DETAILED PROJECT REPORT (DPR) FOR AN URBAN ROAD

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GOVERNMENT OF ASSAM

PUBLIC WORKS DEPARTMENT (ROADS)

GOVERNMENT OF ASSAM, INDIA

Project Preparatory Works Consultancy Services for Assam State Roads Project

DETAILED PROJECT REPORT

Executive Summary

(Mahapurush Madhabdev Path/VIP Road–Panjabari Road; Local, Link Road)

Distance: 1631.8 Meters | 1.63 Km

September 2020

Pegu Constructions Pvt. Ltd.

EXECUTIVE SUMMARY

CONTENTS

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1. INTRODUCTION

1.1 Project Background

1. Assam is one of the most versatile and dynamic states in India. The state has established itself a state of tourism and very strong economic foundation. With upcoming huge scale projects like the 65-storey Twin Tower Trade Centre, Newly Integrated Terminal Building at the LGBI Airport, etc. It is very crucial to connect the rest of state and the city of Guwahati with top quality of roadways. The Government of Assam is all set to start the construction of the tower this year itself.
2. The increasing population and improvement of the infrastructures, increasing number of industries demand better connectivity within the state itself.
3. Guwahati, it is the gateway to all the North-Eastern States with a full time functioning International Airport, therefore it demands top class connectivity of roadways. It is directly affecting the other 6 North-Eastern States (Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya).
4. The Nagpur Plan divided the District Roads into two classes and the District Roads were defined as roads traversing each district, serving areas of production and markets and connecting these with each other or with highways and railways. It was agreed that these roads should be capable of taking road traffic into the heart of rural areas throughout the year with only minor interruptions. It was further agreed to aim at having every village in all highly populated areas within about 2 miles of such a road and within 5 miles or so in other areas. District Roads were subdivided, according to the expected traffic and the specifications necessary, into two classes:

4.1. Major District Roads to be roughly of the same specifications as the Provincial or State Highways,

4.2. Other District Roads to be of a somewhat lower specification."

5. The Road Development Plan of India, 1981-2001, (Lucknow Plan) laid down the following policy and goal for Major District Roads: "Major District Roads should serve and connect all towns and villages with a population of 1500 and above which are not connected directly by National Highway or State Highway. They should also provide interconnection between towns, wherever necessary".

6. In the Indian Roads Congress document on Geometric Design Standards for Rural (Non-Urban) Highways, IRC: 73-1980, the following definition has been given: “Major District Roads are important roads within a district serving areas of production and markets, and connecting these with each other or with the main highways".
7. The Vision Document: 2021, suggests that the length of MDRs should be twice that of the length of SHs.
8. A Strategic Options Study (SOS) was undertaken by the Department in 2009 based on which the State Highways and Major District Roads in the State was formulated. The list of Major District Roads is as below:

Major District Roads

Sl. No.	District	MDR(km)
1.	Bagsa	43.00
2.	Barpeta	171.40
3.	Bongaigaon	16.00
4.	Cachar	165.45
5.	Chirang	223.24
6.	Darrang	118.50
7.	Dhemaji	42.00
8.	Dhubri	53.11
9.	Dibrugarh	162.77
10.	Goalpara	48.00
11.	Golaghat	156.75
12.	Hailakandi	98.90
13.	Jorhat	89.06
14.	Kamrup	229.86
15.	Karbi Anglong	560.84
16.	Karimganj	342.63

17.	Kokrajhar	131.40
18.	Lakhimpur	97.36
19.	Morigaon	86.00
20.	Nagaon	326.50
21.	Nalbari	44.55
22.	NC Hills	199.00
23.	Sibsagar	309.59
24.	Sonitpur	401.60
25.	Tinsukia	170.94
26.	Udalguri	124.58
	Total =	4413.03
TOTAL LENGTH (km):		7547.39

9. The city of Guwahati comes under Kamrup (Metropolitan) district and the list of the roads are:

Major District Roads (Kamrup)

Sl. No.	Road name	Length (km)	New Road Number	Remark
1.	Chepti Kulhati (Rangia Hajo Road)	22.50	Km-M-1	
2.	Changsari Sessa	14.00	Km-M-2	
3.	Bezera Balikuchi	12.50	Km-M-3	
4.	Dharapur Palashbari Uparhali (Old AT Road)	12.81	Km-M-4	
5.	Chaygaon Owguri Kulsi Loharghat	23.10	Km-M-5	

6.	Azara Rani Loharghat (Rani NEC Road)	18.92	Km-M-6	Under NEC
7.	Borkhat Barni	15.00	Km-M-7	
8.	Dhupdhara Adokgiri	11.00	Km-M-8	NEC 6th plan
9.	Singra Hahim	15.51	Km-M-9	NEC 6th plan (Boko Hahim portion of 15.00 km taken up under NESRP)
10.	Sonapur Umden Nongpo	17.52	Km-M-10	NEC 9th plan
11.	Kamalpur Baharghat	11.50	Km-M-11	
12.	Baihata Chariali Goreswar Deochunga	12.00	Km-M-12	
13.	Palashbari Mirza Loharghat Rajapara Chandubi Road	36.00	Km-M-13	Approach road to Chandubi-important tourist place
14.	North Guwahati to Kamrup district boundary (Amingaon Kurua Dumunichowki Khatara Road	5.00	Km-M-14	
15.	Bongsor Soalkuchi	2.50	Km-M-15	It connects Soalkuchi the famous indigenous silk production hub and a major handloom textile producing centre of the State
	Districtwise total length (in km)	229.86		

1.2 Assam State Roads Project

The Assam State Roads Project is an Externally Aided Project (EAP) implemented for by the Public Works Roads Department (PWRD) through the Assam State Road Board (ASRB) for improvement of State Highways (SH) and Major District Roads (MDR) in the State. The total project cost is US$ 400 million. It includes US$ 320 loan assistance from the World Bank through the Govt. of India and US$ 80 million Government of Assam State share. The project development objective is to support the Government of Assam to develop an effective, sustainable, and safe state road network to facilitate integration of Assam's economy with rest of India. The loan and project agreement was signed on November 5, 2012 and the loan became effective from January 25, 2013. The project closing date is March 31, 2018.

The project involves the following major components:

Component 1: Road Improvement: It includes civil works for a combination of road upgradation of about 300 km of state highways and pavement rehabilitation of about 800 Km of state highways and major district roads. It also includes pilot project on innovative bridge designs.

Component 2: Institutional Strengthening: It includes establish a Road Asset Management System for improving road maintenance in the State; institutional strengthening of the Assam State Road Board; computerisation of business processes of the department; institutional strengthening of the Assam Road Research and Training Institute as well as comprehensive skill enhancement of the PWRD staff, etc.

Component 3: Road Safety Management: Implementation of a multi-sectoral Road Safety Action Plan (RSAP); undertaking demonstration projects on road safety engineering measures; road safety assessments of core network; establishing road accident database, etc.

1.3 Broad Objectives and Scope

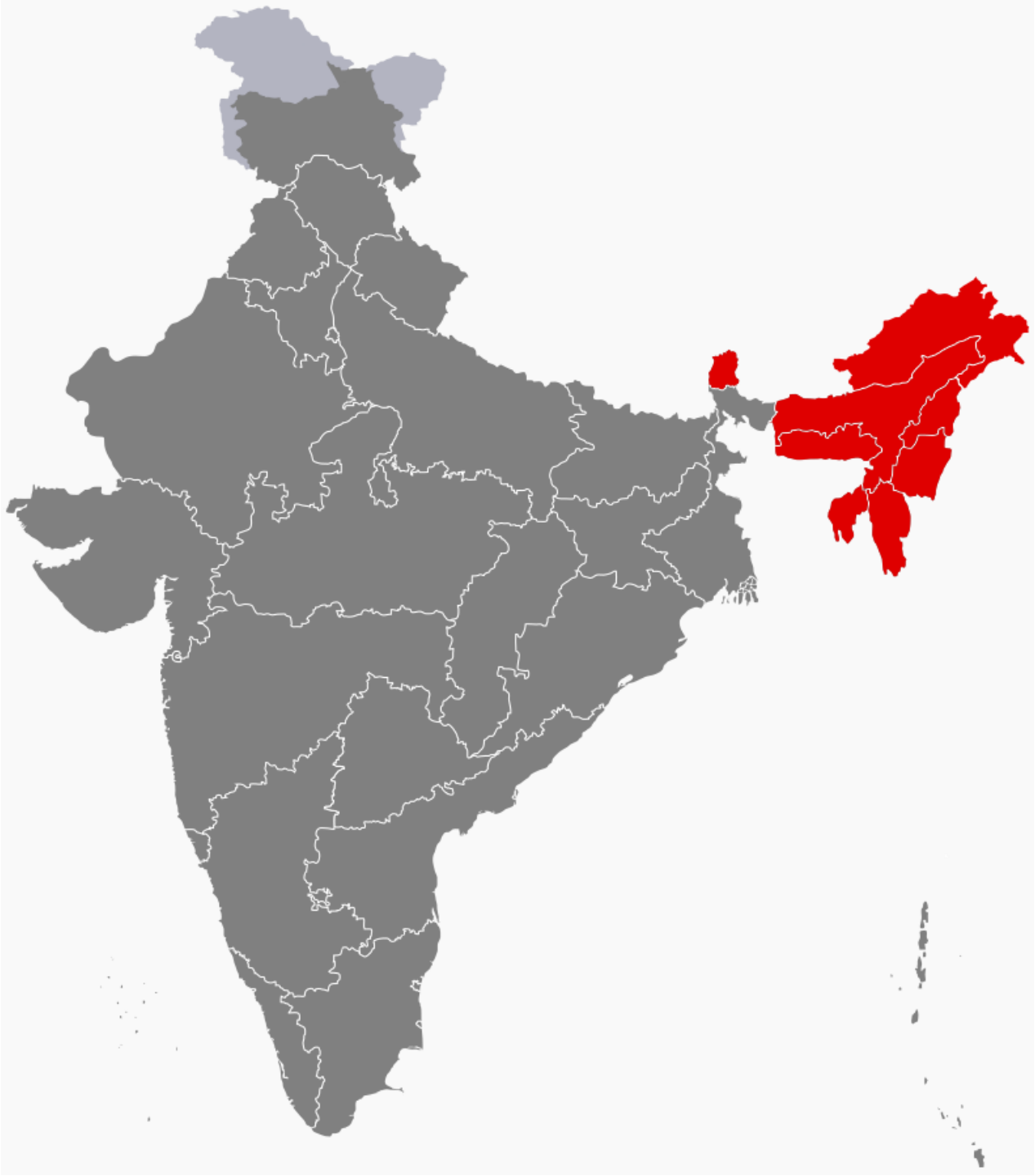
The broad objective of the assignment is to have detailed engineering project ready for bidding. It includes economic analysis for the entire section of the road to be constructed, the integration of road safety audit in final design, operation & management and the implementations. Environmental Impact Assessment (EIA) is not required as it is a small scale and low budget project (i.e. <50 crores INR). Key maps showing the projects path is shown in various views (modes).

1.4 Detailed Project Report

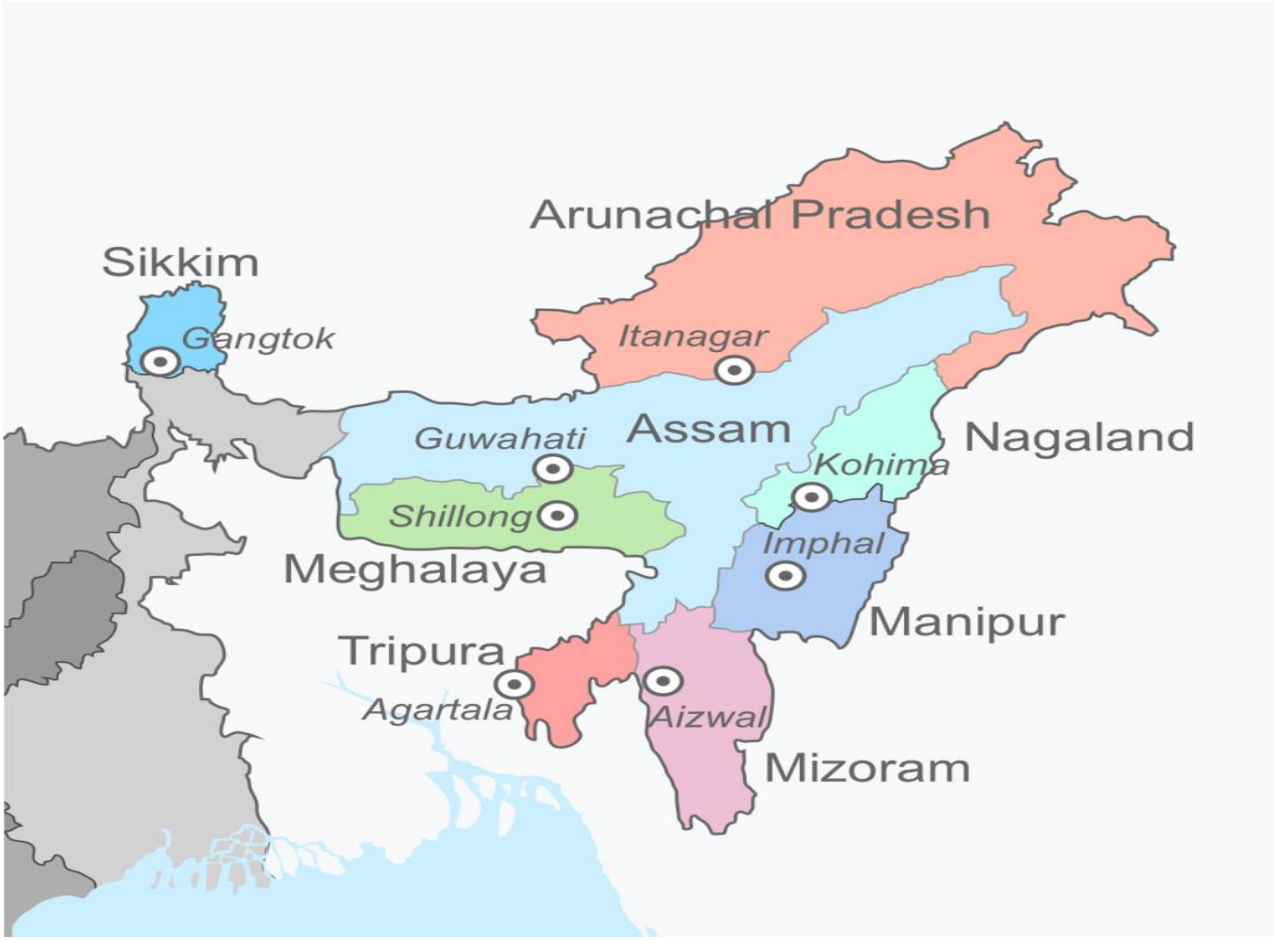
This Executive Summary of DPR pertains to two laning with granular shoulder and raised kerb for the interconnection between Mahapurush Madhabdev Path/VIP Road and Panjabari Road, Guwahati (Kamrup Metropolitan). The total length of the road to be constructed is 1631.8 meters/ 1.63 km.

There are key maps for the project provided below.

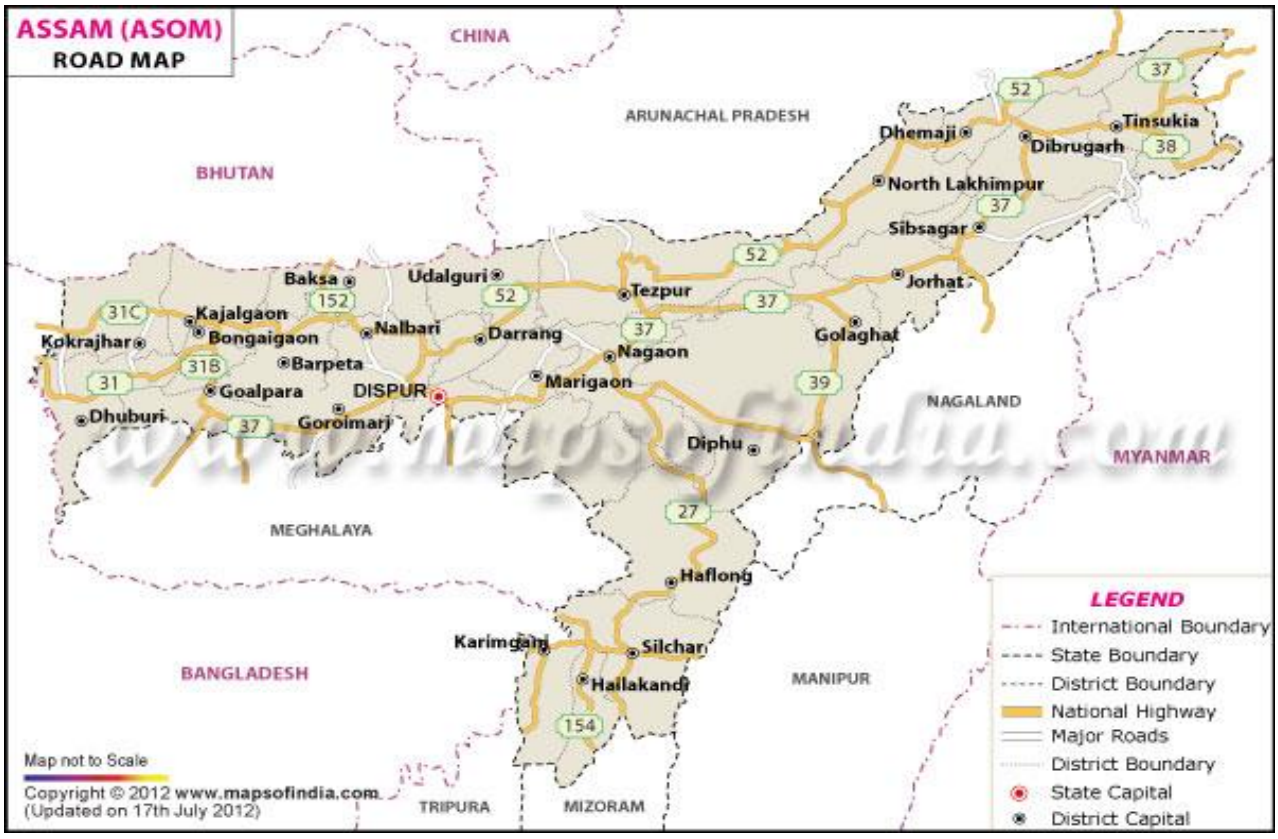
MAP OF INDIA WITH NORTH-EAST HIGHLIGHTED



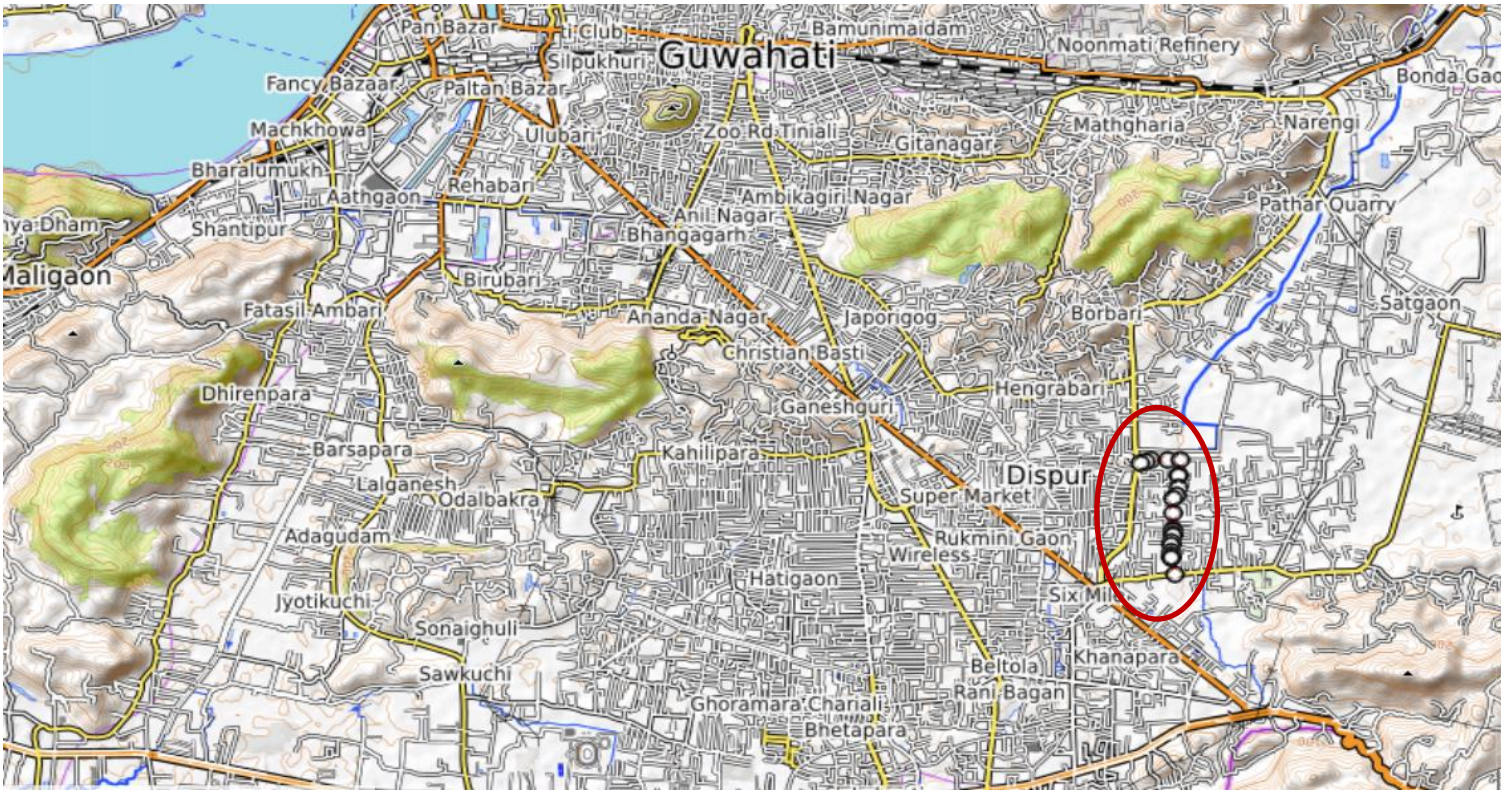
MAP OF NORTH-EAST INDIA



NH MAP OF ASSAM

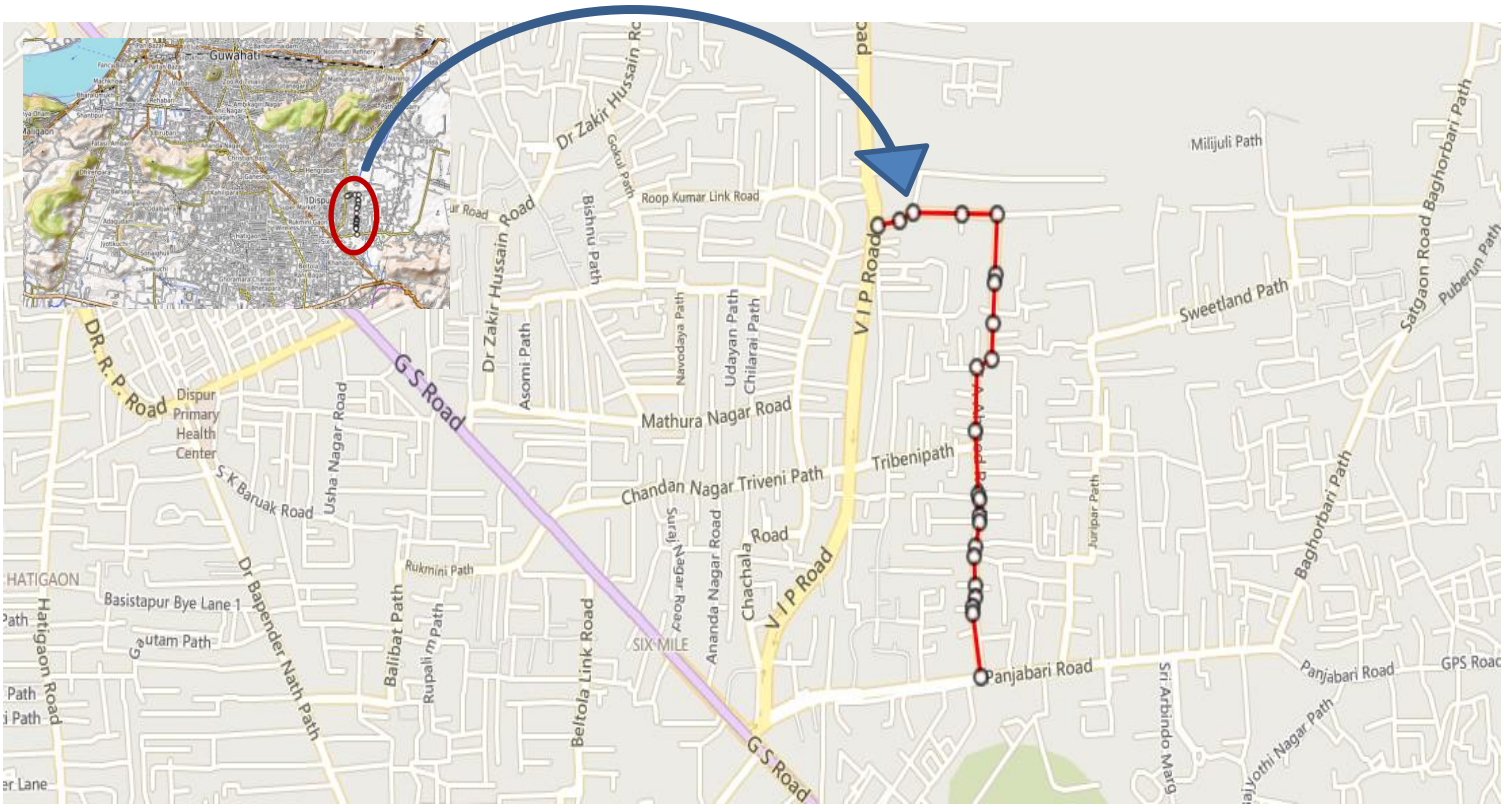


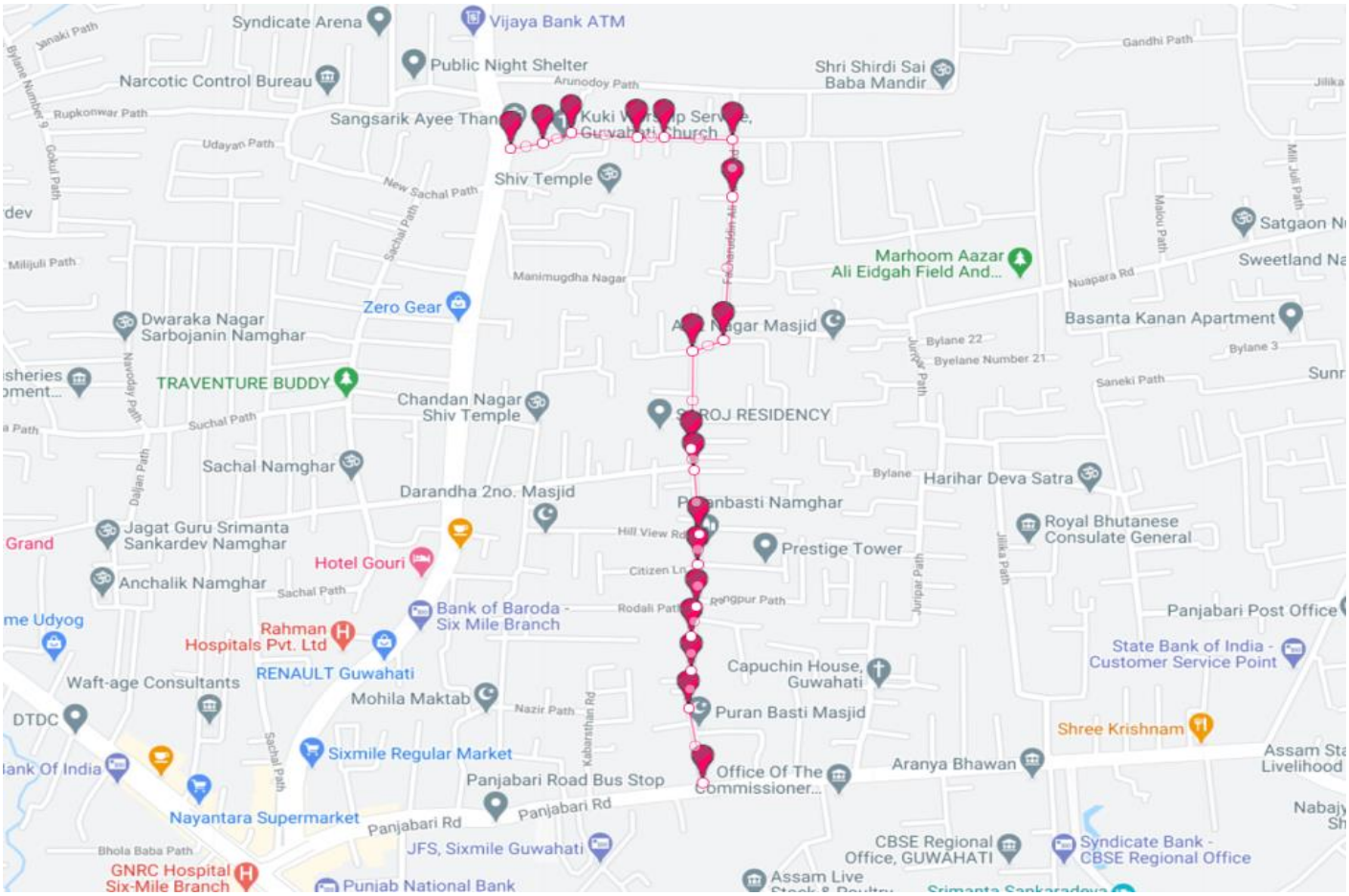
TOPOGRAPHIC MAP OF GUWAHATI: Kamrup (Metropolitan)

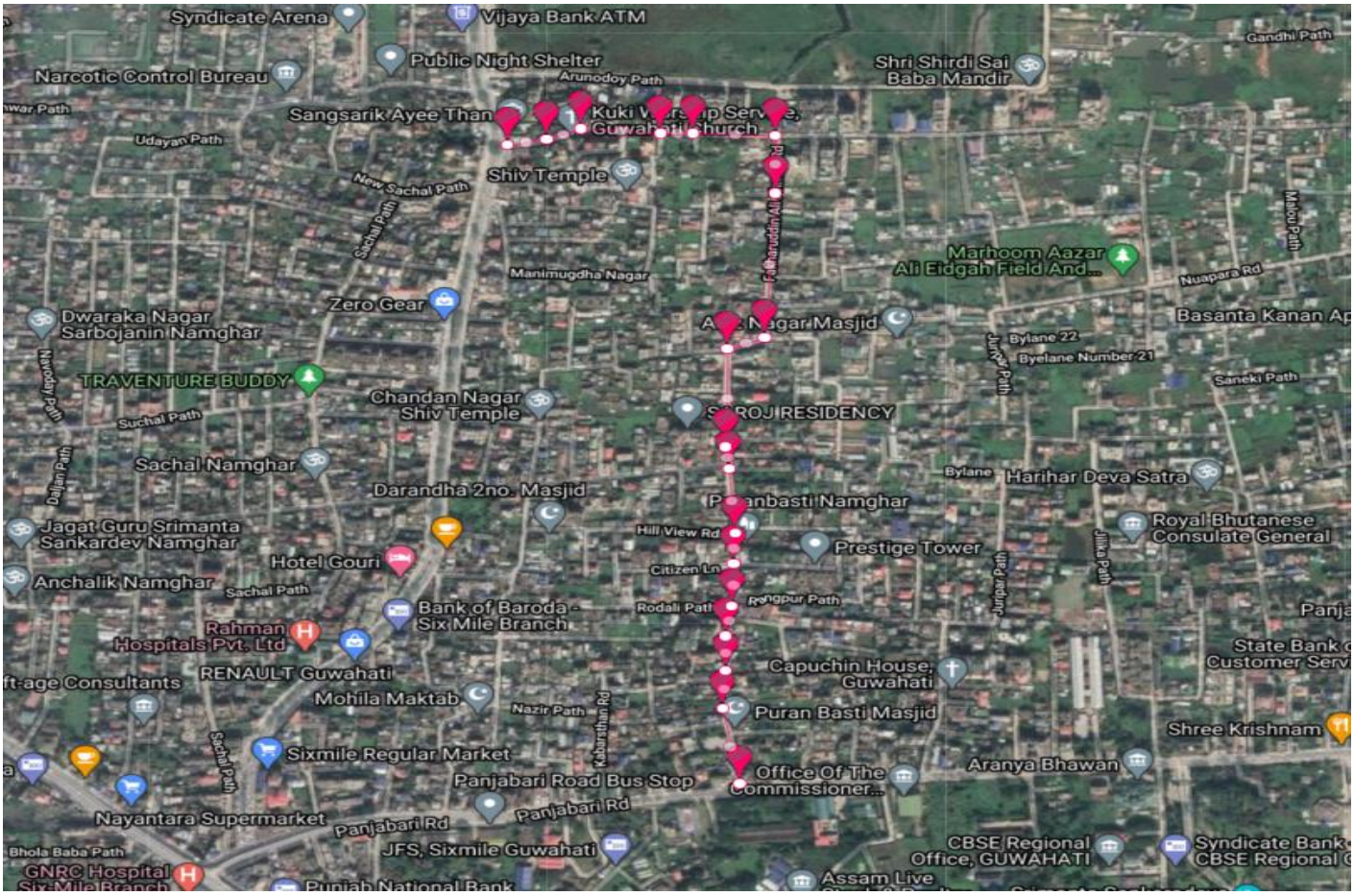


The highlighted section in red colour oval shape is the area where the road is to be constructed.

CLOSER MAP OF THE ROAD SECTION TO BE CONSTRUCTED




Syndicate Arena
Vijaya Bank ATM
Public Night Shelter
Narcotic Control Bureau
Shri Shirdi Sai Baba Mandir
Sangsarik Ayee Than
Shiv Temple
Marhoom Aazar Ali Eidgah Field And...
Zero Gear
Basanta Kanan Apartment
Dwaraka Nagar Sarbojanin Namghar
TRAVENTURE BUDDY
Chandan Nagar Shiv Temple
Sachal Namghar
Darandha 2no. Masjid
Harihar Deva Satra
Jagat Guru Srimanta Sankardev Namghar
Royal Bhutanese Consulate General
Hotel Gouri
Prestige Tower
Anchalik Namghar
Bank of Baroda - Six Mile Branch
Rahman Hospitals Pvt. Ltd
RENAULT Guwahati
Capuchin House, Guwahati
Panjabari Post Office
State Bank of India - Customer Service Point
Waft-age Consultants
Mohila Maktab
Puran Basti Masjid
DTDC
Sixmile Regular Market
Shree Krishnam
Aranya Bhawan
Office Of The Commissioner...
Panjabari Road Bus Stop
Nayantara Supermarket
JFS, Sixmile Guwahati
CBSE Regional Office, GUWAHATI
Syndicate Bank - CBSE Regional Office
GNRC Hospital Six-Mile Branch
Punjab National Bank
Assam Live


Syndicate Arena
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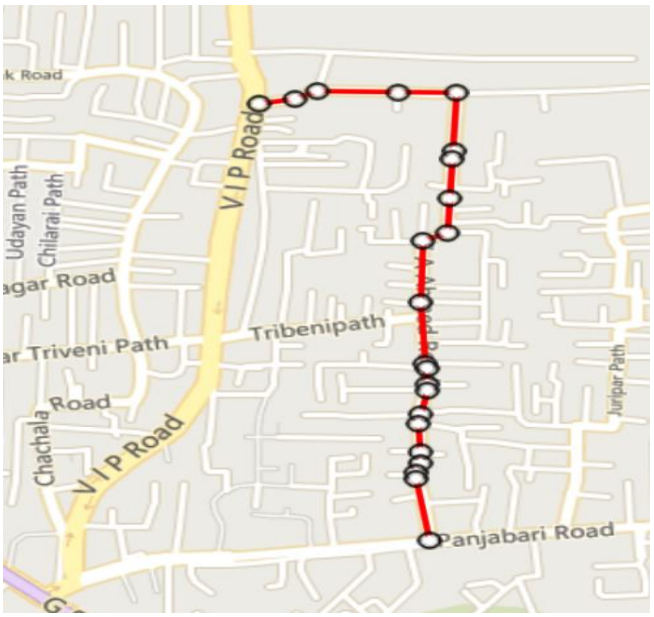
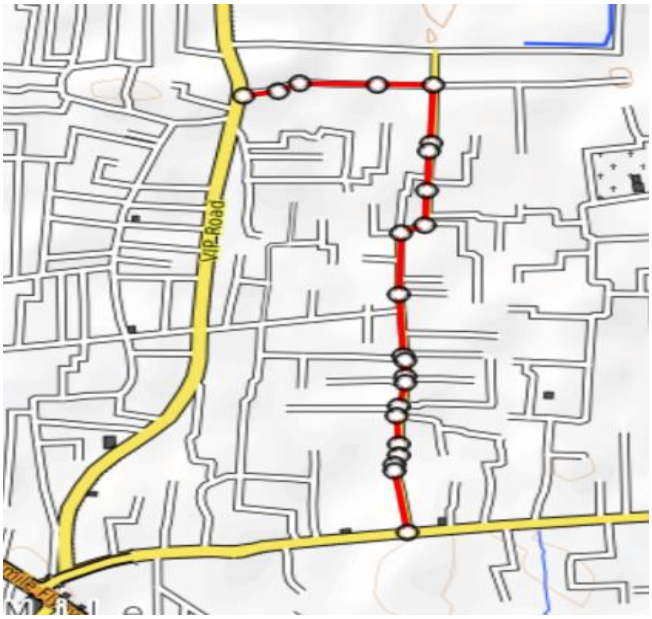
Sachal Namghar
Darandha 2no. Masjid
Harihar Deva Satra
Jagat Guru Srimanta Sankardev Namghar
Royal Bhutanese Consulate General
Hotel Gouri
Prestige Tower
Anchalik Namghar
Bank of Baroda - Six Mile Branch
Rahman Hospitals Pvt. Ltd
RENAULT Guwahati
Capuchin House, Guwahati
Mohila Maktab
Puran Basti Masjid
Sixmile Regular Market
Shree Krishnam
Aranya Bhawan
Office Of The Commissioner...
Panjabari Road Bus Stop
Nayantara Supermarket
JFS, Sixmile Guwahati
CBSE Regional Office, GUWAHATI
GNRC Hospital Six-Mile Branch

STREET VIEW



SATELLITE VIEW

GENERAL REFERENCE VIEW



2. SOCIO-ECONOMIC PROFILE OF THE CORRIDOR

2.1 Demographic and Socioeconomic Profile

The chapter presents the socioeconomic profile of the location where the road is to be constructed, road connecting Mahapurush Madhabdev Path/V.I.P. Road to Panjabari Road, located in eastern part of Guwahati City, Assam (Kamrup [M]). The total length to be constructed is 1.63 km. This link road between two major roads will be directly help decrease the traffic congestion. The project corridor abuts 7 apartment complexes, 4 developing housing projects, 3 small housing facilities for labours, 13 small scale business sites (small standalone shops), 1 supermarket store, 3 guest houses, a Mosque, a Hindu Prayer House (Namghar) and a Church, also 38 houses (RCC and Assam Type).

Population Distribution: The population near the project corridor is **2,526** as per the most recent survey conducted by the Guwahati Municipal Corporation.

The total number of households along project corridor is 492. Average Household (HH) size along the project corridor is 5.

Age and Sex Ratio: The overall population below 9 years age in project corridor is **368 i.e. 14.57 per cent**, above 9 and below 21 is **616 i.e. 24.39 per cent** and above 21 is **1,362 i.e. 61.04 per cent**. The total number of male population is 1,326 and female population is 1,200. The average sex ratio of the project corridor is 874 females per thousand males.

Literacy Rate: The overall literacy rate of the project corridor is **94.69 per cent**

The literacy rate is better than the total overall literacy rate of Guwahati City; the average literacy rate is stated to be 91.47% with male literacy at 94.24% and female literacy at 88.50%.

Urban Population: Refers to the population inhabiting areas that have a greater population density than rural areas and are overall more compact than rural areas. In simple terms, it's the people living in cities. As the area of construction comes within the city of Guwahati, the urban population is **2,526**.

Occupational Structure: Total workers according to recent census report in project corridor was **1,172 i.e. 46.4 per cent**. The compositions of workers in the area of construction are, majority of the workers are engaged in private sector are **622 (53.07 per cent)** and then public sector are **502 (42.83 per cent)** and at last workers performing labour activities are **48 (4.1 per cent)**.

Work Participation Ratio: WPR is the work force participation for the working age population (aged 15 to 64) divided by the total working-age population. WPR for this project corridor is **68.94 per cent.**

Schedule Caste and Schedule Tribe Population: Analysis of social groups for the project corridor has been done on the basis of concentration of Schedule Caste (SC) and Schedule Tribe (ST) population in the area and project corridor settlements. Here, STs consists of the tribal people (i.e. a small Nagamese community) living near the project corridor is the only major consideration for this part, apart from that there are still people from SC and ST within the entire path of the project corridor. Though there is categorization made with respect to the caste system (i.e. ST or SC or OBC) but as Guwahati is a metropolitan city and the locality is in a very developed area most of them are highly educated and highly knowledgeable individuals, ultimately this data will not be impacting the project completion in any way.

Total number of ST population is **132 (5.23 per cent)** and SC population is **62 (2.45 per cent)** and OBC population is **112 (4.43 per cent)**.

Apart, from this there are no specific tribal communities or any rural communities within the area of the project corridor.

3. CORRIDOR CHARACTERISTICS

3.1 Project Corridor

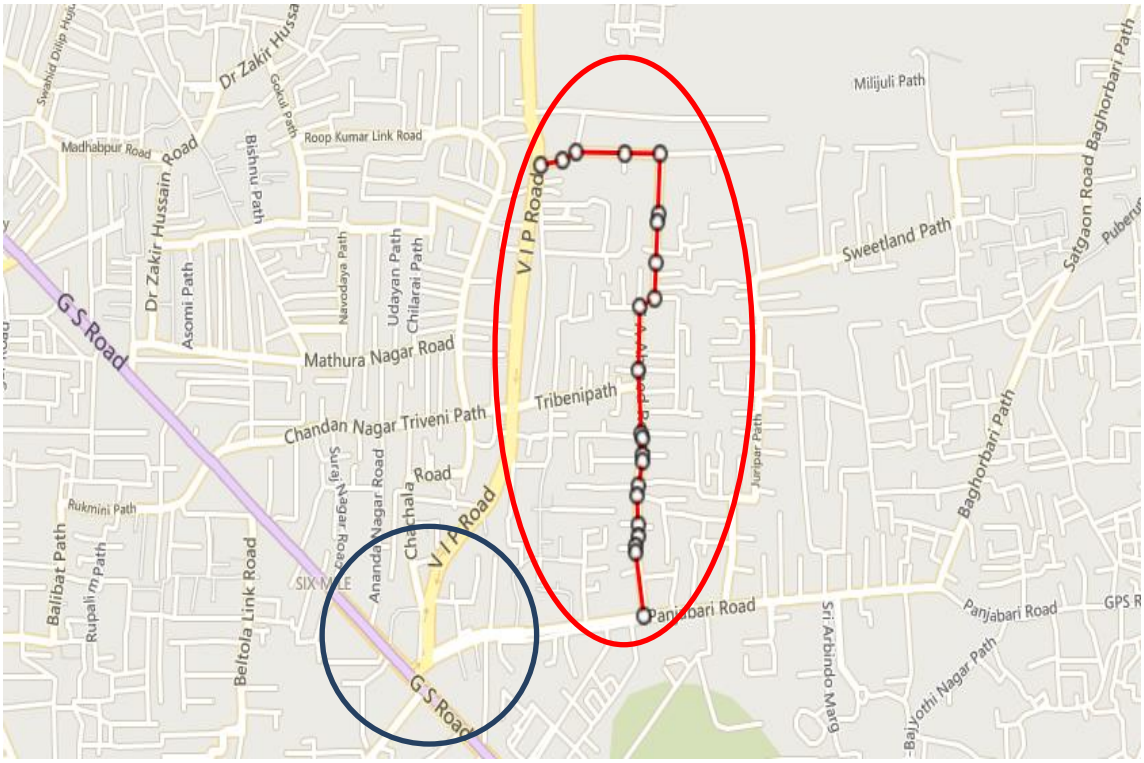
Project corridor is of importance from the perspective of being a road to skip the traffic congestion and get to a nearby destination faster, from VIP Road to Panjabari Road or vice versa. Both the two major roads are very important, useful and at the time being it becomes very congested for the regular users of the road who are living nearby this place. VIP Road is one of the major roads in the city of Guwahati as it is one of the roads that lead to the industrial part of the city and movement of goods/cargo trucks from those places to the railway station or airport or the rest of north-east takes place through is road, it includes the Indian Oil Corporation Limited Refinery or also known as Guwahati Refinery and apart from this there are few other private sector and public sector industries.

On the other hand, Panjabari Road is also a very important road in the city of Guwahati as it situates a very high number of population, public and private sector offices, army transit camps, film studio, few schools and local colleges, a renowned cultural institution cum tourist attraction site Srimanta Sankaradeva Kalakshetra, etc.

Both of these two major roads meet at Six Mile, Guwahati from which it connects these two roads to G.S. Road, which is one of the prime major roads in Guwahati. Due to this meeting point of 3 major roads in Guwahati, it becomes a hotspot for traffic congestion, and on top of that this place is already a highly populated area and consist a large street market and a lot of shops of various kinds, hotels, other street vendors, etc. Though in the past years due to the increase in traffic congestion a flyover bridge was constructed in that spot, but with the increasing population and demand it was really necessary to bring up a new plan in order to cut the traffic by creating a link road for the road users who are coming from Panjabari Road or VIP Road and heading towards the opposite.

Map showing the linkage between the 3 prime major roads in Guwhati City

(GS ROAD, VIP ROAD and PANJABARI ROAD)



The section where the 3 prime major roads meet is highlighted in blue.

The section where the link road will be constructed is highlighted in red.

PICTURE OF THE PROJECT CORRIDOR SHOWING ITS CURRENT CONDITON

Table: Existing Corridor Characteristics

Sr. No.	Components	Details
1	Corridor Name and Area	Radha Nagar Path (Chachal)
2	State and District	Assam (Kamrup Metro)
3	Section Connecting	VIP Road and Panjabari Road
4	Starting Coordinate	**26.14369,91.81215**
5	Ending Coordinate	**26.13298,91.81544**
6	Total length of the road to be constructed	**1631.8 meters / 1.63 km**
7	Carriageway of Width (metre)	7
8	Intersection/Junction	3 major and 17 minor
9	Terrain	Plane
10	Right of way	8 metres (Already a built up area)
11	Traffic	Moderate (Detailed traffic analysis and forecast is done in part 4 of this DPR.
12	Soil Classification	Loamy Silt
13	Pavement Condition	Unpaved (Poor)
14	CD Structures	
	Minor Bridge	0
	Major Bridge	0
	Pipe Culvert	2
	Slab Culvert	0
	Box Culvert	3
	Total number of structures	5
15	Riding Quality - IRI (m/km)	8 (Rough unpaved road)
16	Existing Crust Thickness	N/A (Unpaved)
17	CBR	8% (Poor Rating)
18	Vehicle Damage Factor (VDF)	

VEHICLE TYPE	VDF
Mini Bus	0.98
LCV	0.32
Bus	0.52
2-Axle Truck	4.48
3-Axle Truck	5.97
MAV	2.67

4. TRAFFIC SURVEY AND ANALYSIS

4.1 Introduction

Road development projects are meant for achieving multi-objectives while meeting the basic needs of the road user like mobility and accessibility.
Key functionalities and upcoming utilization of the project corridor in years to come is the essential task for which this link road is needed to be provided.
All proposed solutions from traffic point of view have appropriately been incorporated with respect to issues related to geometry, environmental and social.

4.2 Existing Traffic Characteristics

The analysis of traffic volume data indicates that both the major roads, VIP Road and Panjabari Road have high Average Daily Traffic (ADT) values due to which the unpaved linked road is also affected and we also need to find the ADT for the unpaved link road (project corridor). A proper traffic survey is done for 7 days (excluding the weekends) to find the exact values of ADT.
The categories taken into consideration for the types of vehicles are:
1) Car, Jeep and Van, 2) Auto Rikshaw, 3) Scooters/Bikes, 4) Bus, 5) Truck, 6) Tractor, 7) Cycle, 8) Rikshaws and 9) Hand Cart.

4.3 Traffic Survey 7 day-ADT survey data are as follows:

AVERAGE DAILY TRAFFIC TABLE FOR THE PROJECT CORRIDOR

Vehicles	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Car, Jeep, Van	189	177	180	210	181	228	170
Auto Rikshaw	35	30	32	27	33	28	36
Scooters/Bikes	77	79	82	80	70	72	69
Bus	7	7	6	8	5	9	6
Truck	11	9	10	9	14	7	8
Tractor	0	2	1	0	0	0	1
Cycle	6	10	8	7	7	9	11
Rikshaws	8	9	11	7	12	15	10
Hand Cart	8	9	13	10	8	6	8
Total Vehicles Passing	341	332	343	358	330	374	319

$$ADT = \frac{\text{Total traffic for 7 days}}{7}$$

ADT = 2397 / 7

ADT = 343

Therefore, from the traffic survey for the project corridor, we find the Average Daily Traffic **(ADT) to be = 343**.

AVERAGE DAILY TRAFFIC TABLE FOR VECHILE PASSING THROUGH VIP ROAD – PROJECT CORRIDOR JUNCTION

Vehicles	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Car, Jeep, Van	483	490	522	480	472	480	508
Auto Rikshaw	73	79	88	69	77	82	80
Scooters/Bikes	112	92	108	102	90	97	99
Bus	24	27	26	24	23	24	24
Truck	89	80	108	92	90	112	102
Tractor	15	11	12	14	12	10	11
Cycle	32	30	31	38	22	28	30
Rikshaws	20	22	24	26	31	29	27
Hand Cart	16	11	8	18	15	13	9
Total Vehicles Passing	864	842	927	863	832	875	890

$$ADT = \frac{\text{Total traffic for 7 days}}{7}$$

ADT = 6093 / 7

ADT = 871

Therefore, from the traffic survey for VIP Road - Project Corridor Junction, we find the Average Daily Traffic **(ADT) to be = 871**.

AVERAGE DAILY TRAFFIC TABLE FOR VEHICLE PASSING THROUGH PANJABARI ROAD – PROJECT CORRIDOR JUNTION

Vehicles	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Car, Jeep, Van	523	532	520	502	498	505	517
Auto Rikshaw	92	90	84	86	89	80	92
Scooters/Bikes	142	163	168	160	172	154	150
Bus	38	34	42	36	37	37	38
Truck	52	58	41	48	45	44	50
Tractor	13	8	11	10	12	9	10
Cycle	48	42	44	46	40	45	42
Rikshaws	42	48	56	51	40	47	53
Hand Cart	18	20	16	15	22	14	21
Total Vehicles Passing	968	995	982	954	955	935	973

$$ADT = \frac{\text{Total traffic for 7 days}}{7}$$

ADT = 6762 / 7

ADT = 966

Therefore, from the traffic survey for Panjabari Road - Project Corridor Junction, we find the Average Daily Traffic **(ADT) to be = 966**.

4.4 Traffic Analysis

The data collected from the traffic survey indicates that the project corridor will be used widely once the construction of the project is completed and the pavement is ready, even after the project corridor being in unpaved condition it is widely in used, it shows the need of a paved carriageway.

From the survey data at the junctions where VIP Road is connecting the Project Corridor, it shows the trend of a huge number of trucks being passed on daily basis, which creates a lot of traffic ahead at Six Mile area where 3 major roads are meeting (as described in Corridor Characteristics chapter). Through this we can see that by creating the link road (project corridor), a part of the traffic from this road can be diverted and ultimately it will benefit the problem of traffic congestion.

Again, at the junction where Panjabari Road is connecting with Project Corridor, the traffic survey data shows the movement of public transport and private vehicles in large numbers due to the fact that Panjabari area is highly populated and also it abuts various institutions, offices, etc as mentioned earlier in corridor characteristics chapter. Therefore, the link road (project corridor) can help the private vehicles, rikshaws, cycles, hand carts, etc to tackle the traffic congestion problem ahead at Six Mile. This link road will be shorter and an efficient way for the users who wants to reach VIP Road without having to pass through Six Mile and help in reducing the traffic there.

These analyses show the importance and the need of this project corridor with the current traffic scenario.

LOCATION: SIX MILE, VIP ROAD, GUWAHATI.

5. ROAD SAFETY AUDIT

5.1 Project Brief

VIP Road-Panjabari Road Link Road is proposed to be improved with better riding quality and enhanced safety for the smaller vehicles in comparison to the trucks and busses. Road Safety Audit addresses identification of safety related deficiencies as well as behavioural safety issues while subsequently recommending countermeasures in approaching towards sustainable design solution. All sections of the project corridor are visited and studied. Review and audit of safety measures of the corridor are followed with the prevailing best practices. With proposed plan of two lanes with granular shoulders, the objective focuses on abating road accidents and their severity while improving riding quality and a creating a better passage to avoid traffic as discussed in the earlier section of this DPR.

5.2 Accident Statistics

First Information Report (FIR) details relating to the accidents, fatalities and injuries in the project corridor and its immediate influence area are collected and studied. Though such information is recorded by police stations, there is a potential scope of other minor injury and property damage accidents to not have reported. However, efforts are extended in preparing safety improvement options beyond available accident data and the same is incorporated in final improvement proposals. There is only 1 fatality in the area though 52 minor injuries are also reported in a span of 5 years (2014 – 2019). The 1 fatality was from a drink and drive case where a bike rider crashed into a truck from behind and due to his high speed the impact was fatal. And the 52 minor injuries were suffered by the road users due to the condition of the road and it was mostly two wheelers and rikshaws colliding with cars or trucks.

5.3 Safety Issues for Project Corridor

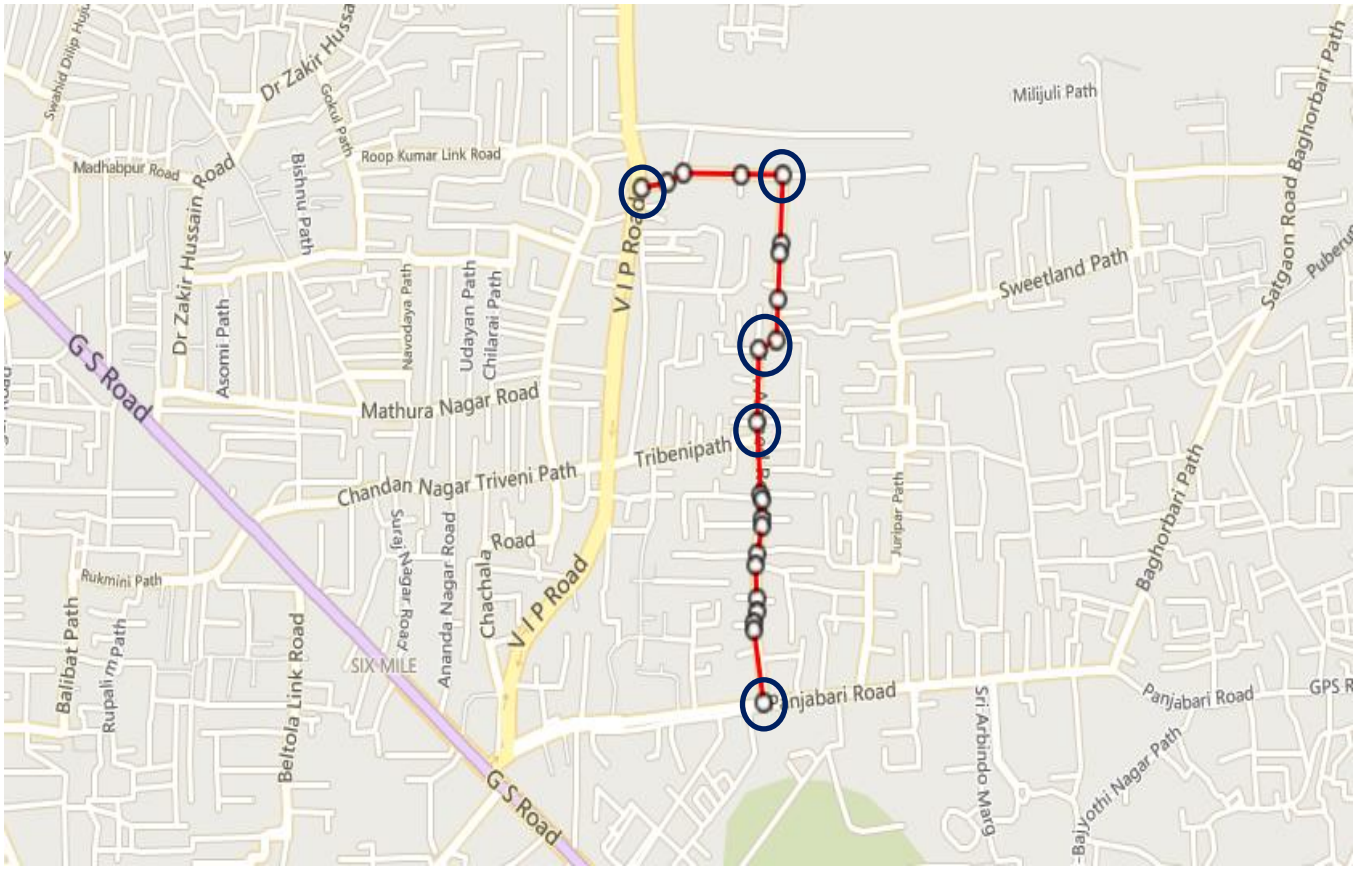
Carriageway

It is observed that carriageway width is adequate but there is not enough right of way to build shoulders of required width as given in IRC guidelines. Shoulders are inadequate in width as the project is located in a built up area. It is essential to utilize the 1 metre of right of way left after the construction of 7 metre width carriageway. As per the circumstances it is important to construct 0.5 metre of granular shoulders on either side for improved safety.

Geometric Design

During the audit, it is identified that sight distance at sharp curves lack in standards including the intersectional curves and needs to be improved with geometric design. Also these curves have visual blockings as it is a built up area. Curve passing at all the 3 major junctions of the project corridor and at intermediate spots needs proper signage. Appropriate control measures are essential.

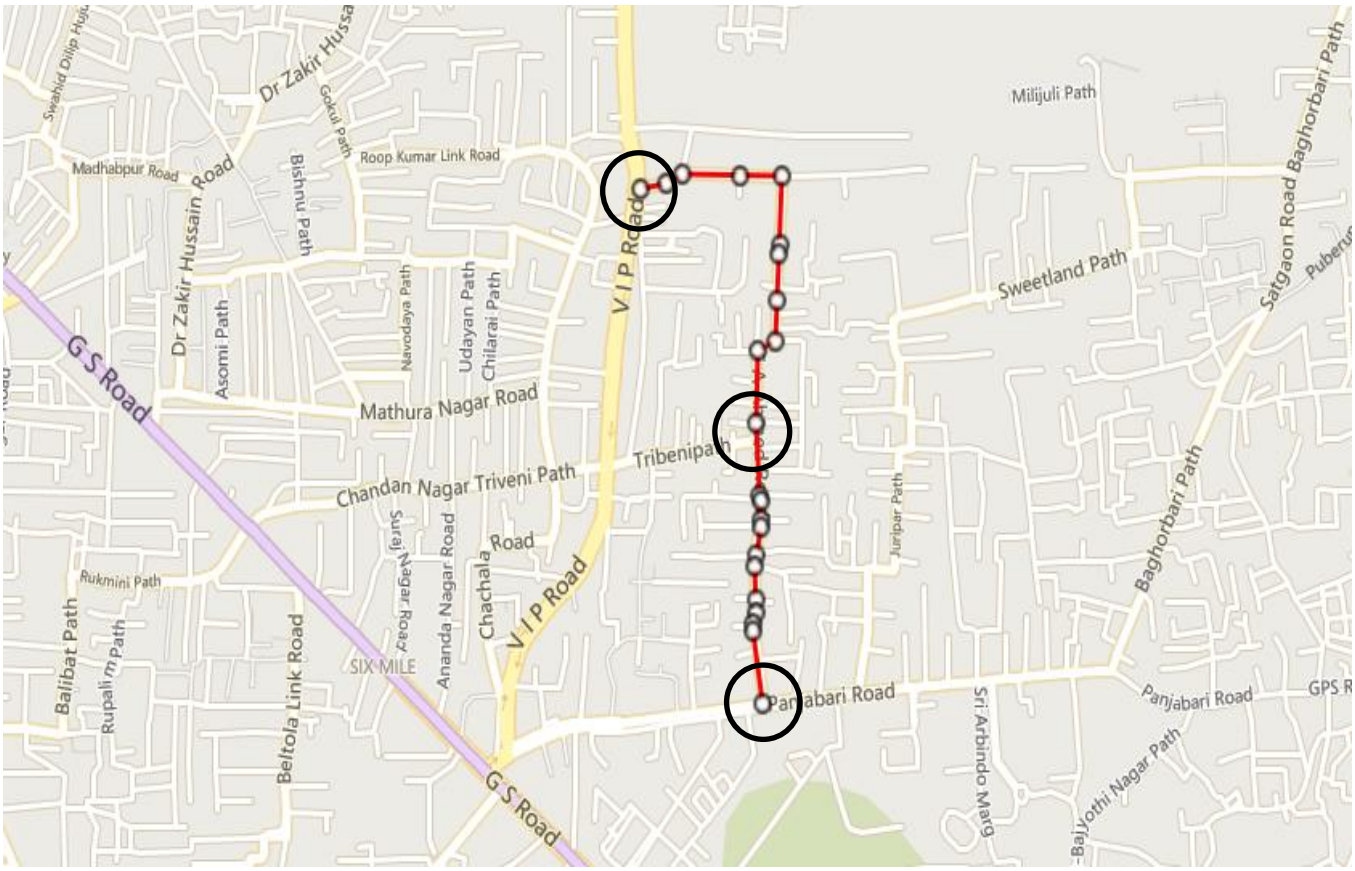
BLUE CIRCULAR MARKINGS REPRESENT THE SPOTS WHERE PROPER SIGNAGE IS REQUIRED



Intersections/Junctions

There are 3 major junctions observed on the project corridor apart from 17 minor. It is observed that considerable traffic gather near the major junctions; thereby generating congestion and fully functional traffic lights are required at all the 3 major junctions. It is audited that the existing junction design lacks in incorporating local travel behaviour and influence of habitations in proximity, which makes them potential accident prone spots also. It is identified that careful attention needs to be given in developing appropriate designs for these junctions. In addition, provision of suitable location of bus stops near 2 junctions (VIP Road and Panjabari Road Junctions) needs to be considered.

BLACK CIRCULAR MARKINGS REPRESENT THE LOCATION OF 3 MAJOR JUNCTIONS/INTERSECTIONS



5.4 CD Structures

2 out of the 5 culverts are narrow in width and also the parapets of these culverts are potential hazards.

5.5 Traffic Management and Control Issues

It is identified that traffic signs needs to be provided at many places. Existing signages are in a poor condition. As the carriageway is not in paved condition it is doesn't have any pavement markings throughout the project corridor. It is must to draw pavement markings once the carriageway is fully constructed.

5.6 Identified Issues

Suggestions, recommendation as well as issues identified from safety audit are incorporated into final improvement options which include, but not limited to:

a. Deficient 5 horizontal curves;

b. Identified 3 major and 17 minor intersections/junctions;

c. Identified poor unpaved carriageway;

d. Identified deficient 2 structures.

The details of the recommended interventions are already presented above.

6. DESIGN OF CORRIDOR

6.1 Introduction

This particular chapter deals with analysis of roadway geometrics, developmental aspects, safety and road furniture requirements, towards providing pleasant and aesthetic highway for road users. This chapter also discusses about pavements, design improvement and restoration proposals of CD structures.

6.2 Topographic Surveys

Topographical survey forms backbone for detailed engineering design. Topographic survey is carried out on the corridor recently, as per the requirements for project preparation. Accuracy of the information collected during the survey has direct bearing on almost all the design activities involved in project preparation. Collection and review of toposheets and available maps/images helped in planning of topographic surveys towards establishing existing geometrics of the road corridor.

For the purpose of detailed engineering design, topographical surveys are divided into following activities:

- Setting up of benchmarks and 2 control stations to be used during construction;
- Establishment of horizontal control to have unique coordinate systems of Northing and Easting along the project corridor; i.e. Easting and northing are geographic Cartesian coordinates for a point. Easting is the eastward-measured distance (or the x-coordinate) and northing is the northward-measured distance (or the y-coordinate).
- Establishment of vertical control to have the elevation coordinates referenced to nearest GTS stations along the project corridor;
- Collection of project corridor drainage data containing the existing sewer system path to form the basis for the new designs;
- Preparation of base plans containing the entire natural and manmade features like buildings, fences, walls, utilities, trees, temples and other religious structures etc. that would govern the finalisation of horizontal alignment.

6.3 Geometric Design

The highway geometric design deals with road geometrics such as horizontal and vertical alignment, interventions due to social impact, design safety and road furniture details.
Highway design has been carried out by considering two aspects:

Functional Aspects: The functional aspects address geometric improvement and visible dimensions of the roadway. Functional aspects manifested in appropriate horizontal and vertical alignments, sight distance availability, lateral and vertical clearances, intersection treatment, improved design speed, road safety and also cover related facilities.

Structural Aspects: The structural aspects deal with designs for pavement, CD structures, bridges and embankments i.e. the ability of the pavement to adequately carry and support the vehicle/ wheel loads over the design period. Structural aspects calls for detailed evaluation of widening options, concentric or eccentric of the existing road; as dictated by site situations like available ROW, existing utilities, terrain, etc., and importantly the existing structural conditions, both for pavement and CD structures.

6.3.1 IMPROVEMENT OPTION

The existing carriageway width of the project corridor is 7.0m, i.e. Two Lane (2L) configuration but it is completely unpaved. The project scope is to improve this carriageway by constructing a fully paved surface with granular shoulder and raised kerb.

The project corridor has right of way of 8m. It is very essential to use the entire width of the project corridor and construct a paved carriageway of 7m and also construct granular shoulder of the remaining right of way i.e. 1 metre, 0.5 metre on each sides of the carriageway. Also raised kerbs would be a good option as the shoulders are lesser in width.

As VIP Road (joining the project corridor) is getting affected by the traffic along with inter, intra state and district commercial vehicle movements, the truck traffic due the IOCL Refinery, other privatized industries and public sector industries are major factors influencing construction, flows and serviceability of the project corridor.

Improvement of the CD structures is very important. 3 of the existing culverts are not in very bad condition and 2 out of the 5 culverts (both pipe culverts) are narrow in width and needs full replacement. Also restoration of the drainage system that is already available in the existing project corridor will also be considered for improvements.

As the existing pavement was unpaved, it never had any markings once the project is completed, it is important to put all the road markings and signages.

All these little details to the project can give this project corridor an excellent outcome.

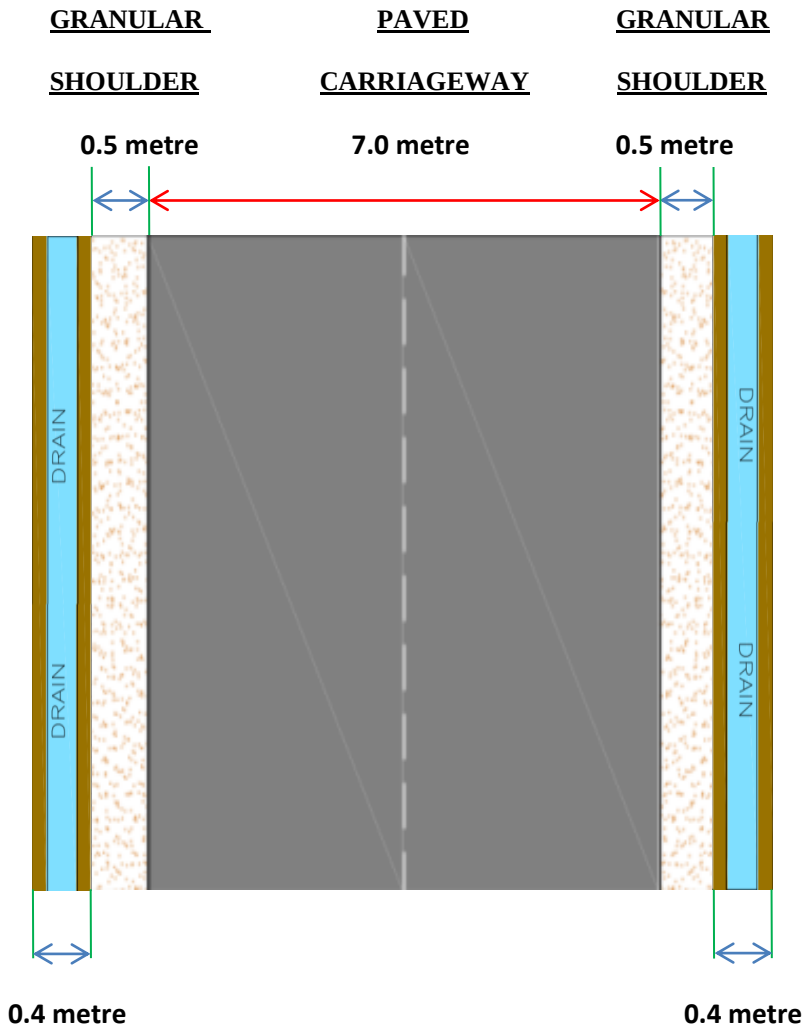
IMPROVEMENT TABLE SECTION WISE FOR CD STRUCTURES AND SIGNAGES

LENGTH POINT START (metres)	LENGTH POINT END (metres)	Proposed Width (metres)	Proposed Shoulder (metres)	Remarks
0	0	7	0.5	Intersection Indication Signage (Major Intersection)
125.4	128.4	7	0.5	Box Culvert Repair
381.0	384.0	7	0.5	Box Culvert Repair
381.0	381.0	7	0.5	Curve Ahead Indication Signage
631.2	633.2	7	0.5	Pipe Culvert Replacement (Replace from 1 to 2 pipes)
758.6	758.6	7	0.5	Curve Ahead Indication Signage
1015.8	1015.8	7	0.5	Intersection Indication Signage (Major Intersection)
1149.0	1152.0	7	0.5	Box Culvert Repair
1442.4	1444.4	7	0.5	Pipe Culvert Replacement (Replace from 1 to 2 pipes)
1631.8	1631.8	7	0.5	Intersection Indication Signage (Major Intersection)

Length Points are starting from the project corridor start point at VIP-Road – Project Corridor Junction i.e. at coordinates **26.14369,91.81215**.

6.3.2 PROPOSED CARRIAGEWAY DESIGN

The proposed carriageway design is provided below.



LENGTH = 1631.8 METRES / 1.63 KM

6.4 Design Interventions

SPEED

Efforts are also made to provide safe designs in settlements considering speeds average speed 40-65km/h. 70 km/hour for cars, 60 km/hour for cargo carriers and 50 km/hour for two-wheelers.

SAFETY

The safety is very much incorporated in the design process; interventions include provision of speed humps at various points such as near religious places, residential apartment complexes and at near start and end point of the project corridor. Raised kerb is also provided throughout the entire length of the project corridor. Street lights will be installed throughout the project corridor at various intervals for the safety and security of road users and residents near the project area.

SOCIAL IMPACT

For the sections through settlements specific care has been taken to safe guard properties, existing permanent structures and kiosks towards reducing the social impacts. In total 8 socially impacted structures are identified in the initial stages of design, the same is reduced to 5 after design interventions coupled with road furniture and safety measures along the project corridor, most of them are kiosks.

6.5 Surveys and Investigations

1. Reconnaissance survey

Reconnaissance survey examines the general character of the area for deciding the most feasible routes for detailed studies. A field survey party may inspect a fairly broad stretch of land along the proposed alternative routes of map in the field. Only very simple instrument like abney level, tangent clinometer, barometer etc. are used by the reconnaissance party to collect additional details rapidly. All relevant details not available in the map are collected and noted down.

2. Preliminary Survey

The preliminary survey is carried out to collect all physical information which are necessary in connection with the proposed alignment. It is done to survey the various alternate alignments proposed after the reconnaissance and to collect all necessary physical information and details of topography, drainage and soil. Also it helps to estimate quantity of earth work materials and other construction aspects and to work out the cost of alternate proposals. And at the end to finalise the best alignment from all consideration.

3. Topographical Survey

After finalization of alignment, detailed site survey was undertaken and temporary bench marks on every available permanent structure were established along with all physical features of site like buildings, tree, culverts, stream/canal crossings, cross drainage structures. Levels for cross section have been taken at every 50m intervals at various locations. Road plans & L-section have been developed on AUTO CAD. These are drawn to scale of 1:5000 for horizontal & 1:500 for vertical. The plan shows formation width of road, centre lines, permanent structures, large trees, junctions, starting and ending chainage of curves, various parameters of curve tangent, apex distance and spirals angles, etc. Central deviation angle for circular curve, length of transitions curve, tangent apex distance and total curve length have been also placed suitable on the drawings.

Benchmark

A benchmark is a point of reference by which something can be measured. In surveying, a "bench mark" (two words) is a post or other permanent mark established at a known elevation that is used as the basis for measuring the elevation of other topographical points.

Types of bench marks

1. Great Trigonometrical Survey (GTS)

2. Permanent

3. Temporary

4. Arbitrary

4. Soil Survey

Soil survey is an essential part of preliminary survey as the suitability of the proposed location is to be finally decided based on soil survey data. The soil survey conducted at this stage also helps in working out earth work, slopes, suitability of materials, subsoil and surface drainage requirements and pavement type and approximate thickness requirement.

S. No.	Type of Test	Method
1.	Feild dry density and sand replacement method	IS 2720 Part 28
2.	Feild dry density using core cutter method	IS 2720 Part 29
3.	Moisture content determination	IS 2720 Part 2 (section I)
4.	Atterbergs limits	IS 2720 Part 5
5.	Sieve analysis - Natural soils - Rock aggregate	 IS 2720 Part 4 IS 2386 Part 1
6.	Compaction Test (Heavy compaction)	IS 2720 Part 8
7.	CBR and swelling pressure (Soaked and unsoked at three energy levels for sub-grade)	IS 2720 Part 16
8.	Aggregate Impact value	IS 2386 Part 4
9.	Coating and Stripping of bitumean aggregate Mixtures	IS 6241
10.	Soundness of aggregates	IS 2368 Part 5
11.	Flackiness and Elongation index	IS 2368 Part 1
12.	Water absorption and specific gravity of aggregates	IS 2386 Part 3

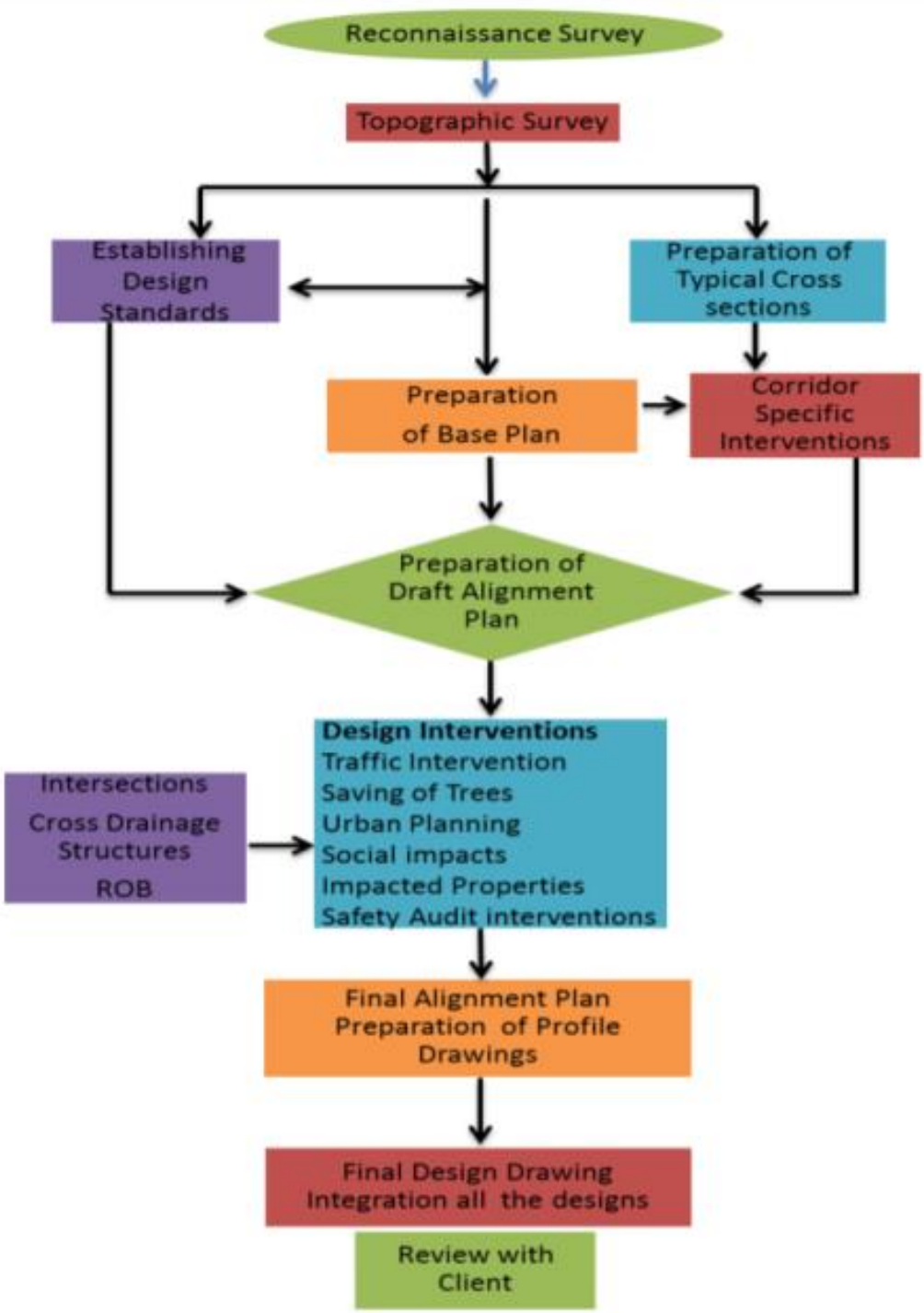
5. Material Survey

The survey of naturally occurring materials like stone aggregates, fine aggregates etc is material survey, it's identification of availability of manufactured materials like cement, lime, brick, etc and their locations should be ascertained. The soil and material survey were done following the guidelines of IRC SP:20:2002 and IRC SP: 2007.

6. Hydrological Survey

Drainage investigation and hydrological survey data are collected so as to estimates the type, number and approximate size of cross drainage structures. Also vertical alignment of the highway, particularly grade line is decided based on the hydrological and drainage data, such as HFL, Pond water level, depth of water table, amount of surface runoff etc. The following data to be collected are: a. Average Annual Rainfall Data, b. Catchment Area, c. Time of Concentration and d. Existing Cross Drainage Structures.

FLOW CHART SHOWING DESIGN INTERVENTIONS AND SURVEYS



6.5 Horizontal Alignment Design

Design of the horizontal alignment has been carried out in CIVIL 3D environment as per the finalised widening scheme. Extensive field checks to verify the feasibility of the proposed alignment have been carried out and suitable modifications to the alignment have been effected wherever considered essential to safeguard sensitive elements. The project road design phases are defined as the 1st phase starting from VIP Road-Project Corridor Junction and ending at 758.6 metres, and 2nd phase continuing form 758.6 metres up till the Panjabari-Project Corridor Junction, summing up the total length of the corridor to be **1631.8 meters / 1.63 km**. Geometric design of project corridor has been conceptualized for a design speed of 40-65km/h as per the design standards formulated for the project. The project corridor has fair horizontal geometrics, though geometric improvement has been carried out, with due consideration of project features, social impact assessment, along with interventions due to poor existing road conditions and poor CD Structures.

6.6 Vertical Alignment Design

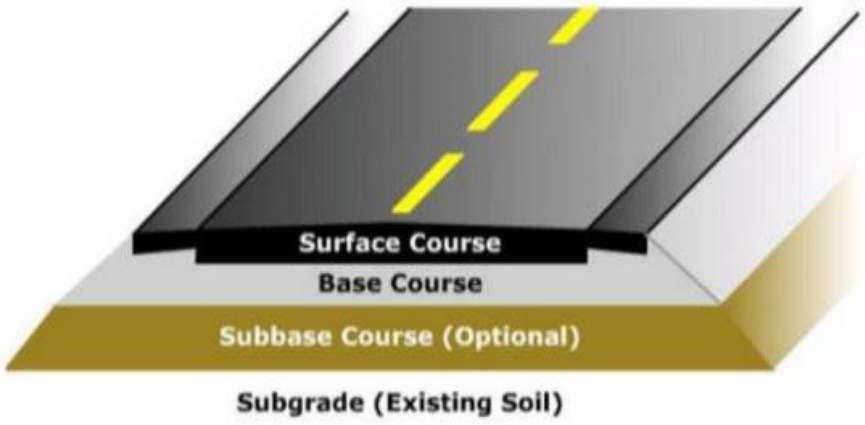
The existing vertical geometry for majority of project road calls for attention. The project road is in place since long, but the proper design of project corridor has probably not taken place in recent times. The existing pavement is in unpaved condition at all places throughout the project corridor. The design Finished Road Levels (FRL) at the centreline of the roadway is determined from overlay and new pavement design. The pavement design necessitates reconstruction, and overlay in sections as discussed in subsequent chapters.

6.7 Road Side Drainage

Project corridor is adjoined to a highly populated residential area and it is almost fully a built up area for the entire course of project corridor, call for attention on the drainage system is necessary. The corridor already has a drainage system that needs to be freshly built again as it is a non-concrete drainage system and there's a problem of stagnation. The longitudinal drain is proposed all along the project corridor. The drain width is 0.4 metres. The drainage analysis along the project road is provided in the proposed carriageway design. The concreted closed drains along the settlements are proposed to prevent the stagnation of water and also act as a small foot path for road users.

6.8 Pavement Compositions

COMPONENTS OF FLEXIBLE PAVEMENT



A. **Subgrade (Existing Soil):** According to IRC, the subgrade material should be well compacted to limit the scope of rotting in pavement. Subgrade should be compacted upto 97 % laboratory dry density achieved by heavy compaction.

For cvpd upto 450 or more, CBR should be 8%.

Also it can be obtained by lab tests results: Log_{10} CBR = 2.456 – 1.12log10 N
Where, N= mm (penetration)/blow.

For the project corridor, **CBR = 8 %**

Generally, CBR ranges from 2-30%:

SOIL	RANGE OF CBR (%)	RATING
Clay	2-5	Very Poor
Silt	5-8	Poor
Sand	8-20	Fair Good
Gravel	20-30	Excellent

Now, According to CBR charts, for the required traffic in MSA (Million Standard Axles) the thickness of subgrade can be obtained.

B. <u>Subbase Course</u>: A subbase may consist of natural sand, powdered rock, gravel, laterite, pebbles, brick material, etc.

The materials should have:

- CBR – 20 to 30 % for traffic upto 2 MSA & more,
- L.L should not be greater than 25 and IP should not be greater than 6,
- Los Angles Abrasion Value < 40.

These subbase layer consist of 2 layers:

1) Lower layer & upper layer granular subbase which forms drainage layer.
   Thickness, Should not be > 150 mm for traffic = 10 MSA
   Should not be > 200 mm for traffic > 10 MSA.
2) For unbounded or (WBM LAYER)
   $MR_{GSB} = 0.2h^{0.45} \times MR_{Subgrade}$
   Where, MR = Resilient modulus
   h = thickness of subbase in mm.

C. <u>Base Course</u>: It consists of water bound macadam or wet mix macadam.

Minimum thickness = 225mm, traffic = 2MSA

= 150mm, traffic > 2MSA

D. <u>Bituminous Surfacing</u>: A bituminous surface treatment (BST), also known as a seal coat or chip seal, is a thin protective wearing surface that is applied to a pavement or base course. It consists of wearing course or binder course. The most commonly used W.C. are surface dressing, open graded premix carpet, and semi-dense bituminous concrete. BSTs can provide all of the following:

1. A waterproof layer to protect the underlying pavement,
2. Increased skid resistance,
3. Filler for the existing cracks or raveled surfaces,
4. An anti-glare surface during wet weather and an increased reflective surface for night driving.

<u>For traffic</u>, Upto 5MSA – Bituminous Macadam is used,
> 5MSA – Dense Bituminous Macadam is used and
> 30MSA – VG 30 Bituminous Grade is used.

6.9 Design of Flexible Pavement as per IRC 37

- **Overview**

Indian roads congress has specified the design procedures for flexible pavements based on CBR values. The Pavement designs given in the previous edition IRC:37-1984 were applicable to design traffic upto only 30 million standard axles (msa). The earlier code is empirical in nature which has limitations regarding applicability and extrapolation. This guideline follows analytical designs and developed new set of designs up to 150 msa in IRC:37-2001.

- **Scope**

These guidelines will apply to design of flexible pavements for Expressway, National Highways, State Highways, Major District Roads, and other categories of roads. Flexible pavements are considered to include the pavements which have bituminous surfacing and granular base and sub-base courses conforming to IRC/ MOST standards. These guidelines apply to new pavements.

- **Design Criteria**

The flexible pavements has been modelled as a three layer structure and stresses and strains at critical locations have been computed using the linear elastic model. To give proper consideration to the aspects of performance, the following three types of pavement distress resulting from repeated (cyclic) application of traffic loads are considered:

1. Vertical compressive strain at the top of the sub-grade which can cause sub-grade deformation resulting in permanent deformation at the pavement surface.
2. Horizontal tensile strain or stress at the bottom of the bituminous layer which can cause fracture of the bituminous layer.
3. Pavement deformation within the bituminous layer. While the permanent deformation within the bituminous layer can be controlled by meeting the mix design requirements, thickness of granular and bituminous layers are selected using the analytical design approach so that strains at the critical points are within the allowable limits. For calculating tensile strains at the bottom of the bituminous layer, the stiffness of dense bituminous macadam (DBM) layer with 60/70 bitumen has been used in the analysis.

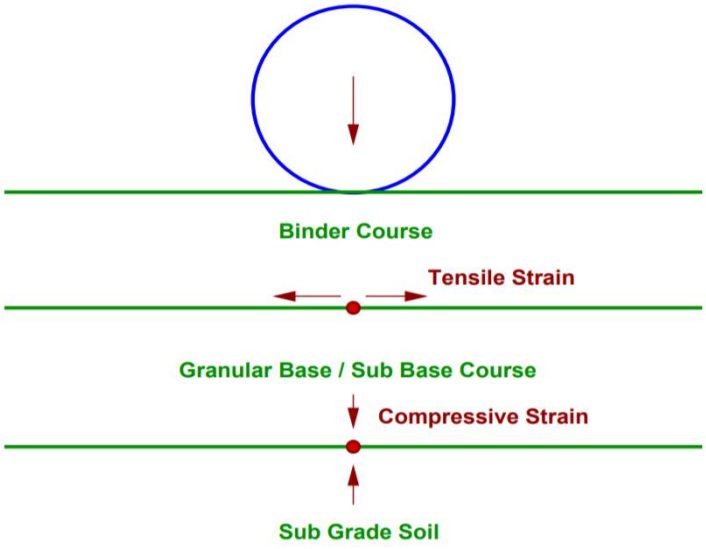


Fig.: CRITICAL LOCATIONS IN PAVEMENT

- **Design Procedure**

Based on the performance of existing designs and using analytical approach, simple design charts and a catalogue of pavement designs are added in the code. The pavement designs are given for subgrade CBR values ranging from 2% to 10% and design traffic ranging from 1 msa to 150 msa for an average annual pavement temperature of 35 C. The later thicknesses obtained from the analysis have been slightly modified to adapt the designs to stage construction. Using the following simple input parameters, appropriate designs could be chosen for the given traffic and soil strength:

1. Design traffic in terms of cumulative number of standard axles and
2. CBR value of subgrade.

- **Design Traffic**

The method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. This requires the following information: 1. Initial traffic in terms of CVPD,
2. Traffic growth rate during the design life,
3. Design life in number of years,
4. Vehicle damage factor (VDF),
5. Distribution of commercial traffic over the carriage way.

INITIAL TRAFFIC

Initial traffic is determined in terms of commercial vehicles per day (CVPD). For the structural design of the pavement only commercial vehicles are considered assuming laden weight of three tonnes or more and their axle loading will be considered. Estimate of the initial daily average traffic flow for any road should normally be based on 7-day 24-hour classified traffic counts (ADT). In case of new roads, traffic estimates can be made on the basis of potential land use and traffic on existing routes in the area.

TRAFFIC GROWTH RATE

Traffic growth rates can be estimated:
(i) by studying the past trends of traffic growth, and
(ii) by establishing econometric models. If adequate data is not available, it is recommended that an average annual growth rate of 7.5 percent may be adopted.

DESIGN LIFE

For the purpose of the pavement design, the design life is defined in terms of the cumulative number of standard axles that can be carried before strengthening of the pavement is necessary. It is recommended that pavements for arterial roads like NH, SH should be designed for a life of 15 years, EH and urban roads for 20 years and other categories of roads for 10 to 15 years.

VEHICLE DAMAGE FACTOR

The vehicle damage factor (VDF) is a multiplier for converting the number of commercial vehicles of different axle loads and axle configurations to the number of standard axle-load repetitions. It is defined as equivalent number of standard axles per commercial vehicle. The VDF varies with the axle configuration, axle loading, terrain, type of road, and from region to region. The axle load equivalency factors are used to convert different axle load repetitions into equivalent standard axle load repetitions. For these equivalency factors refer IRC:37 2001. The exact VDF values are arrived after extensive field surveys.

VEHICLE DISTRIBUTION

A realistic assessment of distribution of commercial traffic by direction and by lane is necessary as it directly affects the total equivalent standard axle load application used in the design. Until reliable data is available, the following distribution may be assumed.

• Single lane roads: Traffic tends to be more channelized on single roads than two lane roads and to allow for this concentration of wheel load repetitions, the design should be based on total number of commercial vehicles in both directions.

• Two-lane single carriageway roads: The design should be based on 75 % of the commercial vehicles in both directions.

• Four-lane single carriageway roads: The design should be based on 40 % of the total number of commercial vehicles in both directions.

• Dual carriageway roads: For the design of dual two-lane carriageway roads should be based on 75 % of the number of commercial vehicles in each direction. For dual three-lane carriageway and dual four-lane carriageway the distribution factor will be 60 % and 45 % respectively.

PAVEMENT THICKNESS DESIGN CHARTS

For the design of pavements to carry traffic in the range of 1 to 10 msa, use chart 1 and for traffic in the range 10 to 150 msa, use chart 2 of IRC:37 2001. The design curves relate pavement thickness to the cumulative number of standard axles to be carried over the design life for different sub-grade CBR values ranging from 2 % to 10 %. The design charts will give the total thickness of the pavement for the above inputs. The total thickness consists of granular sub-base, granular base and bituminous surfacing. The individual layers are designed based on the recommendations given below and the subsequent tables.

- **Pavement Composition**

SUB-BASE

Sub-base materials comprise natural sand, gravel, laterite, brick metal, crushed stone or combinations thereof meeting the prescribed grading and physical requirements. The sub-base material should have a minimum CBR of 20 % and 30 % for traffic upto 2 msa and traffic exceeding 2 msa respectively. Sub-base usually consist of granular or WBM and the thickness should not be less than 150 mm for design traffic less than 10 msa and 200 mm for design traffic of 1:0 msa and above.

BASE

The recommended designs are for unbounded granular bases which comprise conventional water bound macadam (WBM) or wet mix macadam (WMM) or equivalent confirming to MOST specifications. The materials should be of good quality with minimum thickness of 225 mm for traffic up to 2 msa and 150 mm for traffic exceeding 2 msa.

BITUMINOUS SURFACING

The surfacing consists of a wearing course or a binder course plus wearing course. The most commonly used wearing courses are surface dressing, open graded premix carpet, mix seal surfacing, semi-dense bituminous concrete and bituminous concrete. For binder course, MOST specifies, it is desirable to use bituminous macadam (BM) for traffic upto o 5 msa and dense bituminous macadam (DBM) for traffic more than 5 msa.

- **Failure Criteria** (procedure attached below as per IRC 37 guidelines)

A and B are the critical locations for tensile strains (ϵ_t). Maximum value of the strain is adopted for design. C is the critical location for the vertical subgrade strain (ϵ_z) since the maximum value of the (ϵ_z) occurs mostly at C.

Fatigue Criteria:

Bituminous surfacings of pavements display flexural fatigue cracking if the tensile strain at the bottom of the bituminous layer is beyond certain limit. The relation between the fatigue life of the pavement and the tensile strain in the bottom of the bituminous layer was obtained as

$$N_f = 2.21 \times 10^{-4} \times \left(\frac{1}{\epsilon_t}\right)^{3.89} \times \left(\frac{1}{E}\right)^{0.854}$$

in which, N_f is the allowable number of load repetitions to control fatigue cracking and E is the Elastic modulus of bituminous layer. The use of equation 28.1 would result in fatigue cracking of 20% of the total area.

Rutting Criteria

The allowable number of load repetitions to control permanent deformation can be expressed as

$$N_r = 4.1656 \times 10^{-8} \times \left(\frac{1}{\epsilon_z}\right)^{4.5337}$$

N_r is the number of cumulative standard axles to produce rutting of 20 mm.

7. TRAFFIC MANAGEMENT DURING CONSTRUCTION STAGE

Amongst the Assam State Roads Project this is the one project roads carrying high traffic volume once it is fully functional. Share of commercial traffic is significant. Due to the construction of this road the residents will be majorly affected and it is decided by the PWD (Roads) ASRP Committee that it important to build the project corridor phase wise, namely Red Phase (Phase 1) and Green Phase (Phase 2). 1st Phase will consist from the VIP Road -Project Corridor Junction (RED CIRCLE) till the curve section marked in BLACK CIRCLE and the 2nd phase consist the rest of the length from that curve section marked in BLACK CIRCLE till the Panjabari - Project Corridor Junction (GREEN CIRCLE).

The Average Daily Traffic survey data itself shows the project road being used widely by the local private and commercial users even after the carriageway being in poor and unpaved condition. The construction of this pavement will help the residents around the entire project corridor and area. The two lane standard configuration needs immediate upgradation. Looking to immediate and medium term capacity needs the corridor traffic calls for further higher order upgradation.

Due to the construction of this road the residents will be majorly affected and is it decided by the PWD (Roads) ASRP Committee that it important to build the project corridor phase wise with movement of only residents from nearby the project area.

These issues have been discussed with the State Government and Public Works Department (Roads) and looking to the uncertainty of the oil refinery and other industries and traffic associated with the same, as it is decided close the movement of all the vehicles who does not reside inside the project area therefore also give the residents and shopkeeper or concerned individuals working in that area special vehicle passes so that when the first phase section is in construction they can use the other phase section which will be done later and vice versa.

Accordingly while the construction of the paved carriageway is done lane wise in both the phases, one lane can be used only by the vehicle pass holders.

8. TESTING

8.1 Test on Stone Aggregates

- **Aggregate Impact Test**

The aggregates used in pavement layer are subjected to impact due to moving wheel loads. Therefore the aggregates used in pavement layer should have resistance to impact or possess toughness property. The aggregate impact value should not normally exceed 30% for aggregates to be used in bearing course of pavement. The maximum permissible value is 35% for bituminous macadam and 40% for water bound macadam base courses.

- **Los Angeles Abrasion Test**

The aggregates used in pavement surface course have to withstand the high magnitude of load stresses and wear and tear. Therefore the aggregates should have resistance to abrasion caused by traffic movements or should possess hardness property. The Los Angeles abrasion value of good aggregates acceptable for bituminous concrete and other high quality pavement materials should be less than 30%; for cement concrete pavement and dense bituminous macadam binder course the maximum acceptable value is 35%.

- **Polished Stone Value Test or Accelerated Polishing Test**

The aggregates should also have resistance from getting polished or smooth rapidly under traffic movement in order to prevent the pavement surface becoming too slippery particularly under wet condition, resulting in accidents due to skidding of high speed vehicles. As per the MORTH specifications, the Polished Stone Value of coarse aggregates used in Bituminous Concrete and Semi Dense Bituminous Concrete surfacing of roads should be less than 55.

- **Aggregate Crushing Test**

The aggregates should have resistance to crushing and be able to retain the strength characteristics during the service life and therefore should possess adequate strength. The aggregate crushing value for good quality aggregate to be used in base course shall not exceed 45% and the value for surface course shall be less than 30%.

The IRC and BIS have specified that the aggregate crushing value of the coarse aggregates to be used for the cement concrete pavement surface should not exceed 30%.

- **Shape Test - Flakiness Index, Elongation Index, Angularity Number**

The fraction of aggregates which happen to fall in a particular size range may have varying shapes and as a result may not have same resistance to crushing and durability when compared with cubical, angular or rounded particles of same stone. Too flaky and elongated particles should be avoided as far as possible as they can get crushed under the roller during compaction and also may break down under heavy wheel loads. Therefore angular shape coarse aggregates are preferred in flexible pavement layers. The IRC has suggested that the FI of aggregates used in bituminous concrete and surface dressing should not exceed 25%; the aggregates used in water bound macadam and bituminous macadam should not exceed 15%. MORTH has specified the maximum permissible value of the combined index of coarse aggregates as 30% for wet mix macadam base course, dense bituminous macadam binder course and bituminous concrete surface course. The angularity number of aggregates used in constructions generally range from 0 to 11.

- **Soundness Test or Durability Test or Accelerated Weathering Test**

The aggregates should not disintegrate under adverse weather conditions including alternative wet-dry and freeze-thaw cycles or in other words the stones should have enough resistance to weathering action or should possess durability property. For soundness test, the IRC has specified the maximum permissible loss in weight after 5 wet-dry cycles as 12% with sodium sulphate and 18% for magnesium sulphate for aggregates to be used in bituminous binder course and surface course of flexible pavements.

- **Specific Gravity Test and Water Absorption Test**

The presence of air voids or pores in stones will result in lower specific gravity and also indicate lower strength characteristics and durability of stones. The quantum of voids in aggregates is assessed by water absorption test. Higher values of water absorption in coarse aggregates are not desirable for use in bituminous mixes. The specific gravity values of rocks generally vary from 2.6 to 2.9. Rock specimens having more than 0.6% water absorption are considered unsatisfactory unless found acceptable based on strength tests.

- **Bitumen Adhesion Test or Stripping Value Test of Aggregates**

Affinity of aggregates to bituminous binders is an important property of coarse aggregates for use in the bituminous pavement layers. In case the bituminous mix or pavement layer is in contact with water for prolonged periods, stripping of bituminous binder is likely to take place from the coated aggregates, if the aggregates do not have affinity to bituminous binder. The IRC has specified the maximum stripping value as 25% for aggregates to be used in bituminous construction like surface dressing, bituminous macadam and bitumen-mastic. The maximum stripping value suggested by IRC is 10% for aggregates used in open graded premix carpet.

8.2 Test on Bitumen

- **Penetration Test**

The penetration test determines the hardness or softness of bitumen by measuring the depth in tenths of millimetre to which a standard loaded needle will penetrate vertically in five seconds.

Standard Temperature – $25^{o}C$,
Weight of needle – 100 grams,

The bitumen grade is specified in terms of penetration value. 80-100 grade means that the penetration value of bitumen is in the range of 8 to 10 mm. In hot climates lower penetration grade bitumen like 30/40 bitumen is preferred.

- **Ductility Test**

In the flexible pavement constructions where bitumen binders are used, it is important that the binders from ductile thin films around the aggregates. This serves as a satisfactory binder in improving the physical interlocking of the aggregate bitumen mixes.

Standard Temperature – 27^{o} C,
Rate of pull – 50 mm per minute,
Cross Section area – 10 mm x 10 mm,
Ductility Range – 5 to 100 cm,
Minimum Ductility value for Bitumen grade 45 and above (as per BIS) – 75 cm.

- **Viscosity Test**

Viscosity is defined as inverse of fluidity. Viscosity thus defined the fluid property of bituminous material. Viscosity is the general term for consistency and it is measure resistance to flow. The degree of fluidity of the binders at the application temperature greatly influences the strength characteristics of the resulting paving mixes. High and low viscosity during mixing and compaction has been observed to result in lower stability value. There is optimum value of viscosity for each aggregate gradation of the mix and bitumen grade. The viscosity of tar is determined as the time taken in second for 50 ml of the sample to flow through 10 mm orifice of the standard tar viscometer at specified temperature of 35^{o}C, 40^{o}C, 45^{o}C and 50^{o}C.

- **Float Test**

There is a range of consistency of the bituminous materials for which neither an orifice viscometer tests nor could a penetration test be used to define the consistence of the material. The consistence of this group is measured by float test. The time required in second for water to force in its way through the bitumen plug is noted as the float value. The higher the float test value, the stiffer is the material.

- **Specific Gravity Test**

The density of a bitumen binder is a fundamental property frequently used as an aid to classify the binders for use in paving jobs. The density of bitumen is greatly influenced by its chemical composition. Increased amount of aromatic type compounds or mineral impurity cause an increase in specific gravity. The specific gravity of bitumen is determined by using a pycnometer or by preparing a cube shape specimen in semi-solid or solid form. Generally the specific gravity of pure bitumen is in the range of 0.97 to 1.02.

- **Softening Point**

The softening point is the temperature at which the substance attains a particular degree of softening under specified condition of test. The Softening point of bitumen is generally determined by ring and ball test. The softening point of various bitumen grades varies between 35^{o}C to 70^{o}C.

- **Flash Point and Fire Point**

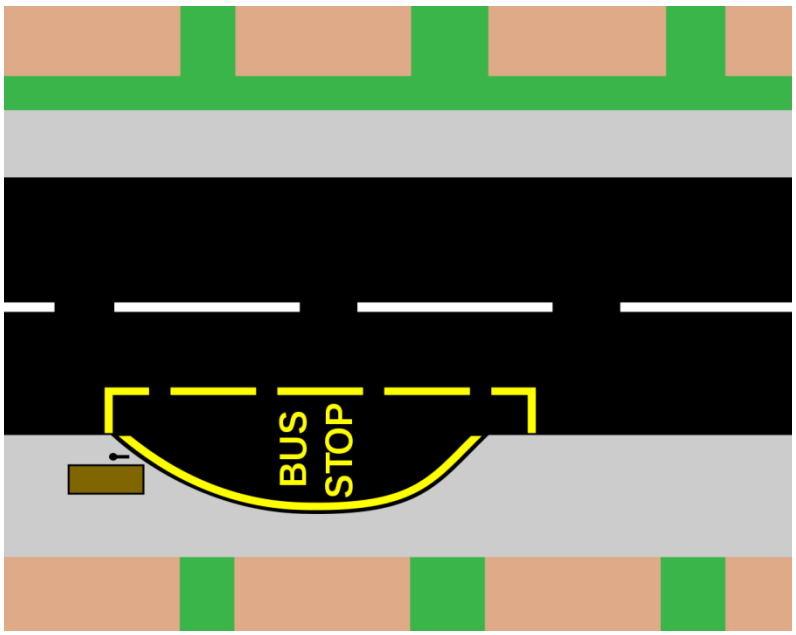
Bitumen material leaves out volatile material at temperatures depending upon their grad. These volatile catch fire causing a flash. This condition is very hazardous and it is therefore essential to qualify this temperature for each bitumen grade, so that paving engineers may restrict the mixing and application temperatures. Flash point of a material is the lowest temperature at which the vapour of a substance momentarily takes fire in the form of a flash under specified condition of test. Fire point is the lowest temperature at which the material gets ignited and burns under specified temperature. The min. specified flash point of bitumen used in pavement construction in Pensky Martens closed type test is 175o C.

- **Solubility Test**

Pure bitumen is completely soluble in solvent like carbon disulphide and carbon tetrachloride. Hence any impurity in the form of inert minerals, carbon, salts etc. could be quantitatively analyzed by dissolving the samples of bitumen in any of the two solvent. The min. proportion of bitumen soluble in carbon disulphide is specified as 99%.

9. WAYSIDE AMENITIES (BUS BAY)

For this project corridor, after the social survey of **2,526** people in the project corridor the most demanding amenity was the provision of bus bay near one of the major junctions, i.e. at Panjabari Road-Project Corridor Junction which will help all the people nearby the area. This wayside amenity was considered after reviewing the status of bus users and it turned out to be feasible. Also there were no proper bus bays nearby from a long time. This bus bay will help all residents who live near or in the project corridor area and also other users, who prefer to utilize public transport like bus such city buses or school buses, etc on a daily basis. Introduction of a bus bay with this project will boost it social impact.



For the construction, IRC 2012 (Guidelines for Pedestrian Facilities) is followed.

10. COST ANALYSIS AND BUDGET PREPARATION

Cost estimation and budgeting are essential tools for planning in the construction industry and play a central role in both preconstruction and construction phases of a project. Best practices dictate a total project budget should be developed as early as possible in a project.

The project corridor is designed involving the construction and maintenance pavement, cross-drainage structures and the drainage system.

For this project, the costing is mainly for the Civil Works which includes Site Clearance, Earthworks, Sub-Base and Base Course work, Pavement Course Work, Cross Drainage work, Drainage and Protection work, Road Appurtenances, Road Lighting Work, Wayside Amenities Work (Bus Bay) and other miscellaneous works are considered such as provision and maintenance of vehicle to the employer and supply of digital records, etc. There are other works which do not come under the Civil Works such as Street Lighting, Utility Relocation, and Environment Enhancement & Landscaping which also has separate costing. Also contingencies are also taken into consideration.
Rest of the costs of project management, quality control, administration charges, etc are also taken into consideration Rate analysis for various mentioned domains have been carried out based on the input rates for Plant, Machinery, Labour and Materials, as adopted in the "Standard Data Book for Analysis (1st Revision 2003) of Ministry of Road and Transport" The Unit Rates arrived through the detailed rate analysis is used for the preparation of Cost Estimate. Cost estimates and the detailed back up calculation have been presented in Page 48 of the Executive Summary (DPR).
Note: Environmental Impact Assessment is not considered as during initial survey of the existing project corridor, it was found that this project didn't have any direct effect on Environment as there were no vegetation or trees on the corridor on top of the fact that it was already a built up area and had residents along the project corridor and also this project was estimated to be less than Rs 50 Crores.
Also, there was no Land Acquisition, therefore these cost elements were also cut down i.e. the Cost of Land Acquisition and the Cost of Rehabilitation & Resettlement.

COST ESTIMATE TABLE

Bill No.	Description	Amount (INR) (in lakhs)
CIVIL WORKS: A		
1	Site Clearance	8.52
2	Earthworks	21.71
3	Sub-Base and Base Course Work	29.25
4	Pavement Course Work (Bitumen Structure Course)	47.12
5	Cross Drainage Work	28.8
6	Drainage and Protection Work	33.2
7	Road Appurtenances	13
8	Wayside Amenities Work	17.6
9	Road Lighting Work	12.8
10	Miscellaneous Work	10
A	SUB TOTAL (CIVIL WORKS)	222.00
B	Street Lighting, Utility Relocation, Environment Enhancement & Landscaping and Contingencies at 10% of Civil Works Cost	22.2
C	SUB TOTAL OF A + B	244.2
D	Project Management, Quality Control and Construction Supervision at 2% of A	4.44
E	Administration Charges at 5% of C	12.21
	TOTAL COST (C + D + E)	Rs 260.85

Based on the estimated quantities and extensive rate analysis, combined project cost including social cost is approximately **Rs. 2,60,85,000/-**.

This cost estimate may vary **+/- 5% to 10%** with the circumstances and due course of time.

All the rates are according to the recent schedule of rates for roads, bridge and culvert works for state highways & major district roads under Assam Public Works (Road) Department, 2018-19. Also few costs are varying as the existing project corridor already consisted that feature.

Approval of cost is to be done by the Chief Engineer of PWD (Roads), Assam and the Hon'ble Cabinet Minister for PWD (Roads and Buildings & NH) Assam.

11. CONCLUSION

The importance of this Project Corridor has been discussed in the previous sections of this Detailed Project Report (Executive Summary); therefore we conclude that this project corridor after completion will benefit all the stakeholders in various ways. This road project is also desirable from the society's point of view. The project corridor as a whole is found to be economically viable, even in the worst scenario of drop in benefits coupled with increase in cost.

This project corridor which acts as a Link Road from VIP Road to Panjabari Road is aimed to be successful from all aspects.

Hence, based on the above results, the project is recommended for implementation.

Declaration

This is to certify that I, **Mr. Dipankar Pegu (Reg. No. 189102066)** have completed the "Detailed Project Report" preparation project for the subject Transportation Engineering-1 (CV 1505) during the 5th Semester of my Bachelor of Technology in Civil Engineering at Manipal University Jaipur entitled "**Project Preparatory Works Consultancy Services for Assam State Roads Project**". This report is an authentic record of my work carried out during a period from July, 2022 to September, 2022 under the supervision of Dr. Sanchit Anand, Assistant Professor, Dept. of Civil Engineering.

The company name, logo, and association with the Assam Public Works Department (Roads) mentioned in this document are purely hypothetical and do not hold any real-life significance.

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