सत्यमेव जयते

# *Consultancy Services for Detailed Engineering & Preparation of Detailed Project Report for Up-gradation to 2-lane of State Road from NONGSTON to DOMIASIAT via WAHKAJI (Tentative Length 66 Km) in the state of Meghalaya*


## DETAILED PROJECT REPORT (DPR)

## VOLUME-I (MAIN VOLUME)

## MARCH - 2014

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# 0.0 EXECUTIVE SUMMARY

## 0.1 Introduction

The Public Work Department (Roads), Government of Meghalaya, intend to undertake widening to 2-lane and improvement of about 66 km length of **MDR-17** from **Nongstoin town** to **Leitjynrai via Nongkhyllam, Nonglwai, Pambriew etc.** and **MDR-20** from **Laitsawsnai via Umdohlun and Wahkaji** in the West Khasi Hill District of State of Meghalaya to augment capacity of the road, with enhanced safety features under **SARDP-NE Scheme** of **Ministry of Road Transport and Highways, Government of India**.

The project road encompasses complete MDR-17 (25 Kms) from Nongstoin to Laitsawsnai. Thereafter it joins MDR-20 at its chainage at Km.46 and follows up to Km.68 at Wahkaji (22 Kms.) where MDR-20 terminates. The project road thereafter follows Uranium Corporation (India) Ltd. (UCIL) road for a length of 19 Kms. approximately.

The project road is a single lane road and has a few timber bridges (Poor in condition). The average formation width of this road is about 6.00 m and the carriageway width is about 3.5m approximately with 1.25m shoulders on either side. The formation width is inadequate from 2-lane standard. The existing pavement is weak in most of the stretch. The terrain is hilly in the entire stretch. The UCIL road from Wahkaji to Domiasiat is a gravel road having formation width varying from 10m to 12m.

## 0.2 Socio – Economic Profile

The District lies in the central part of the State of Meghalaya and is situated between approximately $25^0$ 10' and $25^0$ 51' N latitude, and between $90^0$44' and $91^0$ 49' E longitude. It is bounded on the north-west by Kamrup district of Assam, on the north-east by Ri Bhoi district, on the east by East Khasi Hills district, on the south by Bangladesh, on the west by East Garo and South Garo Hills districts.

The district comprises an area of about 5,247 sq.kms which is approx. 23 percent of the total area of the state. Nongstoin, covering an area of about 76.00 Sq. Kms, is the Headquarter of the District.

West Khasi Hills District was carved out of the erstwhile Khasi Hills District on 28th October, 1976. In the same year, on 10th of November, Mairang Civil Sub-division was inaugurated, whereas the Mawkyrwat Block was converted into an administrative unit. With the up-gradation of Mawkyrwat into a full-fledged sub-division on June 26th, 1982, West Khasi Hills District now comprises three Sub-Divisions (including the Sadar Sub-Division), one administrative unit namely Mawshynrut which came into being on 9th of February, 1996. It also comprises six Community and Rural Development Blocks namely Nongstoin, Mairang, Mawkyrwat, Mawshynrut, Ranikor including Mawthadraishan Block, which was created under the notification of state government.

The Socio-Economic Profile of the Area is given in detail in chapter-2.

## 0.3 Engineering Surveys & Investigations

The Consultant carried out various field studies, engineering surveys and investigations to collect the necessary data for preparation of Preliminary Project Report (PPR) for the project. The investigations were carried out to generate adequate supportive database for preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The various engineering investigations and surveys have been carried out following the relevant IRC.

The various investigations and surveys, which have been carried out by the Consultants, for both the Roads separately are as follows:

- Inventory and condition survey of Road and Pavement
- Inventory and condition survey of Bridges and other cross-drainage structures
- Topographic Survey
- Benkelman Beam Deflection Survey
- Axle Load Survey
- Pavement Investigations

The Survey work has done and the details have been presented in chapter-3.

## 0.4 Traffic Analysis & Demand Forecast

Traffic analysis and forecast form key and important elements of any Project Report preparation. They have a direct bearing on several aspects. Some of these include lane width requirements and pavement thickness, design features and elements, and wayside facilities. All these signify the importance of base year and design year traffic which determines the type and level of facility to be planned and developed, which in turn forms the base towards determining the up gradation cost. Given this, decisions on the type of traffic surveys, locations and duration have therefore been taken judiciously to arrive at representative traffic flows on the various sections, traffic desire patterns and characteristics.

The **Table** below presents location wise traffic in Average Daily Traffic (ADT) in vehicles and in PCU. The table also provides the total number of motorized passenger vehicles, motorized goods vehicles and non-motorized vehicles by location on the project corridor.

| Vehicle Type | Kynron Village (Km 9.00) | Marium Village (Km 34.00) |
|---|---|---|
| Two Wheeler | 107 | 60 |
| Auto Rickshaw | 4 | 2 |
| Car / Jeep / Van | 163 | 87 |

| Vehicle Type | Kynron Village (Km 9.00) | Marium Village (Km 34.00) |
|---|---|---|
| Tempo | 0 | 0 |
| Mini / RTVs Bus | 0 | 0 |
| Standard Bus | 16 | 13 |
| Light Commercial Vehicle | 65 | 54 |
| 2-Axle | 78 | 55 |
| **Total Motorised Vehicles (Number)** | **433** | **271** |
| **Total Motorised Vehicles (PCU)** | **601** | **404** |
| **Total PCU per day** | **601** | **404** |

Other details of Traffic are presented in Chapter – 4.

## 0.5 Design Standards

Design recommendations have been proposed for the two lane facility of the project road according to the IRC 37 manual. The summary of design standards adopted is presented below:

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| 1 | **Design speed** | | | |
| | Ruling | km/hr | 80 | 50 |
| | Minimum | km/hr | 65 | 40 |
| 2 | **Cross sectional elements** | | | |
| (a) | **Carriage way width** | | | |
| | Two lane | m | 7.0 | 7.0 |
| (b) | Shoulder width | | | |
| | Paved Shoulder | m | 1.5 | - |
| | Earthen shoulder | m | 1.0 | 2.5 |
| (c) | Cross Slope | | | |
| | Bituminous surface | % | 2.5 | 2.5 |
| | Earthen surface | % | 3.5 | 3.5 |
| (d) | Extra Widening of pavement at curves | m | - | 0.9 |
| 3 | **Horizontal curve** | | | |
| (a) | Radius | | | |
| | Ruling Minimum | m | 230 | 80 |

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| | Absolute Minimum | m | 155 | 50 |
| (b) | Superelevation (max) | % | 7 | 7 |
| 4 | **Vertical curve** | | | |
| (a) | Length (min) | m | 60 | 30 |

## 0.6 Improvement Proposals

From the topographical survey conducted for the project road, four types of typical cross-sections are proposed for the improvement of the project road. The details of typical cross-section are given below

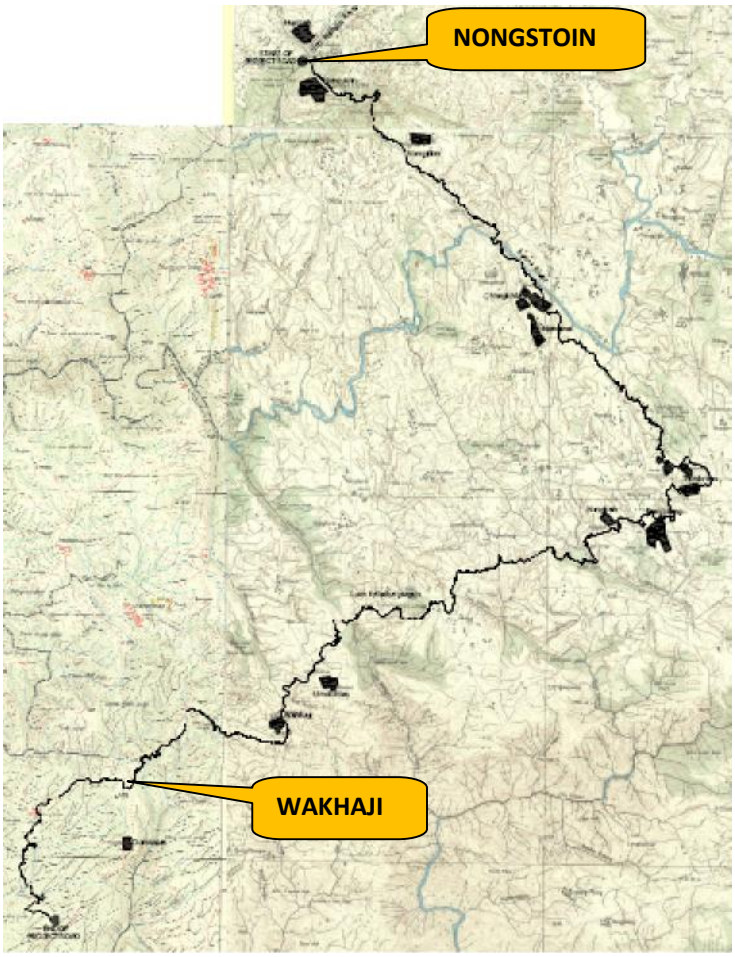
| S.No | Description | Type of Cross-Section | Proposed Length (m) |
|---|---|---|---|
| 1 | Typical cross-section with earthen shoulders in rural stretches with eccentric widening where single lane carriageway exists | Type-I | 34318 |
| 2 | Typical cross-section with earthen shoulders in rural stretches with concentric widening where single lane carriageway exists | Type-II | 357 |
| 3 | Typical cross-section with paved shoulders in urban stretches with concentric widening where single lane carriageway exists | Type-III | 205 |
| 4 | Typical cross-section with earthen shoulders in rural stretches new construction | Type-IV | 23115 |
| | **Total Length (m)** | | **57995** |

Detailed widening scheme is attached at the end of chapter-3 of **Volume-II (Design Report-Part-I, Roads)**

Other details of Improvement proposals for structures and Pavement design is presented in Chapter 6.

# 1.0 INTRODUCTION

## 2.1 Location Map of Project Road


## 2.2 General

2.2.1 An efficient transport system is a pre-requisite for sustained economic development. It is not only the key infrastructural input for the growth process but also plays a significant role in promoting national integration, which is particularly important in a large country like India. The transport system also plays an important role for promoting the development of the backward regions and integrating them with the mainstream economy by opening them to trade and investment. In a liberalized set-up, an efficient transport network becomes all the more important in order to increase productivity and enhancing the competitive efficiency of the economy in the world market.

2.2.2 The Public Works Department, Govt. of Meghalaya along with MORT&H, Govt. of India intends to undertake upgradation of various roads & bridges under Special Accelerated Road Development Programme **(SARDP)** in North East to improve connectivity & accessibility in remote areas and to improve socio-economic status of the area.

## 2.3 Project Road

2.3.2 The Public Work Department (Roads), Government of Meghalaya, intend to undertake widening to 2-lane and improvement of about 66 km length of **MDR-17** from **Nongstoin town** to **Leitjynrai via Nongkhyllam, Nonglwai, Pambriew etc.** and **MDR-20** from **Laitsawsnai via Umdohlun and Wahkaji** in the West Khasi Hill District of State of Meghalaya to augment capacity of the road, with enhanced safety features under **SARDP-NE Scheme** of **Ministry of Road Transport and Highways, Government of India**.

2.3.2 The project road encompasses complete MDR-17 (25 Kms) from Nongstoin to Laitsawsnai. Thereafter it joins MDR-20 at its chainage at Km.46 and follows up to Km.68 at Wahkaji (22 Kms.) where MDR-20 terminates. The project road thereafter follows Uranium Corporation (India) Ltd. (UCIL) road for a length of 19 Kms. approximately.

2.3.3 The project road is a single lane road and has a few timber bridges (Poor in condition). The average formation width of this road is about 6.00 m and the carriageway width is about 3.5m approximately with 1.25m shoulders on either side. The formation width is inadequate from 2-lane standard. The existing pavement is weak in most of the stretch. The terrain is hilly in the entire stretch. The UCIL road from Wahkaji to Domiasiat is a gravel road having formation width varying from 10m to 12m

## 2.4 Objectives of the Project

2.4.1 The objectives of the project, as per the Terms of Reference (TOR) of the Contract Agreement are:

- establishing the technical, economic viability for the project to satisfy the traffic demand over the design period;
- preparing the detailed project report of Project road, making extensive use of current computer-based survey and design techniques (CAD, etc.) and with reference to current international “best practices” for this type of construction;
- preparing detailed design and drawings for the improvement works required along with specifications, bill of quantities, estimates and bidding documents for the construction phase;

## 2.5 Scope of Services

The scope of the consultancy services is to:

I. Conduct preliminary surveys in accordance with Para 6 of IRC Special publication 19.
II. Collect Inventory data and to conduct condition survey of roads, bridges, culverts etc as per IRC: 19 and compile the information in the enclosed Performa and in an acceptable computerized data base format.
III. Prepare strip plans showing the existing road land width, utility services (both above and below ground level), trees, electrical poles, telephone poles, water pipelines, sewage lines, bridges culverts, junctions, adjoining land use, encroachment etc.
IV. Collect Socio-Economic data for state and Project Area.
V. Identify Homogeneous section based on traffic and road geometry.
VI. Conduct 7 day traffic (volume count) survey at one location in each homogeneous section, however, traffic survey shall be conducted at an interval of not more than 50 Kms within a homogeneous section.
VII. Conduct Axle-load survey at a suitable location in each homogeneous section on random sample basis and work out number of equivalent axle load and vehicle damage factor for one day (except holiday).
VIII. Gather information on accidents showing type of accident, frequencies and to identify accident prone locations / section along with main reasons for such situations.
IX. Determine vehicle wise growth rates based on socio-economic data and available past traffic data and also estimate annual growth of traffic.
X. Digging test pits at least 1m below the underside of the lowest pavement layer or rock level, whichever is less whether pavement condition changes or at 2 Km intervals whichever is less. Conduct soil tests e.g. gradation test (IS 2720 part IV), liquid limit, plastic limit, Atterberg limit, field density, moisture content, shrinkage limit test (if required), and deleterious constituents as per relevant IRC Standards.
XI. Determine composition and thickness of existing pavement.
XII. Investigation of design of high embankments based on Ministry's Circular No. NH VI-50 (21) / 79 dated 25.1.1980 and or IRC : 75-1979.
XIII. Identification of borrow areas as per IRC:10, and carry out soil test to determine suitability of soil.
XIV. Conduct representative CBR test on the existing sub-grade as per IRC-37 in alternative Kms.
XV. Carry out Road deflection tests by Benkelman Beam method (IRC:8) for 200m length in alternative Kms.
XVI. Collect information about hydrology e.g. catchment characteristics, rainfall stream / channel characteristics and slit factor for all cross drainage works (existing as well new).
XVII. Drainage studies indicating general drainage pattern, HFL, water level seepage, flow, etc. and prepare drainage designs as per IRC guidelines.
XVIII. Do investigations for naturally occurring materials and to identify suitable quarries for these materials.
XIX. Conduct tests for determining physical strength characteristics, of aggregate material as per relevant IRC standards,
XX. Measurement of pavement roughness by using Bump integrator.

XXI. Trial pits (a) for culverts at an interval of 5 Kms. (b) for minor bridges (length less than 60m) at each location.

XXII. Carry out geotechnical investigations and sub surface exploration by digging bore holes one location for major (length more than 60m).

XXIII. Determine the need of bypass and other realignments and geometric improvements and suggest suitable alignments.

XXIV. Preliminary proposals for widening, strengthening, raising etc.

XXV. Carryout topographic survey i.e. with total station method and establish one B.M. in each Km.

XXVI. Suitable study of alternative for bypasses and other re-alignments and suggest suitable alignment based on merit / demerits of alternatives.

XXVII. Prepare alignment plan, longitudinal and cross sections (The consultant shall prepare complete plan showing improvement proposals. Horizontal control point, bench marks and reference points shall be established as required and indicated on the drawing).

XXVIII. Prepare land plans and relocation plan based on proposed design.

XXIX. Prepare estimate for clearing / shifting of all existing utility services like pipelines for water connection, electrical poles/electrical wires, cables for telecom etc. in consultation with the concerned Departments and also to obtain requisite Forest and Environment Clearance on the forest covered areas.

XXX. Identify level crossing which require up-gradation or construction of R.O.B on the basis of no. of closures, period of closure and expected traffic.

XXXI. Identification of suitable location for lay by, truck parking places and way side amenities.

XXXII. Carry out environment, rehabilitation and resettlement studies as per guidelines of MOEF and IRC: SP: 19 (Revised).

XXXIII. Preparation of rough cost estimates based on

a) Typical cross section of road/approaches
b) GAD for bridge structure.
c) Standard typical drawing for culverts.
d) Widening
e) Strengthening
f) Any other improvement required
g) Analysis of Rates based on Ministry of Road Transport & Highways data book current rates.

XXXIV. Identification and based Prioritization of required works to be taken up for execution in a phased manner.

XXXV. Provide a computer system and requisite software for keeping computerized inventory and digitized maps.

XXXVI. Conduct Economic analysis and Sensitivity tests for the project.

## 2.6 Project Stages

Stage 1: Inception Report (IR)

Stage 2: Detailed Project Report (DPR)

## 2.7 Structure of the Report

**Volume-I: Main Report**

Chapter 0 – Executive Summary

Chapter 1 – Introduction

Chapter 2– Socio-economic Profile of Area

Chapter 3 –Engineering Survey and Investigation

Chapter 4 – Traffic Analysis and Demand Forecast

Chapter 5 – Design Standards

Chapter 6 – Improvement Proposals

Chapter 7 – Project Cost

# 2.0 SOCIO ECONOMIC PROFILE OF PROJECT AFFECTED AREA

## 2.1 Introduction


Weinia fall

The **State of Meghalaya (the abode of clouds)** is geographically known as the "Meghalaya Plateau" or the "Shillong Plateau". The area is made of the oldest rock-formations. Meghalaya consists of the Garo, Khasi and Jaintia hills along with their outliers formed by the Assam ranges. It is the detached north-eastern extension of the Peninsular India. Part of it lies buried under the alluvium deposited by the Ganga - Brahmaputra system of rivers. Endowed with nature's gift and supplemented by the collective Endeavour, the state today is economically stable with revenue surplus. Although it is still a deficit state, Meghalaya has the potential to become a surplus state. Considering the SWOT analysis of the state, its Geo-political status and the emerging free global economy, Meghalaya cannot be expected to become an industrially leading state. It can neither be a state with abundant agricultural surplus production nor a state for intermediate trading. The low productivity in the agriculture sector makes any surplus non-marketable. On the other hand considering the nature's endowment, ethnological diversity, rich cultural heritage, Meghalaya holds high potentiality for economic prosperity through development of tourism.

3.1.2 The West Khasi Hills District lies in the central part of the State of Meghalaya and is situated between approximately 25 degrees 10' and 25 degrees 51' N latitude, and between 90 degrees 44' and 91 degrees 49' E longitude. It is bounded on the north-west by Kamrup district of Assam, on the north-east by Ri Bhoi district, on the east by East Khasi Hills district, on the south by Bangladesh, on the west by East Garo and South Garo Hills districts. The district comprises an area of about 5,247 sq.kms which is about 23 percent of the total area of the state. Nongstoin, covering an area of about 76.00 Sq. Kms, is the Headquarter of the District.

## 2.2 Socio-Economic Profile of Project Influence District

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## 2.3 Physical Features of the State

The physical feature of Meghalaya is well defined in three different regions - the Khasi Hills in the Central part of Meghalaya, Jaintia Hills in the eastern part of Meghalaya and Garo Hills which form the western part of Meghalaya. The Khasi Hills and Jaintia Hills which form the central and eastern part of Meghalaya is an imposing plateau with rolling grassland, hills and river valleys. The southern face of the plateau is marked by deep gorges and abrupt slopes. Water - falls rush down steep slopes and curve deep valleys through which swift- flowing rivers descend to the plains. At the foot of these slopes, a narrow strip of plain land runs along the international border with Bangladesh.

The northern section of the plateau has an undulating topography with a series of hills rising to almost the same height, extending northwards to slope gradually, merging with the plains of Assam. The accordant summit of these hills varies from 170m to 820m. Nongpoh village lying half way on the Guwahati - Shillong road stands on a flat top of 70m height on this hill section.

The height of the central plateau of the Khasi Hills hovers around 1500 m with the Shillong peak (1965m), the highest point in the plateau, overlooking Shillong Town. Khasi hills is popularly known as the 'Scotland of the East' with the pine trees, rolling hills and a numerous waterfalls.

The Garo Hills which form the western part of Meghalaya are lower in elevation. The greater parts of the Garo Hills range in height from 450m to 600m and drop steeply to the Brahmaputra valley on the north and to the plains of Bangladesh on the south. Nortek (1412m) east of Tura town is the highest peak in western Meghalaya.

Meghalaya is endowed with a rich variety of flora and fauna. Of the 17,000 species of orchids in the world, about 1250 exist in India of which nearly 300 are found in Meghalaya. The blue Vanda, Lady's slipper (*Paphiopedilum insigne*) and other rare varieties of orchids are found in Meghalaya. A botanical wonder, the pitcher plant, (an insect eating plant) is found in the districts of Jaintia Hills, West Khasi Hills and South Garo Hills of the state.

## 2.4 Demographic Profile of the Area

The population of the state as it is commonly known contain most of the Tribal people housed within the territory of Meghalaya. Some of the important Tribes that constitute the demographics of Meghalaya are Garo, Khasi and Jaintia.

Of the total Households in Meghalaya, 27 % are from urban Areas. Majority of the households are Christians (72 percent) in the sample. Ninety percent of the households belong to Schedule Tribes. Eleven percent of the households lived in Kutcha and 65% are in Pucca houses. Eleven percent of the households belonged to low economic status.

About 66 percent of population aged seven and above are literate. Percent literate among female is 64 percent where as it is 67 percent for male. Portion of non literate is higher among the older cohort compared to the young ones. Thirty – six percent of eligible women are non-literate and 21 percent have completed 10 or more years of schooling. As regards to the distribution of non-literate women, a lesser portion of younger women below age 30 and above, but in case of non literate husbands the variation is not much across their age cohort.

**Table 2.1: Demographic Profile According to 2001 Census :**

| Sl.No | Items | Units | Year | West Khasi Hills | Meghalaya |
|---|---|---|---|---|---|
| **I. Area and Administrative Units** | | | | | |
| 1 | Area | Sq. Km | 2001 | 5247 | 22429 |
| 2 | Sub-Division(other than district head quarters) | No's | 2007 | 2 | 8 |
| 3 | Police Stations | No's | 2005-06 | 3 | 27 |
| 4 | Police Outpost | No's | 2005-06 | 7 | 56 |
| 5 | Community Dev. Block | No's | 2001 | 6 | 39 |
| 6 | Towns | No's | 2001 | 2 | 16 |
| 7 | No. of Villages | No's | 2001 | 943 | 6026 |
| **II. Population** | | | | | |
| 1 | Total | No's | 2001 | 296.0 | 2318.8 |
| 2 | Male | No's | 2001 | 150.4 | 1176.0 |
| 3 | Female | No's | 2001 | 145.6 | 1142.8 |
| 4 | Rural | No's | 2001 | 261.4 | 1864.7 |

| Sl.No | Items | Units | Year | West Khasi Hills | Meghalaya |
|---|---|---|---|---|---|
| 5 | Urban | No's | 2001 | 34.6 | 454.1 |
| 6 | Scheduled Tribes | No's | 2001 | 290.2 | 1992.9 |
| 7 | Scheduled Castes | No's | 2001 | 42 | 11139 |
| **III. Literacy** | | | | | |
| 1 | Total | P.C | 2001 | 65.1 | 62.6 |
| 2 | Male | P.C | 2001 | 66.5 | 65.4 |
| 3 | Female | P.C | 2001 | 63.7 | 59.6 |
| **IV. Working Population** | | | | | |
| 1 | Cultivators | No's | 2001 | 65.6 | 380.3 |
| 2 | Agricultural Labourers | No's | 2001 | 15.1 | 94.9 |
| 3 | Household Industry | No's | 2001 | 1.4 | 14.0 |
| 4 | Other Workers | No's | 2001 | 15.7 | 267.8 |
| 5 | Total Main workers | No's | 2001 | 97.8 | 757.0 |
| 6 | Marginal workers | No's | 2001 | 31.3 | 213.1 |
| 7 | Non workers | No's | 2001 | 166.9 | 1348.7 |

**Table 2.2: Demographic facts as per the 2011 Census**

| | |
|---|---|
| Total Area (Sq. Km.) | 22429 |
| Total Households | 153420 |
| Total Rural HH | 146909 |
| Total Urban HH | 6511 |
| No of Districts | 7 |
| No of Blocks | 39 |
| Taotal Villages | 5484 |
| Numbers of CD blocks | 31 |
| No of Assembly Segments | 60 |
| Total Length of Road | 7633 Km |
| Blacktopped Road | 3691 Km |
| Total Population | 29,64,007 |
| Male Population | 1492668 |
| Female Population | 1471339 |
| Female | 8,83,670 |
| Decadal population growth (%) | 27.82 |
| Density of Population (per Sq.Km.) | 132 |
| Sex Ratio | 986 |

Population profile of West Khasi Hills District with reference to 2011:

| Particulars | Data |
|---|---|
| Total Population | 3,85,601 |
| Male Population | 1,94,628 |
| Female Population | 1,90,973 |
| Population Growth | 30.25% |
| Area Sq. Km | 5,247 |
| Density/$Km^2$ | 73 |
| Proportion to Meghalaya Population | 13.01% |
| Sex Ratio (No of Females per 1000 males) | 981 |
| Child Sex Ratio (0-6 Age) | 975 |
| Average Literacy | 79.30 |
| Male Literacy | 80.29 |
| Female Literacy | 78.30 |
| Literates | 237,102 |
| Male Literates | 121,049 |

## 2.5 Climate

The State is directly influenced by the South West monsoon and North Eastern winter winds. The region experiences tropical monsoonal climate that varies from Western to Eastern part of the plateau. The climate of the districts are mildly tropical in the northern and southern foothills, while in the central upland zone, the climate is temperate and places at medium altitude in the northern, western and southern parts of the district, experience sub-tropical climate.

The districts are influenced by the South- West monsoon and rainfall is assured during summer, but differs greatly in intensity from area to area within the district. The average rainfall ranges from 1200 mm to 3000 mm per annum with most rainfall concentrated from May to September

The lower elevated areas experience fairly high temperature for most part of the year having a mean maximum of 23 to 26° and a mean minimum of 12 to 17° C. The mean summer temperature is 26°C and the mean winter temperature is 9° C.

## 2.6 Geology

The State of Meghalaya is occupied by: - (a) Archean Gneissic Complex with Acid intrusive (b) Shillong Group of Rocks (mostly Quartzite) usually friable, Schist's, Conglomerates) (c) Granite rocks, (d) Lower Gondwana rocks (e) Sylhet Traps (f) Cretacious – tertiary sediments viz Khasi Group, (Jadugata and Mahadek formation), Garo Group (Simsang, Baghmara,

Chengapara formation).These sediments consist of dominantly sandstone, limestone; silt stone, shale and pebbles, clays, conglomerates. The sedimentary rocks are in a complex form.

Meghalaya is a storehouse of economic minerals. The major minerals that are presently exploited are Coal, Limestone, Clay and Sillimanite. These minerals are utilized in several mineral-based industries in the country. Besides, Coal and Limestone are also exported to Bangladesh, earning a good amount of foreign exchange.

## 2.7 Physiography & Relief

The District may be divided into four broad geographical units. There is the Western sector with dense jungles with an elevation of 600 to 900 meters, bordering the Garo Hills. In the Southern sector, especially the south-eastern part, the hills slope rather abruptly to an elevation of about 150 meters, close to the plains of Bangladesh. In the Northern sector, there are a series of hills and ranges which gradually slope down to an altitude of about 150 meters till they reach the plains of Assam. In the central sector, the hill ranges run parallel from East to West forming the highest part of the district with an average altitude of about 1400 meters.

**Hill Ranges**

The only hill range of significance in the district is the Mawthadraishan range which runs from east to west. Hilly formations, that have potential tourist attraction are the Kyllang rock, which is formed of a huge igneous rock, located near Nongkhlaw (11 kms) from Mairang. Apart from this, the other major hills are U Mawleng in the Lyngngam Area located between Nongiawnaw and Snaram and the Mawhiang rock at Mawkyllei near Pariong. Lum Kyllai-Longsngun at Myriem, 40 Km. from Nongstoin, Lum Iawpaw near Nongnah of Ranikor block, Lum Nongsynrih at Mawkyrwat block , Lum Iangram , Lum Kubuit, Lum Kubah, Lum Langpoin near Pyndeng Umjarain - Nongtynniaw and U Lum Kohtyllaw at Nongtnger, are other peaks in the District.

**River Systems**

There are two important river systems in the district, the Kynshi and the Khri, with a number of tributaries. Kynshi, the bigger of the two, rises in the southern slopes of Marpna Peak near Mawmaram village (about 10 kms from Mairang on the way to Shillong). It follows a westerly course for a considerable distance then takes a sharp bend to the east and enters the plains of Bangladesh at Ranikor. The Khri River rises near Kyllang rock and flows northwards and is joined by Khri Synnia River before it enters the plains of Assam. Other important rivers that constitute the drainage system of the district are the Umngi, Wahblei, Rilang, Riangdo, Tyrsung, Ryndi, Rwiang, Umit Synthi and Btit.

**Land Use Pattern**

Agriculture is the mainstay of the people of the State. About 85 percent of the population of the State live in rural areas and depends on agriculture for their livelihood. Of the total geographical area, about 13 percent is under cultivation. Efforts are being made to increase irrigation potential of the State and bring more area under cultivation It is in the primitive

stage of shifting cultivation in major parts of the State. Shifting Cultivation locally named as 'Jhuming' is practiced extensively on the hill-slopes in the Districts.

The soil and climatic condition of the State is suitable for growing different types of agricultural crops from cereals to fruits in both tropical and temperate climatic environment occurring on different altitudes. The following table shows the land utilization.

**Natural Vegetation**

The State is rich in species of flora and varies from open scrub (Grassland) to pine forest in the central plateau region. The rest is covered by mostly deciduous to evergreen forests and transitional tropical moist deciduous pine forests. Status of forest cover is shown below:

**Agriculture**

Meghalaya is basically an Agricultural State with about 80% of its total population depending entirely on Agriculture for their livelihood. The total cropped area in the State has increased by about 42 per cent during the last twenty-five years. Food grain production sector covers an area of over 60 per cent of the total crop area. Food grains are grown in over 133 thousand hectares, nearly 60% of the state's cultivated area. The production of food grains is over 230 thousand tones. Rice is the dominant food grain crop accounting for over 80% of the food grain production in the state. Other important food grain crops are maize, wheat and a few other cereals and pulses. Oilseeds such as rape and mustard, linseed, soybean, castor and sesame are grown on nearly 10 thousand hectares. Rape and mustard are the most important oilseeds accounting for well over two-thirds of the oilseed production of nearly 6.5 thousand tones. The agricultural production of the districts of project corridor is presented below.

## 2.8 Natural Resources

West Khasi Hills is very rich in mineral resources, but most of the minerals are under investigation. Important minerals in the district are Sillimanite, Coal, limestone and Uranium.

(i) **Sillimanite**: the world's best known deposits of sillimanite are located in Sonapahar under Mawshynrut Block. It is estimated that Sonapahar contains an approximate reserve of 2, 55,000 tones of high grade Sillimanite spread over a belt of 20x10 Kms. This was being mined by the Bharat Refractories Ltd., but has been stopped with the expiry of the land lease.

(ii) **Coal** : The district has good deposits of coal and is being commercially exploited. Coal is found in Shallang area under Mawshynrut block which is being mined, extracted and exported to other states through Assam and also in the international border area around Borsora under Ranikor block which is extracted and exported to Bangladesh.

(iii) **Limestone** : Limestone is found in abundance in the southern part of the district and is being commercially exploited and exported to Bangladesh also.

(iv) **Uranium** extensive exploratory works has been undertaken at Domiasiat, Nongkulang, Tinniang near Nonglanglieh and Tynnai and Nonglang (Mawkyrwat) for uranium deposits which is considered to be of a high- grade quality.

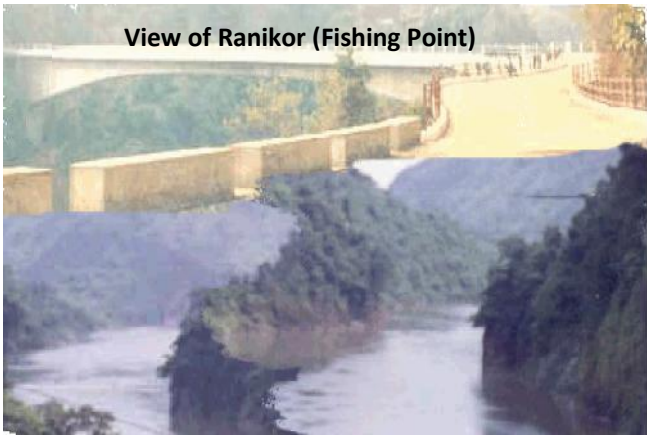
West Khasi Hills district is, at present, having no hydro electric project. However, there is good hydro electric potential from the Khri River and the Kynshi river.

The district is also endowed with vast reserves of sand and stones. Hill sand and river sand are being commercially used for construction purposes. Stone quarrying is a means of livelihood for a number of poor families while Granite cutting is a recent trend.

## 2.9 Tourism

West Khasi Hills District offers a lot of scope for adventure tourism in terms of trekking, rock climbing, angling and the like. It has a number of peaks to be scaled, bridle paths to be trekked and water ways for canoeing. Besides, a number of cascades formed along the river courses add to the natural beauty of the district. There are also a number of attractive picnic spots and camping sites.

Some of the major Tourist spots in West Khasi Hills are as under:


**View of Ranikor (Fishing Point)**

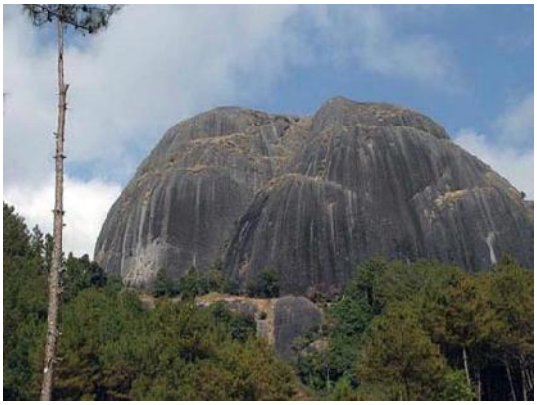
1. **Ranikor**, about 169 Kms from Nongstoin and 129 Kms to Shillong is one of the best fishing spots. Anglers can row up the Ranikor river where the Kynshi and Rilang converge and enjoy angling for the huge golden mahseers, the pride of anglers and other species like the golden carp, silver carp and the common carp are available here. The surrounding rock cliffs and the clear blue water add to the scenic beauty of the place

2. **Nongkhnum river Island**:-A couple of hours trek from Nongstoin is the hitherto little-known river island on the Kynshi known as Nongkhnum. It is in the form of a Plateau with an area of about 25 Sq.kms. The island is form due to the divergence of the river Kynshi near Diangsyiang and Diligim villages, forming the northern stream called Namliang and the southern stream called Phanliang. The island in endowed with beautiful perennial falls namely Weinia fall in the

northern side, Kshaid Thum fall in the southern side and Langshiang fall on the western side. One would wonder the hidden beauty of this river island which the Gods have bestowed on nature, and worthily, describable as an Isle of Waterfalls:

3. **Langshiang falls** formed immediately after the confluence of the diverged streams of the Kynshi river, is situated near Sangriang and can be viewed prominently from Mawpon village. It presents a breathtaking scene to the nature lovers, who admire the challenges of adventure:

4. **Kyllang Rock** which is made of a single, huge solid igneous rock is situated at Mawnai about 10 Kms from Mairang, the sub-divisional Head Quarter. The top of the dome-shape rock can accommodate a considerable number of picnickers. Folklore has it that the rock possesses a sort of magnetic field since, so far, no one has ever fallen off the slope of the huge rock. It can be developed into a good rock-climbing site:



**Kyllang Rock**

# 3.0 ENGINEERING SURVEYS & INVESTIGATIONS

## 3.1 General

**3.1.1** The Consultant carried out various field studies, engineering surveys and investigations to collect the necessary data for preparation of Detailed Project Report (DPR) for the project. The investigations were carried out to generate adequate supportive database for preparing the most appropriate proposal to meet the functional and structural efficiency and safety requirements. The various engineering investigations and surveys have been carried out following the relevant IRC.

The various investigations and surveys, which have been carried out by the Consultants, are as follows:

- Inventory and condition survey of Road and Pavement
- Inventory and condition survey of Bridges and other cross-drainage structures
- Topographic Survey
- Benkelman Beam Deflection Survey
- Axle Load Survey
- Pavement Investigations
- Soil and Material Investigations.

## 3.2 Inventory and Condition Survey of Road and Pavement

### 3.2.1 Road Inventory

3.2.1 The inventory of the project road for assessment of the pavement status has been carried out through measurements and visual inspection. Features like terrain, land use, width of pavement and shoulders, geometric deficiencies, important road junctions, utilities etc. were recorded. The inventory data have been included in **Appendix 3.1** of Appendix Volume of the Main Report.

## 3.3 Topographical Survey

Detailed topographic survey carried out with the objective to capture essential ground features.

Procedure for detailed topographic survey

- A survey corridor of 30 m (i.e. 15m on either side) has been considered.
- 4 no's of Benchmark pillars per kilometer are established on ground.
- All relevant topographical details e.g. all structures, utilities, existing road, electric and telephone lines, trees (girth > 300 mm), huts, buildings, fencing falling within the extent of survey corridor.
- Longitudinal levels at every 25 m intervals along the existing centre line and at closer intervals at curves

- Cross-section at every 25 m intervals or with judiciously selected locations extending to full width of the corridor as far as possible covering sufficient number of natural ground points
- Longitudinal points for cross roads and cross-sections where necessary depending on site condition

The list of Benchmark Pillars (with x,y,z co-ordinates) are presented in **Appendix 3.2** enclosed at Appendix volume of the main report. The centerline co-ordinates of existing road are presented in **Appendix – 3.3** of Appendix Volume of the Main Report.

## 3.4 Pavement Composition

**General:** From start of the project road to Km 36.00 there exists blacktopped road, the condition of that road in this section is generally poor, From Km 36.00 to rest of the project road is Kutcha, and pavement condition is very poor. The pavement composition till Km 36 is given in Table 3.1 below.

**Benkelman Beam Deflection Test:** As described earlier that the Existing project is bituminous up to Km 36.00 hence the BBD test has been done for that following procedure has been adopted.

- One set of ten readings in 250 m for every 1000 m were taken
- Temperature correction with respect to standard temperature of 35$^{o}$C was applied
- Considering moisture content of sub-grade soil and rainfall of the area, further corrections have been applied. Results of the deflection tests are included in the Appendix Volume of Main Report. The characteristic deflection values for homogeneous sections for use in design are shown in **Appendix 3.4.**
- Test pits at every 5.00 km interval to obtain pavement composition details so as to be able to study the correlation between deflection & composition. (refer **Table – 3.1**)

Analysis of the field data collected is presented in **Appendix 3.4** of the Appendix Volume of Main Report.

**Table 3.1: Pavement Composition**

| Sl. No. | Chainage | Bituminous coarse | WBM | GSB | Total Thickness (mm) |
|---|---|---|---|---|---|
| 1 | 1+000 | 35 | 100 | 110 | 245 |
| 2 | 3+000 | 30 | 105 | 130 | 265 |
| 3 | 7+000 | 25 | 95 | 120 | 240 |

| Sl. No. | Chainage | Bituminous coarse | WBM | GSB | Total Thickness (mm) |
|---|---|---|---|---|---|
| 4 | 12+000 | 40 | 100 | 110 | 250 |
| 5 | 15+000 | 30 | 105 | 120 | 255 |
| 6 | 20+000 | 25 | 115 | 130 | 270 |
| 7 | 25+000 | 35 | 110 | 130 | 275 |
| 8 | 30+000 | 25 | 85 | 110 | 220 |
| 9 | 35+000 | 30 | 95 | 125 | 255 |

## 3.5 Sub grade Investigation

**Test Pit Sub grade Investigation:** Test pit investigations were carried out at the interface of main carriageway and earthen shoulder at every 5 km intervals in a staggered manner along the existing road alignment. Following tests were carried out to ascertain the existing physical and strength condition of the sub-grade.

a) In-situ Moisture Content
b) Details of pavement layer composition
c) Laboratory soil characterization (Grain size and Atterberg limits)
d) Laboratory moisture-density characteristics (using modified AASHTO compaction)
e) Dry Density (using sand replacement method)
f) CBR tests on 4 days soaked samples

Dynamic Cone Penetrometer test was conducted at every sub grade investigation pit locations i.e. at every 5 km interval along the project road to assess the in-situ CBR at sub grade and below sub grade level. The field data and analysis of Dynamic Cone Penetrometer test is presented in **Appendix-3.5** of Appendix volume of the Main Report.

**Laboratory Test on Test Sample:** The following laboratory tests were conducted on the sub-grade samples collected from test pits:

| | |
|---|---|
| Grain Size Analysis | IS: 2720 (Part-IV) |
| Atterberg's Limits | IS: 2720 (Part-V) |
| Optimum Moisture Content & Maximum Dry Density | IS: 2720 (Part-VIII) |
| California Bearing Ratio Tests on samples (soaked for 4 days) | IS: 2720 (Part-XXVI) |

Summary of Results of laboratory test of soil samples collected from Test Pits is presented in **Table 3.2** below & detailed calculation with graphs is presented in **Appendix- 3.6** of Appendix volume of the Main Report.

## Table 3.2: Results of laboratory test of soil samples collected from Test Pits

| Lab Sample No | Site Identification | | Grain Size Analysis | | | | | | | Atterberg Limits (%) | | | Soil Class | FDD (gm/cc) | FMC(%) | MDD (gm/cc) | OMC (%) | CBR RESULT | | | | Fre Swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Percentage passing | | | | Quantity (%) | | | | | | | | | | | 25 Blows | | | | |
| | Location (km) | Up/Dn | 4.75 mm | 2.0 mm | 425 micron | 75 micron | Gravel Sand Silt | Sand | Silt | LL (%) | PL (%) | PI (%) | | | | | | Dry Density (gm/cc) | Unsoaked % | soaked % | Moisture Content % | |
| 1 | 0 | UP | 91.82 | 89.24 | 76.81 | 29.41 | 8.18 | 62.41 | 29.41 | 27.24 | 14.86 | 12.38 | GM | 1.74 | 17 | 1.71 | 12.3 | 1.62 | 10.2 | 3.25 | 11.79 | 9.7 |
| 2 | 5 | DN | 98.2 | 91.8 | 82.04 | 24.71 | 1.80 | 73.90 | 24.71 | 26.1 | - | | GC | 1.89 | 19 | 1.87 | 11.6 | 1.58 | 10.6 | 3.54 | 16.32 | 10.8 |
| 3 | 10 | UP | 95.4 | 89.9 | 86.89 | 27.43 | 4.60 | 67.93 | 24.71 | 25.23 | 16.7 | 8.53 | GC | 1.78 | 17 | 1.75 | 12.3 | 1.49 | 9.8 | 3.65 | 15.15 | 11.4 |
| 4 | 15 | DN | 96.4 | 94.3 | 61.22 | 27.88 | 3.60 | 68.52 | 27.88 | 25 | 16.6 | 8.4 | GC | 1.72 | 18 | 1.75 | 13 | 1.54 | 9.6 | 3.85 | 13.58 | 10.2 |
| 5 | 20 | UP | 97.3 | 89.4 | 78.34 | 48.22 | 2.70 | 49.06 | 48.22 | 33.67 | 15.77 | 17.9 | GC | 1.7 | 16 | 1.66 | 9.6 | 1.57 | 9.9 | 3.95 | 10.93 | 10.0 |
| 6 | 25 | DN | 98.7 | 85.4 | 74.33 | 27.44 | 1.30 | 71.26 | 27.44 | 35.69 | 17.89 | 17.8 | GM | 1.63 | 15 | 1.59 | 9.8 | 1.62 | 11.3 | 3.87 | 11.79 | 5.4 |
| 7 | 30 | UP | 97.3 | 92.2 | 89.66 | 29.44 | 2.70 | 67.86 | 29.44 | 30.07 | 22.95 | 7.12 | GM | 1.72 | 15 | 1.68 | 9.5 | 1.65 | 10.7 | 4.2 | 10.8 | 10.0 |
| 8 | 35 | DN | 97.6 | 94.4 | 60.48 | 21.89 | 2.40 | 75.71 | 21.89 | 33.81 | 13.44 | 20.36 | GM | 1.78 | 19 | 1.74 | 12.3 | 1.63 | 10.45 | 4.02 | 14.51 | 14.7 |
| 9 | 40 | UP | 93.3 | 85.8 | 68.11 | 26.12 | 6.70 | 67.16 | 26.12 | 33.88 | 18.47 | 15.41 | GC | 1.76 | 16 | 1.72 | 9.6 | 1.63 | 9.12 | 3.98 | 11.86 | 9.7 |
| 10 | 45 | DN | 93.4 | 82.6 | 68.9 | 29.4 | 6.60 | 64.80 | 29.4 | 28.26 | 14.94 | 13.32 | GC | 1.73 | 19 | 1.73 | 12.5 | 1.65 | 8.95 | 3.56 | 10.8 | 9.7 |
| 11 | 50 | UP | 93.4 | 82.6 | 70.51 | 27.8 | 6.60 | 65.80 | 27.8 | 29.56 | 15.68 | 14.74 | GC | 1.78 | 19 | 1.73 | 12.5 | 1.65 | 8.95 | 3.56 | 10.8 | 9.7 |
| 12 | 55 | DN | 92.2 | 88.1 | 72.12 | 28.13 | 7.80 | 64.07 | 28.13 | 33.38 | 16.45 | 16.93 | GM | 1.79 | 16 | 1.74 | 12.6 | 1.63 | 10.55 | 3.89 | 10.67 | 14.6 |

## 3.6 Material Investigation

### 3.6.1 Type of Materials

The objective of the material survey was to

(i) Locate potential sources of soil, sand, gravel, rock, water and other major construction materials within the project vicinity,

(ii) Examine the engineering properties of the materials relevant to the project as per MoRT&H specification.

As a first step, material sources were identified with the help of existing data, local enquiry and field assessment. Thereafter soil, Moorum and aggregate samples were collected from the sources for testing.

### 3.6.2 Source of Materials

The source of materials is as given below:

| Sr. No. | Name of Material | Site Name |
|---|---|---|
| 1 | Stone Aggregates | Kynron |
| 2 | Sand | Nongba Rangblang village |
| 3 | Water | Wa Kyensi |
| 4 | Other Miscellaneous Materials | Shillong |
| 5 | Bitumen | Guwahati |

### 3.6.3 Sampling of Various types of Materials

A) The samples collected from these identified quarries were tested for the following properties to assess the possibility of utilizing them for the construction of the project road.

- Sieve analysis
- Atterberg's limits
- Heavy compaction
- Four (4) days soaked CBR as per IS standards at 97% of MDD/ 98% of MDD as applicable for sub grade/sub-base (Heavy Compaction)
- 10% fine value test (in case found suitable for GSB)
- Water absorption of coarse fraction

Soundness in case water absorption of coarser fraction is found more than 2%

B) The following tests were conducted on Aggregate from Quarry:

- Sieve Analysis (in case of samples collected from crusher)
- Specific Gravity

- Water Absorption
- Flakiness and Elongation Test (in case of samples collected from crusher)
- Aggregate Impact Value Test
- Coating and Stripping of Bitumen-Aggregate Mixture (without using anti-stripping agent)
- Soundness

C) The following tests were conducted on sand samples:

- Sieve analysis and calculation of fineness modulus.

## 3.7 Results & Discussions on Aggregate Quarries

***Aggregates (for Base & Wearing Courses):*** Altogether nine aggregate samples were collected from Local Quarry (i.e. Nongstoin) for the project corridor. Flakiness and elongation index, being dependent on crusher quality/technique is not considered for the evaluation. Selection of the quarry depends upon engineering properties, lead and quantity available.

All samples were not considered, as the size of the aggregate were more than 90mm. Though all the samples are within limit of AIV they are not fulfilling the limit of stripping value, however with anti stripping agent 0.6% these aggregates can be used. Water absorption is found to be less than 2% for all samples and satisfies the requirement of soundness. All samples from the Quarry can be used for bituminous works and for non-bituminous works. Test results are shown in ***Table-3.3*** *(attached at the end of this chapter).*

## 3.8 Sand Quarries

***Sand:*** The test result of sand samples shown in ***Table-3.4*** includes grain size distribution, fineness modulus and the sand zone. The test result shows that sample- SQ-III fulfill the required grading (FM is 2.26) and comes under zone-III. After screening the remaining samples through 4.75mm IS sieve the sample SQ-I and SQ-II found to coming under zone-II and zone-I having FM 2.61and 3.35 respectively and these samples is therefore recommended for the use in concrete works.

## 3.9 Materials for Granular Sub-base

***Granular Sub Base***: Altogether three GSB material samples were collected for the project corridor. Sample no. MQ-I, MQ-II and MQ-III meet the specification requirement of GSB as stipulated in MoRT&H. LL and PI of these samples are non-plastic and are within the limiting value as stipulated in the MoRT&H specification for GSB materials (Limiting value for LL is 25% and for PI is 6%). Thus all the samples from Nongstoin meets the required specification of GSB material as stipulated in MoRT&H and comes under close graded grading-I and tested for soaked CBR at 98% of MDD (Refer ***Table -3.5*** *attached at the end of this chapter*).

The CBR was found to be more than 30%, which is the limiting value as per the laid standards and can be used in granular sub base. Water absorption of the coarser material has been checked and found to be less than 2%.

As an alternative source for GSB material the crushed aggregate of AQ-V and stone dust were blended at different ratio and tested for the suitability. Test result shows that the all the blended gradation comes under close graded grading-I as stipulated in MoRT&H specification. The LL & PI of the blended sample fulfills the required specification of MoRT&H. The blended material is then tested for CBR at 98% of MDD for the best fit gradations and found to be more than 30%, which is the minimum requirement of CBR for use in GSB. The water absorption of the coarse fraction is found to be less than 2%. 10% fines value is found to be more than 50KN. Crushed aggregate can also be blended with the stone dust at different ratio for use in GSB course as these quarries fulfill the physical requirement of coarse aggregate of MoRT&H specification (Test results: ***Table - 3.6*** *attached at the end of this chapter*)

## 3.7 Axle-Load Survey

### 3.7.1 Analysis of Axle-load Survey Data

***Methodology***

The axle weight data obtained from the axle load surveys were compiled and analyzed to obtain the vehicle loading behavior along the existing road. The data have been analyzed vehicle type-wise to obtain the following information:

- Gross-Vehicle Weight (GVW) and Single Axle Weight (SAW) distribution; and,
- Vehicle damage factor, i.e. Equivalent Single Axle (ESA) load factor.

The Equivalent Single Axle (ESA) load factor (termed as "vehicle damage factor, VDF) for each vehicle has been calculated as per the following relationship:

$$VDF_k = \left[\frac{AXL_j}{SXL_j}\right]^{LE}$$

where,

$VDF_k$ is equivalent Single Axle load factor

LE is Axle Load Equivalency exponent

$AXL_j$ is load on axle, j

$SXL_j$ is standard load for axle, taken as 8.16 Tones for Single Axle load and 14.968 for Tandem Axle load as specified in IRC: 37-2001 Annexure 2.

Detailed calculations for axle load survey and VDF are provided in **Appendix 3.7** of Appendix Volume of the Main Report**.** The VDF values calculated for different vehicle types in each direction are shown in **Table-3.2**

**Table-3.2: Vehicle damage factor for Different types of Vehicles**

| S. No | Vehicle Type | Kynron (Km 9.00) | Maruim Village (Km 34.00) |
|---|---|---|---|
| 1 | Buses | 3.18 | 2.59 |
| 2 | LCV | 1.5 | 0.66 |
| 3 | 2-axle Truck | 3.14 | 1.37 |

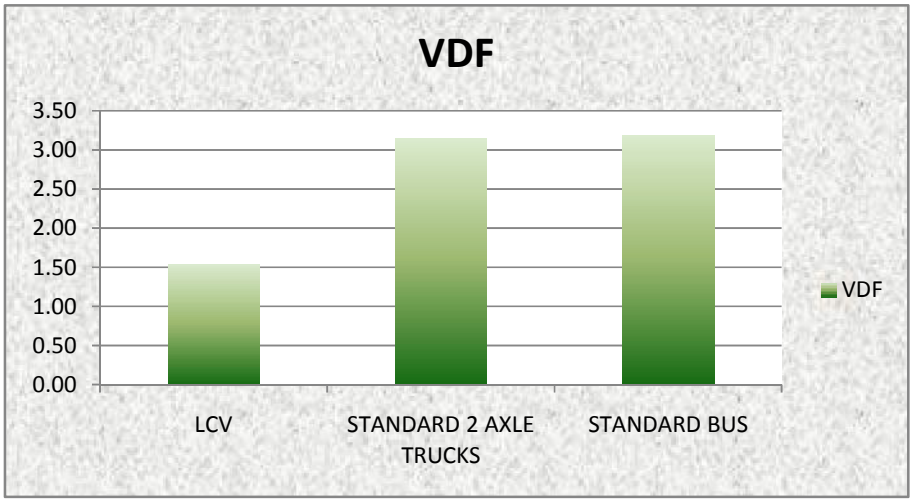



**Figure 3.1 Datewise Traffic composition (in PCU) at Km 9.00 ( Leitjynrai)**

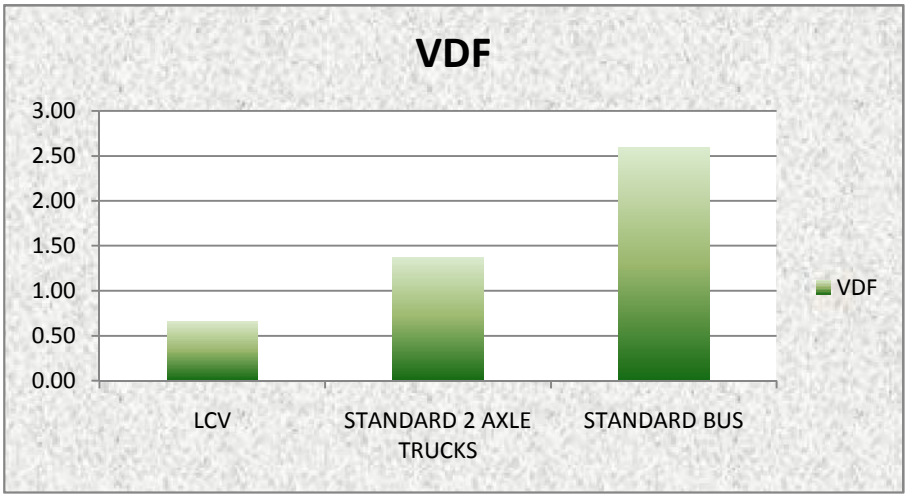



**Figure 3.2 Datewise Traffic composition (in PCU) at Km 34.00 ( Marium)**

## 3.8 Inventory and Condition Survey of Bridge

There are 11 no's of Bridges present in the Project road out of which 8 Bridges are RCC type, One is Wooden and 2 are Iron Bridges. Inventory of Bridges is given in Table 3.3 at the end of this chapter.

## 3.9 Inventory and Condition Survey of Culverts

A total of 434 culverts are present alongside the project road out of which 312 no's are Hume pipe culvert, 13 no's of Slab culverts, 10 no's of Box culverts and rest 98 no's of stone culverts are present. Inventory of Culverts is given in Table 3.4 at the end of this chapter.

## 3.10 Forest Area

The project road passes through the forest area at following chainages:

| S.No | Existing Chainage | | | Design Chainage | | |
|---|---|---|---|---|---|---|
| | From | To | Length | From | To | Length |
| 1 | 1+500 | 5+000 | 3500 | 1+400 | 4+950 | 3550 |
| 2 | 17+750 | 18+450 | 700 | 17+760 | 18+600 | 840 |
| 3 | 27+800 | 29+100 | 1300 | 27+810 | 29+200 | 1390 |
| 4 | 37+550 | 37+900 | 350 | 37+520 | 37+920 | 400 |
| 5 | 45+000 | 58+025 | 13025 | 44+950 | 57+900 | 12950 |

However, Current Right of Way (ROW) of the project report varies between 24 – 30 m and proposed is designed within the current ROW. Hence, there is no additional land is required for construction of road.

**Table 3.3: Detailed Bridge Inventory**

| Sr No. | Name of River /Nala | Ex.Chainage | Type | Span | Length | Width of carriageway |
|---|---|---|---|---|---|---|
| 1 | Stream | 2+425 | RCC | Single | 13.522 | 6.155 |
| 2 | Wenkynsni | 9+111 | Iron | Single | 89+718 | 4.228 |
| 3 | Stream | 9+875 | RCC | Single | 12.448 | 5.544 |
| 4 | Stream | 15+050 | RCC | Single | 8.539 | 5.210 |
| 5 | Stream | 27+795 | Iron | Single | 19.376 | 3.863 |
| 6 | Stream | 40+137 | RCC | Single | 10.345 | 5.019 |
| 7 | Stream | 40+516 | RCC | Single | 8.178 | 4.806 |
| 8 | Stream | 41+827 | Wooden | Single | 11.430 | 4.555 |
| 9 | Stream | 45+293 | RCC | Single | 15.040 | 7.997 |
| 10 | Stream | 55+975 | RCC | Single | 28.332 | 8.141 |
| 11 | Stream | 56+535 | RCC | Single | 19.131 | 8.749 |

## Table 3.4: Detailed Culvert Inventory

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 1 | 0+150 | STONE | 1X1.9 | 6.90 | 1001.707 | 0.800 | POOR |
| 2 | 0+257 | STONE | - | - | | | CHOKED |
| 3 | 0+346 | STONE | - | - | | | CHOKED |
| 4 | 0+396 | HP | 1X600 | - | | | POOR |
| 5 | 0+444 | HP | 1X1200 | - | | | POOR |
| 6 | 0+476 | STONE | - | - | | | CHOKED |
| 7 | 0+537 | HP | 1X600 | - | | | POOR |
| 8 | 0+637 | STONE | - | - | | | CHOKED |
| 9 | 0+700 | STONE | 1X2.06 | 6.90 | 1012.621 | 0.673 | POOR |
| 10 | 0+766 | BOX | 1X0.68 | 8.03 | 1015.256 | 0.900 | POOR |
| 11 | 0+841 | STONE | 1X2.06 | 6.90 | 1012.621 | 0.673 | POOR |
| 12 | 0+914 | STONE | 1X2.83 | 5.17 | 1021.426 | 0.499 | POOR |
| 13 | 0+977 | STONE | 1X1.31 | 6.70 | 1024.943 | 0.422 | POOR |
| 14 | 1+146 | STONE | - | - | | | CHOKED |
| 15 | 1+282 | STONE | - | - | | | CHOKED |
| 16 | 1+375 | STONE | - | - | | | CHOKED |
| 17 | 1+500 | STONE | - | - | | | CHOKED |
| 18 | 1+575 | STONE | - | - | | | CHOKED |
| 19 | 1+580 | STONE | - | - | | | CHOKED |
| 20 | 1+624 | STONE | - | - | | | CHOKED |
| 21 | 1+710 | STONE | 1X0.8 | 11.66 | | | POOR |
| 22 | 1+759 | STONE | - | - | | | CHOKED |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 23 | 1+979 | STONE | - | - | | | CHOKED |
| 24 | 2+060 | STONE | - | - | | | CHOKED |
| 25 | 2+125 | STONE | - | - | | | CHOKED |
| 26 | 2+173 | STONE | - | - | | | CHOKED |
| 27 | 2+200 | STONE | - | - | | | CHOKED |
| 28 | 2+283 | STONE | - | - | | | CHOKED |
| 29 | 2+390 | STONE | 1X1.885 | 12.46 | 1000.527 | 0.800 | POOR |
| 30 | 2+572 | STONE | - | - | | | CHOKED |
| 31 | 2+645 | SLAB | 1X3 | 5.20 | 1016.001 | 2.200 | POOR |
| 32 | 2+760 | HP | 1X1200 | - | | | POOR |
| 33 | 3+060 | HP | 1X1200 | - | | | POOR |
| 34 | 3+151 | STONE | - | - | | | CHOKED |
| 35 | 3+290 | SLAB | 1X1.6 | 5.10 | 1066.158 | 2.500 | POOR |
| 36 | 3+413 | HP | 1X600 | - | | | POOR |
| 37 | 3+482 | STONE | 1X0.9 | 6.11 | 1076.419 | 0.658 | POOR |
| 38 | 3+650 | STONE | 1X0.6 | 7.00 | 1079.582 | 0.800 | POOR |
| 39 | 3+790 | STONE | 1X0.6 | 7.00 | 1087.029 | 0.800 | POOR |
| 40 | 3+857 | STONE | 1X08 | 7.40 | 1090.277 | 0.600 | POOR |
| 41 | 3+900 | HP | 1X1600 | - | | | POOR |
| 42 | 4+075 | STONE | 1X0.3 | 7.62 | 1098.739 | 0.500 | POOR |
| 43 | 4+134 | HP | 1X900 | - | | | POOR |
| 44 | 4+212 | STONE | 1X0.3 | 6.80 | 1102.108 | 0.500 | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 45 | 4+336 | STONE | - | - | | | CHOKED |
| 46 | 4+404 | STONE | - | - | | | CHOKED |
| 47 | 4+450 | STONE | - | - | | | CHOKED |
| 48 | 4+507 | HP | 1X1600 | - | | | POOR |
| 49 | 4+475 | STONE | - | - | | | CHOKED |
| 50 | 4+726 | STONE | - | - | | | CHOKED |
| 51 | 4+845 | STONE | - | - | | | CHOKED |
| 52 | 4+962 | STONE | - | - | | | CHOKED |
| 53 | 4+971 | STONE | - | - | | | CHOKED |
| 54 | 5+015 | HP | 1X1200 | - | | | POOR |
| 55 | 5+090 | HP | 1X1600 | - | | | POOR |
| 56 | 5+152 | STONE | 1X0.5 | 8.40 | 1121.896 | 0.700 | POOR |
| 57 | 5+195 | STONE | 1X0.5 | 8.40 | 1124.146 | 0.800 | POOR |
| 58 | 5+333 | HP | 2X1200 | - | | | POOR |
| 59 | 5+472 | HP | 1X1200 | - | | | POOR |
| 60 | 5+560 | HP | 1X900 | - | | | POOR |
| 61 | 5+868 | HP | 2X1200 | - | | | POOR |
| 62 | 5+870 | HP | 1X1200 | - | | | POOR |
| 63 | 5+900 | HP | 1X900 | - | | | POOR |
| 64 | 5+929 | HP | 1X900 | - | | | POOR |
| 65 | 6+064 | HP | 1x900 | - | | | CHOKED |
| 66 | 6+142 | SLAB | 4.47 | 3.95 | 1140.205 | 3.663 | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 67 | 6+343 | HP | 1X1200 | - | | | POOR |
| 68 | 6+386 | HP | 1X1200 | - | | | POOR |
| 69 | 6+480 | HP | 1X1200 | - | | | POOR |
| 70 | 6+604 | HP | 1X600 | - | | | POOR |
| 71 | 6+716 | SLAB | 1X0.8 | 8.30 | 1135.776 | 0.900 | POOR |
| 72 | 6+744 | HP | 1X900 | - | | | POOR |
| 73 | 6+764 | SLAB | 5.93 | 4.00 | 1133.436 | 3.947 | POOR |
| 74 | 6+778 | HP | 1X600 | - | | | POOR |
| 75 | 6+868 | HP | 1X1200 | - | | | POOR |
| 76 | 7+000 | HP | 1X600 | - | | | POOR |
| 77 | 7+231 | HP | 1X600 | - | | | POOR |
| 78 | 7+336 | HP | 1X600 | - | | | POOR |
| 79 | 7+386 | HP | 1X600 | - | | | POOR |
| 80 | 7+470 | HP | 1X900 | - | | | POOR |
| 81 | 7+612 | HP | 1X1200 | - | | | POOR |
| 82 | 7+712 | HP | 1X1200 | - | | | POOR |
| 83 | 7+800 | HP | 1X600 | - | | | POOR |
| 84 | 7+900 | HP | 1X1200 | - | | | POOR |
| 85 | 8+038 | HP | 1X900 | - | | | POOR |
| 86 | 8+181 | HP | 1X600 | - | | | POOR |
| 87 | 8+425 | HP | 1X600 | - | | | POOR |
| 88 | 8+508 | HP | 1X900 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 89 | 8+577 | HP | 1X900 | - | | | POOR |
| 90 | 8+612 | HP | 1X1200 | - | | | POOR |
| 91 | 8+731 | HP | 1X900 | - | | | POOR |
| 92 | 8+757 | BOX | 1X0.9 | 8.50 | 1130.206 | 0.700 | POOR |
| 93 | 8+825 | HP | 1X900 | - | | | POOR |
| 94 | 8+853 | HP | 1X900 | - | | | POOR |
| 95 | 8+918 | HP | 1X600 | - | | | POOR |
| 96 | 8+975 | BOX | - | - | 1130.302 | 0.500 | CHOKED |
| 97 | 9+011 | HP | 1X900 | - | | | POOR |
| 98 | 9+297 | HP | 1X900 | - | | | POOR |
| 99 | 9+389 | HP | 1X900 | - | | | POOR |
| 100 | 9+475 | HP | 1X900 | - | | | POOR |
| 101 | 9+553 | HP | 1X900 | - | | | POOR |
| 102 | 9+618 | HP | 1X900 | - | | | POOR |
| 103 | 9+800 | HP | 1X900 | - | | | POOR |
| 104 | 10+043 | HP | 1X900 | - | | | POOR |
| 105 | 10+127 | HP | 1X900 | - | | | POOR |
| 106 | 10+175 | HP | - | - | | | CHOKED |
| 107 | 10+455 | HP | 1X900 | - | | | POOR |
| 108 | 10+750 | HP | 1X1200 | - | | | POOR |
| 109 | 10+969 | HP | 1X1200 | - | | | POOR |
| 110 | 11+159 | HP | 1X900 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 111 | 11+300 | HP | 1X1200 | - | | | POOR |
| 112 | 11+445 | HP | 1X1200 | - | | | POOR |
| 113 | 11+467 | HP | 1X1200 | - | | | POOR |
| 114 | 11+570 | HP | 1X600 | - | | | POOR |
| 115 | 11+652 | HP | 1X1200 | - | | | POOR |
| 116 | 11+781 | HP | 1X900 | - | | | POOR |
| 117 | 11+925 | HP | 1X900 | - | | | POOR |
| 118 | 12+034 | HP | 1X900 | - | | | POOR |
| 119 | 12+185 | HP | 1X900 | - | | | POOR |
| 120 | 12+216 | HP | 1X1200 | - | | | POOR |
| 121 | 12+313 | HP | 1X1200 | - | | | POOR |
| 122 | 12+372 | HP | 1X1200 | - | | | POOR |
| 123 | 12+482 | HP | 1X1200 | - | | | POOR |
| 124 | 12+757 | HP | 1X1200 | - | | | POOR |
| 125 | 13+217 | HP | 1X900 | - | | | POOR |
| 126 | 13+382 | HP | - | - | | | CHOKED |
| 127 | 13+456 | HP | 1X900 | - | | | POOR |
| 128 | 13+525 | HP | 1X900 | - | | | POOR |
| 129 | 13+838 | HP | 1X1200 | - | | | POOR |
| 130 | 14+044 | HP | 1X1200 | - | | | POOR |
| 131 | 14+270 | HP | 1X1200 | - | | | POOR |
| 132 | 14+435 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 133 | 14+477 | HP | 1X900 | - | | | POOR |
| 134 | 14+550 | HP | 1X900 | - | | | POOR |
| 135 | 14+555 | HP | 1X900 | - | | | POOR |
| 136 | 14+632 | HP | 1X900 | - | | | POOR |
| 137 | 14+696 | HP | 1X1200 | - | | | POOR |
| 138 | 14+727 | HP | - | - | | | CHOKED |
| 139 | 14+759 | HP | 1X1200 | - | | | POOR |
| 140 | 14+862 | HP | 1X1200 | - | | | POOR |
| 141 | 14+937 | HP | 1X900 | - | | | POOR |
| 142 | 15+186 | HP | 1X1200 | - | | | POOR |
| 143 | 15+244 | HP | 1X900 | - | | | POOR |
| 144 | 15+291 | HP | 1X1200 | - | | | POOR |
| 145 | 15+384 | HP | - | - | | | CHOKED |
| 146 | 1+558 | HP | 1X1200 | - | | | POOR |
| 147 | 15+694 | HP | 1X1200 | - | | | POOR |
| 148 | 15+750 | HP | 1X1200 | - | | | POOR |
| 149 | 15+783 | HP | 1X1200 | - | | | POOR |
| 150 | 15+825 | HP | 1X1200 | - | | | POOR |
| 151 | 15+984 | HP | - | - | | | CHOKED |
| 152 | 16+048 | HP | 1X1200 | - | | | POOR |
| 153 | 16+088 | HP | 1X1200 | - | | | POOR |
| 154 | 16+230 | HP | 1X900 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 155 | 16+285 | HP | 1X1200 | - | | | POOR |
| 156 | 16+591 | HP | 1X1200 | - | | | POOR |
| 157 | 16+762 | HP | 1X1200 | - | | | POOR |
| 158 | 16+813 | HP | 1 x 1200 | - | | | POOR |
| 159 | 16+884 | HP | 1X1200 | - | | | POOR |
| 160 | 17+023 | HP | 1X1200 | - | | | POOR |
| 161 | 17+108 | HP | 1X1200 | - | | | POOR |
| 162 | 17+215 | HP | 1X1200 | - | | | POOR |
| 163 | 17+246 | HP | 1X900 | - | | | POOR |
| 164 | 17+312 | HP | - | - | | | CHOKED |
| 165 | 17+360 | HP | 1X900 | - | | | POOR |
| 166 | 17+405 | HP | 1X1200 | - | | | POOR |
| 167 | 17+467 | HP | 1X900 | - | | | POOR |
| 168 | 17+537 | HP | 1X1200 | - | | | POOR |
| 169 | 17+652 | HP | 1X1200 | - | | | POOR |
| 170 | 17+846 | HP | 1X1200 | - | | | POOR |
| 171 | 17+905 | HP | 1X900 | - | | | POOR |
| 172 | 18+025 | HP | 1X900 | - | | | POOR |
| 173 | 18+096 | HP | 1X1200 | - | | | POOR |
| 174 | 18+114 | HP | 1X1200 | - | | | POOR |
| 175 | 18+339 | HP | 1X900 | - | | | POOR |
| 176 | 18+363 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 177 | 18+421 | HP | 1X1200 | - | | | POOR |
| 178 | 18+475 | HP | 1X1200 | - | | | POOR |
| 179 | 18+548 | HP | 1X1200 | - | | | POOR |
| 180 | 18+614 | HP | 1X900 | - | | | POOR |
| 181 | 18+862 | HP | 1X1200 | - | | | POOR |
| 182 | 18+923 | HP | 1X1200 | - | | | POOR |
| 183 | 19+250 | HP | 1X1200 | - | | | POOR |
| 184 | 19+677 | HP | 1X900 | - | | | POOR |
| 185 | 19+825 | HP | 1X900 | - | | | POOR |
| 186 | 19+944 | HP | 1X900 | - | | | POOR |
| 187 | 20+164 | BOX | - | - | | | CHOKED |
| 188 | 20+260 | HP | 1X900 | - | | | POOR |
| 189 | 20+616 | STONE | 1X0.5 | 8.60 | 1189.824 | 0.800 | POOR |
| 190 | 20+725 | STONE | 1X0.6 | 5.60 | 1194.986 | 0.400 | POOR |
| 191 | 20+789 | HP | 1X1200 | - | | | POOR |
| 192 | 20+909 | HP | 1X1200 | - | | | POOR |
| 193 | 21+219 | HP | 1X1200 | - | | | POOR |
| 194 | 21+309 | HP | 1X1200 | - | | | POOR |
| 195 | 21+788 | STONE | 1X0.6 | 8.60 | 1185.844 | 0.800 | POOR |
| 196 | 22+250 | HP | 1X1200 | - | | | POOR |
| 197 | 22+361 | HP | 2X1600 | - | | | POOR |
| 198 | 22+510 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 199 | 22+632 | STONE | - | - | | | CHOKED |
| 200 | 22+823 | STONE | 1X0.6 | 8.60 | 1178.588 | 0.900 | POOR |
| 201 | 22+923 | HP | 1X1600 | - | | | POOR |
| 202 | 23+196 | HP | 1X1200 | - | | | POOR |
| 203 | 23+421 | HP | 1X1200 | - | | | POOR |
| 204 | 23+679 | HP | 1X1600 | - | | | POOR |
| 205 | 23+761 | HP | 1X1600 | - | | | POOR |
| 206 | 23+885 | HP | 1X1600 | - | | | POOR |
| 207 | 23+946 | STONE | 1X0.6 | 8.60 | 1197.762 | 0.400 | POOR |
| 208 | 23+994 | STONE | 1X0.6 | 8.60 | 1196.826 | 1.500 | POOR |
| 209 | 24+190 | STONE | - | - | | | CHOKED |
| 210 | 24+800 | HP | 1X1200 | - | | | POOR |
| 211 | 25+041 | SLAB | 2X2.4 | 7.30 | 1163.634 | 3.200 | POOR |
| 212 | 25+187 | HP | 1X900 | - | | | POOR |
| 213 | 25+350 | HP | 1X900 | - | | | POOR |
| 214 | 25+450 | HP | 1X1200 | - | | | POOR |
| 215 | 25+753 | HP | 1X900 | - | | | POOR |
| 216 | 25+900 | HP | 1X900 | - | | | POOR |
| 217 | 26+111 | BOX | 1X0.7 | 8.70 | 1176.502 | 0.600 | POOR |
| 218 | 26+170 | SLAB | 1X0.8 | 8.30 | 1171.194 | 1.100 | POOR |
| 219 | 26+341 | SLAB | 1X0.8 | 5.60 | 1148.159 | 2.600 | POOR |
| 220 | 26+458 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 221 | 26+566 | HP | 1X1200 | - | | | POOR |
| 222 | 26+634 | HP | 1X1200 | - | | | POOR |
| 223 | 26+693 | HP | 1X600 | - | | | POOR |
| 224 | 26+788 | HP | 1X900 | - | | | POOR |
| 225 | 26+875 | HP | 1X900 | - | | | POOR |
| 226 | 26+954 | HP | 1X600 | - | | | POOR |
| 227 | 26+998 | HP | 1X900 | - | | | POOR |
| 228 | 27+143 | HP | 1X1200 | - | | | POOR |
| 229 | 27+225 | HP | 1X1200 | - | | | POOR |
| 230 | 27+325 | HP | 1X900 | - | | | POOR |
| 231 | 27+409 | HP | 1X1200 | - | | | POOR |
| 232 | 27+485 | HP | 1X600 | - | | | POOR |
| 233 | 27+568 | HP | 1X900 | - | | | POOR |
| 234 | 27+583 | HP | 1X1200 | - | | | POOR |
| 235 | 27+636 | HP | 1X900 | - | | | POOR |
| 236 | 27+656 | HP | 1X1200 | - | | | POOR |
| 237 | 27+691 | HP | 1X900 | - | | | POOR |
| 238 | 27+871 | HP | 1X600 | - | | | POOR |
| 239 | 27+898 | HP | 1X600 | - | | | POOR |
| 240 | 27+975 | HP | 1X1200 | - | | | POOR |
| 241 | 28+030 | HP | 1X600 | - | | | POOR |
| 242 | 28+084 | HP | 1X600 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 243 | 28+128 | HP | 1X600 | - | | | POOR |
| 244 | 28+293 | HP | 1X1200 | - | | | POOR |
| 245 | 28+352 | HP | 2X600 | - | | | POOR |
| 246 | 28+439 | HP | 1X900 | - | | | POOR |
| 247 | 28+479 | HP | 1X900 | - | | | POOR |
| 248 | 28+530 | HP | 1X900 | - | | | POOR |
| 249 | 28+600 | HP | 1X600 | - | | | POOR |
| 250 | 28+617 | HP | 1X900 | - | | | POOR |
| 251 | 28+663 | BOX | 1X0.7 | 7.90 | 1121.254 | 0.900 | POOR |
| 252 | 28+700 | HP | 1X600 | - | | | POOR |
| 253 | 28+741 | HP | 1X900 | - | | | POOR |
| 254 | 28+838 | HP | 1X600 | - | | | POOR |
| 255 | 28+898 | HP | 1X900 | - | | | POOR |
| 256 | 28+838 | HP | 1X900 | - | | | POOR |
| 257 | 29+003 | BOX | 1X1.5 | 6.74 | 1128.234 | 2.500 | POOR |
| 258 | 29+066 | HP | 1X900 | - | | | POOR |
| 259 | 29+080 | HP | 1X600 | - | | | POOR |
| 260 | 29+100 | HP | 1X600 | - | | | POOR |
| 261 | 29+219 | HP | 1X1200 | - | | | POOR |
| 262 | 29+288 | HP | 1X900 | - | | | POOR |
| 263 | 29+405 | BOX | - | - | | | CHOKED |
| 264 | 29+456 | HP | 1X600 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 265 | 29+512 | HP | 1X600 | - | | | POOR |
| 266 | 29+539 | HP | 1X600 | - | | | POOR |
| 267 | 29+609 | HP | 1X600 | - | | | POOR |
| 268 | 29+650 | HP | 1X1200 | - | | | POOR |
| 269 | 29+748 | BOX | - | - | | | CHOKED |
| 270 | 29+963 | BOX | - | - | | | CHOKED |
| 271 | 30+575 | STONE | - | - | | | CHOKED |
| 272 | 30+807 | BOX | 1X6.0 | 9.10 | 1147.119 | 1.100 | POOR |
| 273 | 30+874 | HP | 1X1200 | - | | | POOR |
| 274 | 30+883 | STONE | 1X0.5 | 6.30 | 1145.514 | 1.200 | POOR |
| 275 | 31+138 | HP | 1X1600 | - | | | POOR |
| 276 | 31+287 | STONE | 1X0.8 | 6.00 | 1136.080 | 1.000 | POOR |
| 277 | 31+323 | STONE | 1X0.4 | 10.00 | 1135.818 | 0.500 | POOR |
| 278 | 31+416 | HP | 1X1200 | - | | | POOR |
| 279 | 31+521 | HP | 1X600 | - | | | POOR |
| 280 | 31+585 | HP | 1X600 | - | | | POOR |
| 281 | 31+674 | HP | 1X900 | - | | | POOR |
| 282 | 31+789 | HP | 1X1200 | - | | | POOR |
| 283 | 31+946 | HP | 1X1200 | - | | | POOR |
| 284 | 32+203 | HP | 1X600 | - | | | POOR |
| 285 | 32+251 | HP | 1X600 | - | | | POOR |
| 286 | 32+350 | HP | 1X750 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 287 | 32+434 | HP | 1X900 | - | | | POOR |
| 288 | 33+202 | STONE | - | - | | | CHOKED |
| 289 | 33+556 | STONE | - | - | | | CHOKED |
| 290 | 34+256 | STONE | - | - | | | CHOKED |
| 291 | 34+433 | STONE | - | - | | | CHOKED |
| 292 | 34+538 | STONE | - | - | | | CHOKED |
| 293 | 34+888 | STONE | - | - | | | CHOKED |
| 294 | 35+096 | STONE | 1X0.6 | 6.50 | 1140.471 | 0.500 | POOR |
| 295 | 35+238 | STONE | 1X0.6 | 6.60 | 1138.909 | 0.300 | POOR |
| 296 | 35+276 | STONE | 1X0.6 | 6.10 | 1137.621 | 0.300 | POOR |
| 297 | 35+365 | STONE | 1X0.6 | 8.00 | 1133.832 | 1.000 | POOR |
| 298 | 35+549 | STONE | 1X1.1 | 8.80 | 1125.570 | 0.900 | POOR |
| 299 | 35+604 | STONE | 1X1.1 | 9.60 | 1123.357 | 0.700 | POOR |
| 300 | 35+763 | STONE | 1X0.6 | 7.80 | 1120.523 | 0.700 | POOR |
| 301 | 35+944 | STONE | 1X1.1 | 6.80 | 1113.236 | 1.600 | POOR |
| 302 | 36+042 | SLAB | 1X2.4 | 6.60 | 1115.829 | 1.200 | POOR |
| 303 | 36+157 | STONE | - | - | | | CHOKED |
| 304 | 36+908 | STONE | 1X0.6 | 7.30 | 1089.626 | 0.700 | POOR |
| 305 | 37+039 | STONE | 1X0.9 | 8.40 | 1082.183 | 1.100 | POOR |
| 306 | 37+192 | STONE | 1X0.9 | 6.00 | 1070.470 | 1.100 | POOR |
| 307 | 37+279 | STONE | 1X0.2 | 8.00 | 1064.161 | 1.000 | POOR |
| 308 | 37+360 | STONE | 1X0.4 | 8.80 | 1057.486 | 0.800 | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 309 | 37+448 | STONE | 1X0.3 | 6.30 | 1049.042 | 1.000 | POOR |
| 310 | 37+460 | STONE | 1X0.2 | 8.20 | 1049.544 | 0.700 | POOR |
| 311 | 37+491 | STONE | 1X0.5 | 9.60 | 1047.190 | 0.600 | POOR |
| 312 | 37+564 | STONE | 1X0.3 | 11.10 | 1044.304 | 0.400 | POOR |
| 313 | 37+623 | STONE | 1X0.9 | 8.70 | 1042.689 | 0.700 | POOR |
| 314 | 37+775 | STONE | 1X0.8 | 12.00 | 1025.847 | 0.800 | POOR |
| 315 | 37+918 | STONE | - | - | | | CHOKED |
| 316 | 37+966 | STONE | - | - | | | CHOKED |
| 317 | 38+051 | STONE | 1X0.3 | 9.50 | 1033.015 | 0.600 | POOR |
| 318 | 38+094 | STONE | 1X0.7 | 8.10 | 1030.522 | 0.500 | POOR |
| 319 | 38+202 | STONE | 1X0.6 | 8.00 | 1036.835 | 0.700 | POOR |
| 320 | 38+585 | STONE | 1X0.6 | 7.80 | 1033.063 | 1.000 | POOR |
| 321 | 38+650 | STONE | - | - | | | CHOKED |
| 322 | 38+815 | STONE | 1X0.7 | 7.40 | 1025.361 | 0.900 | POOR |
| 323 | 39+818 | STONE | 1X0.4 | 10.50 | 1022.125 | 1.000 | POOR |
| 324 | 39+975 | STONE | 1X0.9 | 7.00 | 1018.302 | 0.500 | POOR |
| 325 | 40+300 | SLAB | 1X0.5 | 6.50 | 1018.026 | 0.500 | POOR |
| 326 | 40+632 | HP | 2X1200 | - | | | POOR |
| 327 | 40+883 | SLAB | 1X0.6 | 6.00 | 1005.162 | 0.500 | POOR |
| 328 | 41+069 | STONE | 1X0.6 | 6.40 | 994.003 | 1.000 | POOR |
| 329 | 41+527 | STONE | 1X0.6 | 6.10 | 975.449 | 1.000 | POOR |
| 330 | 41+597 | STONE | 1X0.6 | 6.40 | 973.234 | 1.000 | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 331 | 41+885 | SLAB | 1X2.2 | 4.70 | 952.927 | 2.700 | POOR |
| 332 | 41+948 | SLAB | 1X1.0 | 8.90 | 957.591 | 2.100 | POOR |
| 333 | 42+112 | STONE | 1X0.6 | 7.90 | 973.106 | 0.800 | POOR |
| 334 | 42+188 | STONE | 1X0.3 | 10.70 | 980.062 | 0.400 | POOR |
| 335 | 42+271 | STONE | 1X0.6 | 8.50 | 989.293 | 1.000 | POOR |
| 336 | 42+318 | SLAB | 1X0.9 | 7.40 | 992.733 | 1.100 | POOR |
| 337 | 42+419 | SLAB | 1X0.7 | 10.70 | 998.409 | 0.500 | POOR |
| 338 | 42+576 | STONE | - | - | | | CHOKED |
| 339 | 42+923 | HP | 2X1200 | - | | | POOR |
| 340 | 43+040 | HP | 1X1200 | - | | | POOR |
| 341 | 43+213 | HP | 1X1800 | - | | | POOR |
| 342 | 43+341 | HP | 1X1500 | - | | | POOR |
| 343 | 43+399 | HP | 1X1500 | - | | | POOR |
| 344 | 43+466 | HP | 1X1500 | - | | | POOR |
| 345 | 43+654 | HP | 1X1500 | - | | | POOR |
| 346 | 43+757 | HP | 1X1500 | - | | | POOR |
| 347 | 44+397 | HP | 1X1500 | - | | | POOR |
| 348 | 44+465 | HP | 1X1500 | - | | | POOR |
| 349 | 44+613 | HP | 1X1500 | - | | | POOR |
| 350 | 44+780 | HP | 1X1200 | - | | | POOR |
| 351 | 44+835 | HP | 1X1200 | - | | | POOR |
| 352 | 45+050 | HP | 1X1600 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 353 | 45+175 | HP | 1X1600 | - | | | POOR |
| 354 | 45+415 | HP | 1X1800 | - | | | POOR |
| 355 | 45+479 | HP | 1X900 | - | | | POOR |
| 356 | 45+628 | HP | 1X1200 | - | | | POOR |
| 357 | 45+722 | HP | 1X1600 | - | | | POOR |
| 358 | 45+786 | HP | 1X1500 | - | | | POOR |
| 359 | 45+906 | HP | 1X1600 | - | | | POOR |
| 360 | 46+111 | HP | 1X1500 | - | | | POOR |
| 361 | 46+368 | HP | 1X1500 | - | | | POOR |
| 362 | 46+481 | HP | 1X1500 | - | | | POOR |
| 363 | 46+740 | HP | 1X1500 | - | | | POOR |
| 364 | 47+259 | HP | 2X1200 | - | | | POOR |
| 365 | 47+464 | HP | 1X1000 | - | | | POOR |
| 366 | 47+573 | HP | 1X1200 | - | | | POOR |
| 367 | 47+751 | HP | 1X1200 | - | | | POOR |
| 368 | 47+828 | HP | 1X1200 | - | | | POOR |
| 369 | 47+977 | HP | 1X1800 | - | | | POOR |
| 370 | 48+065 | HP | 1X900 | - | | | POOR |
| 371 | 48+127 | HP | 1X1200 | - | | | POOR |
| 372 | 48+206 | HP | 1X1200 | - | | | POOR |
| 373 | 48+352 | HP | 1X1500 | - | | | POOR |
| 374 | 48+444 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 375 | 48+559 | HP | 1X1200 | - | | | POOR |
| 376 | 48+615 | HP | 1X900 | - | | | POOR |
| 377 | 49+186 | HP | 1X1200 | - | | | POOR |
| 378 | 49+291 | HP | 1X1500 | - | | | POOR |
| 379 | 49+431 | HP | 1X1200 | - | | | POOR |
| 380 | 49+498 | HP | 1X1800 | - | | | POOR |
| 381 | 49+569 | HP | 1X900 | - | | | POOR |
| 382 | 49+616 | HP | 1X900 | - | | | POOR |
| 383 | 49+726 | HP | 1X1800 | - | | | POOR |
| 384 | 49+758 | HP | 1X900 | - | | | POOR |
| 385 | 49+800 | HP | 1X1200 | - | | | POOR |
| 386 | 49+843 | HP | 1X1200 | - | | | POOR |
| 387 | 49+915 | HP | 1X1600 | - | | | POOR |
| 388 | 49+965 | HP | 1X900 | - | | | POOR |
| 389 | 50+159 | HP | 1X1600 | - | | | POOR |
| 390 | 50+279 | HP | 1X1600 | - | | | POOR |
| 391 | 50+443 | HP | 1X600 | - | | | POOR |
| 392 | 50+709 | HP | 1X900 | - | | | POOR |
| 393 | 50+903 | HP | 1X900 | - | | | POOR |
| 394 | 50+999 | HP | 1X1600 | - | | | POOR |
| 395 | 51+308 | HP | 1X1200 | - | | | POOR |
| 396 | 51+501 | HP | 1X900 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 397 | 51+582 | HP | 1X1800 | - | | | POOR |
| 398 | 51+707 | HP | 1X1600 | - | | | POOR |
| 399 | 51+839 | HP | 1X1800 | - | | | POOR |
| 400 | 51+918 | HP | 1X1800 | - | | | POOR |
| 401 | 51+989 | HP | 1X1500 | - | | | POOR |
| 402 | 52+105 | HP | 1X1500 | - | | | POOR |
| 403 | 52+215 | HP | 1X1800 | - | | | POOR |
| 404 | 52+265 | HP | 1X1500 | - | | | POOR |
| 405 | 52+583 | HP | 1X900 | - | | | POOR |
| 406 | 52+782 | HP | 1X1200 | - | | | POOR |
| 407 | 52+907 | HP | 1X900 | - | | | POOR |
| 408 | 53+107 | HP | 2X1800 | - | | | POOR |
| 409 | 53+499 | HP | 1X1800 | - | | | POOR |
| 410 | 53+579 | HP | 1X1800 | - | | | POOR |
| 411 | 53+812 | HP | 1X900 | - | | | POOR |
| 412 | 54+121 | HP | 1X1500 | - | | | POOR |
| 413 | 54+323 | HP | 1X1200 | - | | | POOR |
| 414 | 54+332 | HP | 1X1200 | - | | | POOR |
| 415 | 54+509 | HP | 1X1200 | - | | | POOR |
| 416 | 54+698 | HP | 1X1200 | - | | | POOR |
| 417 | 54+848 | HP | 1X1200 | - | | | POOR |
| 418 | 54+930 | HP | 1X1200 | - | | | POOR |

| Sl. No. | Location (km ) | Type of structures | EXISTING | | | | |
|---|---|---|---|---|---|---|---|
| | | | Span Arrangement and Total ventway (No.x Length(m) | Width of culvert (m) | Invert level | vent height | Remarks |
| 419 | 54+992 | HP | 1X1200 | - | | | POOR |
| 420 | 55+292 | HP | 1X1200 | - | | | POOR |
| 421 | 55+359 | HP | 1X1200 | - | | | POOR |
| 422 | 55+463 | HP | 1X1200 | - | | | POOR |
| 423 | 55+584 | HP | 1X1200 | - | | | POOR |
| 424 | 56+042 | HP | 1X1200 | - | | | POOR |
| 425 | 56+104 | HP | 1X1200 | - | | | POOR |
| 426 | 56+232 | HP | 1X1200 | - | | | POOR |
| 427 | 56+357 | HP | 1X1200 | - | | | POOR |
| 428 | 56+493 | HP | 3X1200 | - | | | POOR |
| 429 | 56+754 | HP | 1X1200 | - | | | POOR |
| 430 | 57+025 | HP | 1X1200 | - | | | POOR |
| 431 | 57+135 | HP | 1X1200 | - | | | POOR |
| 432 | 57+389 | HP | 1X1200 | - | | | POOR |
| 433 | 57+713 | HP | 1X900 | - | | | POOR |
| 434 | 57+877 | HP | 1X900 | - | | | POOR |
| 435 | 57+938 | HP | 1X900 | - | | | POOR |
| 436 | 57+998 | HP | 1X900 | - | | | POOR |

**Table-3.3: SUMMARY OF LABORATORY TEST RESULTS ON AGGREGATES**

| Lab Report No | Grain Size Analysis IS 2386 (Part I) | | | | Flakiness and Elongation Indices (%) (IS 2386 Part I) | Water Absorption (%) (IS 2386 Part III) | Specific Gravity (IS 2386 Part III) | AIV (DRY TEST %) (IS-2386 Part IV) | Coating and Stripping of Bitumen-Aggregate mixtures (IS-6241) Without anti stripping agent | Coating and Stripping of Bitumen-Aggregate mixtures (IS-6241) With anti stripping agent 0.6% | Soudness (% Loss with sodium suphate) ( IS 2386 Part V) | Name of Quarry Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percentage Passing Through | | | | | | | | | | | |
| | 25mm IS Sieve | 20mm IS Sieve | 12.5mm IS Sieve | 6.3mm IS Sieve | | | | | | | | |
| AQ-I | 70 | 20 | 4 | 0 | 35 | 0.74 | 2.97 | 9.00 | <95% | >95% | 4.83 | Nongstoin |
| AQ-II | Aggegate size more than 90mm | | | | - | 2.02 | 2.79 | 12.00 | <95% | >95% | 4.58 | |
| AQ-III | 100 | 85 | 38 | 22 | 42 | 1.62 | 2.93 | 11.00 | <95% | >95% | 4.64 | |
| AQ-IV | 100 | 100 | 5 | 2 | 38 | 3.02 | 2.73 | 12.00 | <95% | >95% | 13.35 | |
| AQ-V | 100 | 90 | 15 | 4 | 52 | 0.91 | 2.90 | 11.00 | <95% | >95% | 1.04 | |
| AQ-VI | Aggegate size more than 90mm | | | | - | 0.31 | 2.63 | 21.00 | <95% | >95% | 1.99 | |
| AQ-VII | 96 | 34 | 5 | 0 | 48 | 1.35 | 2.87 | 13.00 | <95% | >95% | 5.43 | |
| AQ-VIII | Aggegate size more than 90mm | | | | - | 0.96 | 2.99 | 13.00 | <95% | >95% | 5.39 | |
| AQ-IX | Aggegate size more than 90mm | | | | - | 3.96 | 2.55 | 14.72 | >95% | - | 71.44 | |

**Table- 3.4: SUMMARY OF LABORATORY TEST RESULTS ON SAND SAMPLES**

| Lab Sample No | Grain Size Analysis | | | | | | | | FM | CONFIRMING TO ZONE |
|---|---|---|---|---|---|---|---|---|---|---|
| | Percentage passing from IS sieves | | | | | | | | | |
| | 10MM | 4.75 MM | 2.36 MM | 1.18 MM | 600 MIC | 300 MIC | 150 MIC | 75M IC | | |
| SQ-I | 99 | 93 | 85 | 77 | 42 | 15 | 1 | 1 | 2.87 | None |
| SQ-I (After screening through 4.75mm IS sieve) | 100 | 100 | 92 | 83 | 46 | 17 | 1 | 1 | 2.61 | Zone-II |
| SQ-II | 99 | 87 | 67 | 47 | 21 | 8 | 1 | 0 | 3.70 | None |
| SQ-II (After screening through 4.75mm IS sieve) | 100 | 100 | 77 | 54 | 24 | 9 | 1 | 1 | 3.35 | Zone-I |
| SQ-III | 100 | 99 | 93 | 82 | 58 | 36 | 6 | 3 | 2.26 | Zone-III |

## Table-3.5: SUMMARY OF LABORATORY TEST RESULTS ON MOORUM QUARRY

| Lab Sample No. of Moorum from Sindhwala Quarry | Grain Size Analysis | | | | | | | | | | | | Atterberg Limits (%) | | Classification | Heavy Compaction | | CBR AT 98% of MDD (SOAKED) | | | | | | Expansion Ratio (%) | Free Swelling index(%) | Water absorption of coarse fraction (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percentage passing from IS sieve | | | | | | | | | | | | LL | PI | | MDD | OMC | specimen no | Dry density (gm/cc) | C B R (%) | Average CBR | Moisture content after soaking 4 days (%) | Average Moisture (%) | | | |
| | 75 mm | 53 mm | 26.5 mm | 19 mm | 9.5 mm | 4.75 mm | 2.36 mm | 1 mm | 600 mic | 425 mic. | 150 mic. | 75 mic. | | | | (gm/ cc) | (%) | | | | | | | | | | |
| MQ-I | 100 | 100 | 96 | 85 | 65 | 47 | 47 | 20 | 11 | 11 | 8 | 7 | _ | NP | GW-GM | 2.18 | 11.9 | 1 | 2.18 | 38.5 | 38.5 | 9.12 | 9.12 | - | 0 | 1.12 |
| MQ-II | 100 | 100 | 90 | 80 | 61 | 42 | 40 | 16 | 13 | 09 | 8 | 6 | _ | NP | GW-GM | 2.11 | 8.64 | 2 | 2.18 | 39.4 | 39.4 | 9.33 | 9.33 | - | 0 | 1.20 |
| MQ-III | 100 | 100 | 85 | 73 | 51 | 36 | 25 | 19 | 11 | 10 | 7 | 6 | _ | NP | GW-GM | 2.23 | 8.45 | 3 | 2.19 | 37.7 | 37.7 | 8.89 | 8.89 | 0.09 | 0 | 0.90 |

## Table-3.6: SUMMARY OF TEST RESULTS OF STONE DUST WITH QUARRY CRUSHED AGGREGATE FOR USE IN GSB

| IS SIEVE DESIGNATION → / Sample No. ↓ | Percentage passing from IS sieves | | | | | | | | Ratio | | Total percentage passing from IS sieves after blending stone dust with crushed aggregate | | | | | | | | MoRT&H Grading | Liquid Limit (%) | Plasticity Index (%) | 10 % Fines Value (k | Water absorption (%) | Heavy compaction | | Soaked CBR at 98% of MDD | | Suitability for GSB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 75 mm | 53 mm | 26.5 mm | 9.5 mm | 4.75 mm | 2.36 mm | 425 mic | 75 mic | Stone Dust | Crushed Aggregate | 75 mm | 53 mm | 26.5 mm | 9.5 mm | 4.75 mm | 2.36 mm | 425 mic | 75 mic | CLOSE-GRADED (Grading) | | | | | MDD (gm/cc) | OMC (%) | CBR (%) | Average CBR (%) | |
| Stone dust | 100 | 100 | 100 | 100 | 100 | 92 | 32 | 9 | | | | | | | | | | | | | | | | | | | | |
| AQ-V | 100 | 92 | 66 | 33 | 5 | 3 | 2 | 1 | 25 | 75 | 100 | 94 | 75 | 50 | 29 | 25 | 10 | 3 | I | | | | | | | | | |
| | | | | | | | | | 30 | 70 | 100 | 94 | 76 | 53 | 34 | 30 | 11 | 3 | I | 22 | NP | 152 | 0.76 | 2.29 | 6.8 | 51.0<br>55.0<br>49.0 | 52.0 | Ye |
| | | | | | | | | | 35 | 65 | 100 | 95 | 78 | 56 | 38 | 34 | 13 | 4 | I | | | | | | | | | |

# 4.0 TRAFFIC ANALYSIS & DEMAND FORECAST

## 4.1 General

Traffic analysis and forecast form key and important elements of any Project Report preparation. They have a direct bearing on several aspects. Some of these include lane width requirements and pavement thickness, design features and elements, and wayside facilities. All these signify the importance of base year and design year traffic which determines the type and level of facility to be planned and developed, which in turn forms the base towards determining the up gradation cost. Given this, decisions on the type of traffic surveys, locations and duration have therefore been taken judiciously to arrive at representative traffic flows on the various sections, traffic desire patterns and characteristics.

The project road encompasses complete MDR-17 (25 Kms) from Nongstoin to Laitsawsnai. Thereafter it joins MDR-20 at its chainage at Km.46 and follows upto Km.68 at Wahkaji (22 Kms.) where MDR-20 terminates. The project road thereafter follows Uranium Corporation (India) Ltd. (UCIL) road for a length of 19 Kms. approximately.

The project road is a single lane road and has a few timber bridges which are weak. The average formation width of this road is about 6.00 m and the carriageway width is about 3.5m approximately with 1.25m shoulders on either side. The formation width is inadequate from 2-lane standard. The existing pavement is weak in most of the stretch. The terrain is hilly in the entire stretch. The UCIL road from Wahkaji to Domiasiat is a gravel road having formation width varying from 10m to 12m. The upcoming developments of this project road have direct bearing on the travel characteristics and expectations of service levels to be offered by the facility to the road users of the project corridor. In this study, considerable efforts have been made to arrive at realistic traffic picture through an extensive analysis of the database.

## 4.2 Identification of Homologous Sections for Traffic Survey

To comprehensively appreciate the traffic and travel characteristics on the project corridor locations and duration, identified at the inception stage of the study have been followed during data collection exercise with minor modifications on account of site conditions. With a view to capture section wise traffic flow characteristics, the total stretch has been segmented into three homogeneous sections, based upon the major intersections that act as main collectors or distributors of traffic along the project corridor; i.e., sections of more or less similar traffic characteristics. Figure 4-1 presents homogeneous sections of the project corridor along with the adjoining networks in the project influence area. The homogeneous sections identified are tabulated below (Table 4.1).

**Table 4.1: Homogeneous Section**

| Homogeneous Section | Chainage | Length (km) |
|---|---|---|
| Section 1 | Km 0+000 – Km 20+00 | 20.00 |
| Section 2 | Km 20+00 – Km 43+100 | 23.10 |
| Section 3 | Km 43+100 – Km 58+100 | 10.00 |

## 4.3 Traffic Survey Location and Schedule

The survey schedule and survey locations are presented in **Table 4.2** and shown in Figure enclosed**.**

**Table: 4.2 Type of Traffic Surveys and its locations**

| Type of Survey | Duration | No. of Location | Chainage (Km) |
|---|---|---|---|
| Classified Traffic Volume Count Survey | 7 Days x 24 hrs. | Near Kynron Village | 9+000 |
| | | Near Marium village | 34+000 |
| Turning Movement Survey | 8 Hours | At Lietjynrai Junction | 20+775 |
| | | At Wahkaji Junction | 43+100 |

## 4.4 Survey Methodology

### 4.4.1 Classified Traffic Volume Count

Traffic volume count surveys were conducted at two location namely at Km 9.000 (Kynron Villages) and Km 34.00 (Marium Village). The survey was conducted round-the-clock over 7 consecutive days. For recording classified mode-wise information, vehicles were grouped under the categories as given below in **Table 4.3.**

**Table 4.3: Vehicle Classification System adopted**

| Motorised Traffic | | Non-Motorised Traffic |
|---|---|---|
| 2 wheelers | | Bicycle |
| Auto Rickshaw | | Cycle Rickshaw/ Rickshaw Van |
| Passenger Car : Car, Jeep, Taxi | | Animal Drawn/Hand Cart |
| Bus | Mini Bus | |
| | Standard Bus | |
| Truck | Light Commercial Vehicle (LCV) | |
| | 2 – Axle Rigid Chassis Truck | |
| | 3 – Axle Rigid Chassis Truck | |
| | 4-6 Axle Trucks | |
| Tractor | Agriculture Tractor | |
| | Tractor & Trailer | |

Enumerators were locally recruited and trained to conduct traffic counts. For the purpose of counting, a day was divided into three shifts of 8 hours each and separate enumerators with a

Supervisor were assigned for each shift. The count data were recorded within 15-minute intervals for each vehicle group in each direction.

### 4.5.2 Intersection Turning Movement Survey

Turning Movement Surveys were conducted at two locations as described in **Table 4.2** covering all movement combinations. The intersections are Three-armed T type Junctions.

## 4.6 Date Analysis - Classified Traffic Volume Count

### 4.6.1 Average Daily Traffic

The traffic data (in vehicles) collected during field surveys have been compiled and converted into equivalent Passenger Car Units (PCU) to determine the Average Daily Traffic (ADT) in vehicles and in PCU. **Table 4.4** lists the adopted PCU equivalent for different vehicle type based on IRC 106:1990, and also from previous similar studies (carried out in the state of Jharkhand) for the modes not covered in the IRC guideline.

**Table 4.4: Adopted PCU Equivalents for Different Vehicle Type**

| Vehicle Type | PCU Equivalent |
|---|---|
| Two-wheeler | 0.5 |
| Auto Rickshaw | 1.0 |
| Tempo | 1.0 |
| Car/Jeep/Van | 1.0 |
| Standard Bus | 3.0 |
| Mini Bus | 1.5 |
| 2-Axle Truck | 3.0 |
| 3-Axle Truck | 3.0 |
| M-Axle Truck | 4.5 |
| LCV | 1.5 |
| Tractor Without Trailer | 1.5 |
| Tractor with Trailer | 4.5 |
| Cycle | 0.5 |
| Cycle Rickshaw | 1.5 |
| Animal Drawn | 6.0 |

The **Table 4.5** presents location wise traffic in Average Daily Traffic (ADT) in vehicles and in PCU. The table also provides the total number of motorized passenger vehicles, motorized goods vehicles and non-motorized vehicles by location on the project corridor.

**Table 4.5: Average Daily Traffic (ADT) on Project Corridor by Location**

| Location | Motorized Passenger Vehicle | Motorised Goods Vehicle | Non-Motorized Vehicle | Total Vehicle | Total PCU |
|---|---|---|---|---|---|
| **Project Corridor** | | | | | |
| Leitjynrai (Km 9) | 284 | 139 | 0 | 423 | 585 |
| Marium Village (Km 34.00) | 159 | 103 | 0 | 262 | 288 |

The Vehicle to PCU ratio on the project corridor came out to be 1:01 (Vehicle: PCU) signifying a major share of Two wheeler, car jeeps on the project road.

### 4.6.2 Daily Variation of Traffic

The location wise daily variation of traffic for the project corridor is presented in **Table -4.6** and shown in **figure 4.2** and **4.3**.

**Table 4.6: Daily Variation of Traffic on Project Corridor by Location**

| Location | Day-1 | Day-2 | Day-3 | Day-4 | Day-5 | Day-6 | Day-7 |
|---|---|---|---|---|---|---|---|
| ***Leitjynrai (Km 9)*** | | | | | | | |
| Motorized Passenger Vehicle | 194 | 220 | 246 | 252 | 254 | 248 | 247 |
| Motorised Goods Vehicle | 113 | 97 | 107 | 97 | 111 | 115 | 108 |
| Non-Motorized Vehicle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Vehicle | 307 | 317 | 352 | 349 | 365 | 363 | 355 |
| **Total PCU** | **423** | **410** | **465** | **460** | **488** | **496.5** | **478** |
| ***Marium Village (Km 34.00)*** | | | | | | | |
| Motorized Passenger Vehicle | 75 | 101 | 115 | 125 | 127 | 125 | 142 |
| Motorised Goods Vehicle | 65 | 70 | 64 | 67 | 71 | 70 | 68 |
| Non-Motorized Vehicle | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Vehicle | 140 | 171 | 179 | 192 | 198 | 195 | 210 |
| **Total PCU** | **200** | **250** | **253** | **273** | **280.5** | **285.5** | **281** |

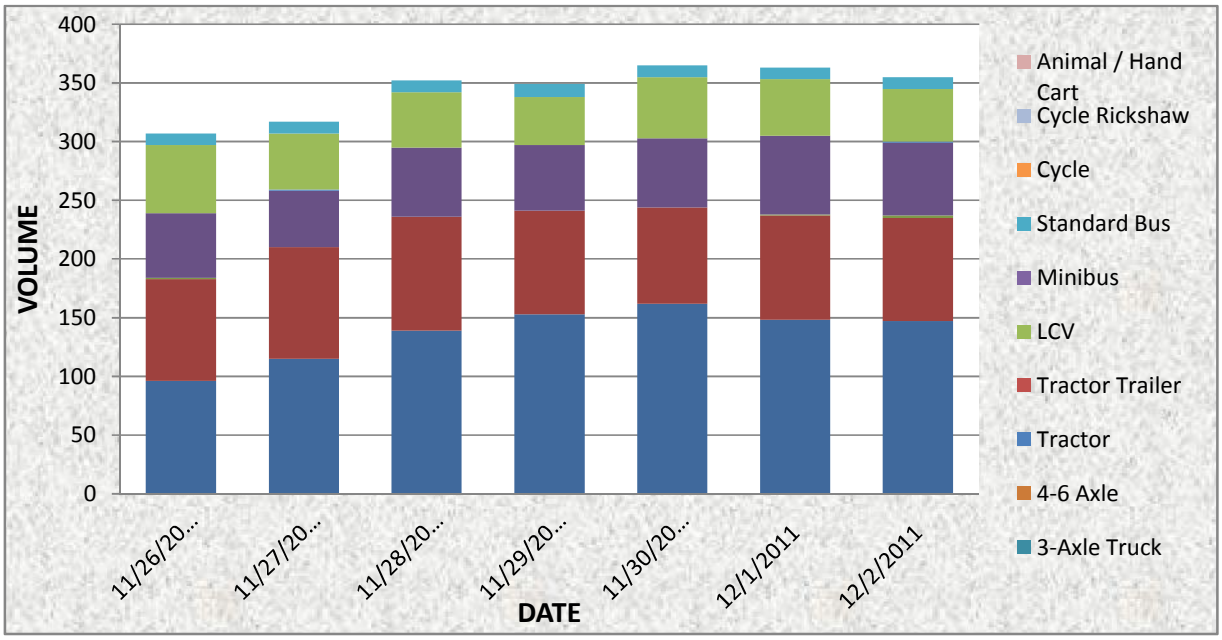



**Figure 4.2 Datewise Traffic composition (in Volume) at Km 9.00 ( Leitjynrai)**

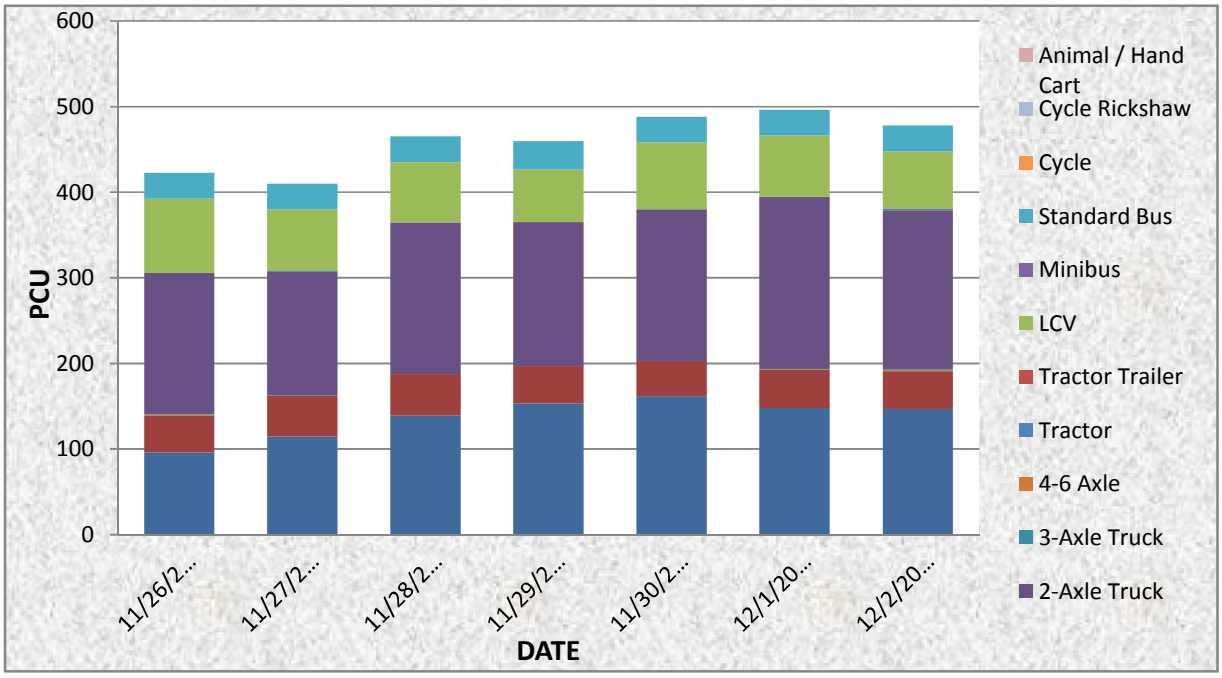



**Figure 4.3 Datewise Traffic composition (in PCU) at Km 9.00 ( Leitjynrai)**

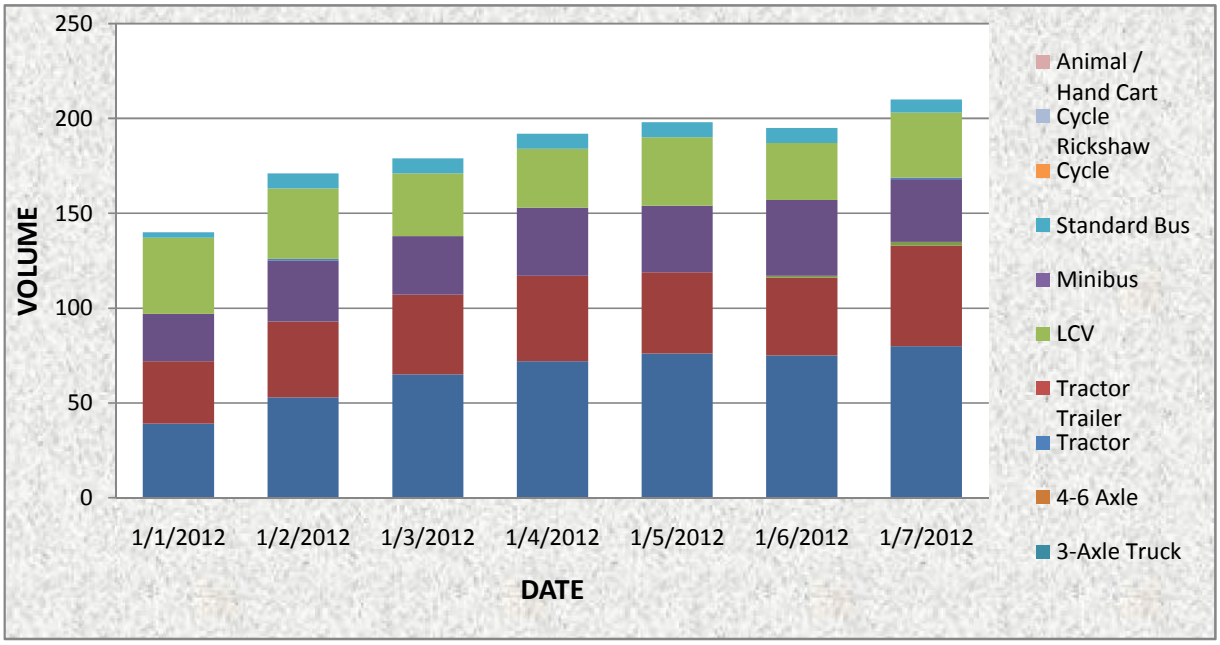



**Figure 4.4 Datewise Traffic composition (in Volume) at Km 34.00 ( Marium Village)**

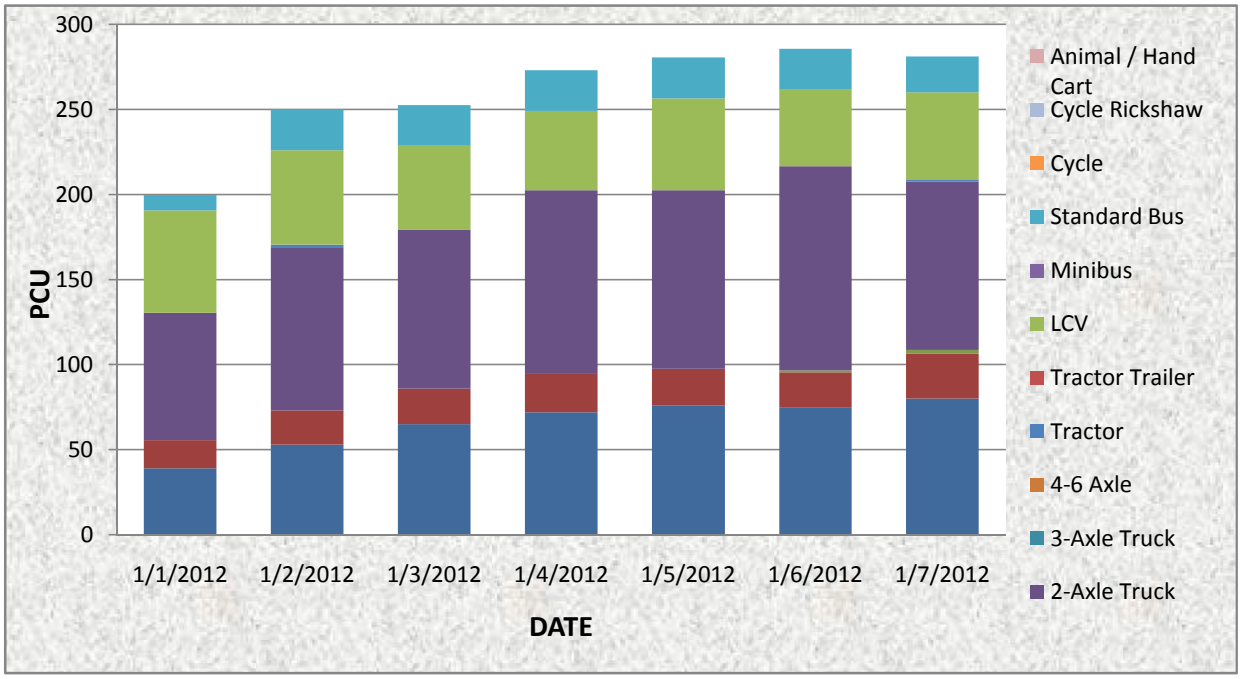



**Figure 4.5 Datewise Traffic composition (in PCU) at Km 34.00 ( Marium Village)**

### 4.6.3 Maximum, minimum and Average Traffic

The analysis of traffic volume data indicates maximum traffic volume on the Project Corridor at Location I i.e. Km 9.00 ( Leitjynrai) is 496.5 PCU/day, the average daily traffic is 487 PCU/Day and the Vehicle to PCU ratio on the project corridor came out to be 1.01 (Vehicle: PCU) signifying a major share of Two wheelers and car/Jeep flow on the same. Whereas at location II i.e. Km 34.00 (Marium Village) maximum traffic volume is 286 PCU/day, the average daily traffic is 288 PCU/Day and the Vehicle to PCU ratio is same as of location I.

### 4.6.4 Hourly Distribution and Directional Distribution of Traffic

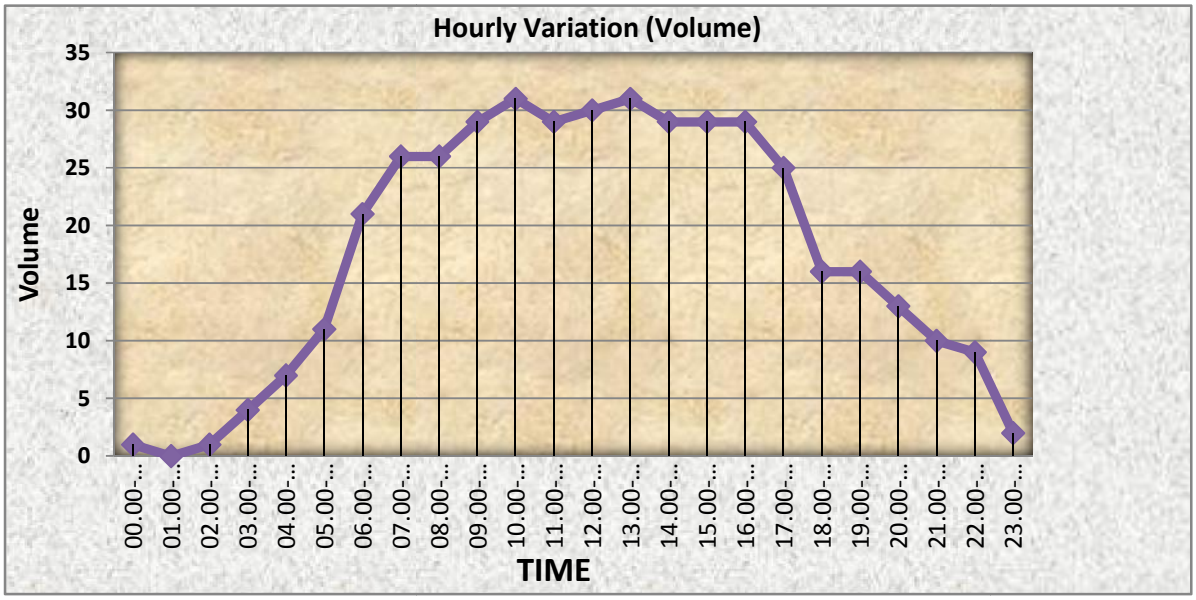



**Figure 4.6 Hourly Variation of Traffic (in Volume) at Km 9.00 (Kynron Village)**

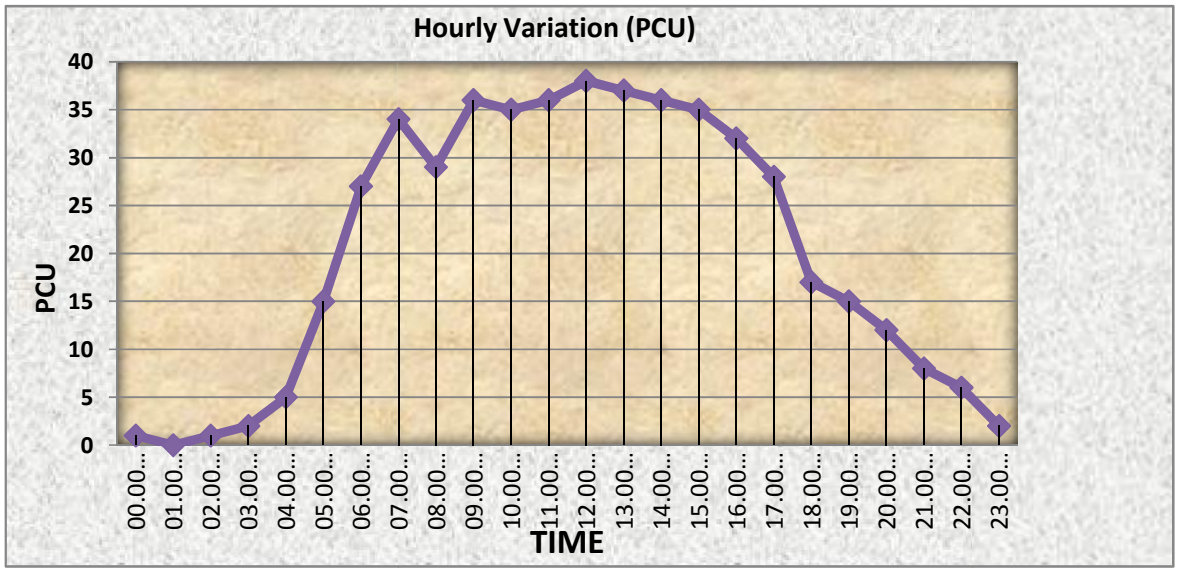



**Figure 4.7 Hourly variation of Traffic (in PCU) at Km 9.00 (Kynron Village)**

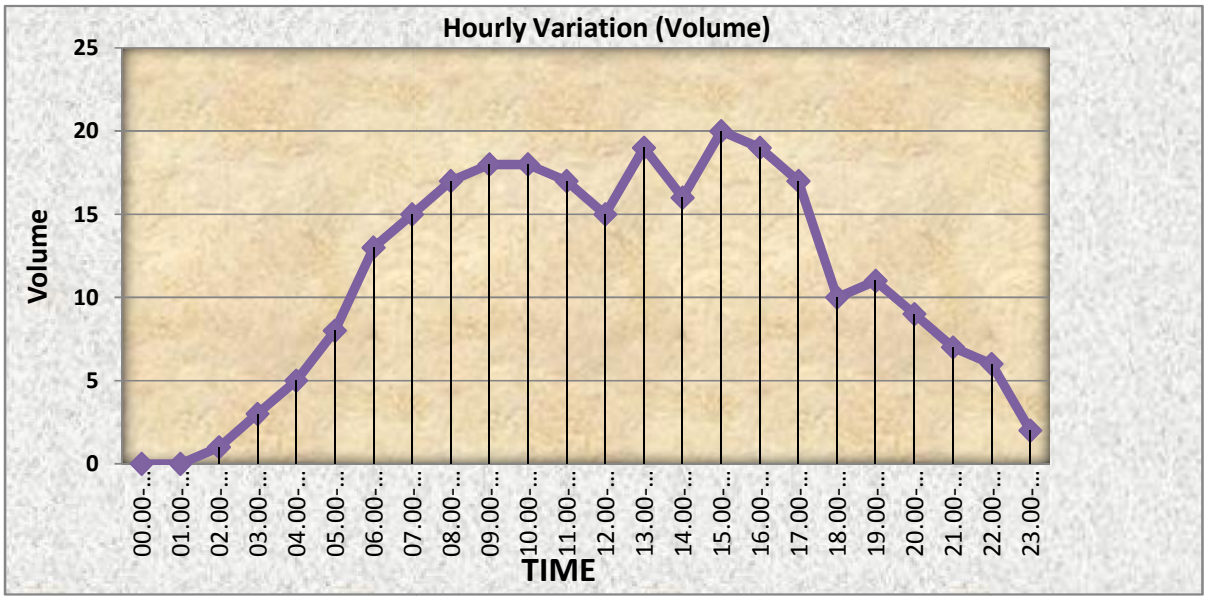



**Figure 4.8 Hourly Variation of Traffic (in Volume) at Km 34.00 (Marium Village)**

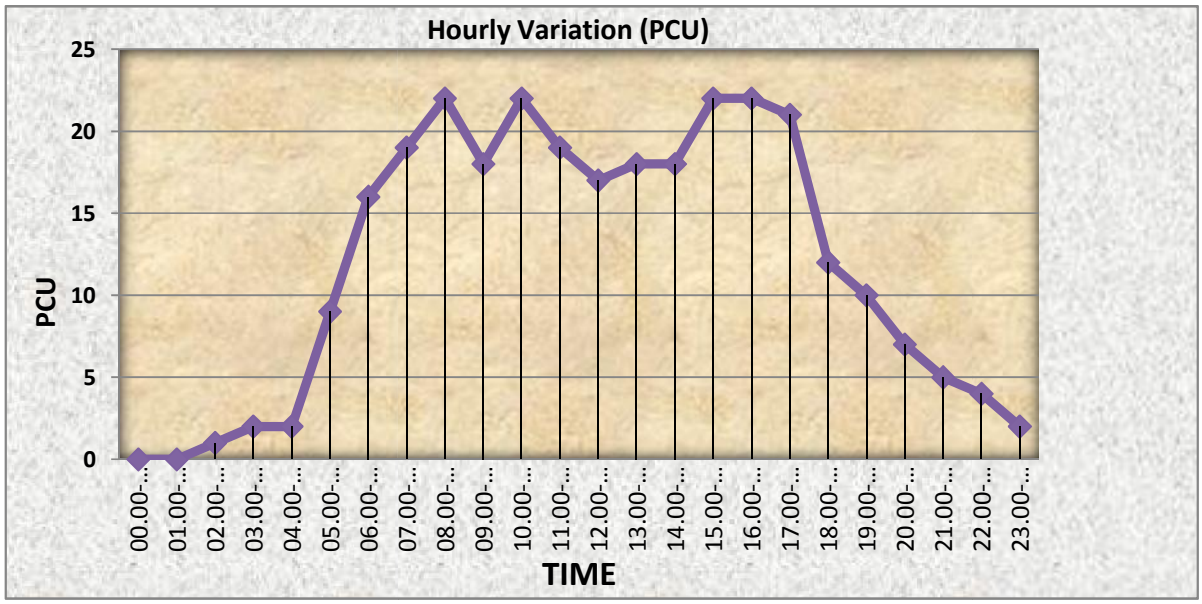



**Figure 4.9 Hourly variation of Traffic (in PCU) at Km 34.00 (Marium Village)**

Figure 4.6 to 4.9 above shows not much variation in traffic intensity over the day.

### 4.6.5 Traffic Composition

From the analysis of the data it can be seen that Cars/jeep/taxi comprise a significant share, ranging between 40%% of the total vehicles, followed by 2-wheelers, LCVs in the range of 26, 14%. The share of commercial traffic (Buses and Trucks) is almost 12% of the total traffic. Non-motorized traffic, primarily bicycles is not present on the project road.

Figure 4.10 to 4.13 below presents overall traffic composition by vehicles along the project corridor.

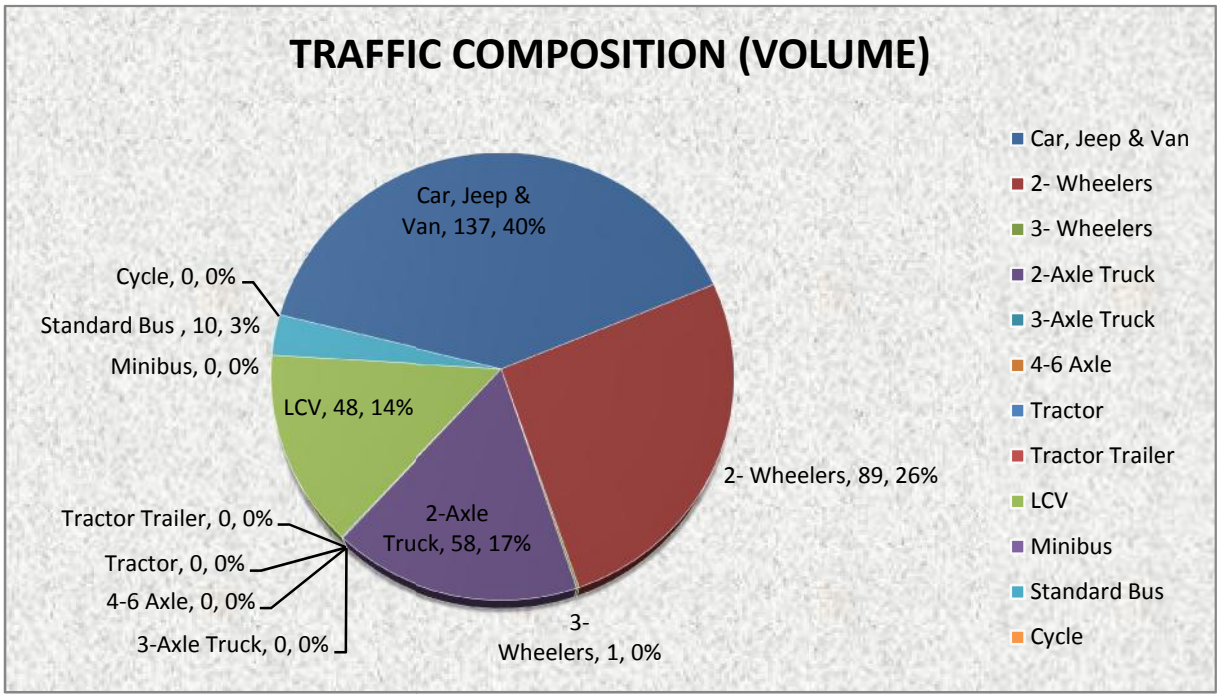



**Figure 4.10:Traffic Composition (in Volume)at Km 9.00 (Leitjynrai Road)**

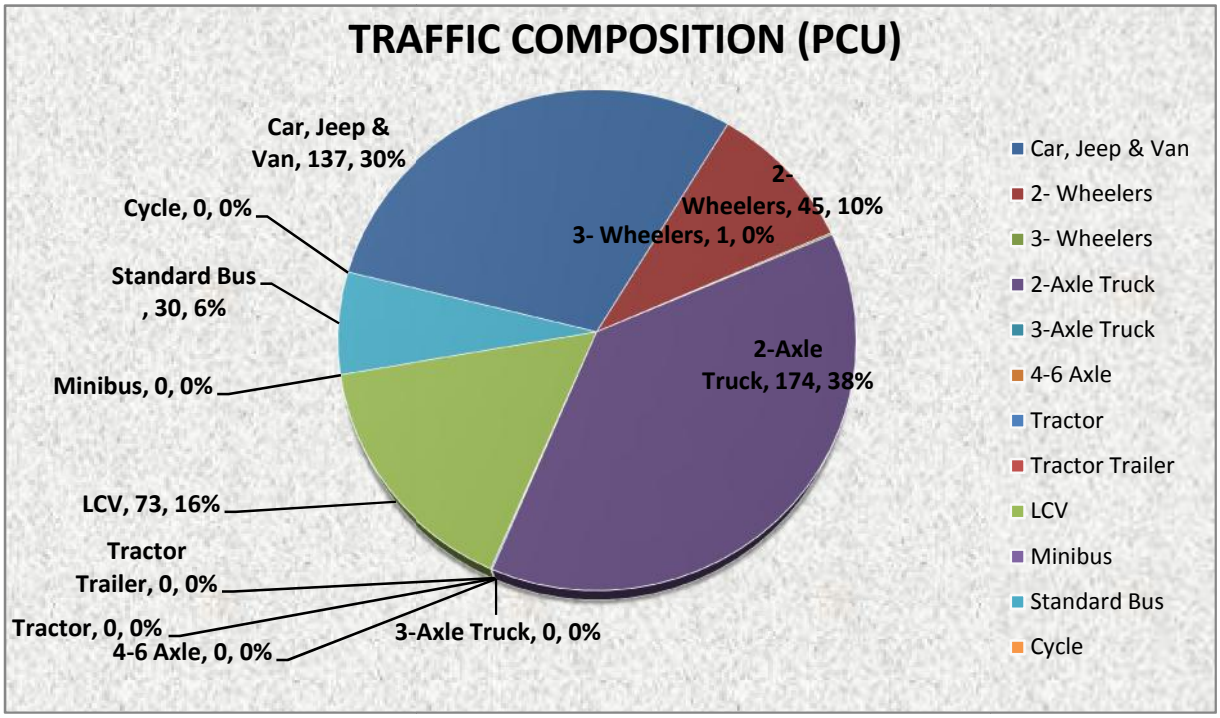



**Figure 4.11:Traffic Composition (in PCU) at Km 9.00 (Leitjynrai Road)**

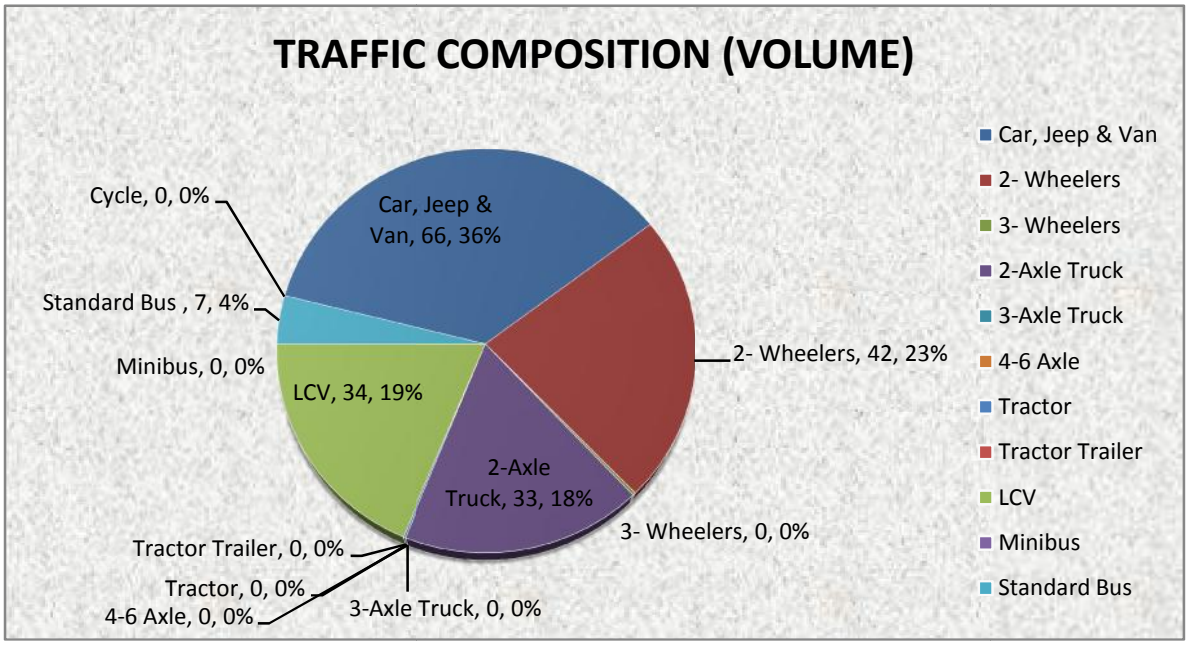



**Figure 4.12:Traffic Composition (in Volume)at Km 9.00 (Leitjynrai Road)**

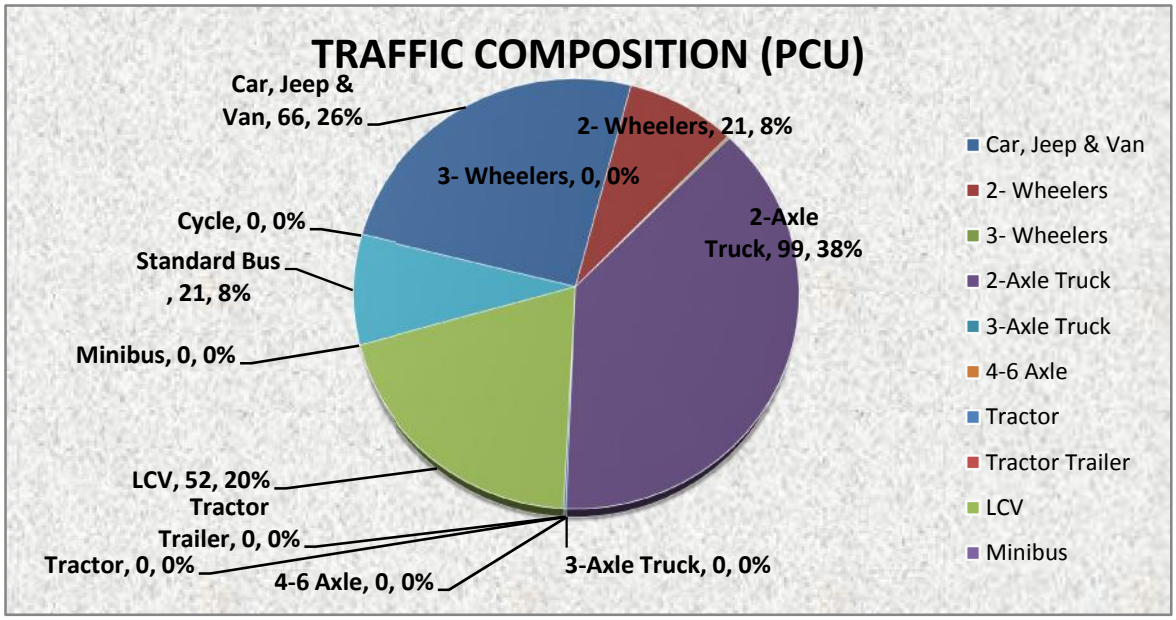



**Figure 4.13:Traffic Composition (in PCU) at Km 9.00 (Leitjynrai Road)**

**Appendix 4.1** of Volume I A: Appendices to Main Volume presents location wise traffic volume survey analysis summary sheet that comprise averaged (7 day) mode wise hourly traffic (Both Directions), as well as directional traffic flow, in terms of total vehicles and PCU, overall directional split, peak hour traffic, daily variation in traffic intensity , traffic composition, mode wise hourly variation, and other salient features

### 4.6.6 Directional Distribution

Like hourly variations, directional distribution of traffic will be useful in the Capacity and LOS analysis and in planning of various road side infrastructure facilities, etc.

The directional distribution observed at the count stations on the Project Road have been presented in **Table 4.7**.

**Table 4.7 : Directional Distribution**

| Time Interval (Hour) | | Kynron Village (Km 9.00) | | | | Marium Village (Km 34.00) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Traffic (PCU) | | Directional Distribution (%) | | Traffic (PCU) | | Directional Distribution (%) | |
| From | To | Nonstoin (Up) | Laitjynrai (Dn) | Nonstoin (Up) | Laitjynrai (Dn) | Laitjynrai (up) | Domiasiet (Dn) | Laitjynrai (up) | Domiasiet (Dn) |
| 8 | 9 | 15 | 14 | **51.72** | **48.28** | 8 | 14 | **36.4** | **63.6** |
| 9 | 10 | 19 | 17 | **52.78** | **47.22** | 8 | 10 | **44.4** | **55.6** |
| 10 | 11 | 17 | 18 | **48.57** | **51.43** | 11 | 11 | **50.0** | **50.0** |
| 11 | 12 | 16 | 20 | **44.44** | **55.56** | 9 | 10 | **47.4** | **52.6** |
| 12 | 13 | 15 | 23 | **39.47** | **60.53** | 8 | 9 | **47.1** | **52.9** |
| 13 | 14 | 17 | 20 | **45.95** | **54.05** | 9 | 9 | **50.0** | **50.0** |
| 14 | 15 | 17 | 19 | **47.22** | **52.78** | 9 | 9 | **50.0** | **50.0** |
| 15 | 16 | 17 | 18 | **48.57** | **51.43** | 12 | 10 | **54.5** | **45.5** |
| 16 | 17 | 15 | 17 | **46.88** | **53.13** | 13 | 9 | **59.1** | **40.9** |
| 17 | 18 | 14 | 14 | **50.00** | **50.00** | 12 | 9 | **57.1** | **42.9** |
| 18 | 19 | 9 | 8 | **52.94** | **47.06** | 7 | 5 | **58.3** | **41.7** |
| 19 | 20 | 8 | 7 | **53.33** | **46.67** | 6 | 4 | **60.0** | **40.0** |
| 20 | 21 | 6 | 6 | **50.00** | **50.00** | 4 | 3 | **57.1** | **42.9** |
| 21 | 22 | 4 | 4 | **50.00** | **50.00** | 2 | 3 | **40.0** | **60.0** |
| 22 | 23 | 2 | 4 | **33.33** | **66.67** | 1 | 3 | **25.0** | **75.0** |
| 23 | 0 | 1 | 1 | **50.00** | **50.00** | 1 | 1 | **50.0** | **50.0** |
| 0 | 1 | 0 | 1 | **0.00** | **100.00** | 0 | 0 | **0** | **0** |
| 1 | 2 | 0 | 0 | **0** | **0** | 0 | 0 | **0** | **0** |
| 2 | 3 | 0 | 1 | **0.00** | **100.00** | 0 | 1 | **0.0** | **100.0** |
| 3 | 4 | 1 | 1 | **50.00** | **50.00** | 1 | 1 | **50.0** | **50.0** |
| 4 | 5 | 3 | 2 | **60.00** | **40.00** | 1 | 1 | **50.0** | **50.0** |
| 5 | 6 | 9 | 6 | **60.00** | **40.00** | 4 | 5 | **44.4** | **55.6** |
| 6 | 7 | 15 | 12 | **55.56** | **44.44** | 7 | 9 | **43.8** | **56.3** |
| 7 | 8 | 19 | 15 | **55.88** | **44.12** | 8 | 11 | **42.1** | **57.9** |
| **Total** | | **239** | **248** | **45.50** | **54.49** | **141** | **147** | **42.3** | **49.3** |

### 4.6.7 Seasonal Correction

The traffic plying on any road generally varies over different periods of year depending on the cycle of different socio-economic activities in the regions through which it passes. Therefore, in order to have more realistic picture of the traffic on the project road, it is required to assess seasonal variation in traffic to estimate Annual Average Daily Traffic (AADT) and Peak Season ADT. Therefore, the ADT observed during the survey duration is multiplied by a Seasonal Correction Factor (SCF) to derive AADT and Peak season ADT. The seasonal correction factor is generally derived from secondary data sources such as past month-wise traffic data on the project road, sales of fuel at different filling stations along the project road etc.

For this project, during traffic survey it was observed that the major part of the traffic is trucks carrying coal and Stone boulders etc to their respective destinations. In rainy season due to the heavy rain the traffic movement in this area decreases significantly. The traffic increases back after Rainy season and it is learnt from local persons that the maximum

**A. Seasonal Correction Factor**

For the present study, firstly the petrol and diesel sale figures have been used from different petrol pumps on & near the project road. The petrol and diesel fuel sale data for the years 2011 & 2012 have been collected and analyzed for estimation of Average Seasonal Correction Factor (ASCF) and Peak Seasonal Correction Factor (PSCF). As the traffic surveys were conducted in the month of March, the above factors for the month of March is considered. The fuel sales figures at the filling station in the region are presented season wise in **Table 4.8**.

**Table 4.8: Summary of Seasonal Variation Factor**

| Month | Diesel | | | Petrol | | |
|---|---|---|---|---|---|---|
| | Sale (in litre) | SI * | Average Seasonal Correction Factor | Sale (in litre) | SI | Average Seasonal Correction Factor |
| *1* | *2* | *3* | *4* | *6* | *7* | *8* |
| **January** | 68,500 | 0.77 | 1.08 | 25,600 | 0.71 | 1.16 |
| **February** | 72,000 | 0.81 | 1.03 | 26,400 | 0.73 | 1.13 |
| **March** | 74,850 | 0.84 | 0.99 | 27,900 | 0.77 | 1.07 |
| **April** | 82,120 | 0.92 | 0.90 | 33,100 | 0.92 | 0.90 |
| **May** | 86,900 | 0.98 | 0.85 | 35,400 | 0.98 | 0.84 |
| **June** | 89,050 | 1.00 | 0.83 | 36,100 | 1.00 | 0.82 |
| **July** | 67,200 | 0.75 | 1.10 | 28,500 | 0.79 | 1.04 |
| **August** | 64,500 | 0.72 | 1.15 | 25,250 | 0.70 | 1.18 |
| **September** | 65,700 | 0.74 | 1.13 | 26,400 | 0.73 | 1.13 |
| **October** | 71,800 | 0.81 | 1.03 | 30,500 | 0.84 | 0.98 |

| Month | Diesel | | | Petrol | | |
|---|---|---|---|---|---|---|
| | Sale (in litre) | SI * | Average Seasonal Correction Factor | Sale (in litre) | SI | Average Seasonal Correction Factor |
| **November** | 74,000 | 0.83 | 1.00 | 32,000 | 0.89 | 0.93 |
| **December** | **71,800** | **0.81** | **1.03** | **29,800** | **0.83** | **1.00** |

** SI: Seasonal Index*

The **Average Seasonal Correction Factor (ASCF)** has been applied on the ADT observed at the count location to derive **AADT** which will be used for **pavement design and Capacity Assessment**.

From above table it can be observed that an Average Seasonal Correction Factor (ASCF) of 1.03 (i.e., increase of 3%) for vehicles runs on Diesel (like LCV, 2-Axle, 3-Axle trucks etc) & ASCF of 1.00 i.e. petrol vehicles are same without any variation.

### 4.6.8 Average Annual daily Traffic

The project corridor lies in the west Khasi hills district of state of Meghalaya. Although the traffic flow in the project corridor does not count in heavy traffic but in rainy season i.e. from July to September due to heavy rains in the area traffic flow falls significantly throughout the project corridor. Hence, a seasonal correction factor of 1.03 and 1.0 respectively for diesel and petrol driven vehicles is applied to calculate the Average Annual Daily Traffic (AADT).

**Table 4.9: Average Annual Daily Traffic (AADT) Considering average correction seasonal factor**

| Vehicle Type | Kynron Village (Km 9.00) | Marium Village (Km 34.00) |
|---|---|---|
| Two Wheeler | 107 | 60 |
| Auto Rickshaw | 4 | 2 |
| Car / Jeep / Van | 163 | 87 |
| Tempo | 0 | 0 |
| Mini / RTVs Bus | 0 | 0 |
| Standard Bus | 16 | 13 |
| Light Commercial Vehicle | 65 | 54 |
| 2-Axle | 78 | 55 |
| **Total Motorized Vehicles (Number)** | **433** | **271** |
| **Total Motorized Vehicles (PCU)** | **601** | **404** |
| **Total PCU per day** | **601** | **404** |

Note: Non motorized vehicles not seen in the project corridor during the traffic survey.

### 4.6.9 Intersection Turning Movement Counts

. Intersection turning movement surveys were carried out at the identified 2 intersections on the project road. The locations considered for intersection turning movement surveys is as described earlier. For ready reference these are listed again below.

1. Laitawasnai - Km 20+775 3 legged
2. Wahkaji – Km 40+100 3 legged

Classified directional turning movements were counted at each of the above two intersections for one day (08 hrs) on a working day. Trained enumerators, under careful supervision of Transport Planners, have carried out these surveys.

The details on the turning movement counts are given in **Appendix: 4.2**.

The peak hour flows (in vehicles and PCUs) have been presented in **Figures 4.14** & **4.15.**

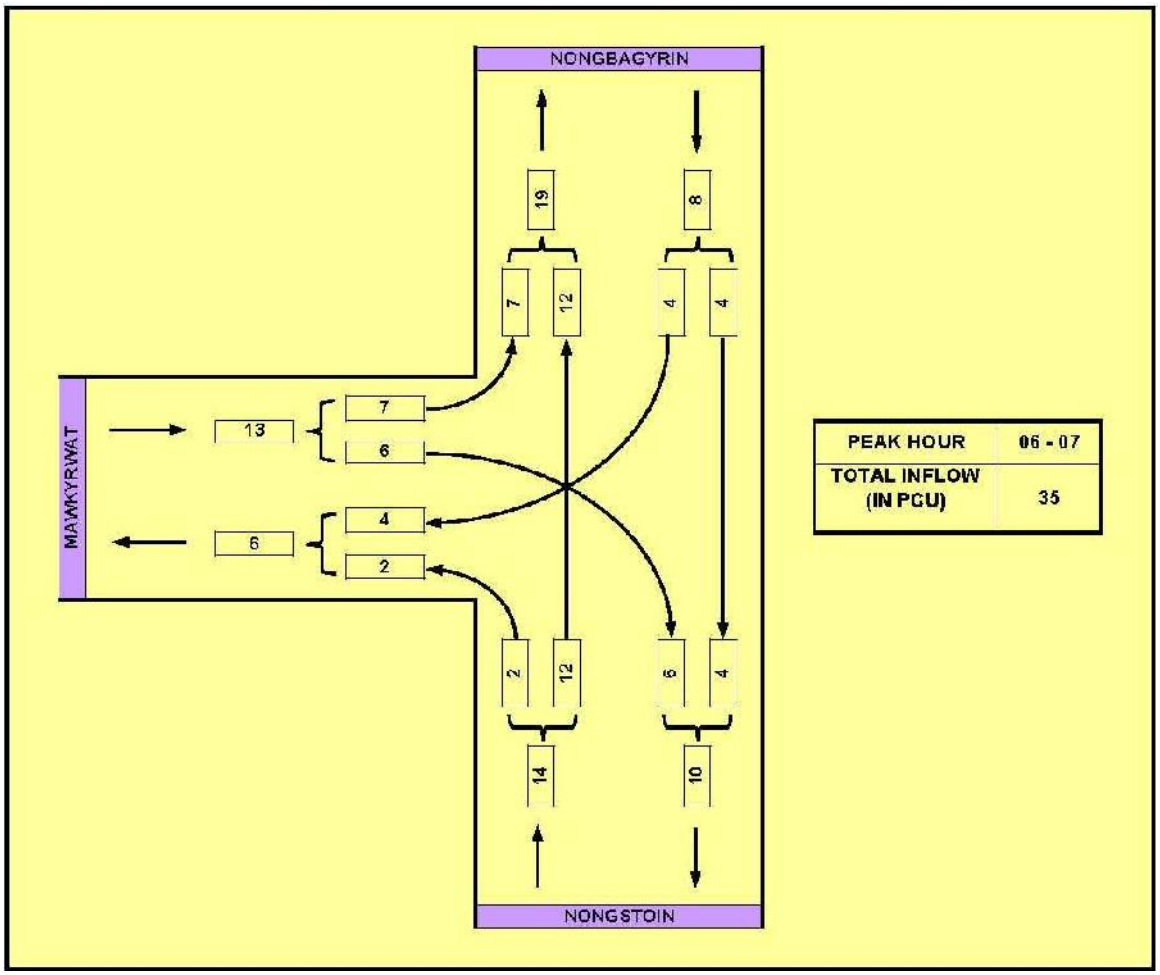



**Fig 4.14 : Peak Hour Flow Diagram PCU per hour at Laitsawsnai More (20+775)**

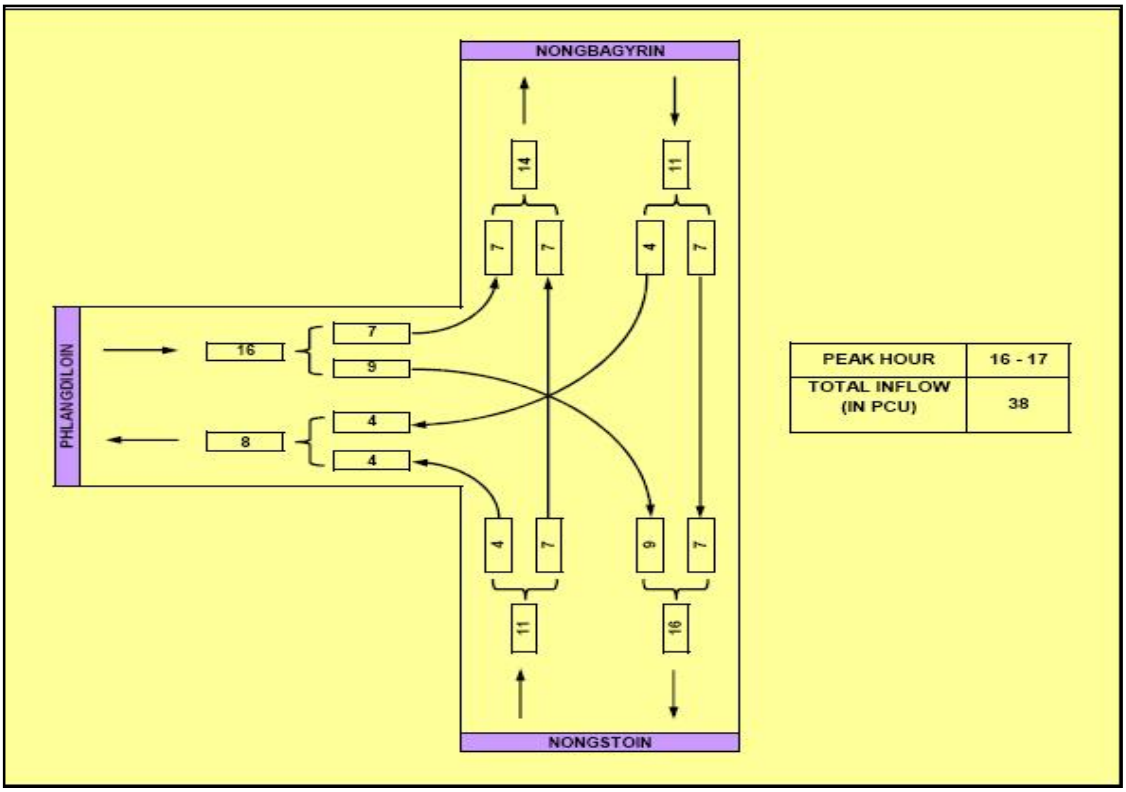
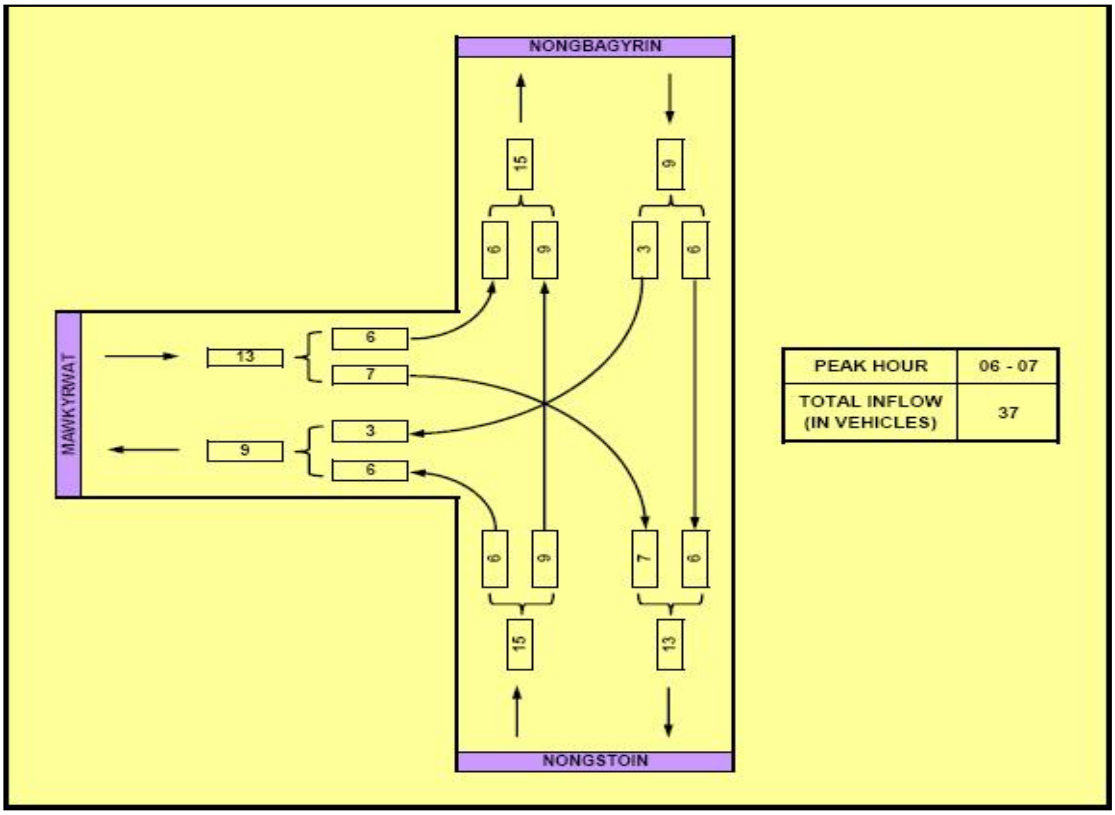



**Fig 4.15 : Peak Hour Flow Diagram in PCUs per Hour at Wahkaji (43+100)**



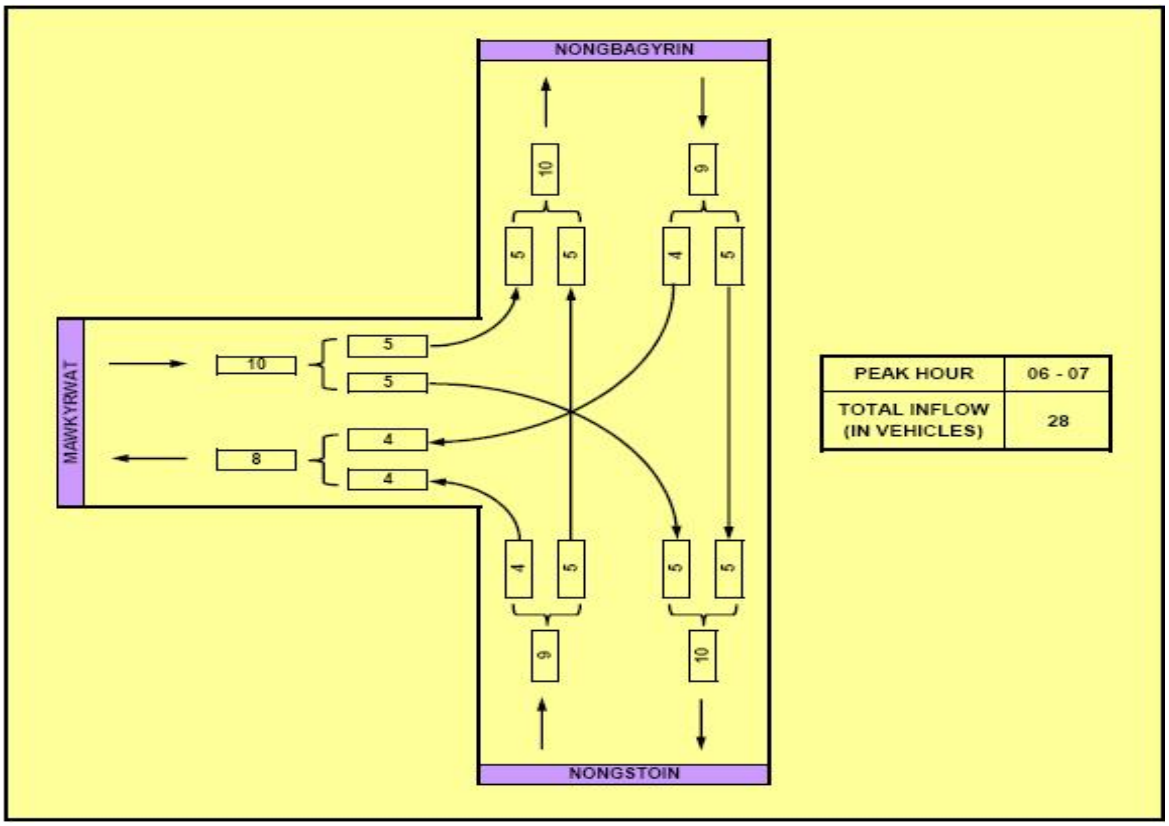



**Fig 4.17: Peak Hour Flow Diagram Vehicle per hour at Wahkaji (43+100)**

### 4.6.10 Forecasts of Intersection Turning Movements

The peak hour turning movements at various major junctions on the Project Road (presented earlier in Section 1.3.4) have been forecasted. These forecasts consider the likely growth in the traffic at intersections. Forecasts of peak hour intersection turning movements are given in IRC: 92-1985 9, Section 3, specifies warrants for providing grade separation. Since the Project Road will not be developed to expressway standards or with full access control, grade separators are needed when the total peak hour traffic at a junction exceeds 10,000 PCUs/hr. The following table shows that the peak hour intersection flow doesn't reach 10,000 PCUs/hr for any locations.

**Table 4.10 : Summary of Peak Hour Intersection Flows**

| Sl.No. | Name of Intersection | Total Jn Peak Hr Flow | |
|---|---|---|---|
| | | Number | PCU |
| 1 | Laitsawsnai Junction (Km 20+775) | 37 | 35 |
| 2 | Eahkaji Junction ( Km 43+100) | 28 | 38 |

## 4.7 Traffic Projection

It is always a tough task to predict traffic volume levels for future years considering uncertainties as persisted in the past and as perceived in the future. These uncertainties are in policy, investment priorities, etc and hence on overall growth patterns. The investment priorities as known are governed by various factors apart from the demand, assessed benefits, and cost of the project. Demand is a factor governing which type of facility / infrastructure is to be created. This in turn determines likely benefits and costs to develop the same. A road project of this nature calls for significant investment. Prediction of traffic demand hence becomes an important task and has to be carried out accurately. The estimation of traffic forms the basis for the design of the facility and governs the viability of the project. Recognizing this, efforts are made to carefully assess all the parameters that govern the traffic demand in the future. It is also important to note that no prediction should ignore different techniques and different scenarios at a broader level. Therefore, the following sections discuss traffic projections based on different techniques and considerations. The theme of different considerations in any technique remains to relate economic growth with vehicular growth. For traffic forecast Econometric Model (as suggested in IRC: 108, 1996) is adopted for present project.

**Econometric Model**

This model is based on the IRC: 108-1996 guidelines. It suggests relating traffic with GDP of State. Past GDP has been collected from the Economic Survey, Government of India. The model was constructed based on traffic data available for each of the two locations and time series GDP in Crore Rs. separately. The model for predicting elasticity values for the project corridor is given below:

$$Ln(P) = m \times Ln(GDP) + A$$

Where, P = Traffic volume (Mode wise)

GDP = Gross Domestic Product (in Rs. Crore)

A = Regression Constant

m = Elasticity coefficient (Regression Coefficient)

The Elasticity Coefficient is the factor by which the GDP growth has been multiplied to arrive at the growth rate of future traffic by mode as shown in equations (Table 5.9). As suggested we also found that the GDP growth rate as single independent variable is not appropriate and this calls for micro level approach using state NSDPs.

The traffic growth of each type of vehicle has been related to the following factors:

(a) Passenger Vehicles : Population growth and Per Capita Income Growth rate;

(b) Freight Vehicles : Avg. Growth rate for Agricultural and Industrial Sector

1. Traffic projections for Passenger Vehicles were done using the formula:

$$= \left[\left(1+\frac{p}{100}\right)\left(1+\frac{R}{100}\right)-1\right] X\, 100 X\, E$$

Where:
P - growth rate of population
R - growth rate of per capita NSDP &
E - elasticity

2. Traffic projections for Goods Vehicles were done using the formula:

$$= \left[\left(1+\frac{A}{100}\right)\left(1+\frac{G}{100}\right)-1\right] x\ 100 x\ E$$

Where: A - growth rate of Agriculture & Industrial Sector,
G - Growth rate of GDP,
E - Elasticity

After analyzing the past trend of GDP growth rate, predicted GDP growth rate per annum as an input to Econometric model for different time periods are as follows:

| Time Period | 2012-2017 | 2017-2022 | 2022-2027 | 2027-2032 | 2032-2037 | 2037-2042 |
|---|---|---|---|---|---|---|
| Annual Average GDP Growth Rate | 6.0% | 7.0% | 7.5% | 7.5% | 6.0% | 5.0% |

### 4.7.1 Transport Demand Elasticity

Long term forecasting of the project road traffic, during the time horizon of the study, is required for designing highway and assessing the economic viability of the proposed investment for improving the facility. In view of this, the projecting future traffic incorporates analysis of some of the key socio-economic characteristics and rate of change expected during the study period in the project influence area.
Estimation of elasticity values for Passenger Vehicles & Freight vehicles based on NSDP & GDP sector wise is given in **Table 4.11.**

**Table 4.11: Elasticity Values of Vehicles**

| Vehicle Category | 2012-2020 | Explanatory Variable | 2020-2030 | 2030-2040 | Beyond 2040 |
|---|---|---|---|---|---|
| Two Wheeler | 1.15 | PCI | 1.05 | 0.97 | 0.90 |
| Three Wheeler | 1.24 | PCI | 1.15 | 1.02 | 0.99 |
| Jeep/ Car/ Taxi | 1.02 | PCI | 0.98 | 0.84 | 0.80 |
| Bus & Minibus | 2.85 | POP | 2.36 | 2.09 | 2.04 |
| Goods vehicle | 0.60 | NSDP | 0.55 | 0.65 | 0.60 |

Using the model coefficient and predicted growth rate of GDP, vehicle-wise growth rate adopted for different locations and for different time perspective are shown in Table 4.11. As a result of variations in elasticity for different vehicle type, growth rates for individual vehicle type also varying to significant extent. But at this stage they are not moderated.

**Table 4.12 : Location wise Predicted Growth Rates for all modes**

| Vehicle Type | 2012- 2017 | 2017- 2022 | 2022- 2027 | 2027-2032 | Beyond 2032 |
|---|---|---|---|---|---|
| Two Wheeler | 8.5 | 8.2 | 7.8 | 7.2 | 5.8 |
| Three Wheeler | 2.9 | 2.6 | 2.4 | 2.1 | 2.0 |
| Car / Jeep / Taxi | 8.6 | 8.2 | 7.7 | 7.1 | 6.7 |
| Bus / Mini Bus | 3.1 | 2.9 | 2.6 | 2.35 | 2.1 |
| Goods Vehicles | 10.2 | 11.9 | 12.8 | 11.7 | 11.2 |

For predicting tractor (local traffic), a growth rate of 3% has been adopted as given in IRC: 102-1998. The traffic growth rate of Non-motorized vehicles is also assumed to be 3% per annum to the year 2024 and, thereafter 1% per annum.

### 4.7.2 Traffic Forecast

The traffic on the project road observed during Traffic survey is very less for its up-gradation from single lane to two lane configuration. But it is noted that the project road is the only road going to Domiasiat (Mawthabah) where Uranium is found. A big setup is planned near Domiasiat for extraction of Uranium in near future. It is assumed that after construction of Uranium Extraction plant, traffic on the project road will increases significantly.

A) **Section I from Km 0.00 to Km 20.00 (Nongstoin to Leitjynrai)** – For this Section of project road it is assumed that the total traffic volume will be increased by three times of the present traffic as well as some new categories of vehicles (3-Axle and MAVs) would also start flowing on the project road due to presence of Uranium Extraction plant in Domiasiat.

B) **Section II & Section III ( Leitjynrai to Nongbajynrin via Wakhaji)** – For this section of project road it is assumed that the total traffic volume will be increased by four times of the present traffic(which is very less), as well as some new categories of vehicles( 3-Axle and MAVs) would also start flowing on the project road due to presence of Uranium Extraction plant in Domiasiat.

The Annual Average Daily Traffic (AADT) is projected using the growth rate mentioned in Table 5.10.

*The Projected traffic considering different Scenario for CTVC at Kynron Village (Km 9.00) and at Marium Village (Km 34.00) is given in the table from* ***Table 4.13*** *&****Table 4.14 .***

**Table 4.13: Projected Traffic (Vehicles/day) for Location I (Km 9.00)**

| Year | Two Wheeler | Auto Rickshaw | Car / Jeep / Van | Tempo | Mini / RTVs | Standard Bus | LCV | 2-Axle | 3-Axle | MAV | Agriculture Tractor | Agriculture Tractor with Trailer | Animal / Hand Drawn Vehicles | Cycle | Cycle Rickshaw | Others | Total Vehicle | Total PCU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2012** | 107 | 4 | 163 | 0 | 0 | 16 | 65 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **433** | **600** |
| **2013** | 117 | 5 | 178 | 0 | 0 | 17 | 72 | 86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **475** | **659** |
| **2014** | 478 | 21 | 728 | 0 | 0 | 70 | 295 | 352 | 180 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | **2264** | **3867** |
| **2015** | 519 | 23 | 790 | 0 | 0 | 76 | 321 | 382 | 196 | 152 | 0 | 0 | 0 | 0 | 0 | 0 | **2459** | **4200** |
| **2016** | 661 | 28 | 1007 | 0 | 0 | 93 | 415 | 493 | 253 | 197 | 0 | 0 | 0 | 0 | 0 | 0 | **3147** | **5392** |
| **2017** | 718 | 29 | 1094 | 0 | 0 | 96 | 458 | 544 | 279 | 218 | 0 | 0 | 0 | 0 | 0 | 0 | **3436** | **5907** |
| **2018** | 780 | 30 | 1189 | 0 | 0 | 99 | 505 | 600 | 308 | 241 | 0 | 0 | 0 | 0 | 0 | 0 | **3752** | **6472** |
| **2019** | 844 | 31 | 1287 | 0 | 0 | 102 | 566 | 672 | 345 | 270 | 0 | 0 | 0 | 0 | 0 | 0 | **4117** | **7161** |
| **2020** | 914 | 32 | 1393 | 0 | 0 | 105 | 634 | 752 | 387 | 303 | 0 | 0 | 0 | 0 | 0 | 0 | **4520** | **7929** |
| **2021** | 989 | 33 | 1508 | 0 | 0 | 109 | 710 | 842 | 434 | 340 | 0 | 0 | 0 | 0 | 0 | 0 | **4965** | **8786** |
| **2022** | 1071 | 34 | 1632 | 0 | 0 | 113 | 795 | 943 | 486 | 381 | 0 | 0 | 0 | 0 | 0 | 0 | **5455** | **9735** |
| **2023** | 1155 | 35 | 1758 | 0 | 0 | 116 | 897 | 1064 | 549 | 430 | 0 | 0 | 0 | 0 | 0 | 0 | **6004** | **10838** |
| **2024** | 1246 | 36 | 1894 | 0 | 0 | 120 | 1012 | 1201 | 620 | 486 | 0 | 0 | 0 | 0 | 0 | 0 | **6615** | **12081** |
| **2025** | 1344 | 37 | 2040 | 0 | 0 | 124 | 1142 | 1355 | 700 | 549 | 0 | 0 | 0 | 0 | 0 | 0 | **7291** | **13470** |
| **2026** | 1449 | 38 | 2198 | 0 | 0 | 128 | 1289 | 1529 | 790 | 620 | 0 | 0 | 0 | 0 | 0 | 0 | **8041** | **15025** |

| Year | Two Wheeler | Auto Rickshaw | Car / Jeep / Van | Tempo | Mini / RTVs | Standard Bus | LCV | 2-Axle | 3-Axle | MAV | Agriculture Tractor | Agriculture Tractor with Trailer | Animal / Hand Drawn Vehicles | Cycle | Cycle Rickshaw | Others | Total Vehicle | Total PCU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2027** | 1563 | 39 | 2368 | 0 | 0 | 132 | 1454 | 1725 | 892 | 700 | 0 | 0 | 0 | 0 | 0 | 0 | **8873** | **16767** |
| **2028** | 1676 | 40 | 2537 | 0 | 0 | 136 | 1625 | 1927 | 997 | 782 | 0 | 0 | 0 | 0 | 0 | 0 | **9720** | **18552** |
| **2029** | 1797 | 41 | 2718 | 0 | 0 | 140 | 1816 | 2153 | 1114 | 874 | 0 | 0 | 0 | 0 | 0 | 0 | **10653** | **20536** |
| **2030** | 1927 | 42 | 2911 | 0 | 0 | 144 | 2029 | 2405 | 1245 | 977 | 0 | 0 | 0 | 0 | 0 | 0 | **11680** | **22739** |
| **2031** | 2066 | 43 | 3118 | 0 | 0 | 148 | 2267 | 2687 | 1391 | 1092 | 0 | 0 | 0 | 0 | 0 | 0 | **12812** | **25187** |
| **2032** | 2215 | 44 | 3340 | 0 | 0 | 152 | 2533 | 3002 | 1554 | 1220 | 0 | 0 | 0 | 0 | 0 | 0 | **14060** | **27905** |
| **2033** | 2344 | 45 | 3564 | 0 | 0 | 156 | 2817 | 3339 | 1729 | 1357 | 0 | 0 | 0 | 0 | 0 | 0 | **15351** | **30785** |
| **2034** | 2480 | 46 | 3803 | 0 | 0 | 160 | 3133 | 3713 | 1923 | 1509 | 0 | 0 | 0 | 0 | 0 | 0 | **16767** | **33967** |
| **2035** | 2624 | 47 | 4058 | 0 | 0 | 164 | 3484 | 4129 | 2139 | 1679 | 0 | 0 | 0 | 0 | 0 | 0 | **18324** | **37495** |
| **2036** | 2777 | 48 | 4330 | 0 | 0 | 168 | 3875 | 4592 | 2379 | 1868 | 0 | 0 | 0 | 0 | 0 | 0 | **20037** | **41402** |
| **2037** | 2939 | 49 | 4621 | 0 | 0 | 172 | 4309 | 5107 | 2646 | 2078 | 0 | 0 | 0 | 0 | 0 | 0 | **21921** | **45729** |
| **2038** | 3110 | 50 | 4931 | 0 | 0 | 176 | 4792 | 5679 | 2943 | 2311 | 0 | 0 | 0 | 0 | 0 | 0 | **23992** | **50518** |
| **2039** | 3291 | 51 | 5262 | 0 | 0 | 180 | 5329 | 6316 | 3273 | 2570 | 0 | 0 | 0 | 0 | 0 | 0 | **26272** | **55824** |
| **2040** | 3482 | 53 | 5615 | 0 | 0 | 184 | 5926 | 7024 | 3640 | 2858 | 0 | 0 | 0 | 0 | 0 | 0 | **28782** | **61703** |
| **2041** | 3684 | 55 | 5992 | 0 | 0 | 188 | 6590 | 7811 | 4048 | 3179 | 0 | 0 | 0 | 0 | 0 | 0 | **31547** | **68221** |
| **2042** | 3898 | 57 | 6394 | 0 | 0 | 192 | 7329 | 8686 | 4502 | 3536 | 0 | 0 | 0 | 0 | 0 | 0 | **34594** | **75446** |

**Table 4.14: Projected Traffic (Vehicles/day) for Location II (Km 34.00)**

| Year | Two Wheeler | Auto Rickshaw | Car / Jeep / Van | Tempo | Mini / RTVs | Standard Bus | LCV | 2-Axle | 3-Axle | MAV | Agriculture Tractor | Agriculture Tractor with Trailer | Animal / Hand Drawn Vehicles | Cycle | Cycle Rickshaw | Others | Total Vehicle | Total PCU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2012** | 60 | 2 | 87 | 0 | 0 | 13 | 54 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **271** | **404** |
| **2013** | 66 | 3 | 95 | 0 | 0 | 14 | 60 | 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **299** | **446** |
| **2014** | 336 | 16 | 484 | 0 | 0 | 72 | 306 | 311 | 180 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | **1845** | **3446** |
| **2015** | 365 | 18 | 526 | 0 | 0 | 79 | 333 | 338 | 196 | 152 | 0 | 0 | 0 | 0 | 0 | 0 | **2007** | **3749** |
| **2016** | 465 | 22 | 671 | 0 | 0 | 97 | 430 | 437 | 253 | 197 | 0 | 0 | 0 | 0 | 0 | 0 | **2572** | **4818** |
| **2017** | 505 | 23 | 729 | 0 | 0 | 101 | 474 | 482 | 279 | 218 | 0 | 0 | 0 | 0 | 0 | 0 | **2811** | **5283** |
| **2018** | 548 | 24 | 792 | 0 | 0 | 105 | 523 | 532 | 308 | 241 | 0 | 0 | 0 | 0 | 0 | 0 | **3073** | **5794** |
| **2019** | 593 | 25 | 857 | 0 | 0 | 109 | 586 | 596 | 345 | 270 | 0 | 0 | 0 | 0 | 0 | 0 | **3381** | **6423** |
| **2020** | 642 | 26 | 928 | 0 | 0 | 113 | 656 | 667 | 387 | 303 | 0 | 0 | 0 | 0 | 0 | 0 | **3722** | **7124** |
| **2021** | 695 | 27 | 1005 | 0 | 0 | 117 | 735 | 747 | 434 | 340 | 0 | 0 | 0 | 0 | 0 | 0 | **4100** | **7906** |
| **2022** | 752 | 28 | 1088 | 0 | 0 | 121 | 823 | 836 | 486 | 381 | 0 | 0 | 0 | 0 | 0 | 0 | **4515** | **8770** |
| **2023** | 811 | 29 | 1172 | 0 | 0 | 125 | 929 | 944 | 549 | 430 | 0 | 0 | 0 | 0 | 0 | 0 | **4989** | **9789** |
| **2024** | 875 | 30 | 1263 | 0 | 0 | 129 | 1048 | 1065 | 620 | 486 | 0 | 0 | 0 | 0 | 0 | 0 | **5516** | **10932** |
| **2025** | 944 | 31 | 1361 | 0 | 0 | 133 | 1183 | 1202 | 700 | 549 | 0 | 0 | 0 | 0 | 0 | 0 | **6103** | **12214** |
| **2026** | 1018 | 32 | 1466 | 0 | 0 | 137 | 1335 | 1356 | 790 | 620 | 0 | 0 | 0 | 0 | 0 | 0 | **6754** | **13649** |

| Year | Two Wheeler | Auto Rickshaw | Car / Jeep / Van | Tempo | Mini / RTVs | Standard Bus | LCV | 2-Axle | 3-Axle | MAV | Agriculture Tractor | Agriculture Tractor with Trailer | Animal / Hand Drawn Vehicles | Cycle | Cycle Rickshaw | Others | Total Vehicle | Total PCU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2027** | 1098 | 33 | 1579 | 0 | 0 | 141 | 1506 | 1530 | 892 | 700 | 0 | 0 | 0 | 0 | 0 | 0 | **7479** | **15259** |
| **2028** | 1178 | 34 | 1692 | 0 | 0 | 145 | 1683 | 1710 | 997 | 782 | 0 | 0 | 0 | 0 | 0 | 0 | **8221** | **16915** |
| **2029** | 1263 | 35 | 1813 | 0 | 0 | 149 | 1880 | 1911 | 1114 | 874 | 0 | 0 | 0 | 0 | 0 | 0 | **9039** | **18755** |
| **2030** | 1354 | 36 | 1942 | 0 | 0 | 153 | 2100 | 2135 | 1245 | 977 | 0 | 0 | 0 | 0 | 0 | 0 | **9942** | **20801** |
| **2031** | 1452 | 37 | 2080 | 0 | 0 | 157 | 2346 | 2385 | 1391 | 1092 | 0 | 0 | 0 | 0 | 0 | 0 | **10940** | **23075** |
| **2032** | 1557 | 38 | 2228 | 0 | 0 | 161 | 2621 | 2665 | 1554 | 1220 | 0 | 0 | 0 | 0 | 0 | 0 | **12044** | **25606** |
| **2033** | 1648 | 39 | 2378 | 0 | 0 | 165 | 2915 | 2964 | 1729 | 1357 | 0 | 0 | 0 | 0 | 0 | 0 | **13195** | **28294** |
| **2034** | 1744 | 40 | 2538 | 0 | 0 | 169 | 3242 | 3296 | 1923 | 1509 | 0 | 0 | 0 | 0 | 0 | 0 | **14461** | **31268** |
| **2035** | 1846 | 41 | 2709 | 0 | 0 | 173 | 3606 | 3666 | 2139 | 1679 | 0 | 0 | 0 | 0 | 0 | 0 | **15859** | **34572** |
| **2036** | 1954 | 42 | 2891 | 0 | 0 | 177 | 4010 | 4077 | 2379 | 1868 | 0 | 0 | 0 | 0 | 0 | 0 | **17398** | **38230** |
| **2037** | 2068 | 43 | 3085 | 0 | 0 | 181 | 4460 | 4534 | 2646 | 2078 | 0 | 0 | 0 | 0 | 0 | 0 | **19095** | **42286** |
| **2038** | 2188 | 44 | 3292 | 0 | 0 | 185 | 4960 | 5042 | 2943 | 2311 | 0 | 0 | 0 | 0 | 0 | 0 | **20965** | **46780** |
| **2039** | 2315 | 45 | 3513 | 0 | 0 | 189 | 5516 | 5607 | 3273 | 2570 | 0 | 0 | 0 | 0 | 0 | 0 | **23028** | **51762** |
| **2040** | 2450 | 46 | 3749 | 0 | 0 | 193 | 6134 | 6235 | 3640 | 2858 | 0 | 0 | 0 | 0 | 0 | 0 | **25305** | **57286** |
| **2041** | 2593 | 47 | 4001 | 0 | 0 | 198 | 6822 | 6934 | 4048 | 3179 | 0 | 0 | 0 | 0 | 0 | 0 | **27822** | **63423** |
| **2042** | 2744 | 48 | 4270 | 0 | 0 | 203 | 7587 | 7711 | 4502 | 3536 | 0 | 0 | 0 | 0 | 0 | 0 | **30601** | **70231** |

## 4.8 Capacity Analysis

Capacity and Design Service Volumes (DSV) specified in IRC-73-1980 vide Table No.10 for capacity of different types of roads, is reproduced as **Table 4.15** below.

**Table 4.15: Capacity of different types of roads**

| Sr.No. | Type of Road | Capacity (PCU per day in both directions) |
|---|---|---|
| 1 | Single –lane roads having a 3.75 m wide carriageway with normal earthen shoulders | 1,000 |
| 2 | Single – lane having 3.75 m wide carriageway with adequate designed hard shoulders 1.0 m wide | 2,500 |
| 3 | Two lane roads having a 7 m wide carriageway with normal earthen shoulders | 10,000 |
| 4 | Road intermediate width i.e. having a carriageway of 5.5 meters with normal earthen shoulders | 5,000 |

*Source: Table 10, P. No. 14, IRC:73-1980*

### 4.8.1 Assessment of Prevailing Capacity Level

The projected sectional traffic is compared with DSV to assess the up-gradation requirement for the corridor under prevailing roadway conditions. Capacity augmentation is generally warranted for roads that cater to traffic volumes in excess of the DSV at LOS B. The present study considers making available the upgraded facility to road users by the time the road starts observing LOS B.

**Table 4.16: Assessment of up-gradation requirement**

| Section | Chainage | | Length (Kms) | Terrain | Based on 2 Lane with Earthern Shoulders LOS "B " exceed in year |
|---|---|---|---|---|---|
| | From | To | | | |
| Sec 1 | Km. 0.00 | Km. 20+000 | 20.000 | Hilly | 2016 |
| Sec 2 & 3 | Km 20+000 | Km 58+100 | 38.100 | Hilly | 2017 |

From **Table 4.16**, it can be inferred that the for both the sections of Project road the requirement of Two lane facility with Earthen shoulder falls in approximately same year. Hence the construction of two lane road with earthen shoulder is proposed on / before Year 2016.

# 5.0 DESIGN STANDARDS

## 5.1 General

Geometric design of a road is the process whereby the layout of the road in specific terrain is designed to meet the needs of the road users keeping in view the road function, type and volume of traffic, potential traffic hazards and safety as well as convenience of the road users. The principal geometrical features for fulfillment of this objective are- the horizontal alignment, vertical alignment and the road cross-section.

The Public Work Department (Roads), Government of Meghalaya, intend to undertake widening to 2-lane and improvement of about 66 km length of **MDR-17** from **Nongstoin town** to **Laitsawsnai via Nongkhyllam, Nonglwai, Pambriew etc.** and **MDR-20** from **Laitsawsnai via Umdohlun and Wahkaji** in the West Khasi Hill District of State of Meghalaya to augment capacity of the road, with enhanced safety features under **SARDP-NE Scheme** of **Ministry of Road Transport and Highways, Government of India**.

The project road encompasses complete MDR-17 (25 Kms) from Nongstoin to Laitsawsnai. Thereafter it joins MDR-20 at its chainage at Km.46 and follows up to Km.68 at Wahkaji (22 Kms.) where MDR-20 terminates. The project road thereafter follows Uranium Corporation (India) Ltd. (UCIL) road for a length of 19 Kms. approximately.

The Consultants have referred to the latest IRC publications and MoRT&H circulars regarding design standards. After careful review of all available data and requirements of the project road the proposed Design Standards for adoption on the project road have been recommended.

## 5.2 Terrain Classification

Terrain is classified by general slope of the country across the project highway alignment, for which the criteria given in Table – 2.1 below have been followed. While classifying the terrain, short isolated stretches of varying terrain were not taken into consideration.

**Table 5.1: Basis of Terrain Classification**

| Sl. No. | Terrain Classification | Percentage Cross Slope of the Country |
|---|---|---|
| 1. | Plain | 0-10 |
| 2. | Rolling | 10-25 |
| 3. | Mountainous or Hilly | 25-60 |
| 4. | Steep | Greater than 60 |

After evaluation of terrain of the project road in the basis of the criteria mentioned in Table -5.1 above, it was found that the terrain for most of the project road is hilly.

## 5.2 Deisgn Speed

For geometric design of the road, design speed is used as primary index that links road function, traffic flow and terrain to the design patterns of sight distance and curvature to ensure that a driver is presented with a reasonable and consistent operating environment. The design speed should correspond to general topography and adjacent land use. The speed selected for design should also *cater to travel needs and habits of nearly all the road users.* The present project road is of MDR category & normally designed for speed as per details given in Table 5.2, however depending on site constraints at some places a lower speed is adopted.

The design speed corresponding to the type of terrain as per IRC: 73-1980, design guidelines are as follows:

**Table 5.2: Design Speed Standards**

| S. No. | Road Classification | Design Speed, Km/h | | | |
|---|---|---|---|---|---|
| | | Rolling Terrain | | Mountainous Terrain | |
| | | Ruling Design Speed | Minimum Design Speed | Ruling Design Speed | Minimum Design Speed |
| 1 | National and State Highways | 80 | 65 | 50 | 40 |
| 2 | Major District Roads | 65 | 50 | 40 | 30 |

*Source: IRC 73-1980*

Assuming a diverse mix of traffic on the project road and its importance, a ruling design speed according to Serial no.1 of Table 5.2 is proposed to be adopted. Use of speed advisory signs is proposed at locations such as sharp curves where design speed cannot be maintained and a lower design speed up to 20 km/hr is adopted. These values are considered logical from safety point of view for driving heavy commercial vehicles over short distances.

## 5.3 Cross Sectional Elements

### 5.3.1 Carriageway Width

5.3.1.1 Adequate roadway width is the pre-requisite for accommodating the required number of traffic lanes and for operational safety in respect of road structure and road function. As specified in the IRC 73-1980. 7.0 m carriageway width is proposed for the project road.

### 5.3.2 Pavement Camber (Cross-fall)

5.3.2.1 IRC: 73-1980 recommends the following camber for various surface types:

**Table 5.2: Provision for Cross fall**

| Surface Type | Camber |
|---|---|
| High Type Bituminous Surfacing | 1.7% - 2.0% |
| Thin Bituminous Surfacing | 2.0% - 2.5% |
| Water Bound Macadam, Gravel | 2.5% - 3.0% |
| Earth | 3.0% - 4.0% |

5.3.2.2 Though high type of bituminous surfacing is expected, considering mixed traffic conditions, the Consultants propose to provide a camber of 2.5% for the main carriageway as well as paved shoulders and 3.5% for the unpaved shoulder.

### 5.3.3 Right of Way

5.3.1.1 IRC: 73-1980 has specified following Right-of Way for different categories of roads:

**Table 5.3: Provision for ROW**

| S.No | Road Classification | Plain and rolling terrain | | | | Mountainous Terrain | |
|---|---|---|---|---|---|---|---|
| | | Open areas | | Built-up areas | | Open areas | Built-up areas |
| | | Normal | Range | Normal | Range | Normal | Normal |
| 1 | National & State Highways | 45 | 30-60 | 45 | 30-60 | 24 | 20 |
| 2 | Major District Roads | 25 | 25-30 | 20 | 15-25 | 18 | 15 |

Considering the category of project road (MDR) in hilly terrain, the 18 m Right of way (ROW) is proposed, however, it is learnt that present ROW of the project road is between 24 – 30 m, so requirement for further acquisition of land is not required.

### 5.3.4 Side Slopes

5.3.4.1 A slope of 1 vertical: 2 horizontal are proposed to be adopted in general. For high embankments (height of fill exceeding 6m), side slopes would be governed by the design requirements.

| | |
|---|---|
| Embankment | 2 H: 1V |
| High Embankment (>6m height) | as per design |

## 5.4 Horizontal Alignment

### 5.4.1 General

5.4.1.1 For balance in road design all geometrical elements should be determined for consistent operation under the design speed. Therefore, a horizontal alignment should be as smooth and consistent as possible with the surrounding topography.

### 5.4.2 Sight Distances

5.4.2.1 Visibility is an important requirement for the safety of travel on roads. For this, it is necessary that sight distance of adequate length should be available in different situations to permit drivers enough time and distance to control their vehicles so that there are no unwarranted accidents.

5.4.2.2 Sight distance is a direct function of the design speed. Minimum stopping sight distance must be provided as a safety requirement. On divided roads the design should correspond at least to Stopping Sight Distance which is the clear distance ahead needed by a driver to bring his vehicle to a stop before meeting a stationary object in his path. On undivided carriageway as of two-lane road, the design should preferably correspond to overtaking sight distance or at least intermediate sight distance.

5.4.2.3 Stopping Sight Distance is a sum of two distances; the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied and the distance required to stop the vehicle from the instant brake application begins. These two distances are referred to as brake reaction distance and braking distance respectively. Intermediate sight distance is two times the safe stopping sight distance.

Safe stopping distances corresponding to various design speeds are given below:

**Table 5.4 : Sight Stopping Distance Criteria**

| Design Speed (Km/h) | Safe Stopping Sight Distance (m) | | |
|---|---|---|---|
| | Perception & Brake Reaction | Braking | Total Distance |
| 20 | 14 | 4 | 18 |
| 25 | 18 | 6 | 24 |
| 30 | 21 | 9 | 30 |
| 40 | 28 | 17 | 45 |
| 50 | 35 | 27 | 62 |
| 60 | 42 | 39 | 81 |

It is desirable to design the road for more liberal values for operational convenience and better appearance of the road. The Consultants propose to adopt following values:

**Table 5.5 : Adopted Sight Distances**

| Design Speed (Km/h) | Stopping Sight Distance (m) | Intermediate Sight Distance (m) | Overtaking Sight Distance (m) |
|---|---|---|---|
| 20 | 20 | 40 | - |
| 30 | 30 | 60 | 120 |
| 40 | 45 | 90 | 165 |

| Design Speed (Km/h) | Stopping Sight Distance (m) | Intermediate Sight Distance (m) | Overtaking Sight Distance (m) |
|---|---|---|---|
| 50 | 60 | 120 | 235 |
| 60 | 80 | 160 | 300 |

### 5.4.3 Horizontal Curve

5.4.3.1 The minimum horizontal radius is the limiting value of curvature for given design speed and is determined from the maximum rate of super elevation and the maximum side friction factor selected for design. As per the IRC: 73-1980 the minimum ruling radii of horizontal curve for village roads corresponding to different terrain conditions are as follows:

**Table 5.6 : Standard Radii**

| S.No | Classification of Road | Rolling Terrain | | Mountainous Terrain | |
|---|---|---|---|---|---|
| | | Ruling minimum | Absolute minimum | Ruling minimum | Absolute minimum |
| 1 | National & State Highways | 230 | 155 | 80 | 50 |
| 2 | Major District Roads | 155 | 90 | 50 | 30 |

5.4.3.2 Absolute minimum and ruling minimum radii correspond to the minimum design speed and the ruling design speed respectively.

5.4.3.3 On new roads, horizontal curves should be designed to have the largest practical radius generally more than the above values corresponding to design speed. The Consultants recommend providing higher radii for smooth curvatures to accommodate possibility of higher speeds in future. This is because improvements in horizontal geometry are likely to prove very costly if taken up in future. Hence the radii proposed are as follows which also correspond to the maximum super-elevation values of 7%.

**Table 5.7: Adopted Horizontal Radius**

| Design Speed (Km/h) | Absolute minimum Radius (m) |
|---|---|
| 50 | 80 |
| 40 | 50 |

### 5.4.4 Transition (Spiral) Curves

5.4.4.1 The purpose of a transition (spiral) curve is to provide a smooth and aesthetically pleasing transition and a natural driving section between a tangent and a circular curve. In addition, the transition curves provide convenient and desirable arrangement for developing super-elevation runoff.

5.4.4.2 The transition length curves shown in table 5.8 (as recommended by IRC: 73-1980).It is proposed to adopt the same.

**Table 5.8: Transition curve lengths**

| Design Speed | Transition Length |
|---|---|
| | Mountainous Terrain |
| 50 | 55 |
| 40 | 40 |

### 5.4.5 Super-elevation

5.4.5.1 The IRC: 73-1980 design standards propose a maximum super-elevation rate of 7% & the same is adopted for Project Road.

### 5.4.6 Widening at Curves

5.4.6.1 The IRC: 73-1980 design standards propose the widening at horizontal curves for radii <300m for 2-lane carriageway pavements as given below:

| Radius of Curve (m.) | Upto 20 | 21-40 | 41-60 | 61-100 | 101-300 | Above 301 |
|---|---|---|---|---|---|---|
| Extra Width in Two lane | 1.5 | 1.5 | 1.2 | 0.9 | 0.6 | Nil |

The project roads design limits horizontal curve radius to the absolute minimum and the carriageway flanked by 1.5m earthen shoulder on either side is considered to compensate the requirement of widening at curves.

## 5.5 Vertical Alignment

### 5.5.1 General

The vertical alignment should produce a smooth longitudinal profile consistent with standard of the road and lay of the terrain. Wherever possible horizontal and vertical curvature should be so combined that the safety and operational efficiency of the road is enhanced.

### 5.5.2 Vertical Curves

As per IRC: 73-1980 design standards, the minimum lengths of vertical curves are shown in the Table below:

| Design Speed (Km/h) | Maximum Grade change (Percent) not requiring a vertical curve | Minimum length of vertical curve (meters) |
|---|---|---|
| Up to 35 | 1.5 | 15 |
| 40 | 1.2 | 20 |
| 50 | 1.0 | 30 |

At complex locations such as interchanges and major intersections the minimum lengths of vertical curves should be designed for safe decision sight distance.

The length of a vertical curve should be calculated using the following equation:

$$L = K \times A,$$

Where L = Length of vertical curve in meters;

K = Coefficient, a measure of the flatness of a vertical curve; and

A = Algebraic difference of grade lines (%)

### 5.5.3 Attainment of Super-elevation

The normal cambered section of the road is changed into super-elevated section in two stages. First stage is the removal of adverse camber in outer carriageway. In the second stage super-elevation is gradually built up over outer and inner carriageways so that the required super-elevation is available at the beginning of the circular curve. Super-elevation source attained by revolving pavement is about the centre-line.

The required super-elevation is to be developed over entire transition length. The rate of drainage of super-elevation is 1 in 150 for plain/ rolling terrain and 1 in 60 for mountainous sections. When cross drainage structures fall on a horizontal curve, their deck is to be super-elevated in the same manner as of the pavement. Paved shoulders are to follow the super-elevation pattern of main carriageway.

### 5.5.4 Standard for Intersections

The design standards for the at-grade junctions and interchange elements are proposed to follow the provisions contained in IRC: SP 41-1994 & MOST Type design and IRC: 92-1985 suitably modified as per the guidelines given in Manual for Safety in Road Design.

## 5.6 Summary of Geometric Design Standards

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| 1 | **Design speed** | | | |
| | Ruling | km/hr | 80 | 50 |
| | Minimum | km/hr | 65 | 40 |
| 2 | **Cross sectional elements** | | | |
| (a) | **Carriage way width** | | | |
| | Two lane | m | 7.0 | 7.0 |
| (b) | Shoulder width | | | |

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| | Paved Shoulder | m | 1.5 | - |
| | Earthen shoulder | m | 1.0 | 2.5 |
| (c) | Cross Slope | | | |
| | Bituminous surface | % | 2.5 | 2.5 |
| | Earthen surface | % | 3.5 | 3.5 |
| (d) | Extra Widening of pavement at curves | m | - | 0.9 |
| 3 | **Horizontal curve** | | | |
| (a) | Radius | | | |
| | Ruling Minimum | m | 230 | 80 |
| | Absolute Minimum | m | 155 | 50 |
| (b) | Superelevation (max) | % | 7 | 7 |
| 4 | **Vertical curve** | | | |
| (a) | Length (min) | m | 60 | 30 |

# 6.0 IMPROVEMENT PROPOSAL

## 6.1 General

This chapter addresses three important geometric design aspects: geometric design standards for the project corridor, detailing of highway design elements, and improvement proposals.

**Geometric Design Standards:** Geometric Standards form the basis of any design in a particular project. The formulation of these design standards is done with the objective to set standards/guidelines for designs, to avoid any inconsistency in design from one section to the other, and to provide a desired level of service and safety. The Terms of Reference for this project not only list a brief with regard to design requirement, but also specify the codes on the basis of which designs are to be carried out.

Design Standards given in relevant IRC codes, guidelines and special publications, and MORT&H circulars as applicable to the National Highways have been followed.

**Highway Design Elements:** With improvement proposals being finalized, and categorization of elements for design standards complete, the various highway design elements have been detailed.

**Improvement Proposals:** It is pertinent to discuss improvement proposals because these need to address present conditions, account for the sustenance of desired Levels of Service with respect to both capacity and pavement condition, and be achieved in a phased manner so as to stagger investments. Based on existing road and traffic conditions and traffic on the project corridor over the project duration, capacities have been reassessed and improvement proposals have been worked out.

## 6.2 Design Standards

The design standards adopted for the study have been evolved on the basis of a study of the existing standards and practices in the country keeping in view the standards recommended by IRC. The standards so evolved are presented in **Table-6.1**.

**Table : 6.1 Geometric Design Standards for the Project Corridor**

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| 1 | **Design speed** | | | |
| | Ruling | km/hr | 80 | 50 |
| | Minimum | km/hr | 65 | 40 |
| 2 | **Cross sectional elements** | | | |
| (a) | **Carriage way width** | | | |
| | Two lane | m | 7.0 | 7.0 |

| Sl No. | Description | unit | Proposed Standards | |
|---|---|---|---|---|
| | | | Rolling | Mountainous |
| (b) | Shoulder width | | | |
| | Paved Shoulder | m | 1.5 | - |
| | Earthen shoulder | m | 1.0 | 2.5 |
| (c) | Cross Slope | | | |
| | Bituminous surface | % | 2.5 | 2.5 |
| | Earthen surface | % | 3.5 | 3.5 |
| (d) | Extra Widening of pavement at curves | m | - | 0.9 |
| 3 | **Horizontal curve** | | | |
| (a) | Radius | | | |
| | Ruling Minimum | m | 230 | 80 |
| | Absolute Minimum | m | 155 | 50 |
| (b) | Super elevation (max) | % | 7 | 7 |
| 4 | **Vertical curve** | | | |
| (a) | Length (min) | m | 60 | 30 |

## 6.3 Widening Scheme

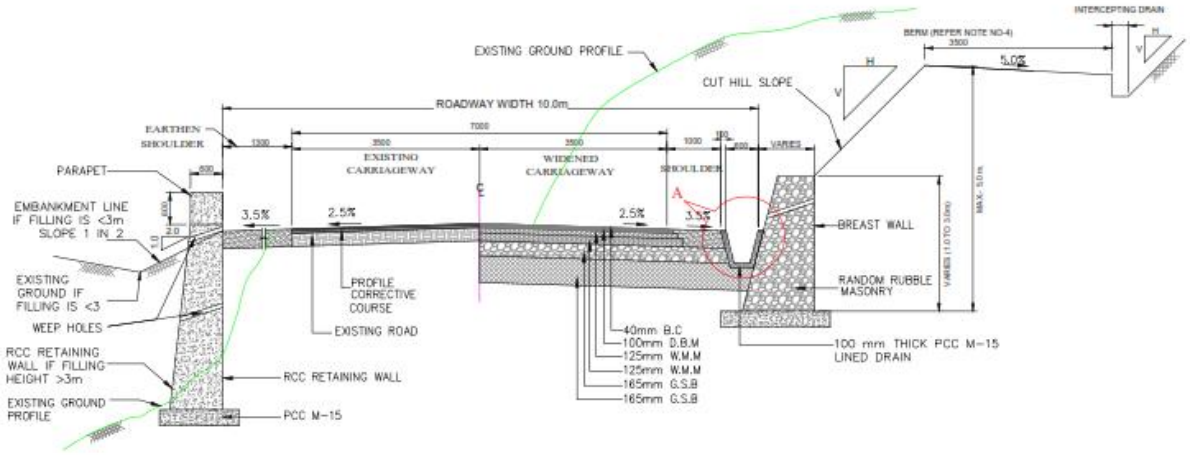
From the topographical survey conducted for the project road, four types of typical cross-sections are proposed for the improvement of the project road. The details of typical cross-section are given below in **Table 6.2.**

**Table : 6.2 Proposal for Short Realignments for the Project Corridor**

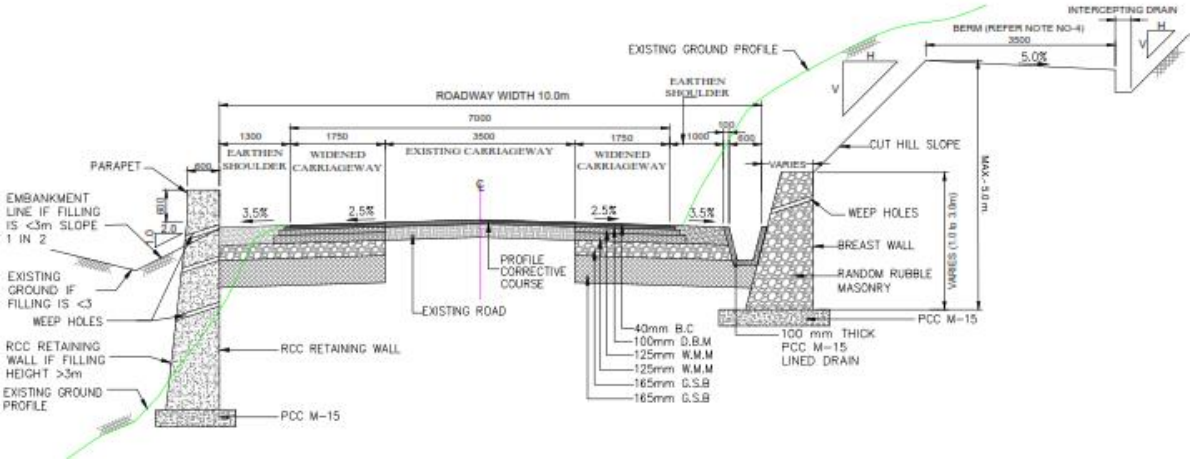
| S.No | Description | Type of Cross-Section | Proposed Length (m) |
|---|---|---|---|
| 1 | Typical cross-section with earthen shoulders in rural stretches with eccentric widening where single lane carriageway exists | Type-I | 34318 |
| 2 | Typical cross-section with earthen shoulders in rural stretches with concentric widening where single lane carriageway exists | Type-II | 357 |
| 3 | Typical cross-section with paved shoulders in urban stretches with concentric widening where single lane carriageway exists | Type-III | 205 |

| S.No | Description | Type of Cross-Section | Proposed Length (m) |
|---|---|---|---|
| 4 | Typical cross-section with earthen shoulders in rural stretches new construction | Type-IV | 23115 |
| | **Total Length (m)** | | **57995** |

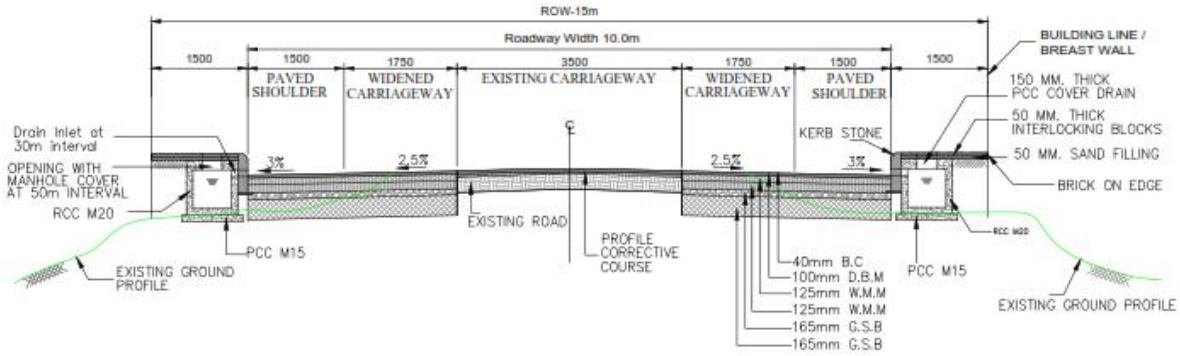
**1) Type-I:- Typical cross section with earthen Shoulders in Rural Stretches with Eccentric widening where single lane carriage way exists**



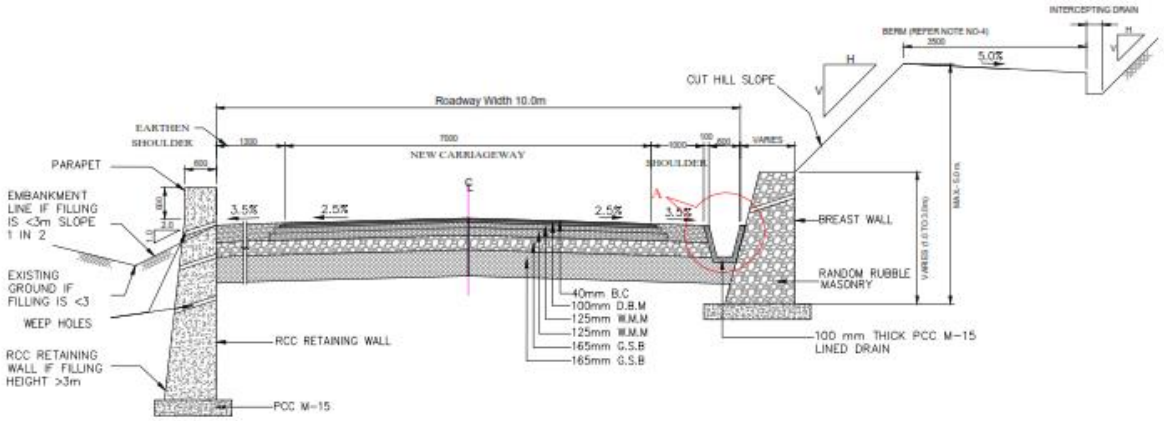

**2) Type-II:- Typical cross section with earthen Shoulders in Rural Stretches with Concentric widening where single lane carriage way exists**



**3) Type-III:- Typical cross section with Paved Shoulders in Urban Stretches with Concentric widening where single lane carriage way exists**




**4) Type-IV:- Typical cross section with earthen Shoulders in Rural Stretches New Construction**




Detailed widening scheme is attached at the end of chapter-3 of **Volume-II (Design Report-Part-I, Roads)**

## 6.4 Geometric Improvement Design

The project corridor has been improved as per the improvement proposals detailed below. Concentric widening is proposed all along the road, except some places where widening is done of one side of the road (Eccentric widening) for curve improvement.

The horizontal alignment design has been done using “MX Road” as per the widening scheme suggested on the base plans. The design standards corresponding to **Table 6.1** have been adopted for the project corridor. Extensive field checks to verify the feasibility of the proposed alignment have been carried out and suitable modifications to the

alignment have been done wherever considered essential to not only safeguard sensitive elements, but also to avoid congested areas.

- Available ROW from the existing Center line
- Geometric improvements
- Built-up/ Urban areas requiring footpath
- Road-side properties
- Road-side utilities

## 6.5 Pavement Design

### 6.5.1 Introduction

The existing project road is single lane road and calls for up gradation to a 2- lane with paved/earthen shoulders, emphasis have been given to rationalize rehabilitation to the extent possible. The general design methodology has been based on the prevalent practices used within India to devise suitable rehabilitation techniques to provide effective treatment of the deficiencies of the existing pavement structure.

It is essential that the rehabilitation techniques utilized correct the existing deficiencies and defects of the existing pavement structure.

### 6.5.2 Methodology of Design

The pavement has been designed using the Indian Road Congress "IRC: 37-2001 "Guidelines for the Design of Flexible Pavements". As this method has been developed in India to suit local conditions and the traffic composition, it is considered to be the most appropriate.

### 6.5.3 Construction and Maintenance Standards

The pavements will be constructed using the latest revision of the Ministry of Road Transport & Highways (MORTH) Specifications for Road and Bridge Works where appropriate.

### 6.5.4 Design Traffic

In accordance with IRC: 37-2001, the design traffic loadings have been calculated in the terms of cumulative number of standard axles using the following formulae:

$$N_S = \sum_{i=1}^{DL} \times \sum_{i=1}^{n} \times \frac{365 \times ADT_i \times \left[(1+r_i)^{DL} - 1\right] \times D \times F}{r}$$

Where:

$N_s$ Is the cumulative number of standard axles to be catered for in the design in terms of ESA.

$ADT_i$ Is the average daily traffic for vehicle category "i" in the initial year

$r_i$ Is the growth rate for the vehicle category "i"

DL Is the Design Life in years

D Is the Lane Distribution Factor

F Is the Vehicle Damage Factor

## AVERAGE DAILY TRAFFIC

The initial year average daily classified commercial traffic volumes based on the traffic volume counts of the classified traffic volume are shown in **Table-6.3**.

**Table 6.3: Estimates of AADT**

| Vehicle Type | Kynron Village (Km 9.00) | Marium Village (Km 34.00) |
|---|---|---|
| Two Wheeler | 107 | 60 |
| Auto Rickshaw | 4 | 2 |
| Car / Jeep / Van | 163 | 87 |
| Tempo | 0 | 0 |
| Mini / RTVs Bus | 0 | 0 |
| Standard Bus | 16 | 13 |
| Light Commercial Vehicle | 65 | 54 |
| 2-Axle | 78 | 55 |
| **Total Motorised Vehicles (Number)** | **433** | **271** |
| **Total Motorised Vehicles (PCU)** | **601** | **404** |
| **Total PCU per day** | **601** | **404** |

Note: Non motorised vehicles not seen in the project corridor during the traffic survey.

## Growth Rates for Traffic

The following growth rates are adopted for traffic forecasting of the project road. The growth percentage is calculated by econometric method considering realistic scenario of economy.

**Table 6.4: Location wise Predicted Growth Rates for all modes**

| Vehicle Type | 2012- 2017 | 2017- 2022 | 2022- 2027 | 2027-2032 | Beyond 2032 |
|---|---|---|---|---|---|
| Two Wheeler | 8.5 | 8.2 | 7.8 | 7.2 | 5.8 |
| Three Wheeler | 2.9 | 2.6 | 2.4 | 2.1 | 2.0 |
| Car / Jeep / Taxi | 8.6 | 8.2 | 7.7 | 7.1 | 6.7 |
| Bus / Mini Bus | 3.1 | 2.9 | 2.6 | 2.35 | 2.1 |
| Goods Vehicles | 10.2 | 11.9 | 12.8 | 11.7 | 11.2 |

For predicting tractor (local traffic), a growth rate of 3% has been adopted as given in IRC: 102-1998. The traffic growth rate of Non-motorized vehicles is also assumed to be 3% per annum to the year 2024 and, thereafter 1% per annum.

## Lane Distribution and Directional Distribution Factor

The values adopted for these factors are those that are suggested by IRC: 37-2012. The values used are given below:

- A directional distribution factor of 0.75 has been adopted.

## Vehicle Damage Factor

The number of equivalent 8.2 ton standard axles for the different categories of commercial vehicles has been based on the axle load surveys carried out. The VDF values obtained from axle load survey are shown in Table-6.5. The VDF considered for design is 3.5

**Table 6.5: Vehicle Damage Factors**

| S. No | Vehicle Type | Kynron (Km 9.00) | Marium Village (Km 34.00) |
|---|---|---|---|
| 1 | Buses | 3.18 | 2.59 |
| 2 | LCV | 1.50 | 0.66 |
| 3 | 2-axle Truck | 3.14 | 1.37 |

## Calculation of Design Traffic Loadings

The above formula and assumptions were used to calculate the design traffic loadings for the following sections of the project corridor where the traffic loadings are uniform.

**Table 6.6: Design Traffic Loadings**

| Year | Design Million Standard Axles (MSA) | |
|---|---|---|
| | Kynron (Km 9.00) | Marium Village (Km 34.00) |
| 2014 | 0.99 | 0.97 |
| 2019 | 6.39 | 6.23 |
| 2024 | 11.79 | 11.49 |
| 2029 | 17.19 | 16.75 |
| 2034 | 22.59 | 22.01 |
| 2039 | 27.99 | 27.27 |
| 2042 | 31.23 | 30.42 |

The Parameter considered for design of new pavement is given in **Table-6.7**

**Table 6.7: Parameters for Design of New Pavement**

| Parameters | Values considered for Design of New Pavement | |
|---|---|---|
| | Kynron (Km 9.00) | Marium (Km 34.00) |
| Design Life (Years) | 5 Years | 5 Years |
| Traffic Loading in Million Standard Axles (MSA) (2019) | 6.39 | 6.23 |
| Lane Distribution Factor | 0.75 | 0.75 |
| Vehicle Damage Factor | 3.5 | 3.5 |
| CBR (%) of Sub grade Soil | 8% | 8% |

From table 6.6 & 6.7, it is observed that the MSA for both the section is near about same, hence same pavement thickness is recommended for entire project road.

## The Recommended Pavement Thicknesses

The recommended pavement thickness (in accordance with IRC: 37-2012) is given in **Table-6.8**

**Table 6.8: Recommended Pavement Thickness for New Pavement**

| Pavement Composition | Pavement Thickness (in mm) |
|---|---|
| **1. Wearing Course** | |
| (a) Bituminous Concrete (BC) | 30 mm |
| (b) Dense Bituminous Macadam (DBM) | 50 mm |
| **2. Base : Wet Mix Macadam (WMM)** | 250 mm |
| **3. Sub-base: Granular Sub base (GSB)** | 200 mm |
| **Total** | **530 mm** |

The above pavement thickness has been recommended for design life of 5 years as per instructions given by MORTH.

## 6.6 Widening of Bridges

The inventory of bridges reveals that, 11 no's of bridges are present along the project road, out of which only 3 no's of bridges are good in condition and proposed to be retained, remaining 8 No. of bridges are proposed for reconstruction.

Summary of improvement for bridges are enclosed at the end of this chapter as **Table – 6.9**.

General Arrangement Drawings (GAD) and detailed drawings of Bridges are enclosed in **Volume-VI** of this submission (Detailed Project Report).

However, detailed design of bridges is presented in separate volume **(Volume II-Part II Design report Bridges)** covering Hydrology and Detailed Bridge Design. Geotech report for bridges is presented in **Volume II A (Geotech Report)** of current submission.

## 6.7 Widening of Culverts

There are total 436 no's of culverts are present along the project road, out of which 312 no's are Hume pipe culverts, 98 no's are stone culverts, 15 no's are slab culverts and 11 no's are box culverts. Condition of all the culverts is poor, hence, Reconstruction of all the 436 culverts is proposed by box culverts of different sizes.

Hydrology of few culverts is sample as enclosed at the end of **Volume-II (Design Report-Part-I, Roads).**

The detailed improvement proposal for culverts is attached at the end of chapter-3 of **Volume-II (Design Report-Part-I, Roads)**

## 6.8 Designs for Road side drainage

In the present project, it is recommended that in rural areas longitudinal lined drain channel (U shaped) is constructed all along the roadway. This drain shall follow the natural gradient of the road and shall discharge into the nearest Cross Drainage. In case of urban sections, rectangular RCC cover drains of size (0.600 m x 0.600 m, inner dimension) is recommended.

## 6.9 Design for Road markings, signs and other safety devices

Road furniture such as "W-Shaped" metal crash barrier, Traffic signs, Kilometre posts, Hectometer stones, and ROW pillar etc on the Project Highway provided as per IRC Codes shall meet requirements of MORT&H Specifications. Where any item is not covered by it, then its specification shall conform to BIS /AASHTO / ASTM /British Standards in that order of precedence. Typical Road Marking and Traffic Sign drawings showing the layout

of road markings and traffic signs is presented in **Volume VII (Miscellaneous Drawings)** of this submission.

## 6.10 Bus Shelters

Bus shelters near every bunch of habitation have been provided for both directions separately. The chainages / Locations of proposed Bus stands have been given in **Table 6.11** below:

**Table 6.11: Location of Bus Shelters**

| S.No | Existing Chainage | Proposed Chainage | Village /Town name | S.No | Existing Chainage | Proposed Chainage | Village /Town name |
|---|---|---|---|---|---|---|---|
| 1 | 0+078 | 0+078 | Nongstoin | 6 | 33+750 | 33+750 | Myriem |
| 2 | 8+925 | 8+933 | Kynron | 7 | 39+357 | 39+340 | Umdulun |
| 3 | 19+362 | 19+372 | Ranblan market | 8 | 42+800 | 42+753 | Mawkhlaitgap market |
| 4 | 23+350 | 23+367 | Rang Blang Village | 9 | 53+400 | 52+675 | New Nongtner |
| 5 | 25+950 | 25+970 | Nonefa Village | 10 | 57+825 | 57+725 | Nonagenarian |

## 6.11 Junctions

There are two major junctions on the project road at Km. 20+800 & Km 43+100 respectively.

There are 18 minor junctions are present along the project road whose details are given in Table 6.12 below:

**Table 6.12: Junctions**

| S.No | Ex. Chainage | Prop. Chainage | Junction Type | |
|---|---|---|---|---|
| 1 | 2+575 | 2+575 | | Y |
| 2 | 4+775 | 4+805 | T | |
| 3 | 9+025 | 9+041 | | Y |
| 4 | 10+875 | 10+900 | | Y |
| 5 | 11+890 | 11+910 | T | |
| 6 | 15+065 | 15+057 | T | |
| 7 | 19+562 | 19+571 | | Y |
| 8 | 19+638 | 19+650 | T | |
| 9 | 20+575 | 20+590 | T | |
| 10 | 20+787 | 20+810 | T | |
| 11 | 24+175 | 24+191 | | Y |

| S.No | Ex. Chainage | Prop. Chainage | Junction Type | |
|---|---|---|---|---|
| 12 | 25+675 | 25+696 | T | |
| 13 | 29+737 | 29+739 | T | |
| 14 | 33+813 | 33+814 | | Y |
| 15 | 40+215 | 40+183 | T | |
| 16 | 42+400 | 42+360 | T | |
| 17 | 43+100 | 43+060 | | Y |
| 18 | 52+943 | 52+875 | T | |

## 6.1 Retaining / Breast wall

Retaining / Breast wall of different heights has been proposed at the following design chainages. Standard drawings of Retaining / Breast wall are presented in **Volume VII (Miscellaneous Drawing)** of this submission.

| S.NO. | RETAINING/BREAST WALL | SIDE | STARTING CHAINAGE (KM) | END CHAINAGE (KM) | LENGTH (M) |
|---|---|---|---|---|---|
| 1 | Breast Wall | Left | 2+885 | 2+915 | 30.00 |
| 2 | Breast Wall | Right | 3+704 | 3+725 | 21.00 |
| 3 | Retaining Wall | Right | 4+816 | 4+846 | 30.00 |
| 4 | Breast Wall | Right | 5+351 | 5+366 | 15.00 |
| 5 | Breast Wall | Right | 5+418 | 5+419 | 1.00 |
| 6 | Retaining Wall | Left | 6+158 | 6+167 | 9.00 |
| 7 | Retaining Wall | Left | 6+760 | 6+771 | 11.00 |
| 8 | Breast Wall | Right | 6+760 | 6+771 | 11.00 |
| 9 | Breast Wall | Left | 6+779 | 6+785 | 6.00 |
| 10 | Retaining Wall | Right | 6+779 | 6+789 | 10.00 |
| 11 | Breast Wall | Left | 7+338 | 7+347 | 9.00 |
| 12 | Retaining Wall | Right | 7+715 | 7+735 | 20.00 |
| 13 | Retaining Wall | Left | 8+039 | 8+047 | 8.00 |
| 14 | Retaining Wall | Left | 9+866 | 9+909 | 43.00 |
| 15 | Breast Wall | Right | 9+866 | 9+909 | 43.00 |
| 16 | Breast Wall | Left | 15+293 | 15+345 | 52.00 |
| 17 | Breast Wall | Left | 15+477 | 15+526 | 49.00 |
| 18 | Breast Wall | Right | 17+536 | 17+542 | 6.00 |
| 19 | Breast Wall | Left | 26+354 | 26+363 | 9.00 |
| 20 | Breast Wall | Right | 26+363 | 26+378 | 15.00 |
| 21 | Retaining Wall | Left | 27+244 | 27+247 | 3.00 |
| 22 | Retaining Wall | Left | 27+424 | 27+431 | 7.00 |
| 23 | Retaining Wall | Right | 27+785 | 27+804 | 19.00 |

| S.NO. | RETAINING/BREAST WALL | SIDE | STARTING CHAINAGE (KM) | END CHAINAGE (KM) | LENGTH (M) |
|---|---|---|---|---|---|
| 24 | Retaining Wall | Left | 40+051 | 40+098 | 47.00 |
| 25 | Breast Wall | Right | 40+059 | 40+101 | 42.00 |
| 26 | Breast Wall | Right | 40+111 | 40+134 | 23.00 |
| 27 | Retaining Wall | Left | 40+112 | 40+138 | 26.00 |
| 28 | Retaining Wall | Left | 40+462 | 40+476 | 14.00 |
| 29 | Breast Wall | Right | 40+472 | 40+477 | 5.00 |
| 30 | Breast Wall | Right | 40+483 | 40+498 | 15.00 |
| 31 | Retaining Wall | Left | 40+483 | 40+493 | 10.00 |
| 32 | Retaining Wall | Right | 40+561 | 40+606 | 45.00 |
| 33 | Breast Wall | Left | 41+767 | 41+773 | 6.00 |
| 34 | Retaining Wall | Right | 41+773 | 41+775 | 2.00 |
| 35 | Breast Wall | Right | 41+813 | 41+864 | 51.00 |
| 36 | Breast Wall | Right | 42+264 | 42+275 | 11.00 |
| 37 | Breast Wall | Right | 43+148 | 43+172 | 24.00 |
| 38 | Breast Wall | Right | 43+279 | 43+291 | 12.00 |
| 39 | Breast Wall | Right | 43+403 | 43+414 | 11.00 |
| 40 | Retaining Wall | Left | 43+584 | 43+620 | 36.00 |
| 41 | Retaining Wall | Left | 43+686 | 43+709 | 23.00 |
| 42 | Breast Wall | Right | 43+951 | 43+985 | 34.00 |
| 43 | Breast Wall | Right | 44+162 | 44+188 | 26.00 |
| 44 | Breast Wall | Right | 44+761 | 44+776 | 15.00 |
| 45 | Breast Wall | Right | 44+875 | 45+143 | 268.00 |
| 46 | Retaining Wall | Left | 46+043 | 46+062 | 19.00 |
| 47 | Breast Wall | Left | 46+399 | 46+428 | 29.00 |
| 48 | Breast Wall | Left | 46+510 | 46+536 | 26.00 |
| 49 | Breast Wall | Left | 46+602 | 46+620 | 18.00 |
| 50 | Breast Wall | Left | 46+671 | 46+689 | 18.00 |
| 51 | Breast Wall | Left | 46+730 | 46+750 | 20.00 |
| 52 | Retaining Wall | Right | 46+759 | 46+781 | 22.00 |
| 53 | Retaining Wall | Left | 46+852 | 46+900 | 48.00 |
| 54 | Retaining Wall | Left | 46+935 | 46+974 | 39.00 |
| 55 | Breast Wall | Left | 47+188 | 47+217 | 29.00 |
| 56 | Breast Wall | Left | 47+399 | 47+426 | 27.00 |
| 57 | Breast Wall | Left | 47+501 | 47+560 | 59.00 |
| 58 | Breast Wall | Right | 47+686 | 47+696 | 10.00 |
| 59 | Breast Wall | Right | 47+724 | 47+737 | 13.00 |
| 60 | Breast Wall | Right | 47+765 | 47+772 | 7.00 |
| 61 | Breast Wall | Left | 47+950 | 48+042 | 92.00 |
| 62 | Retaining Wall | Right | 48+638 | 48+708 | 70.00 |

| S.NO. | RETAINING/BREAST WALL | SIDE | STARTING CHAINAGE (KM) | END CHAINAGE (KM) | LENGTH (M) |
|---|---|---|---|---|---|
| 63 | Breast Wall | Right | 48+856 | 48+964 | 108.00 |
| 64 | Breast Wall | Right | 49+443 | 49+466 | 23.00 |
| 65 | Breast Wall | Right | 49+555 | 49+570 | 15.00 |
| 66 | Retaining Wall | Left | 49+758 | 49+809 | 51.00 |
| 67 | Breast Wall | Left | 49+842 | 49+871 | 29.00 |
| 68 | Breast Wall | Right | 49+943 | 49+968 | 25.00 |
| 69 | Breast Wall | Right | 50+215 | 50+223 | 8.00 |
| 70 | Breast Wall | Left | 50+262 | 50+293 | 31.00 |
| 71 | Breast Wall | Left | 50+335 | 50+410 | 75.00 |
| 72 | Retaining Wall | Left | 51+143 | 51+162 | 19.00 |
| 73 | Retaining Wall | Right | 51+180 | 51+189 | 9.00 |
| 74 | Retaining Wall | Left | 51+423 | 51+436 | 13.00 |
| 75 | Breast Wall | Left | 51+621 | 51+649 | 28.00 |
| 76 | Breast Wall | Right | 51+893 | 51+913 | 20.00 |
| 77 | Breast Wall | Right | 52+312 | 52+340 | 28.00 |
| 78 | Breast Wall | Right | 52+388 | 52+430 | 42.00 |
| 79 | Breast Wall | Right | 52+570 | 52+629 | 59.00 |
| 80 | Retaining Wall | Right | 52+830 | 52+844 | 14.00 |
| 81 | Breast Wall | Right | 53+016 | 53+070 | 54.00 |
| 82 | Breast Wall | Right | 53+187 | 53+204 | 17.00 |
| 83 | Breast Wall | Right | 53+295 | 53+314 | 19.00 |
| 84 | Breast Wall | Right | 53+413 | 53+467 | 54.00 |
| 85 | Breast Wall | Right | 53+488 | 53+509 | 21.00 |
| 86 | Breast Wall | Left | 54+016 | 54+031 | 15.00 |
| 87 | Breast Wall | Left | 54+229 | 54+240 | 11.00 |
| 88 | Breast Wall | Left | 54+243 | 54+249 | 6.00 |
| 89 | Breast Wall | Left | 54+253 | 54+271 | 18.00 |
| 90 | Retaining Wall | Left | 54+751 | 54+772 | 21.00 |
| 91 | Breast Wall | Left | 54+833 | 54+843 | 10.00 |
| 92 | Breast Wall | Left | 54+901 | 54+905 | 4.00 |
| 93 | Breast Wall | Left | 55+499 | 55+501 | 2.00 |
| 94 | Breast Wall | Left | 55+504 | 55+507 | 3.00 |
| 95 | Retaining Wall | Right | 55+864 | 55+867 | 3.00 |
| 96 | Breast Wall | Left | 55+895 | 55+897 | 2.00 |
| 97 | Retaining Wall | Right | 55+896 | 55+899 | 3.00 |
| 98 | Breast Wall | Left | 56+391 | 56+394 | 3.00 |
| 99 | Retaining Wall | Left | 56+399 | 56+401 | 2.00 |
| 100 | Breast Wall | Left | 56+422 | 56+426 | 4.00 |
| 101 | Retaining Wall | Right | 56+455 | 56+457 | 2.00 |

| S.NO. | RETAINING/BREAST WALL | SIDE | STARTING CHAINAGE (KM) | END CHAINAGE (KM) | LENGTH (M) |
|---|---|---|---|---|---|
| 102 | Retaining Wall | Left | 57+615 | 57+636 | 21.00 |
| | | | | **Total Length** | **2611.00** |

## Table 6.9: Bridge Improvement Proposal

| Sr No. | Name of River /Nala | Existing Chainage | EXISTING | | | | Condition | Proposed Chainage | IMPROVEMENT PROPOSAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Type | Span | Length | Width of carriageway | | | Proposal | Type | Span Arrangement |
| 1 | Stream | 2+425 | RCC | 1 | 13.522 | 6.155 | Poor | 2+424 | Reconstruction | RCC Slab | 1 x 14 |
| 2 | Wenkynsni | 9+111 | Iron | 3 | 89+718 | 4.228 | Poor | 9+121 | Reconstruction | RCC Slab | 3 x 30 |
| 3 | Stream | 9+875 | RCC | 1 | 12.448 | 5.544 | Poor | 9+890 | Reconstruction | RCC Slab | 1 x 14 |
| 4 | Stream | 15+050 | RCC | 1 | 8.539 | 5.210 | Fair | 15+041 | Reconstruction | RCC Slab | 1 x 10 |
| 5 | Stream | 27+795 | Iron | 1 | 19.376 | 3.863 | Poor | 27+814 | Reconstruction | RCC Slab | 1 x 20 |
| 6 | Stream | 40+137 | RCC | 1 | 10.345 | 5.019 | Poor | 40+106 | Reconstruction | RCC Slab | 1 x 12 |
| 7 | Stream | 40+516 | RCC | 1 | 8.178 | 4.806 | Poor | 40+520 | Reconstruction | RCC Slab | 1 x 10 |
| 8 | Stream | 41+827 | Wooden | 1 | 11.430 | 4.555 | Poor | 41+782 | Reconstruction | RCC Slab | 1 x 12 |
| 9 | Stream | 45+293 | RCC | 1 | 15.040 | 7.997 | Good | 45+248 | Retained | - | - |
| 10 | Stream | 55+975 | RCC | 1 | 28.332 | 8.141 | Good | 55+881 | Retained | - | - |
| 11 | Stream | 56+535 | RCC | 1 | 19.131 | 8.749 | Good | 56+440 | Retained | - | - |