"Improvement and Upgradation of Mangoldoi-Mazikuchi road from KM 11+000 to KM 26+000 under NESIDS for the year 2024-25 (L=15.000 km)"

Volume: 1
MAIN REPORT & COST ESTIMATES

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Submitted By

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Zenith Associates		
Client: Public Works Department (Border Roads and NEC Works)		
Division: PWD (R) Mangaldoi, Dalgaon and Sipajhar Territorial Roads Division		
Client: PWD (R) Sipajhar Territorial Road Sub-Division		
Location: Darrang, Assam		
Length of Project: 15 Kilometers		
Cost of Project: 51.666 Cr		
Project: **Improvement and Upgradation of Mangoldoi-Mazikuchi road from KM 11+000 to KM 26+000 under NESIDS for the year 2024-25 (L=15.000 km)**	Project No.:	
Title: Detailed Project Report	Document No:	Volume: 1
Notes:		

ABBREVIATIONS

AADT	-	Annual Average Daily Traffic
ADB	-	Asian Development Bank
ADT	-	Average Daily Traffic
AM	-	Arrow Marking
BC	-	Bituminous Concrete
BIS	-	Bridge Information System
BM	-	Block Marking
BOQ	-	Bill of Quantities
BTAD	-	Bodoland Territorial Area District
CBR	-	Californian Bearing Ratio
CDV	-	Correct Deduct Value
CE	-	Chief Engineer
CPR	-	Common Property Resources
CRMB	-	Crumb Rubber Modified Bitumen
CRS	-	Corrosion Resistance Steel
CSS	-	Cationic Bitumen Emulsion
CVC	-	Classified Volume Count
CVPD	-	Commercial Vehicles per Day
CYCRSHW	-	Cycle Rickshaw
DBM	-	Dense Bituminous macadam
DCP	-	Dynamic Cone Penetration
DGPS	-	Differential Global Positioning System
DPR	-	Detailed Project Report
EAP	-	Externally Aided Project
EIRR	-	Economic Internal Rate of Return
EM	-	Ethnic Minority
EMP	-	Environmental Management Plan
ENPV	-	Economic Net Present Value
EPC	-	Engineering Procurement & Construction
EPIP	-	Export Processing Industrial Park
ESAL	-	Equivalent Standard Axle Loading
FEQ	-	Seismic Loads

FM	-	Facility Marking
FOD	-	Footpath Over Drain
FSI	-	Floor Space Index
GAD	-	General Arrangement Drawing
GDP	-	Gross Domestic Product
GFC	-	Good for Construction
GIS	-	Geographic information system
GNP	-	Gross National Product
GOA	-	Government of Assam
GOI	-	Government of India
GPS	-	Global Positioning System
GSB	-	Granular Sub Base
GSDP	-	Gross State Domestic Product
GST	-	Goods and Services Tax
GVA	-	Gross Value Added
HDM	-	Highway Development and Maintenance Management System
HDR	-	High Dynamic Range
HFL	-	High Flood Level
HM	-	Hazard Marking
HS	-	Hard Shoulder
HT	-	High Tension
IDC	-	Interest During Construction
IIDC	-	Industrial Infrastructure Development Centre
INR	-	The Indian Rupee
IP	-	Indigenous People
IRI	-	Information Resources, Incorporated
IS	-	Indian Standard
ISI	-	Indian Standards Institute
JICA	-	Japan International Cooperation Agency
JPCP	-	Jointed Plain Cement Concrete
KM	-	Kilometer
LA	-	Land Acquisition
LCV	-	Light Commercial Vehicles
LM	-	Longitudinal Marking

LMV	-	Light Moving Vehicle
LOI	-	Letter of Intent
LOS	-	Level of Service
MAV	-	Micro air vehicle
MCE	-	Maximum Considered Earthquake
MDB	-	Multilateral Development Banks
MDD	-	Maximum Dry Density
MDR	-	Major District Roads
MIDAS	-	Modular Interactive Data Acquisition System
MJ	-	Mill joule
ML	-	Mili litre
MN	-	Millions
MOEF	-	Ministry of Environment and Forests
MORTH	-	Ministry of Road Transport and Highways
MOSPI	-	Ministry of Statistics and Program Implementation
MSA	-	Million Standard Axles
MSL	-	Mean Sea Level
MT	-	Metric Ton
MW	-	Mega Watt
NBPZ	-	North Bank Plain Zone
NDDP	-	Net District Domestic Product
NGO	-	Non-Governmental Organizations
NH	-	National Highway
NHAI	-	National Highways Authority of India
NHIDCL Corporation	-	National Highways and Infrastructure Development
NMT	-	Non-Motorized Traffic
NPV	-	Net Present Value
NSDP	-	Net State Domestic Product
OD	-	Origin Destination
OFC	-	Oxygen Free Copper
OMC	-	Optimum Moisture Content
OPC	-	Opportunity Cost of Cargo
PAP	-	Project Affected Persons

PCC	-	Portland Cement Concrete
PCE	-	Passenger Car Equivalents
PCI	-	Pavement Condition Index
PCSE	-	Passenger Car Space Equivalency
PCU	-	Passenger Car Units
PIA	-	Project Influence Area
PMGSY	-	Pradhan Mantri Gram Sadak Yojana
PMS	-	Pavement Management System
PPP	-	Public Private Partnerships
PRW	-	Piece Rate Worker
PSC	-	Pre-Stressed Concrete
PSU	-	Public Sector Undertaking
PWD	-	Public Works Department
PWRD	-	Public Works Roads Department
RAP	-	Recycled Asphalt Pavement
RAMS	-	Road Asset Management System
RCC	-	Reinforced Cement Concrete
RFP	-	Reference for Proposal
ROB	-	Road Over Bridge
ROW	-	Right of Way
RP	-	Resettlement Plan
RPF	-	Resettlement Policy Framework
R&R	-	Rehabilitation and Resettlement
RSIS	-	Road Safety Information System
RUB	-	Road under Bridge
RUE	-	Road User Effects
RWFIS	-	Right of way Feature Information System
SB	-	Sub Base
SC	-	Scheduled Caste
SCF	-	Standard Conversion Factor
SCRIM	-	Sideway-force Coefficient Routine Investigation Machine
SERF	-	Shadow Exchange Rate Factor
SH	-	State Highway
SIDL	-	Superimposed Dead Load
SMP	-	Social Management Plan

SNP	-	Structural Number
SQL	-	Structured Query Language
SSD	-	Stopping Sight Distance
ST	-	Scheduled Tribe
STAAD	-	Structural Analysis And Designing Program
SWRF	-	Shadow Wage Rate Factors
TCS	-	Typical Cross Section
TIS	-	Traffic Information System
TM	-	Transverse Marking
TMC	-	Turning Movement Count
TMT	-	Thermo Mechanically Treated
TPC	-	Total Project Cost
TRCT	-	Tractors
TRL	-	Trailer
TUG	-	Temperature differences
TUU	-	Uniform temperature variation
TVC	-	Traffic Volume Count
UFC	-	Unified Facilities Criteria
VDF	-	Vehicle Damage Factor
VOC	-	Vehicle Operating Cost
VOTT	-	Value of Travel Time
WBM	-	Water Bound Macadam
WMM	-	Wet Mix Macadam
WPR	-	Work Force Participation

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1 EXECUTIVE SUMMARY

1.1 Project Background

The state of Assam has about 2,530 km of State Highways (SH) and 4,379 km of Major District Roads (MDR) which are being maintained and managed by the Public Works Roads Department (PWRD), Government of Assam (GOA).

Public Works Roads Department (PWRD), Guwahati, Assam is engaged in improvement and reconstruction of State Highways (SH) and Major District Roads (MDR) across the state for the improvement of 40 numbers of roads having total length of 1268.10 kms. These roads are grouped in five packages in the view of administrative suitability for Preparation of Detailed Project Report for upgradation of roads in State of Assam.

The main objective of the Council is to ensure the balanced and integrated economic development of the North Eastern parts of the country including addressing the communication bottlenecks specially in the backward area in the interstate border. In the State of Assam, the Public Works Road Department (PWRD) is responsible for Planning, designing, construction and maintenance of assets related to road communication with emphasis on durability, quality, functional efficiency, serving the intended purpose, created within the reasonable period within the resource available in time to time. **The North East Special Infrastructure Development Scheme (NESIDS)** is a central sector scheme of the Government of India that aims to improve infrastructure in the North Eastern Region. The scheme includes projects in Assam, such as road construction and social infrastructure development.

1.2 Objectives of the Project

The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project (DPR) reports for rehabilitation and upgrading of the existing single lane road to intermediate lane with provision of capacity augmentation.

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

1.3 Description of Project Road

The project road **Mangaldoi to Mazikuchi** has a length of **15 Kms** and it lies in the district of Darrang. The project road passing through education hub of Darrang District in Deomornoi which currently does not have have proper connectivity to Mangaldoi town and beyond.

The proposed road Mangaldoi to Mazikuchi initiates at a Cross-Junction on Bezpera Chariali Chowk (KM 0+000) and ends in Namkhola Village (Mazikuchi) (KM 26+000) connecting directly to State Highway 11. The Project road from KM 0+000 to KM 11+000 has already been upgraded under RIDF Scheme. The missing link from KM 11+000 (Borigaon) to KM 26+000(Namkhola) shall be upgraded under NESIDS.

The map showing the alignment Mangaldoi to Mazikuchi is presented in ***Figure 1.1.***

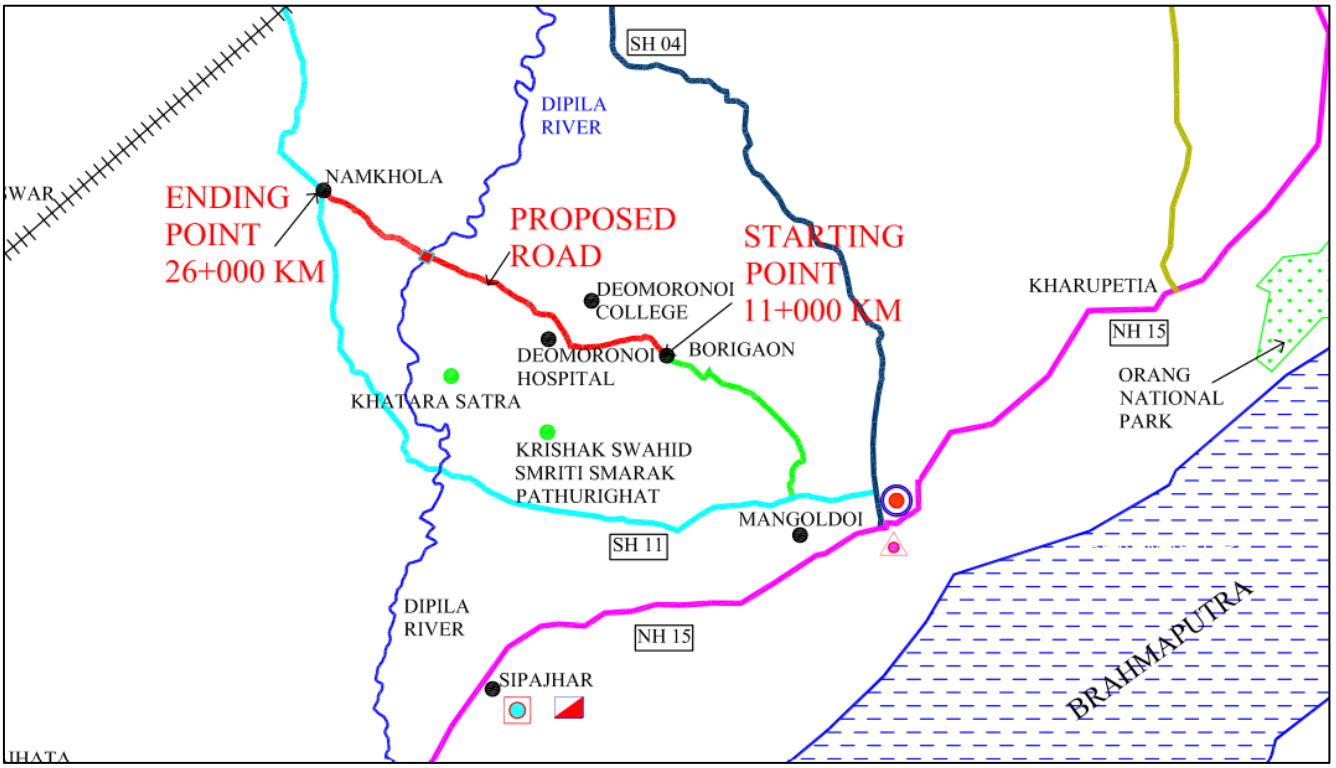
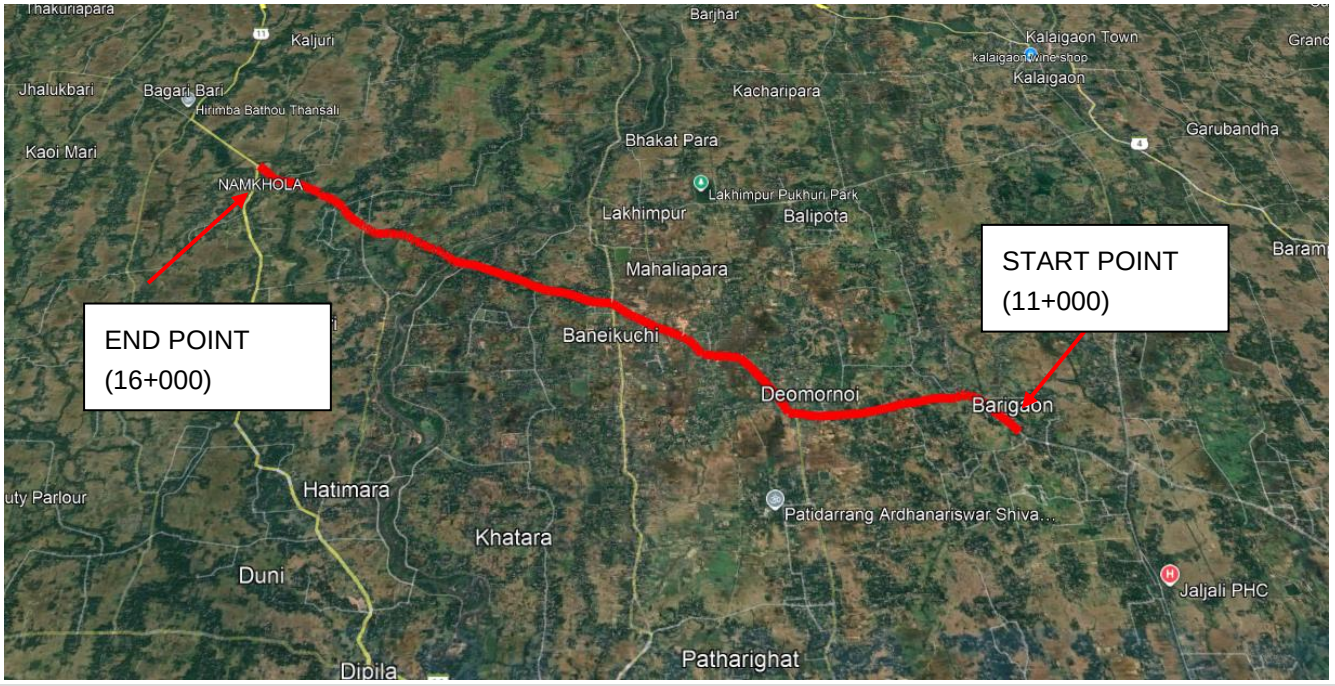


Figure 1.1: Map showing Mangaldoi to Mazikuchi Road.

1.4 Proposed Alignment of Project Road

The recommended alignment of the project road comprises of improved alignment, retained existing alignment wherever possible improved alignment at several locations considering the structures (retained and reconstruction) and realignments to improve the geometry of alignment at certain locations. The alignment is in reconstruction and widening throughout the road stretch. No realignment has proposed.

Figure 1.2: Important Locations along the project corridor



1.5 Traffic Surveys

Traffic Data Collection and projections of traffic volumes are basic requirements for planning of road development and management schemes. Traffic surveys such as mid-block Classified Traffic Volume Counts (TVC) by manual systems, Axel Load surveys are conducted on selected locations i.e. Start and End Point of Project road are carried out to understand the existing traffic pattern and to check the adequacy of the number of homogenous sections of the project road. The locations for the surveys were finalized based on the reconnaissance survey.

(a) Traffic Volume

The summary of the average annual daily traffic for the project stretch is given below:

Table 1.1: Traffic Survey Schedule & Location

Type of Survey	Location	Duration
Classified Traffic Volume Count (TVC) Surveys	Mahaliapara (Ch. 18+500)	3 Days x 24 Hrs.

Source: Consultant Estimates based on Actual Traffic Survey Data

Based on the traffic analysis the recommended Vehicle Damage Factors (VDF) and Million Standard Axles (MSA) values are presented in the following table:

Table 1.2: Recommended VDF & MSA Values

VDF Values	MSA
4	**5**

(b) Capacity Analysis

The capacity analysis of the project road was done on the basis of level of service for Mangaldoi to Mazikuchi Road section. The projected traffic with the corresponding Level of Service for total traffic is presented in ***Chapter 4: Traffic Studies and Demand Forecast.***

As per the projected traffic volume, Mangaldoi to Mazikuchii road section with current Single lane configuration, this project road section is under LOS C. Hence, there is a need to improve the proposed project road to cater the growing traffic demand presently based on the connectivity with important towns and tourist destinations.

1.6 Justifications for 2 Lane Road

- The project road will be the shortest route between District HQ Mangaldoi and Udaguri District Sub-Division Bhergaon, saving almost 7.2 kilometres. Additionally, the current alternate route SH-11, connecting Mangaldoi to Bhergaon, is a single-lane road. Therefore, after the completion of the project, all commuters will prefer the proposed road via Deomornoi town.
- The road will improve connectivity to the important cultural location of **Pathurighat Krishak Shahid Memorial**. This site is where a memorial for the Patharughat massacre, which occurred on

January 28, 1894, by the British colonial rulers during the Patharughat peasant uprising, is located. The day of the massacre is commemorated as the Krishak Swahid Divas (Farmer Martyrs Day).

- Many other tourist destinations such as **Khata Satra,** Historical Lakhimpur Pukhuri, Ramgaon Pukhuri and others lie in the close vicinity of the road.
- The road passes through highly populated Deomornoi Town, which is home to important institutions critical for Darrang District and the state of Assam.
- The road connects important Educational Institutes such as **Deomornoi B.Ed College**, **Deomornoi Degree College**, **Deomornoi Senior Secondary** and **High Schools** and many **LP Schools and Jatiya Bidyalayas**.
- The other important institutions on the proposed road include the State Veterinary Institute, Handloom Extension Centre, Telecom Centre, and Sericulture Seed Production Centre.
- The road connects three LACs in the state of Assam: **Mangaldoi, Sipajhar and Bhergaon.**
- Villages: 24 and Population: 1.5 Lakhs will benefit from the Scheme.

From economic point of view, the improvement of this road is very much essential apart from road communication towards the NE region. Widening and strengthening of this road improve the socio-economic condition of the local people along with the other benefits. Improvement of this road stretch will improve the road communication scenario resulting in savings of vehicle operating cost and time for the vehicles leading to NE region from the other part of India.

The completion of the project will:

- ✓ improve socio-economic condition of the people in the influence area,
- ✓ improve the living condition and quality of life.
- ✓ reduce travel time and vehicle operating costs
- ✓ improve access to health, education, religious and market facilities.
- ✓ and facilitate all round development in educational and health, religious and trade activities for all-round economic growth.

1.7 Surveys & Investigations

Survey & Investigation includes the survey and analysis of road inventory, visual condition survey, structural evaluation survey, roughness survey, sub grade investigations, material surveys conducted following the relevant Specifications/Codes to generate adequate database for preparing the most appropriate proposal for the rehabilitation / upgrading of the existing road.

Various engineering surveys and investigations for the project road which have been carried out for the project are listed below:

- Road Inventory Surveys
- Pavement Condition Survey
- Traffic Surveys
- Sub grade Investigations
- Topographic Survey
- Roughness Survey
- Soil Investigations

The details of the surveys and investigations are presented in **Chapter 5**: Engineering Survey & Investigations. The summary of the surveys is mentioned below:

Table 1.3: Details of Borrow Area

Location	Borrow area Number	Borrow area name village	Side	Area available for borrow material in sq. m	Suitability for embankment / subgrade	Available quantity in Approx. cum.	Required cum.
1	1	Bhakat Para		10 Bigha	Yes	1 Lakh	1.2 Lakh

Table 1.4: Details of Quarry Sample

Name of Quarry	Location	Suitability	Quantity available in cum	Quantity required in cum
Bhutiachang Quarry	Near Bhutan Border	Suitable for GSB, GSB, WMM, DBM, BC, RCC, PCC, also refer remarks and recommendations given in Aggregate test results sheet		

5.4.1. **Improvement Proposals**

The project road is an important connectivity within Darrang district as it connects most of the villages along the road corridor which do not possess proper connectivity. Agricultural activities, Major Tourist destinations and Educational Institutions are major economic drivers of the area. Majority of the project road is a Existing road with single lane width and at places where the proposed alignment meets the existing alignment it is understood that the existing Single Lane facility is inadequate to cater the traffic demand and user satisfaction.

Chapter 7: Proposed Road features and Improvements.

Entire road length is proposed for widening to Intermediate Lane with Hard and Earthen shoulder configuration. Adequate drainage arrangements are also proposed including provision of covered built-up RCC drains in settlement areas. The details of the reconstruction schedule are elaborated below:

Table 1.5: Widening proposal – Intermediate Lane – Flexible Pavement

Lane Configuration	Width (m)						
	Carriageway	Paved Shoulders	Earthen Shoulders+ Hard Shouders	Footpath over Drain (Concrete)	Slip Road	Space for Drain	Utility Corridor
Intermediate Carriage way Open Country Plain and Rolling Terrain	5.5	–	3.5 (1.75+1.75)		–	–	–
Intermediate Carriage way Open Country Plain and Rolling Terrain (Built up Section)	5.5	–	3.5 (1.75+1.75)	2 (1+1)	–	–	–

Source: Typical Cross Section

It is recommended to widen the section as per the above-mentioned widening proposals. The details of the reconstruction schedule are elaborated in ***Table 1.6***.

2 INTRODUCTION

2.1 Background

Assam is the largest state among the North Eastern states of India in terms of population and acts as gateway for the entire North Eastern (NE) states i.e. Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and shares its border with the state of West Bengal and two countries viz. Bangladesh and Bhutan. Its fiscal and economic situation has been improving since last decade, efforts of the government has helped the state to accelerate its Gross State Domestic Product (GSDP). Its geographical location demands huge thrust on the development of road infrastructure in the region thereby enhancing the region's economy. Road infrastructure assets are the key factors of economic development, mobility and social equity for any region or nation. They are not only costly to build but also expensive to maintain in order to adequately meet the public expectations. The key issue is how to manage existing assets in a way that it delivers maximum benefit to public with the limited financial resources. The answer is Road Asset Management System (RAMS) which offers a comprehensive and structured approach to the delivery of the community benefits through management of road networks.

The Government of Assam intends to objectively develop State's road infrastructure for fueling economic growth, by providing transportation and rural connectivity, and also by providing good quality inter-state and international connectivity, making it at par with other replicable Asian economies. The Government of Assam has formulated the "Assam Vision 2030" in line with the UN Sustainable Development Goals (SDG) and the National Development Agenda. The Government of India has also embarked upon 'Act East Policy' and it aims to make Assam the hub of economic activities in South Asia region.
Public Works Roads Department (PWRD), responsible for managing the secondary, urban and rural road network in Assam, had initiated several projects in the state to boost its infrastructure and Assam State Road Project (ASRP), was one of them. Development and implementation of a computerized road asset management system (RAMS) for the maintenance and management of the state road network was one of the key mandates of ASRP. Consequently, such a system was developed and implemented during 2015-18 to meet the needs of PWRD and is called the Assam Road Asset Management System (ARAMS). The ARAMS application was envisioned to assist the PWRD to rationalize and aid the decision-making for planning/ programming of road maintenance and rehabilitation activities and to estimate the long-term funding requirement for preserving the road assets at an acceptable service level, thereby safeguarding their asset value.

It was observed that years of underfunding and perennial neglect to maintenance has dilapidated the State Highways (SH) and Major District Roads (MDR) network. The SHs & MDRs have remained as the 'neglected middle', as compared to NHs which were being improved by MoRTH and Rural Roads which are being constructed largely under PMGSY by Ministry of Rural Development (MORD), GOI. Most SHs & MDRs have poor riding quality, weak pavements, and inadequate capacity. Nearly 35% of SH & MDR have remaining life less than 2 years. The SH & MDR network now needs fast reconstruction and capacity augmentation.

To preserve and improve the secondary network in a serviceable condition is a challenging task for the state. The region is geographically dispersed and experiences a long rainy season thereby submerging a considerable part of network.

The North East Special Infrastructure Development Scheme (NESIDS) is a central sector scheme of the Government of India that includes Assam and other states in the North Eastern Region. The scheme aims to improve infrastructure in the region.

NESIDS in Assam

- The scheme includes projects to improve water supply, power, and connectivity
- It also includes projects to improve social infrastructure like education and health
- The scheme aims to exploit the tourism potential of the region
- The scheme covers all eight states in the North Eastern Region, including Assam

How NESIDS works

- The scheme is fully funded by the Government of India
- The funds are released in two installments
- The scheme is administered by the Ministry of Development of North Eastern Region (MDONER)
- The scheme is implemented through the Implementing Agencies (IA) of the respective state governments

The project road works will generally involve geometric improvement in terms of horizontal and vertical alignment improvement, as well as widening to two lanes with or without paved shoulders depending on necessity and feasibility. Roads to be improved would mostly follow the existing alignment, but at some stretches realignments or new alignments would be adopted for improving the roads. New RCC bridges would be constructed wherever required and existing structurally weak bridges in poor condition would be rehabilitated. Road safety audits will be carried out and counter measures to improve safety would be adopted. Economic analysis would be carried out for each project road to ensure viability of road improvements works.

The DPRs for the road improvement and widening works would include the detailed engineering designs. It would include environmental assessments as per the applicable Government of India guidelines. It would also include Environmental Management Plans (EMP) to mitigate environmental damages along with compensatory afforestation for roadside trees to be felled, meeting the policies and guidelines of funding agencies. Furthermore, the DPRs would include social assessments as per the regulations. It would include land acquisition plans for improving horizontal alignment and widening the roads, prepared based on revenue records. Moreover, it would include resettlement and rehabilitation plans for project affected persons. An entitlement matrix would be prepared for compensation to be paid to affected persons and families.

Preparation of DPRs would further include shifting of utilities along the road, including electrical poles and water supply pipes. The cost estimates would be prepared based on joint inspection at work site with the concerned organizations like Power department, Public Health Engineering Department, etc. The pre-construction works involving land acquisition and utility shifting are planned to be started after DPRs are approved so that encumbrance free site is available to the contractor at the time of award of the work.

2.2 Objective of Consultancy Services

The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project (DPR) reports for rehabilitation and upgrading of the existing road to Intermediate-lane configuration with provision of capacity augmentation.

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

2.3 Scope of Consultancy Services

The scope of Consultancy services as set out in the TOR includes the following major tasks for the PPR and DPR stages of works.

- Traffic studies including traffic surveys and Axle load survey and demand forecasting for next 15 years;
- Road inventory and condition surveys;
- Inventory and condition surveys for culverts and bridges
- Detailed topographic surveys using Total Stations and DGPS;
- Soil investigations, sub-grade characteristics and strength, subsoil and geotechnical investigations.
- Pavement investigations;
- Identification of sources of construction materials;
- Detailed design of all culverts, ROBs, Grade separators, under/over passes and other structures including, preparation of GAD and construction drawings.
- Identification of the type and the design of intersections;
- Design of roadside drainage system.
- Preparation of detailed project report, cost estimate, construction drawings, rate analysis, detailed bill of quantities, bid documents for execution of civil works. All ready to implement "good for construction" drawings shall be prepared.

2.4 Stages of Completion

In developing the Work Plan for completing the assignment, the activities have been considered under stages as follows:

Stage 1 - **Detailed Project Report (DPR)**

The stages will generally follow a sequence, though each stage is inter-related and inter- dependent on one another. The related reports for each stage will be submitted to the PWRD Assam as stipulated in the TOR.

2.5 Reporting Requirements

Detailed Project Report (DPR) document is the 3rd Stage report of a three-stage study of the project. The Detailed Project Report (DPR) constitutes of the following Volumes fulfilling requirement of TOR Clause No. 6.

Volumes	Title
Volume – I	: Main Report & Cost Estimates
Volume – I A	: Design & Estimates of Bridges/CD Structures
Volume – II	: Drawing Volume: Road Works & Bridge Works

2.6 Structure of this Report

This report is constituent "Volume – I: Main Report & Cost Estimates" of the Final Detailed Project Report (FDPR) documents. The contents of **Volume – I: Main Report** is as follows:

Chapters	Title
1	EXECUTIVE SUMMARY
2	INTRODUCTION
3	DESCRIPTION OF EXISTING PROJECT ROAD
4	TRAFFIC STUDIES AND DEMAND FORECASTS
5	ENGINEERING SURVEY & INVESTIGATIONS
6	DESIGN STANDARDS & SPECIFICATIONS
7	PROPOSED ROAD FEATURES & IMPROVEMENTS
8	COST ESTIMATE

3 DESCRIPTION OF EXISTING PROJECT ROAD

3.1 General

This chapter purports the essential features of the existing project road namely **Mangaldoi to Mazikuchi.** It presents a summarized view of the existing location, condition, importance and developments in and around the existing road. It also provides a glimpse of the critical locations like forest and wildlife if any, around the road.

The project work for the proposed road consists of improvement of **Mangaldoi to Mazikuchi (L: 15 Km) District: Darrang respectively. Table 3.1** shows the details of the project road stretch considered for the Detailed Project Report.

Table 3.1: Details of Project Road

Group	Corridor No.	Project Road Stretch	Design Length (km)
		Mangaldoi to Mazikuchi	15 Kms

3.2 Description of Project Road

.The proposed road Mangaldoi to Mazikuchi initiates at a T-Junction on [redacted] road in Mangaldoi village and ends in Mazikuchi Village at a cross section on SH-27(Mazikuchi-Sapekhati Road).

3.3 Existing Alignment

The proposed road Mangaldoi to Mazikuchi initiates at a Cross-Junction on Bezpera Chariali Chowk (KM 0+000) and ends in Namkhola Village (Mazikuchi) (KM 26+000) connecting directly to State Highway 11. The Project road from KM 0+000 to KM 11+000 has already been upgraded under RIDF Scheme. The missing link from KM 11+000 (Borigaon) to KM 26+000(Namkhola) shall be upgraded under NESIDS.

3.4 Terrain, Soil Type and Geology

The district is mainly a flat alluvial tract; in its southern part, a few scattered 'inselbergs' of gneissic rocks not exceeding 90 to 140 m., high above mean sea level, lie along the north bank of the Brahmaputra. In the northern front along the base of the foot-hills of the eastern Himalayas, from where the alluvial plain gradually slopes down to the Brahmaputra, there are several low-lying mounds made up of unsorted river terraces. Some parts of the district are hills, covered with long grass jungle interspersed here and there with patches of rice fields.

Acidity is a general characteristic of the soil of the district and more so in the older alluvial soil. New alluvial soils representing the lands of the river banks are less acidic. There are often neutral and even alkaline. The phosphoric content is good in the river side of the Brahmaputra where tea is grown. Acidic alluvial soils are suitable for cultivation of tea. Heavy clay with high percentage of nitrogen in low land areas give a good return of rice, while sand looms above inundation level give a good yield of crops. Overflowing of the rivers replenishes the soil every year by depositing silt. The potash (k20) content is low in some soils and moderate in others.

3.5 Climate

Darrang district in Assam has a humid, sun-tropical climate. It has a wide range of temperatures, from cold winters to hot summers, and receives heavy rainfall during the monsoon.

Temperature
Winter: December to February, with average maximum temperatures of 25°C and minimums of 7°C
Pre-monsoon: March to May, with average maximum temperatures of 32°C and minimums of 20°C
Monsoon: June to September, with average maximum temperatures of 36°C and minimums of 23°C
Retreating monsoon: October to November, with average maximum temperatures of 29°C and minimums of 16°C
Hottest month: July or August, with temperatures reaching up to 40°C
Coldest month: December or January, with temperatures dropping to almost 15°C

Rainfall
Annual rainfall: 2120 mm
Monsoon rainfall: 60 to 65% of the annual rainfall, from June to September
Pre-monsoon rainfall: 501 mm of rainfall from March to May

Other climate characteristics
The air is highly humid throughout the year
The monsoon season is from May or June and extends up to four months
The northern part of the district is colder than the rest of the district during the winter

3.6 Land Use

The land-use pattern in the project section has major share of agricultural area. The abutting land use patterns observed along the project road is as given in **Table 3.2.**

Table 3.2: Land use pattern

LAND USE		
Type of Land	**Length (Km)**	**Percentage**
Agricultural	5420	36%
Barren Land	0	0%
Built Up	2880	19%
Semi Built up	6700	45%
Total	15000	100%

3.7 Road side Development – Villages & Towns

The project road Mangaldoi to Mazikuchi traverses through Darrang district of Assam and has built-up or semi-built-up areas situated across the project stretch. The project road passes through Deomornoi town, Mahabalipura and Namkhola town are considered as major settlements across the road.

The list of villages and towns on the sides of project highway, identified during reconnaissance survey and the information obtained from village maps are presented in **Table 3.3.**

The identified settlement has been given careful consideration before deciding on the appropriate cross-section, and other related improvement proposals earmarked for the project.

Table 3.3: Important Settlements Abutting Project Highway

S. No.	Design Chainage (Km)		Length (m)	Name of Settlement
	From	To		
1	12+000	12+250	250	Kulshigate Chowk
2	14+000	14+250	250	Deomornoi Twn
3	18+300	18+450	150	Moholiapara Town
4	24+000	24+150	150	Salaipara
5	25+300	25+600	300	Namkhola Market

Source: Road Inventory Survey, Revenue Village Maps

3.8 Existing Traffic

Based on the classified volume count traffic survey the commercial vehicles per day for the project road Mangaldoi to Mazikuchi are calculated and AADT for both directions at Mangaldoi to Mazikuchi project road are presented in the Chapter 4.

3.9 Broad Features & Preliminary Technical Assessment of Existing Road

3.9.1. Carriageway

The project road majorly passes through Existing Road. The shoulder is mostly unpaved and the width of the carriageway is varying between 0 to 3 m and the condition is generally very poor. The details of existing lane configuration are presented in **Table 3.5.**

Table 3.5: Details of existing lane configuration

Lane configuration	Total length (Km)	Length (Km.)	Percentage (%)
Mangaldoi to Mazikuchi	15	-	-
Single Lane	-	15	100%
Intermediate lane	-	-	-
Two Lane without paved Shoulders	-	-	-
Two Lane with paved	-	-	-
Greenfield	-	-	-

3.9.2. Shoulders

The soft shoulders are generally in poor to very poor condition with approximate width of 1 m.

3.9.3. Pavement

Pavement Condition was determined through visual pavement condition survey and summary is presented in **Table 3.6**.

Table 3.6: Pavement Condition Summary

S.No.	Chainage		Length	Ex. CW	FW	Condition	ROAD
	From	To					
1	11000	11100	50		6.4	Poor	Gravel
2	11100	11200	50		6.5	Poor	Gravel
3	11200	11300	50		6.4	Poor	Gravel
4	11300	11400	50		6.2	Poor	Gravel
5	11400	11500	50		6.5	Poor	Gravel
6	11500	11600	50		6.3	Poor	Gravel
7	11600	11700	61.77		6.3	Poor	Gravel
8	11700	11800	39.33		6.3	Poor	Gravel
9	11800	11900	50		6.3	Poor	Gravel
10	11900	12000	50		6.4	Poor	Gravel
11	12000	12100	50		6.2	Poor	Gravel
12	12100	12200	50		6.5	Poor	Gravel
13	12200	12300	50		6.4	Poor	Gravel
14	12300	12400	50		6.2	Poor	Gravel
15	12400	12500	50		6.5	Poor	Gravel
16	12500	12600	50		6.2	Poor	Gravel
17	12600	12700	50		6.4	Poor	Gravel
18	12700	12800	50		6.4	Poor	Gravel
19	12800	12900	50		6.4	Poor	Gravel
20	12900	13000	50		6.3	Poor	Gravel
21	13000	13100	50		6.3	Poor	Gravel
22	13100	13200	50		6.4	Poor	Gravel
23	13200	13300	50		6.5	Poor	Gravel
24	13300	13400	50		6.5	Poor	Gravel
25	13400	13500	50		6.5	Poor	Gravel
26	13500	13600	50		6.4	Poor	Gravel
27	13600	13700	50		6.6	Poor	Gravel
28	13700	13800	50		6.4	Poor	Gravel
29	13800	13900	50		6.3	Poor	Gravel
30	13900	14000	50		6.6	Poor	Gravel
31	14000	14100	50		6.3	Poor	Gravel
32	14100	14200	50		6.3	Poor	Gravel
33	14200	14300	50		6.4	Poor	Gravel
34	14300	14400	50		6.5	Poor	Gravel
35	14400	14500	50		6.5	Poor	Gravel
36	14500	14600	50		6.3	Poor	Gravel
37	14600	14700	50		6.3	Poor	Gravel
38	14700	14800	50		6.6	Poor	Gravel
39	14800	14900	50		6.4	Poor	Gravel
40	14900	15000	50		6.2	Poor	Gravel
41	15000	15100	50		6.5	Poor	Gravel
42	15100	15200	50		6.4	Poor	Gravel
43	15200	15300	50		6.2	Poor	Gravel
44	15300	15400	50		6.4	Poor	Gravel

S.No.	Chainage		Length	Ex. CW	FW	Condition	ROAD
	From	To					
45	15400	15500	50		6.6	Poor	Gravel
46	15500	15600	50		6.4	Poor	Gravel
47	15600	15700	50		6.5	Poor	Gravel
48	15700	15800	50		6.4	Poor	Gravel
49	15800	15900	50		6.5	Poor	Gravel
50	15900	16000	50		6.4	Poor	Gravel
51	16000	16100	50		6.3	Poor	Gravel
52	16100	16200	50		6.2	Poor	Gravel
53	16200	16300	50		6.5	Poor	Gravel
54	16300	16400	50		6.2	Poor	Gravel
55	16400	16500	50		6.3	Poor	Gravel
56	16500	16600	50		6.4	Poor	Gravel
57	16600	16700	50		6.4	Poor	Gravel
58	16700	16800	50		6.6	Poor	Gravel
59	16800	16900	50		6.3	Poor	Gravel
60	16900	17000	50		6.3	Poor	Gravel
61	17000	17100	50		6.5	Poor	Gravel
62	17100	17200	50		6.2	Poor	Gravel
63	17200	17300	50		6.2	Poor	Gravel
64	17300	17400	50		6.5	Poor	Gravel
65	17400	17500	50		6.3	Poor	Gravel
66	17500	17600	50		6.6	Poor	Gravel
67	17600	17700	50		6.5	Poor	Gravel
68	17700	17800	50		6.2	Poor	Gravel
69	17800	17900	50		6.3	Poor	Gravel
70	17900	18000	50		6.5	Poor	Gravel
71	18000	18100	50		6.6	Poor	Gravel
72	18100	18200	50		6.4	Poor	Gravel
73	18200	18300	50		6.6	Poor	Gravel
74	18300	18400	50		6.4	Poor	Gravel
75	18400	18500	50		6.4	Poor	Gravel
76	18500	18600	50		6.4	Poor	Gravel
77	18600	18700	50		6.4	Poor	Gravel
78	18700	18800	50		6.6	Poor	Gravel
79	18800	18900	50		6.2	Poor	Gravel
80	18900	19000	50		6.2	Poor	Gravel
81	19000	19100	50		6.2	Poor	Gravel
82	19100	19200	50		6.5	Poor	Gravel
83	19200	19300	50		6.3	Poor	Gravel
84	19300	19400	50		6.4	Poor	Gravel
85	19400	19500	50		6.6	Poor	Gravel
86	19500	19600	50		6.4	Poor	Gravel
87	19600	19700	50		6.5	Poor	Gravel
88	19700	19800	50		6.4	Poor	Gravel
89	19800	19900	50		6.6	Poor	Gravel
90	19900	20000	50		6.4	Poor	Gravel
91	20000	20100	50		6.5	Poor	Gravel
92	20100	20200	50		6.6	Poor	Gravel
93	20200	20300	50		6.5	Poor	Gravel
94	20300	20400	50		6.4	Poor	Gravel
95	20400	20500	50		6.4	Poor	Gravel
96	20500	20600	50		6.5	Poor	Gravel

S.No.	Chainage		Length	Ex. CW	FW	Condition	ROAD
	From	To					
97	20600	20700	50		6.5	Poor	Gravel
98	20700	20800	50		6.2	Poor	Gravel
99	20800	20900	50		6.5	Poor	Gravel
100	20900	21000	50		6.4	Poor	Gravel
101	21000	21100	50		6.4	Poor	Gravel
102	21100	21200	50		6.5	Poor	Gravel
103	21200	21300	50		6.2	Poor	Gravel
104	21300	21400	50		6.5	Poor	Gravel
105	21400	21500	50		6.6	Poor	Gravel
106	21500	21600	50		6.3	Poor	Gravel
107	21600	21700	50		6.3	Poor	Gravel
108	21700	21800	50		6.5	Poor	Gravel
109	21800	21900	50	3.4	6.4	Good condition	BT
110	21900	22000	50	3.4	6.3	Good condition	BT
111	22000	22100	50	3.5	6.4	Very Poor	Earthen
112	22100	22200	50	3.2	6.4	Very Poor	Earthen
113	22200	22300	50	3.5	6.3	Very Poor	Earthen
114	22300	22400	50	3.5	6.3	Very Poor	Earthen
115	22400	22500	50	3.5	6.6	Very Poor	Earthen
116	22500	22600	50	3.6	6.3	Good condition	BT
117	22600	22700	50	3.3	6.4	Good condition	BT
118	22700	22800	50		6.3	Poor	Gravel
119	22800	22900	50		6.5	Poor	Gravel
120	22900	23000	50		6.4	Poor	Gravel
121	23000	23100	50		6.5	Very Poor	Earthen
122	23100	23200	50		6.2	Very Poor	Earthen
123	23200	23300	50		6.3	Very Poor	Earthen
124	23300	23400	50	3.5	6.3	Very Poor	Earthen
125	23400	23500	50	3.7	6.5	Good condition	BT
126	23500	23600	50	3.2	6.6	Poor	Gravel
127	23600	23700	50	3.3	6.3	Poor	Gravel
128	23700	23800	50	3.6	6.5	Poor	Gravel
129	23800	23900	50	3.4	6.5	Poor	Gravel
130	23900	24000	50	3.6	6.6	Very Poor	Earthen
131	24000	24100	50	3.2	6.2	Good condition	BT
132	24100	24200	50	3.7	6.4	Good condition	BT
133	24200	24300	50	3.7	6.6	Good condition	BT
134	24300	24400	50	3.7	6.4	Good condition	BT
135	24400	24500	50	3.6	6.4	Good condition	BT
136	24500	24600	50	3.7	6.4	Poor	Gravel
137	24600	24700	50	3.6	6.5	Good condition	BT
138	24700	24800	50	3.6	6.5	Poor	Gravel
139	24800	24900	50	3.6	6.4	Poor	Gravel
140	24900	25000	50	3.7	6.5	Poor	Gravel
141	25000	25100	50	3.5	6.4	Poor	Gravel
142	25100	25200	50	3.4	6.5	Poor	Gravel
143	25200	25300	50	3.5	6.3	Poor	Gravel
144	25300	25400	50	3.2	6.4	Good condition	BT
145	25400	25500	50	3.2	6.3	Good condition	BT
146	25500	25600	50	3.5	6.6	Good condition	BT
147	25600	25700	50	3.7	6.5	Good condition	BT
148	25700	25800	50	3.6	6.3	Good condition	BT

S.No.	Chainage		Length	Ex. CW	FW	Condition	ROAD
	From	To					
149	25800	25900	50	3.3	6.5	Good condition	BT
150	25900	26000	50	3.6	6.5	Good condition	BT
151	26000	26100	50	3.5	6.3	Good condition	BT

From road inventory survey as well as reconnaissance survey, the road surface seems to be in poor to very poor condition wherever the project road alignment meets the existing alignment as major portion of the project road passes through Builtup area. However, it can be easily identified that the existing pavement layer beneath the bituminous surface is undergoing distress. Due to absence of most important granular sub base layer and non-treatment of the existing pavement layer, the distress will appear on the bituminous surface in due course of time. After Field observation, it is recommended to go for reconstruction with GSB and new pavement layer. ***Figure 3.5*** depicts the highly distress portions along the project corridor.

Figure 3.5: Photo of Highly Distressed Road along the stretch

3.9.4. Horizontal Geometry of Project Road.

The Horizontal Geometry of the road is okay with no major black spots.

3.9.5. Drainage

Majority of the project road alignment passes through existing road while conducting the road inventory survey, it has been observed that there is no drainage facility available throughout the stretch of the proposed road alignment.

3.9.6. Submergence Locations

No Submergence locations are present along the project road stretch.

3.9.7. Nalah, Stream & Water Bodies abutting the project road

The project road alignment experiences several water bodies in the form of Fish Ponds. There is a presence of 81 number of fish ponds along the complete stretch of project alignment.

Table 3.7: Location of Ponds along the road.

POND ON LHS			
SL NO.	CHAINAGE		LENGTH (m)
	FROM	TO	
1	11500	11530	30
2	11700	11730	30
3	13390	13420	30
4	13700	13730	30
5	15300	15330	30
6	15520	15550	30
7	18000	18030	30
8	19250	19280	30
9	21800	21830	30
10	22530	22560	30
11	23800	23830	30
12	25100	25130	30

POND ON RHS			
SL NO.	CHAINAGE		LENGTH (m)
	FROM	TO	
1	11500	11530	30
2	12760	12790	30
3	12900	12930	30
4	13150	13180	30
5	16720	16750	30
6	18000	18030	30
7	18700	18850	150
8	19250	19280	30
9	21550	21700	150
10	22050	22080	30
11	22250	22280	30

POND ON RHS			
SL NO.	CHAINAGE		LENGTH (m)
	FROM	TO	
12	22530	22560	30
13	22700	22730	30
14	25100	25130	30

Sl.No.	Chainage	River Name
1	14+850	Nallah
2	21+300	Dipila River
3	24+500	Kalpana River

3.9.8. Major & Minor Intersections

The details of the junctions are presented in **Table 3.8**.

Table 3.8: Details of Junctions

JUNCTION					
S.No.	**Chainage**	**Junction Type**	**LHS/RHS**	**Road Name**	**Major/Minor**
1	11700	Y	RHS	Link Road	Minor
2	12150	X	RHS	Baghorbori Road	Minor
3	13000	X	Both Sides	Link Road	Minor
4	14250	T	RHS	Karkhowapara Road	Minor
5	14700	T	LHS	Bordoulgiri_Deomornoi rd.	Minor
6	16100	Y	RHS	Bakultal Chowk	Minor
7	17700	T	LHS	Link Road	Minor
8	18500	X	Both Sides	Sipajhar-BoriChowka-Tangla Road	Major
9	20200	X	Both Sides	Link Road	Minor
10	20800	X	Both Sides	Link Road	Minor
11	22700	T	RHS	Sarbari	Minor
12	23200	Y	LHS	Thakurpara Rd.	Minor
13	23500	T	RHS	Vishnumandir Path	Minor
14	25500	X	Both Sides	Namkhola	Minor
15	26000	Y	LHS	Namkhola(SH-11)	Major

3.9.9. Height of Existing Road Surface from Adjoining Ground Level

A major portion of the project road passes through existing road and the height of road surface where the project road passes through existing road is mentioned in **Table 3.9**.

Table 3.9: Embankment details

Embankment Height (m)	Length (Km)	
	Left	Right
< 0.5	7.5	12
0.5 – 1	12.5	11.7
1 – 2	9.7	6

Source: Road Inventory Survey

3.9.10. Existing Right of Way (RoW)

Based on the information collected from Land Circle Office/ PWD, it was observed that available ROW of the project road varies from 10m to 15m (max) and the same has been considered for evolving the design.

3.9.11. Existing Earth Retaining Structures (Retaining Wall & Breast Wall)

There is no existing retaining wall & breast wall along the project road from Mangaldoi to Mazikuchi.

3.9.12. Existing Bridges & Culverts

There are 1 major and 2 minor existing bridges along the project road. The total no. of culverts along the project road is 19. The list of the existing bridges and culverts along the project road stretch are mentioned in **Table 3.10** and **Table 3.11.**

Table 3.10: List of Culverts

Sl.No.	Chainage	Ext. Type	Ext. Size
1	11380		2X1
2	11890		1000mm dia
3	12150		900mm dia
4	12230		3X1
5	12650		600mm dia
6	12970	SHP	600mm dia
7	13750	2X2	900mm dia
8	14000	BUILT-UP AREA DEOMORONOI	600mm dia
9	14850	EXT SLAB 8 MTR	600mm dia
10	15000		600mm dia
11	15420		1000mm dia
12	15430		600mm dia
13	15750		600mm dia
14	16300	EXISTING DHP	600mm dia
15	16570	SHP	600mm dia
16	17070	SLAB 7.5	600mm dia

Sl.No.	Chainage	Ext. Type	Ext. Size
17	17600	DHP	600mm dia
18	17780	SHP	900Mm dia
19	18030	EXT 4HP	600mm dia
20	18990	EXT. SLAB	4X2
21	19600	EXT 4HP	3x3
22	19850	SLAB	600mm dia
23	20370	SHP	
24	22100	SLAB 1.5	1.5X1.5
25	22350	DHP	2X2
26	22500	4HP	1000mm
27	23050	DHP	1000mm
28	23220	SLAB	
29	23550	SHP	1000mm
30	23950	SLAB 1.5	1000mm
31	24350	DHP	6m
32	24950		8m
33	25500	SLAB 1.5	
34	25600		1000mm

Table 3.11: List of Bridges

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type
1	14+850	RCC Bridge	7	MNB
2	21+300	RCC Bridge	150 m	MJB
3	24+500	RCC Bridge	40 m	MNB

3.9.13. Industrial Area Abutting Project Area

There is no designated industrial area along the project road from Mangaldoi to Mazikuchi.

3.9.14. Utilities

Utilities such as electrical poles and transformers are located along the project road. Low Tension also cross the project road in many locations. Trees are also seen on both sides along the project stretch.

4 TRAFFIC STUDIES AND DEMAND FORECASTS

4.1 Introduction

The Government of Assam, Public Works Roads Department (PWRD), Guwahati, Assam (the "Authority") is engaged in the improvement and development of MDRs/ODRs roads project under NESIDS Program and as part of this endeavor, the Authority has decided to undertake preparation of Detailed Project Report (DPR) for widening to Two to various Roads in the State of Assam (for an approximate length 29.710 Kms) under EPC mode.

As a part of this Authority has decided to appoint Consultancy services for Feasibility Study cum DPR, for improvement and upgradation of Road from Mangaldoi to Mazikuchi under NESIDS for the year 2024-25 under EPC Mode basis and has decided to carry out the bidding process for selection of a private entity as the bidder to whom the Project may be awarded. After evaluation of Technical and Financial proposal, Public Works Roads Department of Assam has appointed Zenith Associates, as consultant to prepare the Detailed Project Report for the above road stretches.

As per the traffic conditions the future requirement to two / four lane with paved shoulder has been proposed. As per the work order and scope of the work, the required traffic surveys (As per IRC: 09-1972 and IRC: 102-1988) carried out and their analysis are discussed in this Chapter.

4.2 Scope of Services

The detailed scope of services for traffic surveys is as follows:

- To carry out 3 days' x 24 hrs. Classified Traffic Volume Count (TVC) Survey at locations informed to Client.
- To analyze the data collected through possible leakage points and study of travel pattern to determine through traffic for important segments of the route.
- Determination of possible leakage points and alternative diversion routes by detailed network study.
- Calculation of MSA values based on Traffic volume for use in the pavement design.
- Parking Surveys in Urban Areas
- Surveys for Bus Shelters and Truck Lay Bye

The details of the data collection, primary as well as secondary, results from its analysis are presented in the following sections

4.3 Traffic Surveys and Analysis

Traffic surveys such as mid-block Classified Traffic Volume Counts (TVC) by manual systems, The locations for the surveys were finalized based on the reconnaissance survey. All surveys have been carried out as per IRC: SP: 19-2001, guidelines.

4.3.1. Traffic Survey Locations and Schedule

Traffic survey schedule is presented in **Table 4-1** and the map of survey locations.

Table 4.1: Traffic Survey Schedule for Project Road

Type of Survey	Location	Duration
Classified Traffic Volume Count (TVC) Surveys	Mahaliapara (Ch. 18+500)	3 Days x 24 Hrs.

4.3.2. Survey Methodology

4.3.2.1. Classified Traffic Volume Count (TVC) Survey

The main objectives of Classified Traffic Volume Counts were to assess the traffic characteristics in terms of average daily traffic, hourly traffic variation, peak hour traffic, traffic composition and directional distribution.

To carryout traffic counts, the vehicles were grouped under the various categories (as per IRC: SP 19-2001 and IRC: 09-1972). Vehicle classification system adopted is given in **Table 4.2**

Table 4.2: Vehicle Classification System

Vehicle Classification System		
Class	**Code**	**Vehicl**
01	2W	Two-
02	3W	Auto Rickshaw
03	LM	Car/Jeep/Tax
04	LC	Minibuse
05	SB	Standard Buses
06	LC	Tempo/Traveler
07	LC	LCV's
08	2A	2-Axle
09	3A	3-Axle
10	MA	Multi-Axle Trucks
11	TRCT+TRL	Tractors with Trailer
12	TRC	Tractors without Trailer
13	CYCL	Cycl
14	CYCRSHW	Cycle Rickshaw
15	A	Animal
16	OV	Other Vehicles

Source: As per IRC: SP 19-2001 and IRC: 09-1972

Traffic volume count was carried out by Classified Traffic Volume Counting (TVC) manual system under the supervision of a Transport Planner. The traffic count data was recorded at 15-minute intervals for each vehicle group. The Performa used for carrying out the traffic count survey.

4.3.3. Passenger Car Units (PCUs) / Passenger Car Equivalent (PCE) Factors

The various vehicle types having different sizes and characteristics were converted into equivalent passenger car units. The passenger car equivalents (PCE) factors for each category of vehicles, recommended by Indian Road Congress in "Guidelines for

Capacity of Roads in Rural Areas" (IRC-64-1990) and IRC-108:2015 were used for this purpose and are presented in **Table 4.3**.

Table 4.3: Recommended PCU Factors for Various Types of Vehicles on Rural Roads

S. No.	Vehicle	Equivalency
1.	Motorcycle or Scooter	0.50
2.	Passenger Car, Pick-up Van, or Auto-rickshaw	1.00
3.	Agricultural Tractor, Light Commercial Vehicles	1.50
4.	Truck or Bus	3.00
5.	Truck-trailer, Agriculture Tractor-trailer	4.50
6.	Cycle	0.50
7.	Cycle-rickshaw	2.00
8.	Hand Cart	3.00
9.	Horse-drawn Vehicle	4.00
10.	Bullock Cart	8.00

Source: Guidelines for Capacity of Roads in Rural Areas (IRC: 64-1990 & IRC-108:2015)

4.3.4. Classified Traffic Volume Count (TVC) Survey

Traffic volume data collected from the location was computerized and analyzed to study average daily traffic, hourly and daily variation of traffic, peak hour share/percentage, traffic composition and directional flows.

4.3.5. Average Daily Traffic (ADT)

Based on reconnaissance survey, classified volume count survey was carried out along the project road and the alternative project influence roads. The traffic volumes counted in 15- minute intervals have been aggregated to one-hour volumes. The hourly volumes have been aggregated into daily volumes for the entire survey period. To express the classified vehicular count in terms of PCUs, the PCU factors as given in IRC-108: 2015 have been considered. Based on the survey at the proposed road, the indicative Average Daily Traffic and is arrived and presented in **Table 4-4.**

Table 4.4: Average Daily Traffic (ADT)

Traffic Survey at 18+500 Mahabolipora										
	Fast Vehicles							Slow Vehicles		
Date	Cars/Jeeps /Autoricks haws	Motorcy cles/sco oters	LCV Mini Truc k	Bus	2 Axle Truc k	Multi Axle Truc k	Agric ultur al Tract or	Cycles/ Ricksh aws	Anim al Drive n Vehic les	Other Vehic les
	Up and Down	Up and Down	Up and Dow n	Up and Dow n	Up and Dow n	Up and Dow n	Up and Dow n	Up and Down	Up and Dow n	Up and Dow n
12-05-2024	1532	2722	205	17	34	7	20	77	5	1
13-05-	1897	3001	202	11	42	9	26	67	7	1

Traffic Survey at 18+500 Mahabolipora										
	Fast Vehicles							Slow Vehicles		
Date	Cars/Jeeps /Autoricks haws	Motorcycles/scooters	LCV Mini Truck	Bus	2 Axle Truck	Multi Axle Truck	Agricultural Tractor	Cycles/ Rickshaws	Animal Driven Vehicles	Other Vehicles
	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down	Up and Down
2024										
14-05-2024	1653	2720	267	16	41	5	32	105	10	0
ADT	1694	2814	225	15	47	7	26	83	7	1
Equivalency Factors	1	0.5	1.5	3	3	4.5	4.5	0.5	8	1
PCU	1694	1407	337.5	45	141	31.5	117	41.5	56	1
Total PCU/ day	**3872**									

The above indicative ADT traffic is used to working out the AADT for estimating the Base Year

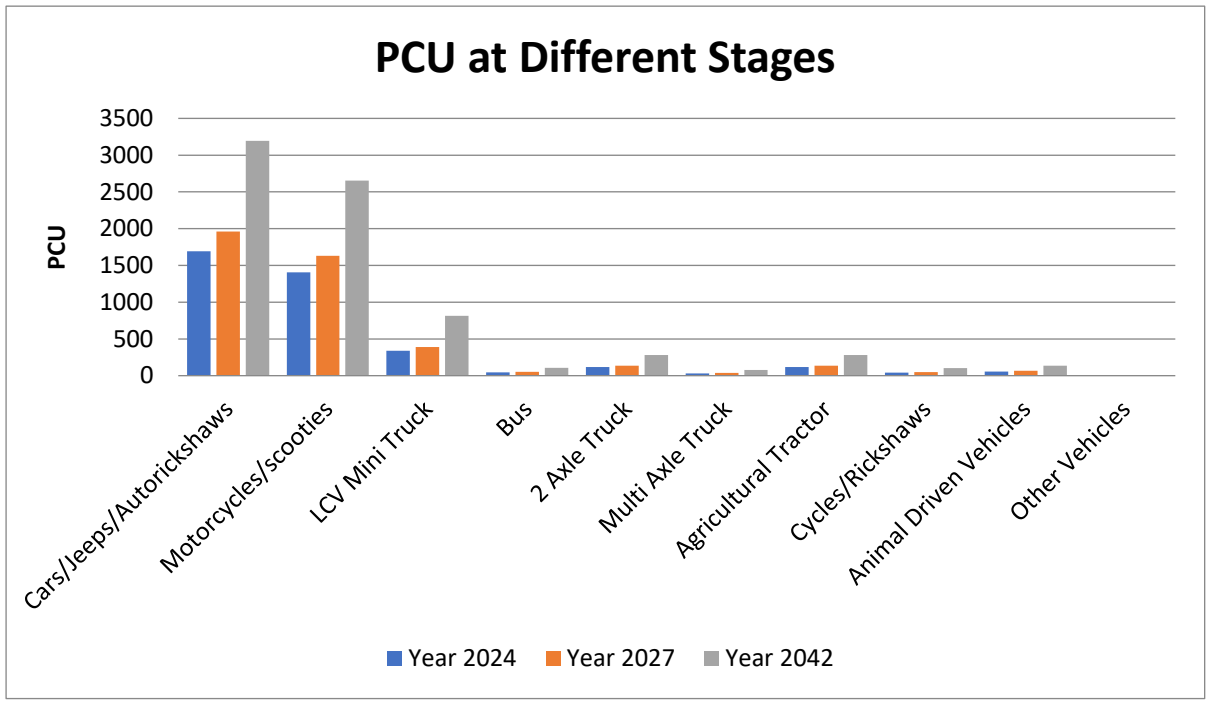
Traffic for existing project road Mangaldoi to Mazikuchi corridor.

Mode-wise daily and Average Daily Traffic (ADT).

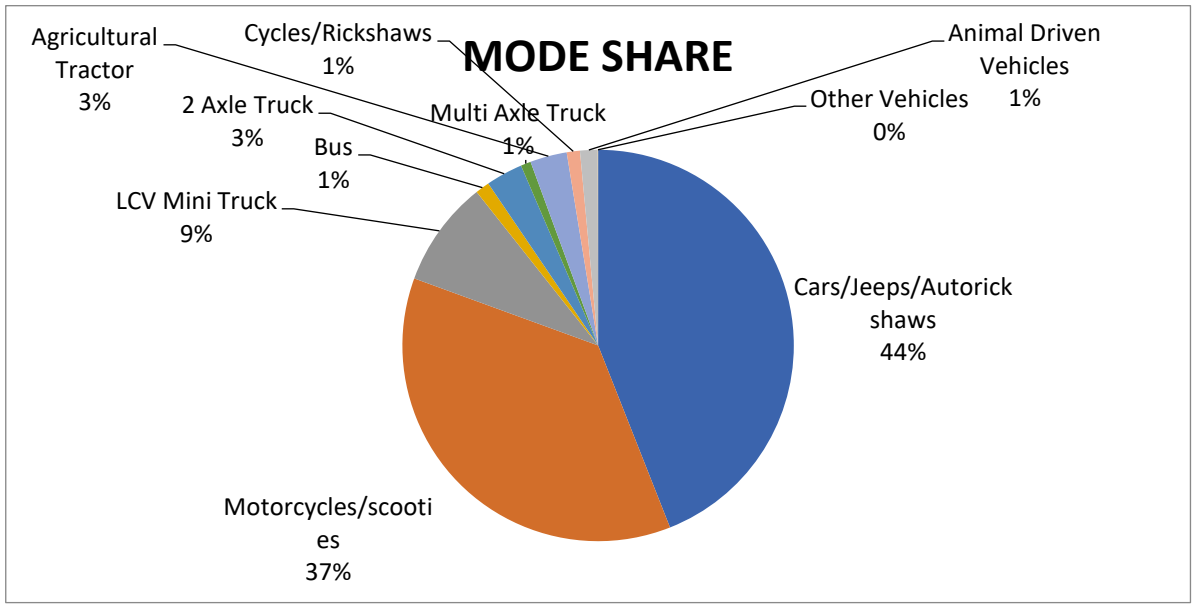
Observations:

- The above Average Daily Traffic (ADT) is derived from actual traffic surveys on the project road.
- The share of Two-Wheeler traffic (44.01%) is observed higher than other vehicles.
- The share of Passenger traffic i.e., Buses, and passenger Auto traffic observed about 13.82%.
- The share of Car, jeep, van is observed to be 39%.

4.3.5.1. PCU/day Vs Vehicle type



4.3.5.1. ADT Composition Pattern



4.4 Projected Traffic

Traffic projections were carried out for study period 15 years (2027 to 2042) by applying the estimated vehicle-wise traffic growth rates to the base year (2024) traffic.

The projected traffic volume obtained in terms of AADT, and its composition is shown in **Table 4.6** for Normal Growth Scenario.

Table 4.6: Projected Traffic at Mangaldoi to Mazikuchi Road

Analysis of PCU for the next 15 years after completion of Road

Year of traffic count	Vehicle Type	PCU/ day	ADT	Growth rate (r)	Tentative year of Completion	Initial Design PCU near completion of construction	Initial Design Traffic near completion of construction	Multiplication Factor after opening of road	Traffic after opening of road	Growth rate (r)	PCU after 15 years
2024	Cars/Jeeps/Autorickshaws	1694	1694	5.0%	2027	1961	1961	1	1961	5.0%	3194
2024	Motorcycles/scooties	1407	2814	5.0%	2027	1629	3258	1	1629	5.0%	2653
2024	LCV Mini Truck	338	225	5.0%	2027	391	260	1	391	5.0%	813
2024	Bus	45	15	5.0%	2027	52	17	1	52	5.0%	108
2024	2 Axle Truck	117	39	5.0%	2027	135	45	1	135	5.0%	281
2024	Multi Axle Truck	32	7	5.0%	2027	37	8	1	37	5.0%	77
2024	Agricultural Tractor	117	26	5.0%	2027	135	30	1	135	5.0%	281
2024	Cycles/Rickshaws	42	83	5.0%	2027	49	96	1	49	5.0%	102
2024	Animal Driven Vehicles	56	7	5.0%	2027	65	8	1	65	5.0%	135
2024	Other Vehicles	1	1	5.0%	2027	1	1	1	1	5.0%	2
		3849				**4455**	**5684**				**7646**

4.5 Million Standard Axles (MSA)

MSA is worked out based on initial traffic in terms of CVPD, traffic growth rates during the design life, design life in number of years, vehicle damage factor (VDF) and distribution of commercial traffic over the carriage way for proposed project road. The summary of MSA results is given below in **Table 4.7**

. **Table 4.7: MSA at Mangaldoi to Mazikuchi Road**

CALCULATION OF DESIGN TRAFFIC (at 18+500) Mohabalipura							
Year of traffic count	**VEHICLE TYPE**	**CVPD (On the day of Traffic Oening) - P**	**Growth rate (r)**	**VDF**	**Lateral Distribution factor**	**Design period**	**Design Traffic**
2024	LCV	260	5.0%	2.00	0.75	15 Years	3.07
2024	Bus	17	5.0%	3.90	0.75	15 Years	0.39
2024	Truck 2 - Axle	45	5.0%	3.90	0.75	15 Years	1.04
2024	Multi-Axle Truck	8	5.0%	3.90	0.75	15 Years	0.18
2024	Agricultural Tractors	30	5.0%	3.90	0.75	15 Years	0.69
Total CVPD		**360**			**Design MSA**		**5.38**

Based on the above analysis the recommended **Million Standard Axles (MSA) value is 5.**

4.6 Conclusions and Recommendations

The estimated traffic movement on the project road corridor is observed at medium level. This project road. The capacity of project road for Single laning is getting saturated by 2025 with LOS-D with its current traffic estimates. Hence, it is recommended that project shall be taken up for Intermediate widening to 5.5m CW width and upgrading to ensure safe and smooth movement of traffic at higher speed. It will also help to reduce the congestion and accidents level on the project road. It will be also beneficial to the uses for reducing journey travel time and operating cost of the vehicles. It will also help to protect the interest of pedestrian movement and animal crossing by providing the appropriate safeguard measures along the project corridor.

5 ENGINEERING SURVEY & INVESTIGATIONS

5.1 Introduction

This chapter deals with the survey and analysis of road inventory, visual condition survey, structural evaluation survey, roughness survey, sub grade investigations, material surveys conducted following the relevant Specifications/Codes to generate adequate database for preparing the most appropriate proposal for the rehabilitation / upgrading of the existing road.

Various engineering surveys and investigations for the project road which have been carried out for the project are listed below:

- Road Inventory Surveys
- Pavement Condition Survey
- Sub grade Investigations
- Topographic Survey
- Roughness Survey
- Soil Investigations

5.2 Objectives

Preparation of highway projects involves a chain of activities, like field surveys & investigations, selection of alignment, carrying out various designs, preparation of drawings and estimates, etc. The objective of engineering surveys and investigations carried out on a particular project road is to provide a comprehensive set of data which is further analysed to obtain a conclusion on various aspects such as selection of the most cost-effective design, estimation of quantities, determination of pavement condition, topography of the road, etc.

To be compatible with technical requirements it is essential to carry out various engineering surveys, investigations and their Analysis. This could be achieved by carrying out the project preparation work either departmentally or with the help of consultants. In all the case, it must be ensured that experts having the required knowledge are deployed on the work. Use of modern instruments and survey techniques ensure high degree of accuracy and speeds up the work process.

5.3 Road & Structure Inventory

The road and bridge inventory have been carried out on the Project Road section for obtaining information regarding the location of the roads and bridges and its basic inventory such as Road Name, Surface Type, Road Width, Bridge Type and bridge width. Information obtained from inventory survey signifies the data that are most ly static in nature and describe the physical element of the road system and road assets.

5.3.1. Road Inventory Survey

A detailed inventory of roads was carried out from 10th November 2024 to 14th November, 2024 and inventory of structures were carried out on 10th November 2023 to 13th November 2024 for preparation of repair and rehabilitation proposals. The

data/details of road inventory were collected, by actual verification & measurements. The following data were collected in the inventory survey.

Table 5.1: Road Inventory Data

S. No.	Particular	Key
A)	**General Road Data**	
1	Terrain code	Plain, Rolling, Mountainous, Steep
2	Land Use	AG, C, BR, BU, IN, SBU, FR
3	Earthworks type	Cut, Fill, Ground level
4	Earthworks height	m
5	Width of Right of way	m
6	Surfacing type	Bitumen, Gravel, Concrete, Earthen, Paver
7	Carriage way width	m
8	Shoulders	Left side: type, width; Right side: type, width (Paved/ Earthen)
9	Road Junctions	Type, Details
10	Drainage type	Left side: type, width; Right side: type, width (Lined/Unlined)
11	Drainage Condition	Existing Type of drain
12	Footpath Width	m
13	Median	Type and Width
B)	**Pavement Condition Survey**	
1	Pavement condition for every 100m	Cracking (Longitudinal, Transverse, Alligator, Block), Rutting, Pot Holes, Bleeding,
C)	**Retaining structures and their condition**	
1	Road side arboriculture	Yes / No
2	Utilities	Shifting required, if any
3	Critical structures	Nos.
4	Trees	Nos.

The codes used in the inventory are as follows:

Table 5.2: List of Road Inventory Codes

Terrain	**Land use**
P = Plain R = Rolling M = Mountainous S = Steep	AG = Agriculture C = Commercial BR = Barren Land BU = Built up Area IN = Industrial SBU = Semi built up FR = Forest
Signs	**Pavement/Carriageway**

Terrain	**Land use**
I = Informatory R = Regulatory	B = Bituminous C = Cement Concrete
Terrain	Land use
W = Warning	W = Water Bound Macadam
Median	Road Junction
1= Stone 2 = Steel 3 = Open 4 = Tapered	M = Multi leg junction T = T Junction R = Rotary Y = Y junction + - = 4 leg junction
Drain Type	Drain Condition
E = Earth L = Lined P = Pipe	G = Good F = Fair P = Poor VP = Very Poor
Severity of Pavement Condition	Shoulder Condition
L – Low Severity M – Medium Severity H – High Severity	G = Good F = Fair P = Poor VP = Very Poor

5.3.2. Inventory & Condition Survey for Structures

- **Condition survey of bridges & culverts**
  A project team carried out the visual condition survey of existing bridges and culverts as per guidelines stipulated in IRC-SP: 35-1990. The project team inspected all the existing culverts, bridges and other structures on the project road and recorded data using proforma prepared for carrying out the detailed condition survey. The deficiencies in the existing structures were noted to ascertain the measures required for strengthening of the structure.
- **Inventory survey of bridges & culverts**
  Bridge inventory surveys were carried out as per IRC SP: 19-2001. As per survey, it was found that there are 6 numbers of minor bridges present along the entire project road which are in good condition. The thickness of slab, span arrangement and total ventway, width of culvert, etc. was recorded in the prescribed format for culverts and other structures. List of bridges along with their configuration and inventory data for culverts and bridges.

5.4 Pavement condition surveys

5.4.1. General

Pavement Investigation is an important aspect of any road improvement project, since the performance of road directly depends on the performance of its pavement and the cost of improvement of pavement is equally important to arrive at the cost of project. The data collected in the survey is an important factor in economic analysis as it has influence upon vehicle operating cost and is utilized to identify the stretches of reconstruction and rehabilitation. Detailed Pavement Condition Survey was carried out along the entire project road from 12th November 2024 to 15th November, 2024.

5.4.2. Survey Procedure

We carried out visual pavement condition survey/Road Inventory Survey on the project road to examine the functional efficiency of the existing pavement. Condition survey data have been collected at every 50 m interval with the help of straight edge and measurement scale for main carriageway and paved shoulder.

Based on the above site condition, the pavement condition analysis is carried out separately for main carriageway and earthen shoulder.

5.4.3. Major Distresses observed

Majority of the project road passes through Greenfield areas and wherever the project road meets the existing alignment, it passes through either paver block roads or mud road. The existing paver block road is going through several failures which are observed during the survey of the project road. The following are the types of failures observed.

- Uneven pavers
- Border pavers falling off
- Water puddling on Pavers
- Individual pavers separating

5.4.4. Pavement Condition Rating

5.4.4.1. Data Analysis

The key component of an effective pavement management system is an accurate assessment of the condition of the existing pavement network. The surface cracking of a pavement is represented by a Surface Rating and Dominant Distress for each section of the pavement network. Pavement condition Rating (PCR) is an indicator that rates the surface condition of the pavement. It is built based on visual inspection of road section. The survey for the project road was conducted on foot in order to map the type and extent of distresses in detail. The root causes of these distresses must be addressed in any comprehensive rehabilitation strategy PCR is used to quantify the road condition. A properly executed visual evaluation is one of the most reliable and efficient forms of pavement evaluation available. It is simple, inexpensive, and provides a great deal of valuable information about pavement condition. This method provides a comprehensive record of pavement distresses at the time of the evaluation and are highly repeatable. A visual inspection of the pavement surface can provide valuable information. Visual inspection data is used to evaluate current pavement condition, predict future pavement performance, determine and prioritize pavement maintenance and rehabilitation needs, estimate repair quantities, and evaluate the performance of different maintenance and rehabilitation techniques and materials. All the distress along the project roads were noted and mentioned in the Road Inventory Survey.

5.4.4.2. **Pavement Condition**

Pavement Condition of the project road was determined through visual pavement condition survey.

From road inventory survey as well as reconnaissance survey, the road surface seems to be in very poor condition at few locations of the road. After Field observation, it is recommended to go for reconstruction with GSB and new pavement layer

5.4.4.3. **Photographs of Distresses**

The following pictures gives us insight on the prevalent pavement condition.

5.4.4.3.1. **Longitudinal Cracking**

Longitudinal cracks are those which occur parallel to the centreline. The longitudinal cracking is measured in terms of crack width (for severity identification) and length of crack.

Figure 5.1: Longitudinal Cracking along Project Road

5.4.4.3.2. **Alligator Cracking**

It is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. Cracking begins at the bottom of the asphalt surface (or stabilized base) where tensile stress and strain are highest under a wheel load.

Figure 5.2: Alligator Cracking along Project Road

5.4.4.3.3. **Raveling**

Raveling is due to wearing away of the pavement surface caused by the loss of asphalt binder and dislodged aggregate particles

Figure 5.3: **Raveling along Project Road**

5.4.4.3.4. **Potholes**

Potholes are small (usually less than 3 feet in diameter), bowl-shaped depressions in the pavement surface. They generally have sharp edges and vertical sides near the top of the hole.

The densities of potholes vary from Low to High Severity but high severity cracks are lesser

Figure 5.4: Potholes along Project Road

5.4.4.3.5. **Edge Failure**

Edge cracks are parallel to and usually within 1 to 2 feet of the outer edge of the pavement. This distress accelerated by traffic loading and can be caused by frost-weekend base or sub grade near the edge of the pavement.

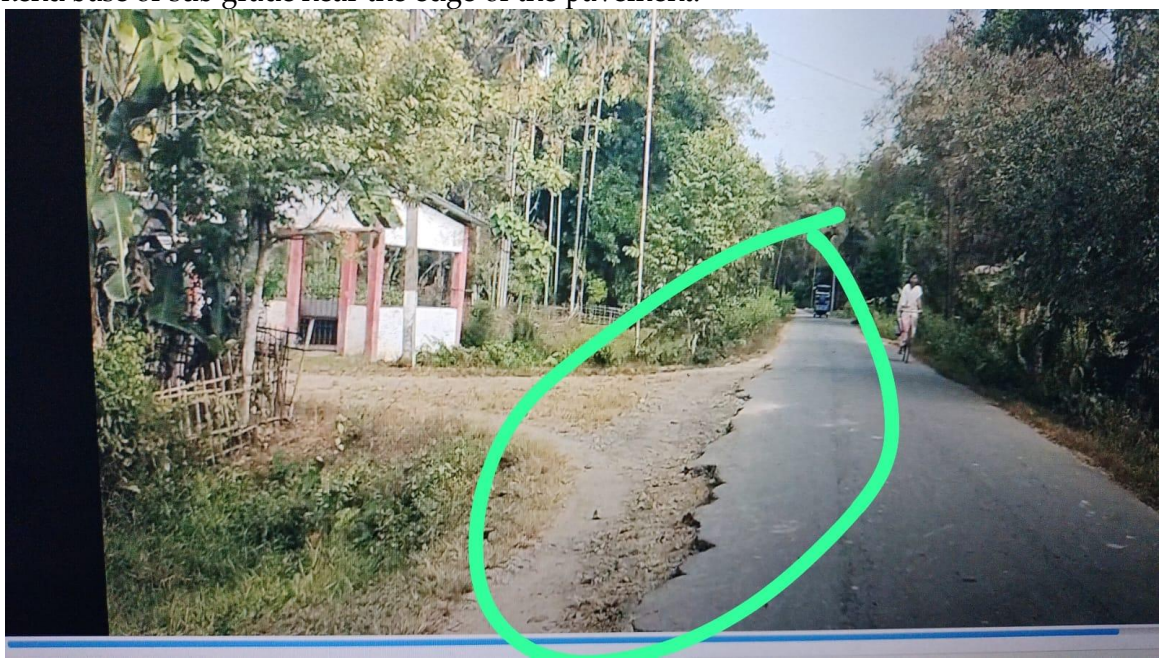


Figure 5.5: Edge Failure along Project Road

5.4.5. **Highly Distressed Sections along the Project Road**

The following figure shows the highly distress road along the project corridor respectively

Figure 5.6: Photo of Highly Distressed Road along the stretch

5.5 Topographic survey

Topographical survey is the backbone of any highway design. Accuracy of the information collected during this survey has a direct bearing on all the design activities involved in project preparation. The first activity at the start of the topographical survey is the collection of Survey of India topographical maps. The main objective of the topographic survey is to capture the essential ground features at the study areas for working out improvements. Before starting topographic survey all the survey instruments were checked for errors and approved by the site engineer.

The surveyor was maintaining a field book, in which all relevant observations would be noted along with field sketches. The methodology followed for the topographic surveys are as following:

- Identification of suitable location for DGNSS Control Points at an approximate interval of 5.00 km.

- Establishing survey networks by conducting horizontal and vertical traverse connecting all DGNSS Control Pillars. Ensuring survey networks are connected with an accuracy of 1:20,000 for horizontal and 12√K for vertical control.
- Conducting detailed topographic survey including longitudinal section at every 25m intervals and cross section at 50m intervals for a width of 30m on either side of the center line of the existing road.
- Collection of details of all physical features for a width of 30m or up to first row of buildings.

5.5.1. Detailed Topographic Survey

Topographic survey was commenced only after establishing the survey network and coordinates systems. Detailed survey was carried out generally up to a distance of 30 m on either side from the center of the existing road or building lines on either side of the center line of the existing road.

Landside features given below, but not limited to, were captured and presented in drawings.

- Electrical poles and lines, telephone pole and lines, high tension lines and towers, mast, transformers, water pipe lines above ground, manholes, and all OFC lines are shown in drawing.
- Locations where transmission lines cross the road are identified recorded and presented in the drawing. Elevation of transmission lines crossing the road was established.
- Tree position and girth of trees are measured.
- Building lines, type of buildings (kutcha / semi pucca / pucca / shops / houses etc.), wherever possible are captured.
- Existing road pavement edges, shoulders, median, center line of carriageway, footpaths, side drains, km / hectometre stones installed in earthen shoulder.
- Location of traffic islands, median, channelizing islands, traffic signals, traffic signs and police chokes with its locations.
- Places such as temples, temple mast, mosque, church, etc.; its location, boundary lines/compound walls, and entrances.
- Locations and width of drain clearly identifying the type (open / closed / kutcha/pucca, with footpath), including the beginning and end of drain.
- Residential, commercial, shops and business established areas.
- All existing structures along the Project Corridor – including location, width of flyover / bridge / culvert (width of slab or diameter of pipe), position of piers / abutments, bed level, culvert, type of culvert, head wall, parapet etc. if available.
- High tension towers, transformers, lamp posts.
- Details of roads crossing the Project Corridor. All minor and major intersections were surveyed for a distance of 100m from the edge of existing road.
- For existing Road, the following details were collected
    - At center line of existing carriageways
    - Edges of carriageways

- Median edges – top and bottom
- Paved shoulder/ Earthen shoulder/Footpath edges
- Top and toe of embankment

- For Culverts
  - Type of culvert, size of vent, span, soffit level of culvert

5.5.2. Generation of Topographic Drawing

While preparing the drawings, it was ensured that all lines are in 3D. All the topography features, reference pillars indicating complete details such as DGNSS control points, secondary control pillars and co-ordinates etc., were mentioned in the drawing. All key features captured in the survey were described with specified text height and style in the drawing.

The project road has been proposed for Widening and Strengthening to two lanes with paved shoulder. Hence, the project road has been investigated subjectively as well as objectively, for their structural and functional performance. The various surveys/ investigations of the pavement are discussed below:

- Roughness Survey
- Test pit Investigations

5.6 Test Pit Investigations

5.7.1. General

Investigations have been carried out to assess the adequacy of existing pavement layers including subgrade soil properties to establish the strengthening / reconstruction requirements of the project road. Test pits were excavated at the pavement-shoulder interface, extending through the pavement layers and down to the level of the subgrade. Pits were dug at the pavement-shoulder interface at every 1000 m interval in staggered on both the sides extending through the Subgrade layer. The objective of the investigations is to understand the composition and characteristics of the existing pavement subgrade and the scope of work includes:

- Study of Pavement Composition.
- Study for existing Base Course & Sub Base Course.
- In-Situ Density at Sub grade.
- Dynamic Cone Penetrometer Test at Sub grade Level.
- Collection of Sub grade Samples for Laboratory Test.

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5.7.2. Details of the Test carried out

The details of all the tests carried out on subgrade for their Physical, Strength and Stability
Characteristics are given in **Table 5.5.**

Table 5.5: Different Tests carried out on Subgrade Soil

S. No.	Test Parameters	Method
1	Dynamic Cone Penetration	ASTM-D6951-03
2	Field Density	IS:2720 (Part 28)

3	Water Content	IS:2720 (Part 2)
4	Grain Size Analysis	IS:2720 (Part 4)
5	Atterberg Limits	IS:2720 (Part 5)
6	MDD-OMC(Compaction)	IS:2720 (Part 8)
7	CBR	IS:2720 (Part 16)
8	Free Swell Index	IS:2720 (Part 40)

The objective of the investigations is to understand the composition and characteristics of the existing soil:

- In-Situ Density of soil
- Characterization (Grain Size Distribution and Atterberg limit)
- Laboratory CBR
- Moisture-Density Characteristics

The results of the various lab tests conducted on the samples collected from trail pits (from existing subgrade pit) is shown in ***Table 5-9.***

Sl no.	Location / Chainage(KM)	Sample No.	Sieve Analysis						ATTERBERG LIMIT			LS Classification	Differential Fine Swell Index %	Laboratory Compaction Heavy		Soaked CBR at 3 energy levels						Soaked CBR at 97% of MDD
																Test 1		Test 2		Test 3		
			20 mm	10 mm	4.75 mm	2.00 mm	425 µ	75 µ	LL (%)	PL (%)	PI (%)			MDD (gm/cc)	OMC (%)	DD (gm/cc)	Soaked CBR (5)	DD (gm/cc)	Soaked CBR (5)	DD (gm/cc)	Soaked CBR (5)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	11.250	B-1	100	100	100	100	99	91	32	21	11	CL	10	2.019	11.12	1.814	7.3	1.763	7.27	1.945	7.1	7.3
	12.500	B-2	100	94	76	55	31	3	37	23	14	SC	2.13	1.713	12.45	1.794	6.98	1.818	6.63	1.942	6.9	6.98
3	15.000	B-3	100	94	85	67	48	12	46	26	20	ML	0	1.717	11.47	1.849	6.68	2.019	6.98	1.814	7.019	6.68
4	16.700	B-4	100	97	92	84	70	55	43	23	21	SC	13.04	2.019	11.12	1.814	6.5	1.946	5.26	1.983	6.17	6.5
5	18.200	B-5	100	97	90	87	84	55	41	26	15	MI	4.35	1.724	11.58	1.674	6.98	1.812	6.63	1.999	6.14	6.98
6	20.000	B-6	100	97	93	83	72	41	42	28	14	MI	5.5	1.845	12.72	1.627	7.57	1.813	7.49	1.953	7.00	7.57
7	21.000	B-7	100	95	81	68	63	60	45	27	18	SC	4.35	1.918	5.34	1.68	7.27	1.934	7.22	1.986	7.83	7.27
8	22.000	B-8	100	95	89	76	71	61	28	19	9	CL	2.33	1.779	13.02	1.69	6.98	1.923	6.12	1.964	6.86	6.98
9	23.200	B-9	100	95	86	76	64	51	35	28	7	SC	0	1.809	13.75	1.763	7.27	1.945	7.99	1.957	7.70	7.27
10	21.800	B-10	100	97	79	65	45	12	34	29	5	SC	0	1.806	14.51	1.559	7.7	1.844	7.20	1.982	7.78	7.7
11	22.500	B-11	100	97	90	80	68	52	34	27	7	SC	0	1.809	13.62	1.444	7.57	1.651	7.52	1.924	7.98	7.57
12	24.500	B-12	100	95	88	79	68	54	36	29	8	SC	0	1.871	15.3	1.625	6.53	1.86	6.48	1.925	6.29	6.53
13	25.500	B-13	100	97	90	87	84	55	41	26	15	MI	4.35	1.797	13.02	1.674	6.1	1.812	5.89	1.999	6.14	6.1

TABLE 5.9: CBR REPORT AT SITE

The CBR Reports are attached as Axxexure 1 at the back of the report.

6 DESIGN STANDARDS & SPECIFICATIONS

6.1 General

This section describes the design standards and principles based on which the various designs will be carried out. These proposed standards are consistent with the parameters recommended in the relevant standards of the Indian Roads Congress (IRC). The aim of this chapter is to evolve Design Standards and Material Specifications for the study primarily based on IRC publications and MORT&H circulars and relevant recommendations from the international standards and to recommend the same for concurrence/approval of PWRD, Assam.

6.2 Terrain Classification

The following terrain classification recommended by IRC: SP: 73-2018 is proposed to be adopted:

Table 6.1: Terrain classification

Terrain Classification	Percentage Slope of the Country
Plain and Rolling	Upto 25 Percent
Mountainous and Steep	More than 25 Percent

The proposed alignment follows predominantly Plain terrain as per above classification and thus geometric designs is prepared based on IRC: SP: 73-2018 for plain terrain.

6.3 Guiding Principles

While doing the geometric design, the following are taken into consideration:

- The designed facility shall not become obsolescent before the design year.
- Design shall be consistent and the standards followed for different elements shall be compatible with one another.
- The design will be done aiming at minimizing the vehicle operating cost including initial cost, cost of maintenance etc.
- The design will take into consideration the environmental, aesthetic and landscaping aspects of the project road.

6.4 Sight Distance

The sight distance is an important component of project highway which deals with the visibility of the project corridor. It is necessary that sight distance of adequate length is available if different situation, to permit drivers enough time and distance to control their vehicles so that chances of accident are minimized. As the project stretch consist of two lanes, at least twice the safe stopping sight distance shall be available throughout. The recommended sight distance for various speed is elaborated as below:

Table 6.3: Sight Distance for Various Speeds

Design Speed	Minimum Sight Distance (m)	Overtaking Sight Distance (m)
100	360	640
80	240	470
60	180	340
40	90	165

6.6.1. Super-elevation

The guidelines issued by PWRD Assam namely "Guidelines for Preparation of Detailed Project Report under NESIDS" are followed for Superelevation design. The same are elaborated as below,

- Maximum Superelevation shall be limited to 7% for the curve less than 400m radius (for plain and rolling terrain)
- Maximum Superelevation shall be limited to 5% if the radius of curve is more or equal to 400m (for plain and rolling terrain)
- For hilly and mountainous terrain, the maximum Superelevation shall be limited to 7%.
- Maximum Superelevation Shall be limited to 5% if the project corridor passes through an urban section or falls on major junction.

6.6.2. Transition Curves

The rate of change of super elevation should be such as not to cause discomfort to travellers. The same is considered not steeper than 1 in 150. The transition curve length is calculated as per IRC 73, the minimum length of transition curve is determined from the following consideration and subsequent formulae,

$Ls = 2.7 V^2 / R$ from IRC 73:1980

$Ls = 0.0215 V^3 / CR$

$Ls = e \times w \times 150$

considering rate of change of super elevation

Where:

R	-	Radius of curve in meters
V	-	Vehicle speed in Km/hour
Ls	-	Length of transition in meters
C	-	Rate of change of acceleration
e	-	Rate of change of super elevation
w	-	Width of road in m

6.5 Vertical Alignment

The vertical alignment of road is designed to provide the smooth longitudinal profile. Grade changes are kept as minimum as possible to avoid the kinks and visual discontinues in the profile. The gradient specified by IRC and followed to design the vertical profile is as follows:

Table 6.5: Gradients

Nature of Terrain	Ruling Gradient (%)	Limiting Gradient (%)
Plain and Rolling	2.5%	3.3%
Mountainous	5.0%	6.0%
Steep	6.0%	7.0%

6.6 Vertical Curves

Vertical curves are designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values are adopted wherever this is economically feasible. Valley curves are designed for headlight sight distance. The 'K' values for design control and the minimum length of vertical curves for the project road which is in plain terrain as per IRC 73 and IRC SP 23 are as follows:

Table 6.6: Vertical Curves

Design Speed (kmph)	'K' Value**			Minimum Length of curve (m)
	Summit Curves for Stopping Sight Distance (SSD)	Valley Curves for Headlight Sight Distance	Value for ISD	
80	33	26	60	50
65	19	18	35	40
50	9	10	15	30
40	4.6	6.6	8.4	20
30	2	3.5	3.8	15

6.7 Camber/Crossfall

Each carriageway is designed considering the unidirectional crossfall. The crossfall considered for the flexible pavement is 2.5% and for rigid pavement is 2%. The crossfall considered for earthen shoulder as 3%.

6.8 Geometric Design Control

The detailed design for geometric elements are based on, but not limited to the following major aspects:

- Horizontal alignment
- Longitudinal profile/Vertical alignment
- Cross-sectional elements
- Intersections etc

The detailed analysis of traffic flow and level of service for the existing road is made and traffic flow capacity for the project road is worked out and this analysis form the basis to establish the widening requirements with respect to the different horizon period.

6.9 Pavement Design

The guidelines comprise the following:

a) Flexible Pavement

Design will be primary in accordance with IRC guidelines. The recommendation given in IRC-37:2018 will be used for new carriageway and paved shoulders. The pavement will be designed for a service life of 10 years for Bituminous Layer & 20 years for Granular Layer.

b) Site Specific Data

The complete estimate data with temperatures and rainfall, as well as the road construction and maintenance history for the last 10 years will be considered.

6.11.1. Design Traffic

The design traffic shall be estimated in terms of cumulative numbers of standard axles (8160kg) to be carried by the pavement during design period. The general consideration shall include the Initial Daily Average Traffic Flow, likely changes due to development/improvement of project facility, change in land use etc. The following guidelines shall be followed for the consideration of Design traffic for pavement design,

- The guidelines issued by PWRD Assam namely "Guidelines for Preparation of Detailed Project Reports under NESIDS".
- Minimum Design traffic stipulated by IRC specifications.

6.11.2. Pavement Performance Indicators and Requirements

The pavement performance and structural capacity shall be measured in terms of objective measurable performance and strength indicators, i.e., roughness, rutting, cracking and deflection.

6.10 Standards for At-Grade Intersections

The standards proposed in IRC SP: 41 "Guidelines for the Design of At-Grade Intersection in Rural and Urban Areas" and IRC SP 73: 2018 are applied for designing the intersections.

6.11 Traffic signs and Road Markings

The design of traffic signs and road marking shall be done according to the IRC standards. Following is the list of IRC standards, which will be followed**:**

- IRC: 30-1968 - Standard letters and Numerals of different heights for highway signs
- IRC: 35-2015 - Code of practice for Road markings
- IRC: 67-2012 - Code of practice for Road Signs
- IRC: 93-1985 - Guidelines on Design and Installation of Road Traffic Signals
- IRC: SP: 55-2014 - Guidelines for Safety in Construction Zones

The detailed Design Standards are mentioned in **Volume II**: Part 1 - Roads

Design Standards for Structures

6.12 Introduction

6.14.1. General

This section deals with the standards to be adopted vis-à-vis for bridges and culverts. It also provides for the type of materials and their specifications that would be adopted for the structures, the loads and forces to be considered.

The design standards for bridges has been worked out on the basis of recommendations regarding loading and material strength characteristic contained in the current bridge design practices and are contained in the relevant IRC standards.

The preliminary design of bridges will be based on various parameters and data such as design discharge of stream, HFL, scour level, characteristic of stream/river, sub-soil type, selection of site, etc. The selection of proper bridge site, computation of design discharge, bearing capacity and characteristic of soil are required to conceptualize a new bridge. The carriageway width, footpaths, crash barrier are provided as per MORT&H guidelines. Based on all these data, type of bridge, length of bridge, height of bridge, type of foundation whether shallow or deep is decided. Two or three alternatives of bridge superstructure and sub-structure will be conceived and the cost of each alternative worked out, the most economical alternative will be selected. The various data required for bridge design, method of computation of these data and parameters of bridge design are also discussed.

6.14.2. Site Data

- **Topographical Data**

Site Investigation Report will include drawings (soft (AutoCAD) and hard copies) of site plan of all bridges with close contours and salient features-area 1 km^2 for major bridges, 0.25 km^2 minimum for others-around bridge center. Corresponding bed/ground profile drawings at cross sections and longitudinal section of stream will also be furnished. Other salient data like HFL from local witnesses, flood damage records as available will also be included in the report.

In addition, topographic maps of catchment area of rivers for estimating area, length, average slope (from source to bridge) will also be included in the DPR.

- **Hydrological Data**

Rational Formula, Dickens method, Ingli's method and Area Velocity method will be used for estimation of design discharge. The design discharge is defined in IRC 78 as 100-year flood with some mandatory increase for design of substructure. Catchment area characteristics will be derived from topographical data and Toposheets of Survey of India given in Site Investigation Report.

- **Hydraulic Data**

The objective of this investigation is to plan the structures so that the bridge/CD structure should pass safely the design discharge without disturbing the regime of river. The CD structure should not obstruct the flow of river and the length of bridge should be equal to regime width of the river as given by the formula for regime condition in IRC:5. It is necessary to access correctly the

discharge of river, HFL, scour depth, flood frequency, intensity of rainfall and average velocity of flow.

Minimum waterway will be conformed to subject to review of bed profile data. For evaluation of scour, for rivers applicability of Lacey's formula shall be reviewed on the basis of topographical and bed material data. For other minor channels lowest bed level measured shall be deemed as design scour level.

- **Estimation of Discharge**

The design discharge for which the waterway of bridge is to be designed shall be the maximum flood discharge on record for a period of 100 years for major bridges and 50 years for minor bridges.

Design discharge can be determined by following methods given below:

- Rational Formula
- Dickens methods
- Ingli's method
- Area Velocity method

In case where the discharges are not available it shall be calculated by various rational formulas and methods given in literature

- **Foundation Soil Data / Soil Investigation Report as per IRC: 78**

Geotechnical Report forms part of Site Investigation Report and will contain evaluation of basic foundation design data like allowable bearing pressures, pile capacity, settlement. Data is evaluated in close consultation with PWD officials and reviewed for any modification needed. Besides, Geotechnical Report shall contain all soil profile data, classification and laboratory test data which is duly reviewed.

- **Condition assessment of Bridges**

Structural assessment of the bridges is carried out as per IRC: SP: 35-1990 "Guideline for Inspection and Maintenance of Bridges" and our experience in the field for analyzing strength/Integrity of Structure. Structural assessment of Bridges is carried out when change in structural resistance, structural behavior and change in the loading on the structure. The main task of assessment is to identify the extent of damage/ deterioration of the bridges for its safety and serviceability of structure. While preliminary assessment of bridge chainage of the structure, type of structure, Dimension of structure and hydraulic details of structure is carried out.

In detailed assessment of structure any damages, cracks and condition of every component of bridge is inspect on site. From this inventory report and hydraulic design of every culvert including minor and major bridges improvement proposal is finalized.

After detail visual inspection of existing crossings, the proposed structure are categories as under:

I. Reconstruction
II. New construction
III. Widening

IV. To be retained with minor repairs.

- All RCW are proposed to be replaced by minor / major bridges and categorized as 'Reconstruction.'
- All structures having inadequate waterway proposed to be replaced as minor bridges and categorized as 'Reconstruction'.
- All-natural crossings are proposed for minor / major bridges and categorized as 'New Construction'.
- All bridges in good condition and having adequate waterway with minimum 7.00m roadway are proposed to be kept on it is with minor repairs / protection work and categorized as 'Retain with minor repairs.
- All bridges in good condition and adequate waterway but having roadway less than 7.0m are proposed for widening and categorized as 'Widening'.

6.14.3. **Deck Configuration/Carriageway widths**

New Construction Bridges / Culverts: - The bridges which having inadequate waterways, which are in deteriorate condition are to be dismantled. For all such bridge under NESIDS new bridge ha to be constructed on the road corridors the total width of bridge (outer to outer) shall be 8.5 m.

For all existing pipe culvert shall be replaced by Box Culverts. Carriage way width of existing slab culvert is less than 9m then new box culvert shall be constructed in full formation width.

Widening of Bridges: - For existing major and minor bridges having carriageway less than 7.0m, then new bridge shall be constructed parallel to the existing bridge.

6.14.4. **Carriageway Drainage**

Minimum cross fall / camber will be kept as 2.5% both sides for the deck drainage. Water will be taken down to ground/drainage courses through proper downspouts and take down pipes at the edge of carriageway shall be provided according to standard practice to provide efficient transverse drainage.

Longitudinal drainage is much more efficient and a minimum nominal longitudinal gradient of ± 0.5% to 1% may be proposed to minimize intrusion of drainage inlets. Road Side Drainage has been designed as per specifications of IRC SP 42-2014.

6.13 Hydrologic Design for Bridges

6.15.1. **General**

Hydrological inputs play an important role in planning, execution and operation of any hydraulic structures located along the road corridor. In most of the cases, sufficient hydrological & meteorological records are not available of the catchment areas are ungauged. This report covers the Methodology, Input data used and various method used to calculate required parameter for Hydrologic design of road bridges.

6.15.2. **Objectives**

The main objectives of the hydrologic study of bridges at preliminary project reports,

i) Deciding the bridge location on the proposed road alignment considering various factors.
ii) Determination of Linear waterway of the bridge for Design flood discharge
iii) Calculation of Afflux
iv) Scour depth Calculations 0

6.15.3. **Input Data:**

i) For deciding bridge location on the proposed road alignment following data was collected and some guidelines are used:

A. First the road alignment is marked on the Google earth and the location of crossing is identified. As most of the rivers in the region shows meandering and braiding characteristics, the river changes its width with due course of time. Therefore, historical data for river width is collected using google earth application. The river width as seen from historical images from google earth are marked till year 2008. And control points were identified where the river shows minimum meandering nature. The figure shows the example for the same.

B. Then for deciding the bridge location some guidelines from the book "River Behavior Management and Training" volume 1 published by Central board of Irrigation and Power are followed.

ii) Rainfall data: For finding design discharges of any given return period, input rainfalls for the design return period are required for all the cross-drainage structure. These data are taken from the 24-hour Isopluvial maps published by Indian metrological department (CWC flood estimation report Brahmaputra basin subzone 2a/2b). As per recommendations of the Indian Road Congress (IRC: 5-2015 and IRC: SP: 42-2014), these rainfall values of 24 hr. duration are adjusted for evaluating design storm corresponding to time of concentrations for all catchments. Rainfall values used for computing discharge is found from mean annual rainfall and 24-hour rainfalls for 25 years, 50 years and 100 years return periods.

iii) Toposheets for locating bridge location and determination of catchment area characteristics

iv) Cross section data of the river at bridge location, Upstream and downstream of the bridge location from site surveys, google earth and toposheets.

v) Reconnaissance survey data and photos collected during site visits.

vi) Flood estimation report for Brahmaputra basin (Subzone-2a/2b).

6.15.4. **Methodology adopted for Hydrologic design of bridges:**

All structures will be designed in accordance with the relevant codes, standards and specifications, Special publications and guidelines of the Indian Road Congress. Following steps are followed for hydraulic design of proposed bridges.

6.15.4.1. **Delineation of catchment**

Catchment area delineation is done using the toposheet and location of bridge. The bridge location marked on the toposheet along with the road alignment. The toposheet and google earth imaginary have been studied with respect to proposed bridge location. The catchment area is marked based on the existing drainage network and ridge line identified in the toposheet. Then the longest stream is identified and its slope is determined using google earth. Also, the catchment characteristics are studied from the toposheet to get the run-off coefficient.

6.15.4.2. **Calculation of peak discharge**

IRC: SP:13-2004 has recommended various method for calculation of design discharge for the bridge location. Design discharge will be calculated in accordance with the guidelines given in the IRC: SP:13-2004. Data available for particular location governs the method to be used for calculation of discharge. Following are the method used for calculating the peak discharge.

i) Catchment area methods (Empirical and rational method)

ii) Area-velocity method

6.15.4.3. **Determination of linear waterway and HFL:**

a) Regime width of stream will be calculated based on Peak flow computed. This waterway will be compared existing waterway of nearby bridge at just u/s or d/s of proposed bridge. If existing waterway is greater than required waterway, existing waterway will be adopted for proposed bridge. As far as possible odd number of spans may be fixed from hydraulic and aesthetic point of view and to avoid placing of centre pier at deepest location of the stream. Proposed waterway of bridge will be near to Regime width of stream or actual existing width of stream for design discharge.

b) Afflux will be calculated as per applicability for Weir flow condition or Orifice flow condition. If difference in upstream head and downstream head is not less than 0.25 times downstream head, afflux computed from weir flow formula will be adopted, otherwise afflux computed orifice flow formula will be used for HFL computation.

Then HFL will be calculated by adding afflux, total water head and bed level at just upstream of proposed bridge.

c) Scour depth will be computed by appropriately increasing design discharge as per IRC:78-2014. Design criteria and detailed hydraulic design calculations for proposed bridge structures are presented in subsequent sections.

6.15.5. **Hydrologic design criteria**

Sizing of proposed bridge structure involves estimation of peak flow, determination of linear waterway, Scour depth calculation, HFL calculations as stated in previous section. The bridges can be classified as minor or major bridges. Design standards for hydrologic study of bridges are discussed in subsequent Sub-sections. The term and important factor used in calculations are explained below.

6.15.5.1. **Return period**

Return period is the average interval, in year, between events which equals or exceed a given magnitude. It is usually designated as T. As per IRC: SP:13-2004, for sound economy the return period recommended is 50 years for small and medium structures. Also, as per IRC:5-2015 the return period for calculation of design discharge recommended is 100 years. As per IRC: SP:73-
2004, all the structures shall have adequate waterway. The design discharge shall be evaluated for flood of 50-year return period.

Hence, Hydraulic design of structures will be for the flood of 50 years and this design discharge will be utilized for estimation of linear waterway and HFL calculations.

6.15.5.2. **Estimation of design flood peak**

Depending upon the size of catchment area, availability of field data and other related data of the project area and the purpose for which it to be used, various methods are available for design flood peak estimation which are described as follows:

6.15.5.2.1. **Empirical Formulae**

In this method area of a basin or a catchment is considered mainly. All other factors which influence peak flow are merged in a constant.

a) Dicken's Formula:

It was formerly adopted only in northern India but now it can be used in most of the States in India after proper modification of the constant.

b) Ingli's Formula:

This formula was devised for erstwhile Bombay Presidency. These empirical formulae involve only one factor viz. the area of the catchment and all the so many other factors that affects the run-off have to be taken care of in selecting an appropriate value of the co-efficient.

6.15.5.2.2. **Rational Formulae**

The rational formulae for assessment of peak discharge from project catchment takes into account rainfall, runoff under various circumstances, time of concentration and critical intensity of rainfall.

6.15.5.2.3. **Area-velocity Method**

The slope-area method based on the hydraulic characteristics of the stream is the reliable method. This method is based on conveyance factor (K) and the slope (S)

of stream. For calculation of the conveyance factor, several cross-sections have been used. These are at bridge site, upstream of bridge site and downstream of bridge site at specified locations.

6.15.5.3. **Final Design flood discharge:**

After computing peak discharges of bridges by different methods as described above sections are compared with one another. As far as possible, maximum of peak discharges computed using rational formulae and Unit hydrograph methods are taken as Design Discharge.

When the variation between the highest two values of discharges computed by different methods is less than 50%, the highest discharge has been taken as design discharge. When the variation between the highest two values of the discharges computed by different methods is more than 50%, and then design discharge has to be taken as 1.5 times the lower of the two maximum values.

6.15.6. **Linear Water way of the bridge:**

When bridge is proposed crossing artificial channel for irrigation or navigation or when the banks of natural stream are well defined, linear waterway should be full width of the channel or stream. For alluvial stream with undefined banks, the required effective linear waterway/ regime width (W) of bridge can be determined using Lacey's formula:

$W = C (Q)^{1/2}$

Where, W= Liner water way in meters

C = A coefficient varying according to local conditions, the usual value adopted being 4.5 to 6.3 (for regime channel) and as per I.R.C: SP: 13-2004 C = 4.8

Q = Design flood discharge in cumecs.

When stream overflows their bank for carrying discharge of 100-year return period and creates wide surface width with shallow side sections, Engineering judgments have to be used. Based for existing width of natural stable stream at HFL, width of nearby existing bridge nearby site on the same stream, Regime width calculated, the clear linear waterway is fixed and then hydraulic flow condition around bridge is analysed, If the chosen linear waterway is viable for hydraulic flow through the bridge without causing excessive afflux and exit velocity, then this waterway is adopted for HFL calculations.

Actual waterway provided for the bridge in the meandering and braiding flood plain of a river may be substantially different from Lacey's waterway. In some of the cases, Lacey's waterway has been provided but, in some others, waterway provided is found to be much more than Lacey's waterway.

6.15.7. **Determination of Afflux**

Afflux is the heading up of water over the flood level caused by constriction of waterway at the bridge location in the stream. It is equal to the difference in water levels at u/s and d/s of the bridge. Afflux will be calculated as per Molesworth's formula.

$h = [V^2 /17.88 + .015] [(A/A1)^2 - 1]$

Where V is the mean velocity of flow in the river prior to bridge construction i.e. corresponding to normal HFL, A and A1 are the areas of flow section at normal HFL in the approach river section and under the bridge respectively.

6.15.8. Vertical clearance

In the case of a channel(stream), vertical clearance is usually the height from the design highest flood level with afflux of the channel to the lowest point of the bridge superstructure at the position along the bridge where clearance is being denoted. The minimum vertical clearance will be kept in accordance with the table 12.1 of IRC-13-2004. The minimum clearance is measured from the lowest point of the deck structure inclusive of main girder in the central half of the clear opening.

6.15.9. Scour Depth

Foundation and protection work of the structure should be designed for larger discharge by increasing design flood as per section 703.1.1 of IRC:78-2014.

As per IRC:5-2015, IRC: SP:13-2004 & IRC 78-2014, published by Indian Roads Congress (IRC), recommend use of Lacey's (1930) equations for estimating scour depth. IRC method does not distinguish between local scour, constriction scour and general scour. The normal scour depth (measured below HFL) is given by Lacey's equations below:

$R = 0.473(Q/f)^{1/3}$

when clear waterway of bridge is not less than regime width of the stream. When clear waterway ear width of bridge (Le) is less than regime width or and less than natural unobstructed width of the stream (W), following Lacey's equation is used for estimating normal scour depth as per IRC: 5-2015.

$R = 1.34 (q^2/f)^{1/3}$, when L/W is less than one.

Where,

R = the Lacey's regime scour depth, measured below HFL,

q = design discharge per unit width through bridge in m^3/s per meter f = silt factor

The silt factor is calculated by the following equation:

$f = 1.76 (d_{50})^{1/2}$ Where, d_{50} is the mean size bed materials obtained up to deepest anticipated scour in mm and its value is to be obtained from sieve size analysis of the riverbed materials collected at the site.

The maximum depth of scour below the highest flood Level (HFL) at obstructions and configurations of the channel should be estimated from the value of 'd_{sf}' on the following basis:

a) For the design of piers and abutments located in a straight reach and having individual foundations without any floor protection works

i. In the vicinity of piers = 2.0 * d_{sf}

ii. Near abutments = 1.27 * d_{sf}

b) For bad sites on curves or where diagonal current exist or the bridge is multi-span structure, the maximum scour depth should be taken as two times the normal scour depth.

6.14 Design Hypothesis

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 structures have been modelled by grillage analysis or finite element Technique using **STAAD Pro V8i. or MIDAS Civil.** Analysis has been performed to get various output such as bending moment, shear forces and torsion values at various locations along the span of bridges/culverts. 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, well 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. For this corridor, box culverts, Minor Bridge and Major Bridge are designed by in house bridge experts, prepared
corresponding design worksheets.

6.16.1. Design Philosophy

The Design philosophy shall be Limit State Philosophy of Design as per IRC-112-2019 and the Structure shall be checked for the following:

1. Ultimate Limit State
2. Serviceability Limit State

The Design Methodology adopted for Foundations shall be Limit State Method for Load Combinations mentioned in Annex-B of IRC:06-2017.

6.16.2. Material

The Stress deformation characteristics and Engineering properties of materials shall be considered as per IRC 112-2019.

6.16.2.1. Concrete Characteristics:

- Min Grade of Concrete (Pre-Stressed Girder) - M 50
- Minimum Grade of Concrete (Substructure) - M 35
- Minimum Grade of Concrete (Foundation) - M 30
- Minimum Grade of Concrete (Box Culvert) - M 30
- Poisson's Ratio of Concrete - 0.15
- Coefficient of Thermal Expansion - $12 \times 10^{-6}/^{0}C$
- Modulus of Elasticity of Concrete - Table 6.5, IRC:112-2019, eq A2-5, IRC 112-2019

Note:

A. Concrete used for foundations, substructures and super structures from consideration of durability, sustainability, only.

B. Concrete strength can be considered as per IRC 112-2019 Clause No 6.4.1 (a) Note 3.

6.16.2.2. **Reinforcing Steel Characteristics**

- Characteristics Strength of Reinforcement - Fe500D
- Modulus of Elasticity - 200 GPa
- Coefficient of Thermal Expansion - $12 \times 10^{-6}/^{0}C$

Reinforcements shall be thermos mechanically treated TMT deformed with corrosion resistance steel (CRS) bars of grade Fe 500D conforming to IS-1786:2008.

6.16.3. **Stress Limitation**

6.16.3.1. **Allowable stress in concrete**

As Per IRC-112-2019, Cl.12.2 Maximum compressive stress in concrete under rare combinations 0.48 f_{ck}. Where Compressive stress in concrete under Quasi-Permanent load is within 0.36 f_{ck}, linear creep may be assumed.

6.16.3.2. **Allowable tensile stress in steel**

Maximum tensile stress in steel under rare combinations 0.8 fyk.

6.16.3.3. **Pre-stressing Steel Limits**

In exceptional conditions temporary overstressing during stressing operation is permitted up to 95% of 0.1% proof load, provided that the accuracy of measurement is ensured to be within +-5%.

Maximum Pre-stressing force P_0 applied to structure immediately after transfer shall not be greater than 75% of fpk or 0.85 X 0.87 = 0.739 whichever is less.

6.16.3.4. **Pre-stressing Steel Characteristics**

Pre-stressing Steel Characteristics is mentioned in VOLUME-II, Part -2, Design Report of Structures.

6.16.4. **Stress Block Parameters**

The Stress Check for members designed for axial compression and uniaxial bending shall be done using the equivalent Stress Block as mentioned in Annexure A-2 of IRC 112-2019.

6.16.5. **Bearing Characteristics**

Spherical Bearing shall be adopted as per requirement/design for all spans. Design of Bearings shall be as per IRC: 83.

6.16.6. **Expansion Joint Characteristics**

Strip-seal type Expansion Joint shall be adopted for all aforesaid categorized Superstructures conforming to IRC-SP 69-2011, maximum movement up to 100mm shall be considered for simply supported span.

6.16.7. **Exposure**

The type of exposure considered in design is severe. The Exposure condition shall be used to check the crack width in 'Limit State of Serviceability' for Frequent and Quasi Permanent Load Combinations as given in the Table 12.1 of IRC 112-2019.

6.16.8. **Reinforcement Cover**

Considering service Life of 100 yrs. minimum cover to the outermost reinforcements is,

Table 6.7: Minimum Reinforcement Cover

• Superstructure	50 mm
• Substructure	50 mm
• Foundation	75 mm
• Underpasses / Box Culvert	
• Earth Side / surface in contact with soil	75mm
• Non-Earth Side	50mm

Minimum Cover shown above can be reduced by 5mm in case of factory made precast concrete elements.

6.15 Load

The loads which are considered for design of structures is as per IRC:06-2017. The details of Load are elaborated in VOLUME-2, Part 2, of Design Report of Structures.

6.17.1. **Load Factors and Combinations**

6.17.1.1. **Partial Safety factor for loads**

The partial safety factors shall be used in combinations for Limit State Design shall be used as per Annex B of IRC-6:2017.

6.17.2. **Partial Safety Factor for Pre-stress**

The partial safety factors for pre-stressing shall be used as per Clause 7.9.5 of IRC: 112-2019.

6.16 Design Approach

6.18.1. **Load Types Definitions**

The underlying section depicts the Analysis and Design of the structure for the various loads and load combinations as mentioned in above section. The Analysis is carried out as following:

- Longitudinal analysis of the grillage systems for other superstructures (PSC Girder Systems)
- Transverse Analysis for Girder and Slab system
- Local Analysis for the End blocks, diaphragms (Areas of High Stress Concentration).

The Longitudinal Analysis, Transverse Analysis and Local Analysis is elaborated in VOLUME-II, Part 2, Design Report of Structures.

6.18.2. Analysis of Substructure

The Analysis of Pier & Pier Cap shall be carried out for the system of forces as shown in the figure above. The Portal frame fixed at the top of foundation shall be analyzed for:

- Dead Loads
- SIDL
- Bearing forces in Longitudinal direction
- Wind
- Seismic.
- Barage Impact

The analysis for the system of forces shall be carried out load combinations as mentioned in above section of Loads and Load Combinations. The Structural components shall be checked for Ultimate and Serviceability Limit States as per IRC:112-2019.

6.18.3. Bearing System

Each end of span of the bridge will be POT/PTFE or spherical bearing or elastomeric bearing is placed underneath end-diaphragm at pier location for transfer of vertical and horizontal forces.

6.18.4. Design of Foundations

The foundation system shall be designed as per Geotechnical Investigations carried out in the field for the load combinations as given Annex B of IRC-6:2017. The Foundations envisaged in the project mainly comprise of following Types:

1. Raft Foundation
2. Open Foundation
3. Pile Foundation
4. Well Foundation

The methodology of design of foundation is elaborated in VOLUME-II, Part -2, Design Report of Structures.

6.17 Relevant Codes

IRC: 112 (2019) – Code of Practice for Concrete Road Bridges.
IRC: 78 (2014) – Design Standard for Foundation and Substructure of Road Bridges.

- IRC: 5 (2015) – General Features of Design of Road Bridges.
- IRC: 6 (2017) – Loads and Stresses for Road bridges.
- IRC: 45-1972 – Recommendations for Estimating the Resistance of Soil Below the Maximum Scour Level in Damage of Well Bridge.
- IRC:89-2010 – Guidelines for Design and Construction of River Training,
- IS 1343-2012 – Code of Practice for Prestress Concrete.
- IS 14268-2017 – Uncoated stress Relieved Low Relaxation Seven Ply Strand for Prestress Concrete Specification.
- IS: 2911 (2010) – Design Standard for Pile Foundations.
- IS: 6403 (1981) – Determination of Breaking Capacity of Shallow foundation.
- IS: 13920 (2016) – Ductile Detailing Standard for RCC Structures.
- IRC: 83 Part III (2002) – Standard Specifications & Code of Practice for Road.
- IS: 800 (2007) – Design Standard for Steel Structures.
- IRC SP: 73 (2018) – Manual for Specifications & Standards for Two Laning of Highways with Paved Shoulder.
- IRC: SP:114-2018 – Guidelines for Seismic design of Road Bridges.
- IRC: SP:65-2018 – Guidelines for Design and Construction of Segmental bridges
- IRC: SP:66-2005 – Guidelines for the Design of Continuous Bridges
- IRC: SP:69-2011 – Guidelines and Specification for Expansion Joint
- MoRT&H – Specifications of Road and Bridge Work (Fifth Revision)
- Wherever IRC-112-2019 is silent, the latest revisions of the following codes shall be preferred.

7 PROPOSED ROAD FEATURES & IMPROVEMENTS

7.1 Introduction

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

7.2 Selection of Widening Scheme

Based on the traffic movement survey at different locations, the consultant along with PWRD officials had made the several site visit to finalize the type of roads & section accordingly the project stretch is proposed to be reconstructed/widening.

7.3 Typical Cross-sections of road, bridges, ROB, RUB and culvert

The typical cross sections (TCS) proposed in the project stretch are detailed as in **Table 7.2.**

Table 7.2: Typical Cross Section Details

Sl No	Chainage		Length	TCS Type
	From	To		
1	11000	12000	1000	2
2	11500	11600	100	3
3	11600	11700	100	2
4	11700	11770	70	4
5	11770	12000	230	2
6	12000	12250	250	1
7	12250	12760	510	2
8	12760	12820	60	4
9	12820	12900	80	2
10	12900	12950	50	4
11	12950	13150	200	2
12	13150	13195	45	4
13	13195	13390	195	2
14	13390	13455	65	4
15	13455	13700	245	2
16	13700	13760	60	4
17	13760	15300	1540	2
18	15300	15380	80	4
19	15380	15520	140	2
20	15520	15590	70	4
21	15590	16720	1130	2
22	16720	16750	30	4
23	16750	18000	1250	2
24	18000	18080	80	3
25	18080	18460	380	2
26	18460	18600	140	1
27	18600	19600	1000	2

Sl No	Chainage		Length	TCS Type
	From	To		
28	18700	18850	150	4
29	18850	19250	400	2
30	19250	19320	70	3
31	19320	19600	280	2
32	19600	19850	250	1
33	19850	21000	1150	2
34	21000	21200	200	1
35	21200	21550	350	2
36	21550	21700	150	4
37	21700	21800	100	2
38	21800	21875	75	4
39	21875	22050	175	2
40	22050	22310	260	3
41	22310	22530	220	2
42	22530	22595	65	3
43	22595	22700	105	2
44	22700	22750	50	4
45	22750	23800	1050	2
46	23800	23870	70	4
47	23870	24000	130	2
48	24000	24100	100	1
49	24100	25300	1200	2
50	25100	25170	70	3
51	25170	25600	430	1
52	25600	26000	400	2
53	26000	26200	200	1

7.4 Pavement Design

Design of Flexible Pavement for new/reconstruction and widening of existing carriageway: -

The Design of flexible pavement based on design life, design traffic, lane distribution factor, Vehicle damage factor, Traffic growth rate and design MSA.

(a) Design Life

As per clause 5.4.1 of IRC SP: 73-2018, the following design life has been adopted for different layers.

For BT Layers : 15 Years (2027 to 2042)

For Base/Sub-base Layers : 15 Years (2027 to 2042)

(b) Design Traffic

The traffic loading in terms of the cumulative number of standard axles for the given period has been computed using the following relationship:

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

Where,

N = Cumulative number of standard axles to be catered for in the design in terms of msa.

A = Initial traffic in the year of completion of construction in terms of the number of Commercial Vehicles per Day (CVPD).

D = Lane distribution factor

F = Vehicle Damage Factor (VDF).

n = Design life in years.

r = Annual growth rate of commercial vehicles in decimal (e.g., for 5 per cent annual growth rate, r = 0.05) as per IRC 37-2018, clause no. 4.2.2.

(c) Lane Distribution Factor (*DLn*):

100% of the number of vehicles in each direction (section 4.5.1 of IRC 37-2018).

(d) Directional Distribution Factor:

The value of 0.50 has been adopted as the directional distribution factor.

(e) Traffic Growth Rates:

Traffic growth rates shall be established for each category of commercial vehicles. In the absence of data for estimation of the annual growth rate of commercial vehicles minimum 5% should be used for estimating the design traffic as per clause no. 4.2.2 of IRC 37:2018.

(f) Design MSA

Based on the vehicle damage factors and the projected traffic volumes, the traffic loading in terms of cumulative number of equivalent 8.16 t standard axle loads have been computed for the design period and the design MSA considered as **5 MSA** as per IRC 73-2015.

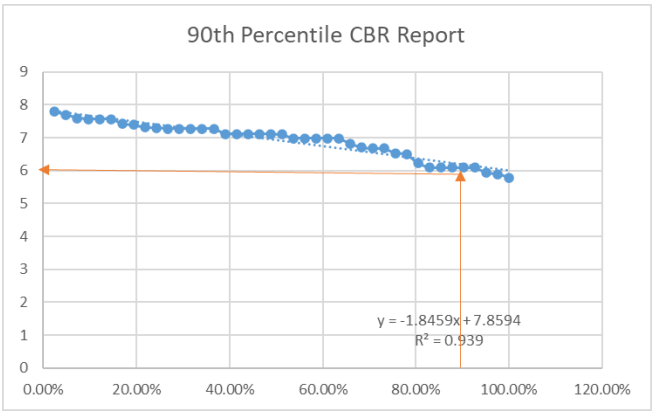
(g) Vehicle Damage Factor:

As the project road passes through Plain terrain the VDF considered as per the table below of IRC 37-2018 is 4.

(h) Design Subgrade Strength

As per IRC 37-2018, pavement design is done based on the effective CBR of 6% of the subgrade. Effective CBR of the subgrade has been derived based on the investigation of borrow area and embankment soil (OGL soil) samples and considerations of CBR requirements as per clause 6 of IRC:37 :2018.

As per Clause 6.2.2 of IRC 37:2018, the design CBR is % (90th Percentile)



(i) Pavement Design

Therefore, as per Plate 42 of IRC 37 2018, the pavement composition for 5 MSA and 6% CBR is shown below:

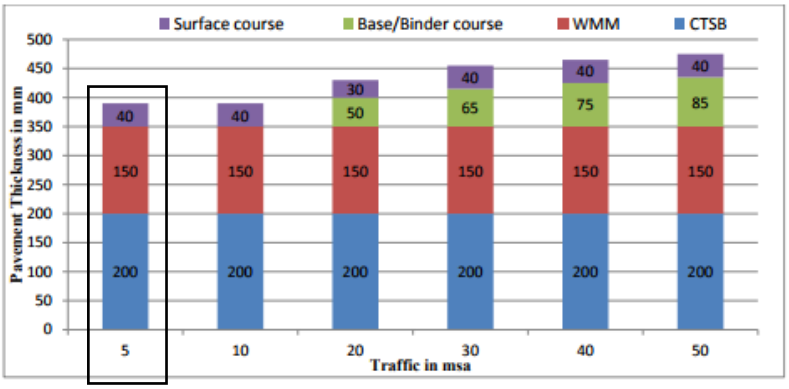


Figure 12.42 Catalogue for pavement with bituminous surface course with CTSB and granular base course - Effective CBR 6% (Plate-42)

Table 7.3: New Flexible Pavement Composition

Homogeneous Section	Design Period		Design Traffic		Design CBR (%)	Pavement Composition (As Per IRC: 37-	Specification
	Granular Course	Bituminous Course	Granular Course	Bituminous Course			
11+000 to 26+000	15	15	5	5	6	BC - 40mm	VG-30
						WMM 150	
						CTSB- 200mm	Grading V

Source: Pavement Design

7.5 Profile Corrective Course and Pavement Composition for Raised Portion of Road

No Profile Corrective Course has been considered for the entire stretch.

7.6 Road Rehabilitation Proposals

As per the visual inspection and reconnaissance survey, it was observed that the condition of the existing road was bad with most of the cracks being clearly visible. So, no overlay has been proposed along the entire stretch. Entire stretch is considered for reconstruction. Entire stretch is considered for reconstruction.

7.7 Intersection/Junction Improvement Proposals

There are 2 major junctions and 10 minor junctions proposed along the project corridor. Cross roads with paved carriageway are only considered for development. **NO JUNCTIONS HAVE BEEN CONSIDERED FOR DEVELOPMENT UNDER THIS PROJECT.**

7.8 Proposal for Service Roads

The details of the proposals for service roads are presented in **Table 7.5.**

Table 7.5: Schedule of Service Road

SI. No.	Design		Side	Length (m)	Remarks
	From	To			

Nil

7.9 Bypass and Realignment Proposals

The details of the proposals for service roads are presented in **Table 7.6**.

Table 7.6: Summary of Recommended Bypass/Realignments

SI. No.	Start Point		End Point		Length of Bypass/ Realignme	Cost (Rs. Million
	Place	Existing Chainage	Place	Existing Chainage		
Nil						

7.10 Recommended Alignment of Project Road

The recommended alignment of the project road comprises of widening and reconstruction of existing alignment passing through existing centre line, retained existing alignment almost possible.

7.11 RCC Covered Drains

The details of the road side drains are presented in **Table 7.7**.

Table 7.7: Details of road side drains

SL.NO	CHAINAGE		LENGTH	SIDE	REMARKS
	FROM	TO			
1	12000	12250	250	B.H.S	KULSIGATE CHOWK
2	14000	14150	150	B.H.S	DEOMORNOI TOWN
3	18460	18600	140	B.H.S	MOHOLIAPARA CHOWK
4	19600	19850	250	B.H.S	
5	21000	21200	200	B.H.S	RAISING 100 mtr DRAIN 200 mtr
6	24000	24100	100	B.H.S	
7	25300	25600	300	B.H.S	NAMKHOLA MARKET
8	26000	26200	200	B.H.S	END CHAINAGE

At following locations RCC Covered Drain have been proposed:

Figure 1 : Mohalipara Chowk 18+600

Figure 2 Kulsigate Chowk

7.12 Proposal for ROB and RUB

No ROB and RUB have been proposed along the entire project road.

7.13 Proposal for New Culverts

No New Culvert has been proposed along the entire project road.

7.14 Proposal for Flyover

No Flyover has been proposed along the entire project road.

7.15 Improvement Proposal for existing bridges

Minor Bridge at 14+850 has been proposed for new construction as the existing structure cannot fulfil the minimum waterway requirement as per Hydraulic Calculation.

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
1	14+850	RCC Bridge	7	MNB	12	8.5	New Construction

7.16 Improvement Proposal for existing culverts

The improvement proposal for existing culverts along the project road stretch are mentioned in **Table 7.8.**

Table 7.8: Improvement Proposal for Existing Culverts

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
1	11380		2X1	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
2	11890		1000mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
3	12150		900mm dia	Box culvert	2/44/0	10 m	Re-Construction
4	12230		3X1	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
5	12650		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
6	12970	SHP	600mm dia	Box culvert	1/22/0	10 m	Re-Construction
7	13750	2X2	900mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
8	14000	BUILT-UP AREA DEOMORONOI	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
9	14850	EXT SLAB 8 MTR	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
10	15000		600mm dia	Box culvert	1/33/0	10 m	Re-Construction

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
11	15420		1000mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
12	15430		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
13	15750		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
14	16300	EXISTING DHP	600mm dia	Box culvert	1/33/0	10 m	Re-Construction
15	16570	SHP	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
16	17070	SLAB 7.5	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
17	17600	DHP	600mm dia	Box culvert	1/22/0	10 m	Re-Construction
18	17780	SHP	900Mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
19	18030	EXT 4HP	600mm dia	Box culvert	1/43/0	10 m	Re-Construction
20	18990	EXT. SLAB	4X2	Box culvert	1/43/0	10 m	Re-Construction
21	19600	EXT 4HP	3x3	Box culvert	1/43/0	10 m	Re-Construction
22	19850	SLAB	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
23	20370	SHP			1/22/0	10 m	Re-Construction
24	22100	SLAB 1.5	1.5X1.5	Box culvert	1/22/0	10 m	Re-Construction
25	22350	DHP	2X2	Box culvert	1/22/0	10 m	Re-Construction
26	22500	4HP	1000mm	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
27	23050	DHP	1000mm	Box culvert	1/33/0	10 m	Re-Construction
28	23220	SLAB			1/22/0	10 m	Re-Construction
29	23550	SHP	1000mm	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
30	23950	SLAB 1.5	1000mm	Box culvert	1/22/0	10 m	Re-Construction
31	24350	DHP	6m	Box culvert	1/22/0	10 m	Re-Construction
32	24950		8m	Box culvert	2/44/0	10 m	Re-Construction
33	25500	SLAB 1.5			1/1.5x1.5/0	10 m	Re-Construction
34	25600		1000mm	Box culvert	1/22/0	10 m	Re-Construction

7.17 Rehabilitation Proposal for existing bridges and culverts

Two Existing Bridges have been proposed for rehabilitation which include works such as Painting and Repair of RCC Railing and a fresh layer of Mastic Asphalt on bridge deck.

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
1	21+300	RCC Bridge	150 m	MJB			Retained
2	24+500	RCC Bridge	40 m	MNB			Retained

7.18 Protection Works

The project comprises many water bodies (small and large ponds) along the alignment. Therefore protection measures such as toe walls and boulder pitching have been proposed at various locations to protect the slope from erosion.

SCHEDULE OF BULDER PITCHING						
LOCATION. NO.	Chainage		Length	SIDE	TYPE	REMARKS
	From	To				
1	11500	11600	100	LHS	Boulder Pitching	
2	11500	11590	90	RHS	Boulder Pitching	
3	11700	11770	70	LHS	Boulder Pitching	
4	12760	12820	60	RHS	Boulder Pitching	

SCHEDULE OF BULDER PITCHING						
LOCATION. NO.	Chainage		Length	SIDE	TYPE	REMARKS
	From	To				
5	12900	12950	50	RHS	Boulder Pitching	
6	13150	13195	45	RHS	Boulder Pitching	
7	13390	13455	65	LHS	Boulder Pitching	
8	13700	13760	60	LHS	Boulder Pitching	
9	15300	15380	80	LHS	Boulder Pitching	
10	15520	15590	70	LHS	Boulder Pitching	
11	16720	16750	30	RHS	Boulder Pitching	
12	18000	18080	80	LHS	Boulder Pitching	
13	18000	18080	80	RHS	Boulder Pitching	
14	18700	18850	150	RHS	Boulder Pitching	
15	19250	19310	60	LHS	Boulder Pitching	
16	19250	19320	70	RHS	Boulder Pitching	
17	21550	21700	150	RHS	Boulder Pitching	
18	21800	21875	75	LHS	Boulder Pitching	
19	22050	22110	60	RHS	Boulder Pitching	
20	22250	22310	60	RHS	Boulder Pitching	
21	22530	22590	60	LHS	Boulder Pitching	
22	22530	22595	65	RHS	Boulder Pitching	
23	22700	22750	50	RHS	Boulder Pitching	
24	23800	23870	70	LHS	Boulder Pitching	
25	25100	25155	55	LHS	Boulder Pitching	
26	25100	25170	70	RHS	Boulder Pitching	
			Total	**1875**		

SCHEDULE OF TE WALLS						
Sl. No.	Start	End	Length(M)	Height(m)	Sides	Remarks
1	18000	18030	30	1.5	PCC Toe Wall	
2	18000	18030	30	1.5	PCC Toe Wall	
3	18700	18850	150	1.5	PCC Toe Wall	
4	19250	19280	30	1.5	PCC Toe Wall	
5	19250	19280	30	1.5	PCC Toe Wall	
6	21550	21700	150	1.5	PCC Toe Wall	

SCHEDULE OF TE WALLS						
Sl. No.	Start	End	Length(M)	Height(m)	Sides	Remarks
7	21800	21830	30	1.5	PCC Toe Wall	
8	22050	22080	30	1.5	PCC Toe Wall	
		TOTAL	**480**			

Some of the locations of protection works are shown below:

7.19 Traffic Facilities

7.19.1 Proposal for Bus Bays / Bus Shelters

The details of the Bus Bays and Bus Shelters are presented in **Table 7.9** and **Table 7.10** respectively.

Table 7.9: Bus Bay Details

SI. No.	Location	Existing Chainage	Design Chainage	Side
Nil				

Table 7-10: Bus Shelter Details

S. No.	Design Chainage	Side	Location	Remarks
NIL				

7.18.1. **Proposal for Truck Lay Byes**

The details of the Truck Lay Byes are presented in **Table 7-11**.

Table 7-11: Truck Lay Byes Details

S.No.		Location	Design Chainage	Remarks
	Nil			

7.18.2. **Proposal for Pedestrian and Cattle Crossing**

There are no Pedestrian and Cattle Crossing proposed along the project road from Mangaldoi to Mazikuchi.

7.18.3. **Wayside Amenities**

Wayside Amenities like Bus Shelters, Bus Bays and Bus Stops are provided as mentioned in **Table 7.9** and **Table 7.10**. Solar Street Lights are proposed at Major & Minor Junctions. Overhead Gantry is proposed at start and end of the project road and Cantilever Gantry are proposed at all the Major Junctions.

7.18.4. **Miscellaneous provisions for traffic guidance and safety**

The road traffic signs, road markings and safety devices for the project are provided as per IRC standards.

- Cautionary / Warning sign boards at turning/bend, structure, junction, school and built-up locations.
- Regulatory Sign Board at speed restrict location and junctions.
- Informatory sign board at junctions, villages and existing facility locations.
- Chevron Board at curve locations.
- Hazard marker at structure, crash barrier location and island locations.

7.20 Road Furniture and Safety Measures

7.19.1. Introduction

The road furniture, traffic safety features and other facilities included in the design are:

- Road Markings
- Kilometre Stone
- 200m Stones and Boundary Stones
- Delineators and Object Markers
- Crash Barrier
- Rumble Strips
- Road Studs
- Traffic Control and calming devices
- Traffic Diversion Plan

7.19.2. Road Markings

Road markings perform the important function of guiding and controlling traffic on a highway. The markings serve as psychological barriers and signify the delineation of traffic paths and their lateral clearance from traffic hazards for safe movement of traffic. Road markings are therefore essential to ensure smooth and orderly flow of traffic and to promote road safety. The Code of Practice for Road Markings, IRC: 35-2015 will be used in the study as the design basis.

The location and type of marking lines, material and colour is followed using IRC: 35-2015 – "Code of Practice for Road Markings".

The road markings are carefully planned on carriageways, intersections, parking and bridge locations.

Figure 7.1: Road Marking

7.19.3. Road Signages - Cautionary, Mandatory and Informatory Signs

Cautionary, Mandatory and Informatory signs are provided depending on the situation and function they perform in accordance with the IRC: 67-2012 guidelines

for Road Signs. Overhead and Cantilever gantry sign boards are proposed at appropriate locations.

Figure 7.2: Road Signages

Figure 7.3: Schematic Gantry Signage's at Project Road

7.19.4. Kilometre Stone Details

The details of kilometre stones are in accordance with IRC: 8-1980 guidelines. Kilometre stones are located on the left-hand side of the road as one proceeds from the station from which the Kilometre count starts. On divided roads with a central median, kilometre stones should be provided at the left on both sides of the road i.e., independently for each direction of travel. Kilometre stones shall be fixed at right angles to the centre line of the carriageway.

Figure 7.4: Kilometer stone details

7.19.5. 200 m Stones and Boundary Stones

The details of 200m stones and boundary stones conform to IRC: 26-1967 and IRC: 25-1967 respectively. 200m stones are located on the same side of the road as the kilometre stones. The inscription on the stones shall be the numerals 2,4,6 and 8 marked in an ascending order in the direction of increasing kilometerage away from the starting station. The numerals shall be 80mm high. The colour of the numerals shall be black on a white background. Boundary stones shall be located on either side of the road opposite every 200m stone and kilometre stone. In addition, these shall be fixed at all angular points of the boundary. Where the boundary is on a curve or the land is of significant value and likely to be encroached upon, the boundary stones, as required, shall be installed at closer intervals.

7.19.6. Guard Rails

The guard rail is proposed at the built-up section where the pedestrian movement is predominant and need to bifurcate the road users among pedestrian and vehicular.

7.19.7. Crash Barrier

Metal Beam Crash Barrier is proposed at locations where the embankment height is more than 3.0m, at horizontal curves of radius less than 230m and also at major bridge approaches.

Figure 7.5: Crash Barrier

Wire Rope Crash Barrier are proposed for curve radii more than 450 m only. The barrier is extended at full height not less than 30 m in advance of the hazard on the approach side and shall continue at full height for 7.5 m beyond the hazard on the departure side.

Figure 7.6: Wire Rope Crash Barrier

7.19.8. Road Studs

Retro reflective studs are used to supplement longitudinal/transverse reflectorized marking, which would improve visibility at night time and adverse weather conditions. Road Studs are also used across the carriage way to serve as speed arrester coupled with eschewing warning through the creation of the rumbling sensation of the user. Following are the locations where road studs are proposed,

- At Junctions
- At Urban Portions
- At Structure Approaches
- Sharp Curves

7.19.9. Rumble Strips

The Road Humps are formed by providing a rounded hump of 3.7m width (17m radius) and 0.15m height for the preferred advisory crossing speed of 25kmph for general traffic as per the IRC: 99– 1988 guidelines. The basic material for construction is open premix bituminous surfacing on minor roads or perpendicular arms about 25m away from the inner edge of the carriageway. Proper signs boards and markings are provided to caution the drivers in advance of the situation. Road humps are extended across carriageway up to the edge of paved shoulder.

Rumble Strips are formed by a sequence of transverse strips laid across a carriageway. Maximum permitted height of 15mm provided no vertical face exceeds 6mm. These rumble device produce audible and vibratory effects to alert drivers to take greater care and do not normally reduce traffic speeds in themselves. The typical design details of rumble strips proposed are transverse strips of open premix bituminous surfacing 500mm wide and overall

thickness 15mm laid across a carriageway up to the end of paved shoulder. There will be 6 such transverse strips spaced at 1.0m c/c. Rumble strips are proposed in advance of:

i. Sharp curves with radius less than 170m.
ii. Transition zones (speed limit zones).
iii. Village/urban approaches.

Proper sign boards and marking are proposed to advise the drivers in advance of the situation.

Figure 7.7: Rumble Strip

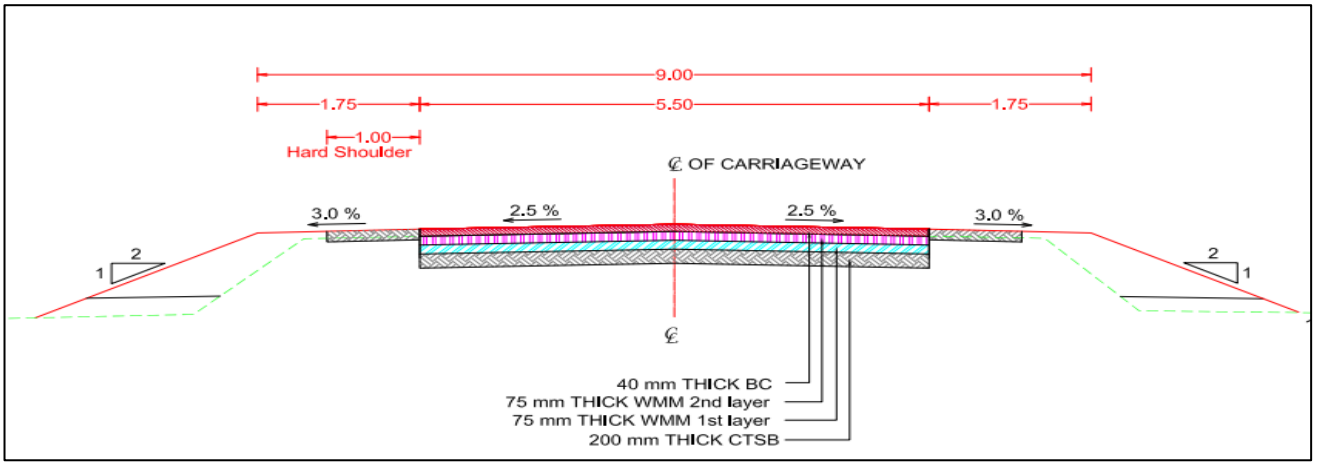
8 COST ESTIMATE

8.1 Introduction

Cost estimation is a vital input for assessing financial and economic viability of the project. This chapter presents cost estimation for **"Improvement and upgradation of Mangaldoi-Mazikuchi road from KM 11+000 to KM 26+000 under NESIDS for the year 2024-25 (L=15 kms)"**. The total length of the project section is **15 km** Total project cost includes construction of all civil works and non-civil cost. Each of those components are discussed in the following sections.

8.2 Cross Section

Existing road consists of single lane sections Improvements proposed for the existing road are widening and reconstruction of the existing pavement, to intermediate lane with earthen shoulder configuration. The total length of the project section is 15.000 km. The pictorial representation of typical cross section is shown below:



8.3 Methodology

- Quantities of various components are worked out based on preliminary engineering.
- Rate analysis template published by MORTH is used.
- This Details Project report is prepared on the basis "Schedule of Rates for Roads, Bridge and Culvert works for National Highways under Assam P.W. (Building & NH) Deptt, for the year 2020-21" has been considered while the works will be executed as per APWD general Specification and norms that is current in the state.
- Entire project road corridor is considered for reconstruction with flexible pavement.
- Unit rates for key materials have been referred from SOR & market rates.
- CTSB mixing Methodology - The CTSB Material is spread with the help of motor grader on the approved layer of Sub-grade in single layer of 200 mm with Grading V. During spreading and mixing by rotavator in site, water is sprinkled over the material by water browser mounted on water tanker.
- WMM mixing Methodology- Wet Mix Macadam consist of laying spreading and compacting of clean, crushed, well-graded granular materials on a prepared and approved Granular sub-Base. The material is well mixed with water and rolled to a dense mass. It shall be laid on two

layers as per line and level, grade and cross section shown in the drawing or as directed by the Engineer. The thickness of single compacted Wet Mixed Macadam (WMM) Base shall 125 mm. Maximum thickness of compacted layer base 250 mm approval of Engineer. Refer: - Clause-406(As per Morth)

- BC mixing Methodology- The temperature of bitumen is controlled through the digital display of temperature in the control cabin. The batch weight as per JMF is fixed in the control cabin to get the mix as per the approved job mix formula. The bitumen content is set by calibrating the plant by extraction test and feeding the resulting correction to the plant value. Mixing time of 12 seconds is fixed so that the all the aggregates and bitumen are thoroughly mixed and all aggregate are coated with bitumen content.

Aggregate mixing = 170 - 185 ^{0} C
Bitumen mixing = 170 - 175 ^{0} C Mix temperature = 170 - 175 ^{0} C Laying = 160 – 165 ^{0} C Rolling = 150 -160 ^{0} C

8.4 Lead Chart of Construction materials

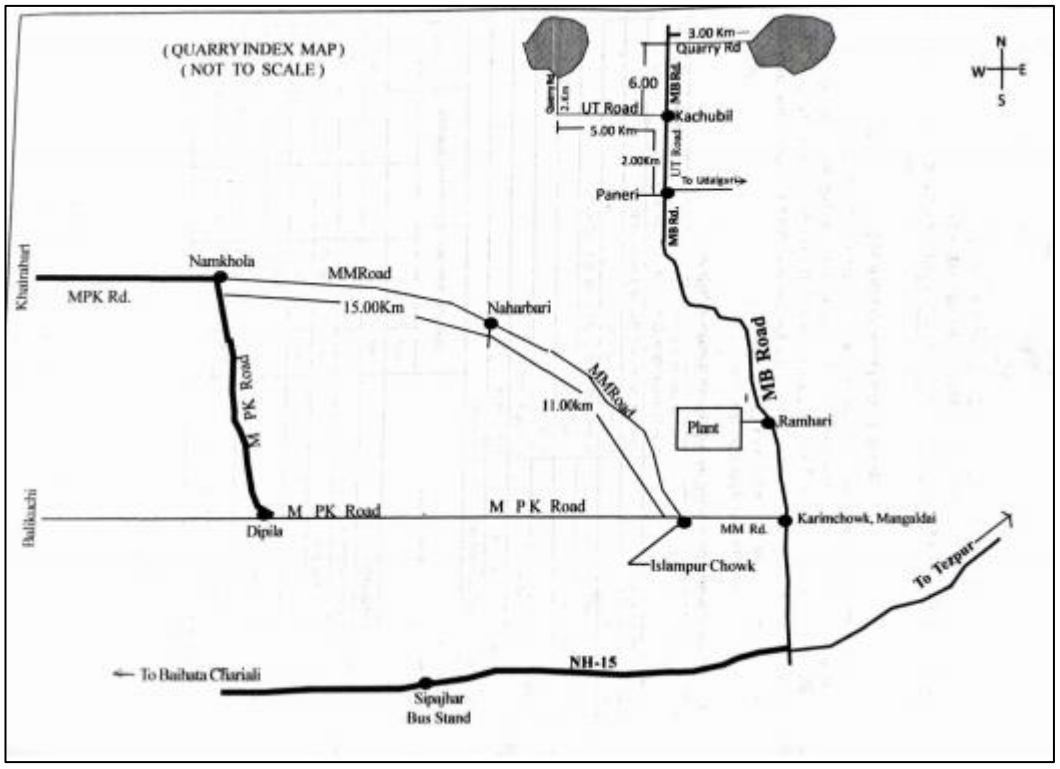


Figure 8.1: Lead Chart

Road Name	Road Type	Total Lead	Initial Lead	Net Lead
Quarry Road =	Katcha Road	3.0 Km.	3.0 Km.	0.0 Km.
MB Road(Upto Mangaldoi) =	Surfaced Road	32.0 Km.	2.0 Km.	30.0 Km.
UT Road (Kachubil to Panery) =	Surfaced Road	2.0 Km.		2.0 Km.
MM Road(Upto Naharbari) =	Surfaced Road	11.0 Km.		11.0 Km.
Proposed Road (avg)=	Surfaced Road	8.0 Km.		8.0 Km.
	Total Lead =	**56.0 Km.**	**5.0 Km.**	**51.0 Km.**

8.5 Unit Rates of Materials

Stone/metal quarries have been identified nearest to the road and average lead has been worked out as **56 km**. The rates for cement, bitumen and steel have been taken as Schedule rates. Rates of important items are escalated as per market rate**.**

8.6 Estimation of Quantities and Cost

The quantities of major items of works have been worked out based on developmental proposal, inventory, condition surveys, and other pavement investigations data. The pavement quantities have been worked based on the typical cross section and widening schedule prepared for project road

8.6.1. Site clearance and dismantling

Site clearance includes the dismantling of pavement courses, drains, kilometer stones, hectometer stones, road signs, metal beam crash barriers etc. The area considered for Site Clearance is the area within the proposed Right of Way minus the existing carriageway area.

8.6.2. Earthwork

Earthworks includes items like excavation necessary for roadway construction, embankment construction with excavated and/or borrow materials, construction of sub-grade and earthen shoulder with selected materials from borrow, median fill materials etc.

The total earthwork in cut-and-fill has been determined from computerized CAD software ("Road Estimator").

8.6.3. Pavement Works

a) Sub-Base and Granular Base Course

CTSB and WMM for the main road are billed under this heading.

b)Bituminous Course and Cement Concrete Pavement

This covers all items of bituminous courses and surfacing for flexible pavement considered.

8.6.4. Structure and CD Works

a) Rehabilitation of structures

Repair and rehabilitation of all type of existing retained structures is included.

b)New construction / reconstruction

Cost towards construction of all type of new structures including minor / major bridges, box culvert, and slab culvert is considered.

8.6.5. Drainage and Protective Work

Lined drains are proposed to be constructed in the settlement areas and unlined drains are proposed to be constructed in the open areas. Stone pitching will be provided for embankment height more than 3m. Metallic crash barriers are proposed at embankment height more than 3 m.

8.6.6. Road Appurtenances

Appurtenances are accessories to roadways, not part of their travelled portions. They include curbs and gutters, sidewalks, driveways, drainage structures, signs, guardrail, bridge railing, traffic signals and light poles. They are all important components of roadways.

8.6.7. Road Safety Measures

The road traffic signs, road markings and safety devices for the project are provided as per IRC standards. This includes the quantities of road markings, road signs (all kinds), crash barriers required for smooth functioning of roads.

8.6.8. **Wayside Amenities**

The Government intends to develop the following types of Wayside Amenities Projects to include Bus Shelter &Bus Bay, Solar Street Lights on Highways for road users.

8.6.9. **Utility Services**

The cost is considered for affected services like water pipes, sewers, oil pipelines, cables, gas ducts etc.

8.6.10. **Miscellaneous**

All other necessary provisions such as Footpath, Solar Street Lighting. have been made for all the items present along the project corridor.

The road furniture, traffic safety features and other facilities included in the design are:

a) Road Markings
b) Kilometer Stone
c) 200m Stones and Boundary Stones
d) Chevron and Object Markers
e) Crash Barrier

8.6.11. **Environmental Mitigation**

Environmental management plan has been prepared for mitigation/management/ avoidance of the potential adverse impacts and enhancement of various environmental components along the project road. For each mitigation measure to be carried out its location, time frame, implementation and overseeing/ supervising responsibilities have been identified. Monitoring plan for construction and operation phase is being framed to ensure effective implementation EMP.

8.6.12. **Land Acquisition and R&R**

Resettlement & Rehabilitation approach is based on the requirement of the ROW and Available ROW. The proposed road project will acquire land or structure by recognizing the social issues that may arise due to the proposed project. The land acquisition for the proposed project will be as per RFCTLAAR 2013 & its amendments for the proposed land and structure to be acquired.

8.7 Non-Civil Cost

Cost towards relocation of utilities shifting & tree cutting are received from respective government agencies and included in estimates. However, cost towards implementation of Environmental management plan, implementation of Resettlement plan, land acquisition is worked out as per prevailing procedures and included in estimate.

Provisions for overhead and administrate expense are considered in total project cost as per prevailing procedure of ASSAM PWRD.

8.8 Abstract of Cost Estimate

Table 1: Abstract of Cost Estimate (As per New Technology)

SN	Item of Work	Quantity	Unit	Rate	Total (Rs.)
1	**Site clearance (from Km. 0+0 to Km. 15+000 = 14646 km**				
1.1	Clearing and Grubbing Road Land				
	(14646 x 6.0 /10000) =8.788 Hect	8.788	Hect	53954.00	4,74,148
1.1	Dismantling of existing structure				4,66,809
1.2	Cutting of Trees				31,026
2	**Earth work (Formation Width- 9.0M)**				
2.1	Filling (Material Obtained from Borrow Pits)	117316	cum	475.00	5,57,25,224
3	**Pavement work (Carriageway width - 5.5 m)**				
3.1	Scarifying existing bituminous surface	54922.50		9.00	4,94,303
3.2	**CTSB: 200 mm - Existing Pavement : width-3.75 m : (Net length-14646 M)**				
3.2.1	CTSB 200 mm for full stretch (14646 x 5.6 x .2)	16403.52	cum	5552.16	9,10,74,968
3.2.2	Hard shoulder at Open Country : GSBC-150 mm @ .5 m both sides Area- (2 x 13206 x .5 x 0.150	1980.90	cum	4620.57	91,52,887
3.2.3	Hard shoulder at Built-Up Areas : GSBC-150 mm @ 1.75 m both sides Area- (2 x 1440 x 1.75 x 0.150	756.00	cum	4620.57	34,93,151
3.3	WMM 150 mm (14646 x 5.5 x 0.15) =12082.95	12082.95	cum	5322.86	6,43,15,851
3.4	Prime coat (14646 x 5.5) =80553	80553.0	sqm	31.00	24,97,143
3.5	BC 40 mm (14646 x 5.5 x 0.040) =3222.12	3222.12	cum	11670.60	3,76,04,074
4	**Protection Works**				
4.1	Pitching and boulder appron	1875	Rm	9355.69	1,75,41,914
5.2	Toe Wall (Height 1.0m)				
4.2	Toe Wall (Height 1.50m)	480	Rm	16463.44	79,02,451
5	**RCC Drain**				
5.4	RCC Covered Drain of size 1.0m x .75 m	3180	Rm	10735.56	3,41,39,087
6	**Cross Drainage Works (New Box Culverts)**				
6.1	RCC Box Culvert: 1.5 m x 1.5 m	17	no.	1551801.82	2,63,80,631
6.2	RCC Box Culvert: 2 m x 2 m	9	no.	1765132.77	1,58,86,195
6.3	RCC Box Culvert: 3 m x 3 m	3	no.	2466495.01	73,99,485
6.4	RCC Box Culvert: 4 m x 3 m	3	no.	3085433.00	92,56,299
6.5	RCC Box Culvert: 2x 4 m x 3 m	2	no.	3995019.66	79,90,039
7	**Traffic signs & Road marking (as per estimate)**	**15.00**	Km	278064.00	41,70,955
7.1	Metal Beam Crash Barrier	1000.00	RM	3475.00	34,75,000
				Total Road Cost - (A)	**39,94,71,639**
8	**RCC Bridges**				
8.1	Minor Bridge (Km. 14850)	12.0	Rm	860846.00	1,03,30,154
8.2	Rehabilitation of RCC Bridges (KM 21300 and KM 24500)	190.0	RM		13,20,595
				Total Bridge Cost - (B)	**1,16,50,749**
				Total Road Bridge Cost (A+B) --- (C)	**41,11,22,388**
9	Add GST as applicable on C (18%)	*Refer Para 02 of preface of SoR 2020-21*			7,40,02,030

SN	Item of Work	Quantity	Unit	Rate	Total (Rs.)
10	Labour welfare cess on C (1%)				41,11,224
11	**Maintainace Cost for 4 years**				
	1st Year(Defect Liability)				0.00
	2nd Year(0.5% of C)				20,55,612
	3rd Year(0.5% of C)				20,55,612
	4th Year(0.5% of C)				20,55,612
	5th Year(0.5% of C)				20,55,612
12	Add Contingency @2% on C (Plain Area)				82,22,448
13	Add Quality Control @1% on C				41,11,224
14	Consultancy service for bridge work : 1% on(B)				1,16,507
15	Consultancy service (@ 2.50 lakh/Km)	15.00	Km	2,50,000	37,50,000
16	Utility Shifting @ 2,00,000 for approx. 15 kms of Project Road	15.00	Km	2,00,000	30,00,000
				Grand total	**51,66,58,269**
				Say Rs.(in Crore)	**51.666 Cr.**

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Executive Engineer, PWD
Mangaldoi, Dalgaon and Sipajhar
Territorial Road Division

Chief Engineer, P.W.D.
Border Roads & NEC Works
Assam, Chandmari, Guwahati-3

Commissioner & Spl. Secretary to
the Govt. of Assam
Public Works Department
Dispur, Guwahati-6

Table 2: Abstract of Cost (As per Conventional Method)

SN	Item of Work	Quantity	Unit	Rate	Total (Rs.)
1	**Site clearance (from Km. 0+0 to Km. 15+000 = 14646 km**				
1.1	Clearing and Grubbing Road Land				
	(14646 x 6.0 /10000) =8.788 Hect	8.788	Hect	53954.00	4,74,148
1.1	Dismantling of existing structure				4,66,809
1.2	Cutting of Trees				31,026
2	**Earth work (Formation Width- 9.0M)**				
2.1	Filling (Material Obtained from Borrow Pits)	117316	cum	475.00	5,57,25,224
3	**Pavement work (Carriageway width - 5.5 m)**				
3.1	Scarifying existing bituminous surface	54922.50		9.00	4,94,303
3.2	**GSB: 150 mm - Existing Pavement : width-3.75 m : (Net length-14646 M)**				
3.2.1	GSB 150 mm for widening (14646 x 3 x .15)	6590.70	cum	5552.16	3,65,92,621
3.2.2	Hard shoulder at Open Country : GSBC-150 mm @ .5 m both sides Area- (2 x 13206 x .5 x 0.150	1980.90	cum	4620.57	91,52,887
3.2.3	Hard shoulder at Built-Up Areas : GSBC-150 mm @ 1.75 m both sides Area- (2 x 1440 x 1.75 x 0.150	756.00	cum	4620.57	34,93,151
3.3	WMM 250 mm (14646 x 5.5 x 0.25) =20138.25	20138.25	cum	5322.86	10,71,93,085
3.4	Prime coat (14646 x 5.5) =80553	80553.0	sqm	31.00	24,97,143
3.5	DBM 60 mm (14646 x 5.5 x 0.060) =4833.18	4833.2	cum	10535.91	5,09,21,949
3.6	Tack Coat (14646 x 5.5) =80553	80553.0	cum	11.00	8,86,083
3.7	BC 30 mm (14646 x 5.5 x 0.030) =2416.59	2416.59	cum	11670.60	2,82,03,055
4	**Protection Works**				
4.1	Pitching and boulder appron	1875	Rm	9355.69	1,75,41,914
4.2	Toe Wall (Height 1.50m)	480	Rm	16463.44	79,02,451
5	**RCC Drain**				
5.4	RCC Covered Drain of size 1.0m x .75 m	3180	Rm	10735.56	3,41,39,087
6	**Cross Drainage Works (New Box Culverts)**				
6.1	RCC Box Culvert: 1.5 m x 1.5 m	17	no.	1551801.82	2,63,80,631
6.2	RCC Box Culvert: 2 m x 2 m	9	no.	1992232.00	1,79,30,088
6.3	RCC Box Culvert: 3 m x 3 m	3	no.	2466495.01	73,99,485
6.4	RCC Box Culvert: 4 m x 3 m	3	no.	3085433.00	92,56,299
6.5	RCC Box Culvert: 2x 4 m x 3 m	2	no.	3995019.66	79,90,039
7	**Traffic signs & Road marking (as per estimate)**	**15.00**	Km		41,70,955
7.1	Metal Beam Crash Barrier	1000.00	RM	3475.00	34,75,000
				Total Road Cost - (A)	**43,23,17,434**
8	**RCC Bridges**				
8.1	Minor Bridge (Km. 14850)	12.0	Rm	860846.00	1,03,30,154
8.2	Rehabilitation of RCC Bridges (KM 21300 and KM 24500)	190.0	RM		13,20,595
				Total Bridge Cost - (B)	**1,16,50,749**
				Total Road Bridge Cost (A+B) --- (C)	**44,39,68,183**

Table 2: Abstract of Cost (As per Conventional Method)

SN	Item of Work	Quantity	Unit	Rate	Total (Rs.)
9	Add GST as applicable on C (18%)	*Refer Para 02 of preface of SoR 2020-21*			7,99,14,273
10	Labour welfare cess on C (1%)				44,39,682
11	**Maintainace Cost for 4 years**				
	1st Year(Defect Liability)				0.00
	2nd Year(0.5% of C)				22,19,841
	3rd Year(0.5% of C)				22,19,841
	4th Year(0.5% of C)				22,19,841
	5th Year(0.5% of C)				22,19,841
12	Add Contigency @2% on C (Plain Area)				88,79,364
13	Add Quality Control @1% on C				44,39,682
14	Consultancy service for bridge work : 1% on (B)				1,16,507
15	Consultancy service (@ 2.50 lakh/Km)	15.00	Km	2,50,000	37,50,000
16	Utility Shifting @ 2,00,000 for approx 15 kms of Project Road	15.00	Km	2,00,000	30,00,000
				Grand total	**55,73,87,054**
				Say Rs.(in Crore)	**55.739 Cr.**

Table 3: Comparative Statement (New Technology vs Conventional Menthod)

SN	Item of Work	As per Conventional method	As per Provision of New Technology	Cost difference	Remarks
1	Site clearance	9,71,983	9,71,983	0	
2	Earth work (Formation Width-9.0M)	5,57,25,224	5,57,25,224	0	
3	Pavement work (Carriageway width - 5.5 m)	-	-	0	
3.1	Scarifying existing bituminous surface	4,94,303	4,94,303	0	
3.2	Sub base course		-	0	**Pavement Thicknesses for new technology considered as per Plate 44 of IRC 37 2018**
	GSBC for Widening Portion	3,65,92,621		36592621	
	CTSB for full stretch		9,10,74,968	-91074968	
	Hard shoulder : GSBC	1,26,46,038	1,26,46,038	0	
3.3	Non-Bituminous Base Course (WMM)	10,71,93,085	6,43,15,851	42877234	
3.4	Bituminous Base Course (DBM)	5,09,21,949	0	50921949	
3.5	Prime Coat	24,97,143	24,97,143	0	
3.6	Tack Coat	8,86,083	0	886083	
3.7	Wearing Coat (Bituminous Course)	2,82,03,055	3,76,04,074	-9401018	
4	RCC Rectangular Covered Drain (built up area) (1m x 1m)	3,41,39,087	3,41,39,087	0	
5	Protection Works	2,54,44,365	2,54,44,365	0	
6	Cross Drainage Works (New Box Culverts)	6,89,56,542	6,69,12,649	2043893	
7	Traffic signs & Road marking (as	76,45,955	76,45,955	0	

Table 3: Comparative Statement (New Technology vs Conventional Menthod)

SN	Item of Work	As per Conventional method	As per Provision of New Technology	Cost difference	Remarks
	per estimate)				
	Total Road Cost - (A)	**43,23,17,434**	**39,94,71,639**	**3,28,45,795**	
8	RCC Bridges			0	
	Minor Bridge (Km. 14850)	10330154	10330154	0	
	Rehabilitation of RCC Bridges (KM 21300 and KM 24500)	1320595.0	1320595	0	
	Total Bridge Cost - (B)	**1,16,50,749**	**1,16,50,749**	**0**	
11	Junction				
	Total Road Bridge Cost (A+B) --- (C)	**44,39,68,183**	**41,11,22,388**	**3,28,45,795**	
9	Add GST as applicable on C (18%)	7,99,14,273	7,40,02,030	5912243	
10	Labour welfare cess on C (1%)	44,39,682	41,11,224	328458	
11	Maintainace Cost for 4 years			0	
	1st Year(Defect Liability)	0.00	0.00	0	
	2nd Year(0.5% of A)	2219840.91	2055611.94	164229	
	3rd Year(0.5% of A)	2219840.91	2055611.94	164229	
	4th Year(0.5% of A)	2219840.91	2055611.94	164229	
	5th Year (0.5% of A)	2219840.91	2055611.94	164229	
12	Add Contigency @2% on C (Plain Area)	8879363.65	8222447.76	656916	
13	Add Quality Control @1% on C	4439681.83	4111223.88	328458	
14	Consultancy service for bridge work : 1% on (B)	116507.49	116507.49	0	
15	Consultancy service (@ 2.50 lakh/Km)	3750000.00	3750000.00	0	
16	Utility Shifting @ 2,00,000 for approx 15 kms of Project Road	3000000.00	3000000.00	0	
	Grand total	**55,73,87,054**	**51,66,58,269**	**4,07,28,785**	

8.9 BILL OF QUANTITIES

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
Bill NO. 1. SITE CLEARANCE AND DISMANTLING						
1.01	2.3	**Clearing and Grubbing Road Land .** (Clearing and grubbing road land including uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth up to 300 mm, removal of stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable material to be used or auctioned up to a lead of 1000 metres including removal and disposal of top organic soil not exceeding 150 mm in thickness.)				
	(i)	By Manual Means:-				
	A	In area of light jungle				
		Quantity as per Anexure-1	Hct.	8.788	53954.00	4,74,147.75
1.02	2.4	**Dismantling of existing structure** of Structures (Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts and lead of 1000 metres)				
	(i)	a) Lime /Cement Concrete				
	I	By Manual Means				
		B) Cement Concrete Grade M-15 & M-20	Cum	774.00	560.00	4,33,440.00
	(ix)	Removing all type of hume pipes and stacking within a lead of 1000 metres including earthwork and dismantling of masonry works.				
		A) Up to 600 mm dia	m	49.00	183.00	8,967.00
		B) Above 600 mm to 900 mm dia	m	98.00	249.00	24,402.00

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
1.03	2.1	Cutting of Trees, including Cutting of Trunks, Branches and Removal (Cutting of trees, including cutting of trunks, branches and removal of stumps, roots, stacking of serviceable material with all lifts and up to a lead of 1000 mtrs and earth filling in the depression/pit.				
	(i)	Girth from 300 mm to 600 mm	each	40	305.00	12,200.00
	(ii)	Girth from 600 mm to 900 mm	each	22	608.00	13,376.00
	(iii)	Girth from 900 mm to 1800 mm	each	5	1090.00	5,450.00
					Total Cost for C&G =	**9 71 982.75**
Bill No. 2. EARTH WORK						
2.01	3.16	**Embankment Construction with Material Obtained from Borrow Pits** (Construction of embankment with approved material obtained from borrow pits with all lifts and leads, transporting to site, spreading, grading to required slope and compacting to meet requirment of table 300-2(Including cost of testing of materials at site and laboratory as directed by the deptt.) a. from private land ***Quantity as per Anexure-2***	cu.m	117316.26	475.00	557 25 223.50
					Total Cost for Earth work =	**557 25 223.50**
Bill NO .3. Pavement work						
3.01	3.15	Scarifying existing bituminous surface to a depth of 50 mm by mechanical means (Scarifying the existing bituminous road surface to a depth of 50 mm and disposal of scarified material with in all lifts and lead upto 1000 metres.)	sqm	54922.50	9.00	4,94,302.50
3.02	4.2	Cement Treated Crushed Rock or combination as per clause 403.2 and table 400.4 in Sub base/ Base (Providing, laying and spreading Material on a prepared sub grade, adding the designed quantity of cement to the spread Material, mixing in place with rotavator grading with motor grader and compacting with road roller at OMC to achieve desired unconfined compressive strength and to form a layer of sub base / base.)				
		for grading- II Material				

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
	(i)	For Sub-Base course	Cum	16403.52	5552.16	910 74 967.60
3.02	4.2	Granular Sub-Base with Coarse Graded Material (Table:- 400- 2) (Construction of granular sub-base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC,and compacting with vibratory roller to achieve the desired density,complete as per cl. 401(with an initial lead of 5 Km.)				
	(iii)	For Hard shoulder (2 x 14646 x 1.00 x 0.150)	Cum	2736.90	4620.57	126 46 038.03
3.03	4.12	Wet Mix Macadam (Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sb-base/base course on well prepared surface and compacting with vibratory roller to achieve the desired density (including carriage up to initial lead of 5.0 km from quarry and carriage of mixed materials up to 10.0 Km initial lead from mixing plant)				
	(ii)	For Base course	Cum	12082.95		
			Cum	12082.95	5322.86	643 15 851.24
3.05	5.1	**Prime coat** (Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 1.00 kg/sqm using mechanical means.)(Including cost of testing of materials at site and laboratory as directed by the deptt.)				
		B.(i) With bitumen emulsion-CSS-1h	sq.m	80553.00	31.00	24 97 143.00

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
3.07	5.8	**Bituminous Concrete** (Providing and laying bituminous concrete with 100-120 TPH batch type hot mix plant producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5.4 to 5.6 % of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MoRT&H specification clause No. 509 complete in all respects) (including carriage up to initial lead of 5.0 km from quarry and carriage of mixed materials up to 10.0 Km initial lead from mixing plant)(Including cost of testing of materials at site and laboratory as directed by the deptt.) A. With hydrated lime/cement as filler (refer table 500-9 of MoSRT&H specification) II. with Polymer modified bitumen 70 (i). for Grading-I (19 mm nominal size)	Cum	3222.12	11670.60	376 04 073.67
					Total :	**20,86,32,376.04**
Bill No. 5. DRAIN WORKS						
A. Longitudinal RCC Covered Drain						
4.01	1	Construction of RCC Closed drain of size 1.0 m x 0.75 m	Rm	3180.0	10735.6	34139087.16
				Sub - Total =		**3,41,39,087.16**
Bill NO. 6. PROTECTION WORK						
		A. Boulder Pitching and Floor Appron				
5.01	2503	**Boulder Apron laid in wire crates** (Providing and laying of boulder apron laid in wire crates made with 4mm dia GI wire conforming to IS: 280& IS:4826 in 100mm x 100mm mesh(weaved diagonally) including 10%extra for laps and joints laid with stone boulders weighting not less than 40kg each	cum	1757.813	5212.00	9161718.75

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
5.02	2504	Providing and laying pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankment complete as per drawing and technical specifications A. Stone/Boulder	cum	562.500	3070.00	1726875.00
5.03	2504	Providing and laying filter material underneath pitching in slope in slopes complete as per drawing and technical specification	cum	1757.813	3785.00	6653320.31
Annexure 7. PCC Toe wall						
7.10	2	Construction of PCC Toe Wall of height 1.5 m Rate as per annexure 12 B	Rm	480.00	16463.44	7902451.20
					Sub - Total for Protection work =	**2,54,44,365.26**
Bill NO. 4. CROSS DRAINAGE WORKS						
	A	Construction of RCC Box culvert of Size 1/1.51.5/0 with wing wall (Rate as per annexure-6A	Nos	17	1551801.82	263 80 630.94
	B	Construction of RCC Box culvert of Size 1/22/0 with wing wall (Rate as per annexure-6B	Nos	9	1765132.77	158 86 194.93
	C	Construction of RCC Box culvert of Size 1/33/0 with wing wall (Rate as per annexure-6C	Nos	3	2466495.01	73 99 485.03
	D	Construction of RCC Box culvert of Size 1/43/0 with wing wall (Rate as per annexure-6D	Nos	3	3085433.00	92 56 299.00
	A	Construction of RCC Box culvert of Size 2/43/0 with wing wall (Rate as per annexure-6E	Nos	2	3995019.66	79 90 039.32
					Sub - Total for culvert work =	**6,69,12,649.22**
Bill NO. 8. RCC BRIDGE WORKS						
Bill NO. 8-A. Minor BRIDGE WORKS						
		Construction of RCC Bridge no 15//1	Rm	12	860846.00	103 30 152.00
Bill NO. 8-Bridge Rehabilitation works						
8.01		Repair of RCC Railing (Carrying out repair of RCC M30 railing to bring it to the original shape.)	Rm	190	250.00	47 500.00
8.02	***14.16***	Painting on concrete surface (Providing and applying 2 coats of water based cement paint to unplastered concrete surface after cleaning the surface of dirt, dust, oil, grease, efflorescence and applying paint @ of 1 litre for 2 Sq.m.)	Rm	190	1053.00	2 00 070.00
	B	For RCC Railing				

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
8.03	***5.14***	Mastic Asphalt (Providing and laying mastic asphalt wearing course with paving grade bitumen meeting the requirements given in table 500-29 (binder having penetration as (15+/-5) at 25 deg. centrigrade), prepared by using mastic cooker and laid to required level and slope after cleaning the surface, including providing anti skid surface with bitumen pre coated fine grained hard stone ships of 13.2mm nominal size at the rate of .005cum per 10 sqm. and at an approximate spacing of 10 cm center tpo center in both direction , pressed into surface when the temperature of surfaces not less than 1000C, protuding 1mm to 4mm over mastic surface , all complete as per clause 515 .(including carriage up to initial lead of 5.0 km from quarry.)	sqm	1425.00	753.00	10 73 025.00
		Sub - Total forRCC Bridges work =				**1,16,50,747.00**
Bill No. 9. TRAFFIC SIGNS MARKING AND OTHER ROAD APPURTENANCES & PLANTATIONS						
7.01	8.14	**Kilo Metre Stone** (Reinforced cement concrete M15grade kilometre stone of standard design as per IRC:8-1980, fixing in position including painting and printing etc)				
		i) 5th km stones	No.	0	5429.00	
		ii) Km stones	No.	20	3289.00	65780.00
		iii) Hectometer stones	No.	0	862.00	
7.02	8.13	**Road Marking with Hot Applied Thermoplastic Compound** 2.5 mm thick including reflectorising glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35 .The finished surface to be level, uniform and free from streaks and holes and conforming to the MoSrt&H specifications	sq.m	3090.00	750.00	2317500.00

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
7.03	8.4	**Retro reflectorised Traffic sign:** Providing and erecting of Retro-Reflectrorised cautionary, mandator & informatory sign as per IRC: 67 made of high intensity encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminium sheeting, 2 mm thick fixed on an angle iron of 25x25x4mm supported on a mild steel angle iron post 75mm x 75mm x 6mm firmly fixed to the ground by means of properly design foundation with M-15 grade Cement concrete 45cm x 45cm x 60cm, 60cm below ground level as per approved drawing and sign. (All the Steel work must be Tata/Sail/or any other approved brand)				
	(i)	90cm equilateral traingle	No.	15	4900.00	73500.00
	(ii)	60cm equilateral traingle	No.	15	3595.00	53925.00
	(iii)	60cm circular	No.	15	4200.00	63000.00
	(iv)	80cmm x 60 cm rectangular	No.	15	5300.00	79500.00
	(v)	60cmm x 45 cm rectangular	No.	15	5200.00	78000.00
	(vi)	60cmm x 60 cm square	No.	15	5200.00	78000.00
	(vii)	90cm high octagon	No.	15	7850.00	117750.00
7.06	8.47	**Solar Studs of Tata BP providing sparkle solar stud** Providing 'Sparkle Solar Road Studs, manufactured by Tata B.P. Solar India Ltd. Of size (125mmx125mm), 90mm height (from bottom of shank to the top of stud) with detachablebattery, m6LEDsthree on each side for Bi-directional studs/3 LEDs on one side for unidirectional studs, ultra bright LED in amber and red colour, weight per stud 700+25 gms, flash rate of 50-65 times per minute completely water resistant and weather proof with replacement warranty and free maintenance fro one year from the date of installation of stud on road-(installation should be made using adhesives and procedures recommended by manufacturer under the supervision of their competent technician).a) Bi-directional Stud-	each	100	3500.00	350000.00

Sl. No.	Ref	Description	Unit	Quantity	Rate	Amount
7.09		Providing reflective pavement marker with Micro prismatic lens in both direction having thermoplastic body adhering to the specification and guidelines of MoRT&H's fixed to the road surface using the adhesives and the procedures recommended by the manufacturers with three months replacement warranty and free maintenance.	each	3000.00	298.00	8,94,000.00
					Sub - Total fortraffic work =	**41,70,955.00**
7.05	8.24	**Type - A, "W" : Metal Beam Crash Barrier** (Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2m center to center, 1.8 m high, 1.1m below ground/road level, all steel parts and fitments to be galvanized by hot dip process, all fitting to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150mmX75mmX5mm, 330mm long complete as per clause 810.)	m	1000.00	3475.00	3475000.00
					Total Cost =	**41,11,22,388**

ANNEXURES AND APPENDICES OF COST ESTIMATE

Annexure 1 - DETAILS OF MEASUREMENT

Item No.	Descriptions	Unit	No.	Length	Width	Ht/Th	Area	Quantity
Bill NO. 1.	**SITE CLEARANCE AND DISMANTLING**							
1.01	Clearing and Grubbing of Road land	Hct	1	14646	6.00			8.788
1.02	Transplantation of trees							
a)	Girth of trees upto 50cm.	No.	40					40
b)	Girth of trees beyond 50cm and upto 90cm.	No.	22					22
c)	Girth of trees beyond 90cm and upto 150cm.	No.	5					5
1.02	Dismantling of existing structures							
a)	Plain/Reinforced cement concrete structures							
	i) PCC M-10 & M-15							
	Culverts	cum	10	6.00	5.50	0.30		99.00
	Total							**99.00**
	ii) RCC M-20 MNB							
		cum	3	10.00	7.50	3.00		675.00
	Total							**675.00**
b)	Stone Masonary							
	Culverts	cum						
	Total							**0.00**
c)	Ordinary KM Stone	No.						0
d)	Removal of Hume Pipes							
	i) Upto 600mm dia	m	7	7.00				49.00
	ii) 900mm dia and above	m	14	7.00				98.00
1.03	Scarifying existing bituminous surface							
a)	Ext Bituminous pavement							
		cum						54922.50
Bill NO. 2. EARTHWORK								
	Embankment							
2.01	Excavation in Marshy Soil	Cum		***2400***	***2***	***1***		4800.00
2.01	Quantity for Embankment construction	cum	***Ref. Annexure 2***					**112516.26**
2.01	Embankment Construction with Material Obtained from Borrow Pits	cum		112516	-	0.00		112516.26
	Refill trenchess of Marshy soil	Cum						4800.00
	Total =							**117316.26**
Bill NO .3. PAVEMENT WORK								
3.01	CTSB	cum	***Ref. Annexure 3 A***					16403.52
3.02	WMM	cum	***Ref. Annexure 3 B***					12082.95
3.03	Primer Coat	sqm	***Ref. Annexure 3 C***					80553.00

Annexure 1 - DETAILS OF MEASUREMENT

Item No.	Descriptions	Unit	No.	Length	Width	Ht/Th	Area	Quantity
3.04	BC	cum						3222.12
3.05	Hard Shouder	cum	2	*14646.00*				
Bill No. 4 CROSS DRAINAGE WORKS								
5.01	Box Culverts	Nos	34		***Ref. Annexure 6***			
Bill No. 5. DRAIN WORKS								
6.01	RCC Cover Drains	Rm	3180		***Ref. Annexure 5***			
Bill No. 6. PROTECTION WORK								
13	Boulder Pitching and Floor Appron	Rm	1875		**Refer Annexure 4**			
Bill No. 7. TOE WALL WORK								
14	Gabion Toe Toe wall	Rm	480		**Refer Annexure 7**			
Bill No. 8. REHABILITATION OF EXISTING BRIDGES								
15	Repair of Existing Bridges	Rm	190			7.50		1425.00
Bill No. 9.TRAFFIC CONTROL AND MARKINGS								
16	Traffic Safety Works	KM	15		**Refer Annexure 8**			

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
1	11000	11200	200	3.75	6.4	3	3	((((4.5-3.2)+(4.5-3.2-3+1.5x3))/2)x3)+((((4.5-3.2)+(4.5-3.2-3+1.5x3))/2)x3) =	12.3	2460
2	11200	11320	120	3.75	6	2.5	1	((((4.5-3)+(4.5-3-2.5+1.5x2.5))/2)x2.5)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	7.063	847.56
3	11320	11380	60	3.75	6	3	2	((((4.5-3)+(4.5-3-3+1.5x3))/2)x3)+((((4.5-3)+(4.5-3-2+1.5x2))/2)x2) =	10.75	645
4	11380	11500	120	3.75	6	3	2	((((4.5-3)+(4.5-3-3+1.5x3))/2)x3)+((((4.5-3)+(4.5-3-2+1.5x2))/2)x2) =	10.75	1290
5	11500	11700	200	3.75	6.1	2.5	3	((((4.5-3.05)+(4.5-3.05-2.5+1.5x2.5))/2)x2.5)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	11.788	2357.6
6	11700	11800	100	3.75	6.1	3	1	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1) =	8.3	830
7	11800	11890	90	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	630
8	11890	11930	40	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	296
9	11930	12000	70	3.75	6.1	3	2	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	10.5	735
10	12000	12150	150	3.75	6.1	0	0	((((4.5-3.05)+(4.5-3.05-0+1.5x0))/2)x0)+((((4.5-3.05)+(4.5-3.05-0+1.5x0))/2)x0) =	0	0
11	12150	12230	80	3.75	6.5	0	0	((((4.5-3.25)+(4.5-3.25-0+1.5x0))/2)x0)+((((4.5-3.25)+(4.5-3.25-0+1.5x0))/2)x0) =	0	0
12	12230	12300	70	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	546
13	12300	12400	100	3.75	6.1	3	1	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1) =	8.3	830
14	12400	12550	150	3.75	6	2	3	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-3+1.5x3))/2)x3) =	10.75	1612.5
15	12550	12650	100	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	760
16	12650	12720	70	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	924
17	12720	12760	40	3.75	6.4	1	1	((((4.5-3.2)+(4.5-3.2-1+1.5x1))/2)x1)+((((4.5-3.2)+(4.5-3.2-1+1.5x1))/2)x1) =	3.1	124
18	12760	12900	140	3.75	6.4	2	2	((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2)+((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2) =	7.2	1008
19	12900	12970	70	3.75	6.4	2	3	((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2)+((((4.5-3.2)+(4.5-3.2-3+1.5x3))/2)x3) =	9.75	682.5
20	12970	13050	80	3.75	6	3	3	((((4.5-3)+(4.5-3-3+1.5x3))/2)x3)+((((4.5-3)+(4.5-3-3+1.5x3))/2)x3) =	13.5	1080
21	13050	13150	100	3.75	6.3	3	1	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1) =	7.9	790
22	13150	13200	50	3.75	6.3	3	3	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3) =	12.6	630
23	13200	13390	190	3.75	6	2	2	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-2+1.5x2))/2)x2) =	8	1520
24	13390	13500	110	3.75	6.3	2	1	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1) =	5.3	583

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
25	13500	13700	200	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	1520
26	13700	13750	50	3.75	6.2	3	3	((((4.5-3.1)+(4.5-3.1-3+1.5x3))/2)x3)+((((4.5-3.1)+(4.5-3.1-3+1.5x3))/2)x3) =	12.9	645
27	13750	14000	250	3.75	6.3	3	3	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3) =	12.6	3150
28	14000	14100	100	3.75	6.2	0	0	((((4.5-3.1)+(4.5-3.1-0+1.5x0))/2)x0)+((((4.5-3.1)+(4.5-3.1-0+1.5x0))/2)x0) =	0	0
29	14100	14230	130	3.75	6.5	1	3	((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1)+((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3) =	7.5	975
30	14230	14750	520	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	6864
31	14750	14850	100	3.75	6.3	4	4	((((4.5-3.15)+(4.5-3.15-4+1.5x4))/2)x4)+((((4.5-3.15)+(4.5-3.15-4+1.5x4))/2)x4) =	18.8	1880
MINOR BRIDGE						0	0			
32	14860	14900	40	3.75	6.4	4	4	((((4.5-3.2)+(4.5-3.2-4+1.5x4))/2)x4)+((((4.5-3.2)+(4.5-3.2-4+1.5x4))/2)x4) =	18.4	736
33	14900	15000	100	3.75	6.1	2	3	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	10.5	1050
34	15000	15300	300	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	2220
35	15300	15400	100	3.75	6.5	2.5	1	((((4.5-3.25)+(4.5-3.25-2.5+1.5x2.5))/2)x2.5)+((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1) =	6.188	618.8
36	15400	15420	20	3.75	6.3	1	1	((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1)+((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1) =	3.2	64
37	15420	15430	10	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	78
38	15430	15520	90	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	702
39	15520	15550	30	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	210
40	15550	15750	200	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	1520
41	15750	15800	50	3.75	6.4	2	2	((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2)+((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2) =	7.2	360
42	15800	16200	400	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	5280
43	16200	16300	100	3.75	6	2	1.5	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-1.5+1.5x1.5))/2)x1.5) =	6.813	681.3
44	16300	16400	100	3.75	6.1	1.5	1.5	((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5) =	5.475	547.5
45	16400	16570	170	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	1326
46	16570	16720	150	3.75	6.5	3	3	((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3)+((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3) =	12	1800
47	16720	16850	130	3.75	6.3	1.5	1.5	((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.15)+(4.5-3.15-	5.175	672.75

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
								1.5+1.5x1.5))/2)x1.5) =		
48	16850	17070	220	3.75	6.2	1.5	1.5	((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5) =	5.325	1171.5
49	17070	17600	530	3.75	6.3	1.5	1.5	((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5) =	5.175	2742.75
50	17600	17700	100	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	780
51	17700	17750	50	3.75	6.5	0	1	((((4.5-3.25)+(4.5-3.25-0+1.5x0))/2)x0)+((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1) =	1.5	75
52	17750	17780	30	3.75	6.4	1	2	((((4.5-3.2)+(4.5-3.2-1+1.5x1))/2)x1)+((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2) =	5.15	154.5
53	17780	17920	140	3.75	6.3	3	3	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3) =	12.6	1764
54	17920	18000	80	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	608
55	18000	18030	30	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	396
56	18030	18100	70	3.75	6	2	2	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-2+1.5x2))/2)x2) =	8	560
57	18100	18400	300	3.75	6	1.5	1	((((4.5-3)+(4.5-3-1.5+1.5x1.5))/2)x1.5)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	4.563	1368.9
58	18400	18450	50	3.75	6.3	1	1.5	((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1)+((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5) =	4.188	209.4
59	18450	18460	10	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	78
60	18460	18600	140	3.75	6.2	1	1	((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	3.3	462
61	18600	18700	100	3.75	6.2	0.5	1	((((4.5-3.1)+(4.5-3.1-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	2.413	241.3
62	18700	18850	150	3.75	6	0.5	1	((((4.5-3)+(4.5-3-0.5+1.5x0.5))/2)x0.5)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	2.563	384.45
63	18850	18900	50	3.75	6.3	2	1	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1) =	5.3	265
64	18900	18990	90	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	684
65	18990	19150	160	3.75	6.5	3	3	((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3)+((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3) =	12	1920
66	19150	19250	100	3.75	6.1	1	2	((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	5.6	560
67	19250	19300	50	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	370
68	19300	19400	100	3.75	6.5	2	0	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-0+1.5x0))/2)x0) =	3.5	350
69	19400	19550	150	3.75	6.5	3	2	((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	9.5	1425

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
70	19550	19600	50	3.75	6.1	1.5	1.5	((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5) =	5.475	273.75
71	19600	19650	50	3.75	6.2	0.5	1	((((4.5-3.1)+(4.5-3.1-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	2.413	120.65
72	19650	19700	50	3.75	6.3	0.5	0.5	((((4.5-3.15)+(4.5-3.15-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.15)+(4.5-3.15-0.5+1.5x0.5))/2)x0.5) =	1.475	73.75
73	19700	19600	-100	3.75	6.2	1	1	((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	3.3	-330
74	19600	19850	250	3.75	6	0.5	1	((((4.5-3)+(4.5-3-0.5+1.5x0.5))/2)x0.5)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	2.563	640.75
75	19850	19900	50	3.75	6.5	1	1	((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1)+((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1) =	3	150
76	19900	20050	150	3.75	6.1	0.5	1	((((4.5-3.05)+(4.5-3.05-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1) =	2.488	373.2
77	20050	20200	150	3.75	6	2	0	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-0+1.5x0))/2)x0) =	4	600
78	20200	20370	170	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	1326
79	20370	20700	330	3.75	6.2	0.5	1	((((4.5-3.1)+(4.5-3.1-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	2.413	796.29
80	20700	21000	300	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	2100
81	21000	21200	200	3.75	6.1	1.5	1.5	((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5) =	5.475	1095
82	21200	21270	70	3.75	6.3	3	3	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3) =	12.6	882
Nonoi River						0	0			
83	21340	21500	160	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	2112
84	21500	21550	50	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	390
85	21550	21700	150	3.75	6.2	1	1	((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1)+((((4.5-3.1)+(4.5-3.1-1+1.5x1))/2)x1) =	3.3	495
86	21700	21800	100	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	700
87	21800	22000	200	3.75	6	1	1	((((4.5-3)+(4.5-3-1+1.5x1))/2)x1)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	3.5	700
88	22000	22050	50	3.75	6.4	1	2.5	((((4.5-3.2)+(4.5-3.2-1+1.5x1))/2)x1)+((((4.5-3.2)+(4.5-3.2-2.5+1.5x2.5))/2)x2.5) =	6.363	318.15
89	22050	22100	50	3.75	6.3	1.5	2	((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	6.288	314.4

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
90	22100	22150	50	3.75	6.3	3	2	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	10	500
91	22150	22250	100	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	760
92	22250	22300	50	3.75	6.1	2	3	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	10.5	525
93	22300	22350	50	3.75	6.2	1.5	1.5	((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5) =	5.325	266.25
94	22350	22500	150	3.75	6.2	3	3	((((4.5-3.1)+(4.5-3.1-3+1.5x3))/2)x3)+((((4.5-3.1)+(4.5-3.1-3+1.5x3))/2)x3) =	12.9	1935
95	22500	22530	30	3.75	6.1	2	2	((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2)+((((4.5-3.05)+(4.5-3.05-2+1.5x2))/2)x2) =	7.8	234
96	22530	22700	170	3.75	6.3	1	0.5	((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1)+((((4.5-3.15)+(4.5-3.15-0.5+1.5x0.5))/2)x0.5) =	2.338	397.46
97	22700	22750	50	3.75	6.1	1	1	((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1)+((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1) =	3.4	170
98	22750	22950	200	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	1480
99	22950	23050	100	3.75	6.1	1	1	((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1)+((((4.5-3.05)+(4.5-3.05-1+1.5x1))/2)x1) =	3.4	340
100	23050	23220	170	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	1190
101	23220	23300	80	3.75	6	1	1	((((4.5-3)+(4.5-3-1+1.5x1))/2)x1)+((((4.5-3)+(4.5-3-1+1.5x1))/2)x1) =	3.5	280
102	23300	23550	250	3.75	6.5	2	2	((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2)+((((4.5-3.25)+(4.5-3.25-2+1.5x2))/2)x2) =	7	1750
103	23550	23800	250	3.75	6.3	1.5	1.5	((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5) =	5.175	1293.75
104	23800	23900	100	3.75	6.3	3	2	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	10	1000
105	23900	23950	50	3.75	6.3	1.5	1.5	((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.15)+(4.5-3.15-1.5+1.5x1.5))/2)x1.5) =	5.175	258.75
106	23950	24000	50	3.75	6.2	2	2	((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2)+((((4.5-3.1)+(4.5-3.1-2+1.5x2))/2)x2) =	7.6	380
107	24000	24350	350	3.75	6.3	3	3	((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3)+((((4.5-3.15)+(4.5-3.15-3+1.5x3))/2)x3) =	12.6	4410
108	24350	24400	50	3.75	6.4	2	2	((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2)+((((4.5-3.2)+(4.5-3.2-2+1.5x2))/2)x2) =	7.2	360
109	24400	24500	100	3.75	6	3	3	((((4.5-3)+(4.5-3-3+1.5x3))/2)x3)+((((4.5-3)+(4.5-3-3+1.5x3))/2)x3) =	13.5	1350
MINOR BRIDGE 10X4						0	0			
110	24540	24650	110	3.75	6.5	3	3	((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3)+((((4.5-3.25)+(4.5-3.25-3+1.5x3))/2)x3) =	12	1320
111	24650	24800	150	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	1110

Annexure 2: Earth work Statement

SL NO.	Chainage		Length	Ext. Carriageway	Ext. Formation	Height from ext. shoulder to Toe		Area Calculation	Cross sectional area in m^2	Earthwork Quantity in m^3
	From	**To**				**LHS**	**RHS**			
112	24800	24950	150	3.75	6.2	1.5	1.5	((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5)+((((4.5-3.1)+(4.5-3.1-1.5+1.5x1.5))/2)x1.5) =	5.325	798.75
113	24950	25100	150	3.75	6.1	0.5	1.5	((((4.5-3.05)+(4.5-3.05-0.5+1.5x0.5))/2)x0.5)+((((4.5-3.05)+(4.5-3.05-1.5+1.5x1.5))/2)x1.5) =	3.525	528.75
114	25100	25200	100	3.75	6	2	2	((((4.5-3)+(4.5-3-2+1.5x2))/2)x2)+((((4.5-3)+(4.5-3-2+1.5x2))/2)x2) =	8	800
115	25200	25300	100	3.75	6.3	1	1	((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1)+((((4.5-3.15)+(4.5-3.15-1+1.5x1))/2)x1) =	3.2	320
116	25300	25500	200	3.75	6.3	2	2	((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2)+((((4.5-3.15)+(4.5-3.15-2+1.5x2))/2)x2) =	7.4	1480
117	25500	25600	100	3.75	6	1	0.5	((((4.5-3)+(4.5-3-1+1.5x1))/2)x1)+((((4.5-3)+(4.5-3-0.5+1.5x0.5))/2)x0.5) =	2.563	256.3
118	25600	25800	200	3.75	6.1	3	3	((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3)+((((4.5-3.05)+(4.5-3.05-3+1.5x3))/2)x3) =	13.2	2640
119	25800	26000	200	3.75	6.5	1	1	((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1)+((((4.5-3.25)+(4.5-3.25-1+1.5x1))/2)x1) =	3	600
									Total Quantity =	**112516.3**

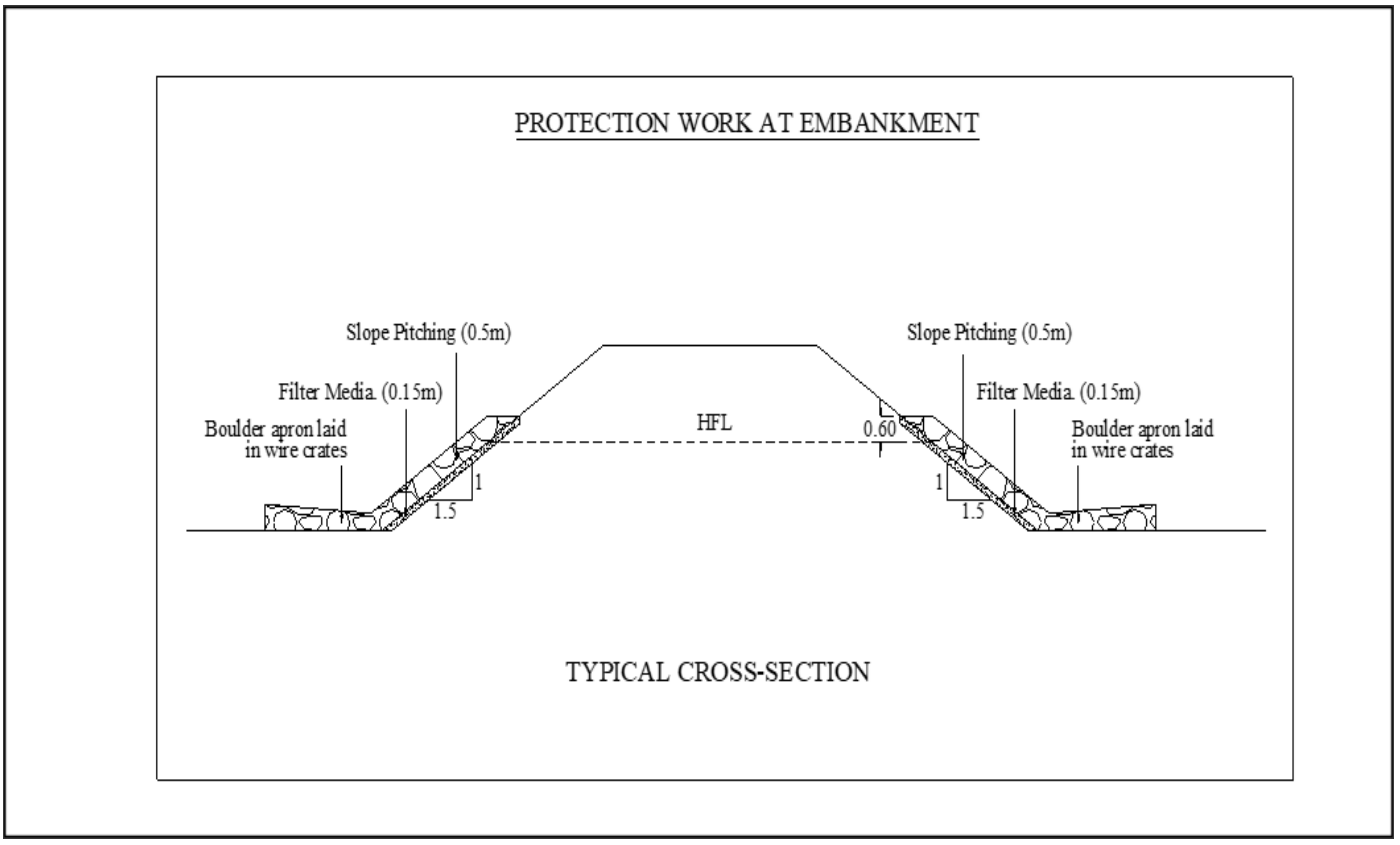
Annexure - 3 A										
CTSB Statement										
Chainage								**ctsb**		
From	To	Total Length	Water Gap	Net Length	width of Ext. Carriage way	Ext. condition whether GSB required or not required		width of Proposed carriage way	Thk.	Qntty.
0	15000	15000	354.00	14646.0	3.75	FULL WIDTH CTSB		5.60	0.20	16403.52
	Total =	**15000.0**	**354.0**	**14646.0**						**16403.52**

Annexure - 3 B										
WMM Statement										
Chainage								**WMM**		
From	To	Total Length	Water Gap	Net Length	width of Ext. Carriage way	Ext. condition whether GSB required or not required	width of Proposed carriage way	widening	Thk.	Qntty.
0	15000	15000	354.00	14646.0			5.50	5.50	0.15	12082.95
	Total =	**15000.0**	**354.0**	**14646.0**						**12082.95**

Annexure - 3 C										
BC Statement										
Chainage								**BC**		**Prime coat/Tack coat**
From	To	Total Length	Water Gap	Net Length	width of Ext. Carriage way	width of Proposed carriage way	widening	Thk.	Qntty.	Area
0	15000	15000	0.00	15000.0		5.50	5.50	0.04	3300.00	82500.00
	Total =	**15000.0**	**0.00**	**15000.0**					**3300.00**	**82500.00**

Annexure 4: Quantity Calculation for Protection Work (Boulder Pitching)

Sl. No.	Item	length (m)	Width (m)	Area (m^2)	Thickness (m)	Quantity (m^3)
1	Filter Media	1875.0	1.000	1875.00	0.15	281.250
2	Slope Pitching	1875.0	1.000	1875.00	0.30	562.500
3	Boulder Apron	1875.0	1.50	2812.500	0.625	1757.81



Annexure 5 : QUANTITY & COST CALCULATIONS FOR RCC DRAIN

Analyisis of rate for RCC Covered Drain

Size = 1.0 m x 0.9 m

Assuming Length for quantity calculation = 10 m

Length of Covered Drain = **3180.0** m

Item No.	Particulars/Descrption of items	Unit	Rate		Calculation			For 10 m Length		For 3180 m length	
				No	L	B	H	Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
1	2	3	4	5	6	7	8	9	10	11	12
1/12.1 B (i)	Excavation:										
				1	10.00	1.20	1.00	12.000			
			66.00					**12.000**	₹ 792.00	3816.000	₹ 2,51,856.00
2/ 15.9	Boulder flooring										
				1	10.00	1.20	0.150	1.800			
		cum	3487.00					**1.800**	₹ 6,276.60	572.400	₹ 19,95,958.80
3 / 12.4	PCC 1:3:6										
				1	10.00	1.20	0.100	1.200			
		cum	7267.00					**1.200**	₹ 8,720.40	381.600	₹ 27,73,087.20
4 / 13.5 (N) B	RCC Grade M25										
	Bottom Slab =	cum		1	10.00	1.00	0.125	1.250			
	Side Wall =	cum		2	10.00	0.125	0.750	1.875			
	Cover Slab =	cum		1	10.00	1.00	0.125	1.250			
		cum	10074.00				Total	**4.375**	₹ 44,073.75	1391.250	₹ 1,40,15,452.50
5 / 13.6	HYSD bar										
	Drain Proper										
	Base Slab										
	10 mm dia @ 175 c/c (bottom bar)	10		1	58	1.2	0.620	43.152			

Annexure 5 : QUANTITY & COST CALCULATIONS FOR RCC DRAIN

Analyisis of rate for RCC Covered Drain

Size = 1.0 m x 0.9 m

Assuming Length for quantity calculation = 10 m

Length of Covered Drain = **3180.0** m

Item No.	Particulars/Descrption of items	Unit	Rate		Calculation			For 10 m Length		For 3180 m length	
				No	L	B	H	Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
1	2	3	4	5	6	7	8	9	10	11	12
	10 mm dia @ 175 c/c (top bar)	10		1	58	1.2	0.620	43.152			
	8 mm dia @ 175 c/c (binder)	8		2	7	10.00	0.390	54.600			
	Wall										
	12 mm dia @ 175 c/c (outer face)	10		2	58	1.375	0.620	98.890			
	10 mm dia @ 175 c/c (inner face)	10		2	58	1.375	0.620	98.890			
	8 mm dia @ 175 c/c (binder)	8		4	5	10.00	0.390	78.000			
	Cover Slab										
	12 mm dia @ 150 c/c (bottom Bar)	12		1	68	1.10	0.890	66.572			
	10 mm dia @ 150 c/c (top Bar)	10		1	68	1.00	0.620	42.160			
	8 mm dia @ 150 c/c	8		2	8	10.00	0.390	62.400			
	kg							587.816			
			Add 5% for lapping =					29.391			
								617.207			
	MT		68210.00					**0.617**	₹ 42,085.57	196.206	₹ 1,33,83,211.26
6 /13.8	Weep holes	each	275.00	**2**	1			**2**	₹ 550.00	636.000	₹ 1,74,900.00
7 / 13.10	Filter Media										
				1	10.00	0.3	0.45	1.350			
		Cum	3598.00					**1.350**	₹ 4,857.30	429.300	₹ 15,44,621.40
						Total cost for 10 RM =			₹ 1,07,355.62		**₹ 3,41,39,087.16**
							Hence cost per RM =		₹ 10,735.56		

Annexture No. 6-A

CONSTRUCTION OF SINGLE CELL BOX CULVERT

Quantity Calculation of 1 m Segmental R.C.C.Box Cell , 1/22/0 & Wing Wall

	Nos of Cell =				1				
	Length of Box =				10.0	m			
	Span of Culvert =			**a**	2000	2.000	m		
	Height of Culvert =			**b**	2000	2.000	m		
				c	0	0.000	m	Shear Key	
				d	250	0.220	m	Top Slab	
				e	300	0.250	m	Bottom Slab	
				f	250	0.220	m	Side Wall	
				g	0	0.000	m	Bracket	

Item No.	Description	Nos.	Length (m)	Breadth (m)	Height (m)	unit	Quantity	Rate	Amount
1	**Excavation**								
	Box Culvert	1	11.00	3.64	3.94		157.758		
		1	3.64	0.45	0.95		1.556		
	Return Wall	as per annexure-I					43.575		
					Total	Cum	**202.89**	66.00	13390.67
2	**PCC M15**								
	Below Box Culvert	1	8.20	2.64	0.15		3.247		
		1	2.64	1.34	0.15		0.531		
	Below Curtain walls								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	0.000		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	3.800		
	Return Wall	as per annexure-I				Cum	2.905		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	7.600		
					Total	Cum	**18.083**	7336.00	132656.89
3	**PCC M20**								
	Return Wall	as per annexure-I				Cum	43.701		
	Total Qty					Cum	**43.701**	7945.00	347204.45
4	**RCC M35**								
	Box Cell								
	Side Wall	2	10.0	0.2	2	Cum	8.000		
	Bottom Slab	1	2.0	0.22	2.4	Cum	1.056		
	Top Slab	1	2.0	0.2	2.4	Cum	0.960		
	Haunch	4	0.0	0.15	0.15	Cum	0.000		
	Bracket	2	0.2	0.3	0.6	Cum	0.079		
					Total =	Cum	**18.000**	8844.00	159192.00
5	**Reinforcement**								
A	For Box Culvert								
	Interpolated by 10 m	**@150 Kg /m3**				Tonne	2700		
					Total =	Tonne	**2.7**	68070.00	183789.00

	PCC M15								
	Curtain wall type- I								
	down stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	14.000		
	Curtain wall type- II								
	up stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	10.900		
							24.900	7336.00	
7	**Flat Stone**								
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	3.800	3070.00	11666.00
8	**Flexible Apron**								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	49.900	3131.00	156236.90
9	**Levelling course below Approach Slab**								
		2	3.60	10.000	0.150	Cum	10.800		
					Total =	Cum	**10.800**	7336.00	79228.80
10	**Approach Slab**								
		2	3.50	10.000	0.300	Cum	21.000		
					Total =	Cum	**21.000**	12862.00	270102.00
11	**Wearing Coat**								
	Box Proper	1	2.44	8.900		Sqm	21.716		
	Approach slab	2	3.50	8.900		Sqm	62.300		
					Total =	Sqm	**84.016**	617.00	51837.87
12	**Drainage Spout**	1	2			Nos	**2**	7737.00	15474.00
13	**Back Filling**	0	10.0	1.50	1.5	cum	**0**	3178.00	0.00
14	**Strip Seal Expansion Joint**	2	10.0			Rm	**20**	704.00	14080.00
15	**Weep Holes**								
	Box Proper	2	7			no	14		
	Return Wall	as per annexure-I				no	8		
							22	275.00	6050.00
16	**Filter media**								
	Box Proper	2	9.0	0.5	1.500	cum	13.5		
	Return Wall	as per annexure-I				cum	17.32		
							30.8208	3598.00	110893.24
									1551801.82

Annexture No. 6-B

CONSTRUCTION OF SINGLE CELL BOX CULVERT

Quantity Calculation of 1 m Segmental R.C.C.Box Cell , 1/22/0 & Wing Wall

Nos of Cell =			1		
Length of Box =			10.0	m	
Span of Culvert =	**a**	2000	2.000	m	
Height of Culvert =	**b**	2000	2.000	m	
	c	0	0.000	m	Shear Key
	d	250	0.250	m	Top Slab
	e	300	0.300	m	Bottom Slab
	f	250	0.250	m	Side Wall
	g	0	0.000	m	Bracket

Item No.	Description	Nos.	Length (m)	Breadth (m)	Height (m)	unit	Quantity	Rate	Amount
1	**Excavation**								
	Box Culvert	1	11.00	3.70	3.94		160.358		
		1	3.70	0.45	0.90		1.499		
	Return Wall	as per annexure-I					43.575		
					Total	Cum	**205.43**	66.00	13558.51
2	**PCC M15**								
	Below Box Culvert	1	8.30	2.70	0.15		3.362		
		1	2.70	1.27	0.15		0.514		
	Below Curtain walls								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum			
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	3.800		
	Return Wall	as per annexure-I				Cum	2.905		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	7.600		
					Total	Cum	**18.181**	7336.00	133375.82
3	**PCC M20**								
	Return Wall	as per annexure-I				Cum	43.701		
	Total Qty					Cum	**43.701**	7945.00	347204.45
4	**RCC M35**								
	Box Cell								
	Side Wall	2	10.0	0.2	2	Cum	8.000		
	Bottom Slab	1	9	0.22	2.4	Cum	4.752		
	Top Slab	1	9	0.2	2.4	Cum	4.320		
	Haunch	4	9	0.15	0.15	Cum	0.810		
	Bracket	2	9	0.3	0.6	Cum	3.240		
				Total =		Cum	**29.132**	8844.00	257643.41
5	**Reinforcement**								
A	For Box Culvert								

	Interpolated by 10 m	**@150 Kg /m3**				Tonne	4369.8		
				Total =		Tonne	**4.3698**	68070.00	297452.29
7	**Flat Stone**								
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	3.800	3070.00	11666.00
8	**Flexible Apron**								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	49.900	3131.00	156236.90
9	**Levelling course below Approach Slab**								
		2	3.60	10.000	0.150	Cum	10.800		
				Total =		Cum	**10.800**	7336.00	79228.80
10	**Approach Slab**								
		2	3.50	10.000	0.300	Cum	21.000		
				Total =		Cum	**21.000**	12862.00	270102.00
11	**Wearing Coat**								
	Box Proper	1	2.50	8.900		Sqm	22.250		
	Approach slab	2	3.50	8.900		Sqm	62.300		
				Total =		Sqm	**84.550**	617.00	52167.35
12	**Drainage Spout**	1	2			Nos	**2**	7737.00	15474.00
13	**Back Filling**	0	10.0	1.50	1.5	cum	**0**	3178.00	0.00
14	**Strip Seal Expansion Joint**	2	10.0			Rm	**20**	704.00	14080.00
15	**Weep Holes**								
	Box Proper	2	7			no	14		
	Return Wall	as per annexure-I				no	8		
							22	275.00	6050.00
16	**Filter media**								
	Box Proper	2	9.0	0.5	1.500	cum	13.5		
	Return Wall	as per annexure-I				cum	17.32		
							30.8208	3598.00	110893.24

1765132.77

Annexture No. 6-C

CONSTRUCTION OF SINGLE CELL BOX CULVERT

Quantity Calculation of R.C.C.Box Cell , 1/33/0 & Wing Wall

Nos of Cell =			**1**	
Length of Box =			**9.0**	m
Span of Culvert =	**a**	3000	**3.000**	m
Height of Culvert =	**b**	3000	**3.000**	m
	c	900	**0.900**	m
	d	420	**0.420**	m
	e	420	**0.420**	m
	f	420	**0.420**	m

Item No.	Description	Nos.	Length (m)	Breadth (m)	Height (m)	unit	Quantity	Rate	Amount
1	**Excavation**								
	Box Culvert	1	10.00	6.84	3.94		269.496		
		1	6.84	0.45	0.78		2.401		
	Return Wall	as per annexure-II					47.565		
				Total =		**Cum**	**319.46**	66.00	21084.49
2	**PCC M15**								
	Below Box Culvert	1	7.54	5.84	0.15		6.605		
		1	5.84	1.10	0.15		0.964		
	Below Curtain walls								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	6.400		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	11.400		
	Return Wall	as per annexure-II				Cum	3.171		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	18.600		
				Total =		**Cum**	**47.140**	7336.00	345819.04
3	**PCC M20**								
	Return Wall	as per annexure-II				Cum	40		
	Total Qty					**Cum**	**40.000**	7945.00	317800.00
4	**RCC M20**								
	Box Cell								
	As per MORTH drawing No SD/108 (SHEET 3 OF 6)								
	Quantity = 94 cum for a width of 12 m								
	Interpolated by 9 m					Cum	55.00		
	Total Qty			**Total =**		**Cum**	**55.000**	8153.00	448415.00
5	**Reinforcement**								
A	For Box Culvert								
	As per MORTH drawing No SD/108 (SHEET 3 OF 6)								
	Quantity = 5.688 tonne for a width of 12 m								
	Interpolated by 9 m					Tonne	4.266		
				Total =		**Tonne**	**4.266**	68070.00	290386.62
6	**Curtain wall**								
	PCC M15								

	Curtain wall type- I								
	down stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	12.000		
	Curtain wall type- II								
	up stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	10.000		
						Cum	**22.000**	7336.00	161392.00
7	**Flat Stone**								
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	11.400	3070.00	34998.00
8	**Flexible Apron**								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	85.600	3131.00	268013.60
9	**Levelling course below Approach Slab**								
		2	3.60	9.000	0.150	Cum	9.720		
				Total =		**Cum**	**9.720**	7336.00	71305.92
10	**Approach Slab**								
		2	3.50	9.000	0.300	Cum	18.900		
				Total =		**Cum**	**18.900**	12862.00	243091.80
11	**Wearing Coat**								
	Box Proper	1	3.84	7.900		Sqm	30.336		
	Approach slab	2	3.50	7.900		Sqm	55.300		
				Total =		**Sqm**	**85.636**	617.00	52837.41
12	**Drainage Spout**	1	2			**Nos**	**2**	7737.00	15474.00
14	**Strip Seal Expansion Joint**	2	9.0			**Rm**	**18**	704.00	12672.00
15	**Weep Holes**								
	Box Proper	2	12			**no**	24		
	Return Wall	as per annexure-II				**no**	8		
							32	275.00	8800.00
16	**Filter media**								
	Box Proper	2	9.0	0.5	2.500	**cum**	22.5		
	Return Wall	as per annexure-II					25.97		
							48.4728	3598.00	174405.13
									24,66,495.01

Annexture No. 6-D

CONSTRUCTION OF SINGLE CELL BOX CULVERT

Quantity Calculation of R.C.C.Box Cell , 1/43/0 & Wing Wall

Nos of Cell =			**1**	
Length of Box =			**10.0**	m
Span of Culvert =	**a**	4000	**4.000**	m
Height of Culvert =	**b**	3000	**3.000**	m
	c	400	**0.400**	m
	d	450	**0.450**	m
	e	500	**0.500**	m
	f	500	**0.500**	m

Item No.	Description	Nos.	Length (m)	Breadth (m)	Height (m)	unit	Quantity	Rate	Amount
1	**Excavation**								
	Box Culvert	1	11.00	6.00	3.94		260.040		
		1	7.00	0.45	0.70		2.205		
	Return Wall	as per annexure-II					47.565		
				Total		**Cum**	**309.81**	66.00	20447.46
2	**PCC M15**								
	Below Box Culvert	1	8.70	5.00	0.15		6.525		
		1	5.00	0.99	0.15		0.743		
	Below Curtain walls								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	9.000		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	22.900		
	Return Wall	as per annexure-II				Cum	3.171		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	45.800		
				Total		**Cum**	**44.000**	7336.00	322784.00
3	**PCC M20**								
	Return Wall	as per annexure-II				Cum	30		
	Total Qty					**Cum**	**30.000**	7945.00	238350.00
4	**RCC M20**								
	Box Cell								
	As per MORTH drawing No SD/108 (SHEET 3 OF 6)								
	Quantity = 114 cum for a width of 12 m								
	Interpolated by 10 m					Cum	95.00		
	Total Qty			**Total =**		**Cum**	**70.00**	8153.00	570710.00
5	**Reinforcement**								
A	For Box Culvert								
	As per MORTH drawing No SD/108 (SHEET 3 OF 6)								
	Quantity = 7.12 tonne for a width of 12 m								
	Interpolated by 10 m					Tonne	5.933		
				Total =		**Tonne**	**5.933**	68070.00	403859.31
6	**Curtain wall**								
	PCC M15								
	Curtain wall type- I								

	down stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	34.000		
	Curtain wall type-II								
	up stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					**Cum**	26.300		
						Cum	**60.300**	7336.00	442360.80
7	**Flat Stone**								
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	22.900	3070.00	70303.00
8	**Flexible Apron**								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	120.900	3131.00	378537.90
9	**Levelling course below Approach Slab**								
		2	3.60	10.000	0.150	Cum	10.800		
					Total =	**Cum**	**10.800**	7336.00	79228.80
10	**Approach Slab**								
		2	3.50	10.000	0.300	Cum	21.000		
					Total =	**Cum**	**21.000**	12862.00	270102.00
11	**Wearing Coat**								
	Box Proper	1	5.00	8.900		Sqm	44.500		
	Approach slab	2	3.50	8.900		Sqm	62.300		
					Total =	**Sqm**	**106.800**	617.00	65895.60
12	**Drainage Spout**	1	2			**Nos**	**2**	7737.00	15474.00
15	**Strip Seal Expansion Joint**	2	10.0			**Rm**	**20**	704.00	14080.00
16	**Weep Holes**								
	Box Proper	2	14			**no**	28		
	Return Wall	as per annexure-II				**no**	8		
							36	275.00	9900.00
17	**Filter media**								
	Box Proper	2	10.0	0.5	2.500	**cum**	**25**		
	Return Wall	as per annexure-II					25.97		
							50.973	3598.00	183400.13
									3085433.00

Annexture No. 6E

CONSTRUCTION OF DOUBLE CELL BOX CULVERT

Nos of Cell =			2	
Length of Box =			10.0	m
Span of Culvert =	**a**	4000	4.000	m
Height of Culvert =	**b**	3000	3.000	m
	c	300	0.300	m
	d	470	0.470	m
	e	450	0.450	m
	f	420	0.420	m
	g	350	0.350	m

Item No.	Description	Nos.	Length (m)	Breadth (m)	Height (m)	unit	Quantity	Rate	Amount
1	**Excavation**								
	Box Culvert	1	11.00	7.99	3.45		303.221		
		1	6.64	0.45	0.750		2.241		
	Return Wall	as per annexure-I					47.565		
					Total	Cum	**353.03**	66.00	23299.78
2	**PCC M15**								
	Below Box Culvert	1	8.60	7.99	0.15		10.307		
		1	7.99	1.06	0.15		1.270		
	Below Curtain walls								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	8.200		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	16.700		
	Return Wall	as per annexure-I				Cum	3.171		
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	33.500		
					Total =	Cum	**73.148**	7336.00	536613.73
3	**PCC M20**								
	Return Wall	as per annexure-I				Cum	60.55		
	Total Qty					Cum	**60.550**	7945.00	481069.75
4	**RCC M20**								
	Box Cell								
	As per MORTH drawing No SD/110 (SHEET 2 OF 2)								
	Quantity = 144 cum for a width of 12 m								
	Interpolated by 10 m					Cum	120.00		
	Total Qty				**Total =**	Cum	**120.00**	8153.00	978360.00
5	**Reinforcement**								
A	For Box Culvert								
	As per MORTH drawing No SD/108 (SHEET 2 OF 2)								
	Quantity = 9.895 tonne for a width of 12 m								
	Interpolated by 10 m					Tonne	8.246		
					Total =	Tonne	**8.246**	68070.00	561305.22
6	**Curtain wall**								
	PCC M15								
	Curtain wall type- I								

	down stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	30.800		
	Curtain wall type- II								
	up stream side								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	23.800		
							54.600	7336.00	400545.60
7	**Flat Stone**								
	Floor Appron								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	16.700	3070.00	51269.00
8	**Flexible Apron**								
	As per MORTH drawing No SD/111 (SHEET 4 OF 4)					Cum	109.500	3131.00	342844.50
9	**Levelling course below Approach Slab**								
		2	3.60	10.000	0.150	Cum	10.800		
					Total =	Cum	**10.800**	7336.00	79228.80
10	**Approach Slab**								
		2	3.50	10.000	0.300	Cum	21.000		
					Total =	Cum	**21.000**	12862.00	270102.00
11	**Wearing Coat**								
	Box Proper	1	9.19	8.900		Sqm	81.791		
	Approach slab	2	3.50	8.900		Sqm	62.300		
					Total =	Sqm	**144.091**	617.00	88904.15
12	**Drainage Spout**	1	2			Nos	**2**	7737.00	15474.00
14	**2 mm thick corrugated copper plate in expansion joint**	2	10.0			Rm	**20**	704.00	14080.00
15	**Weep Holes**								
	Box Proper	2	14			no	28		
	Return Wall	as per annexure-I				no	8		
							36	275.00	9900.00
16	**Filter media**								
	Box Proper	2	9.0	0.5	1.500	cum	13.5		
	Return Wall	as per annexure-I				cum	25.97		
							39.473	3598.00	142023.13

3995019.66

Annexure 7: Quantity calculation of Toe wall

Sl. No	SOR Ref.	Item	Unit	Quantity	Total Qty	Rate	Amount
				1.5 m ht. Toe wall			
1	12.1	Earthwork in Excavation	cum	345.60	345.600	66.00	22,809.60
2	15.9	Boulder flooring	cum	115.20	115.200	3487.00	4,01,702.40
3	12.4	PCC 1:3:6 in Foundation	cum	57.60	57.600	7267.00	4,18,579.20
4	13.5 (N)	Plain/Reinforced cement concrete, in sub structure complete as per drawing and technical specification and steel shuttering formwork	cum	840.00	840.000	8404.00	70,59,360.00
						Total Cost =	**79,02,451.20**

Annexure7.1- Analyisis of rate for PCC Toe wall (1.5 m height)

Length= 480 m
Total Height= 2.00 m
Top Width = 0.60 m
Bottom with = 1.00 m
Inner dip= 0.3 m

Item No.	Particulars / Descrption of items	Unit	Rate		Calculation			For 1m Length		For 480 m length	
				No	L	B	H	Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
1	2	3	4	5	6	7	8	9	10	11	12
1	Excavation:										
				1	1.00	1.20	0.60	0.720			
		cum	66.00					**0.720**	47.52	345.600	22,809.60
2	Boulder flooring										
				1	1.00	1.20	0.200	0.240			
		cum	3487.00					**0.240**	836.88	115.200	4,01,702.40
3	PCC 1:3:6										
				1	1.00	1.20	0.100	0.120			
		cum	7267.00					**0.120**	872.04	57.600	4,18,579.20
4	PCC Grade M20										
		cum		1	1.00	0.80	2.00	1.600			
		cum		1	1.00	1.00	0.15	0.150			
		cum	8404.00				Total	**1.750**	14707.00	840.000	70,59,360.00
							Total cost =		**16463.44**		**79,02,451.20**

Annexure -8 - TRAFFIC SIGNS MARKING AND OTHER ROAD APPURTENANCES

Item No.	Descriptions	Unit	No.	Length	Width	Ht/Th	Area	Quantity/KM	Minimum Quantity
			Road Length =	**1000.00**	**m**				
1	Providing and fixing of PCC M-15 KM stones								
	KM Stone	**No.**						1	15
2	Hot applied thermoplastic paint								
	(Edge Line = 1000 x 2)	**sqm**	2	1000	0.10		100.0	200.00	
	At Junctions	**sqm**	2	30.00	0.10		3.0	6.00	
								206.00	3090
3	Cautionary, mandatory and informatory signs								
(i)	90cm equilateral traingle	**No.**	1				1.10	1.103	15
(ii)	60cm equilateral traingle	**No.**	1				0.49	0.490	15
(iii)	60cm circular	**No.**	1				0.280	0.280	15
(iv)	80cmm x 60 cm rectangular	**No.**	1				0.480	0.480	15
(v)	60cmm x 45 cm rectangular	**No.**	1				0.270	0.270	15
(vi)	60cmm x 60 cm square	**No.**	1				0.360	0.360	15
(vii)	90cm high octagon	**No.**	1				0.640	0.640	15
							Total =	3.623	105.000
4	Solar Studs At Bridge Locations	**nos**	1	40				40	280
5	Road Studs	**nos**	2	1000				200	3000
6	Metal beam crash barrier	**RM**							2000

APPENDIX

Appendix-I

ANALYSIS OF RATE FOR ITEM OF WORKS INCLUDING EXTRA LEAD BEYOND THE INITIAL LEAD AS PER SCHEDULE

Sl. No.	Name of Quarry	Item of works	Unit of work	Lead from quarry of work site	Extra lead of different roads (in KM)		Rate/m^3/Km as per SOR (in Rs)	Loose quantity reqd/unit(m^3)	Cost of extra carriage 9=6x7x8	Total Cost of Carriage	Cost as per SOR	Total (in Rs) 12=10+11
1	2	3	4	5	6		7	8	9	10	11	12
1	**Bhutiachang Quarry**	GSB	m^3	51.00	Surfaced Road	51.00	20.20	1.277	1315.57	1315.57	3305.00	4620.57
					Unsurfaced Road	0.00	24.21	1.277	0.00			
					Kutcha Road	0.00	48.78	1.277	0.00			
2		WMM	m^3	51.00	Surfaced Road	51.00	20.20	1.320	1359.86	1359.86	3963.00	5322.86
					Unsurfaced Road	0.00	24.21	1.320	0.00			
					Kutcha Road	0.00	48.78	1.320	0.00			
3		CTSB	m^3	53.00	Surfaced Road	53.00	20.20	1.277	1367.16	1367.16	4185.00	5552.16
					Unsurfaced Road	0.00	24.21	1.277	0.00			
					Kutcha Road	0.00	48.78	1.277	0.00			
4		BC	m^3	51.00	Surfaced Road	51.00	20.20	1.510	1555.60	1555.60	10115.00	11670.60
					Unsurfaced Road	0.00	24.21	1.510	0.00			
					Kutcha Road	0.00	48.78	1.510	0.00			

Lead for GSB, WMM, DBM and BC

		Total Lead	Initial Lead	Net Lead
Quarry Road =	Katcha Road	3.0 Km.	3.0 Km.	0.0 Km.
MB Road (Upto Mangaldoi) =	Surfaced Road	32.0 Km.	2.0 Km.	30.0 Km.
UT Road (Kachubil to Panery) =	Surfaced Road	2.0 Km.		2.0 Km.
MM Road (Upto Naharbari) =	Surfaced Road	11.0 Km.		11.0 Km.
Proposed Road (avg)=	Surfaced Road	8.0 Km.		8.0 Km.
	Total Lead =	**56.0 Km.**	**5.0 Km.**	**51.0 Km.**

Lead for Plant Mix CTSB

		Total Lead	Initial Lead	Net Lead
Quarry Road =	Katcha Road	3.0 Km.	3.0 Km.	0.0 Km.
MB Road=	Surfaced Road	32.0 Km.	2.0 Km.	30.0 Km.
UT Road=	Surfaced Road	2.0 Km.		2.0 Km.
MM Road =	Surfaced Road	11.0 Km.		11.0 Km.
MM Road TO Plant=	Surfaced Road	10.0 Km.		10.0 Km.
Plant to site =	Surfaced Road			
	Total Lead =	**58.0 Km.**	**5.0 Km.**	**53.0 Km.**

Appendix-II

SCHEDULE FOR EMBANKMENT PROTECTION (Slope Pitching)

LOCATION . NO.	Chainage		Length	SIDE	TYPE	REMARKS
	From	To				
1	11500	11600	100	LHS	Boulder Pitching	
2	11500	11590	90	RHS	Boulder Pitching	
3	11700	11770	70	LHS	Boulder Pitching	
4	12760	12820	60	RHS	Boulder Pitching	
5	12900	12950	50	RHS	Boulder Pitching	
6	13150	13195	45	RHS	Boulder Pitching	
7	13390	13455	65	LHS	Boulder Pitching	
8	13700	13760	60	LHS	Boulder Pitching	
9	15300	15380	80	LHS	Boulder Pitching	
10	15520	15590	70	LHS	Boulder Pitching	
11	16720	16750	30	RHS	Boulder Pitching	
12	18000	18080	80	LHS	Boulder Pitching	
13	18000	18080	80	RHS	Boulder Pitching	
14	18700	18850	150	RHS	Boulder Pitching	
15	19250	19310	60	LHS	Boulder Pitching	
16	19250	19320	70	RHS	Boulder Pitching	
17	21550	21700	150	RHS	Boulder Pitching	
18	21800	21875	75	LHS	Boulder Pitching	
19	22050	22110	60	RHS	Boulder Pitching	
20	22250	22310	60	RHS	Boulder Pitching	
21	22530	22590	60	LHS	Boulder Pitching	
22	22530	22595	65	RHS	Boulder Pitching	
23	22700	22750	50	RHS	Boulder Pitching	
24	23800	23870	70	LHS	Boulder Pitching	
25	25100	25155	55	LHS	Boulder Pitching	
26	25100	25170	70	RHS	Boulder Pitching	
		Total	**1875 M**			

Appendix-III

TOE WALL STATEMENT

Sl. No.	Start	End	Length(M)	Height(m)	Sides	Remarks
1	18000	18030	30	1.5	PCC Toe Wall	
2	18000	18030	30	1.5	PCC Toe Wall	
3	18700	18850	150	1.5	PCC Toe Wall	
4	19250	19280	30	1.5	PCC Toe Wall	
5	19250	19280	30	1.5	PCC Toe Wall	
6	21550	21700	150	1.5	PCC Toe Wall	
7	21800	21830	30	1.5	PCC Toe Wall	
8	22050	22080	30	1.5	PCC Toe Wall	
		TOTAL	**480**			

1.5 m height toe wall = 480.00 m

Appendix-IV

SCHEDULE FOR RCC BRIDGE

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
1	14+850	RCC Bridge	7	MNB	12	8.5	New Construction
2	21+300	RCC Bridge	150 m	MJB			Retained
3	24+500	RCC Bridge	40 m	MNB			Retained

Appendix-V

SCHEDULE OF RCC COVERED DRAIN

SL.NO	CHAINAGE		LENGTH	SIDE	REMARKS
	FROM	TO			
1	12000	12250	250	B.H.S	KULSIGATE CHOWK
2	14000	14150	150	B.H.S	DEOMORNOI CHOWK
3	18460	18600	140	B.H.S	MOHOLIAPARA CHOWK
4	19600	19850	250	B.H.S	
5	21000	21200	200	B.H.S	RAISING 100 mtr DRAIN 200 mtr
6	24000	24100	100	B.H.S	
7	25300	25600	300	B.H.S	NAMKHOLA MARKET
8	26000	26200	200	B.H.S	END CHAINAGE

Total Length of Drain= 3180

Appendix-VI

SCHEDULE OF CROSS DRAINAGE WORK

Sl.No.	Chainage	Ext. Type	Ext. Size	Proposed Type	Proposed Size	width	Proposal
1	11380		2X1	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
2	11890		1000mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
3	12150		900mm dia	Box culvert	2/44/0	10 m	Re-Construction
4	12230		3X1	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
5	12650		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
6	12970	SHP	600mm dia	Box culvert	1/22/0	10 m	Re-Construction
7	13750	2X2	900mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
8	14000	BUILT-UP AREA DEOMORONOI	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
9	14850	EXT SLAB 8 MTR	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
10	15000		600mm dia	Box culvert	1/33/0	10 m	Re-Construction
11	15420		1000mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
12	15430		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
13	15750		600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
14	16300	EXISTING DHP	600mm dia	Box culvert	1/33/0	10 m	Re-Construction
15	16570	SHP	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
16	17070	SLAB 7.5	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
17	17600	DHP	600mm dia	Box culvert	1/22/0	10 m	Re-Construction
18	17780	SHP	900Mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
19	18030	EXT 4HP	600mm dia	Box culvert	1/43/0	10 m	Re-Construction
20	18990	EXT. SLAB	4X2	Box culvert	1/43/0	10 m	Re-Construction
21	19600	EXT 4HP	3x3	Box culvert	1/43/0	10 m	Re-Construction
22	19850	SLAB	600mm dia	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
23	20370	SHP			1/22/0	10 m	Re-Construction
24	22100	SLAB 1.5	1.5X1.5	Box culvert	1/22/0	10 m	Re-Construction
25	22350	DHP	2X2	Box culvert	1/22/0	10 m	Re-Construction
26	22500	4HP	1000mm	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
27	23050	DHP	1000mm	Box culvert	1/33/0	10 m	Re-Construction
28	23220	SLAB			1/22/0	10 m	Re-Construction
29	23550	SHP	1000mm	Box culvert	1/1.5x1.5/0	10 m	Re-Construction
30	23950	SLAB 1.5	1000mm	Box culvert	1/22/0	10 m	Re-Construction
31	24350	DHP	6m	Box culvert	1/22/0	10 m	Re-Construction
32	24950		8m	Box culvert	2/44/0	10 m	Re-Construction
33	25500	SLAB 1.5			1/1.5x1.5/0	10 m	Re-Construction
34	25600		1000mm	Box culvert	1/22/0	10 m	Re-Construction

Re-Construction		1/1.5x1.5/0	17	Nos.
Re-Construction		1/22/0	9	Nos.
Re-Construction		1/33/0	3	Nos.
Re-Construction		1/43/0	3	Nos.
Re-Construction		2/44/0	2	Nos.
		Total =	**34**	Nos.

SOIL REPORTS (CBR DATA & BRIDGE SSI REPORTS)

ZENITH
Associates

Project No: NSC/NESIDS/CTR/2024-24/343 Date: 23.10.2024

Project Name: " ***Improvement and Upgradation of Mangoldoi-Mazikuchi road from KM 11+000 to KM 26+000 under NESIDS for the year 2024-25 (L=15.000 km)"***

Client: Assam PWD (Roads), Border and NEC Works

DPR Consultant: Zenith Associates, Guwahati

1. Introduction

   The soil and material investigations were done following the guidelines of IRC: SP: 19-2001 and IRC: 37-2018 and other relevant IS codes. The potential sources of borrow areas for soil and quarry sites will be identified.

   As per Clause 13.7.2 of IRC SP 19-2001, the soil data already collected in earlier phases of the survey should be studied in detail to ascertain variability/homogeneity of the soil profile, planning further investigations.

   For Pavement Design, apart from the general soil test referred to earlier, the CBR test shall be conducted for soaked, unsoaked or both these conditions depending on the design requirements spelt out IRC 37 2018.

   This report is based on the results of field tests conducted on selected soil samples collected from test pit locations.

2. Soil Sample Collection and Testing

   Soil samples have been collected along and around (1 Km lead) the road alignment at one location per km, from the adjoining borrow areas, and one sample is collected from the existing road. Soil Classification tests like grain size analysis and Atterberg's limit were conducted for all collected samples.

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group or more tests due to variation of soil type. The following tests were conducted as detailed below:

- Atterberg's limit as per IS : 2720 (Part 5) – 1985
- Standard Proctor density test as per IS : 2720 (Part 7) – 1980
- 4 day soaked CBR test as per IS : 2720 (Part 16) – 1985

3. Results

The laboratory-soaked CBR value ranges from 5.8% to 7.8%. The soil is in between coarse-grained and fine-grained soils with predominantly sandy and silty characteristics. The MDD of the soils ranges from 1.7-1.85 g/cc with OMC varying from 10-12 percent. The Liquid Limit of the soil varies from 19-24% and the Plastic Limit of the soil varies from 11-15%.

4. Effective 4-Day Soaked CBR (90th Percentile CBR) as per IRC 37:2018.

Sl no.	Chainage(KM)	4-days Soaked CBR(%)
1	11250	7.3
2	12500	6.98
3	15000	6.68
4	16700	6.5
5	18200	6.98
6	20000	7.57
7	21000	7.27
8	22000	6.98
9	23200	7.27
10	21800	7.7
11	22500	7.57
12	23200	7.27
13	24500	6.53
14	25500	6.1

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Associates

As Per Clause 6.2.2 of IRC 37 2018, 90th Percentile CBR has been evaluated from the data.

From, the equation generated from the curve, **effective CBR =6.19%**

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GUWAHATI, ASSAM

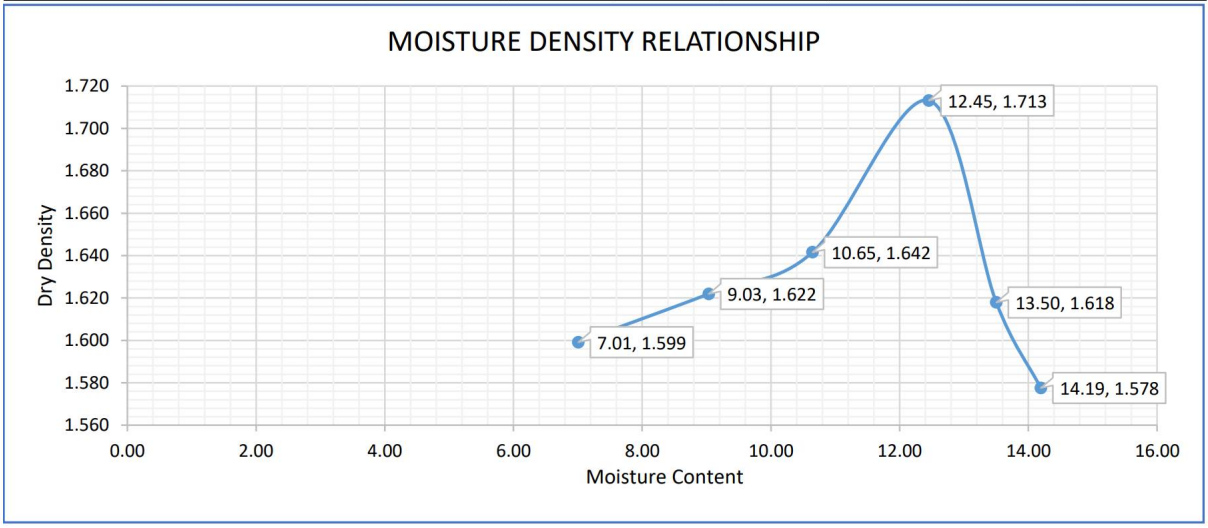
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name:MM Road [redacted] District:Darrang [redacted]

Source of Material:	CH : 12+500 L/S		**Date Of Testing :**	16-10-2024
Sample No.:	21		**Wt of Mould :**	4470.90
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	Units	Determinations					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	%	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8150	8274	8376	8613	8419	8344
Wt of Mould	gm	4470.9	4471.9	4470.9	4470.9	4470.9	4470.9
Wt. of Compacted Soil	gm	3679.1	3802.1	3905.1	4142.1	3948.1	3873.1
Bulk Density of Soil	gm/cc	1.711	1.768	1.816	1.927	1.836	1.801
Container No.	No	B-1	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	101.1	104.2	106.6	109.2	110.4	111.2
Wt. of dry Soil + Container	gm	95.6	97	98	99	99.3	99.5
Wt. of Water	gm	5.5	7.2	8.6	10.2	11.1	11.7
Wt. of dry Soil	gm	78.5	79.7	80.8	81.9	82.2	82.4
Moisture Content	%	**7.01**	**9.03**	**10.65**	**12.45**	**13.50**	**14.19**
Dry Density	gm/cc	**1.599**	**1.622**	**1.642**	**1.713**	**1.618**	**1.578**



Maximum Dry Density (g/cc)	**1.713**	**Optimum Moisture Content(%)**	**12.45**

CALIFORNIA BEARING RATIO

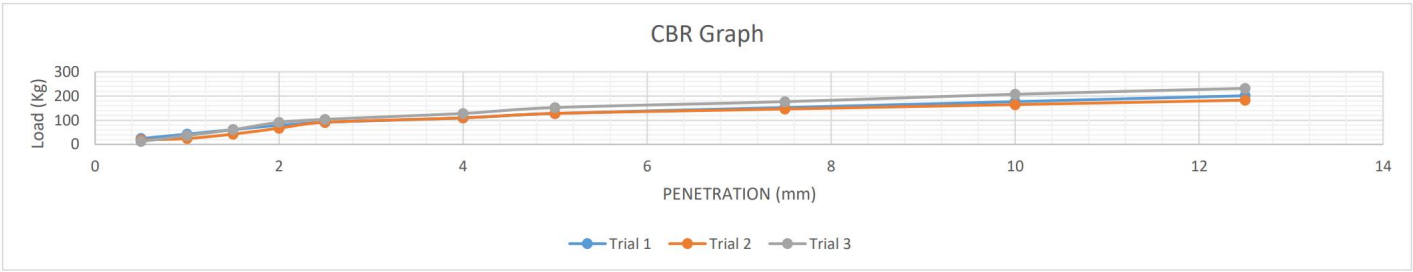
IS 2720 PART XVI

Location :	CH : 12+500 L/S		Date of Casting:	16-10-2024
Type of Material:	Soil		Date of Testing :	20-10-2024
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.713
Volume of Mould (cc):	2150		OMC of Sample (%):	12.45

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		2	12.2	
1.963 Sqcm	1.0	7	42.7		4	24.4		6	36.6	
Standard Load	1.5	10	61		7	42.7		10	61	
Penetration Unit	2.0	13	79.3		11	67.1		15	91.5	
	2.5	15	91.5	6.68	15	91.5	6.68	17	103.7	7.57
2.5 70 (1370 Kg)	4.0	18	109.8		18	109.8		21	128.1	
	5.0	21	128.1	6.23	21	128.1	6.23	25	152.5	7.42
	7.5	25	152.5		24	146.4		29	176.9	
5 105 (2055 Kg)	10.0	29	176.9		27	164.7		34	207.4	
	12.5	33	201.3		30	183		38	231.8	
Average CBR Value (%)		2.5:	6.98		5.0	6.63				



Authorised Signatory

NEW SUN CONSULTING FIRM
Guwahati, Assam

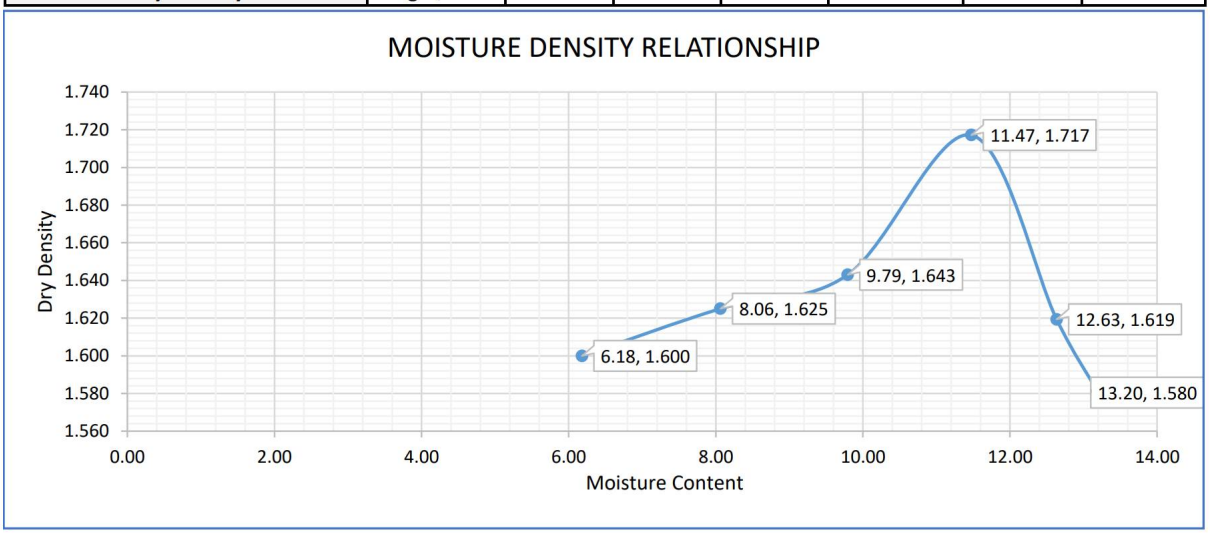
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name:MM Road [redacted] District: Darrang [redacted]

Source of Material:	CH : 15+000 R/S		**Date Of Testing :**	17-10-2024
Sample No.:	22		**Wt of Mould :**	4496.30
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	**Units**	**Determinations**					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	%	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8148.8	8272.8	8374.8	8611.8	8417.8	8342.8
Wt of Mould	gm	4496.3	4497.3	4496.3	4496.3	4496.3	4496.3
Wt. of Compacted Soil	gm	3652.5	3775.5	3878.5	4115.5	3921.5	3846.5
Bulk Density of Soil	gm/cc	1.699	1.756	1.804	1.914	1.824	1.789
Container No.	No	B-1	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	101.3	104.4	106.9	109.4	110.7	111.4
Wt. of dry Soil + Container	gm	96.4	97.9	98.9	99.9	100.2	100.4
Wt. of Water	gm	4.9	6.5	8	9.5	10.5	11
Wt. of dry Soil	gm	79.3	80.6	81.7	82.8	83.1	83.3
Moisture Content	%	**6.18**	**8.06**	**9.79**	**11.47**	**12.63**	**13.20**
Dry Density	gm/cc	**1.600**	**1.625**	**1.643**	**1.717**	**1.619**	**1.580**



Maximum Dry Density (g/cc)	**1.717**	**Optimum Moisture Content(%)**	**11.47**

CALIFORNIA BEARING RATIO

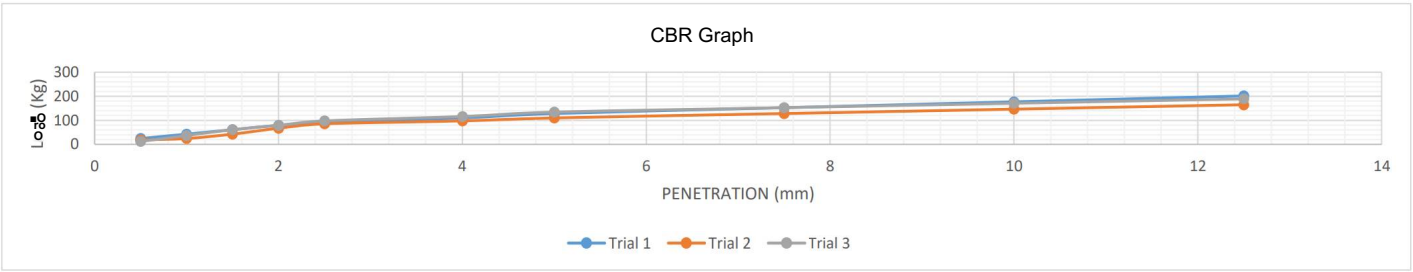
IS 2720 PART XVI

Location :	CH : 15+000 R/S		Date of Casting:	17-10-2024
Type of Material:	22		Date of Testing :	21-10-2024
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.717
Volume of Mould (cc):	2150		OMC of Sample (%):	11.47

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		2	12.2	
1.963 Sqcm	1.0	7	42.7		4	24.4		6	36.6	
Standard Load	1.5	10	61		7	42.7		10	61	
Penetration Unit	2.0	13	79.3		11	67.1		13	79.3	
	2.5	15	91.5	6.68	14	85.4	6.23	16	97.6	7.12
2.5 70 (1370 Kg)	4.0	18	109.8		16	97.6		19	115.9	
	5.0	21	128.1	6.23	18	109.8	5.34	22	134.2	6.53
	7.5	25	152.5		21	128.1		25	152.5	
5 105 (2055 Kg)	10.0	29	176.9		24	146.4		28	170.8	
	12.5	33	201.3		27	164.7		31	189.1	
Average CBR Value (%)		2.5:	6.68		5.0	6.04				



Authorised Signatory

NEW SUN CONSULTING FIRM
Guwahati, Assam

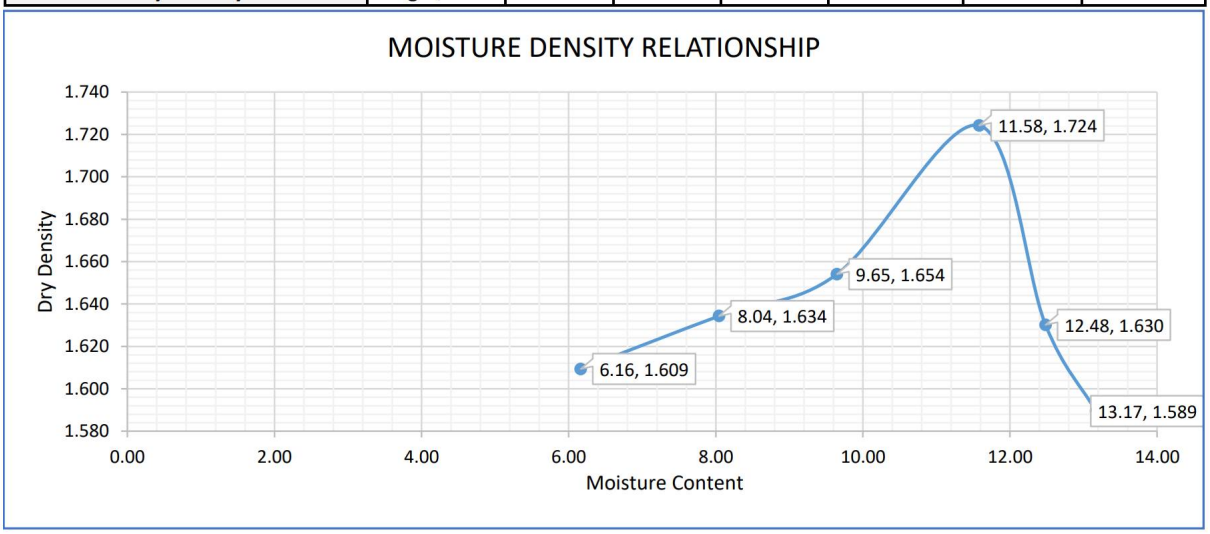
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name: MM Road [redacted] District: Darrang [redacted]

Source of Material:	CH : 18+200 L/S		**Date Of Testing :**	17-10-2024
Sample No.:	23		**Wt of Mould :**	4498.50
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	**Units**	**Determinations**					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	%	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8171.9	8295.9	8397.9	8634.9	8440.9	8365.9
Wt of Mould	gm	4498.5	4499.5	4498.5	4498.5	4498.5	4498.5
Wt. of Compacted Soil	gm	3673.4	3796.4	3899.4	4136.4	3942.4	3867.4
Bulk Density of Soil	gm/cc	1.709	1.766	1.814	1.924	1.834	1.799
Container No.	No	B-1	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	101.5	104.6	107	109.6	110.8	111.6
Wt. of dry Soil + Container	gm	96.6	98.1	99.1	100	100.4	100.6
Wt. of Water	gm	4.9	6.5	7.9	9.6	10.4	11
Wt. of dry Soil	gm	79.5	80.8	81.9	82.9	83.3	83.5
Moisture Content	%	**6.16**	**8.04**	**9.65**	**11.58**	**12.48**	**13.17**
Dry Density	gm/cc	**1.609**	**1.634**	**1.654**	**1.724**	**1.630**	**1.589**



Maximum Dry Density (g/cc)	**1.724**	**Optimum Moisture Content(%)**	**11.58**

CALIFORNIA BEARING RATIO

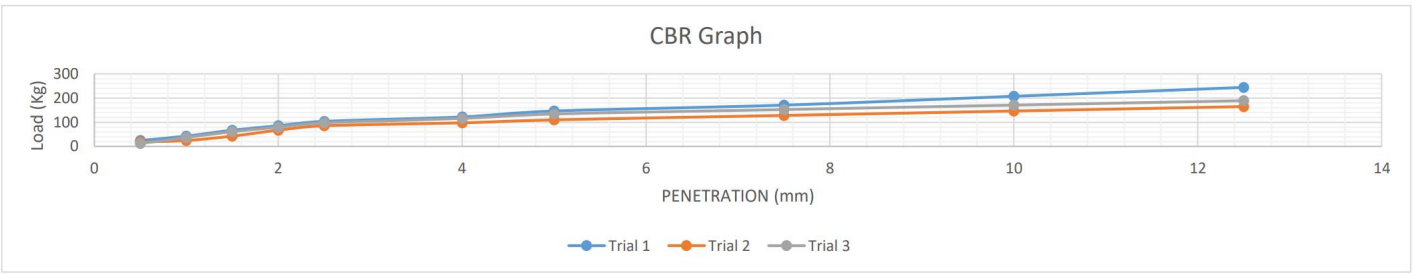
IS 2720 PART XVI

Location :	CH : 18+200 L/S		Date of Casting:	17-10-2024
Type of Material:	22		Date of Testing :	21-10-2024
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.724
Volume of Mould (cc):	2150		OMC of Sample (%):	11.58

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		2	12.2	
1.963 Sqcm	1.0	7	42.7		4	24.4		6	36.6	
Standard Load	1.5	11	67.1		7	42.7		10	61	
Penetration Unit	2.0	14	85.4		11	67.1		13	79.3	
	2.5	17	103.7	7.57	14	85.4	6.23	16	97.6	7.12
2.5 70 (1370 Kg)	4.0	20	122		16	97.6		19	115.9	
	5.0	24	146.4	7.12	18	109.8	5.34	22	134.2	6.53
	7.5	28	170.8		21	128.1		25	152.5	
5 105 (2055 Kg)	10.0	34	207.4		24	146.4		28	170.8	
	12.5	40	244		27	164.7		31	189.1	
Average CBR Value (%)		2.5:	6.98		5.0	6.33				



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NEW SUN CONSULTING FIRM
Guwahati, Assam

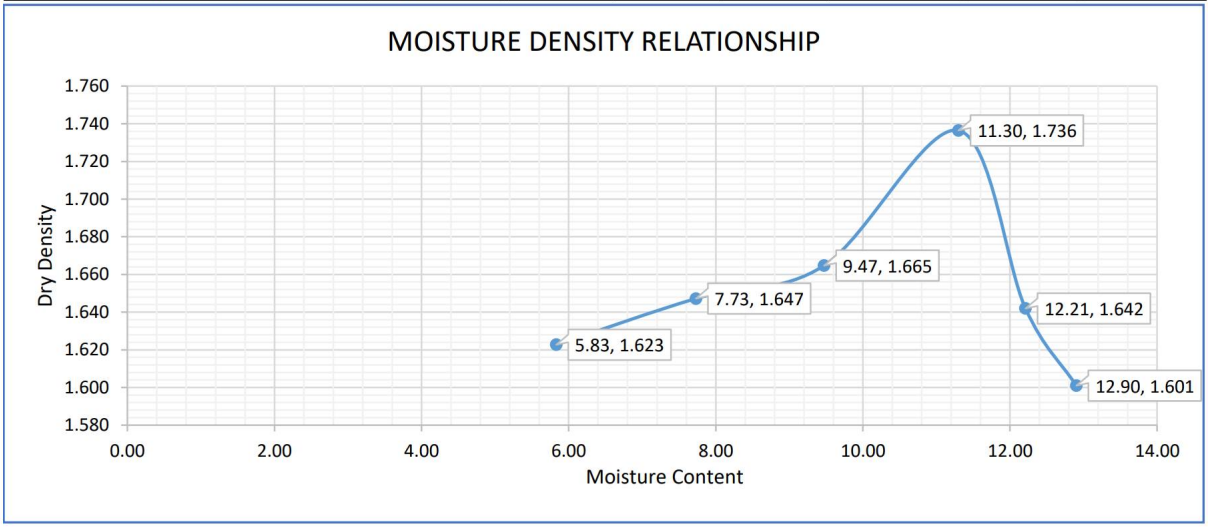
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name: MM Road [redacted] District: Darrang [redacted]

Source of Material:	CH : 20+000 L/S		**Date Of Testing :**	17-10-2024
Sample No.:	24		**Wt of Mould :**	4484.50
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	**Units**	**Determinations**					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	%	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8176.7	8300.7	8402.7	8639.7	8445.7	8370.7
Wt of Mould	gm	4484.5	4485.5	4484.5	4484.5	4484.5	4484.5
Wt. of Compacted Soil	gm	3692.2	3815.2	3918.2	4155.2	3961.2	3886.2
Bulk Density of Soil	gm/cc	1.717	1.775	1.822	1.933	1.842	1.808
Container No.	No	B-1	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	100.6	103.7	106.2	108.7	109.9	110.7
Wt. of dry Soil + Container	gm	96	97.5	98.5	99.4	99.8	100
Wt. of Water	gm	4.6	6.2	7.7	9.3	10.1	10.7
Wt. of dry Soil	gm	78.9	80.2	81.3	82.3	82.7	82.9
Moisture Content	%	**5.83**	**7.73**	**9.47**	**11.30**	**12.21**	**12.90**
Dry Density	gm/cc	**1.623**	**1.647**	**1.665**	**1.736**	**1.642**	**1.601**



Maximum Dry Density (g/cc)	**1.736**	**Optimum Moisture Content(%)**	**11.30**

CALIFORNIA BEARING RATIO

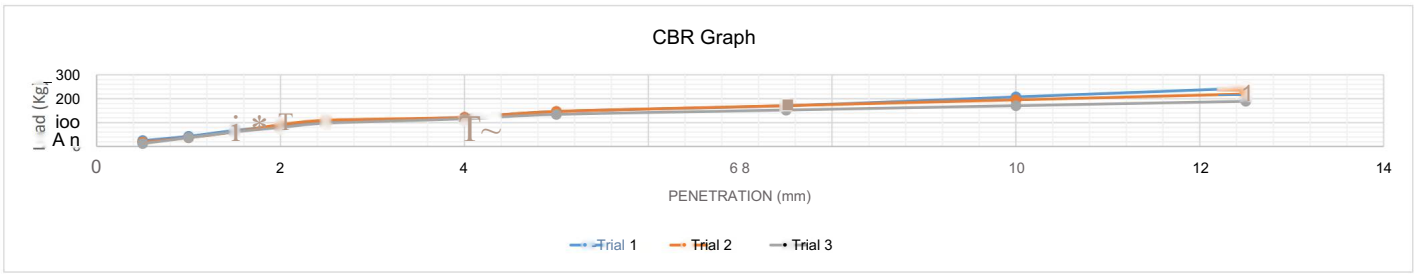
IS 2720 PART XVI

Location :	CH : 20+000 L/S		Date of Casting:	17-10-2024
Type of Material:	24		Date of Testing :	21-10-2024
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.736
Volume of Mould (cc):	2150		OMC of Sample (%):	11.30

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		2	12.2	
1.963 Sqcm	1.0	7	42.7		6	36.6		6	36.6	
Standard Load	1.5	11	67.1		10	61		10	61	
Penetration Unit	2.0	14	85.4		15	91.5		13	79.3	
	2.5	17	103.7	7.57	18	109.8	8.01	16	97.6	7.12
2.5 70 (1370 Kg)	4.0	20	122		20	122		19	115.9	
	5.0	24	146.4	7.12	24	146.4	7.12	22	134.2	6.53
	7.5	28	170.8		28	170.8		25	152.5	
5 105 (2055 Kg)	10.0	34	207.4		32	195.2		28	170.8	
	12.5	40	244		36	219.6		31	189.1	
Average CBR Value (%)		2.5:	7.57		5.0	6.93				



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NEW SUN CONSULTING FIRM
Guwahati, Assam

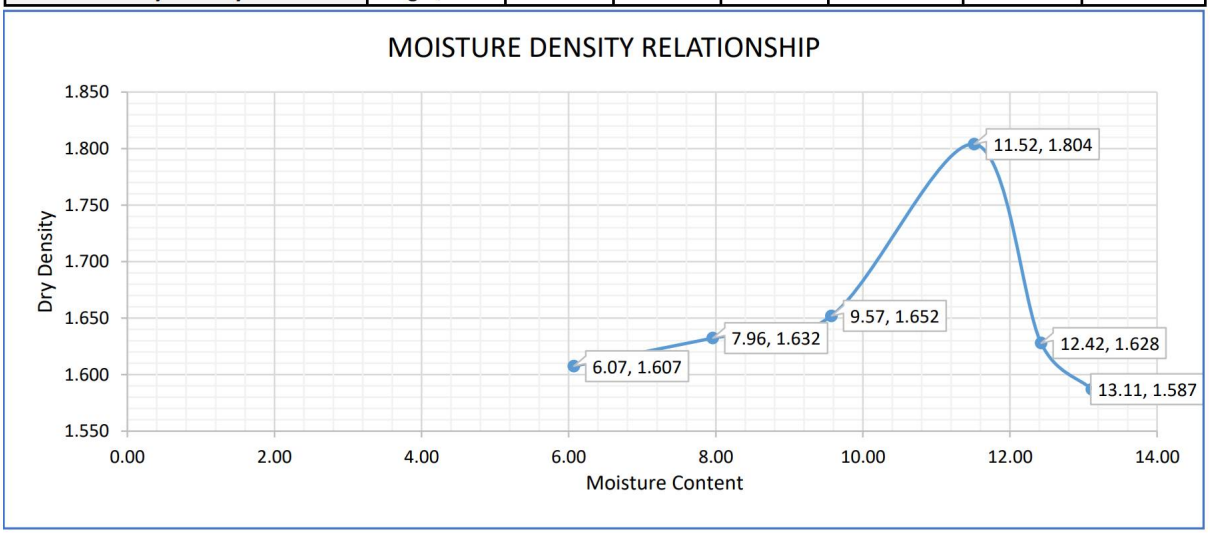
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name: MMRoad [redacted] District:Darrang [redacted]

Source of Material:	CH : 23+200 L/S		**Date Of Testing :**	17-10-2024
Sample No.:	25		**Wt of Mould :**	4500.00
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	**Units**	**Determinations**					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	%	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8165.8	8289.8	8391.8	8628.8	8434.8	8359.8
Wt of Mould	gm	4500	4501	4500	4500	4500	4500
Wt. of Compacted Soil	gm	3665.8	3788.8	3891.8	4325	3934.8	3859.8
Bulk Density of Soil	gm/cc	1.705	1.762	1.810	2.012	1.830	1.795
Container No.	No	B-1	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	101	104.1	106.5	109.1	110.3	111.1
Wt. of dry Soil + Container	gm	96.2	97.7	98.7	99.6	100	100.2
Wt. of Water	gm	4.8	6.4	7.8	9.5	10.3	10.9
Wt. of dry Soil	gm	79.1	80.4	81.5	82.5	82.9	83.1
Moisture Content	%	**6.07**	**7.96**	**9.57**	**11.52**	**12.42**	**13.11**
Dry Density	gm/cc	**1.607**	**1.632**	**1.652**	**1.804**	**1.628**	**1.587**



Maximum Dry Density (g/cc)	**1.804**	**Optimum Moisture Content(%)**	**11.52**

CALIFORNIA BEARING RATIO

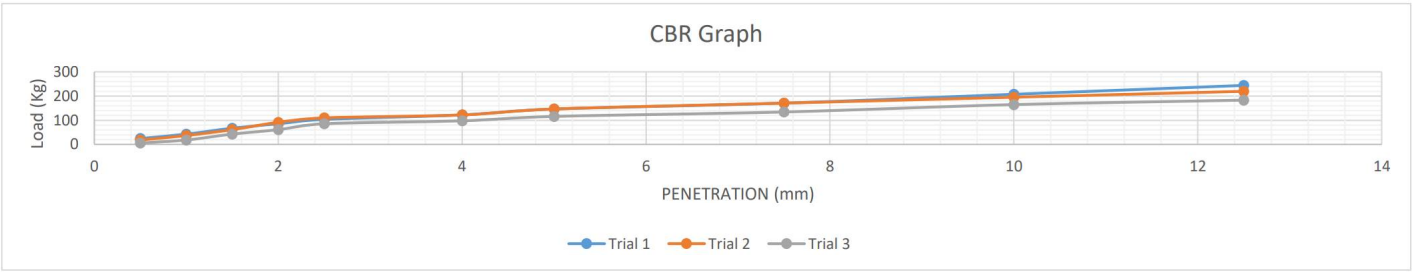
IS 2720 PART XVI

Location :	CH : 23+200 L/S		Date of Casting:	17-10-2024
Type of Material:	25		Date of Testing :	21-10-2024
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.804
Volume of Mould (cc):	2150		OMC of Sample (%):	11.52

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		1	6.1	
1.963 Sqcm	1.0	7	42.7		6	36.6		3	18.3	
Standard Load	1.5	11	67.1		10	61		7	42.7	
Penetration Unit	2.0	14	85.4		15	91.5		10	61	
	2.5	17	103.7	7.57	18	109.8	8.01	14	85.4	6.23
2.5 70 (1370 Kg)	4.0	20	122		20	122		16	97.6	
	5.0	24	146.4	7.12	24	146.4	7.12	19	115.9	5.64
	7.5	28	170.8		28	170.8		22	134.2	
5 105 (2055 Kg)	10.0	34	207.4		32	195.2		27	164.7	
	12.5	40	244		36	219.6		30	183	
Average CBR Value (%)		2.5:	7.27		5.0	6.63				



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NEW SUN CONSULTING FIRM
Guwahati, Assam

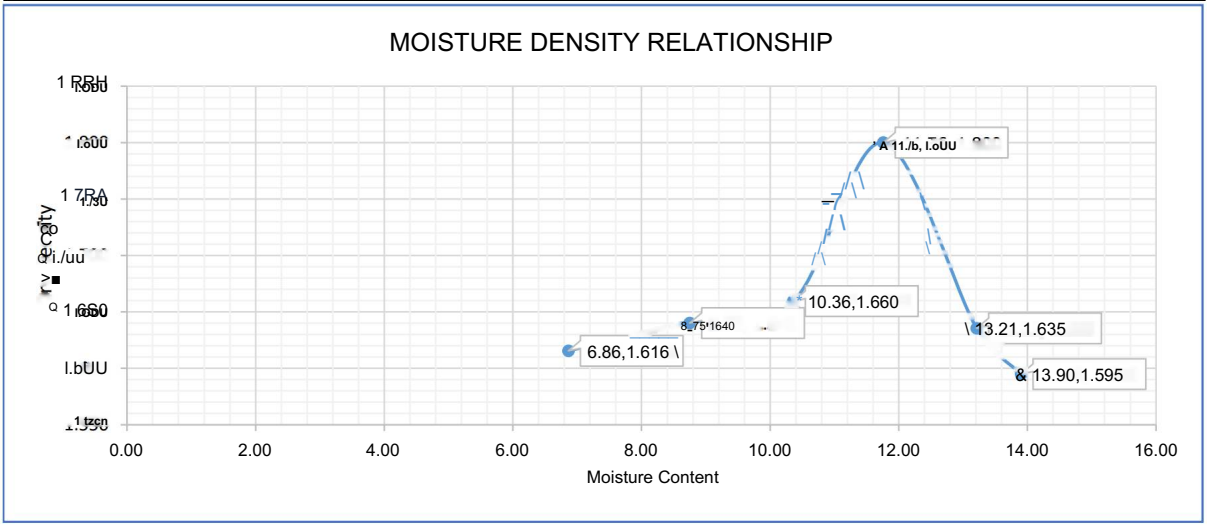
PROCTOR COMPACTION TEST

IS 2720 PART VIII

Project Name: Chowkihola Tarapung District: Karbi Anglong

Source of Material:	CH : 24+500 L/S		**Date Of Testing :**	17-10-2023
Sample No.:	26		**Wt of Mould :**	4468.80
Wt. Of Sample :	6000 gms		**Volume of Mould (cc):**	2150

Description	**Units**	**Determinations**					
Trail	**No**	**1**	**2**	**3**	**4**	**5**	**6**
Water added	°/o	4	6	8	10	12	14
Wt. of Mould + Wt. of Soil	gm	8180.5	8304.5	8406.5	8643.5	8449.5	8374.5
Wt of Mould	gm	4468.8	4469.8	4468.8	4468.8	4468.8	4468.8
Wt. of Compacted Soil	gm	3711.7	3834.7	3937.7	4325	3980.7	3905.7
Bulk Density of Soil	gm/cc	1.726	1.784	1.831	2.012	1.851	1.817
Container No.	No	B-I	B-2	B-3	B-4	B-5	B-6
Wt. of Empty Container	gm	17.11	17.29	17.22	17.1	17.09	17.07
Wt. of Wet Soil + Container	gm	101.2	104.3	106.7	109.3	110.5	111.3
Wt. of dry Soil + Container	gm	95.8	97.3	98.3	99.6	99.6	99.8
Wt. of Water	gm	5.4	7	8.4	9.7	10.9	11.5
Wt. of dry Soil	gm	78.7	80.0	81.1	82.5	82.5	82.7
Moisture Content	°/o	**6.86**	**8.75**	**10.36**	**11.76**	**13.21**	**13.90**
Dry Density	gm/cc	**1.616**	**1.640**	**1.660**	**1.800**	**1.635**	**1.595**



Maximum Dry Density (g/cc)	**1.800**	**Optimum Moisture Content(%)**	**11.76**

CALIFORNIA BEARING RATIO

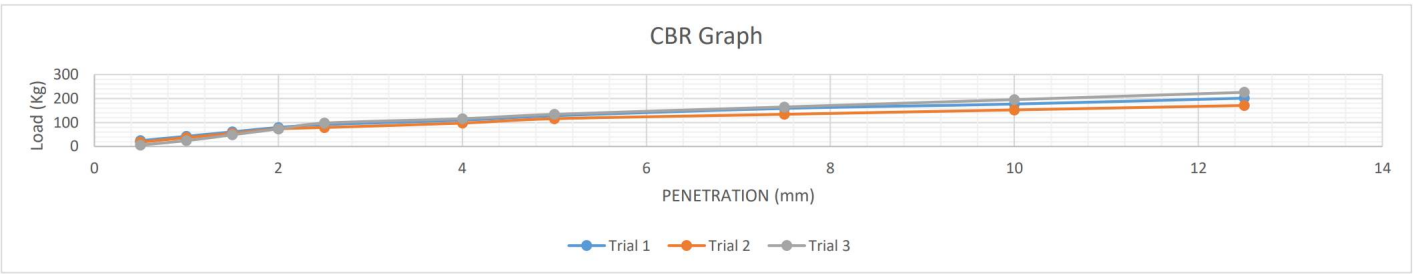
IS 2720 PART XVI

Location :	CH : 24+500 L/S		Date of Casting:	17-10-2023
Type of Material:	26		Date of Testing :	21-10-2023
Soaking Period :	96 Hours		MDD of Sample (gm/cc):	1.800
Volume of Mould (cc):	2150		OMC of Sample (%):	11.76

0

Load Penetration Test Data

Calibration Factor:	6.10 Kg/Div	TRIAL -1			TRIAL - 2			TRIAL- 3		
Note : Refer Encl. Load vs Penetration Curve	Penetration (mm)	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value %	Proving Ring Dial Gauge Reading	Load (Kg)	Corrected CBR Value °/o
Mould No.			1			2			3	
Standard Piston Area	0.5	4	24.4		3	18.3		1	6.1	
1.963 Sqcm	1.0	7	42.7		6	36.6		4	24.4	
Standard Load	1.5	10	61		9	54.9		8	48.8	
Penetration Unit	2.0	13	79.3		12	73.2		12	73.2	
	2.5	15	91.5	6.68	13	79.3	5.79	16	97.6	7.12
2.5 70 (1370 Kg)	4.0	18	109.8		16	97.6		19	115.9	
	5.0	21	128.1	6.23	19	115.9	5.64	22	134.2	6.53
	7.5	26	158.6		22	134.2		27	164.7	
5 105 (2055 Kg)	10.0	29	176.9		25	152.5		32	195.2	
	12.5	33	201.3		28	170.8		37	225.7	
Average CBR Value (%)		2.5:	6.53		5.0	6.13				



Authorised Signatory

NEW SUN CONSULTING FIRM
Guwahati, Assam

REPORT ON

GEOTECHNICAL INVESTIGATION

FOR
CONSTRUCTION OF RCC BRIDGE
AT CHAINAGE: 14+850

MANGALDOI-MAZIKUCHI ROAD

REPORT SUBMITTED TO

ZENITH ASSOCIATES _

REPORT PREPARED BY

RELIANT ENGINEERS

H-7, BYE LANE NO: 1(A, NORTH), PANJABARI ROAD
SIXMILE, GUWAHATI - 22

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Email: rel_engrs@yahoo.com

REPORT ON SOIL INVESTIGATION WORK FOR CONSTRUCTION OF RCC BRIDGE OVER RIVER AT CHAINAGE:14+850

1. INTRODUCTION:

1.1 This report presented herein deals with the field and laboratory investigations carried out by us to access the nature of sub-strata and to evaluate the soil parameters required for design of foundations proposed to be constructed for proposed bridge.

1.2 Client's help is gratefully acknowledged in providing bore hole locations, close supervision and checking during boring, sampling, various testing operations and cooperation and guidance during finalization of report.

1.3 The work of Geotechnical Investigation was awarded to RELIANT ENGINEERS, H-7, BYE LANE NO.1 (A.NORTH), PANJABARI ROAD, SIXMILE, GUWAHATI-22 for the project construction of bridge.

1.4 This report is based upon the results of field , laboratory tests conducted on selected soil/rock samples collected from bore hole up to the depth of 30.0 M each and interpretation of results were done as per IRC 78-2000 and pertinent IS code of practices.

most destructive earthquakes in human history. The mountainous tracts of the region are inhabited by people of diverse ethnic groups and cultural affinities lured by the pioneering spirit of man in quest of the unknown, be it geographical or geological. The earliest reference of the region is found in the Mahabharata and documentation of the geological information was made mostly by the British military expeditions during the early part of the nineteenth century prior to establishment of the GSI in 1851. This excludes the meticulous records of the earthquakes which are available since the middle of the last century.

2. SCOPE OF WORK:

The scope of work provided to us for this project was limited to the following:-

3.1 Mobilizing necessary plant, equipments and personnel to the project site, setting up the equipment, carrying out the field investigations on land and demobilization on completion of work.

3.2 Making 150 mm nominal diameter bore holes at the site in all types of soil using suitable approved method of boring to be given at site by the Engineer-in-Charge. Refusal shall mean when SPT field 'N' value reaches 100 for 30 cm or less penetration of SPT sampler.

3.2.1 Conducting standard penetration tests in the bore holes at 1.50 m interval in depth as per specifications / instructions of Engineer-in-Charge.

3.2.2 Collecting undisturbed soil samples from bore holes at 3.0m interval or every change of strata, whichever is earlier as per specifications.

3.2.3 Collecting disturbed soil samples from bore hole at regular interval and at every identifiable change of strata to supplement the boring records.

3.2.4 Recording the depth of ground water table in all the bore hole if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

3.3 Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from bore hole / test locations :-

(a) Bulk density and Moisture content

(b) Sieve analysis

(c) Hydrometer analysis

(d) Liquid limit & Plastic limits

(e) Specific gravity

(f) Shear test on undisturbed and remoulded saturated disturbed soil samples

(g) Determination of void ratio.

3.4 Preparation and submission of report in three copies.

4.0 FIELD INVESTIGATIONS:

4.1 Necessary plant, equipment and personnel for conducting the requisite field work were mobilized to the site.

4.2 One number borehole was first marked on the ground surface as per the layout given to us by the Engineer-in-Charge.

4.3 Bore hole was bored at this site using rotary drilling method as per IS: 1892-1979.

4.3.1 **Standard penetration** tests were conducted in the above bore hole at every 1.50 m interval & at change of strata as per specifications / instructions of Engineer-in-Charge. The bore was cleaned up to the desired depths. Standard split spoon sampler attached to lower end of 'A' drill rods was driven in the bore holes by means of standard hammer of 63.5 Kg. falling freely from a height of 75 cm. The sampler was driven 45 cm as per specifications & the numbers of blows required for each 15 cm penetration were recorded. The numbers of blows for the first 15 cm penetration were not taken into account. This was considered as seating drive. The numbers of blows for next 30 cm penetration were designated as SPT 'N' value. Wherever the total penetration was less than 45 cm, the number of blows & the depth penetrated is

incorporated in respective bore logs. Disturbed soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded and carefully transported to the laboratory for testing.

4.3.2 **Undisturbed** soil samples were collected from the bore hole at every 3.00 m interval in depth & at change of strata as per sampling specifications. These sampling tubes after retrieval from the bore hole was properly waxed and sealed at both ends. These were carefully labeled and transported to the laboratory for testing. Undisturbed soil samples wherever slipped during lifting, were duly marked in the field bore logs as well as in the soil profile.

4.3.3 **Disturbed soil** samples were also collected from the bore hole at suitable depths/intervals to supplement the boring records. These samples were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded & carefully transported to the laboratory for testing.

4.3.4 The depth of ground water table was checked / measured in all bore holes.

4.3.5 **Summary of bore holes:**

Table1

Borehole No	RL of bore hole top	Depth of Bore hole(M)	Water level during the time of field work(M)
BH1	49.729	30.0	1.30

5.0 LABORATORY INVESTIGATIONS:

5.1 The following laboratory tests were conducted on selected soil samples recovered

from bore hole / test locations: -

(a) Bulk density and Moisture content

(b) Sieve analysis

(c) Hydrometer analysis

(d) Liquid limit & Plastic limits

(e) Specific gravity

(f) Shear test on remolded and saturated disturbed soil samples

(g) Determination of void ratio..

All the above laboratory tests were carried out as per relevant Indian Standards. All the soil samples were identified and classified as per IS: 1498-1970.

6.0 FINDING OF GEOTECHNICAL INVESTIGATION:

The study of bore logs/results of laboratory and other field tests are tabulated through different tables as annexure.

7.0 Calculation of scour depth

HFL = 53.510
LBL=48.715
Mean scour depth (hydraulic calculation) = 4.795
Maximum Scour around Abutment =4.795 x1.27=6.089 Say6.1
Estimated Scour level = 53.510 – 6.1= 47.41

8.0 Design of Pile foundation (Uniform dia Pile)

Ultimate bearing capacity in compression in sand, Q_U from IS: 2911(Part-I)-1981

$Qu = Q_P + Q_f$

= End bearing resistance + Frictional resistance of pile in sand and clay.

$Qu = Ap\ (1/2\ D\ \gamma\ N\gamma + P_D\ Nq) + (\alpha\ Ca\ As + \Sigma\ K\ P_{Di}\ \tan\delta\ A_{Si})$

$Q_P = Ap\ (1/2\ D\ \gamma\ N\gamma + P_D\ Nq)$

$Q_{fs} = \Sigma\ K\ P_{Di}\ \tan\delta\ A_{Si}$

$Q_{fc} = \alpha\ Ca\ As$

$Qsafe = Q_U/FOS = Q_U/2.5$

where

Ap = Cross sectional area of pile toe in cm^2.

As (cm^2) = surface area of the stem

Nγ, Nq = bearing capacity factors depending upon the angle of internal friction

K = earth pressure coefficient (usually taken as 1.5 for sandy soils)

δ = Angle of wall friction between pile and soil.

As = Circumferential area of pile stem = Πx l x d

l = Length of embedment .

d = Diameter of the pile.

Pile load capacity in uplift

Ultimate uplift capacity Q_{Uf} = Skin friction in sand + Skin friction in clay.

$= Q_{fs} + Q_{fc}$

Table1: Pile load capacity for Pile foundation

Foundation Depth from LBL (M)	Foundation Depth from scour level (M)	RL of pile terminating level (m)	Pile Diameter (mm)	Safe load on pile in compression (ton)	Safe load on pile in uplift (ton)
13.3	12.00	35.410	1000	125.28	26.80
			1200	177.54	34.99
15.3	14.00	33.410	1000	157.97	39.37
			1200	221.67	50.64
17.3	16.00	31.410	1000	193.55	54.35
			1200	269.27	69.17

9.0 CONCLUSION AND RECOMMENDATION: Soil at this site is in soft state up to a depth of 7.00M so pile foundation is recommended

ANNEX I

γ (ton/m^3) in clay = 0

Pile is designed as Pile resting in Sand

γ (ton/m^3) in sand = 1.99

Here , cp(t/sqm)= 0 ca(t/sqm)= 0 $\emptyset^0$ = 32

Nc= 36.532 Nq= 33.2 Ng= 32.652

Diameter of pile D (cm)= 100 **Length of Pile below EGL(M) 12**

Pile cutoff length (m)+ scour 2

Area of pile tip(sqm) = 0.785

Circumferential area of pile stem in sand(sqm) = 15.7

Circumferential area of pile stem in Clay(sqm) = 0

Qp Ton)= 268.12 ton

Qfs (Sand) = 45.07 ton

Qfc (Clay) = 0 ton

Qf=Qf (Sand)+Qf (Clay) = 45.07 ton

Qu=Qp+Qf = 313.20

Safe load in compression(Ton) **Qcs = 125.28** ton
(FOS=2.5)

Safe load in uplift (ton) **Qus** = 15.0 ton + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus = 26.80**

Diameter of pile D (cm)= 120 **Length of Pile below EGL(M) 12**

γ(ton/m^3) = 1.99

Here , cp(t/sqm)= 0 ca(t/sqm)= 0 $\emptyset^0$ = 32

Nc= 36.532 Nq= 33.2 Ng= 32.652

Area of pile tip(sqm) = 1.1304

Circumferential area of pile stem in sand(sqm) = 18.84

Circumferential area of pile stem in Clay(sqm) = 0

Qp Ton)= 389.75

Qf (Sand) = 54.09

Qf (Clay) = 0.00

Qf=Qf (Sand)+Qf (Clay) = 54.09

Qu=Qp+Qf = 443.84

Safe load in compression(Ton) **Qs = 177.54**

Safe load in uplift (ton) **Qsu** = 18.0 + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus = 34.99**

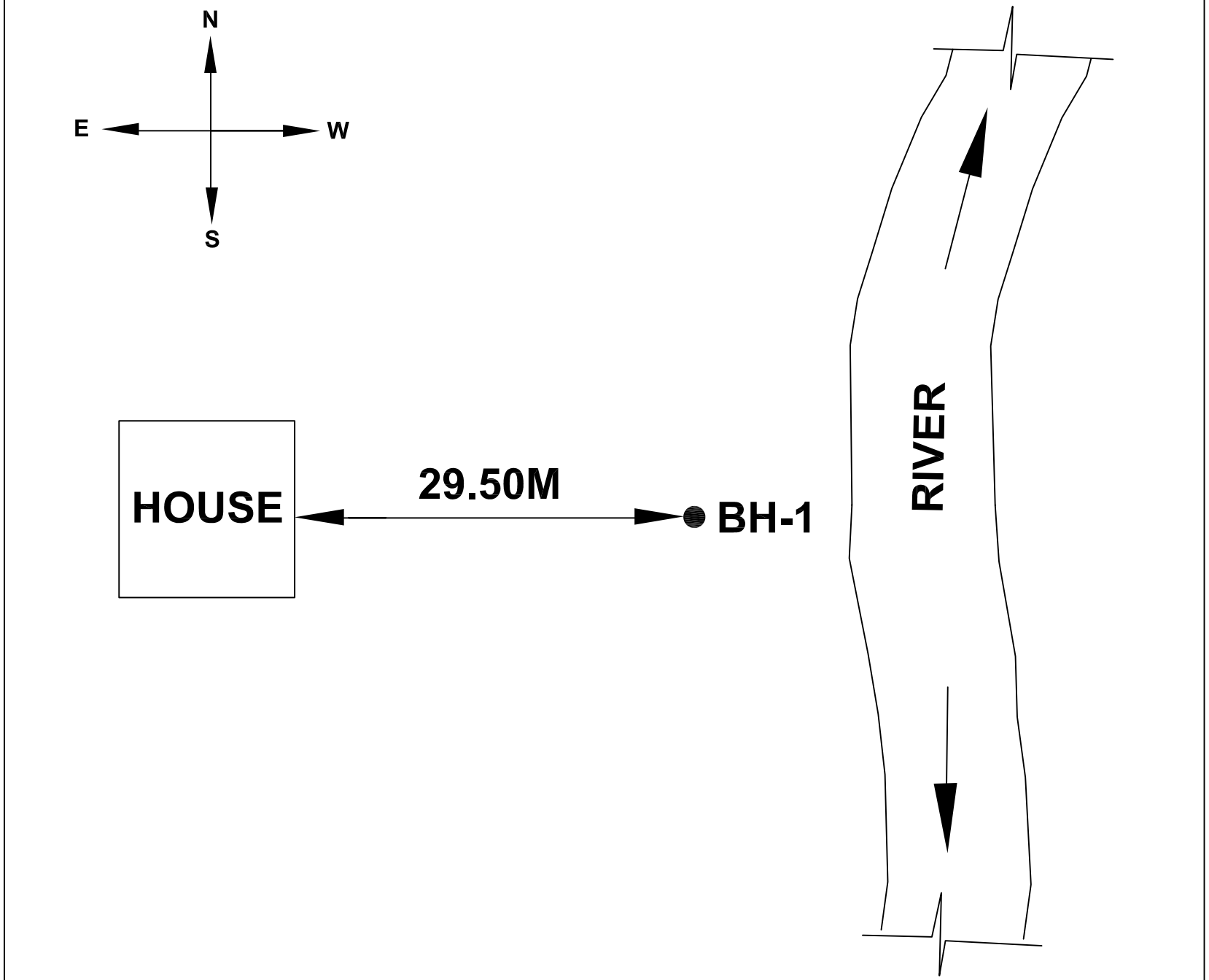


Fig : Site plan showing Bore holes location

N.B.: Not in Scale

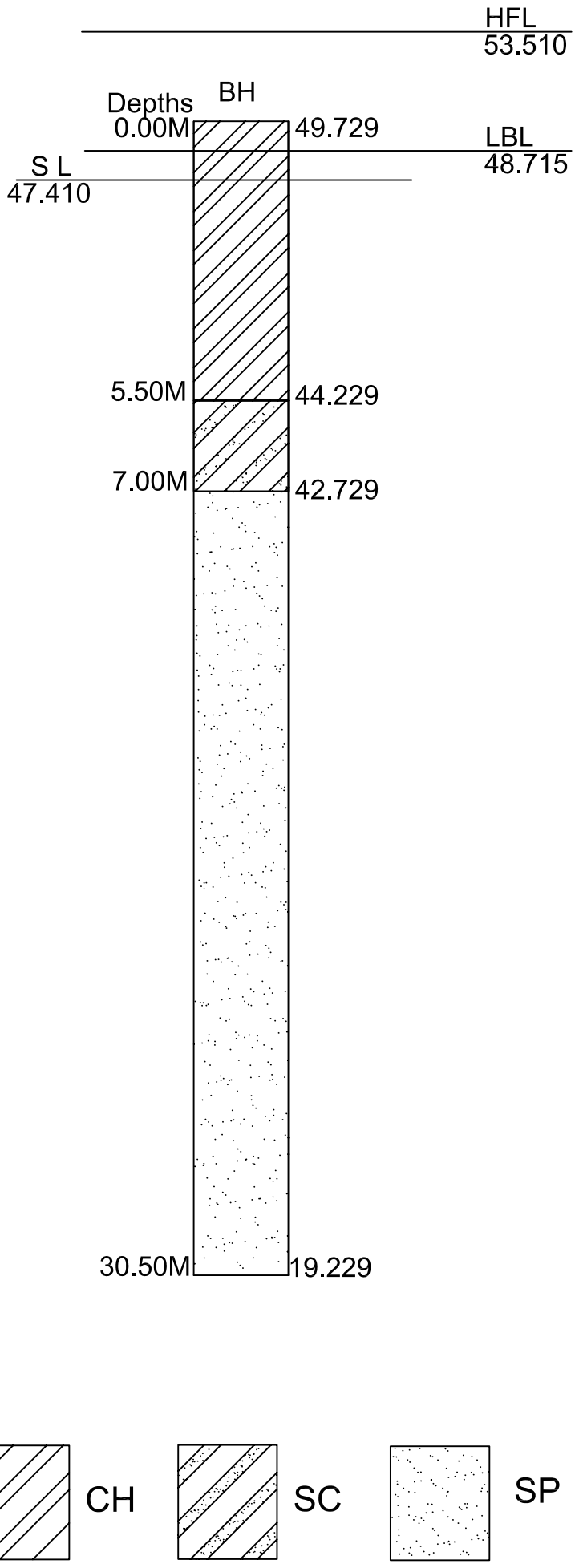


Fig1:Cross-section & subsoil profile

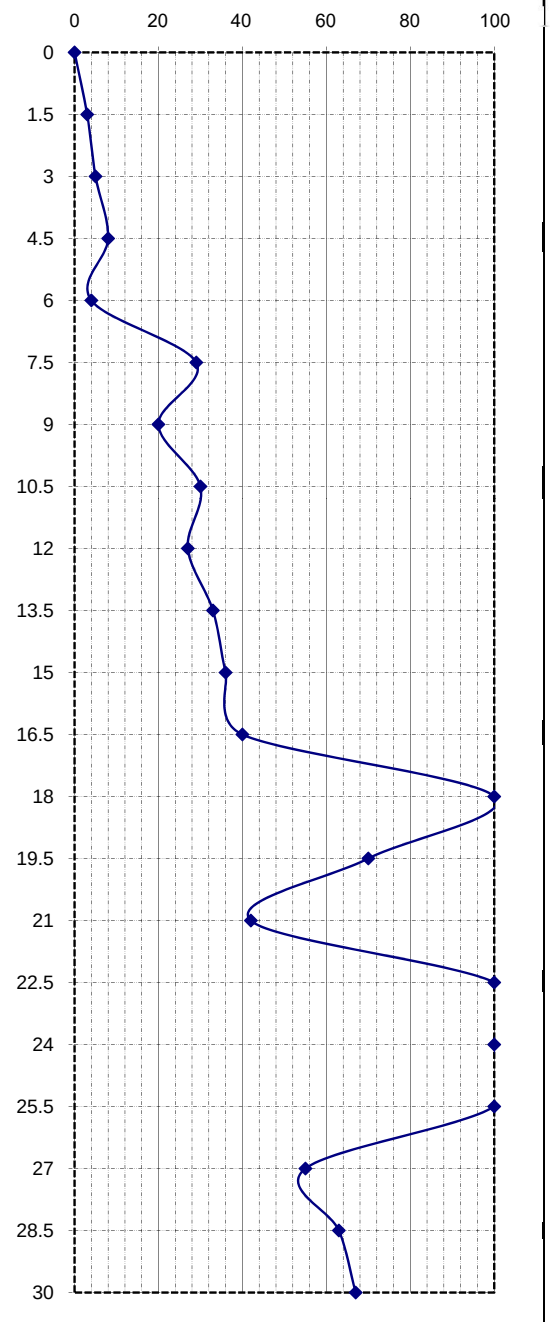
Name of Project: CONSTRUCTION OF RCC BRIDGE OVER RIVER AT CHAINAGE 14+850.

BORE LOG CHART

BORE HOLE NO:1	DATE OF STARTING:06-10-2024 DATE OF COMPLETION:07-10-2024	GROUND WATER LEVEL 1.30M from EGL	AUGER & WASH BORING

DEPTH (M)	TYPE OF SAMPLE	SPT 15 CM	SPT 15 CM	SPT 15 CM	N-Value	VISUAL DESCRIPTION OF SOIL	LOG
1.50	P	1	2	1	3	Grayish CLAY some silt.	
2.00	U						
2.00	2	3	2	3	5		
3.50	U						
4.50	P	3	3	5	8	5.50M	
5.00	U						
6.00	P	2	2	2	4	Grayish fine SAND some silt & clay.7.00M	
6.50	D						
7.50	P	10	13	16	29		
8.00	D						
9.00	P	7	9	11	20	Grayish fine to medium SAND.	
9.50	D						
10.50	P	13	14	16	30		
11.00	D						
12.00	P	10	12	15	27		
12.50	D						
13.50	P	13	15	18	33		
14.00	D						
15.00	P	16	16	20	36		
15.50	D						
16.50	P	15	18	22	40		
17.00	D						
18.00	P	28	R	R	R		
18.50	D						
19.50	P	21	35	35	70		
20.00	D						
21.00	P	17	19	23	42		
21.50	D						
22.50	P	30	R	R	R		
23.00	D						
24.00	P	R	R	R	R	30.50M	
24.50	D						
25.50	P	R	R	R	R		
26.00	D						
27.00	P	15	25	30	55		
27.50	D						
28.50	P	18	28	35	63		
29.00	D						
30.00	P	21	30	37	67		
30.50	D						

GRAPHICAL REPRESENTATION OF N-Value



U:UDISTURBED SAMPLE | **D: DISTURBED SAMPLE** | **P: STANDARD PENETRATION TEST**

BORE LOG CUM LABORATORY TEST RESULT

Name of Project: **CONSTRUCTION OF RCC BRIDGE OVER RIVER KUIAPANI AT CHAINAGE 1+808.**

Boring method: Shell& Auger & Wash Boring dia: 150mm Date Commenced: 06.05.17 Date completed: 07.05.17

BH: 1 DEPTH OF WATER TABLE=1.30M from EGL.

Depth in meters below reference	Types of Sample	Observed N-Value	Group Symbol	Visual description of soil	% Gravel > 75mm	% Sand 4.75-0.075 mm	Silt 0.075-0.002	% Clay < 0.002 mm	Field density, gms/cm³	Specific Gravity	Void Ratio	Natural moisture content	Unconfined compressive Strength Kg/cm² (U D)	Shear Parameter		Compression Index Cc	LL%	PL%	Passing 75 micron (%)
														Cohesion 'c' Kg/cm²	Angle of shearing resistance (Φ°)				
1.5-1.95	P	3	**CH**	Grayish CLAY some silt.															
2.0	U						20	80	1.63	2.65				0.19	8				
3.0-3.45	P	5																	
3.5	U						15	85											
4.5-4.95	P	8																	
5.0	U			5.50M			25	75	1.68	2.65				0.45	8				
6.0-6.45	P	4	**SC**	Grayish fine SAND some silt & clay.7.00M															
6.5	D					60	20	20											
7.5-7.95	P	29	**SP**	Grayish fine to medium SAND.															
8.0	D					100			1.89	2.65					32				
9.0-9.45	P	20																	
9.5	D					100													
10.5-10.95	P	30																	
11.0	D					100			1.90	2.65					32				
12.0-12.45	P	27																	
12.5	D					100													
13.50-13.95	P	33																	
14.0	D					100			1.93	2.65					34				
15.0-15.45	P	36																	
15.5	D			15.50M		100													

U: Undisturbed Sample:: D: Disturbed Sample:: P: Standard Penetration test:: DS: Direct shear test:: R=Refusal, N-value>100

BORE LOG CUM LABORATORY TEST RESULT

Name of Project: **CONSTRUCTION OF RCC BRIDGE OVER RIVER KUIAPANI AT CHAINAGE 1+808.**

Boring method: Shell& Auger & Wash Boring dia: 150 mm Date Commenced: 06-05-17 Date completed: 07-05-17

BH: 1 DEPTH OF WATER TABLE=1.30M from EGL

Depth in meters below reference	Types of Sample	Observed N-Value	Group Symbol	Visual description of soil	% Gravel > 4.75mm	% Sand 4.75-0.075 mm	Silt 0.075-0.002	% Clay < 0.002 mm	Field density, gms/cm³	Specific Gravity	Void Ratio	Natural moisture content	Unconfined compressive Strength Kg/cm² (U D)	Shear Parameter		Compression Index Cc	LL%	PL%	Passing 75 micron (%)
														Cohesion 'c' Kg/cm²	Angle of shearing resistance (Φ')				
16.5-16.95	P	40	**SP**	Grayish fine to medium SAND.															
17.0	D					100			2.13	2.65					39				
18.0-18.45	P	R																	
18.5	D					100													
19.5-19.95	P	70																	
20.0	D					100													
21.0-21.45	P	42																	
21.5	D					100			2.19	2.65					39				
22.5-22.95	P	R																	
23.0	D					100													
24.0-24.45	P	R																	
24.50	D					100													
25.5-25.95	P	R																	
26.0	D					100			2.24	2.65					40				
27.0-27.45	P	55																	
27.5	D					100													
28.5-28.95	P	63																	
29.00	D					100													
30.0-30.45	P	67																	
30.5	D					100													

U: Undisturbed Sample:: D: Disturbed Sample:: P: Standard Penetration test:: DS: Direct shear test:: R=Refusal, N-value>100

SITE PHOTOGRAPHS

SITE PHOTOGRAPHS


Latitude: 26.497686
Longitude: 91.944798
Elevation: 63.89±81 m
Accuracy: 16.3 m
Time: 26-10-2024 12:28
Note: mm canel
Powered by NoteCam


Latitude: 26.498678
Longitude: 91.91645
Elevation: 62.88±37 m
Accuracy: 101.2 m
Time: 26-10-2024 13:14
Note: mm pond3a