junctions are improved as at-grade junctions.

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	Name	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
1	21+900	VUP	2 Lane BT	LHS-Nutan Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6





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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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Sl. No	Type / Location of Structure	Name	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
2	22+950	LVUP	2 Lane BT	LHS-Nutan Bazar RHS-Clever House	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
3	24+325	LVUP	2 Lane BT	LHS-Nutan Bazar RHS-Clever House	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
4	26+610	VUP	2 Lane BT	LHS-Kabuganj	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
5	31+610	VUP	2 Lane BT	LHS-Narsingour RHS-Bor Jalenga	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
6	33+860	VUP	2 Lane BT	LHS-Ramprasadpur RHS-Paloipunji	Village Road	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
7	35+810	VUP	2 Lane BT	LHS-Dholai Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
8	36+513	LVUP	Intermediate Lane BT	LHS-Dholai Bazar RHS-Gurudayalpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
9	38+450	VUP	2 Lane BT	LHS-Bagha Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
10	40+380	VUP	2 Lane BT	LHS-Bagha Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
11	41+743	LVUP	Intermediate Lane ER	LHS-Bagha Bazar RHS-Loknathpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
12	43+375	LVUP	1 Lane BT	LHS-Bagha Bazar RHS-Joydhanpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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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	21+420	22+375	955	7.5	21+420	22+375	955	7.5
2	26+160	26+610	450	11	26+160	27+140	980	7.5
3	26+610	27+140	530	7.5				
4	30+970	32+060	1090	7.5	30+970	32+060	1090	7.5
5	33+300	33+860	560	11	33+300	34+295	995	7.5
6	33+860	34+295	435	7.5				
7	35+290	36+190	900	7.5	35+290	36+190	900	7.5
8	37+985	38+965	980	7.5	37+985	38+965	980	7.5
9	39+600	40+380	780	11	39+600	40+910	1310	7.5
10	40+380	40+910	530	7.5				
11	44+530	47+360	2830	7.5	44+530	47+180	2650	7.5
12	48+325	49+040	715	7.5	48+325	49+040	715	7.5
Total Length (m)			10755				10575	

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 crossroad to merge at desired location with through traffic on highway and proceed to distanced destinations.

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<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>		
<p>Chapter 7: Improvement Proposals (Highways)</p>		

- To provide opportunity to through traffic on project road to exist on to service road and proceed to desired destination through crossroad 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 runoff 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 <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • Longitudinal drains / ditches
3	Cross drainage structure at streams / river crossings.	Culverts and bridges have been provided as per hydrological requirements.



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)

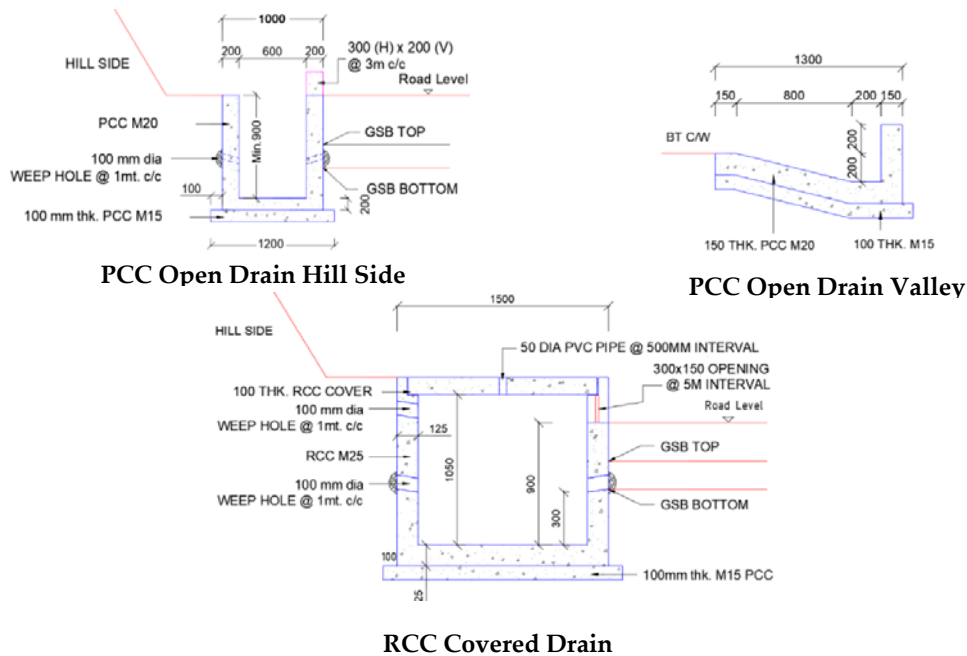


The proposed cross fall on the road pavement is 2.5% to ensure proper drainage of the road surface. For road segments traverses through plain terrain, in areas of super elevation transition a minimum longitudinal grade of 0.3% is to be adopted to ensure that the pavement surface drains properly.

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.



Note: Ref. separate TCS drawings for more details.

Fig 7.23 Types of Drain

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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a) RCC Cover Drain

Details of RCC Cover drain schedules are mentioned below.

Table 7.19 Schedule of RCC Cover Drain

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	20+000	20+300	300	20+000	20+300	300
2	21+420	22+375	955	21+420	22+375	955
3	26+160	26+660	500	26+160	26+660	500
4	26+660	27+140	480	26+660	27+140	480
5	30+970	32+060	1090	30+970	32+060	1090
6	33+300	33+860	560	33+300	33+860	560
7	33+860	34+295	435	33+860	34+295	435
8	34+295	34+900	605	34+295	34+900	605
9	35+305	36+190	885	35+305	36+190	885
10	37+985	38+965	980	37+985	38+965	980
11	39+600	40+380	780	39+600	40+380	780
12	40+380	40+910	530	40+380	40+910	530
13	44+530	45+430	900	44+530	45+430	900
14	45+430	47+070	1640	45+430	47+070	1640
15	47+070	47+360	290	47+070	47+360	290
16	48+320	49+040	720	48+320	49+040	720
Total Length=			11650			11650

b) PCC Open drain (On Hill Side)

Details of PCC Open drain on hill side schedules are mentioned below.



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Table 7.20 Schedule of PCC Open drain (On Hill Side)

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	47+620	47+780	160	47+360	47+420	60
2	47+900	47+970	70	47+600	47+790	190
3	48+220	48+330	110	47+900	47+980	80
4	48+690	48+800	110	48+690	48+880	190
5	48+840	48+880	40	48+930	49+290	360
6	49+160	49+190	30	49+330	49+520	190
7	49+380	49+510	130			
Total Length=			650			1070

c) PCC Open drain (On Valley Side)

Details of PCC Open drain on valley side schedules are mentioned below.

Table 7.21 Schedule of PCC Open drain (On Valley Side)

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	47+410	47+620	210	47+420	47+600	180
2	47+780	47+900	120	47+790	47+900	110
3	47+970	48+220	250	47+980	48+690	710
4	48+330	48+690	360	48+880	48+930	50
5	48+800	48+840	40	49+290	49+330	40
6	48+880	49+160	280	49+520	49+550	30
7	49+190	49+380	190			
8	49+510	49+550	40			
Total Length=			1490			1120

d) Un-Line Drain

Apart from the above drains, unlined drains are also proposed at below locations;



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Table 7.22 Schedule of Un-Line Drain

Sl No	LHS			RHS		
	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	20+300	21+420	1120	20+300	21+420	1120
2	22+375	26+160	3785	22+375	26+160	3785
3	27+140	30+970	3830	27+140	30+970	3830
4	32+060	33+300	1240	32+060	33+300	1240
5	34+900	35+305	405	34+900	35+305	405
6	36+190	37+985	1795	36+190	37+985	1795
7	38+965	39+600	635	38+965	39+600	635
8	40+910	44+530	3620	40+910	44+530	3620
	Total Length		16430			16430

7.12 Protection Works

The proposed road alignment also passes through portion of hilly terrain at last stretch of the project 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

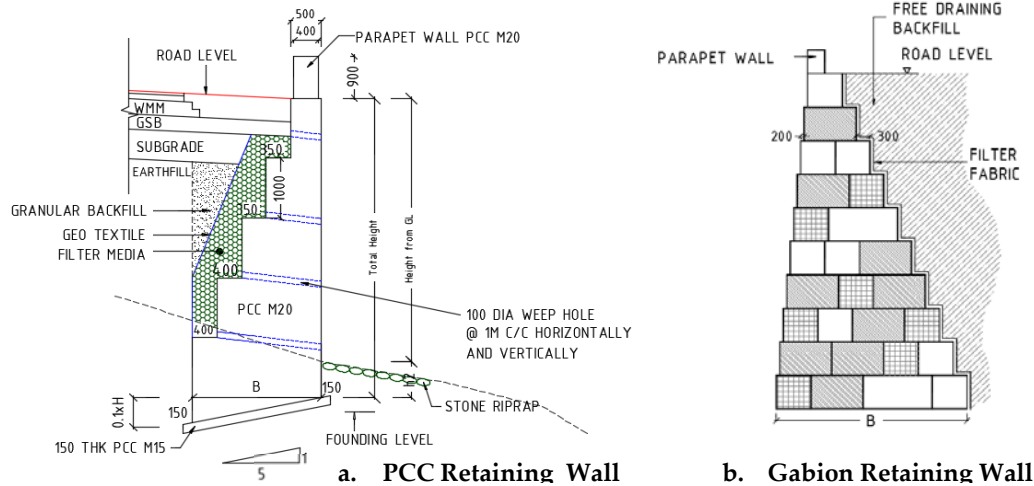
Retaining walls are permanent structures usually built at the toe of the slope or at shoulder edge to resist lateral pressure due to existing soil, earth filling, back fill, water pressure etc. Retaining walls have been proposed, a) where the existing ground is steep, and embankment is not feasible b) to restrict the formation width at ROW constraint locations.



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Note: Ref. separate Standard drawings for more details.

Fig 7.24 Retaining Wall Types

Detail locations of Retaining walls are given below.

Table 7.23 Schedule of Retaining Wall

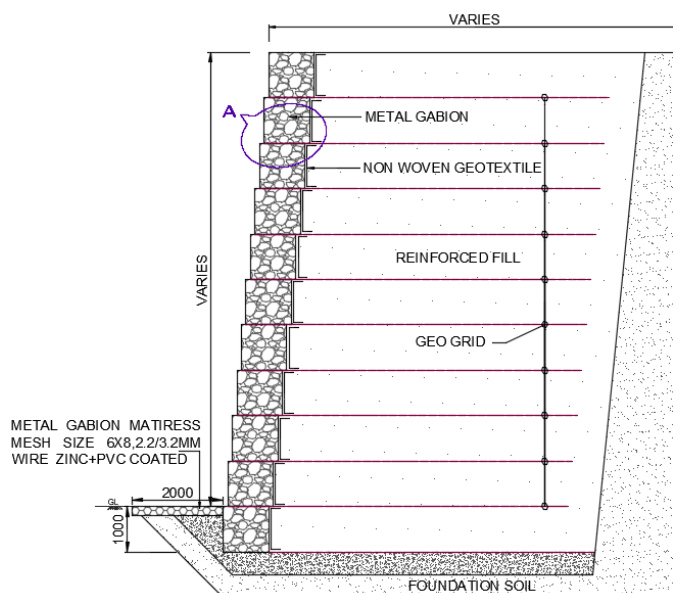
Sl No	LHS					RHS				
	Chainage (m)		Length (m)	Height based on IL taken in Topo-survey (m)	Remarks	Chainage (m)		Length (m)	Height based on IL taken in Topo-survey (m)	Remarks
	From	To				From	To			
1	21+640	21+690	50	2	PCC					
2	22+730	22+780	50	2	PCC	22+730	22+780		2	PCC
3	25+650	25+850	200	2	PCC	25+650	25+850		2	PCC
4	28+300	29+370	1070	2	PCC	28+300	29+370	1070	2	PCC
5	29+600	30+400	800	2	PCC	29+600	30+400	800	2	PCC
6	36+540	36+680	140	2	PCC	36+540	36+680	140	2	PCC
7	40+940	41+120	180	2	PCC	40+940	41+120	180	2	PCC
8	42+700	42+800	100	2	PCC	42+700	42+800	100	2	PCC
9	47+460	47+620	160	3	PCC	47+460	47+540	80	3	PCC
10	47+780	47+850	70	6	Gabion	47+990	48+670	680	5	PCC
11	48+900	49+050	150	6	Gabion					
Total Length=			2970					3300		



7.12.2 Reinforced Soil

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.

However, in this project road the RS Wall is proposed base on the site condition, mentioned as below;



Note: Ref. Separate standard drawings for more details.

Fig 7.25 Reinforced Soil Wall with Gabion Facia

The details of the same is given in table below;

Table 7.24 Details of proposed RS Wall protection

Sl No	LHS				RHS			
	Chainage (m)		Length (m)	Height (m)	Chainage (m)		Length (m)	Height (m)
	From	To			From	To		
1	47990	48210	220	12				
2	48330	48690	360	10				
Total Length (m)			580					



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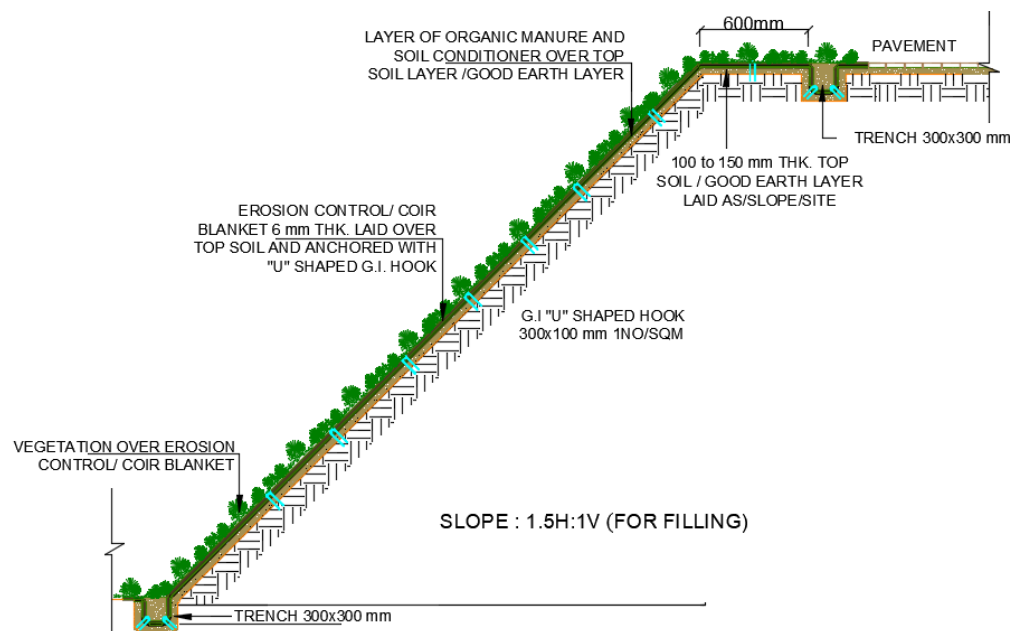
Table 7.25 Details of proposed RS Slope protection

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

7.12.3 Fill Slope protection using Erosion Control Blankets

The protection on valley side in free fall embankment has been protected with Turfing for height less than 4m. and for embankment greater than 4m high, side slope has been protection with geo green blanketing, Which is anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely woven polymer nettings and seeds broadcasting on the treated site.

In this package, Fill Slope using Erosion Control Blankets is proposed for area of **142183 sqmt.**



Note: Ref. separate standard drawings for more details.

Fig 7.26 Fill Slope protection using Erosion Control Blankets

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.



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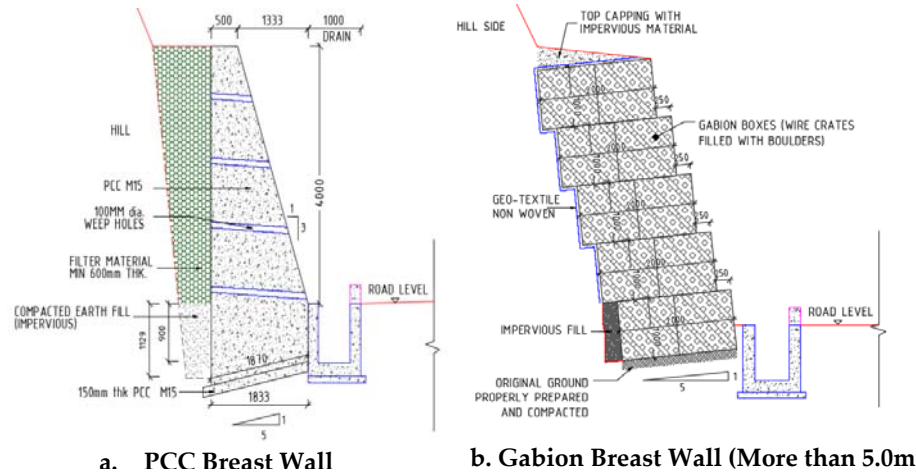
Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



- To keep the road edge defined
- To protect the hill slope to the height of breast wall from silps
- 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 is considered as per site requirement. In general PCC breast wall has been proposed to the certain height (5m max) whereas Gabion breast wall has been proposed for more than 5m as per below diagram.



Note: Ref. separate standard drawings for more details.

Fig 7.27 Types of Breast Wall

Detail locations are mentioned below;

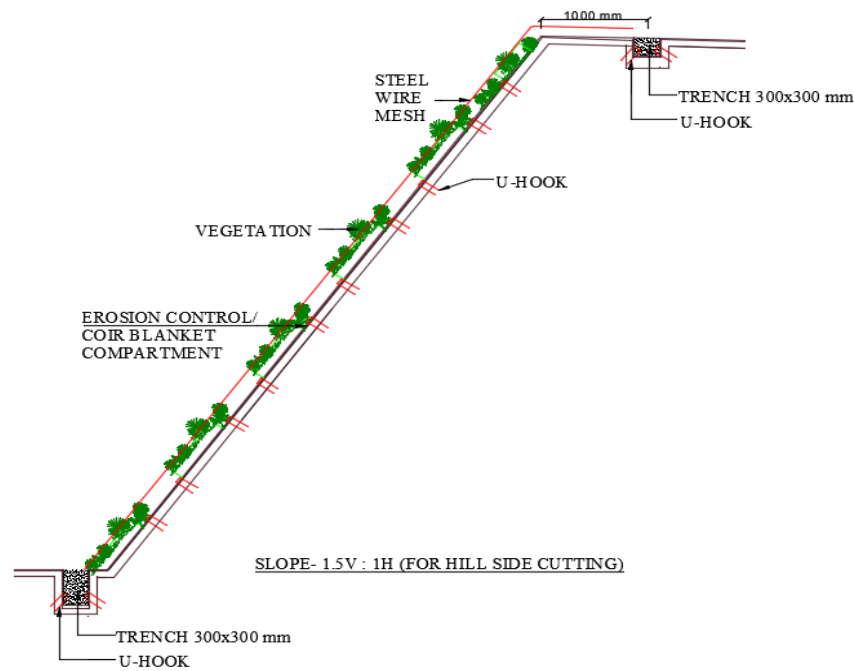
Table 7.26 Schedule of Breast Wall

LHS					RHS					
Sl No	Chainage (m)		Length (m)	Height (m)	Remarks	Chainage (m)		Length (m)	Height (m)	Remarks
	From	To				From	To			
1						47+640	47+770	130	4	PCC
2						47+920	47+960	40	4	PCC
3						48+740	48+830	90	4	PCC
4						49+390	49+490	100	6	Gabion
Total Length=								360		



7.12.5 Cut Slope using Erosion Control Blankets Compartment System

The protection on hill side in free fall embankment using erosion control blankets component of vegetation over erosion control/ coir blanket with "U" shaped hook and steel wire mesh shall be executed as per site condition in consultation with Authority/IE.



Note: Ref. separate Standard drawings for more details.

Fig 7.28 Cut Slope using Erosion Control Blankets Compartment System

In this package, Cut Slope using Erosion Control Blankets Compartment System is proposed for area of **9543 sqmt.**

For better appreciation, DPR consultant has tabulated the summary of protection work in length/Area wise as below.

Table 7.27 Summary of Slope Protection

Type	Length (m)	Area (sqm)
Retaining Wall	6270	-
Reinforced Soil Wall	580	-
Fill Slope - Erosion Control	-	142183
Breast Wall	360	-
Cut slope Protection	-	9543

7.12.6 Guard/Parapet Wall

Generally, Parapets shall be proposed on valley side at stretches where, either drains or retaining walls are not proposed however, proposed alignment does not encounter Guard /Parapet Wall in this package.

7.12.7 RE Wall

Generally, RE Wall shall be proposed on the approaches of Grade separated structures as per site condition. Detail length is given below;

Table 7.28 Schedule of RE Wall

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	21+420	22+375	955	21+420	22+375	955
2	26+160	27+140	980	26+160	27+140	980
3	31+080	32+060	980	31+080	32+060	980
4	33+300	34+295	995	33+300	34+295	995
5	35+290	36+190	900	35+290	36+190	900
6	37+985	38+965	980	37+985	38+965	980
7	39+840	40+910	1070	39+840	40+910	1070
8	44+530	45+430	900	44+530	45+430	900
9	47+110	47+365	255	47+110	47+365	255
10	48+320	49+040	720	48+320	49+040	720
Total Length=			8735			8735

7.12.8 Crash Barrier

Three Metal 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, Project alignment runs on embankment more than 3m, throughout provision has been made except at structures where concrete crash barrier is provided. With these criteria, detail length of crash barrier is given below;



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Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Table 7.29 Schedule of Crash Barrier

Sl No	LHS			RHS		
	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
1	19+670	19+710	40	22+500	23+260	760
2	22+720	23+240	520	23+820	24+670	850
3	23+760	24+650	890	28+460	28+670	210
4	25+670	25+840	170	28+790	29+070	280
5	28+600	28+860	260	29+640	29+840	200
6	28+920	29+260	340	30+050	30+400	350
7	29+580	30+400	820	30+500	30+540	40
8	33+060	33+190	130	32+670	33+010	340
9	36+180	36+700	520	36+190	37+150	960
10	37+610	37+920	310	37+670	38+020	350
11	41+090	41+980	890	39+040	39+120	80
12	42+680	43+480	800	39+270	39+310	40
13	43+540	43+590	50	40+940	41+360	420
14	43+730	44+340	610	41+450	42+000	550
15	44+490	44+520	30	42+680	43+000	320
16	47+250	47+420	170	43+120	43+630	510
17	47+470	47+620	150	47+440	47+580	140
18	47+780	47+870	90	43+820	44+300	480
19	47+910	48+270	360	47+360	47+880	520
20	48+330	48+680	350	47+990	48+800	810
21	48+900	49+140	240	49+150	49+250	100
22	49+260	49+360	100			
Total Length=			7840			8310

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Jersey crash barrier shall be provided along the project highway where median is proposed for 2.5m (with kerb shy), indicated in TCS given in Schedule B and IRC: SP-91-2019. Minimum length of crash barrier is 19130m.

Table 7.30 Schedule of Jersey Crash Barrier

I.no.	Design Chainage		Length (m)	Side	Design Chainage		Design Chainage	Side
	From	To			From	To		
1	20+000	20+300	300	LHS	20+000	20+300	300	RHS
2	20+300	21+420	1120	LHS	20+300	21+420	1120	RHS
3	33+300	33+860	560	LHS	33+300	33+860	560	RHS
4	33+860	34+295	435	LHS	33+860	34+295	435	RHS
5	34+295	34+900	605	LHS	34+295	34+900	605	RHS
6	34+900	35+305	405	LHS	34+900	35+305	405	RHS
7	39+600	40+380	780	LHS	39+600	40+380	780	RHS
8	40+380	40+910	530	LHS	40+380	40+910	530	RHS
9	44+530	45+430	900	LHS	44+530	45+430	900	RHS
10	45+430	47+070	1640	LHS	45+430	47+070	1640	RHS
11	47+070	47+360	290	LHS	47+070	47+360	290	RHS
12	47+360	47+460	100	LHS	47+360	47+460	100	RHS
13	47+460	47+620	160	LHS	47+460	47+620	160	RHS
14	47+620	47+780	160	LHS	47+620	47+780	160	RHS
15	47+780	47+850	70	LHS	47+780	47+850	70	RHS
16	47+850	47+970	120	LHS	47+850	47+970	120	RHS
17	47+970	48+320	350	LHS	47+970	48+320	350	RHS
18	48+320	49+040	720	LHS	48+320	49+040	720	RHS
19	49+040	49+360	320	LHS	49+040	49+360	320	RHS
	Total		9565	LHS	Total		9565	RHS

Note: Apart from above RCC Crash barrier is proposed at all approaches of Grade Separator.

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, 12 numbers of bus bays with bus shelters and 06 nos of only bus shelters 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;



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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Table 7.31 Details of Bus bays and Bus shelter

Sl. No.	Design Chainage	Side	Name Of Village	Remarks
1	26+390	LHS	Kabuganj	BS & BL
2	26+910	RHS	Kabuganj	BS & BL
3	31+400	LHS	Narsingpur	BS & BL
4	31+820	RHS	Narsingpur	BS & BL
5	35+460	LHS	Ramprasadpur	BS & BL
6	36+010	RHS	Ramprasadpur	BS & BL
7	40+110	RHS	Islamabad	BS & BL
8	40+150	LHS	Islamabad	BS & BL
9	45+745	RHS		BS & BL
10	45+870	LHS	Lailapur	BS & BL
11	48+690	LHS	Vairengte	BS & BL
12	48+990	RHS	Vairengte	BS & BL

7.13.2 Truck lay-byes

There is no proposal of truck lay bye in this Package.

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

	<p>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)).</p>	
	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Highways)</p>	

7.13.5 Check Post

User amenities in the form of state boundary check post is proposed along the project road corridor. The land for admin block for check post is (50 x 20) m in size is allocated and is generally proposed at 50 m apart in staggered manner. In the opinion of the consultant the following two locations are most suitable place for check post. However cost towards check post facilities in terms of infrastructure and equipment shall be borne by the State Government.

Table 7.32 Details of Check Post location

Sl. No.	Design Chainage	Side
1	49+150	RHS
2	49+200	LHS

7.13.6 Toll Plaza

There is no Toll Plaza has been proposed in this Package.



7.13.7 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.

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Highways)</p>	
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7.14 Summary of Improvement Proposal

Table 7.33 Summary of Improvement Proposals

Sl. No.	Description (Prop)	Unit	Total
1	Alignment & Geometrics		
	Total Length	Km	29.360
	Re-alignments	Km	2.260
	Bypass / Short Bypass		
	Bypasses	Km	16.400
	Short Bypass	Km	2.000
	Total (Realignments +Bypass)	Km	20.66
2	Cross Section		
	4-Lane Road	No	29.360
	6-Lane Road (Approach of structures)	No	Nil
3	Bridges		
	Existing		
	Minor Bridges (Along Existing Road)	Nos	05
	Major Bridges (Along Existing Road)	Nos	Nil
	Proposed (Major/ Minor)		
	Minor Bridges (Reconstruction & New Construction)	Nos	12
	Major Bridges	Nos	Nil
	Rehabilitation Proposal of Existing Bridges		
	Existing Bridges reconstruction (1 no culvert & 4 nos of Minor Bridge proposed to Minor Bridge)	Nos	05
	Existing Bridges Repair/ Retain MJB	Nos	Nil
	Existing Bridges Widening	Nos	Nil
	Existing Bridges Abandoned	Nos	01
	New Bridges		
	a. Minor Bridges	Nos	07
	b. Major Bridges	Nos	Nil



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Description (Prop)		Unit	Total
4	Culverts			
	Existing Culverts (Along Existing Road)		Nos	34
	Proposed Culverts (Reconstruction & New Construction)		Nos	65
	Rehabilitation Proposal of Culvert			
	Existing Culverts reconstruction (to 4-Lane)		Nos	17
	Existing Culverts Widening (to 4-Lane)		Nos	Nil
	Existing Culverts Retain (4 to Retain)		Nos	Nil
	Existing Culverts Abandon		Nos	16
	New Culvert along project road		Nos	48
	New Culvert for cross roads		Nos	25
5	Major & minor Junctions (Proposal)			
	Major Junction		Nos	15
	Minor Junctions		Nos	11
6	Toll Plaza		Nos	Nil
7	Service/Slip Road (excluding Tapper Length)		Km	21.330
8	Rest Area		Nos	Nil
9	Grade Separator			
	Overpass		Nos	01
	Vehicular Underpass (VUP)		Nos	08
	Light Vehicular Underpass (LVUP)		Nos	07
10	Bus Bay with Bus Shelter and Bus Shelter			
	Bus Bay with Bus Shelter		Nos	12
11	Truck Lay bye		Nos	Nil
12	Drain			
	RCC Cover Drain	LHS	Mts	11650
		RHS	Mts	11650



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Description (Prop	Unit	Total
	PCC Open Drain (On Hill Side)	LHS	Mts
		RHS	Mts
	PCC Open Drain (On Valley Side)	LHS	Mts
		RHS	Mts
	Un Line Drain	LHS	Mts
		RHS	Mts
13	Protection Work		
	Retaining Wall	LHS	Mts
		RHS	Mts
	RS Wall	LHS	Mts
		RHS	Mts
	Fill Slope protection using Erosion Control Blankets	sqm	142183
	Breast Wall	LHS	Mts
		RHS	Mts
	Cut Slope using Erosion Control Blankets Compartment System	sqm	9543
	Thrie Beam Crash Barrier	LHS	Mts
		RHS	Mts
	RE Wall	LHS	Mts
		RHS	Mts
14	Additional Land requirement for the project	Km.	29.360
15	% of Land Requirement for the Project (Length wise)	%	100.00
16	Pavement Design Life		
	Flexible	Year	20
	Rigid (not used in this package)	Year	30
17	Traffic in MSA : Km 20+000 to Km 49+360	MSA	40
18	Pavement Type Proposed 1. Km 20+000 to Km 49+360	Flexible	Flexible –4L



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Highways)



Sl. No.	Description (Prop)	Unit	Total
	Existing Type	BT	
	<u>New 4 Lane (Main Carriageway)</u>	Flexible	
	BC(PMB/CRMB)	mm	40
	DBM (VG-40)	mm	60
	WMM	mm	150
	Geogrid		Biaxial
	Granular Sub-Base (GSB)	mm	300
	Subgrade	mm	500
	<u>Service Road (10 MSA)</u>	Flexible	
	BC(VG-30)	mm	30
	DBM (VG-30)	mm	60
	WMM	mm	250
	Granular Sub-Base (GSB)	mm	200
	Subgrade	mm	500

7

Chapter 7 – Improvement Proposals (Structures)

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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

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	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Structure)</p>	
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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

Topography of hill generates numerous water courses. This coupled with continuous gradient of roads in hill and high intensity of rain fall calls for effective drainage of roads. Uncontrolled water is the primary cause of problems like soft surfaces, potholes 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 61nos. of existing culverts, out of which 5nos are Slab on NH-306, 10nos are Box on NH-37 and 46 are Pipe culverts, Out of which 16nos are on Silchar bypass and 30 nos are on NH-306 along Silchar to Vairengte Section. However, as per Package-2 there are 04 nos of Slab culvert and 30 no's of pipe culvert on NH-306 which details are mentioned below;

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Structure)</p>	
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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-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;



	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Structure)</p>	
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Table 7.1 Summary of Culverts

Existing				Proposed					Total
Pipe	Slab	Box	Total	New Box	Reconstruction	Widening	Retained	Abandoned (does not fall under PCL)	
30	04	-	34	48	*17	-	-	16	65

**Note: Existing 01 numbers of culvert has been proposed to minor bridge.*

Table 7.2 Summary of proposed culvert according to sizes

Type	Size	Nos.	Total no.
BOX	1 x 2 x 2	41	65
BOX	1 x 3 x 3	21	
BOX	1 x 4 x 3	1	
BOX	1 x 5 x 4	2	

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					20+215	Box	1 x 2 x 2	New Construction	Nutan Bazar Bypass
2					20+720	Box	1 x 2 x 2	New Construction	
3					21+050	Box	1 x 2 x 2	New Construction	
4					21+310	Box	1 x 2 x 2	New Construction	
5					21+840	Box	1 x 2 x 2	New Construction	
6					22+085	Box	1 x 2 x 2	New Construction	
7					22+580	Box	1 x 2 x 2	New Construction	
8					22+760	Box	1 x 2 x 2	New Construction	
9					23+070	Box	1 x 2 x 2	New Construction	
10					23+350	Box	1 x 2 x 2	New Construction	
11					23+909	Box	1 x 5 x 4	New Construction	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)



Sl. No.	Existing Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
12					24+340	Box	1 x 2 x 2	New Construction	Nutan Bazar Bypass
13					24+520	Box	1 x 2 x 2	New Construction	
14					25+410	Box	1 x 2 x 2	New Construction	
15					25+780	Box	1 x 3 x 3	New Construction	
16					26+590	Box	1 x 2 x 2	New Construction	
17					26+940	Box	1 x 2 x 2	New Construction	
18					27+155	Box	1 x 2 x 2	New Construction	
19					28+360	Box	1 x 2 x 2	New Construction	
20					28+510	Box	1 x 2 x 2	New Construction	
21	21+290	Pipe	2x0.9		28+670	Box	1 x 3 x 3	Reconstruction	Following existing
22	21+470	Pipe	2x0.9	17.2	28+849	Box	1 x 3 x 3	Reconstruction	
23	21+600	Pipe	2x1.2	17	28+980	Box	1 x 3 x 3	Reconstruction	
24	22+380	Pipe	2x1.2	17.3	29+758	Box	1 x 3 x 3	Reconstruction	
25					30+320	Box	1 x 2 x 2	New Construction	Katakhal Bypass
26					30+520	Box	1 x 2 x 2	New Construction	
27					30+865	Box	1 x 2 x 2	New Construction	
28					31+090	Box	1 x 3 x 3	New Construction	
29					31+700	Box	1 x 3 x 3	New Construction	
30					32+170	Box	1 x 3 x 3	New Construction	
31					32+515	Box	1 x 3 x 3	New Construction	
32					32+935	Box	1 x 3 x 3	New Construction	
33					33+235	Box	1 x 3 x 3	New Construction	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)



Sl. No.	Existing Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
34	26+010	Pipe	2x0.9		33+460	Box	1 x 3 x 3	Reconstruction	Following existing
35	26+810	Pipe	2x1.2	17.1	34+250	Box	1 x 3 x 3	Reconstruction	
36	27+255	Pipe	2x1.2	17.2	34+700	Box	1 x 3 x 3	Reconstruction	
37					35+050	Box	1 x 2 x 2	New Construction	
38	27+930	Slab	1x4	17.5	35+370	Box	1 x 5 x 4	Reconstruction	
39					35+680	Box	1 x 3 x 3	New Construction	Dholai Bypass
40					35+980	Box	1 x 3 x 3	New Construction	
41					36+610	Box	1 x 3 x 3	New Construction	
42	30+900	Pipe	1 x 0.9		38+390	Box	1 x 2 x 2	Reconstruction	Following existing
43					38+930	Box	1 x 2 x 2	New Construction	Baga Bazar Bypass
44					39+440	Box	1 x 2 x 2	New Construction	
45	32+840	Pipe	2x1.2	17.8	40+085	Box	1 x 2 x 2	Reconstruction	Following existing
46					40+390	Box	1 x 2 x 2	New Construction	Baga Bazar Bypass
47					40+680	Box	1 x 2 x 2	New Construction	
48					41+045	Box	1 x 3 x 3	New Construction	
49					42+080	Box	1 x 3 x 3	New Construction	
50					42+735	Box	1 x 3 x 3	New Construction	
51					43+435	Box	1 x 2 x 2	New Construction	
52					44+310	Box	1 x 2 x 2	New Construction	
53					44+695	Box	1 x 2 x 2	New Construction	
54					45+045	Box	1 x 2 x 2	New Construction	



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)



Sl. No.	Existing Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
55	38+350	Pipe	1 x 0.9		45+400	Box	1 x 2 x 2	Reconstruction	Following existing Lailapur
56	38+570	Pipe	2x1.2	17.5	45+615	Box	1 x 2 x 2	Reconstruction	
57	38+800	Pipe	2x1.2	18.5	45+840	Box	1 x 2 x 2	Reconstruction	
58	39+300	Pipe	2x1.2	17.8	46+345	Box	1 x 2 x 2	Reconstruction	
59	39+645	Pipe	2x1.2	18	46+690	Box	1 x 2 x 2	Reconstruction	
60	40+140	Slab	1x2.8	12.2	47+190	Box	1 x 4 x 3	Reconstruction	
61	40+300	Pipe	1x0.9	11	47+290	Box	1 x 3 x 3	Reconstruction	
62					47+825	Box	1 x 2 x 2	New Construction	Realignment
63					48+920	Box	1 x 2 x 2	New Construction	
64					49+030	Box	1 x 2 x 2	New Construction	
65					49+310	Box	1 x 2 x 2	New Construction	

In addition to the above s 25 No. of 1x2x2m Box Culvert are proposed for crossroads.

Table 7.4 Culverts for Cross Road

Sl. No.	Design Chainage	Type	Span (m)	Minimum Vent Height (m)
1	21+600 (at Cross Road)	Box	1x2	2
2	21+900 (at Cross Road)	Box	1x2	2
3	26+000 (at Cross Road)	Box	1x2	2
4	26+200 (at Cross Road)	Box	1x2	2
5	26+350 (at Cross Road)	Box	1x2	2
6	26+610 (at Cross Road)	Box	1x2	2
7	28+420 (at Cross Road)	Box	1x2	2
8	30+300 (at Cross Road)	Box	1x2	2
9	31+060 (at Cross Road)	Box	1x2	2
10	31+600 (at Cross Road)	Box	1x2	2



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 Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)

Sl. No.	Design Chainage	Type	Span (m)	Minimum Vent Height (m)
11	31+960 (at Cross Road)	Box	1x2	2
12	33+100 (at Cross Road)	Box	1x2	2
13	33+900 (at Cross Road)	Box	1x2	2
14	35+900 (at Cross Road)	Box	1x2	2
15	36+480 (at Cross Road)	Box	1x2	2
16	37+500 (at Cross Road)	Box	1x2	2
17	38+400 (at Cross Road)	Box	1x2	2
18	39+400 (at Cross Road)	Box	1x2	2
19	40+440 (at Cross Road)	Box	1x2	2
20	44+940 (at Cross Road)	Box	1x2	2
21	45+320 (at Cross Road)	Box	1x2	2
22	46+700 (at Cross Road)	Box	1x2	2
23	46+840 (at Cross Road)	Box	1x2	2
24	47+330 (at Cross Road)	Box	1x2	2
25	48+800 (at Cross Road)	Box	1x2	2

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.



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)).

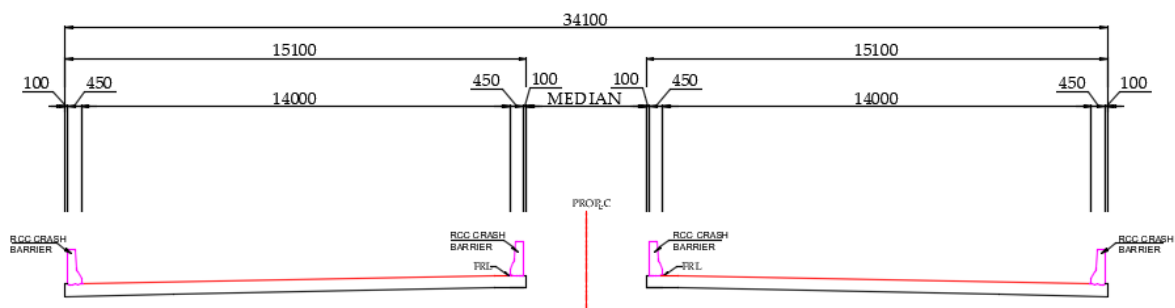


Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)

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 Flyover 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.



Typical Cross Section (TCS TYPE) - 8
Grade Separated Structure Vehicular Underpass and Elevated section 6-Lane Divided Highway

These grade separation facilities are classified and tabulated in following Table;

Table 7.5 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	21+900	VUP	2 Lane BT	LHS-Nutan Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
2	22+950	LVUP	2 Lane BT	LHS-Nutan Bazar RHS-Clever House	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
3	24+325	LVUP	2 Lane BT	LHS-Nutan Bazar RHS-Clever House	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
4	26+610	VUP	2 Lane BT	LHS-Kabuganj	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6




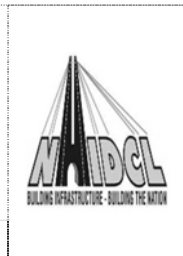
Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).



Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)

Chapter 7: Improvement Proposals (Structure)

Sl. No.	Type / Location of Structure	Name	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
5	31+610	VUP	2 Lane BT	LHS-Narsingour RHS-Bor Jalenga	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
6	33+860	VUP	2 Lane BT	LHS-Ramprasad pur RHS-Paloipunji	Village Road	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
7	35+810	VUP	2 Lane BT	LHS-Dholai Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
8	36+513	LVUP	Intermediate Lane BT	LHS-Dholai Bazar RHS-Gurudayalpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
9	38+450	VUP	2 Lane BT	LHS-Bagha Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
10	40+380	VUP	2 Lane BT	LHS-Bagha Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6
11	41+743	LVUP	Intermediate Lane ER	LHS-Bagha Bazar RHS-Loknathpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
12	43+375	LVUP	1 Lane BT	LHS-Bagha Bazar RHS-Joydhanpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
13	44+050	LVUP	1 Lane BT	LHS-Bagha Bazar RHS-Joydhanpur	Village Road	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
14	44+960	VUP	2 Lane BT	LHS-Bagha Bazar	NH-306 (Existing)	Span = 1 x 20m Vertical Clearance = 5.5 m	2x11.6

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Structure)</p>	
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Sl. No.	Type / Location of Structure	Name	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
15	47+355	LVUP	2 Lane BT	LHS- Lailapur RHS-Army Campus	NH-306 (Existing)	Span = 1 x 12m Vertical Clearance = 4.0 m	2x11.6
16	48+820	OP	2 Lane BT	LHS- Lailapur RHS- Vairengte	NH-306 (Existing)	Span = 2 x 12m Vertical Clearance = 5.5 m	2x11.6

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 SVUP'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:

This structure is provided at Km 48+820, junction with Lilapur-Vairengte (ExistingNH-306), Overpass (OP) has been proposed, where cross road is elevated and project road at ground level with a span of 2x12m, vertical clearance of 5.5m and total structure width of 2 x 11.6m.

7.3.6 POP:

These structures POP (OP) has been proposed, where cross road is elevated and project road at ground level with a span of 2 x 30 m, vertical clearance of 7.5m and total structure width of 1 x 6m.

7.3.7 Railway Level Crossings/ROB/RUB

The project road does not cross any Railway line, ROB and RUB.

7.4 Bridges

7.4.1 General

As we discussed in previous chapter i.e. we are starting the Package-2 from Km 20+000 and ending at Km 49+360 towards Vairengte

There is no existing major bridge falling under this package with no proposal of major bridge as per site requirement.

Minor Bridges:

There are total 5 Nos. of minor bridges falling under this package, from which 1 no is abandoned for bypass proposal and remain 4 nos with 1 no culvert are proposed to reconstruct Minor Bridge. As per site requirement 07 nos of minor bridge have been proposed for new construction.

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 the minor bridges.

Table 7.6 Summary of Minor Bridges



Existing		Proposed			Total
Type	Existing No	New	Reconstruction	Widening	
Minor Bridge	05	7	5	-	01
					12

**Note: Existing 01 numbers of culvert has been proposed to minor bridge.*

Table 7.7 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)	Proposal	Remarks
			No. of Span	Span Length (m)				
1	-	36+750	2	25	PSC Girder Type, with Footpath	2 x 13.5	New Construction	
2	-	37+169	1	15	PSC Girder Type, with Footpath	2 x 13.5	New Construction	

	<p>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)).</p> <p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 7: Improvement Proposals (Structure)</p>	
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Sl. No.	Ex. Des Ch. (Km)	Des.Ch. (Km)	Span Arrangement		Type of Structure Proposed	Total Deck Width (m)	Proposal	Remarks
			No. of Span	Span Length (m)				
3	-	41+230	1	12	Box Type, with Footpath	2 x 13.5	New Construction	
4	-	47+480	1	15	PSC Girder Type, with Footpath	2 x 13.5	New Construction	
5	-	48+167	4	2.0m dia	Pipe Type, with Footpath	2 x 17.0	New Construction	
6	-	48+390	4	2.0m dia	Pipe Type, with Footpath	2 x 11.6+2 x 11.0	New Construction	
7	-	48+610	4	2.0m dia	Pipe Type, with Footpath	2 x 11.6+2 x 11.0	New Construction	

Reconstruction of Minor Bridges

Sl. No.	Ex. Des Ch. (Km)	Des.Ch. (Km)	Span Arrangement		Type of Structure Proposed	Total Deck Width (m)	Proposal	Remarks
			No. of Span	Span Length (m)				
1	22+560	29+938	1	10	Box Type, with Footpath	2 x 13.5	Reconstruction	
2	30+215	37+700	1	40	PSC Girder Type, with Footpath	2 x 13.5	Reconstruction	
3	38+490	45+533	1	10	Box Type, with Footpath	2 x 11.6+2 x 11.0	Reconstruction	
4	39+210	46+257	1	20	PSC Girder Type, with Footpath	2 x 11.6+2 x 11.0	Reconstruction	
5	39+990	47+033	1	20	PSC Girder Type, with Footpath	2 x 11.6+2 x 11.0	Reconstruction	

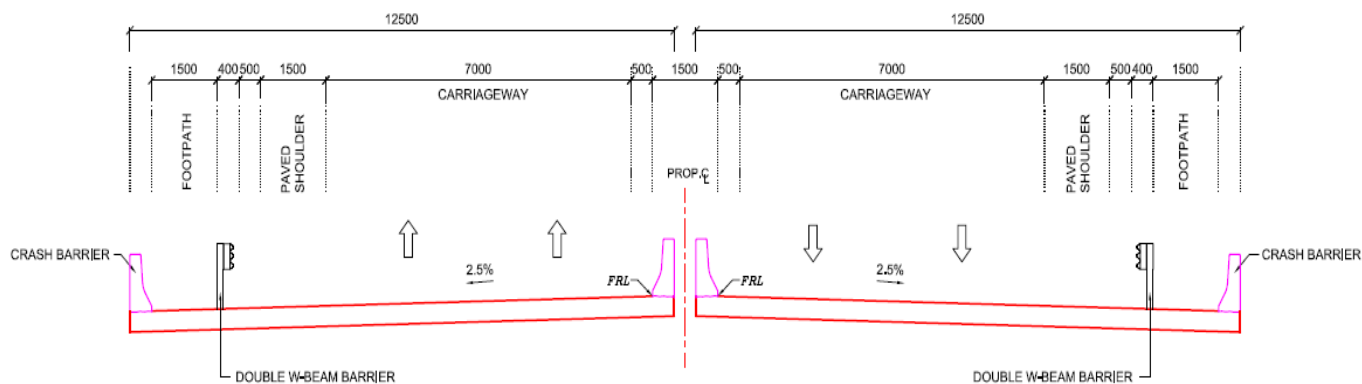
7.4.2 Width of the bridges:

7.4.3 Width of the bridges:

- All new/ reconstructed bridges are proposed with 2 x 12.5m total deck width as per Fig 7.6 of 4-lane manual.



- ii. For the bridges, which are in proposed 4-lane configuration, total width of 25m 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.



7.4.4 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.



7.4.5 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 $\leq 12\text{m}$	-	RCC Solid Slab.
Spans $>12\text{m}$ to $\leq 20\text{m}$	-	RCC I-Girder
Spans $>20\text{m}$ to $\leq 40\text{m}$	-	PSC I-Girder

7.4.6 Substructure

Substructure for the proposed bridges will generally consist of RCC wall type abutments and solid circular piers.

	<p>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)).</p>	
	<p>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 7: Improvement Proposals (Structure)</p>	

7.4.7 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.

7.4.8 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.

Environmental Screening and Initial Environmental Assessment

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: Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)

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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.

Whereas project road in Assam State starts from Silchar at existing km 263+350 on NH-37 and ends at Vairengte (Assam/Mizoram border) km 43+000 on NH-306. Corresponding Design chainage lies between D. Ch. 0+000 and D. Ch. 46+000. Total design length of the project road is 46.0km. The Project Road rests on one districts viz. Cachar.



Project Road from Silchar to Sairang further divided in to 8 packages based on assessment done in view of construction aspect. The packages are as under,

Table 8.1 Package Distribution

Sl. No.	Construction Packages	Design Chainage			Existing Chainage			State
		From	To	Length (km)	From	To	Length (km)	
1	Package-1	0+000	20+000	20.000	263+800 (Of NH-37)	12+920 of NH-306	18.820	Assam
2	Package-2	20+000	*49+360	29.360	12+920	43+000	30.080	Assam
3	Package-3	46+000	**60+850	14.850	43+000	59+700	16.700	Mizoram
4	Package-4	61+000	77+500	16.500	59+700	86+000	26.300	
5	Package -5	77+500	95+500	18.000	86+000	107+850	21.850	
6	Package -6	95+500	111+850	16.350	107+850	126+315	18.465	
7	Package -7	111+850	125+500	13.650	126+315	142+060	15.745	
8	Package -8	125+500	136+400	10.900	142+060	158+900	16.840	
	Total Design Length			139.610			164.800	

* EQ (km 49+360 = km 46+000) ** EQ (km 60+850 = km 61+000)

This Report mainly deals with Package-2 wherever applicable.

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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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

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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.

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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Project Component for Design	Details of Environmental. Features
Quarries and borrow area	
Illegal and / or improper mining	<ul style="list-style-type: none"> Only approved and licensed Quarries and Borrow pits shall be permitted.
	<ul style="list-style-type: none"> Non-Productive, barren lands, raised lands, riverbeds are recommended for borrowing the material.
Location of Camps	
Site selection/ Location of Labour Camp/ Construction Camps	<ul style="list-style-type: none"> 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.
	<ul style="list-style-type: none"> All sites used for camps should be adequately drained and they should not be subjected to periodic flooding.
	<ul style="list-style-type: none"> Camps should be located such that drainage from and through the camps will not endanger any domestic or public water supply.
	<ul style="list-style-type: none"> Living accommodation and ancillary facilities should be erected and maintained to standards and scales parameters set by the concerned authorities.
	<ul style="list-style-type: none"> Toilets and urinals should be provided in accessible places away from the asphalt plant and mixing yard.
	<ul style="list-style-type: none"> Construction Camp should not be placed in ecologically sensitive areas.
Utilities	
Relocation of utility lines / community utilities.	<ul style="list-style-type: none"> Affected utilities like electric poles, water pipelines, hand pumps, etc. shall be relocated with prior approval of the concerned agencies/departments.
	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Temporary traffic arrangement during construction shall be planned in an advance.
	<ul style="list-style-type: none"> The contractor shall take all necessary measures for the traffic during demolition and site clearing activities.

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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Project Component for Design	Details of Environmental. Features
Pedestrian safety	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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, 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:

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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- 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); or
- 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).

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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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 mitigative 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.

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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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 as shown in the below figure;

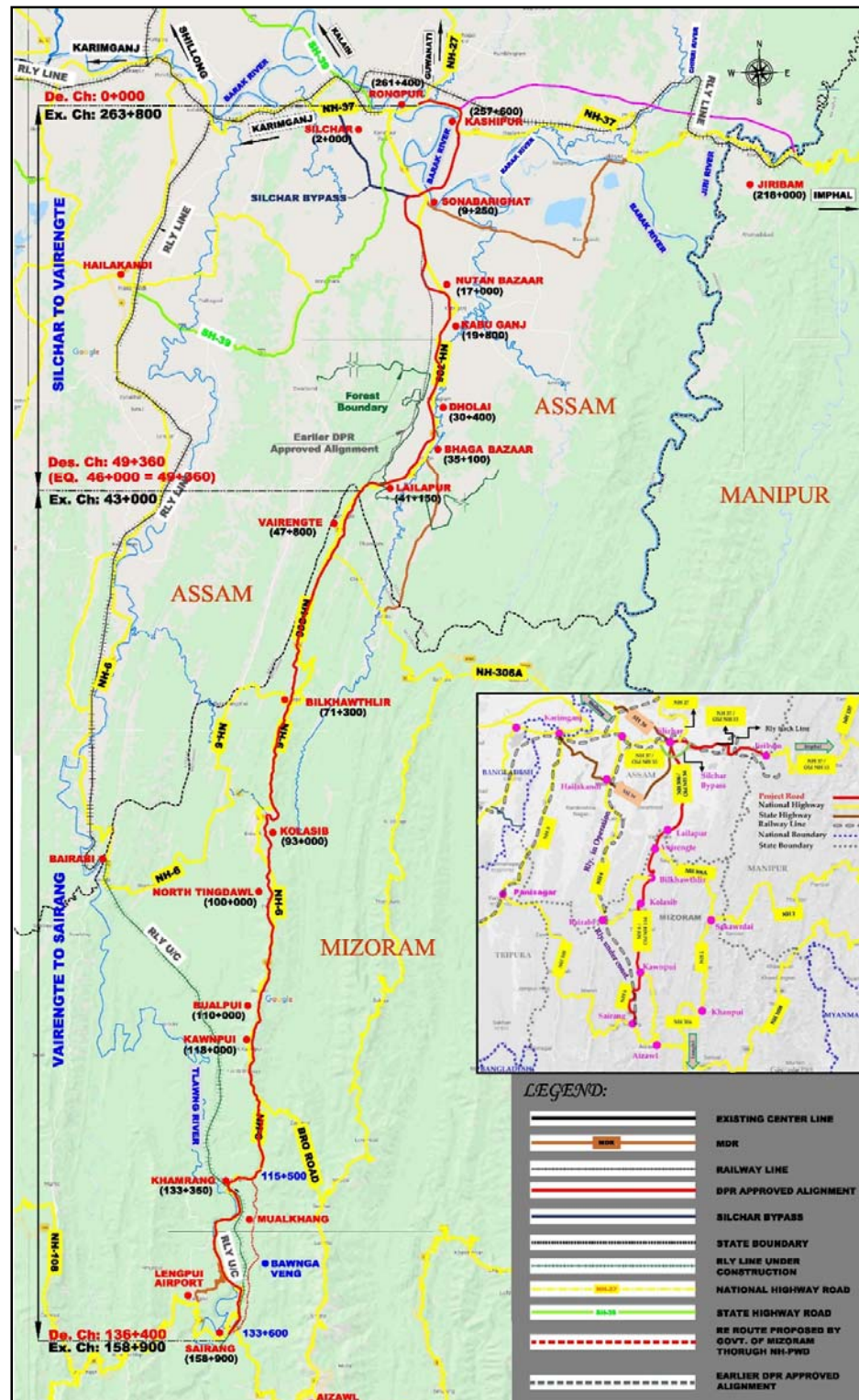




Fig 8.1 Key Plan for Proposed Road

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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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

Sr. 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

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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Sr. No.	Parameter	Source of Data Collection
	<ul style="list-style-type: none"> Agricultural development, mineral development, and tourism facilities 	By Conducting Survey, District /State statistical Diary/ Profile
Iv	Social and Cultural:	
	<ul style="list-style-type: none"> Population and communities (e.g., numbers, locations, composition, employment) 	Census data, District /State statistical Diary/ Profile
	<ul style="list-style-type: none"> Health facilities 	Census data, District /State statically Diary/ Profile
	<ul style="list-style-type: none"> Education facilities 	Census data, District /State statically Diary/ Profile
	<ul style="list-style-type: none"> Socio-economic conditions (e.g., community structure, family structure, social well-being) 	Census data, District /State statically Diary/ Profile
	<ul style="list-style-type: none"> Physical or cultural heritage current use of lands and resources for traditional purposes by Indigenous 	By Conducting Survey, District /State statically Diary/ Profile
	<ul style="list-style-type: none"> 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

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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- 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 Vairengte is a combination of new alignment (as bypasses) and improvement of existing road with NH-37 up to Kasipur, Partially using Silchar Bypass up to Sonabarighat & NH-306 up to Lailapur. Total design length of project road is 46.0km. The Entire Project road passes through Cachar district. The kolasib district 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 occupies an area of 3786 km². Silchar town is the administrative headquarters of the district.



	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 8: Environmental Screening and Initial Environmental Assessment</p>	
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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, Lakhimpur, Barkhola and Katigora. 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, Dimas 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.

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 hot 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.

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8.4 Environment Screening

The main objectives of the study are: i) identify the impacts of the project improvement on environment and ii) alleviate the unsafe condition and congestion of the existing highway on NH 306 by enhancing the capacity and quality of the road to the users in a sustainable and environment friendly manner.

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

Key Environmental Laws & Policies:

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

- *EIA Notification, September 2006 & subsequent Amendments*
- *The Environment (Protection) Act, 1986*
- *The Water (Prevention and Control) Act, 1974*
- *The Air (Prevention and Control) Act, 1981*
- *The Indian Forest Act, 1927*
- *The Karnataka Forest Act, 1963*
- *The Forest (Conservation) Act, 1980 (as amended in 1988)*
- *The Forest Conservation Rules, 1981*
- *The Wildlife Protection Act, 1972*
- *The Hazardous Waste (Management and Handling) Rules, 1989*
- *Fly ash Notification, 2009*
- *The Ancient Monuments and Archaeological Sites and Remains Act 1958*
- *The Motor Vehicles Act 1988*
- *Public Liability Insurance Act, 1991*
- *Coastal Regulation Zones Act*
- *The Factories Act 1956*

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

Baseline Environment:

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

Analysis of Alternatives:

The National Highway NH-306 is an existing Highway being up-graded with new alignment, except for minor realignments for improving the road geometrics and for smoothening the sharp curves and bypasses to avoid narrow and congested stretches of the project road. Hence analysis has been done only for bypasses in terms of alternatives to alignment. Different cross section alternatives have been considered for proposed stretch of the project road. Different cross section alternatives have been considered for the project to suit the different classes of land uses and reduce the impact of land acquisition.

Stakeholder Consultation:

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

Anticipated environmental impacts and mitigation measures:

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

Environmental Attributes	Physical Environment			Biological Environment		Geology		Topo- graphy
	Air	Water	Noise	Flora	Fauna	Natural Drainage	Soil	
I. Construction Phase								
Labour Camp Activities		-ve/t						

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



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

Environmental Management Plan:

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

Conclusion:

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

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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-306 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 Aizwal. 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

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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

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: Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)

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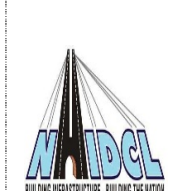
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9 Chapter 9 – Preliminary Cost Estimate Chapter

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”.

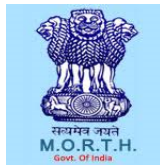
Rates has been analysed based on prevailing material rate and hire charge of plant and equipment mentioned in the SOR Assam 2020-21 and has been escalated as per WPI indices.

The project road is divided into eight packages as shown in the following table and the estimates are presented separately for each package The instant Package-2 is from Dhanehari at km.20+000 /Ex. Ch. 12+920 toward Vairengte km. 49+360/ Ex. Ch. 43+000 in the State of Assam.

Table 9.1 Package Distribution

Sl. No.	Construction Packages	Design Chainage			Existing Chainage			State
		From	To	Length (km)	From	To	Length (km)	
1	PKG-01	0+000	20+000	20.000	263+800 (Of NH-37)	12+920 (Of NH-306)	18.820	Assam
2	PKG -02	20+000	*49+360	29.360	12+920	43+000	30.080	
3	PKG -03	*46+000	**60+850	14.850	43+000	59+700	16.700	Mizoram
4	PKG -04	**61+000	77+500	16.500	59+700	86+000	26.300	
5	PKG -05	77+500	95+500	18.000	86+000	107+850	21.850	
6	PKG -06	95+500	111+850	16.350	107+850	126+315	18.465	
7	PKG -07	111+850	125+500	13.650	126+315	142+060	15.745	
8	PKG -08	125+500	136+400	10.900	142+060	158+900	16.840	
	Total Design Length			139.610			164.800	

* EQ (km 49+360 = km 46+000) ** EQ (km 60+850 = km 61+000)



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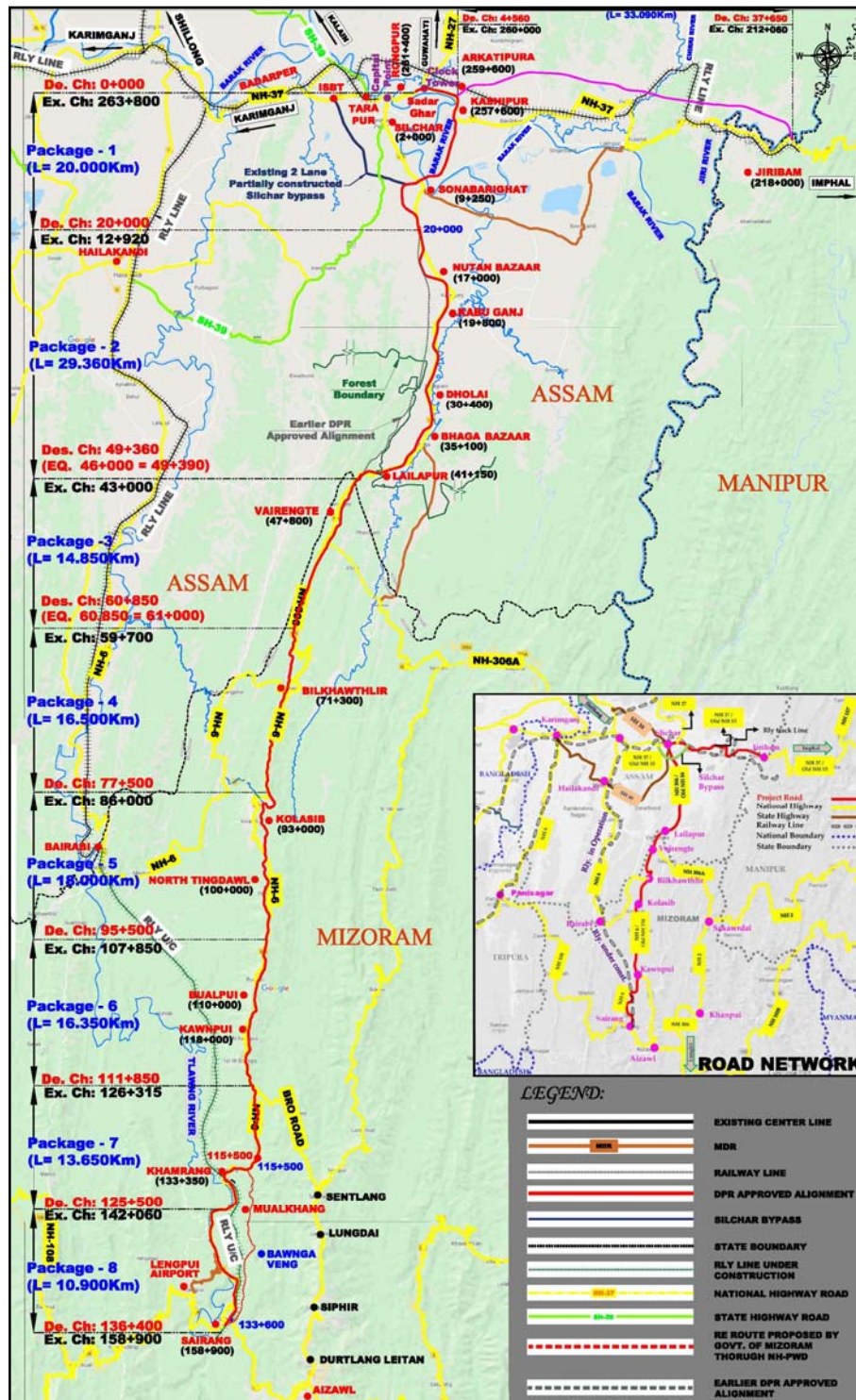


Fig 9.1 Key Plan for Proposed Construction Packages

9.3 Cost Estimate

In general, the work is to be executed as per the Technical Specifications contained in “Specifications Road and Bridge Works” (Fifth Revision) issued by MOR&TH, with suitable modifications depending on the project requirements.



The quantities of major items of work have been worked out based on typical cross sections, detailed survey and preliminary designs. The following are the major items of works, which have been estimated separately:

Table 9.2 Summary of Estimate Items

Bill No.	Item of works
A	Highways
1	Site Clearances
2	Earthwork
3	Granular Sub-Base & Base Courses
4	Bituminous Base & Surface Courses
5	Drain works
6	Protection Works
6A	Reinforced earth wall
6B	Retaining wall/ Toe wall
6C	Breast Wall
6D	Slope protection work
7	Traffic Signs, Markings & Road Appurtenances
8	Miscellaneous works
9	Cross Drainage Works
9A	Box Culverts
10	Bridges
10A	Minor Bridges
11	Vehicular Underpasses
11A	LVUP
11B	VUP
12	Vehicular Overpass

9.4 Site Clearance

Site clearance quantity is estimated, as overall area required clearance for construction of road. It includes necessary excavation, back filling, grubbing & disposal of cleared material etc. The area has been calculated considering the width between the proposed toe lines on both sides.

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9.5 Earth Works

The earthwork quantity is calculated from cross-section generated by the design software MX Road and presented in excel sheet. Considering the uneven surface of existing ground, the calculation is done at 10m intervals to increase the accuracy of quantity of earthwork. Earthwork quantities are calculated as per the proposed cross sections and cut/fill slopes @ 10m interval. The bridge gaps and all other structures are considered for deduction for the earth work and also for different pavement layers

- Earthwork in cut/fill have been calculated considering: in case of fill sections – up to bottom of subgrade level; in case of cut sections – up to top of subgrade level.
- An average lead of 1km has been considered for the disposal of cut material.
- Average lead of earth material from borrow pit is 5 km. Earth for filling embankment has been borrowed from private land and or government land. 40% of total borrowed earth has been met from private land and 60% from government land.
- 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 from roadway cutting top soil and top soil came from Clearing and grubbing.
- Geo grid layer was placed before proceeding with embankment filling since there is saturated soil with moisture.
- 150mm thick Sand blanket layer was placed at a depth of 1.5m below Finish road level as a capillary cut-off layer so that moisture capillary couldn't enter in to the subgrade layer in a stretch of weak strata.

9.6 Pavement Material



The quantities are calculated as per the proposed cross-sectional width including extra widening at curves, junctions @ 10m interval. At junctions, the area of improvement has been measured in AutoCAD and accordingly quantities are calculated.

Type of pavement – Flexible

Flexible pavement includes BC (Bituminous concrete), DBM (Dense bituminous macadam), WMM (Wet mix macadam), WMM (Wet Mix Macadam), biaxial geogrid layer underneath WMM and GSB (Granular Subbase). Crust for flexible pavement are 40mm BC, 60mm DBM, 150mm WMM and 300mm GSB (two layers each has 150mm thick).

9.7 Cross Drainage Structures, Underpasses and Flyovers

The construction of new bridges, underpasses, interchanges and culverts are assessed on proposed length and the earthwork, pavement and shoulders for bridge

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approaches have been included as appropriate roadwork items. The other items like RCC and PCC work of bridges, culverts and Underpasses are calculated as per design and drawings.

9.8 Drainage and Protection Works

9.8.1 Longitudinal Drains

PCC open longitudinal drains have been provided throughout the length on hill side. If the valley side is in cut, drain has been proposed on valley side also. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII**.

9.8.2 Reinforced Earth wall

There are all together three location where reinforced earth wall has been proposed. In approach of flyover, LVUP and VUP and also on approach of overpasses reinforced earth wall has been provided. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII**.

9.8.3 Breast Wall

Breast walls are provided to protect uphill slopes, which fail by slumping, sliding, toe failures and failures below formation level. PCC/RR Masonry/Gabion breast walls has been proposed at open areas. There are two types of PCC and Gabion breast wall has been considered in this package. For height upto 5m PCC breast wall has been considered and height more than 5m gabion breast wall was been considered. PCC breast detailed locations and quantity calculations are given in **Volume-VI, VII & VIII**.

9.8.4 Retaining wall & Parapet Wall

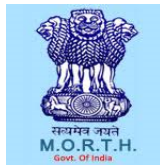
Retaining walls have been proposed, a) where the existing ground is steep and embankment is not feasible b) to restrict the formation width at RoW constraint locations. Retaining wall are of two types PCC and Gabion. Detailed locations and quantity calculations are given in **Volume-VI, VII & VIII**.

For heights up to 5m PCC and for heights more than 5m gabion retaining walls have been proposed. For PCC parapet walls over PCC & Gabion retaining wall has been proposed.

Slope Protection - Location and quantities are given in **Volume-VI, VII & VIII**.

Fill Slope Protection –

Embankment fill side slope has been protected with Turfing for height less than 4m. and for embankment greater than 4m high, side slope has been protection with geo green blanketing, which is anchoring of the blanket of natural geotextile made from coconut fibre reinforced with closely woven polymer nettings and seeds broadcasting on the treated site.



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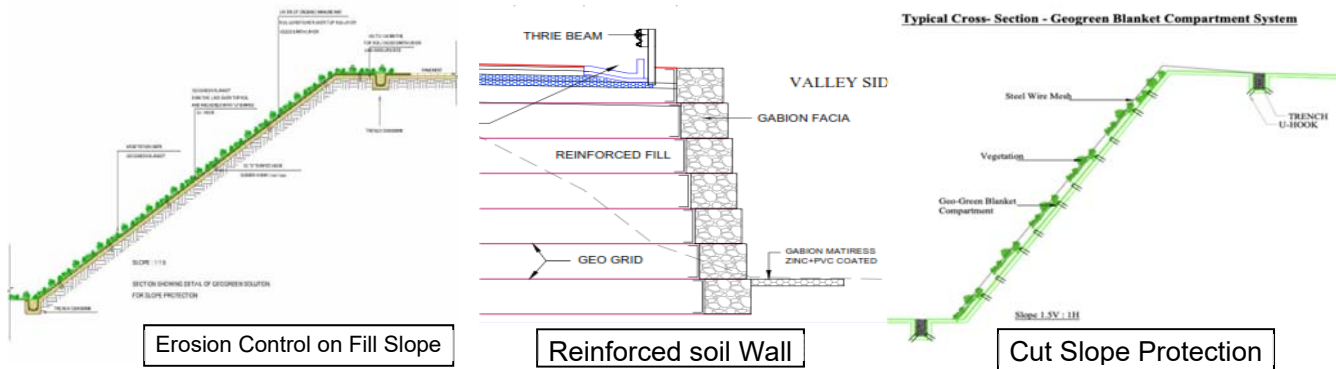


Fig 9.2 Protection Wall

Reinforced soil wall - installation of Gabion fascia wall with geogrid with vegetation.

Cut slope protection - geo composite product with Soil nailing, made from natural coconut fibre reinforced with closely woven polymer nettings impregnated with seeds.

9.9 Road Junctions, Interchange, Bus Stops and Truck Lay Bys

The quantities for Road junctions, Interchanges has been referred from "Type designs for Intersections on Economic Corridor" published by MoRTH and for safety measures like truck lay-byes and Bus Stops etc have been referred from IRC:SP:84-2019. Quantities have been calculated based on the Design drawings provided in the Drawing Volume Report.

9.10 Traffic Signs, Markings & Other Road Appurtenances

Provision have to be made for the traffic safety all along the stretches of the proposed road i.e. road sign- mandatory, informatory & cautionary, road markings, way side amenities etc. as per IRC: 35-1997, IRC: 67-2012.

9.11 Toll Plazas- Nil

9.12 Other Miscellaneous Works

Provision for Traffic Management and Miscellaneous has been taken in the estimate. The following items are considered in the Estimate. Street lighting is provided at the locations of built-up areas, toll plaza, bus stops, truck lay byes, underpasses, flyover and throughout length of service road and slip road. High Mast lightings are considered at all major junctions and toll plaza locations.

9.13 Land Acquisition and Compensation for Structure

The land for bypasses and new alignment has been acquired in varying width as per site requirement. Land acquisition requirements also cover the provision of Service Road.

Toll Plaza, Lay-Byes and Interchange etc. will require additional land to accommodate the proposed carriageway facility. Based on alignment design, land and structure acquisition cost including rehabilitation and Resettlement costs are assessed.

The LA cost has been assessed based on tentative rate obtained from revenue department however, final LA cost is updated in final DPR only after CALA verified estimate which is in progress at moment.

9.14 Rehabilitation and Social Costs

The rehabilitation and social costs of the project-affected people have been assessed based on the assumption (with multiplication factor of 2 but without solatium) however, final R&R cost will be incorporated after CALA verified estimate during FDPR stage.

9.15 Environmental Improvement Works

The cost of environmental improvements works including the cost of tree cutting, replanting, monitoring during construction i.e., all the civil and non-civil works have been included in the project cost estimate.

9.16 Rate Analysis

9.16.1 Basic Rates

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 analysis of rates has been done with Standard Data Book 2019 published by IRC.

A comparative state of rates have also been prepared with escalated rates of SOR 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:

S. no.	WPI Index at year of SOR	WPI Index for current year 2021-22	Percentage of escalation
SOR 2013-14	112.50 (Year 2013-14)	139.40	24%
SOR 2021-21	123.40 (Year 2020-21)	139.40	13%

Year	WPI Index
2013 - 14	112.5
2014 - 15	113.9
2015 - 16	109.7
2016 - 17	111.6
2017 - 18	114.9
2018 - 19	119.8
2019-2020	121.8
2020-2021	123.4
2021-2022	139.4

From the above table adopted percentage rate of escalation for SOR 2020-21 to arrive at current fiscal year 2022-23 is 13%. Since there is no circular or guidelines to apply escalation on SOR rates, the same SOR is applicable for the year till revised SOR is published. Hence SOR 2020-21 has been adopted for current fiscal year.

For comparison, Rate have been analysed using standard Data Book 2019 for current fiscal year considering the basic rates of material, labour and machineries referred from SOR and escalated basic rates up to current fiscal year and considering input for analysis of rates.

9.16.2 Basis of Analysing item rates



Rates are analysed as per Standard Data Book 2019. 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 2013-14 and escalated @ 18.45% to arrive at the current rates. Adopted labour rates are tabulated below:

Table 9.3 Man power Charges

Sl. No.	Description of Labour	Unit	SOR Assam 2020-21	Escalated by 13% for 2022-23
L-01	Blacksmith (IInd class)	day	380.79	430.00
L-02	Blacksmith (Ist class)/ Welder/ Electrician	day	500.47	566.00
L-03	Blaster (Stone cutter)	day	315.42	356.00
L-04	Carpenter I Class	day	500.47	566.00
L-05	Chiseller (Head Mazdoor)	day	380.79	430.00
L-06	Driller (Jumper)	day	380.79	430.00
L-07	Driver	day	380.79	430.00
L-08	Fitter	day	402.55	455.00
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

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

9.16.5 Lead & Basic rate of materials including carriage charges

The conveyance of materials from source of supply to final placement may be in stage or in multi stage, depending on the nature of works. The conveyance of materials within the site area is reckoned as “initial lead” and is generally included in the basic rate provided in the SoR. The lead up to the site/plant is reckoned as “Additional lead”.

While estimating lead of materials, the consultants assumed that:

- Moorum, boulders, filler materials, and granular materials for embankment protection works and granular sub-base would be directly transported to the construction site, and
- Stone boulders, spalls, sand etc would be transported to the plant location and ready mixed material such as concrete, bitumen mix then be carried to the work site.

9.17 Material Rates

9.17.1 Plant Location



The following locations have been considered for WMM/Bitumen/Concrete plants to arrive at the lead of various construction materials, which will be subsequently used in the analysis of rates. These locations are arrived considering the terrain, location of built-up areas, package limits and minimum lead distances from plant to site.

Plant location – 1 km on RHS. At Existing Ch 34 +500 NH-306 (near Rajanikhal).

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

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rate has been adopted for rate analysis. Cartridge cost from source to plant location has been added to arrive rate at site.

Lead from Star Cement, 2nd Floor Mayur Garden G.S. Road Opp. Rajiv Bhawan, ABC, Bhangagarh, Guwahati, Assam 781005.

Lead Calculation:

Cement source at Guwahati to Km. 0+000 NH-306 is **310.50 km** via NH-53.

Add average lead from Km. 0+000 NH-306 up to plant location at 34+500 – **35.50 km**

Total lead from source to plant location is **346.00 km**

Table 9.4 Rate Adopted for cement

Basic Rate March 2022 as per cementprice.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 rate are valid in all district of the Assam, Lead from Silchar market to km 0+000 NH-306 is **3.40 km**.

Add average lead from Km. 0+000 NH-306 upto plant location at 34+500 – **35.50 km**

Total lead from source to plant location is **39 km**

Table 9.5 Rate Adopted for steel

Basic Rate as per SOR 2020-21	Escalated rate @ 13%	Lead charges i/c loading and unloading	Total rate of steel
Rs. 46,200/MT	Rs. 52,206/MT	Rs. 382/MT	Rs. 52588/MT

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9.17.4 Bitumen

The nearest outlet for bitumen is Haldia refinery in West Bengal which is 1448 km upto plant location P2 at ex. Ch. 34+500 NH-306. 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 50 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	-	3403	60085
Bitumen (60-70 grade) VG-30	49882	MT	-	3403	53285
Bitumen (80-100 grade) VG-10	56682	MT	-	3403	60085
Bitumen (30-40 / 40-50 grade) VG-40	52992	MT	-	3403	56395

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:

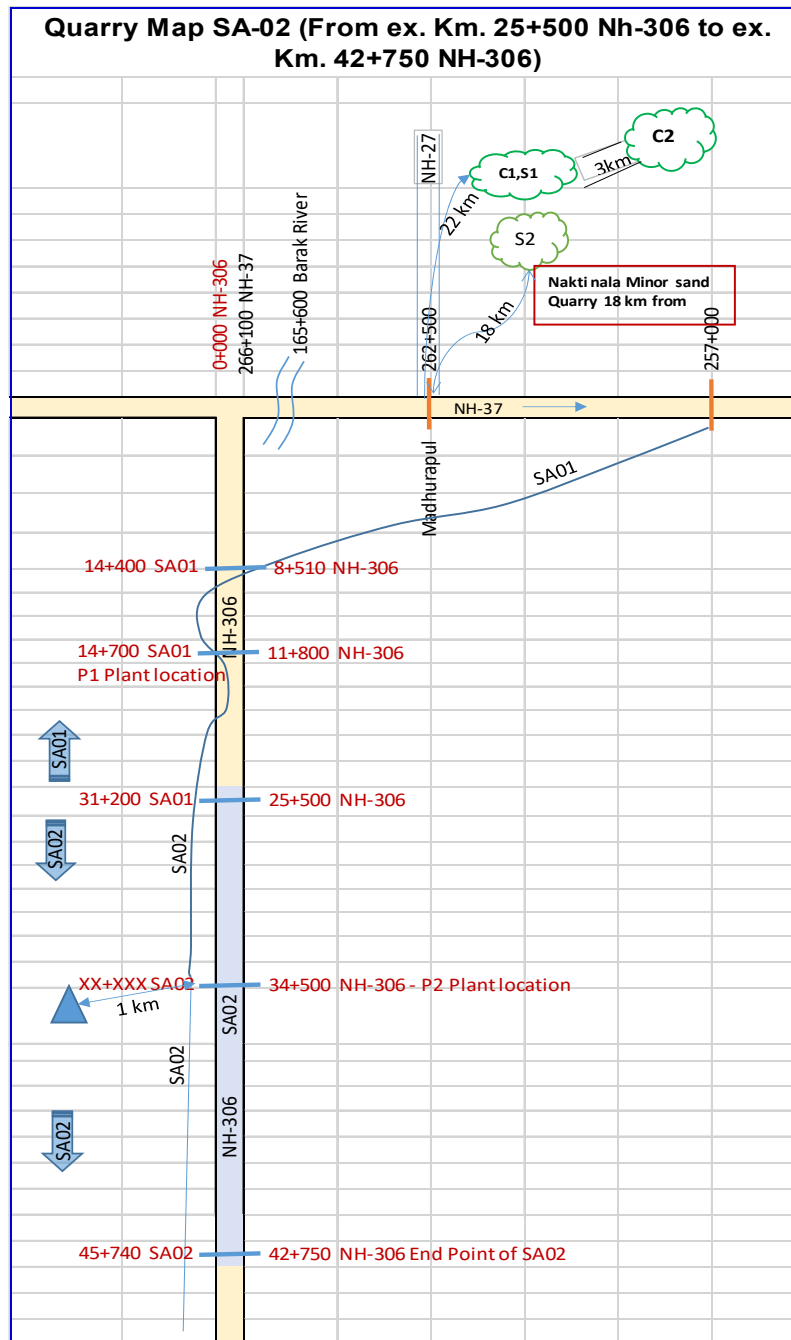




Fig 9.3 Lead Map

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 9: Preliminary Cost Estimate</p>	
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9.18 Overhead and Contractor's profit

Contractor's profit and Overhead charges have been incorporated in the rate analysis in accordance with guide lines in the MoRT&H Standard Data Book 2019 and reproduced as under:

Small project: Civil works cost less than INR 200 Cr.



Medium Project: Civil works cost greater than INR 200 Cr. and less than INR 500 Cr.

Large Project: Civil works cost greater than INR 500 Cr.

Current project fall under category of **large project**. So overhead and contractor' profit considered in the rate analysis for large project are as below:

Overhead for road works	8%
Contractor's profit for road works	10%
Overhead for new/widening/ structure works	20%
Overhead for rehabilitation of bridges/ structure	30%
Contractor's profit for bridge work	10%


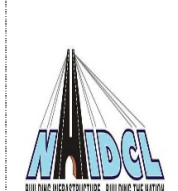
The Summary of Rate analysis is given in Volume-VI, VII & VIII.

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p> <p>Chapter 9: Preliminary Cost Estimate</p>	
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9.19 Project Total Cost

Table 9.7 GENERAL ABSTRACT OF COST

Bill No.	Item of works	Quantity	Cost (Rs. Crores)
A	Site Clearance		0.83
B	Earthwork		124.34
C	Granular Sub-base & Base Courses	29.36 Km.	177.40
D	Bituminous Base and Surface Courses	29.36 Km.	90.73
E	Drains	4330 m.	22.03
F	Protection Works		
	a) Reinforced earth wall	153421 Sqm.	116.89
	b) Breast wall	360 m.	2.05
	c) Retaining /Toe wall	6270.00 Km.	25.21
	d) Slope protection	154428 m.	7.92
G	Traffic Signs, Markings and Other Road Appurtenances	29.36 Km.	54.13
H	Miscellaneous works	29.36 Km.	4.03
I	Cross Drainage Works - Box Culverts		
	a) Pipe Culverts		7.66
	b) Box Culverts		28.30
J	Bridges		
a	Minor Bridges	5035.48 Sqm	29.71
K	Underpasses		
	a) LVUP	2564.86 Sqm	11.89
	b) VUP	4203.84 Sqm	24.87
L	Vehicular Overpass	738.75 Sqm	4.77
1	Cost of Civil Works (in Crores)		732.76
2	Utility Shifting Cost		18.27
3	Cost of Civil work i/c utility shifting		751.03
4	GST @18% on (3)		135.19
5	Land Acquisition and Rehabilitation & Resettlement cost		705.08
7	Environment and Forest clearance cost		12.76
8	Supervision Charge 2.5% of (2) + GST @ 18%		0.54
9	Contingency @ 1% of (1)		7.33
10	Agency Charges @ (3% of (1) + 1% of (5)) + GST @ 18%		34.26

	<p>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)).</p> <p>Section : Vairengte to Sairang (Package-2, mod. from Km 20+000 to Km 49+360)</p>	
	<p>Chapter 9: Preliminary Cost Estimate</p>	

Bill No.	Item of works	Quantity	Cost (Rs. Crores)
11	Supervision Charge @ 3% of (1)		21.98
12	Price Adjustment @ 5% of (1)		36.64
13	Maintenance @ 2.5% of (1) + GST @ 18%		21.62
14	Utilty Cost of PGCIL Towers		18.16
15	Additional compensation (Land + tree+ asset) for 540m length falls under cacher forest but physically control under Gov. of Mizoram		12.25
16	Total Project Cost		1756.84
17	Length of the project road (Km)		29.36
18	Total Civil Cost per km		25.58
19	Total Project Cost per km		59.84

