



Ministry of Road Transport and Highways  
(GOVERNMENT OF INDIA)

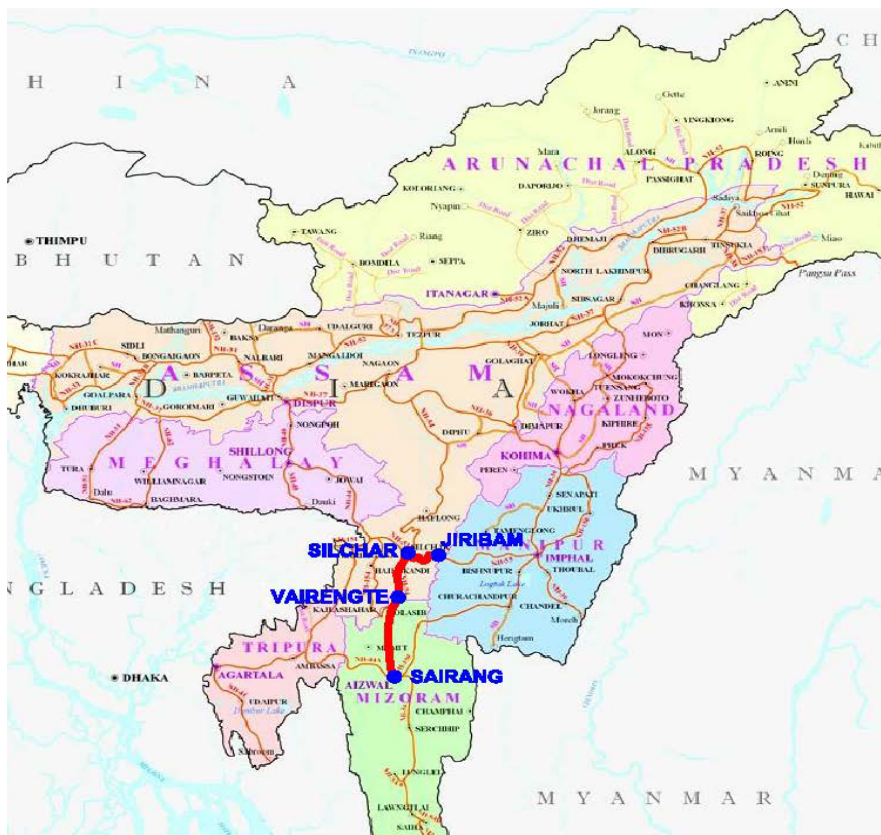


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**Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9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

**January 2023**



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**DRAFT DETAILED PROJECT REPORT**

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

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



**Vol-II**

**Design Report (Highway)**

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**Section: Silchar to Vairengte (Package-2, mod. from 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)).

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



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## 1 Volume-II Design Report (Highway)

### 1.1 Introduction

**Bharatmala Pariyojana** is a mega plan of the government and the second-largest highways project after the NHDP. Many defined highway stretches totaling 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. 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 neighboring countries. . This would lead to the formation of a more integrated and economically consolidated South and South East Asia. The company would also endeavor 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.

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.

## 1.2 Objective of Document

This Design Report presents the work approach & methodology proposed to be adopted by the Consultants while preparing the designs and drawings for the project. The report primarily covers the design philosophy, various standards & codes of practices, various bridge furniture details, design methodology, design & drawing standards, road safety features etc. which will be followed for development of economic corridors in terms of 4-lane access controlled.

This document aims at standardizing the procedure of designs to be performed in order to achieve techno-economic feasibility, financial viability of the project aspects of value engineering, requirement of quality & safety, safety of operation and efficient maintenance of the facility, durability and conformance to standards, optimization and ease of construction. The aim is also to highlight the basic philosophy of design and the work approach to the Client and Authority engineer at the start of project so that any input from client / IE can be taken care at the early stage of the project for incorporation in designs.

## 1.3 The Project Highway

### As per Contract Agreement (CA)

As per CA the Project stretch Silchar to Vairengte is the section of NH-306 (old NH-54) start at the junction of NH-37 (old NH-53) at km 266+700 and Km 0+000 of NH-306 (Capital point) in Assam State and ends at Km 49+900 of NH-306 near Phainuam Junction of NH 306A at Vairengte town in Mizoram State for approximate length of 49.9 Km.



### **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.

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. 46+000 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.**

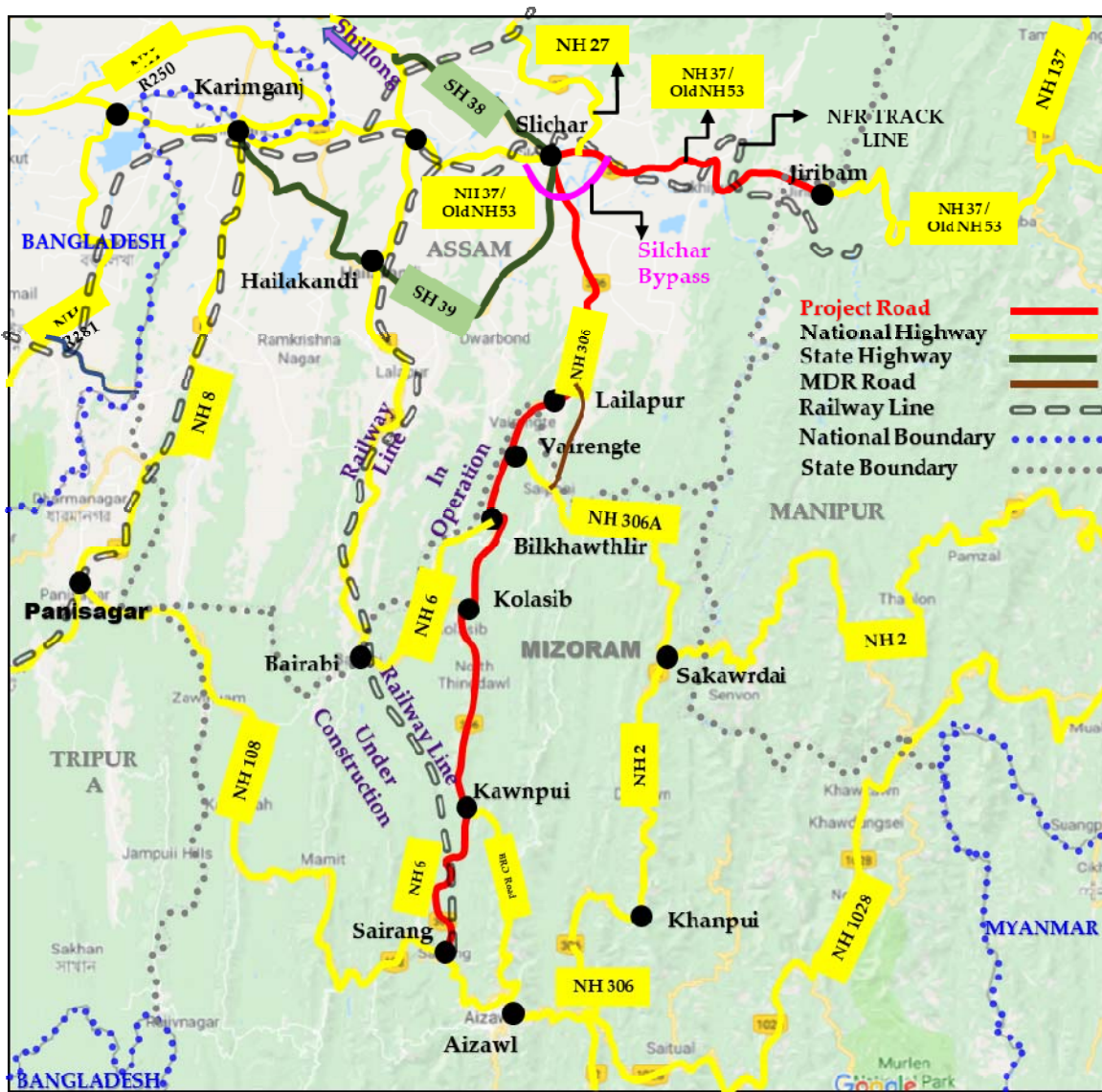
The latitude and longitude of the start and end point of the project road are as given in below table.

**Table 1.1 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

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

The key plan diagram of project road is showing below;



**Fig 1.1 Key Plan of Project Road**

In addition, this report mainly deals with Package-1 that starts at existing Km 263+800 of NH-37 (D. Chainage 0+000) and ends at Existing Km 12+920 of NH-306 (D. Chainage 20+000) however, for better comprehension DPR consultant has furnished the details from Sicha to Vairengte state border.

#### 1.4 Project Site Appreciation

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, Manipur, Guwhathi, Silchar and other parts of Assam. The project road is the single source of trade for Mizoram and International trade like Mayanmar and Bangladesh. Hence the project road needs to be improved on priority under Bharatmala Pariyojana as an Economic corridor.

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 in table;

**Table 1.2 Details of Homogenous road sections**

Section	Homogenous Section	Chainage (Existing)		Length (Km)
		From (Km)	To (Km)	
Section – 1	Silchar to Vairengte	0+000	42+750	42.75

**Note:**

The stretch between Km 0+000 to Km 7+950 (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*

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

The project road has 14.0m wide carriageway for 800m, 10.0m wide carriageway for 37.100 Km, 7.0 m carriageway for 3.5 Km, and 7.5 km is under construction flying along Silchar bypass.

- Throughout the project road, the type of pavement is of bituminous type 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 subbase as subbase course on varying type of sub grade all along the project road. Results of the test pit survey indicate appreciably varying thickness of pavement layers for the carriageway. Total thickness of the pavement is varying between 100 mm and 540 mm. The thickness of bituminous layer is varying between 80mm-120mm.
- The existing pavement surface condition varies from Poor to Fair for the project road length from Km 7+950 to Km 43+000 as per condition survey was conducted in the year 2018. However as per the latest site visit during February 2020, the road maintenance work was in progress by NH-PWD / NHIDCL department at some locations along the project road.

**Table 1.3 Existing road configuration with Condition**

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) (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) (Silchar Bypass)
4	7+950	12+100	4150	10.00 m	Uttar Krishnapur-Saidpur	Package-1 (263+800 to 12+920) (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)
7	13+000	22+000	8800	10.00m	Sildubi point to Kabuganj	
8	22+000	25+500	3500	10.00 m	Kabuganj to Jalenga	

Sl No	Existing Chainage		Length	Lane Configuration (as per site inventory)	Section	Remarks
	From	To				
9	25+500	40+400	14900	10.00 m	Jalenga to Lailapur	Package-2 (12+920 to 43+000)
10	40+400	43+000	2600	7.00 m	Lailapur-Vairengte	

- The project road passes through rolling and hilly terrain. 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 land use along the project highway is 56.00% Built up Area, 12.00% Semi Built up Area, 29.00% Agricultural Land and 4.00% Hill cum Forest Area.
- The important habitations along the project road are Rongpur, Kashipur, Sonabharighat, Nutan Bazar, Kabuganj, Dolhai and Baga Bazar. The other important built-up areas are Saidpur Mukkam, Narsingpur, Katalak, Panibhora, Ramprasadpur, Saptagram, Islamabad and Lailapur. The Project road lies in Cachar district. Details of these built-up areas are given below:

**Table 1.4 Land Use pattern and villages /Towns along 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	
5	20+000	18+100	1900	50	Kashipur	Silchar Bypass Package-1 (263+800 to 12+920)
6	18+100	15+300	2800	50	Badripar	
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	



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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				
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	NH-306 Package-2 (12+920 to 43+000)
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	
32	38+000	38+500	500	20	Howaitang	
33	38+500	39+500	1000	20	Joydhanpur	
34	39+500	41+000	1500	20	Lailapur	
35	41+000	43+000	2000	9	Borkhal	

- 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 vary from 20 to 25m along the entire stretch. The existing ROW along the stretch is given in following.

**Table 1.5 Details of Proposed and Existing RoW**

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
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



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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.	Design Chainage (m)		Length (m)	Ex. ROW (m)	Proposed ROW (m)	Additional ROW (m)	Area of additional land to be acquired (Sqm)
	From	To					
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
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





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

## Volume II-Design Report (Highway)



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					
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
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



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



## Volume II-Design Report (Highway)

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					
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
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



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

## Volume II-Design Report (Highway)

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					
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
125	at major junction	31+600		3914.703	26524.990	22610.287	22610.287



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

## Volume II-Design Report (Highway)

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					
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							

- There are 54nos. of existing culverts, out of which 5nos are Slab on NH-306, 10nos are Box on NH-37 and 39 are Pipe culverts, out of which 15nos are on Silchar bypass and 24 nos. are on NH-306 along Silchar to Vairengte Section. However, as per Package-1 there are 01 nos of Slab culvert on NH-306, 10 nos.

of Box on NH-37 and 16 nos. of pipe culvert, out of which 15 nos. are on Silchar bypass and 01 no is on NH-306.

- In Silchar to Vairengte Section, 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.

**Table 1.6 Salient features of existing road**

Sl. No.	Particulars	Existing Details Silchar to Vairengte to Sairang Section	Existing Details Package-1
1	Start	Km 263+800 on NH-37	Km 12+920
2	End	Km 43+000 on NH-306	Km 43+000
3	Total Length	48.900 Km	30.08 Km
4	District	1 No (Cachar)	1No (Cachar)
5	Major Bridge	01 nos (Constructed up to A1, P1 and P2 & Abandoned)	NIL
6	Minor Bridge	09 Nos	05 Nos
7	Culverts	53 Nos	34 Nos = 30 no's HP, 04 no's Slab Culverts
8	Level Crossing/ROB/ RUB	Nil	Nil
9	Major Junction	08 Nos	05 Nos
10	Minor Junction	95 Nos	76 Nos
11	Villages/Towns	30 Nos	18 Nos
12	Existing Pavement	Flexible	Flexible
13	Terrain	Rolling & Hilly	Rolling
14	Soil Type	Silty and Clay	Silty and Clay
15	ROW	8 to 12m	8 to 12m

## 1.5 Highway Design Proposals

Design and Construction of project highway shall confirm to "The manual of specifications and standards for 4-laning of Highways through Public Private Partnership (IRC: SP: 84-2019).

As the project road is of 4-Lane configuration and accesses the existing alignment barring realignment stretches. The proposed scheme presents the 4-Lane in such a way that the project highway will be operated as a partially controlled access highway so as to improve the safety and operational efficiency of the highway. It passes through Rolling /Hilly terrain. The some portion of the road has Inner line-Forest land. Considering the physical constraints, it is considered desirable that the improvement proposals are conceived and developed under two sets of standards, namely:

- The desirable standards which could be adopted as a rule.
- The minimum standards, which could be accepted for difficult stretches where application of the desirable standards, would lead to additional land acquisition.

Accordingly design standards for geometric elements have been proposed under "desirable" and "minimum" categories. 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.

### 1.5.1 Specifications and Standards

Design and construction of project highway shall conform to the "Manual of specifications & standards for Four laning of highways through public private partnership" (Second Revision) (IRC Publication No. IRC: SP: 84-2019) published by IRC. All circulars issued by NHAI/MoRTH amending/modifying specific clauses of IRC: SP: 84-2019 are applicable.

### 1.5.2 Design Speed

Design speed is the basic parameter, which determines geometric features of the road. As per table 2.1 of IRC: SP: 84-2019 and table 6.1 of IRC: SP: 48, for Mountainous /Steep terrain corresponding ruling and minimum speeds are 60 and 40 km/hr. respectively. In general, ruling design speed has been adopted for the various geometric design features of the road. Minimum design speed, however, be adopted in sections where, ROW is constraint and varying terrain conditions. 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 1.7 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%

### 1.5.3 Cross Sectional Elements

#### 1.5.3.1 Cross-slopes

As per clause 2.8 of 4-lane manual IRC:SP:84-2019, the cross fall on straight sections of carriageway, paved shoulder, paved portion of median and Service Road shall be 2.5% for bituminous surface and 2.0% for cement concrete surface. The cross fall shall be unidirectional for either side carriageway sloping towards the shoulder in straight reaches and towards lower edge on horizontal curves. The camber on the existing road shall be modified to unidirectional cross fall.

Where the project road is passing through Rolling and Hilly terrain, coupled with continuous gradients and high intensity of rainfall calls for effective drainage of roads. Uncontrolled water is the primary cause of problems like erosion of valley side slopes, potholes, rutting, washed out shoulders, and even failure of complete sections of roadway structures. Hence the camber of road is proposed to be uni-directional, completely sloping towards hillside, so that water flows into longitudinal drains on hill side and then to culverts. However, on horizontal curves camber/ superelevation shall be provided as per the direction of curve.

The cross fall for earthen shoulder on straight portion shall be at least 0.5 steeper than the slope of the pavement and paved shoulder, subjected to a minimum of 3%. On super elevated sections, the earthen portion of the shoulder on the outer side of the

curve would be provided with reverse cross fall of 0.5% so that the earth does not drain on the carriageway and the storm water drains out with minimum travel path.

**Table 1.8 Cross fall**

S.No	Description	Design Slope	Remarks
1	Paved Carriageway	2.5% / 2.0%	IRC:SP:84-2019
2	Service roads	2.5%	IRC:SP:84-2019
3	Earthen shoulder	Min. 3.0%	IRC:SP:84-2019

#### 1.5.3.2 Width of carriageway, paved shoulder and earthen shoulder

The highway is proposed 4-Lane standard. The Consultants have studied various alternatives provided/proposed in similar projects, appropriate design standards satisfying the terrain and traffic scenario. Accordingly, the consultants are of the opinion that the minimum effective roadway width for the project road derived and recommended is as given below;

**Table 1.9 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



**Table 1.10 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

#### 1.5.4 Service Roads / 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 1.11 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
<b>Total Length (m)</b>			<b>10755</b>				<b>10575</b>	

#### 1.5.5 Typical Cross - Sections

In accordance with 4-lane and hill road 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. Following table gives detailed description of each type of cross section.

The typical cross sections have been developed as per 4-lane manual. The different types of cross sections to be adopted for the project highway are specified also in schedule B and also below also for ready reference.

**Table 1.12 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 Raod 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	600	Open Area



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



**Volume II-Design Report (Highway)**

Sl. No.	Type of Cross Section		Description	Length (m)	Location/ Remarks
			Wall Protection + 1 x 2.0m ES (Include CB & Drain) on Valley Side		
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 Valley Side with retaining wall	230	Open Area
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 +	500	



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



## Volume II-Design Report (Highway)

Sl. No.	Type of Cross Section		Description	Length (m)	Location/ Remarks
			(1x7.5)m SR including (Include 2x0.25m Kerb shyness) on RHS + (2x1.5m) Footpath cum Drain		
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	
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

Sl. No.	Type of Cross Section		Description	Length (m)	Location/ Remarks
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-1 on subsequent pages.

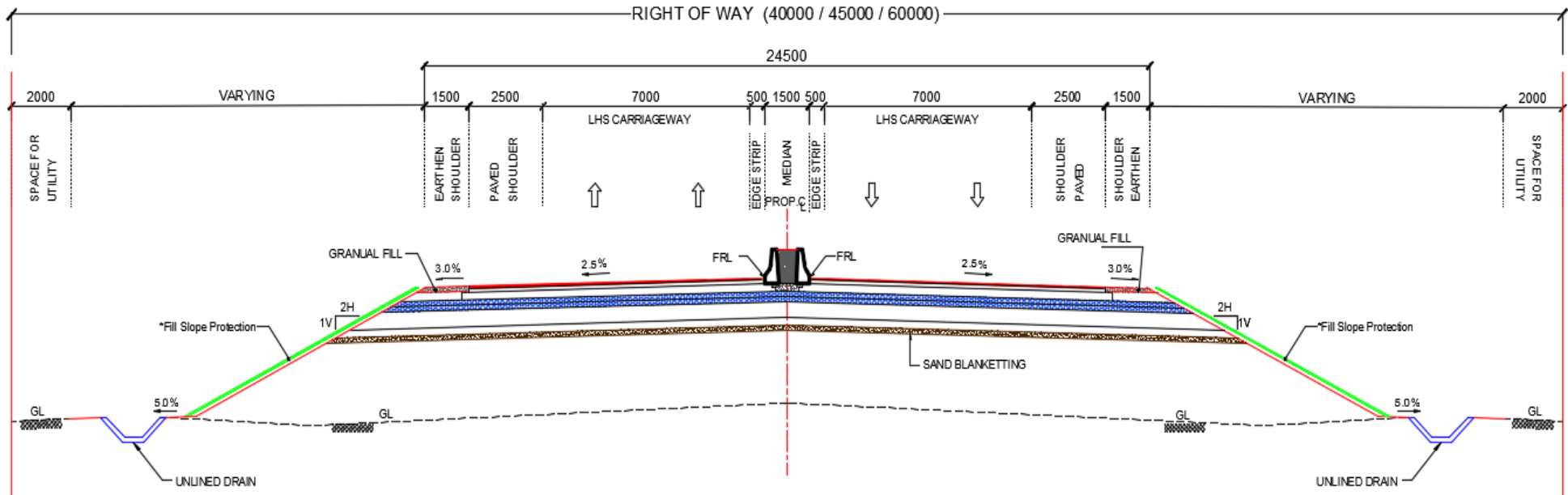


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).



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

## Volume II-Design Report (Highway)



*\*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 1.2** 4-Lane Road with Paved and Earthen Shoulder with 2.5m raised median (TCS-1)

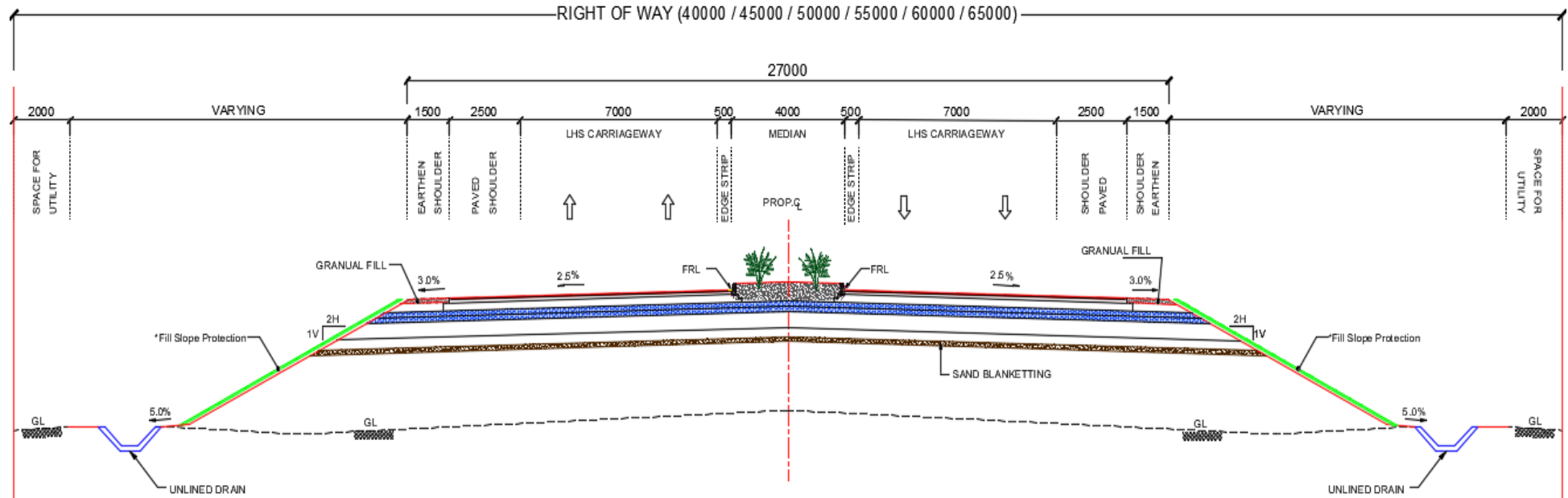


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).



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

## Volume II-Design Report (Highway)



*\*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 1.3** 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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

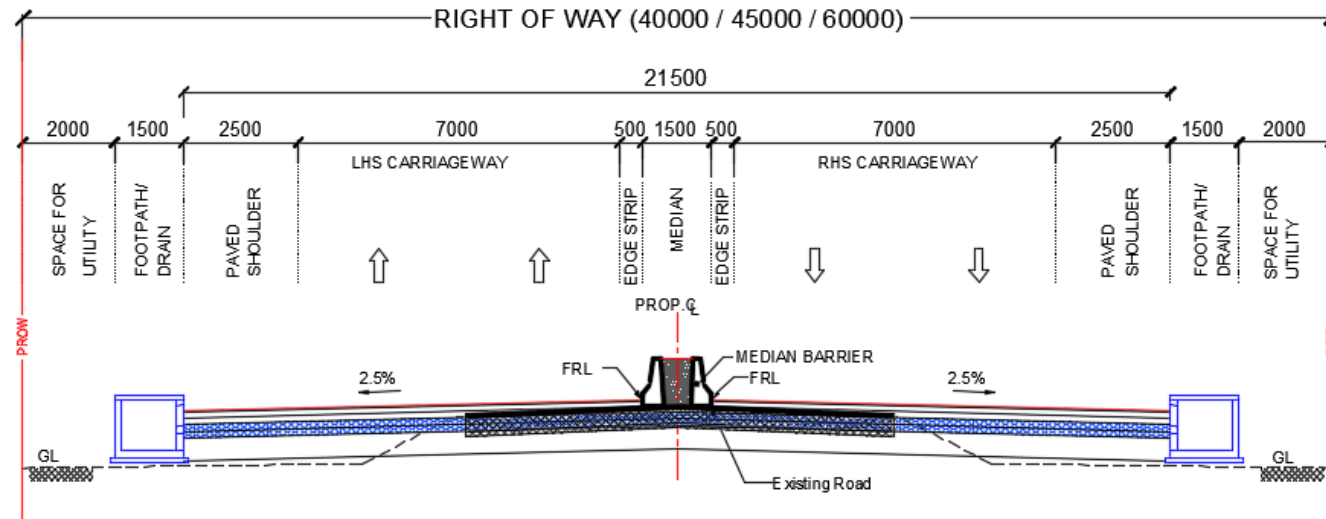


Fig 1.4 4 Lane with Paved Shoulder and RCC Drain on Both Side in Built-up Area along the Existing Road with 2.5 m Median (TCS-3)



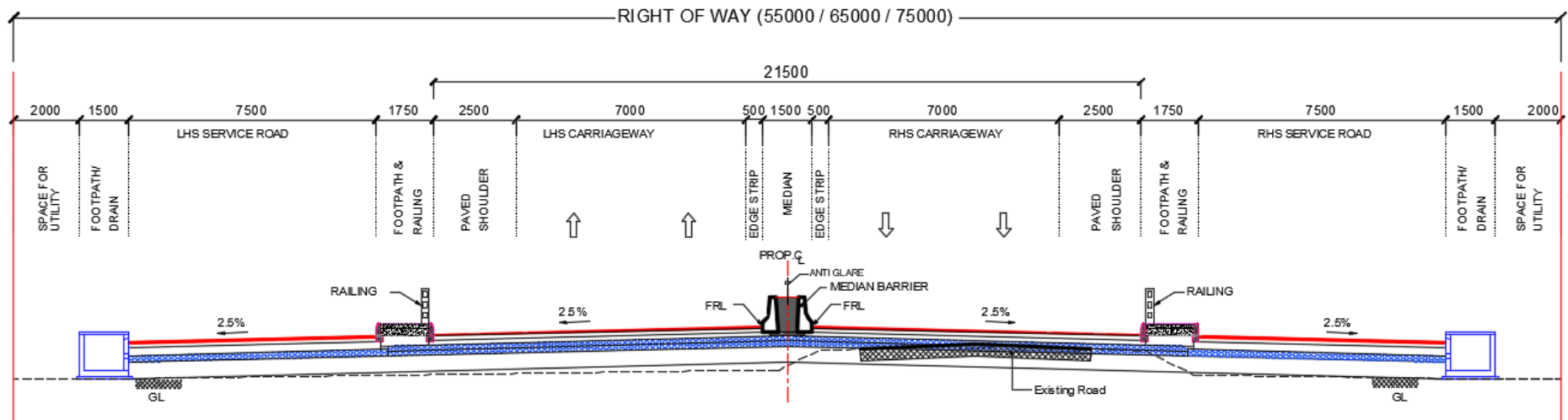


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).



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

## Volume II-Design Report (Highway)



**Fig 1.5** 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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

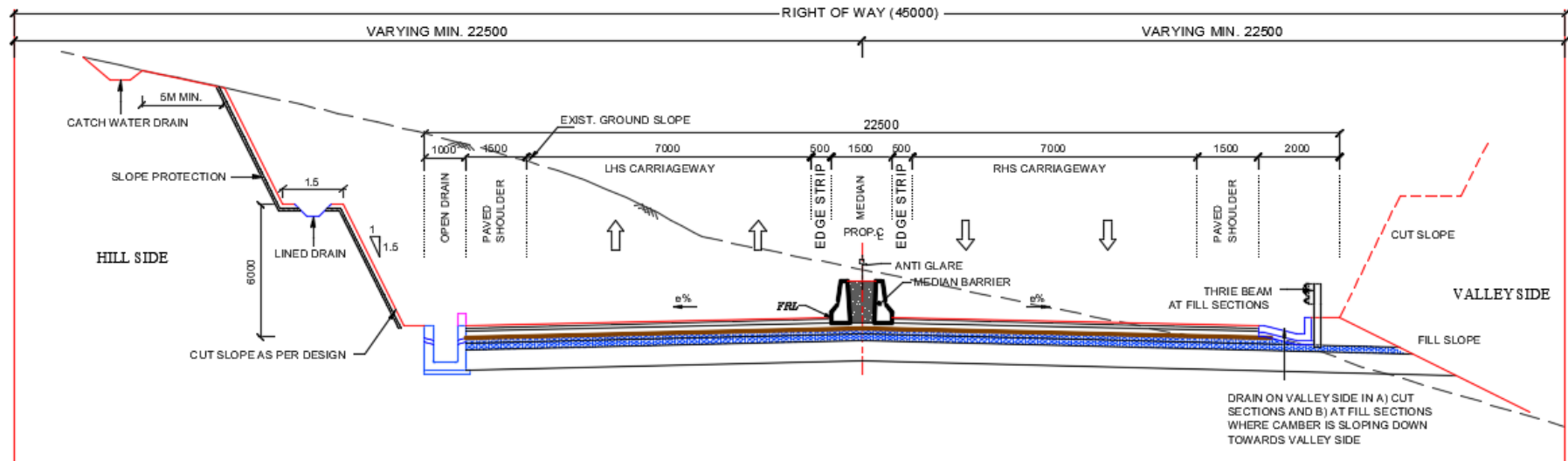
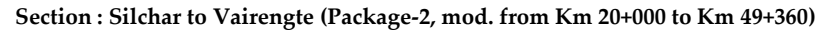
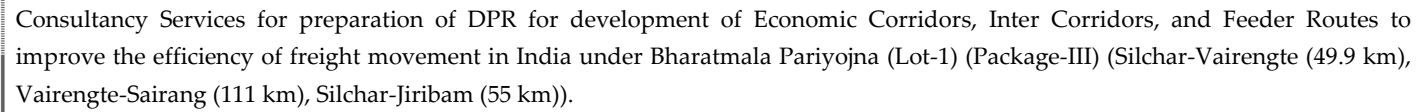


Fig 1.6 4-lane divided highway with Cut on Hill Side and Cut/Fill on Valley Side (TCS-5)



The diagram illustrates a cross-section of a road with the following components and dimensions:

- Top Dimensions:** VARYING MIN. 22500 (left), RIGHT OF WAY (60000 / 110000) (center), VARYING MIN. 22500 (right).
- Hill Side (Left):**
  - CATCH WATER DRAIN (5M MIN. width)
  - SLOPE PROTECTION (1.5:1 slope)
  - LINED DRAIN (1.5:1 slope)
  - CUT SLOPE AS PER DESIGN (6000 height)
  - BREAST WALL PCC/GABION (AT THE LOCATIONS SHOWN IN PLAN)
- Main Roadway (Center):**
  - EXIST. GROUND SLOPE (dashed line)
  - 22500 total width
  - 1000 OPEN DRAIN
  - 1500 PAVED SHOULDER
  - 7000 LHS CARRIAGEWAY
  - 500 EDGE STRIP
  - 1500 MEDIAN (PROP. C)
  - 500 EDGE STRIP
  - 7000 RHS CARRIAGEWAY
  - 1500 PAVED SHOULDER
  - 2000 (right shoulder)
- Valley Side (Right):**
  - CUT SLOPE (dashed line)
  - FILL SLOPE (dashed line)
  - THIRD BEAM AT FILL SECTIONS
  - ANTI GLARE
  - MEDIAN BARRIER
  - PRL (Proprietary Road Layout)
- Additional Notes:**
  - Drain on valley side in A) CUT SECTIONS AND B) AT FILL SECTIONS WHERE CAMBER IS SLOPING DOWN TOWARDS VALLEY SIDE

**Fig 1.7** 4-Lane divided highway with Breast Wall on Hill Side and Cut/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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

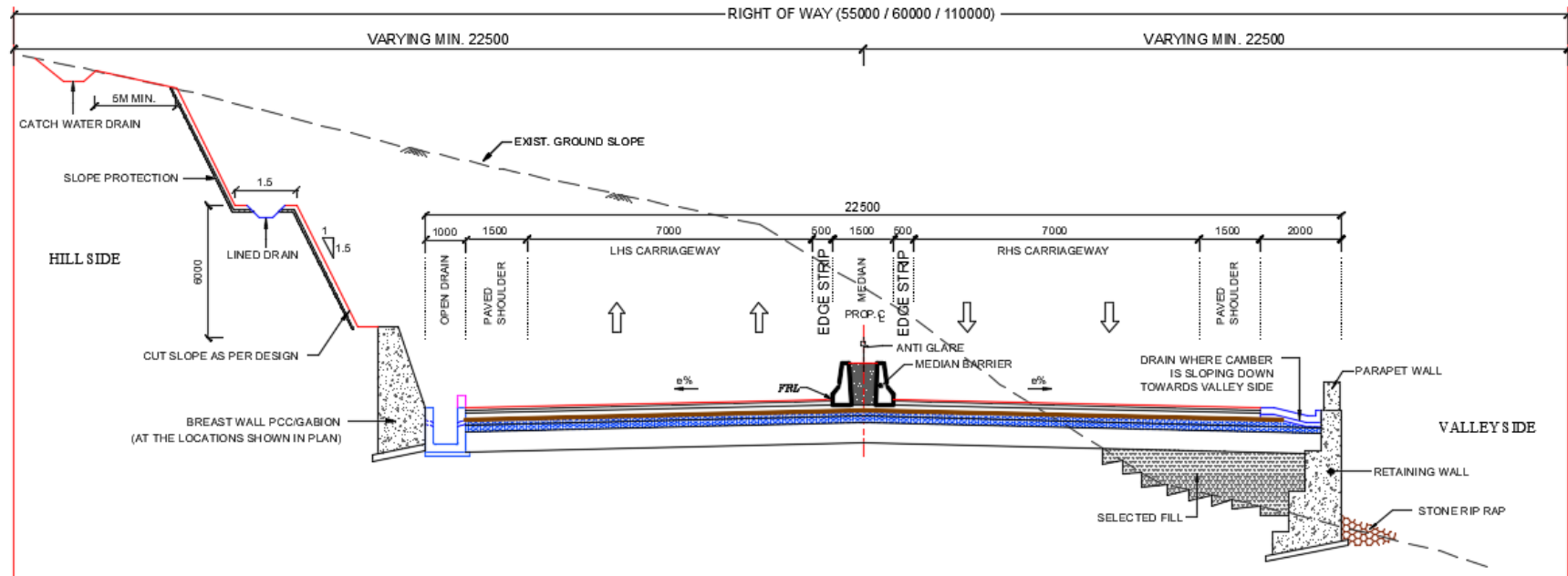


Fig 1.8 4-Lane divided highway with Breast Wall on Hill Side and Realignment wall on Valley Side (TCS-7)

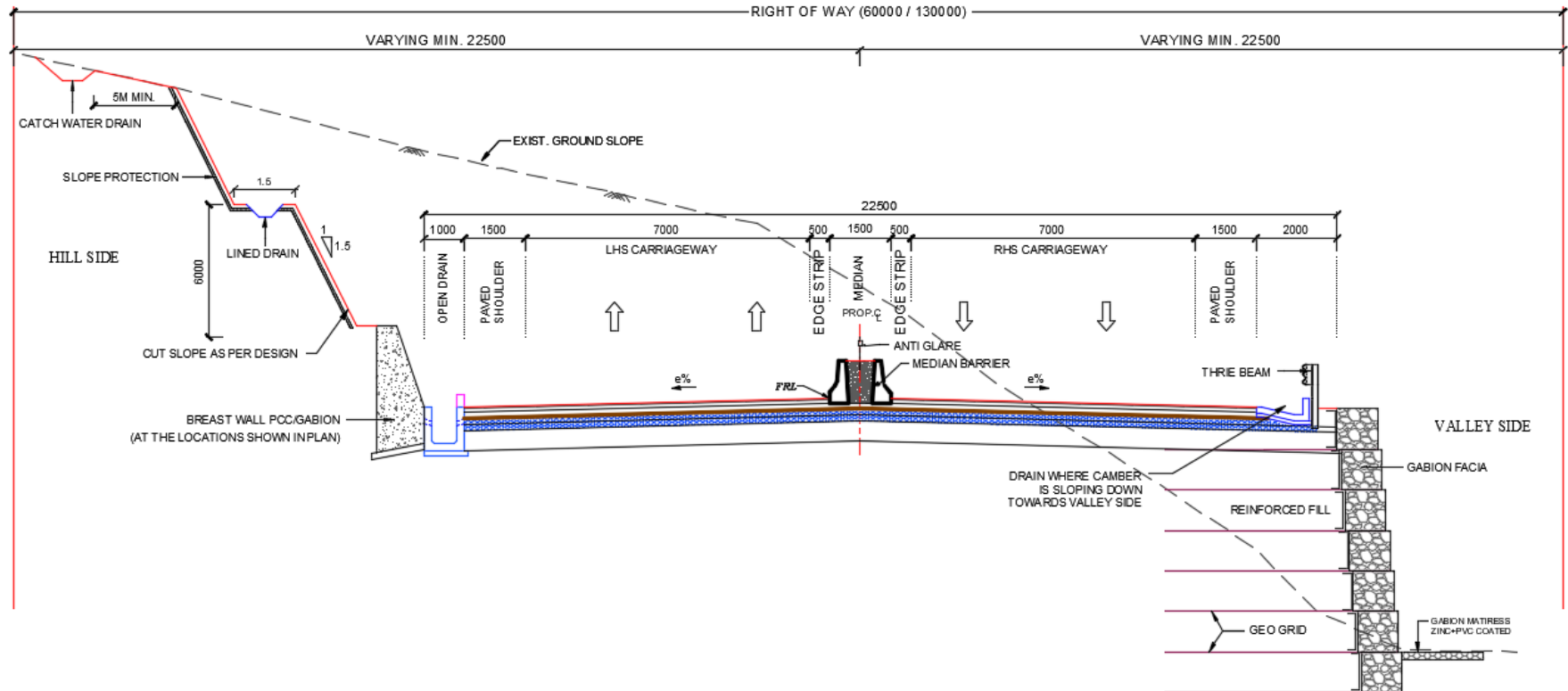


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).



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

## Volume II-Design Report (Highway)



**Fig 1.9** 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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

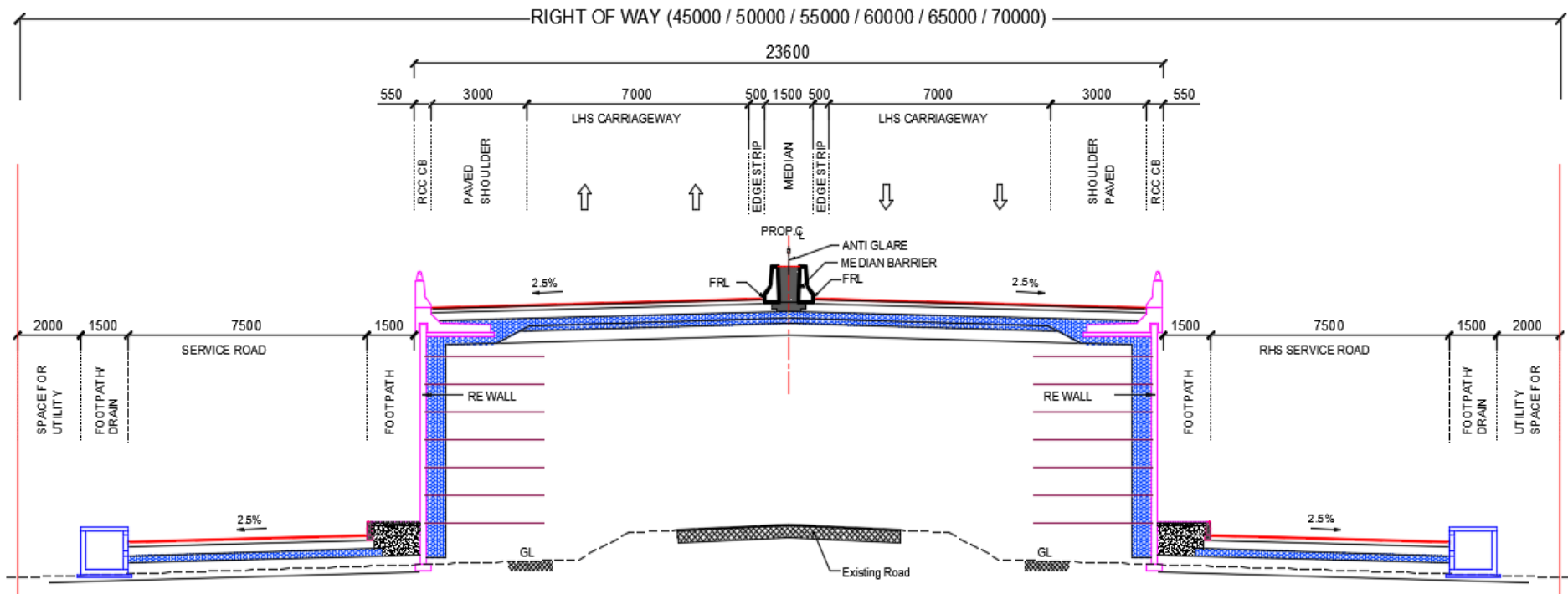


Fig 1.10 4-Lane Approaches of Grade separated structure with 7.5m wide Service Road and RCC Drain on both side with 2.5 m median (TCS-9)

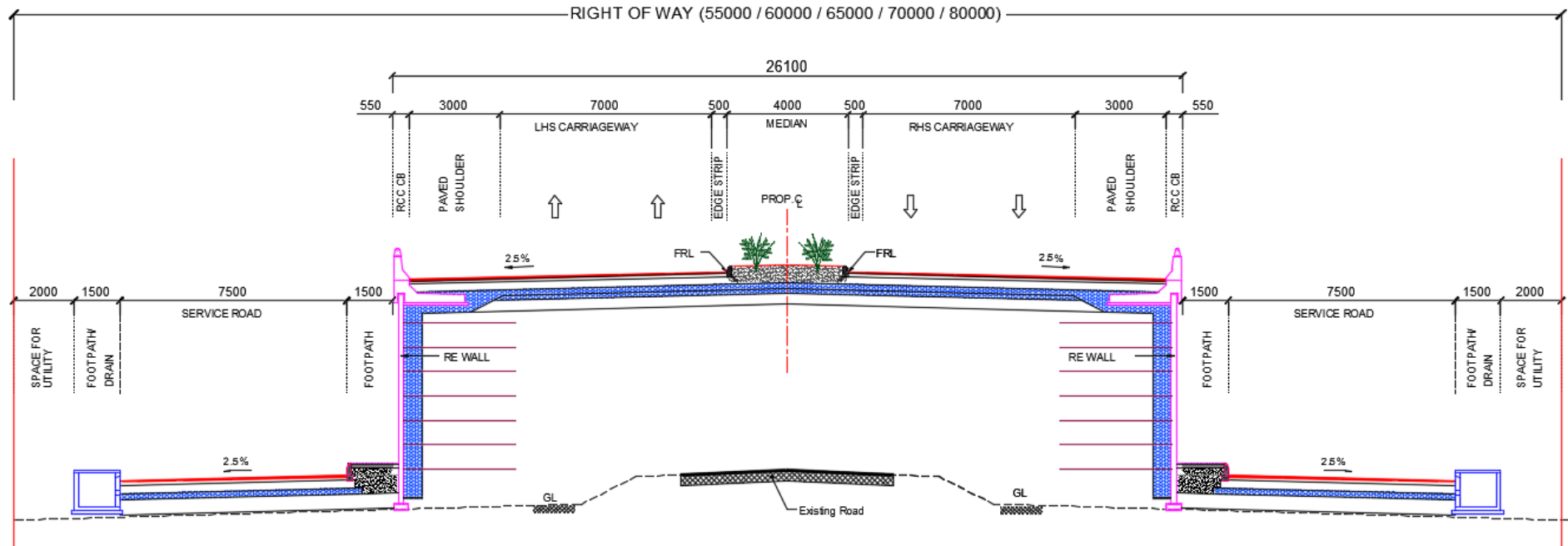


Consultancy Services for preparation of DPR for development of Economic Corridors, Inter Corridors, and Feeder Routes to improve the efficiency of freight movement in India under Bharatmala Pariyojna (Lot-1) (Package-III) (Silchar-Vairengte (49.9 km), Vairengte-Sairang (111 km), Silchar-Jiribam (55 km)).

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



## Volume II-Design Report (Highway)



**Fig 1.11** 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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

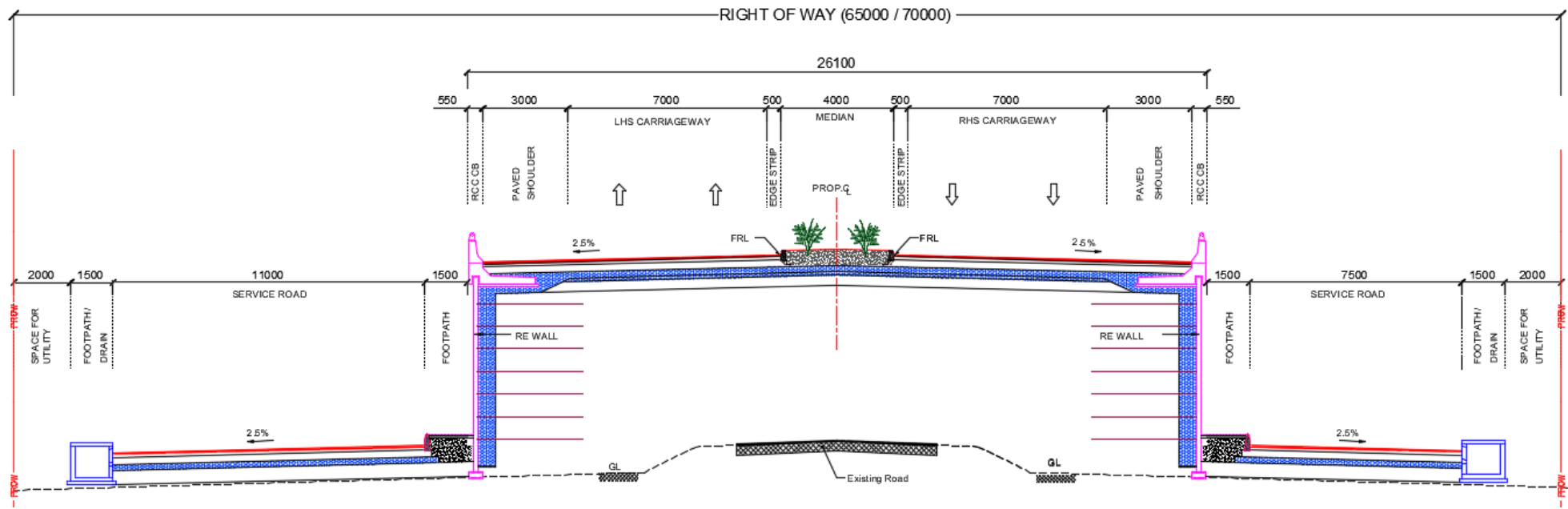


Fig 1.12 4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both side along Existing Road with 5.0 m Median (TCS-11)





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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

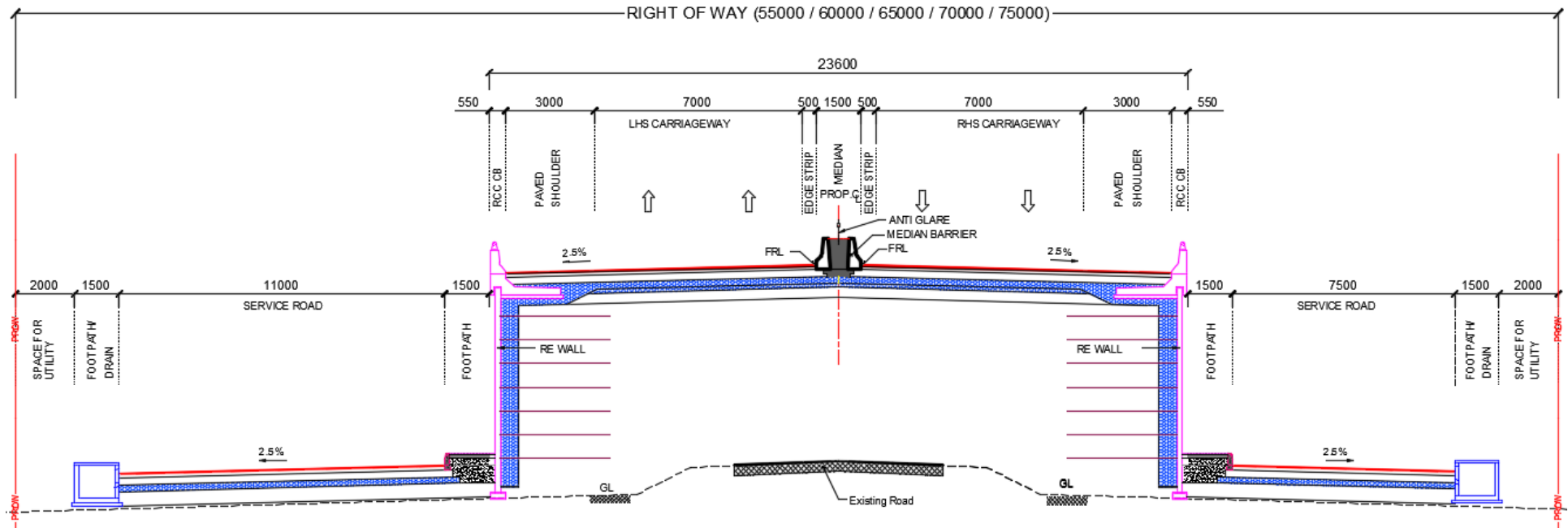


Fig 1.13 4 Lane Approaches of Grade separated structure with Service Road and RCC Drain on both side along Existing Road with 2.5 m Median (TCS-12)

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

Volume II-Design Report (Highway)

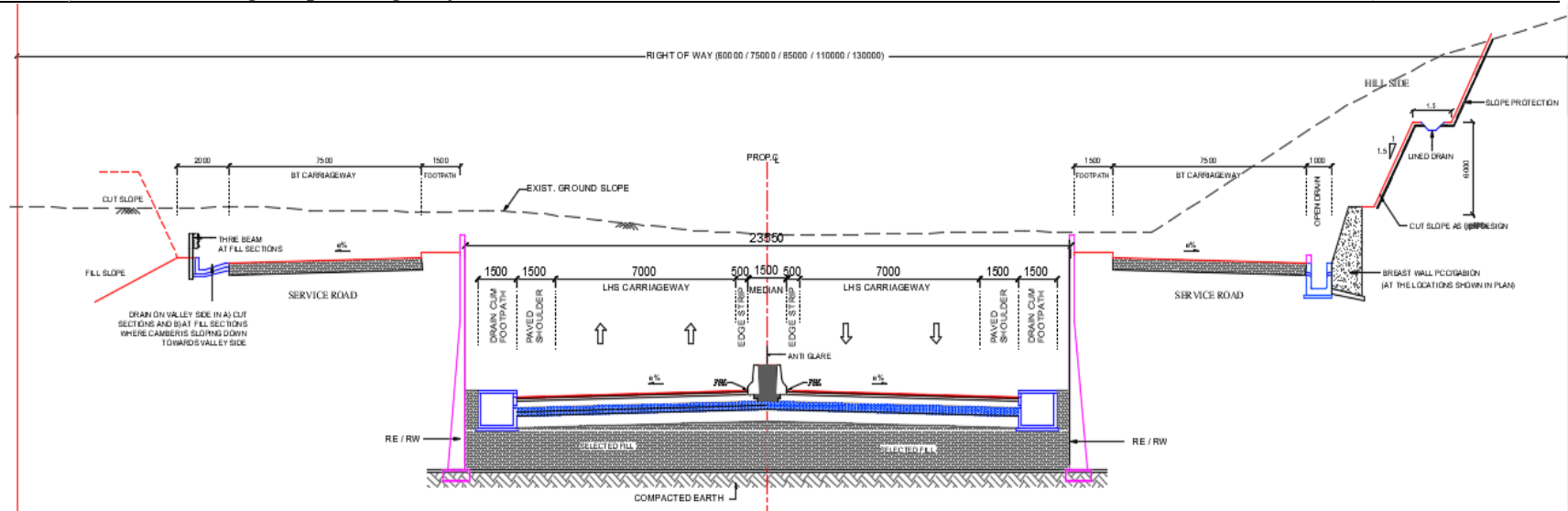


Fig 1.14 4 Lane Divided highway at VOP Approaches (TCS-13)

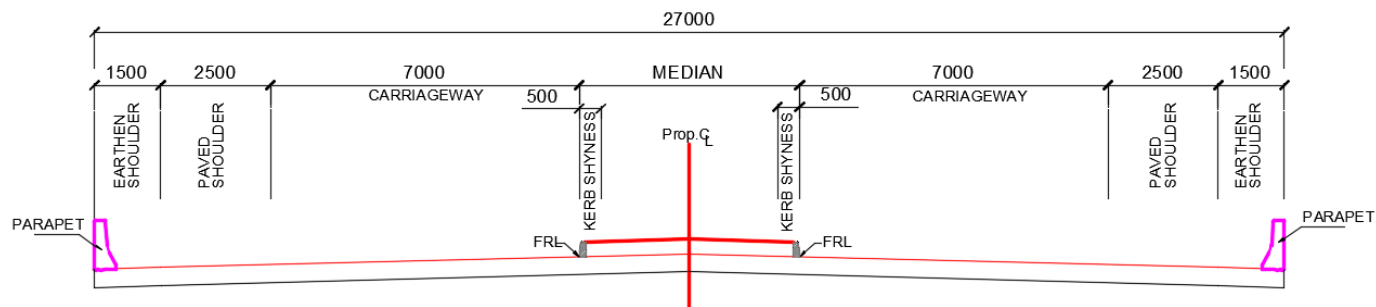


Fig 1.15 4-Lane Buried Culvert (Pipe/Slab/ Box) at Road Level (TCS-14)



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 20+000 to Km 49+360)

Volume II-Design Report (Highway)

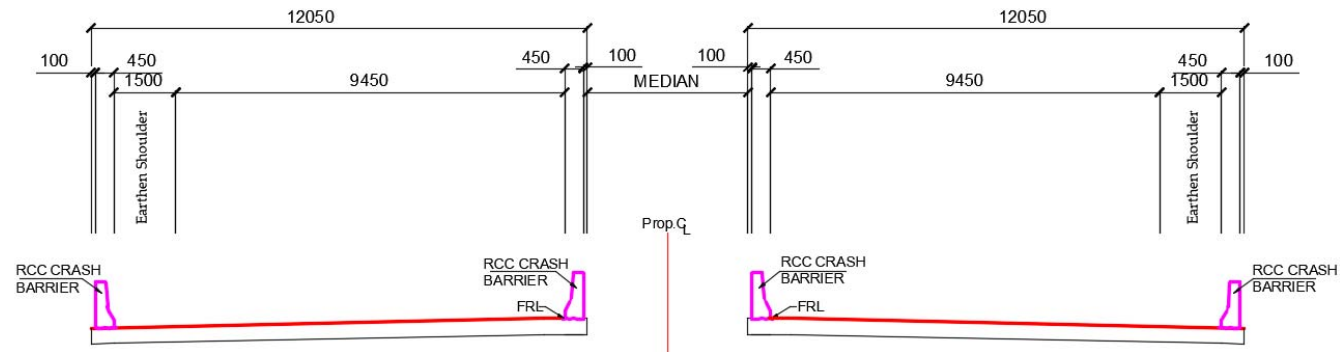


Fig 1.16 4-Lane Slab/ Box Culvert at Road Level (TCS-15)

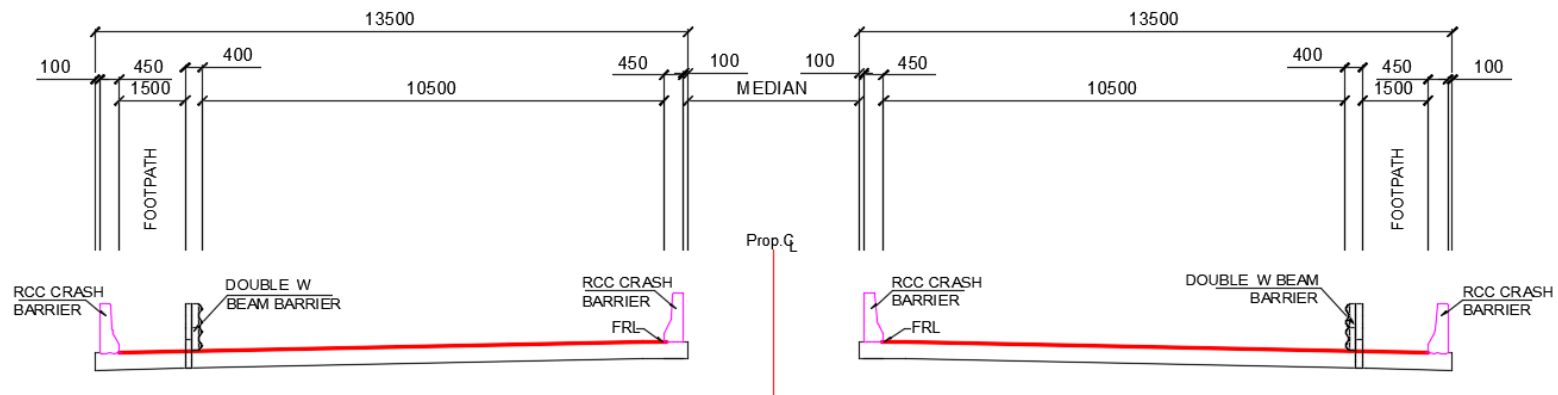


Fig 1.17 4-Lane Bridge at Deck Level without Footpath (TCS-16)



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 20+000 to Km 49+360)

## Volume II-Design Report (Highway)

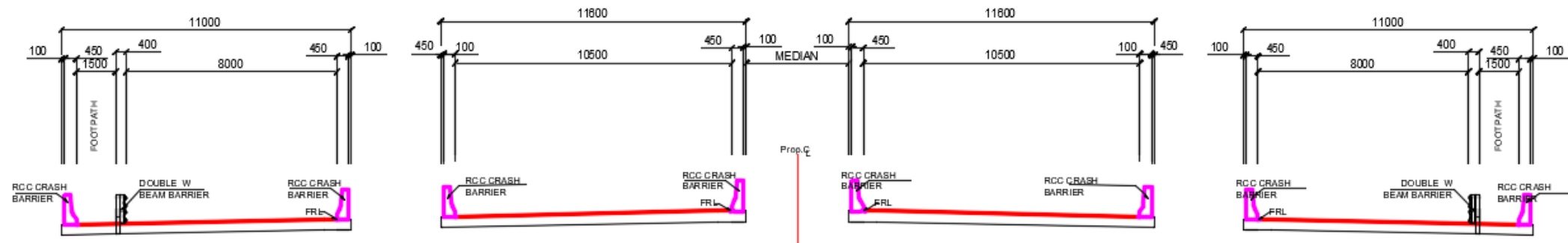


Fig 1.18 4-Lane Bridge at Deck Level with Service Road and Footpath (TCS-17)

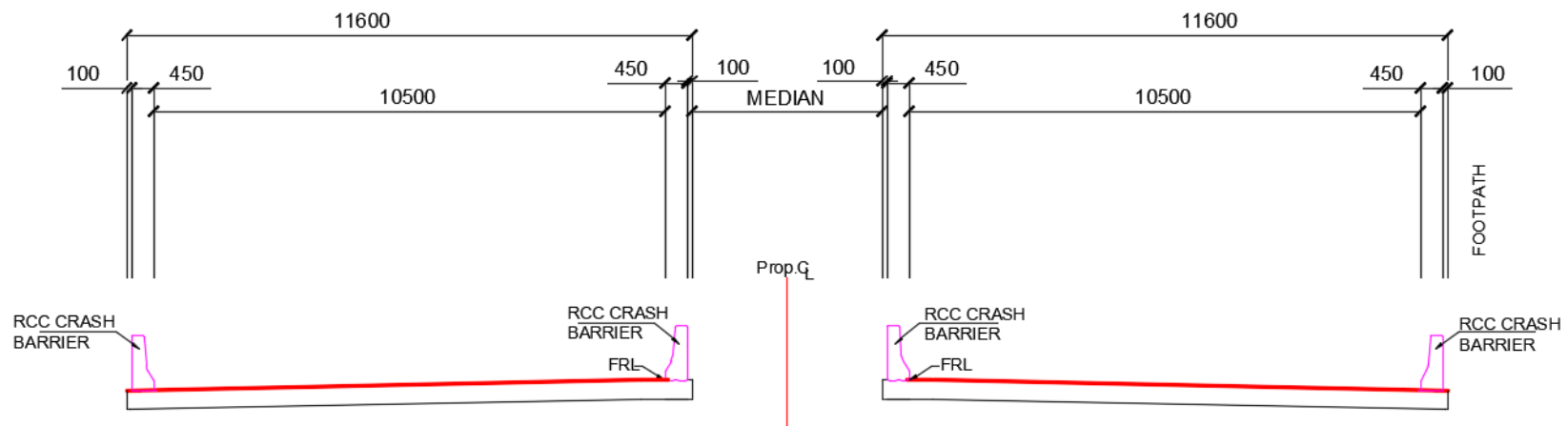


Fig 1.19 4-Lane Grade separated Structures at Deck level (TCS-18)



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)**

**Volume II-Design Report (Highway)**



**Table 1.13 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
14	24+140	24+540	400	-	New Alignment	TCS 2	60	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)**



**Volume II-Design Report (Highway)**

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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	
28	27+340	27+430	90	10	Follow Existing	TCS 2	45	
29	27+430	29+630	2200	10	Follow Existing	TCS 2	40	



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)



**Volume II-Design Report (Highway)**

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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
46	33+300	33+680	380	10	Follow Existing	TCS 12	60	
47	33+680	33+780	100	10	Follow Existing	TCS 12	55	



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)**



**Volume II-Design Report (Highway)**

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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
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





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)**



## Volume II-Design Report (Highway)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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
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



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)**



**Volume II-Design Report (Highway)**

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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	
103	45+970	47+070	1100	10	Follow Existing	TCS 4	55	
104	47+070	47+180	110	-	New Alignment	TCS 9	55	Realignment



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



## Volume II-Design Report (Highway)

SL No	Chainage		Length	Existing CW	Const. Type	Type	PRoW	Remarks
	From	To						
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
<b>Total Length</b>			29360					

### 1.5.6 Horizontal Alignment Design

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 design parameters governing the curve elements are given in following sections.

#### 1.5.6.1 Radius of Curves

Efforts have been made, during design of horizontal alignment, to take the proposed center 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.

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, radii for horizontal curves corresponding to ruling and minimum design speeds will be given below:

**Table 1.14 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 1.15 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

The summary of proposed horizontal curves are given below

**Table 1.16 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%

#### 1.5.6.2 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.

Super elevation is required to be provided at horizontal curves to counter the effects of centrifugal force and is calculated from the following equation.

$$e = V^2 / 225R$$

Where,

e = Super elevation in meter per meter width of road

V = design speed in km/h

R = radius of horizontal curve in m.

The above formula assumes that the centrifugal force corresponding to three-fourth of design speed is balanced by super elevation and one-fourth counteracted by the side friction between the tires of vehicle and the road surface.

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 as per IRC: SP:84-2019, section 2.9.3. and as per IRC: SP:48-1998 clause 6.8.2.2., it is limiting to 10% in hilly areas not bound by snow.

Super elevation 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 cases where transition cannot be provided due to constraints, two third super

elevation may be attained on the straight section before the start of the curve, the balance of which shall be inside the circular portion. In developing the required super elevation, the pavement edge is to be rotated such that, the longitudinal slope of the pavement edge compared to the centerline (i.e. the rate of change of super elevation) is not steeper than 1 in 150 for roads in plain and rolling terrain.

### 1.5.6.3 Transition Curves

Transition curves are necessary to have smooth entry from a straight section into a circular curve. The transition curves also improve aesthetic appearance of the road as well as provide a gradual application of the super elevation and extra widening of the carriageway needed at the horizontal curves. For this purpose, spiral curves shall be used.

As per IRC: 84, minimum length of the transition curve shall be determined from the following considerations and the larger of the values adopted for the design.

- a)  $L_s = 0.0215V^3/CR$
- b)  $L_s = 2.7 V^2/R$  (for plain & rolling terrain) and
- c)  $L_s = 150 \times w \times e$

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 minimum of 0.5)
- $e$  = Superelevation (%)
- $w$  = Width of Carriageway

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 1.17 Curve Radius (m) Not Requiring Transition**

Design Speed (Kmph)	100	80	65	50	40
Radius (m)	2000	1200	800	500	300

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 are given in below table;



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**Section : Silchar to Vairengte (Package-2, mod. from 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)).

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



**Volume II-Design Report (Highway)**

**Table 1.18 Summary of Proposed Horizontal Curves From Km 20+000 to Km 49+360**

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





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



## Volume II-Design Report (Highway)

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											
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
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														

## 1.5.7 Geometric Improvements/ Bypasses or Re-Alignments

### Bypasses or Re-Alignments

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. The entire Package-2 is falling under Green field alignment.

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.

**Table 1.19 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						

Sl. No	Location	Exist. Chainage (Km)		Exist. Length (m)	Prop. Chainage (Km)		Prop Length (m)
		Start	End		Start	End	
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

### 1.5.8 Vertical Alignment Design

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 profile of the project alignment was designed primarily on the basis of DTM data collected during the topographic survey. The following considerations are made to design the vertical profiles.

#### 1.5.8.1 Gradient

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 1.20 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 %

The “Limiting Gradient” is adopted only where the adoption of gentle gradient would result in excessive cost or other limiting factor like underpasses and intersections necessitating a change in gradient.

The cumulative rise/fall in elevation over 2 Km length shall not exceed 100 in mountainous terrain and 120 m in steep terrain.

Vertical alignment should provide a smooth longitudinal profile. Desirably there should be no change in grade within a distance of 150 m. Vertical profile should be coordinated suitably with horizontal alignment.

However, for the VUP and Fly-over approaches, a maximum gradient of 2.5% is considered.

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

**Table 1.21 Distribution of proposed vertical grades**

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

#### 1.5.8.2 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.

As per 2.9.6 clause of IRC: SP: 84-2019, design shall provide for values of at least stopping sight distance (SSD) corresponding to the design speed. The desirable values of sight distance shall be adopted unless there are site constraints. A minimum of safe stopping sight distance shall be available throughout.

**Table 1.22 - Safe 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.

### 1.5.8.3 Vertical Curves

Parabolic vertical curves shall be provided at all changes in grade except where the change is 0.5% or less. The minimum length of vertical curve for the ruling design speed of 100 Kmph shall be 60m.

#### A. Summit

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.  $L > S$ ,

$$L = \frac{NS^2}{4.4}$$

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.  $L < S$ ,

$$L = \frac{2S^2}{N}$$

- (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.  $L > S$ ,

$$L = \frac{NS^2}{9.6}$$

Where,

N = Deviation angle

L = Length of parabolic vertical curve

S = Sight distance in metres.

When the length of curve (L) is less than the required sight distance (S) i.e.  $L < S$ ,

$$L = 2S - 9.6 / N$$

## B. Valley Curves

Valley curves are designed for head light sight distance. The length of valley curves shall be calculated by the following two criteria:

- (i) When the length of curve (L) exceeds the required sight distance (S), i.e.  $L > S$ ,

$$L = NS^2 / (1.50 + 0.035S)$$

- (ii) When the length of curve (L) is less than the required sight distance (S), i.e.  $L < S$ ,

$$L = 2S - [(1.50 + 0.035S)/N]$$

Where,

N = Deviation angle

L = Length of parabolic vertical curve

S = Sight distance in meters.

## C. "K" Value

Vertical curves will be designed to provide for visibility at least corresponding to the desirable 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 1.23 "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

Minimum length of vertical curve as per IRC: 73-1980 Clause 10.3.3 is 60m for 100 km/hr & 50m for 80 km/hr. Based on the same clause the vertical curve is not required if % of grade difference is less than 0.5% for 100 km/hr and 0.6% for 80 km/hr

The summary of proposed vertical curves are shown in below table,

**Table 1.24 Summary of Vertical Curve**

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
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



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



## Volume II-Design Report (Highway)

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			
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
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





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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			
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
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



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



## Volume II-Design Report (Highway)

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			
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
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

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			
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		

## 1.6 Pavement Design

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. 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. The pavement design for flexible pavement will be done based on the IRC 37-2012 and the pavement design for rigid pavement will be done based on the IRC 58-2015.

### 1.6.1 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.

## 1.6.2 Option-01 Flexible Pavement Design for Main Carriage way

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.

### 1.6.2.1 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.

### 1.6.2.2 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%.

### 1.6.2.3 Homogeneous section for Pavement design

For the design purpose based on the traffic along the project road, the proposed alignment from Silchar to Sairang is divided into 4-homogenous sections and the details of the homogeneous section are given in below table.

**Table 1.25 Details of Homogenous Section**

Section	Homogenous Section	Chainage		Design Length (Km)
		Existing	Design	
Section – 1	Start point of P-1 to Vairengte	From Km 263+000 (NH-37) to 42+750 (NH-306)	From Km 0+000 to Km 46+000	46.000

### 1.6.2.4 Axle load survey

The axle load survey provides data to enable the assessment of the damaging effect of the loaded vehicles. The survey was carried out 48 hours using the electronic axle-weighing pad. Due to the requirement of stopping the vehicle for weighing, it was not possible to weigh all the commercial vehicles passing through the site. So

commercial vehicles were weighed on a random sampling basis. About 30% to 50% of commercial vehicles in both directions were stopped for weighing in the 48-hour duration (two days) on a random sampling basis to get the vehicle Damage Factor (VDF). The time of measurement, the axle load, and the axle load group have been recorded.

Axle load pads have been calibrated on a weigh bridge before commencement of surveys. Necessary police help and other arrangements for lighting and shade have been made before the commencement of survey. Enumerators for the surveys were trained properly for the identification of axle type and vehicle type. The traffic volume survey has also been carried out in conjunction with axle load surveys.

Based on the Axle load survey data, Vehicle Damage Factor (VDF) for estimation of cumulative Million Standard Axles (MSA) for thickness design of Flexible Pavements and Spectrum of axles loads for rigid pavement design where cumulative damage principle is used for determining fatigue life of cementitious bases for heavy traffic are calculated.

The Vehicle Damage Factor (VDF) is a multiplier to convert the number of commercial vehicles of different axle loads and axle configuration into the number of repetitions of standard axle load of magnitude 80 KN. It is defined as equivalent number of standard axles per commercial vehicles. The VDF varies with the vehicle axle configuration and axle loading.

The equations for computing equivalency factors for single, tandem and tridem axles as given below has been used for converting different axle load repetitions into equivalent standard axle load repetitions.

Single axle with single wheel on either side	=	$\left( \frac{\text{axle load in KN}}{63} \right)^4$
Single axle with dual wheels on either side	=	$\left( \frac{\text{axle load in KN}}{80} \right)^4$
Tandem axle with dual wheels on either side	=	$\left( \frac{\text{axle load in KN}}{148} \right)^4$
Tridem axle with dual wheels on either side	=	$\left( \frac{\text{axle load in KN}}{224} \right)^4$

Analysis of axle load data for finding the value of VDF for individual category of commercial vehicles has been given at Chapter: 04 "Traffic Studies and Demand Forecast. Based on analysis, the VDF values of each category of commercial vehicles for the different homogeneous sections of the project road are given below;

**Table 1.26 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 46+000	Silchar to Vairengte	0.63	0.79	6.44	5.49	7.88
			Vairengte to Silchar	0.03	0.78	0.54	3.06	1.52
			<b>Adopted VDF</b>	<b>0.63</b>	<b>0.79</b>	<b>6.44</b>	<b>5.49</b>	<b>7.88</b>

*Axle load survey was carried at Km 29+200 (Ext. Chainage) and for section from 0+000 to 46+000 (Design Chainage) the VDF values/ axle load spectrum at Km 29+200 is considered.*

#### 1.6.2.5 Design commercial traffic:

The design traffic in terms of the cumulative number of standard axles to be carried during the design life of the road has been computed based on the

- Annual Average Daily Traffic of Commercial vehicles
- Annual growth rate of commercial vehicles at different horizon years.

**Base year commercial traffic:** The base-year (2020) average daily classified commercial traffic volumes based on the classified traffic volume count surveys carried out for the project road are given in Chapter 4: under “Traffic Studies and Demand Forecast”. Since, the section from Silchar to 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 whereas, section from Vairengte to Sairang, traffic at location Km 98+000 being considered. The summary of the same is given in table below.

**Table 1.27 Summary of commercial traffic volumes**

Section (Design Chainage)	Bus	LCV	Truck		
			2 Axle	3 Axle	Multi Axle
From Km 0+000 to Km 46+000	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 Vol-I Main report** submitted and the summary is given in table below:

**Table 1.28 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%

Vehicle Type	Upto 2025	2026-30	2031-35	2036-40	Beyond 2040
2A Trucks	5.00%	5.00%	5.00%	5.00%	5.00%
3A Trucks	5.00%	7.00%	6.50%	6.00%	5.00%
MAV	5.00%	7.00%	6.50%	6.00%	5.00%

*The details of the traffic growth rates are given in the chapter 4 Traffic report*

**Design Traffic Loading :** As suggested in IRC: 37 – 2018, the design traffic loading is considered in terms of the cumulative number of standard axles in the lane carrying maximum traffic, to be carried during the design life of the road. Design Traffic loads were computed using the following equation:

$$N = 365 \times \left\{ (1 + r)^n - 1 \right\} \times A \times D \times \frac{F}{r}$$

Where,

N	=	the cumulative number of standard axles to be catered for in the design in terms of CSA (Cumulative Standard Axles)
A	=	Initial traffic in the years of completion of construction in terms of the number of commercial vehicles per day
D	=	lane distribution factor as per IRC: 37 – 2018 (cl: 4.5.1)
F	=	Vehicle Damage Factors
n	=	Design life in years (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** attached here. The design traffic volume for different design period in terms of Million Standard Axles for different section based on volume count stations of the project road is given below;

**Table 1.29 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 46+000	9.16	16.57	26.29	38.86	Annex.6.1A

*The copy of the Annexure is attached in Chapter 6 of Vol-I Main report.*

#### 1.6.2.6 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 ( $\epsilon_t$ ) at the bottom of the bituminous layer and the vertical subgrade strain ( $\epsilon_v$ ) 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. Below figure shows the critical locations for stress and strain at pavement layers.



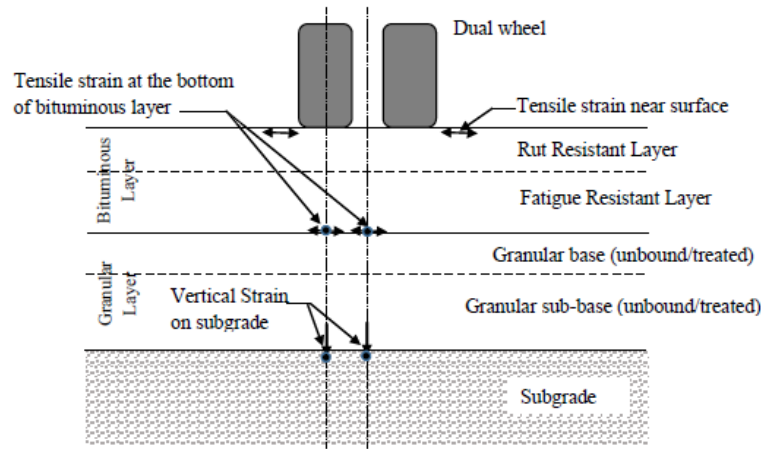


Fig 1.20 Critical locations of Stress and Strain in Flexible Pavement

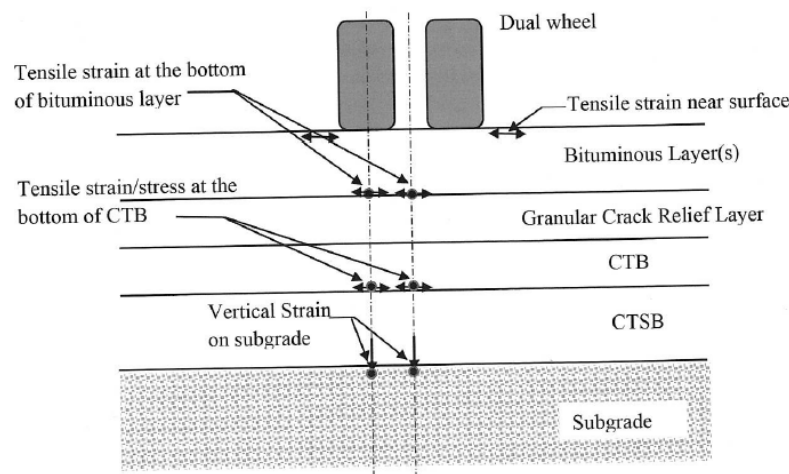


Fig 1.21 Critical locations of Stress and Strain in CTB and CTSB

#### 1.6.2.7 Design Traffic (Million Standard Axles - MSA):

The design traffic is defined in terms of the cumulative number of standard axles in MSA that can be carried before a major strengthening, rehabilitation or capacity augmentation of the pavement is necessary. The design MSA calculation for different traffic count locations of the road has been presented at clause 6.2.7 of **Chapter 6 of Vol-I Main report**. The recommended design MSA considered for flexible pavement design is given below.

**Table 1.30 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 46+000	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.*

### 1.6.2.8 Pavement Material Properties

#### a) Properties of Subgrade

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 at below table.

The behavior 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 behavior 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:

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

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

$M_R$  = Resilient modulus of subgrade soil.

The proposed effective CBR value adopted for different sections of the road is given below;

**Table 1.31 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 136+400	7.57	64.29	0.35

#### Limiting Strain in Subgrade (Rutting Model):

Rutting is the permanent deformation in pavement usually occurring longitudinally along the wheel path. The rutting may partly be caused by deformation in the subgrade and other non-bituminous layers which would reflect to the overlying layers to take a deformed shape. The bituminous mixes also may undergo rutting due to secondary compaction and shear deformation under heavy traffic load and higher temperature. Excessive rutting greatly reduces the serviceability of the pavement and therefore, it has to be limited to a certain reasonable value.

Subgrade strain criterion is used to limit the compressive strain in the top of subgrade to a tolerable level throughout the life of the pavement. The pavement is designed for limiting rutting as per the equations given below;

**Table 1.32 Rutting Model equations**

Design MSA	Reliability Factor	Equation
Less than equal to 30 MSA	80 %	$N = 4.1636 \times 10^{-08} \times \left[ \frac{1}{\epsilon_v} \right]^{4.2917}$
Greater than 30 MSA	90 %	$N = 1.41 \times 10^{-08} \times \left[ \frac{1}{\epsilon_v} \right]^{4.2937}$

Where,

N = Number of cumulative standard axles, and

$\epsilon_v$  = Vertical strain in the subgrade

#### b) 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 1.33 Physical Properties of GSB**

Properties	Requirement as per MoRT&H
Water absorption value (%)	Less than 2%, if more than 2% Wet AIV should be performed.
Aggregate Impact	40 % Maximum
Liquid Limit	Maximum 25
Plasticity Index	Maximum 6
CBR at 98% dry density	Minimum 30

**c) 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 1.34 Physical properties of WMM**

Properties	Requirement as per MoRT&H
Water absorption value (%)	Less than 2 %, if more than 2% soundness test should be carried out
Aggregate Impact Value	30% Maximum
Combined Flakiness and Elongation index (Total)	Maximum 35%

When both Sub-Base and Base layers are made up of granular layers, the composite resilient modulus of the granular sub-base and the base is given as:

$$M_{R\_Granular} = 0.2 * h^{0.45} \times M_{R\_Subgrade}$$

Where h= thickness of granular sub-base and base, mm

Poisson's ratio of granular bases and sub-base is recommended as 0.35.

**d) Properties of Bituminous Layer:**

Pavement Temperature: for the purpose of design Average annual pavement temperature is considered as 35oC. 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 1.35 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 1.36 Fatigue Model equations**

Reliability Factor	Equation
90 %	$N = 0.316 \times C \times 10^{-0.4} \times \left[ \frac{1}{\sigma_t} \right]^{2.5} \times \left[ \frac{1}{M_R} \right]^{0.824}$

$$C = 10^{M^f}$$

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

$V_a = 3.5$  % (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

**$\epsilon t$**  : Allowable tensile strain at the bottom cement treated base layer

#### 1.6.2.9 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 below table. The pavement has been modelled as a three-layer system and strain at critical locations have been computed using the linear viscoelastic model IITPAVE analytical design of flexible pavements. The proposed crust thickness, corresponding allowable strains from fatigue/rutting models and computed strains from IITPAVE software are given below.

**Table 1.37 – 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

<b>Pavement Crust (mm)</b>	
Granular Sub-base (GSB)	200
Wet Mix Macadam (WMM)	250
Dense Bituminous Macadam (DBM)	110
Bituminous Concrete (BC)	40

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

<b>Poissons Ratio (<math>\mu</math>) of</b>	
Subgrade	0.35
Granular layer (GSB+WMM)	0.35
Bituminous Layers (DBM & BC)	0.35

<b>Allowable Strains</b>	
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 ( $\epsilon_t$ )	188.647E-06
Vertical strain at top of subgrade ( $\epsilon_v$ )	390.45E-06

Computed strains	
Horizontal tensile strain at the bottom of DBM layer ( $\epsilon_t$ )	185.500E-06
Vertical strain at top of subgrade ( $\epsilon_v$ )	311.90E-06

### 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

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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
  
```

#### 1.6.2.10Flexible pavement design – Option 2

Pavement crust in this option has been designed by considering the following materials in different layers-



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)**



## Volume II-Design Report (Highway)

- 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 below table. The proposed crust thickness, corresponding allowable strains from fatigue/rutting models and computed strains from IITPAVE software are given below.

**Table 1.38 – 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 <sub>be</sub>	11.50
Volume of Air Voids (%) V <sub>a</sub>	3.50
CBR of embankment soil (Upper 500mm)	6.00
CBR of Subgrade (%)	8.00
Effective CBR of Subgrade (%)	7.57

<b>Pavement Crust (mm)</b>	
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

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





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)**



## Volume II-Design Report (Highway)

Poissons Ratio ( $\mu$ ) 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 ( $\epsilon_t$ )	188.65E-06
Compressive strain at top of subgrade ( $\epsilon_v$ )	390.45E-06
Tensile strain at the bottom of CTB layer ( $\epsilon_t$ )	072.31E-06

Computed strains	
Horizontal tensile strain at the bottom of DBM layer ( $\epsilon_t$ )	113.2 E-06
Vertical strain at top of subgrade ( $\epsilon_v$ )	182.8 E-06
Tensile strain at the bottom of CTB layer ( $\epsilon_t$ ) with 0.80 Mpa tyre contact pressure	045.4 E-06



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)

## Volume II-Design Report (Highway)



### Input Screen

No of Layers  [HOME](#)

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Layer: 4	Elastic Modulus(MPa)	<input type="text" value="600"/>	Poisson's Ratio	<input type="text" value="0.25"/>	Thickness(mm)	<input type="text" value="200"/>
Layer: 5	Elastic Modulus(MPa)	<input type="text" value="64.289"/>	Poisson's Ratio	<input type="text" value="0.35"/>		

Wheel Load(Newton)  Tyre Pressure(MPa)

Analysis Points

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



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)**

**Volume II-Design Report (Highway)**



**Check for fatigue cracking in cementations layers using cumulative damage analysis:**

The thickness of cement treated base layer is first evaluated from fatigue considerations in terms of cumulative standard axles and corresponding tensile stresses at the bottom of cement treated base layer due to individual wheel load was computed using IITPAVE software.

Since there are plenty of single, tandem and Tridem axle loads which are far higher than standard axle load used for pavement design, thickness of cemented layer is checked for sudden fracture of cemented base due to higher axle loads using cumulative damage principle. Axle weights of tandem and Tridem axle are taken as equivalent to two and three single axles respectively. The fatigue life has been calculated using the following equation.

Where,

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

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

$\sigma_t$  : 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 1.39 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
2029	53	438	1337	273	102	804048	3569061



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)



## Volume II-Design Report (Highway)

Year	in both directions					Total Veh. in one direction per year	Cumulative Comm Veh.
	Bus	LCV	2A Truck	3A Truck	M Axle Truck		
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 1.40 Cumulative Fatigue Damage Analysis – Option 2**

Axle load in KN	Expected single axle repetitions (ni)	Tensile Stress at the bottom of CTB $\sigma_t$ , in Mpa	Stress Ratio ( $\sigma_t/M_{rup}$ )	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
120	1510296	0.39	0.28	2.31E+08	0.007
110	1415903	0.36	0.26	4.46E+08	0.003



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)



## Volume II-Design Report (Highway)

Axle load in KN	Expected single axle repetitions (ni)	Tensile Stress at the bottom of CTB $\sigma_t$ , in Mpa	Stress Ratio ( $\sigma_t/M_{rup}$ )	Fatigue life (Nf)	Fatigue life consumed (ni/Nf)
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
<b>Cumulative Fatigue Damage in CTB due to Single Axles</b>					<b>0.322</b>
<b>Tandem Axles</b>					
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
<b>Cumulative Fatigue Damage in CTB due to Tandem Axles</b>					<b>0.238</b>
<b>Tridem Axles</b>					
600	0	0.66	0.47	1.22E+06	0.000
570	0	0.63	0.45	2.35E+06	0.000
540	0	0.59	0.42	4.52E+06	0.000
510	0	0.56	0.40	8.71E+06	0.000
480	0	0.53	0.38	1.68E+07	0.000
450	0	0.49	0.35	3.23E+07	0.000
420	0	0.46	0.33	6.23E+07	0.000
390	0	0.43	0.31	1.20E+08	0.000
360	0	0.39	0.28	2.31E+08	0.000
330	0	0.36	0.26	4.46E+08	0.000
300	0	0.33	0.23	8.59E+08	0.000



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)**



## Volume II-Design Report (Highway)

Axle load in KN	Expected single axle repetitions (ni)	Tensile Stress at the bottom of CTB $\sigma_t$ , in Mpa	Stress Ratio ( $\sigma_t/M_{rup}$ )	Fatigue life (Nf)	Fatigue life consumed (ni/Nf)
270	14037663	0.30	0.21	1.65E+09	0.008
255	84225978	0.28	0.20	2.30E+09	0.037
<b>Cumulative Fatigue Damage in CTB due to Tridem Axles</b>					<b>0.045</b>

<b>Cumulative Fatigue Damage</b>			
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:

### 1.6.2.11 Option 03: Flexible Pavement Design with Geo grid provision in hill / mountainous region

Pavement crust in this option has been designed by considering the following materials in different layers-

- Surface Layer - BC with (CRMB/PMB)
- Bituminous Base layer - DBM with VG40
- Biaxial Geo-grid
- Granular Base layer – Wet mix macadam (WMM)
- Sub-base layer – Granular sub-base (GSB)

**Table 1.41 Proposed Pavement Crust (Option-3)**

Design Period	20 Years
Design Traffic (MSA) - BT	40.0
Effective CBR of Subgrade	7.57
Grade of Bitumen for DBM	VG40
Grade of Bitumen for BC	PMB/CRMB
Bitumen Content (%)	4.50
Volume of air voids (%)	3.50



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)**



## Volume II-Design Report (Highway)

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 ( $\mu$ ) 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 ( $\epsilon_t$ )	188.647E-06
Vertical strain at top of subgrade ( $\epsilon_v$ )	390.45E-06

Computed strains	
Horizontal tensile strain at the bottom of DBM layer ( $\epsilon_t$ )	186.900E-06
Vertical strain at top of subgrade ( $\epsilon_v$ )	327.40E-06

## Input Screen

No of Layers 
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) 
Tyre Pressure(MPa)

Analysis Points

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 

(1- Single wheel  
2- Dual wheel)

Submit
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-03-0.4719E-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 0.00-0.1840E-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
  
```

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 than 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.

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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.*

### 1.6.3 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 fibers 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.

#### 1.6.3.1 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.

#### 1.6.3.2 Tyre Pressure

Tyre pressures and shape of contact areas of the commercial vehicles (CV) also govern load stresses. For most of the commercial vehicles, it ranges from 0.7 to 1 MPA, but it is found that stresses in concrete pavements having thickness of 20cm or more are not affected significantly by the variation of tyre pressure. A tyre pressure of 0.8 MPa has been adopted for design as per section 5.2 of IRC: 58-2015.

### 1.6.3.3 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.

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

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.

### 1.6.3.4 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 0C /14.3 0C as given in table 1 of IRC: 58-2015.

**Table 1.42 Temperature Differential**

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

### 1.6.3.5 Characteristics of Sub grade and Sub base

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.

### 1.6.3.6 Characteristics of Sub grade and Sub base

- 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) sub base 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.

### 1.6.3.7 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.

**Table 1.43 Characteristics of Concrete**

Elastic Modulus of PQC, MPa	30000
Poisson's Ratio ( $\mu$ )	0.15
Unit weight of PQC, kN/m <sup>3</sup>	24
28 days flexural strength, MPa	4.5
Grade of Concrete	M40

### 1.6.3.8 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



$$N = \left[ \frac{4.2877}{SR - 0.4923} \right]^{3.268} \quad \text{When } 0.45 \leq SR \leq 0.55$$

$$\log_{10} N = \frac{0.9718 - SR}{0.0526} \quad \text{for } SR > 0.55$$

### 1.6.3.9 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.

### 1.6.3.10 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.

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:

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

$\beta$  = 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, mm<sup>4</sup>

P<sub>t</sub> = 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;

Fb = Allowable bearing stress, MPa

B = Dowel diameter, mm

fck = Ultimate compressive strength of concrete, MPa (For M40 concrete, fck = 40 MPa (28 days) and 48 MPa (90 days))

#### 1.6.3.11 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 mm<sup>2</sup> 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

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.

$$L = \frac{2SA}{B F}$$

Where;

L = Length of tie bar, cm

S = Allowable working stress in steel, MPa

A = Cross-sectional area of one tie bar mm<sup>2</sup>

B = Maximum permissible bond stress, MPa

#### 1.6.3.12 Design of Slab Thickness for Section from Km 0+000 to Km 46+000 (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



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



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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 <sup>3</sup>
Grade of Concrete	=	40	
28 day Flexural strength of cement concrete	=	4.5	Mpa
Modulus of elasticity of concrete, E	=	30000	Mpa
Poisson's ratio, $\mu$	=	0.15	
Radius of relative stiffness, l	=	0.684	
Coefficient of thermal expansion of concrete, $\alpha$	=	$10 \times 10^{-6}$	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

### 1.6.3.13 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 1.44 Cumulative number of commercial vehicles at Ch 7+100**

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	
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

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		
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

#### 1.6.3.14 Design Traffic Estimation

##### a) at Km 29+200 (Ext. Chainage)

Design Period (years)	30
Cumulative No of Commercial vehicles during design period (two-way), <b>A</b>	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>B</b>	2.00
Cumulative No of Commercial Axles during design period (two-way), <b>C = A*B</b>	86580132
Proportion of traffic in predominant direction, <b>D</b>	49%
Lateral Placement factor, <b>E = 0.25*D</b>	10606066
Factor for selection of traffic for BUC analysis (for six-hour period	0.23



during day)), <b>F</b>		
Factor for selection of traffic for TDC analysis (for six-hour period during day), <b>G</b>		0.27
Design axle repetitions for BUC analysis (for 6 hour day time traffic), <b>H = C*E*F</b>		2437580
Proportion of vehicles with spacing between front and the first rear axle less than the spacing of transverse joints, <b>I</b>		19.15%
Design axle repetitions for TDC analysis (for 6-hour night time traffic), <b>J = C*E*G*I</b>		548803
Proportion of Front single (steering) Axles, <b>K1</b>	} As per Axle load surveys	0.502
Proportion of Rear single Axles, <b>K2</b>		0.180
Proportion of Tandem Axles, <b>K3</b>		0.316
Proportion of Tridem Axles, <b>K4 = (1-K1-K2-K3)</b>		0.002

### 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
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

### 1.6.3.15 Axle load spectrum

Expected number of applications of different axle load groups has 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:



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

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**Table 1.45 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
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



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**Section : Silchar to 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
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

### 1.6.3.16 Fatigue Damage Analysis

Due to the simultaneous application of traffic loads and temperature differentials between the top and bottom of a concrete slab, concrete pavements are subjected to Bottom-Up Cracking (BUC) during day hours and Top-Down Cracking (TDC) during night hours. Hence, the pavement design is checked for cumulative bottom-up and top-down cracking damages.

*Analysis has been done for the following cases:*

*Bottom-up Cracking – For single rare axle and tandem rare axle*

*Top-down Cracking – For single, tandem and Tridem rare axle*

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

**Table 1.46 Cumulative Fatigue Damage Analysis at Ch: 7+100 Km**

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



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



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Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
115-125	120	2.00	0.404	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
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



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



## Volume II-Design Report (Highway)

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
295-305	300	1.86	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
<b>Fatigue Damage from Rear Tandem Axles</b>							<b>0.000</b>
<b>ii) Cumulative Fatigue Damage Analysis for Top-down Cracking (TDC)</b>							
<b>Single Axle</b>							
<=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



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



## Volume II-Design Report (Highway)

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
<b>Fatigue Damage from Single Axles</b>							<b>0.004</b>
<b>Rear Tandem Axles</b>							
<=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



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



## Volume II-Design Report (Highway)

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
335-345	340	2.35	0.474	0.00	0	3718917.68	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
475-485	480	2.76	0.558	0.00	0	98189.0736	0.000
<b>Fatigue Damage from Tandem Axles</b>							<b>0.000</b>
<b>Rear Tridem Axles</b>							
<=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



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



## Volume II-Design Report (Highway)

Axle load (AL), KN		Flexural Stress, MPa	Stress Ratio	% of Axles	Expected Repetitions (ni)	Allowable Repetitions (Ni)	Fatigue Damage (ni/Ni)
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
<b>Fatigue Damage from Rear Tridem Axles</b>							<b>0.000</b>

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.



### 1.6.3.17 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
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 <sup>4</sup>
Radius of relative stiffness, $l$	=	1027.686	mm
Relative stiffness of bar embedded in concrete	=	0.022	mm <sup>-1</sup>
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, $P_t$	=	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

### 1.6.3.18 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 <sup>3</sup>
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 <sup>2</sup> /m
Cross sectional area of tie bar , A	=	113.10	mm <sup>2</sup>
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

#### 1.6.4 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. Thus, it will be very difficult and time consuming to achieve the surface finish to the desired levels.
- 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 Mountainous / 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 1.47 Summary of Pavement Type**

Sl No	Sections	Length (Km)	Type of Pavement	Thickness
1	From Km 0+000 to Km 46+000	46.000	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 been considered between subgrade and selected earth (embankment) wherever applicable/as per site condition.

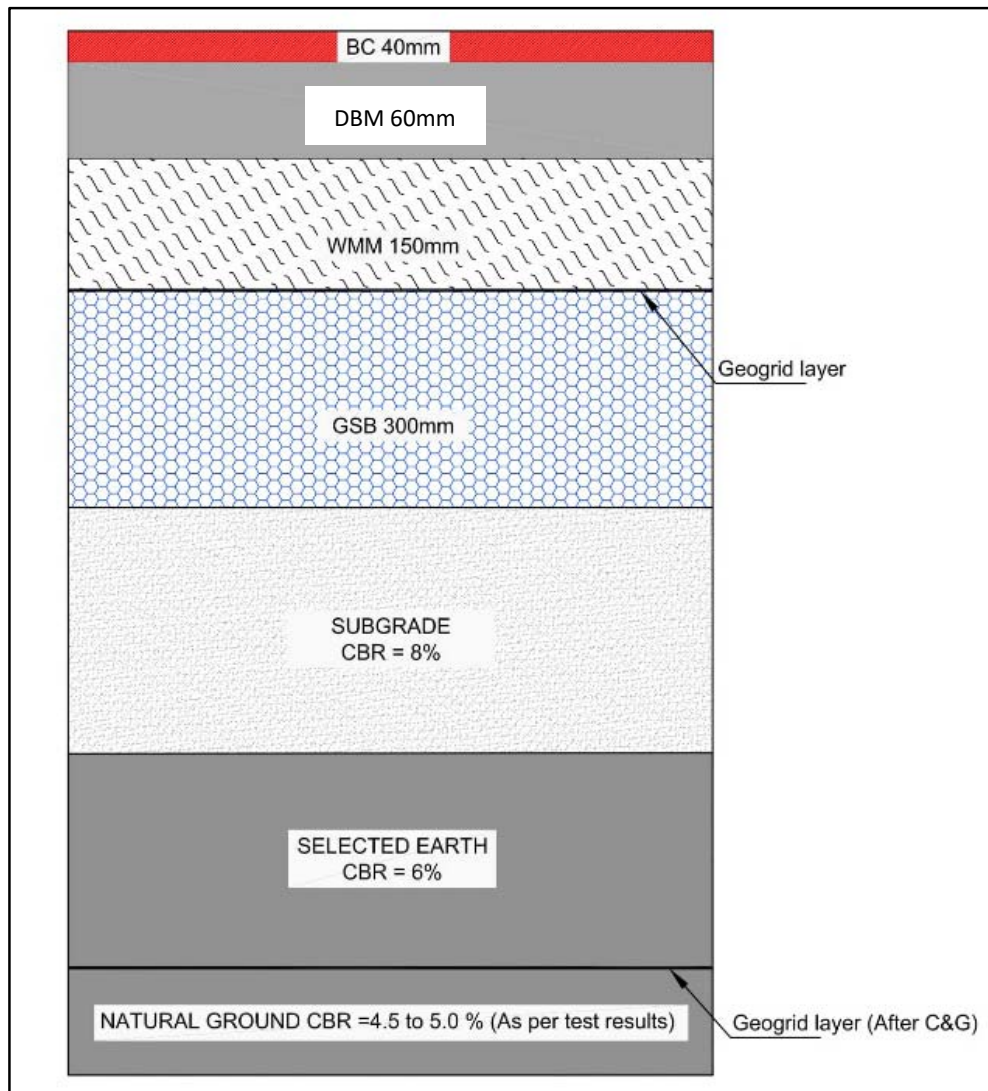


Fig 1.22 Flexible Pavement cross section with Geo grid provision

### 1.6.5 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.

**Table 1.48 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 136+400	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	

The details of service/Slip road provided along the project road are shown below (according to proposed chainage).

#### 1.6.6 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.

**Table 1.49 Details of Bus bays**

c	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	Lailapur	BS & BL
10	45+870	LHS	Lailapur	BS & BL

c	Design Chainage	Side	Name Of Village	Remarks
11	48+690	LHS	Vairengte	BS & BL
12	48+990	RHS	Vairengte	BS & BL

#### 1.6.7 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.

There is no proposal of truck lay bye in this Package.

#### 1.6.8 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**

#### 1.6.9 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 1.50 Details of Check Post location**

Sl. No.	Design Chainage	Side
1	49+150	RHS

Sl. No.	Design Chainage	Side
2	49+200	LHS

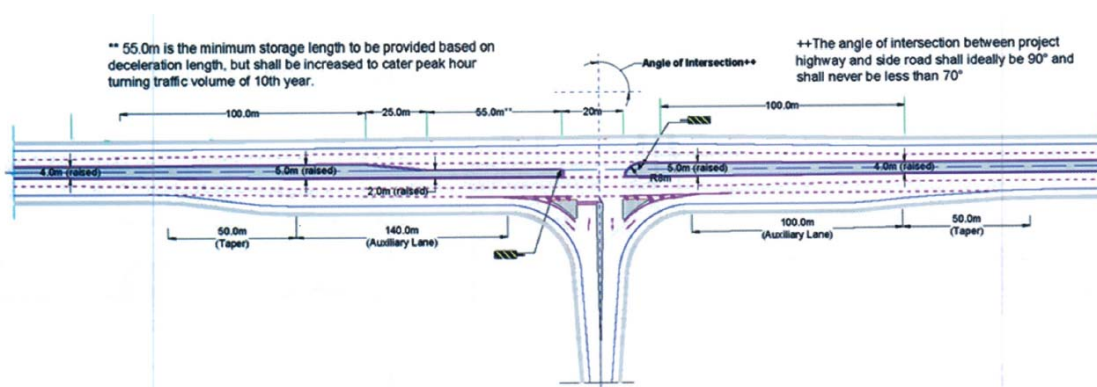
### 1.6.10 Toll Plaza

There is no Toll Plaza has been proposed in this Package.

## 1.7 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.

All the junctions are developed as per manual with parallel entry/exit at built-up areas and tapered entry/exits at rural areas. Schematic arrangement of junctions is given below:



**Fig 1.23 Schematic Plan of T-Intersection**

### 1.7.1 Major Intersections

All junctions are designed as at-grade junctions with proper acceleration and deceleration arrangements.

These junctions have been developed as per IRC SP: 41 "Guidelines for the Design of At-Grade Intersection in Rural and Urban Areas" and "Type designs for intersections on National Highways" published by MoRT&H. Details of Major Intersections are mentioned below;





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

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**Table 1.51 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	Refer Plan metric drawing for ready reference
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	
6	31+610	24+990	Narsingpur - Bor Jalenga	4 Legged (Below Underpass)	BHS	NH-306 (Exist. Road)	2 Lane BT	
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	



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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.	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					
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	

### 1.7.2 Minor Intersections

Details of Minor Intersections are mentioned below;

**Table 1.52 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	

### 1.7.3 Speed Changing Lanes at major junctions

#### 1.7.3.1 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 1.53 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.

### 1.7.3.2 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 1.54 Minimum Deceleration Lane Lengths**

Highway		Deceleration Length (m) for design speed of exit (kmph)								
		Stop condition	25	30	40	50	60	65	75	80
Design Speed (kmph)	Speed Reached (kmph)	For Average Running Speed of Exit Curve (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.

#### 1.7.4 Entry/Exit arrangement

Entry/exit has been provided at the start and end of slip roads as per Fig 2.1A of manual. Schematic arrangement of Entry/Exit Ramp is given below:

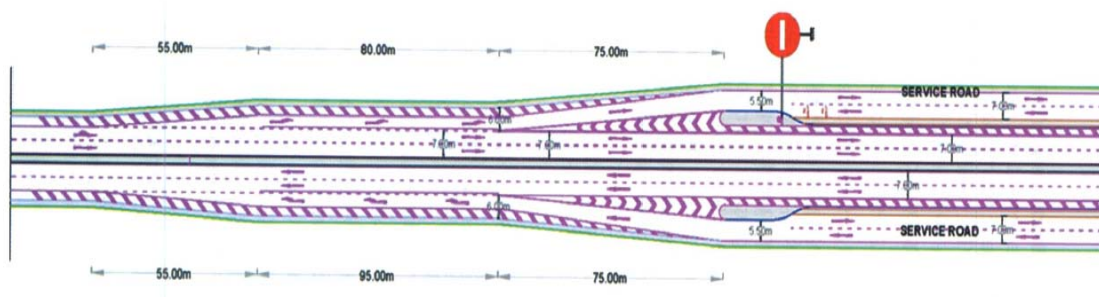


Fig 1.24 Schematic Plan of entry/exits

### 1.8 Drain Design

Keeping in view the good health of the road, a proper drainage design is one of the important aspects. Open side drains are normally provided on both or one side of the roadway in order to intercept surface water runoff from the carriageway, shoulders and verges. Drains in rural area will be designed as per the guidelines fixed in IRC: SP-42 and in urban area are to be designed as per IRC: SP-50.

#### 1.8.1 Design parameter and assumption

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.



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

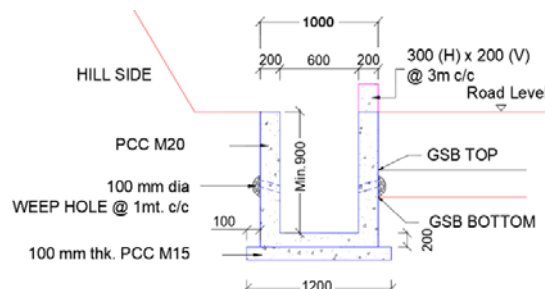
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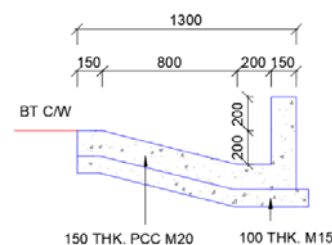
**In urban areas:** Lined covered drains have been proposed along the road passing through built-up areas. RCC covered drain, which shall serve as footpath also has been provided. And at the locations where the cross section is in cutting, trapezoidal type lined drains have been proposed.

In rural area, open unlined trapezoidal drain will be provided. As per guidelines for four lane manual IRC: SP: 84-2019, side slope of unlined drain shall not be steeper than 2H: 1V. These slopes can be made steeper in case of lined drains.

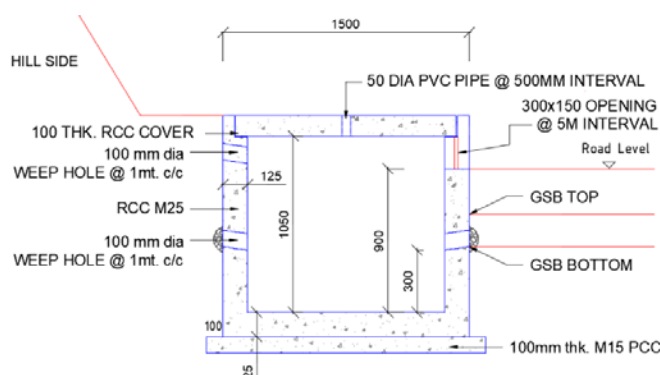
- Permissible non erodible flow velocity should be kept in view in accordance with IRC: SP: 42. If it gets increased beyond this limit, flow channels need to be lined. This is as per IRC: SP: 42.
- Open unlined drains if provided at ground level, should be kept sufficiently away from the toe of the embankment.
- Top of unlined toe drain will be kept below subgrade bottom or at ground level, whichever is lower.
- In case of depressed median, longitudinal drain (lined or unlined) shall be provided to drain off rain water. The drain should have adequate longitudinal slope to the nearest culvert to drain off transversely. In super elevated sections the longitudinal drains should be designed to take the discharge from one side carriageway also. In super elevated sections combination of covered longitudinal and cross drains shall be provided.
- To avoid erosion of slopes in high embankment and approaches to structures, provision of chute drain is to be given. The chutes may be lined with cement concrete on stable base and will be located at 10 to 15m interval depending upon the rainfall, width, cross slope and longitudinal slope of the carriageway. Energy dissipation device i.e. stilling basin would be provided at the end of the chute drain to avoid the erosion of toe of the embankment.
- For important roads like National Highways and State Highways, the frequency of the storm shall be taken as 25 year and for depressed roads and underpasses, it may be increased to 50 years.
- The drain shall be designed for a flash flood of 1 hour. Drain design would be based on 25 years return period with one hour flash flood.



**a. PCC Open Drain Hill Side**



**b. PCC Open Drain Valley Side**



c. RCC Covered Drain

*Note: Ref. separate TCS drawings for more details.*

Fig 1.25 Types of Drain

## 1.8.2 Hydrological Design of Drain

To estimate the amount of runoff from the carriageway, rational method is a universally adopted empirical formula.

Once the quantity of runoff is estimated, next stage is to do the hydraulic design of the drain. Capacity of the drain is to be determined by Uniform flow equation i.e. Manning's equation;

$$Q = \frac{1}{n} * A * R^{2/3} * S^{1/2}$$

Where

Q = Discharge in (cum/sec)

V = Mean velocity (m/sec)

n = Manning's roughness coefficient, is to be adopted as per IRC: SP-42

R = Hydraulic radius in m

S = Energy slope of the channel, which is roughly taken as slope of drain bed

A = Area of the flow cross-section in sq.m

## 1.8.3 Longitudinal Drainage

Details of drain schedules are mentioned below;

**Table 1.55 RCC Cover Drain**

LHS				RHS		
SI 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
<b>Total Length=</b>			<b>11650</b>			<b>11650</b>

**Table 1.56 PCC Open Drain (On Hill Side)**

LHS				RHS		
SI 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



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



**Volume II-Design Report (Highway)**

LHS				RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)		Length (m)
	From	To		From	To	
6	49+160	49+190	30	49+330	49+520	190
7	49+380	49+510	130			
<b>Total Length=</b>			<b>650</b>			<b>1070</b>

**Table 1.57 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			
<b>Total Length=</b>			<b>1490</b>			<b>1120</b>

**Table 1.58 Open 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
	<b>Total Length</b>		<b>16430</b>			<b>16430</b>



## 1.9 Proposed Fill Slopes

Geologically the project area comprises of normal soil with marginal length of rocks from the oldest Precambrian gneissic complex to the recent alluvium formations. **Hence for protection of fill slope it proposed 65234sqm using turfing and 142183 sqm using erosion control Geogreen.**

## 1.10 Proposed Cut Slopes

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.



Hence for cut slope protection below are the provision proposed;

- i. Cut Slope treatment by Vetiver Grass: Area 1068 sqm.
- ii. Cut Slope treatment by Seeding and Mulching: Area 1602 sqm
- iii. Cut Slope treatment by non-woven coir erosion control blanket/DT Mesh for Face 2.7/3.7mm dia. wire, ZN+PVC - Area 9543 Sqm

## 1.11 Highway facilities

The following items, necessary for traffic safety, shall be provided as per Schedule C.

- **Traffic Signs and Pavement Markings** - as per IRC: 67 and IRC: 35 respectively.
- **Blinker Signals and Object Markers** to be provided at major intersections and all traffic diversion during construction for night time visibility.
- **Metal Beam Crash Barriers:** As per cl.9.7.1.1 of IRC: SP-84-2019 Roadside safety barriers is warranted at locations with embankment height more than 3.0m when embankment slope is 2H:1V.
- **Pedestrian Guard Rails** - on bridges on outer side of footpath and between main carriageway and service road. However, it is also required at other locations such as Junctions/Intersections, in the vicinity of Schools and bus-stops.
- **Chevron Signboards** - on either side of carriageway at horizontal curvature. Minimum 2No.s of boards shall be visible at all sections of curvature
- **Road Studs** - on all curves on both carriageways, at median openings and at intersections as per clause IRC: SP-84-2019.
- **Kilometer and hectometer stones** - based on IRC:8 and MORTH circular
- **Road Boundary Stones** - at every 200m interval

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- **Overhead Gantries** - Start and end of Project Highway
- **Hazard Markers** – at every structure like culverts, bridges and flyovers

**Vol-II**

**Design Report (Structure)**

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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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# 1 Volume-II Design Report (Structure)

## 1.1 Introduction



**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 Pariyojana**".

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. 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. . This would lead to the formation of a more integrated and economically consolidated South and South East Asia. 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.

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

## 1.2 Objective of Document

This Design Report presents the work approach & methodology proposed to be adopted by the Consultants while preparing the designs and drawings for the project. The report primarily covers the design philosophy, various standards & codes of practices, various bridge furniture details, design methodology, design & drawing standards, road safety features etc. which will be followed for development of economic corridors in terms of 4-lane access controlled.

This document aims at standardizing the procedure of designs to be performed in order to achieve techno-economic feasibility, financial viability of the project aspects of value engineering, requirement of quality & safety, safety of operation and efficient maintenance of the facility, durability and conformance to standards, optimization and ease of construction. The aim is also to highlight the basic philosophy of design and the work approach to the Client and Authority engineer at the start of project so that any input from client / IE can be taken care at the early stage of the project for incorporation in designs.



## 1.3 The Project Highway

### As per Contract Agreement (CA)

As per CA the Project stretch Silchar to Vairengte is the section of NH-306 (old NH-54) start at the junction of NH-37 (old NH-53) at km 266+700 and Km 0+000 of NH-306 (Capital point) in Assam State and ends at Km 49+900 of NH-306 near Phainuam Junction of NH 306A at Vairengte town in Mizoram State for approximate length of 49.9 Km.

### 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

	<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><b>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</b></p> <p><b>Volume II - Design Report (Structure)</b></p>	
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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. 46+000 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.

 <p>संयोजित जलम M.O.R.T.H. Govt. of India</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>NADCL BUILDING INFRASTRUCTURE - BUILDING THE NATION</p>
	<p><b>Volume II - Design Report (Structure)</b></p>	

**Table 1.1 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-Vairente Border	24°30'58.93"	92°46'39.72"	119.00

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

The key plan diagram of project road is showing below;



**Fig 1.1 Key Plan of 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><b>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</b></p> <p><b>Volume II - Design Report (Structure)</b></p>	
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**In addition, this report mainly deals with Package-1 that starts at existing Km 263+800 of NH-37 (D. Chainage 0+000) and ends at Existing Km 12+920 of NH-306 (D. Chainage 20+000) however, for better comprehension DPR consultant has furnished the details from Schar to Vairengte state border.**

## 1.4 Structures

The structures are classified based on their functional use. The structures for the project road are classified as given below:

### i) Drainage Structures

- Culverts
- Major Bridges
- Minor Bridges

### iii) Grade Separators

### ii) Viaducts

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.

### 1.4.1 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, pot holes and even failure of complete sections of road. Adequate drainage is a primary requirement for maintaining the structural soundness and functional efficiency of a road.

The existing drainage infrastructure consists mainly of small diameter pipe culverts and slab culverts. Culverts which are found in good condition are proposed to be widened in case of proposed alignment follows existing road and the culverts which are in bad condition are proposed to be reconstructed. There are 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;

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.

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Existing road is a 2-Lane road, which has to be 4-Lane 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;

**Table 1.2 Summary of Culverts**

Existing			Proposed						Total
Pipe	Slab	Box	New Box	Reconstruction	Widening	Retained	Abandoned (not falling under proposed alignment)	Dismantle	
30	04	-	34	48	*17	-	-	16	65

*\*Note: Existing 01 numbers of culverts has been proposed to change in bridges. 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 1.3 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
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



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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 Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
11					23+909	Box	1 x 5 x 4	New Construction	Nutan Bazar Bypass
12					24+340	Box	1 x 2 x 2	New Construction	
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	





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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 Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
33					33+235	Box	1 x 3 x 3	New Construction	
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	

Sl. No.	Existing Details				Design Chainage (Km)			Proposal	Remarks
	Existing Design Chainage (Km)	Type	Size	Deck Width (m)	Chainage (Km)	Type	Size		
54					45+045	Box	1 x 2 x 2	New Construction	
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 25 No. of 1x2x2m Box culverts are proposed for crossroads.

**Table 1.4 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

Sl. No.	Design Chainage	Type	Span (m)	Minimum Vent Height (m)
9	31+060 (at Cross Road)	Box	1x2	2
10	31+600 (at Cross Road)	Box	1x2	2
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

#### 1.4.2 Grade Separated Structures

The structures through which the traffic flows at different levels are called 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 and also it passes through no. of places of habitation. Junctions with NH, SH and Major District Road and other important junctions are to be upgraded 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 other roads are joining the project highway at habitations, at grade junction improvement is proposed. However, consultants proposed grade separation facilities of different configuration for different classes of crossings along the route.

Such under/over passes shall also be provided across other categories of roads as per site requirements for crossing of traffic. The structure may be either an underpass or an overpass depending upon the nature of terrain, vertical profile of road and availability of adequate right of way etc. Decision whether the cross road or the Project Highway will be carried at the existing level will be taken at the time of preparing the feasibility report and would be based on considerations of drainage, land acquisition, provision of ramps for the grade separated facility, height of embankment and project economy etc.

These grade separation facilities are classified and tabulated in following Table.

**Table 7.1 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
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



Sl. No.	Type / Location of Structure	Name	Concept	Leading to	Category of Road	Span arrangement and Vertical clearance	Total Width of Structure (m)
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
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

#### 1.4.2.1 Vehicular Underpass (VUP)

A grade separated structure which is provided for crossing of vehicles under the Project Highway is called as Vehicular Underpass (VUP).

#### 1.4.2.2 Vehicular Overpass (VOP)

A grade separated structure which is provided for crossing of vehicles over the Project

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Highway is called as Vehicular Overpass (VOP).

#### 1.4.2.3 Light Vehicular Underpass (LVUP)

A grade separated structure which is provided for crossing of light vehicles under the Project Highway is called as Light Vehicular Underpass (LVUP).

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.

#### 1.4.2.4 Small Vehicular Underpass (SVUP)

A grade separated structure which is provided for crossing of small vehicles under the Project Highway is called as Small Vehicular Underpass (SVUP).

#### 1.4.2.5 Flyover

Flyover is synonymous to VUP/OP/LVUP/SVUP.

#### 1.4.2.6 Road Over Bridge (ROB)

A structure provided over the railway lines to carry the Project Highway is called Road over Bridge (ROB).

- a) In case a 2-lane bridge exists over the railway tracks, another two-lane bridge shall be constructed for one side traffic. The treatment to existing structure shall be considering as per clause no 7.3 (IV) of IRC: SP: 84-2019.
- b) In case the bridge is to be provided over an existing level crossing, twin 2-lane bridges shall be constructed with overall width as given in Clause no 7.3 (ii) of IRC: SP: 84-2019. If the alignment of road at the existing railway crossing has skew angle more than 45 degrees, the alignment of road or of pier/abutment shall be suitably designed to reduce skew angle up to 45 degrees.
- c) The horizontal and vertical clearances to be provided shall be as per requirement of the Railway authorities.
- d) The Concessionaire shall be required to obtain approvals of all designs and drawings from the concerned Railway authorities.
- e) The construction of ROB within the railway boundary shall be under the supervision of Railway authorities.
- f) The approach gradient shall not be steeper than 1 in 40.
- g) In cases of ROB, the service road on both the sides shall be joined through one of the viaducts of ROB. This arrangement shall be on either side of the railway crossing.

#### 1.4.2.7 Road under Bridge (RUB)

A structure provided below the railway lines to carry the Project Highway is called Road under Bridge (RUB).

- Full roadway width as in the approaches shall pass below the bridge structure allowing for widening of Project Highway to 6-lane at a later date. The service roads where provided shall be continued in the bridge portion also.
- The vertical and lateral clearances shall be as per Guidelines of IRC: SP: 84-2019.
- These structures shall be designed to carry railway loads. The Concessionaire shall be required to obtain approvals of all designs and drawings from the concerned Railway Authorities. The design of structure shall be in accordance with relevant Railway codes.
- The construction of RUB and its approaches shall be carried out in conformity with the terms specified in the approval granted by the Railway Authorities.

#### 1.4.2.8 Trumpet

A Trumpet interchange is a grade separator structure provided at major T-junction facilitating uninterrupted flow of traffic in each direction.

#### 1.4.2.9 Cloverleaf

A Cloverleaf is a grade separator structure provided at a major crossroad junction facilitating uninterrupted flow of traffic in each direction.

#### 1.4.2.10 Median

The width is the distance between inside edges of carriageway is depending upon the availability of Right of Way. Minimum width of median, subject to availability of Right of Way is mentioned below;

**Table 1.5 Width of Median**

Type of Section	Minimum Width of Median (m)		
	Plain and Rolling Terrain		Mountainous and Steep Terrain
	Raised	Depressed Median	Raised
Approach to Grade Separated Structures	5.0	NA	2.5

\* Including kerb shyness of 0.50m on either side.

In case width of median is different from the approach section due to constraints, transition of 1 in 50 shall be provided approaches for guiding vehicular traffic. The median shall be open to sky with 0.5m safety barrier from the edge of carriageway. A suitable designed catch pit shall be provided to collect and carry discharge from median drain.

#### 1.4.2.11 Shoulders

The minimum shoulder width on the outer side is given below;

**Table 1.6 Width of Shoulders in different terrain**

Type of Section	Terrain		Width of Shoulder (m)		
			Paved	Earthen	Total
Approach to Grade Separated Structures	Plain and Rolling		2.5	-	2.5
	Mountainous and Steep (Hilly Area)	Hill Side	0.25 m+ 1.5 m (Raised)	-	1.75
		Valley Side	0.25 m+ 1.5 m (Raised)	-	1.75

Width of Paved Shoulder in approaches to grade separated structures shall extend on either side of the structure in the entire length of retaining walls. The retaining walls on either side shall be abutting the paved shoulders and shall have crash barriers on the top.

#### 1.4.2.12 Lateral and Vertical Clearance

In case of any type of underpass, the proposed structure base shall be kept 150mm above the ground level to prevent water accumulation. Guard rail/Crash barriers shall be provided for protection of vehicles from colliding with the abutments and piers and the deck of the structures.

The minimum horizontal and vertical clearances are given below;

**Table 1.7 Clearances for Underpasses**

Type of Underpass	Vertical Clearance (m)	Horizontal Clearance (m)
<b>Vehicular Underpass (VUP)</b>	5.5	20.0
<b>Light Vehicular Underpass (LVUP)</b>	4.0	12.0
<b>Smaller Vehicular Underpass (SVUP)</b>	4.0	7.0

Whenever any structure is provided over the Project Highway, the minimum clearance of 5.5m shall be provided at all points of carriageway.

#### 1.4.2.13 Width of Structure

The width of new structure shall be as per 6-Lane standards. It shall be designed for the condition when footpath is used as carriageway. The footpath portion may be provided at the same level as the structure carriageway and separated by crash barrier in non-built up area. In built up areas, raised footpaths shall be provided.





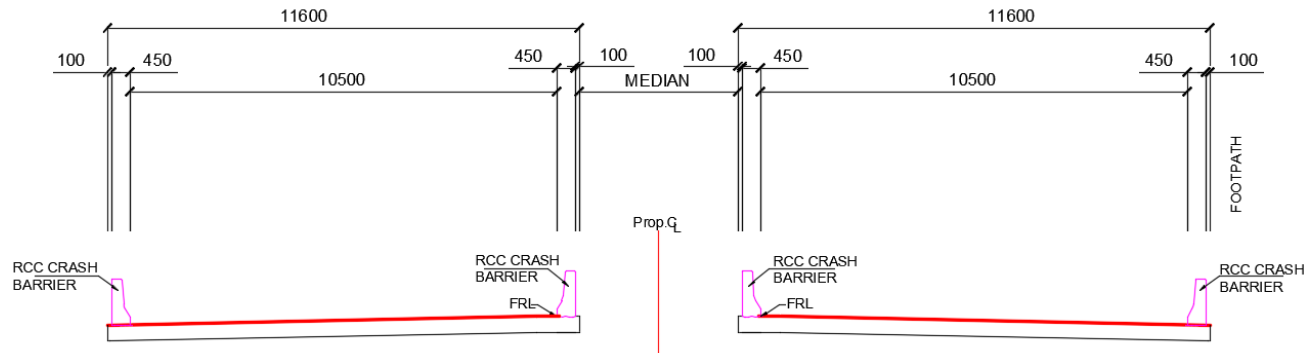
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**Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)**

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The design for service life of structure shall be of 100years.



### 1.4.3 Bridges

#### 1.4.3.1 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 new bridges.

**Table 1.8 Summary of Proposal of Major Bridges**

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

*\*Note: Existing 01 numbers of culvert has been proposed to minor bridge.*

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**Table 1.9 Improvement Proposal of Major 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	
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	1	2.0m dia	Pipe Type, with Footpath	2 x 11.6+2 x 11.0	New Construction	
7	-	48+610	1	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	



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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.	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)				
5	39+990	47+033	1	20	PSC Girder Type, with Footpath	2 x 11.6+2 x 11.0	Reconstruction	

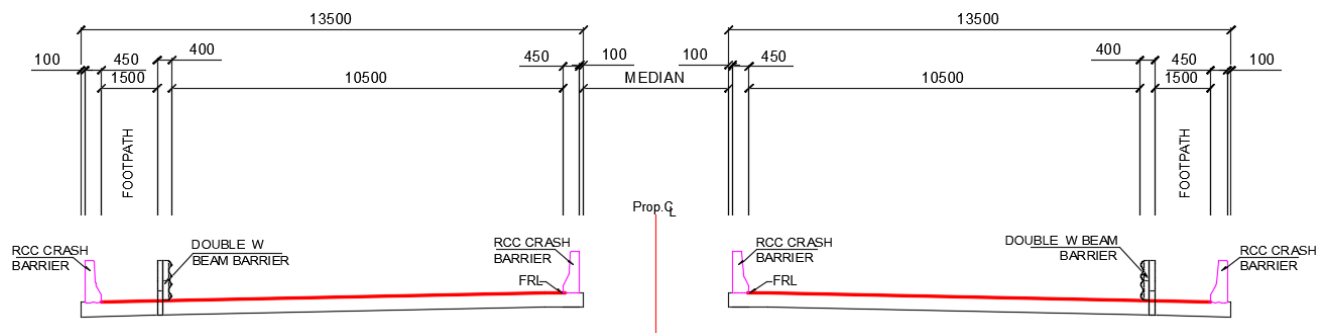
### 1.5 Design & engineering methodology

#### 1.5.1 Salient Features

##### 1.5.1.1 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.

##### 1.5.1.2 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 crossroads;
- Vertical profile of the proposed project road and
- Vertical clearance required above the high flood level.

To achieve salient features of the design, competitive and analysis for the loading is given below:

### 1.5.1.3 Design Loading

The loading conditions are generally based on the requirements of IRC: 6- 2017 and the design criteria given in the tender document. The salient dead loads are listed below for ready reference.

#### a) Dead Loads

Plain Cement Concrete	2300 Kg / m <sup>3</sup>
Reinforced Cement Concrete	2400 kg / m <sup>3</sup>
Pre-stressed concrete	2500 kg / m <sup>3</sup>
Earth fill / sand fill	1800 kg / m <sup>3</sup>
Wearing Coat (Bitumastic concrete)	2200 / m <sup>3</sup>

#### b) Carriageway Live Load

Vehicular Loading is as per IRC 6-2017 and Vehicular Combinations are considered depending on the lane width (carriageway width) of the Bridge has been provided.

#### c) Tractive and Braking Force

The tractive and braking forces have been considered as per the provisions of clause no. 211 of IRC: 6-2017.

#### d) 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.

#### e) Wind Loads

More severe effect of the wind at right angles to the viaduct or with 65% of right angle to the viaduct and 35% along the traffic has been considered. Procedures are given in IRC: 6:2017 clause no. 209.

#### f) Temperature Loads

Effect of temperature differences within the superstructure for positive temperature difference and reverse temperature differences are considered for design purpose according to IRC: 6.2016.

#### g) Seismic Loads

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.

#### **h) Erection Loads**

Normally these considered as 60% over loading. The launching will be generally by pneumatic tyres mounted cranes.

#### **i) Earth Pressure**

The following soil parameters for fill materials behind abutment shall be adopted as per MORTH standards.

Dry density Saturated density

Angle of internal friction

Cohesion

#### **j) 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.

#### **k) 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 %

### **1.5.2 Material**

#### **1.5.2.1 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.

#### **1.5.2.2 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/m<sup>3</sup> of concrete as per clause 14.3.2.5 of IRC: 112-2011.

#### **1.5.2.3 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

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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.

#### 1.5.2.4 Admixtures

To improve workability of concrete, admixtures conforming to IS: 9103 will be used

#### 1.5.2.5 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

#### 1.5.2.6 Reinforcement



Deformed or TMT reinforcement bar conforming to IS: 1786 will be used for components of the structures. The reinforcement grade will be Fe500D.

#### 1.5.2.7 Prestressing Steel

Prestressing tendons normally take the form of separate wires, wires spun together helically to form strands or bars. For pre-tensioned steel, wires, strands and occasionally bars are used, simply to permit the concrete to bond directly to them; when post-tensioning is used, it is common practice to group the separate tendons together, so as to reduce the number of anchorages and ducts required to accommodate them. When grouped in this way, the tendons in each duct are usually termed a cable.

Uncoated stress relieved low relaxation steel conforming to IS: 14268 will only be used for pre-stressing steel so as to reduce losses due to relaxation. Data in respect of modulus of elasticity, relaxation loss at 1000 hours, minimum ultimate tensile strength, stress-strain curve etc. will necessarily be obtained from manufacturers. Pre-stressing steel will be subjected to acceptance tests prior to actual use on the works (guidance may be taken from BS: 4447). The modulus of elasticity value, as per acceptance tests, will conform to the design value which will be within a range not more than 5 percent between the maximum and minimum.

Many cables with different arrangements of wires and strands and different methods of anchorage are available as pre-stressing steel. So, type and size of cable and methods of anchorage will be decided on the basis of design requirement.

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### 1.5.2.8 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.

### 1.5.3 Preliminary Design and Methodology

This aims at providing the basic criteria for design of foundation, substructure, superstructure etc. for the various parameters of loads, stresses, materials, grades of concrete for various structural elements, exposure criteria, foundation designs, functional elements, finishing item etc. The flyover structures have been modelled by Finite element Technique using CSI bridge software Advanced Version 17 / STAAD Pro V8i. Analysis has been performed to get various output such as bending moment, shear forces and torsion values at various locations along the span of flyover/Minor Bridges. The detail design of super structure is performed as per IRC standards using in-house developed spread sheet programs.

The substructure components such as abutment, piers, pile foundation and other miscellaneous structural elements have been designed by using in-house developed programs (spread sheets) based on various formulas, expressions & empirical equations to satisfy IRC codal stipulations. A modular standardized span design has been followed to reduce variation & ease in construction & maximum use of post-tensioned pre-cast members.



Based on the input parameters, design approach is formulated to take into account the various parameters such as minimum land acquisition etc., which primarily consists of the following.

#### 1.5.3.1 Superstructure

This consists of standard span configuration of 25m, 38m, & 40m, as PSC I Girder and 15m Pre-cast RCC I Girder, and with a cast-in-situ deck slab for major bridges minor bridges and flyover.

##### 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

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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.

- d) 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.
- e) 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.
- f) 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**

- g) For span up to equal to 20 mts. or more PSC girders will be considered for design
- h) 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.
- i) 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).
- j) 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.
- k) 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.



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- l) 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.
- m) The design of deck slab supported transversely on the precast girder will be carried out assuming un-yielding support at the girder points.
- n) Effect of differential shrinkage and creep between precast girder and in-situ slab will be considered.

**c. Design of PSC segmental box girder**



- o) For 50m span or greater, PSC segmental Box Girder can be adopted.
- p) 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.
- q) 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.

**1.5.3.2 Sub Structure**

Based on the available data, Piers are of RCC cast-in-situ wall type piers, Circular type piers with cantilever pier cap to house the bearings. The abutment also consist end wall type abutments with flared capital to accommodate the dirt wall and bearings. . Pre-cast retaining earth panels with a soil reinforcement strips assembled to constitute the return walls in the approach ramp area for flyover and end return wall is provided for the major bridge.

**a. Foundation**

Based on the available soil data input, the foundation are designed as open foundations the required depths of foundations are finalized by considering the scour depth and by SBC of soil as per IRC recommendations.

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## 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:

- a) 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.
- b) The thickness of the footings shall not be less than 300 mm.
- c) 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.
- d) 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.
- e) The shear strength of the footing may be checked at the critical section which is the vertical section at a distance 'd' from the face of the wall for one-way action where 'd' is the effective depth of the section at the face of the wall.
- f) To ensure proper load transfer, a limiting value of ratio of depth to length/width of footing equal to 1:3 is specified. Based on this, for sloped footings the depth effective at the critical section shall be the minimum depth at the end plus 1/3rd of the distance between the extreme edges of the footing to the critical section for design of the footing for all purposes.

## Well Foundation

In general, the design of well and well cap will conform to provisions of IRC: 78-2014. The various specific assumptions to be made for the design of Well and Well cap will be as follows:

- a. Well foundations shall be taken down to the depth which will provide a minimum grip of 1/3<sup>rd</sup> the maximum depth of scour below the design scour level specified in Clause 703.3 of IRC: 78-2014. The minimum dimension of dredge-hole shall not be less than 3 m.
- b. The thickness of the staining should be such that it is possible to sink the well without excessive Kent ledge and without getting damaged during sinking or during rectifying the excessive tilts and shift. The staining should also be able to resist differential earth pressure developed during sand blow or other conditions, like, sudden drop.

- c. The minimum thickness of staining shall be not less than 500 mm and also satisfy the following relationship:

$$H = Kd \sqrt{l}$$

h = minimum thickness of staining in m

d = external diameter of circular well of dumb dell shaped well or in case of twin D wells smaller dimensions in plan area in meters

l = depth of well in meters below the toe of well cap or LWL whichever is more (for floating cassion 'l' may be taken as depth of well in meters below bed level)

K = a constant

Values of constant shall be as follows:

Well in cement concrete K = 0.03

Well in brick masonry K = 0.05

Twin D wells K = 0.039

### Bottom Plug

The bottom plug shall be provided in all wells and the top shall be not kept lower than 300 mm in the centre above the top of the curb as shown in Appendix – 3 (Fig. 2) of IRC 078: 2014.

### Well Cap



The bottom of well cap shall be laid as low as possible but above the LWL in the active channel. Where the bed level is higher than LWL the bottom of well cap may be suitably raised

The design of well cap shall be based on any acceptance rational method, considering the worst combination of loads and forces as per Clause 706 if IRC 078: 2014.

### Pile Foundation

In general, the design of pile and pile cap will conform to provisions of IRC:78. The various specific assumptions to be made for the design of pile and pile cap will be as follows:

- a. The vertical load carrying capacity of the pile will be determined based on static formula given in Appendix-5 of IRC:78 which shall be given by Geo-tech

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- b. The vertical load carrying capacity as calculated by static formula will be verified by conducting initial load tests and routine load tests on piles conforming to IS:2911 (Part 4).
- c. The lateral load carrying capacity of the pile will be determined by using empirical formula given in IS:2911 (Part-1/Sec-2) by limiting the lateral deflection to 1% of pile diameter at its tip considering it as fixed headed pile under normal conditions. The capacity so evaluated will be used purely for the purpose of arriving at the upper bound of lateral load capacity. Routine load test shall be conducted to verify lateral load carrying capacity of pile. This deflection limitation will not be applicable in load combination with seismic/wind conditions for which the resulting stresses and the structural capacity of the section would be the governing criteria.
- d. Soil stiffness for lateral loads will be taken from IS:2911 (Part-1/Sec-2), Appendix C. Unconfined compressive strength will be calculated from the results of Geotechnical Investigation Reports. Cohesion, as calculated using unconsolidated undrained test with required modification of angle of internal friction will be used for working out unconfined compressive strength. For cohesionless soil (sand), standard penetration resistance (N), as calculated from Standard penetration test will be used.
- e. For calculating the bending moment in a pile shaft corresponding to unit lateral force, a single pile is idealized in STAAD.PRO. The pile is restrained by spring supports along the length of pile representing soil stiffness with appropriate value as per IS:2911 (Part 1/Sec 2). Then, reinforcement in pile shaft will be curtailed as per the bending moment of the pile shaft.

#### **Pile cap**

- a. The minimum thickness of pile cap will be kept as 1.5 times the pile diameter.
- b. Top of the pile will project 50mm into the pile cap.
- c. Pile cap will be designed either by truss analogy or by bending theory, depending upon the spacing and number of piles in a pile group.
- d. Pile cap will be provided with an offset of at least 150mm beyond the outer face of the outer piles.

#### **Pier and Pier cap**

- a. The piers are to be designed for combined axial load and biaxial bending as per the provisions of IRC: 112. Piers shall also be checked for Slenderness as per clause 11.2 of IRC: 112.

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- 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.

### 1.5.3.3 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.

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.

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

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

#### 1.5.3.4 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.

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### Elastomeric Bearings

Elastomeric bearing can accommodate translation movements in any direction and rotational movements in any axis by elastic deformation. They should not be used in tension or when rotation is high and vertical load small. The basis of design is that the elastomer is an elastic material, the deflection of which under a compressive load is influenced by its shape (shape factor). Reinforcing plates should be bonded to the elastomer to prevent any relative movement at the steel/elastomer interface. The dimension and the number of internal layers of elastomer chosen will satisfy the following clauses of IRC: 83(Part-II).

IRC: 83 (Part-II) recommends that chloroprene (CR) only will be used in the manufacture of bearing. The elastomer will conform to all the properties specified in table 1 of IRC: 83 (Part-II), and tolerances in dimensions specified in table2 of IRC: 83 (Part-II).

### Pot/PTFE Bearings, Metallic Pin / Guided Bearings

Due to easy availability, maintenance free and easy replacement, for simply supported structures elastomeric bearing will be used. Wherever it is unavoidable POT/ PTFE bearings will be used. However, for continuous structure POT/ PTFE bearing will be used.

The design of the POT/ PTFE bearing will be done by the manufacturer conforming the provisions of material as well as design parameters IRC: 83(part-III). However, the forces, movements and rotation etc will be provided by the designer of the project on the format given in appendix –1 of IRC: 83 (part-III). In support of quality assurance, acceptance specification given in clause 928 of IRC: 83(part-III) will be followed.

### 1.5.3.5 Loading

#### a) 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/m<sup>2</sup> (Surfacing) & 800 kg/m (Crash Barrier).

#### b) 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.

#### c) 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<sup>-6</sup> per degree Celsius. For design purpose, maximum variation in temperature is considered as below:

Maximum temperature = 35.5°C (As per Notification 2 of IRC: 6-2017)

Minimum temperature = 6.1 °C (As per Notification 2 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.

#### d) Differential Temperature Gradient

The Superstructure is designed for the positive & reverse temperature gradient along the depth of superstructure as per clause 215.3 of IRC: 6-2017.

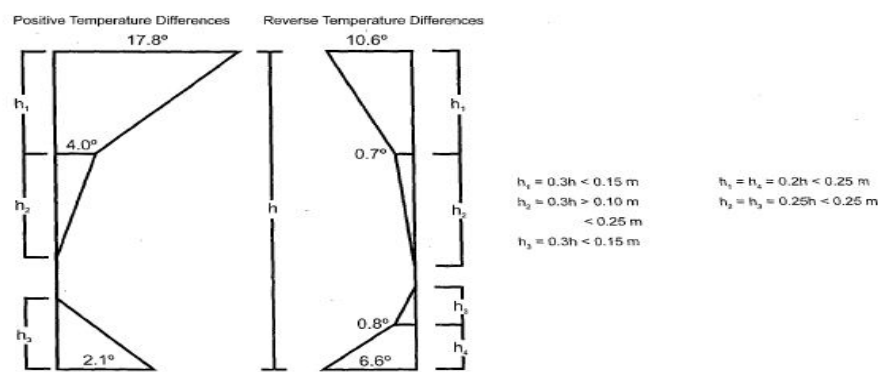


Fig. 10 (a) Design Temperature Differences for Concrete Bridge Decks

While

deriving the effect of temperature gradient variation, short term/instantaneous modulus of concrete shall be taken.

#### e) 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.

#### f) Seismic Force

The seismic forces will be calculated for seismic zone V, with zone factor Z=0.36 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.

#### g) Condition of exposure

Moderate Exposure conditions shall be adopted as per table 14.1 of IRC: 112-2011.



#### h) Other Loads

The loads which are not mentioned in this Clause, will be as per IRC: 6-2017.

#### i) 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  $f_{ck}$ . 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.

#### 1.5.3.6 Deflection Limitations

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

- For vehicular live load: Span/800
- For vehicular LL on cantilever: cantilever span/300

#### 1.5.3.7 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

#### 1.5.3.8 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.

### 1.5.3.9 Expansion Joints

Provisions of IRC: SP:69-2011 will be followed. These will also conform to Section 2600 Specifications for Roads & Bridge Works issued by MoRT&H.

Types of Expansion joints based upon the length of the span and movements are given below:

Sr. No.	Span	Expansion Joints
(i).	For RCC slabs up to 11 m span only	Buried type expansion joints
(ii).	For all other bridges having span longer than 11 m and where movements are up to total 80mm	Elastomeric Single Strip Seal type expansion joints
(iii).	For all other bridges having span longer than 11 m and where movements are more than 80mm	Elastomeric Modular Strip Seal type expansion joints

### 1.5.3.10 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.



### 1.5.3.11 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.

### 1.5.3.12 Miscellaneous elements

This comprises of Drainage planning & design of the deck structure. Provisions of the bearing for smooth transfer of super structure loads to the sub structure are made. Expansion joints to take care of the movements of superstructure, crash barrier for safety to the traffic movements, wearing courses are provided.

**Drainage –** To ensure effective drainage of the deck superstructure, it is proposed to provide transverse chamber and to trap the drainage water at intervals through MS gratings and guide through a common header to be tapped at intervals at pylons.

	<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><b>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</b></p> <p><b>Volume II - Design Report (Structure)</b></p>	
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Further, this will be connected & guided to the chambers at grade level before connecting to the at-grade box drain.

**Crash Barrier** – These are designed & detailed to take up the accidental loads as per codes and as a safety barrier for the movement of the traffic. They are detailed as New Jersey RCC cast-in-situ crash barrier with MS tube railing at the top.

**RCC hand rail** - These are designed & detailed to take up the loads as per codes and as a safety barrier for the movement of the pedestrian traffic.

**Wearing Coat** – It is being planned to provide as an insulation layer to the deck from traffic movement and also serve as a waterproofing layer (mastic asphalt layer) and laid with bituminous concrete.

## 1.6 Protection Works

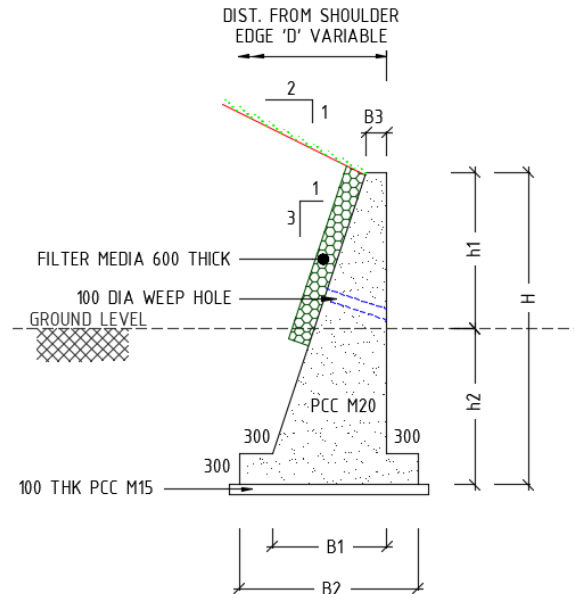
The proposed road alignment passes through hilly terrain, major stretch of the road passes through reaches with either full cutting or part cutting and filling. Due to high cut & fill natural stability of the hill slopes disturbs. Watercourses along the slopes cause erosion affecting road stability. Soil movement along slopes tend to disturb the road formation. All these must 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

### 1.6.1 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.



*Note: Ref. separate Standard drawings for more details.*

**Fig 1.2 Toe Wall Types**

Detail locations of Retaining walls are given below;

**Table 1.10 Schedule of Toe 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

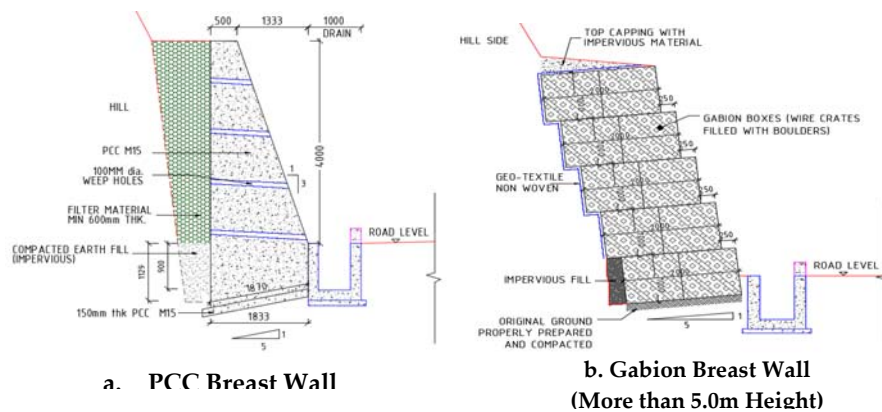
LHS						RHS				
Sl No	Chainage (m)		Length (m)	Height based on IL taken in Topo-survey (m)	Remarks	Chainage (m)		Length (m)	Height based on IL taken in Topo-survey (m)	Remarks
	From	To				From	To			
10	47+780	47+850	70	6	Gabion	47+990	48+670	680	5	PCC
11	48+900	49+050	150	6	Gabion					
Total Length=			2970					3300		

### 1.6.2 Breast Walls

Breast walls are provided to protect uphill slopes, which fail by slumping, sliding, toe failures and failures below formation level. Breast walls would also serve the following functions.

- To keep the road edge defined
- To protect the hill slope to the height of breast wall from 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 1.3** Types of Breast Wall

Detail locations are mentioned below;

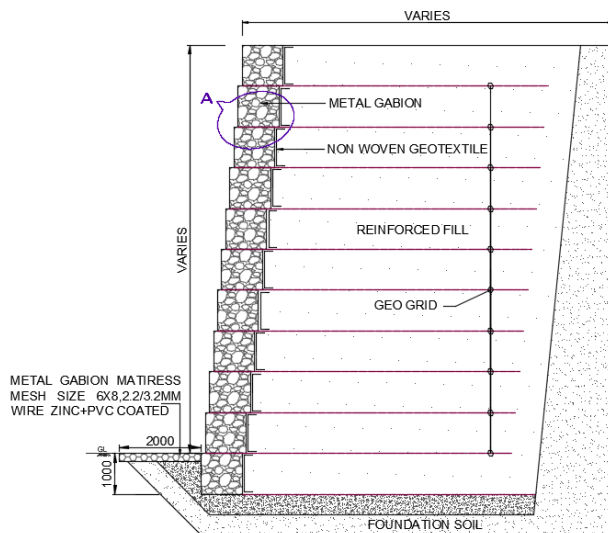
**Table 1.11 Schedule of Breast Wall**

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		

### 1.6.3 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 1.4 Reinforced Soil Wall with Gabion Facia**

The details of the same is given in table below;

**Table 1.12 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				
<b>Total Length (m)</b>			<b>580</b>					

#### 1.6.4 RE Wall

Generally, RE Wall hall be proposed on the approaches of Grade separated structures as per site condition. Detail length is given below;

**Table 1.13 Schedule of RE Wall**

Sl No	LHS			RHS		
	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
<b>Total Length=</b>			<b>8735</b>			<b>8735</b>

#### 1.6.5 Crash Barrier

Thrie Beam metal Crash barrier is proposed where the embankment height is 3m or more, on curves having radii less than 150m for upgrades and 300m for downgrades and at locations where, ground slope is steeper than 2 horizontal 1 vertical (2:1) on valley side, on the approaches of bridges for a length of at least 30m on both sides. With these criteria, detail length of W-beam crash barrier is given below;

**Table 1.14 Schedule of Crash Barrier**

LHS				RHS		
Sl No	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



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 1.15 Schedule of Jersey Crash Barrier**

l.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
	<b>Total</b>		<b>9565</b>	<b>LHS</b>	<b>Total</b>		<b>9565</b>	<b>RHS</b>

## 1.7 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 1.16 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

LHS			RHS		
Sl No	Chainage (m)		Length (m)	Chainage (m)	
	From	To		From	To
4	33+300	34+295	995	33+300	34+295
5	35+290	36+190	900	35+290	36+190
6	37+985	38+965	980	37+985	38+965
7	39+840	40+910	1070	39+840	40+910
8	44+530	45+430	900	44+530	45+430
9	47+110	47+365	255	47+110	47+365
10	48+320	49+040	720	48+320	49+040
<b>Total Length=</b>			<b>8735</b>		<b>8735</b>

## 1.8 Codes

- 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: 78-2014 : Standard Specifications and Code of Practice for Road Bridges, Section VII- Foundations and Substructures (Revised Edition)
- IRC: 83-2015 (Part I) : Metallic Bearings
- IRC: 83-2018 (Part II) : Elastomeric Bearings
- IRC:83-2018 (Part III) : Standard Specifications and Code of Practice for Road Bridges Section – IX Bearings (Part III: Pot, Pot-cum PTFE, Pin and Metallic Guided Bearings)
- IRC:22-2015 : Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design) (Third Revision)
- IRC: SP:114-2018 : Guidelines for Seismic Design of Road Bridges
- 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:69-2011 : Guidelines and Specifications for Expansion Joints

	<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><b>Section : Silchar to Vairengte (Package-2, mod. from Km 20+000 to Km 49+360)</b></p> <p><b>Volume II - Design Report (Structure)</b></p>	
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- IRC: SP:71-2006 : Guidelines for Design & Construction of Precast Pre-tensioned Girders for Bridges
- MoRT&H : Specifications for Road and Bridge Works, 2013 (Fifth Revision)
- IRC: 87-2011 : Guidelines for the Design and Erection of Falsework for Road Bridges
- IS-2911-2002 : Code of practice for design and construction of pile foundations Part I Section II

Other relevant codes.

