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# MATERIAL REPORT

## 1.1 INTRODUCTION

As a part of the study a Detailed Project Report (DPR) is to be prepared after carrying out detailed engineering surveys and appropriate assessment of a design considering the site conditions, the present traffic and its growth, the environmental impact assessment as well as the social aspects along with cost assessment.

In highway design the identification and study of materials suitable for use in embankments, pavements and for structural foundations forms an integral part of the design process. Field surveys are carried out to understand the geo-physical and geo-morphological characteristics and material properties of project stretch, and make a general assessment on the quality, quantity and suitability of the available materials based on visual observation followed by an appropriate test to determine its character.

The material and sub-grade investigations study for this project are divided into three parts as:

- Part I - Investigation of existing sub grade and existing pavement detail.
- Parts II -Investigation of borrow area soil
- Part III- Investigating of construction materials.

## 1.2 THE PROJECT HIGHWAY

**"Consultancy Services for preparation of Feasibility Study and Detailed Project Report for Construction of 2 lane/2 lane with paved shoulder from Kohima to Nagaland/Manipur border section of NH-29 (Old NH-150) in the State of Nagaland under SARDP Phase-B on EPC Mode"**.

Existing Project Highway, part of NH-29 (old NH-150) starts at 7.880 km where Kohima Nagaland Bypass (proposed by other consultant under NHIDCL) ends and terminates near existing km 131.894 at its junction with NH-202 (old NH-155) near Jessami in Manipur state

The Project Highway passes through districts Kohima and Phek in the state of Nagaland and Ukhrul in the state of Manipur. It connects important Town / Villages namely Kohima, Chakabama, Kiruma, Fpsutsero, Misulumi, Enhulum, Chizami, Losami, Laniye and Jessami.

The existing length of the Project Highway is about 124.014 kms while design length along the proposed alignment of Project Highway is 121.090 kms. There is no requirement of bypassing any town/ village along the entire proposed alignment of Project Highway.

## 1.3 Construction Packages

The entire Project Highway has been divided into six packages and the details are given in table below:

**Table 1.1. Construction Package Details**

| Package No. | Existing Location (km) | | Design Chainage (Ch.) | | Total Length (kms) | | Name of nearest Town/ Village | |
|---|---|---|---|---|---|---|---|---|
| | From | To | From | To | Existing | Design | From | To |
| I | 7.880 | 30.474 | 7.880 | 29.600 | 22.594 | 21.720 | Chedama Road/Kohima Town | Near Junction of Kigwema Road, Chakahabama |
| **II** | **30.474** | **53.220** | **29.600** | **51.500** | **22.746** | **21.900** | **Near Junction of Kigwema Road, Chakahabama** | **Near Kikruma Village** |
| III | 53.220 | 76.320 | 51.500 | 74.200 | 23.100 | 22.700 | Near Kikruma Village | Near Mesulumi Village |
| IV | 76.320 | 98.380 | 74.200 | 95.700 | 22.060 | 21.500 | Near Mesulumi Village | Near Chizami |
| V | 98.380 | 120.367 | 95.700 | 117.200 | 21.987 | 21.500 | Near Chizami | Nagaland/ Manipur Border |
| VI | 120.367 | 131.894 | 117.200 | 128.970 | 11.527 | 11.770 | Nagaland/ Manipur Border | At junction of NH-29 with NH-202 (old NH-155) near Jessami Village in Manipur State |

*As per ToR all the onwards submissions including Draft PPR, Final PPR, Draft DPR and Final DPR are to be submitted construction package-wise therefore from here onwards "The Project Highway" referred shall be confined to the section of that particular construction package only.*

***Therefore, this Detailed Project Report pertains to "Construction of 2 lane/ 2 lane with paved shoulder from near Junction of Kigwema Road, Chakahabama in Nagaland State section of NH-29 from existing km 30.474 (Design Ch. 29.600) to km 53.220 (Design Ch. 51.500) - Construction Package – II" only.***

## 1.4 SUB-GRADE INVESTIGATIONS

### 1.4.1 Objective

The objective of the investigations is to (i) understand the composition and characteristics of the existing pavement / sub-grade, (ii) establish the engineering characteristics of material available for inclusion in various types of pavements viz. pavements and (iii) be aware of about the materials for the proposed sub-grade as materials of shoulders.:

- Field investigation on exiting pavement & collection of secondary and primary data regarding the composition of existing pavement and its characteristics.
- Existing sub-grade type and sub-soil conditions.
- Local soil investigation for new pavement.

### 1.4.2 Field and Laboratory Investigations

The field and laboratory tests are carried out as described below:

### 1.4.3 Test Pits on Existing Pavement

Test pits of approx. 1.0 m x 1.0 m size staggered on both sides of the pavement are excavated upto sub-grade level at an interval of 5.0 km along the project road alignment and test pits at 500m interval. These pits are excavated on shoulders extending about 20 cms into the pavement. The following field and laboratory tests have been carried out on each test pit as described below:

- The thickness and type of the pavement layers are measured and noted on all the three exposed faces of the pavement.
- The bottom surface is leveled by scrapping the sub-grade by about 25 mm. Field density and natural moisture content of the sub-grade are determined in-situ by core-cutter and rapid moisture meter methods, conducted on one corner of the pit. The results are given in Table 6.0.
- DCP tests are conducted in the pit at a depth of approx. 1.0 m below the sub-grade level. The DCPT equipment used is standard TRL penetrometer with 8 kg hammer, 575 mm drop height and 60°C cone, having a diameter of 20 mm.
- Approx. 50 kg of the disturbed samples from existing sub-grade is collected from each test pit and brought to the laboratory for testing index properties of sub-grade soil and field soaked CBR test on remolded sample.

### 1.4.4 DCP test on the Existing Sub – grade

The test pits of size 1mx1m have been excavated in staggered way at five km interval upto depth till the existing sub-grade is reached. DCPT has been performed on the sub-grade soil upto a depth of 500mm to evaluate the field CBR value. The field moisture content has been calculated by rapid moisture meter and field dry density and bulk density has been calculated by Core-Cutter method.

The Dynamic Cone Penetration test is an instrument designed to provide a measure of the in-situ strength of sub-grade. A schematic diagram of DCPT instrument has been shown in Figure 1. The depth of penetration is measured after each blow, the output of the DCP test is in mm/blow. The benefits of using DCPT is evaluate sub-grade strength in quick succession, and large amount of data can be calculated in a short time, though, being a correlation method it may not give the laboratory soaked CBR values. Therefore, this gives a comparative strength of sub-grade at different locations.

The field dry density and bulk density has been calculated by the core cutter (As per IS-2720 PART-29) method and the field moisture content has been calculated by the Rapid moisture meter. The core-cutter method is consists of a steel rammer of 9.8 kg weight with solid mild steel foot 140mm diameter and 75mm height with a concentrically screwed 25mm diameter solid mild steel staff.

The Schematic diagram of DCPT equipment is shown as Figure Below:

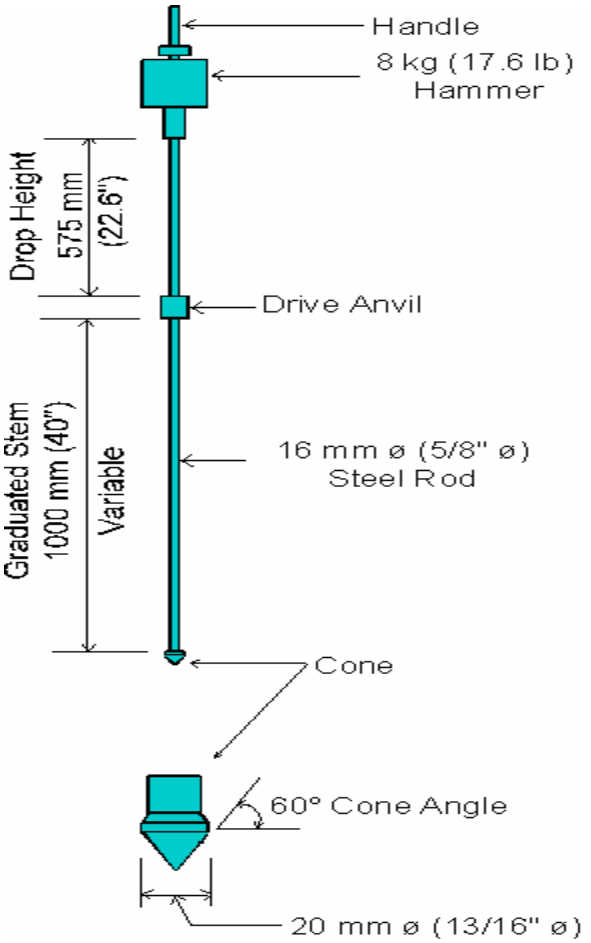


**Figure 1.1: Schematic of DCP**

The penetration for each blow has been noted down in the field data sheet and after that the field CBR from DCPT test has been calculated using correlation between CBR and PI (Penetration Index), the correlation has been given in the table below:

**Table 1.2. Correlation between CBR and PI (after Harison 1987 and Gabr et al. 2000)**

| Author | Correlation | Field or Laboratory based Study | Material Tested |
|---|---|---|---|
| Kleyn(1975) | log(CBR)=2.62-1.27log(PI) | Laboratory | Unknown |
| Harison(1987) | log(CBR)=2.56-1.16log(PI) | Laboratory | Cohesive |
| Harison(1987) | log(CBR)=3.03-1.54log(PI) | Laboratory | Granular |
| Livneh et. Al.(1994) | log(CBR)=2.46-1.12log(PI) | Field and Laboratory | Granular and Cohesive |

| Author | Correlation | Field or Laboratory based Study | Material Tested |
|---|---|---|---|
| Ese et. Al.(1994) | log(CBR)=2.44-1.07log(PI) | Field and Laboratory | Aggregate base course(ABC) |
| NCDOT(1998) | log(CBR)=2.60-1.07log(PI) | Field and Laboratory | ABC and Cohesive |
| Coonse(1999) | log(CBR)=2.53-1.14log(PI) | Laboratory | Piedomont residual soil |
| Gabr(2000) | log(CBR)=1.40-0.55log(PI) | Field and Laboratory | Aggregate base course(ABC) |

The correlation for cohesive soil has been used to convert the DCPT into CBR. For the existing sub-grade soil is appraised as cohesive soil by visual means, CBR has been calculated by formulas given by Kleyn (1975) and Livneh et al (1994) and Harrison (1987) formula to compare the CBR values. The summery of the field test result are given in table below:

**Table 1.3. Summary of DCP Test Results**

| Sl no | Chainage | Direction | Visual classification of soil | FMC (%) | Field Bulk Density(gm/cc) | Field Dry Density(gm/cc) | DCPT inferred CBR |
|---|---|---|---|---|---|---|---|
| 1 | 34+090 | L/S | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 15.27 | 2.067 | 1.793 | 3 |
| 2 | 38+985 | L/S | Yellowish, Clayey Silt / Silty Clay with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 | 1.967 | 1.775 | 5 |
| 3 | 43+730 | L/S | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 8.26 | 1.984 | 1.832 | 62 |
| 4 | 48+825 | R/S | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 | 2.022 | 1.835 | 37 |

- **Field dry density test:**

Field dry density has been performed for soil samples in accordance with the method described in IS: 2720 (Part 29). This standard covers the method for the determination of the in-place density of fine-grained natural or compacted soils free from aggregates using a core-cutter. For the purpose of the tests described in this standard, a soil shall be termed as fine-grained soil if not less than 90 percent of it passes a 4.75mm IS Sieve.

### 1.4.5 Laboratory Investigations of Soil Samples

The following tests were carried out on soil samples collected from each test pit.

- Gradation tests (As per IS: 2720 –Part 4).
- Atterberg's limits test (As per IS: 2720-Part 5).
- Modified proctor tests (As per IS: 2720-Part 8).
- Soaked & Un-soaked CBR tests (As per 2720-Part 16).
- Free Swell index test (As per 2720-Part 40).
- Field dry density test (As per 2720-Part 29).
- Gradation tests:

The grain size distribution analysis has been carried out for soil samples in accordance with the method described in IS: 2720 (Part 4). Compliance with the Standard, with respect to minimum sample quantity is dependent on the maximum significant grain size and the method of sampling. Two methods are given for finding the distribution of grain sizes; the first method, wet sieving shall be applicable to all soils and the second, dry sieving, shall be applicable only to soils which do not have an appreciable amount of clay.

- **Atterberg's limits test:**

The Atterberg's Limits comprising liquid limit, plastic limit and plasticity index were determined for soil samples in accordance with the methods described in IS: 2720 (Part 5). The liquid limit has been determined by three methods (namely, mechanical method, one point method and cone method) most popularly method is mechanical method by Casagrande apparatus. The soil sample preparation, in accordance with the code of practice, included removal of soil particles retained on the 425micron sieve. Accordingly, where a significant quantity of coarser particles was present, it is imperative that the Atterberg Limits results are representative of the relatively fine soil fraction, and not of the complete soil sample.

- **Modified proctor tests:**

The Modified proctor test, to determination of water content - dry density relation using heavy compaction, has been carried out for soil samples in accordance with the method described in IS: 2720 (Part 8).

- **Soaked & Unsoaked CBR tests:**

Soaked & Unsoaked California Bearing Ratio has been performed for soil samples in accordance with the method described in IS: 2720 (Part 16). The CBR value of a soil can be considered to be an index which in some fashion is related to its strength. The value is highly dependent on the condition of the material at the time of testing. The CBR values are usually calculated for penetrations of 2.5 and 5 mm.

California Bearing Ratio = PT/PS x 100
PT= Test load
PS= Standard load

Generally, the CBR value at 2.5 mm penetration will be greater than that at 5 mm penetration and in such a case; the former shall be taken as the CBR value for design purposes. If the CBR value corresponding to a penetration of 5 mm exceeds that for 2.5

mm, the test shall be repeated. If identical results follow, the CBR corresponding to 5 mm penetration shall be taken for design.

- **Free Swell index test:**

Free Swell index test of soil, can be determine with the help of IS:2720 (Part-40), helps to identify the potential of a soil to swell which might need further detailed investigation regarding swelling under different field conditions. Samples use for this test must be passes through 425-micron IS Sieve.

### 1.4.6 Test Results of Existing Sub-grade

Gradation, Atterberg's limit test, soil classifications, OMC, MDD and CBR tests are carried out for the samples collected from the test pits. Laboratory CBR tests are carried out on pit samples as per IS: 2720 (Part- 16). CBR moulds are prepared by compacting the soil in five layers. CBR moulds are prepared at three energy levels (18, 35 & 60 blows for each layer of sample). CBR at FDD has been determined to verify the current CBR at present condition.

From the lab result, it can be seen that Liquid Limit varies from 30.2 to 39.6, Plastic Limit varies from 21.3 to 24.4 and Plasticity index varies from6.83 to 18.10. The existing sub-grade CBR results show that the average value is 4.43, Maximum value is 5.29 and the minimum is 3.89. The CBR values with respect to the road section are in table below:

**Table 1.4. Minimum, Average and Maximum CBR values**

| Road Section | Existing Sub-grade CBR Values | | |
|---|---|---|---|
| | Minimum | Average | Maximum |
| Km 30+474 to km 53+220 | 3.89 | 4.43 | 5.29 |

Test pits investigations were carried out at junction of pavement at 500 meter interval for in-situ testing of sub-grade materials and pavement composition. The existing pavement thickness as observed at pit locations has been recorded. Average, Minimum and maximum thickness of the pavement crust is given table below:

**Table 1.5. Minimum, Average and Maximum Pavement Thickness**

| Road Name | Pavement Composition | Pavement Thickness (mm) | | |
|---|---|---|---|---|
| | | Minimum | Average | Maximum |
| Kohima-Jessami ( NH-150) | Bituminous | 70 | 77 | 92 |
| | Base Course (WBM, , Stone, Gravels, | 86 | 143 | 181 |
| | Sub Base ( GSB, Boulders and Gravel ) | 198 | 230 | 264 |

The detailed existing pavement thickness is given in table below:

**Table 1.6. Summary of Existing Crust Composition**

| Identification No. | Location (Chainage) km | Existing Crust Composition Details | mm | Total Thickness (mm) | Type of Sub-Grade Soil (Visual Identification) | Field Moisture Content (%) by Rapid Moisture Meter |
|---|---|---|---|---|---|---|
| 30/49 | 30+810 (R/S) | BT | 92 | 481 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 12.72 |
| | | WBM | 175 | | | |
| | | Boulder | 214 | | | |
| 31/50 | 31+325 (R/S) | BT | 90 | 460 | Reddish / Light Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 14.64 |
| | | WBM | 134 | | | |
| | | Boulder | 236 | | | |
| 31/51 | 31+815 (L/S) | BT | 73 | 425 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.64 |
| | | WBM | 137 | | | |
| | | Boulder | 215 | | | |
| 32/52 | 32+310 (L/S) | BT | 73 | 382 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 14.00 |
| | | WBM | 111 | | | |
| | | Boulder | 198 | | | |
| 32/53 | 32+805 (L/S) | BT | 73 | 434 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.64 |
| | | WBM | 141 | | | |
| | | Boulder | 220 | | | |
| 33/54 | 33+285 (L/S) | BT | 76 | 443 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 11.45 |
| | | WBM | 152 | | | |
| | | Boulder | 215 | | | |
| 33/55 | 33+790 (L/S) | BT | 79 | 465 | Yellowish, Silty Clay / Clayey Silt with some Shale Pieces / Silt Stone / Clay Stone mixed. | 12.09 |
| | | WBM | 152 | | | |
| | | Boulder | 234 | | | |
| 34/56 | 34+090 (L/S) | BT | 0 | 320 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 15.27 |
| | | WBM | 86 | | | |
| | | Boulder | 234 | | | |
| 34/57 | 34+275 (L/S) | BT | 0 | 334 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 95 | | | |
| | | Boulder | 239 | | | |
| 34/58 | 34+780 (L/S) | BT | 84 | 452 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 14.64 |
| | | WBM | 134 | | | |
| | | Boulder | 234 | | | |
| 35/59 | 35+295 (R/S) | BT | 78 | 475 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 146 | | | |
| | | Boulder | 251 | | | |
| 35/60 | 35+810 | BT | 73 | 444 | Reddish, Silty Clay / Clayey Silt | 14.00 |

| Identification No. | Location (Chainage) km | Existing Crust Composition Details | mm | Total Thickness (mm) | Type of Sub-Grade Soil (Visual Identification) | Field Moisture Content (%) by Rapid Moisture Meter |
|---|---|---|---|---|---|---|
| | (L/S) | WBM | 140 | | with little Shale Pieces / Silt Stone / Clay Stone mixed. | |
| | | Boulder | 231 | | | |
| 36/61 | 36+310 (L/S) | BT | 72 | 449 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 11.45 |
| | | WBM | 139 | | | |
| | | Boulder | 238 | | | |
| 36/62 | 36+820 (L/S) | BT | 77 | 484 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 12.09 |
| | | WBM | 150 | | | |
| | | Boulder | 257 | | | |
| 37/63 | 37+330 (R/S) | BT | 84 | 478 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 12.09 |
| | | WBM | 135 | | | |
| | | Boulder | 259 | | | |
| 37/64 | 37+810 (L/S) | BT | 73 | 450 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 142 | | | |
| | | Boulder | 235 | | | |
| 38/65 | 38+260 (L/S) | BT | 74 | 471 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 11.45 |
| | | WBM | 141 | | | |
| | | Boulder | 256 | | | |
| 38/66 | 38+745 (L/S) | BT | 76 | 473 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 151 | | | |
| | | Boulder | 246 | | | |
| 38/67 | 38+985 (L/S) | BT | 74 | 479 | Yellowish, Clayey Silt / Silty Clay with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 151 | | | |
| | | Boulder | 254 | | | |
| 39/68 | 39+220 (L/S) | BT | 91 | 467 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 11.45 |
| | | WBM | 161 | | | |
| | | Boulder | 215 | | | |
| 39/69 | 39+700 (L/S) | BT | 76 | 455 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 145 | | | |
| | | Boulder | 234 | | | |
| 40/70 | 40+150 (R/S) | BT | 84 | 493 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 9.54 |
| | | WBM | 145 | | | |
| | | Boulder | 264 | | | |
| 40/71 | 40+715 (R/S) | BT | 70 | 433 | Light Yellowish / Light Grey, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 143 | | | |
| | | Boulder | 220 | | | |

| Identification No. | Location (Chainage) km | Existing Crust Composition Details | mm | Total Thickness (mm) | Type of Sub-Grade Soil (Visual Identification) | Field Moisture Content (%) by Rapid Moisture Meter |
|---|---|---|---|---|---|---|
| 41/72 | 41+180 (L/S) | BT | 72 | 454 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 8.90 |
| | | WBM | 144 | | | |
| | | Boulder | 238 | | | |
| 41/73 | 41+700 (L/S) | BT | 78 | 468 | Yellowish, Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 156 | | | |
| | | Boulder | 234 | | | |
| 42/74 | 42+275 (R/S) | BT | 84 | 433 | Yellowish, Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 143 | | | |
| | | Boulder | 206 | | | |
| 42/75 | 42+765 (L/S) | BT | 71 | 437 | Yellowish, Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 9.54 |
| | | WBM | 143 | | | |
| | | Boulder | 223 | | | |
| 43/76 | 43+250 (R/S) | BT | 73 | 457 | Yellowish, Clayey Silt with some Shale Pieces/Silt Stone /Clay Stone mixed. | 10.17 |
| | | WBM | 156 | | | |
| | | Boulder | 228 | | | |
| 43/77 | 43+730 (L/S) | BT | 92 | 504 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 8.26 |
| | | WBM | 181 | | | |
| | | Boulder | 231 | | | |
| 43/78 | 43+980 (R/S) | BT | 73 | 457 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 147 | | | |
| | | Boulder | 237 | | | |
| 44/79 | 44+175 (L/S) | BT | 76 | 442 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 146 | | | |
| | | Boulder | 220 | | | |
| 44/80 | 44+660 (R/S) | BT | 71 | 467 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 10.81 |
| | | WBM | 158 | | | |
| | | Boulder | 238 | | | |
| 45/81 | 45+140 (L/S) | BT | 78 | 465 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 11.45 |
| | | WBM | 151 | | | |
| | | Boulder | 236 | | | |
| 45/82 | 45+625 (L/S) | BT | 85 | 461 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 142 | | | |
| | | Boulder | 234 | | | |
| 46/83 | 46+100 (L/S) | BT | 79 | 424 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 14.00 |
| | | WBM | 140 | | | |
| | | Boulder | 205 | | | |
| 46/84 | 46+580 | BT | 73 | 402 | Yellowish, Clayey Silt with some | 10.17 |

| Identification No. | Location (Chainage) km | Existing Crust Composition Details | mm | Total Thickness (mm) | Type of Sub-Grade Soil (Visual Identification) | Field Moisture Content (%) by Rapid Moisture Meter |
|---|---|---|---|---|---|---|
| | (R/S) | WBM | 125 | | Shale Pieces / Silt Stone / Clay Stone mixed. | |
| | | Boulder | 204 | | | |
| 47/85 | 47+075 (L/S) | BT | 78 | 459 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 14.64 |
| | | WBM | 143 | | | |
| | | Boulder | 238 | | | |
| 47/86 | 47+560 (L/S) | BT | 90 | 427 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 9.54 |
| | | WBM | 134 | | | |
| | | Boulder | 203 | | | |
| 48/87 | 48.050 (R/S) | BT | 75 | 449 | Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 138 | | | |
| | | Boulder | 236 | | | |
| 48/88 | 48+525 (R/S) | BT | 74 | 450 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 146 | | | |
| | | Boulder | 230 | | | |
| 48/89 | 48+825 (R/S) | BT | 73 | 409 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 132 | | | |
| | | Boulder | 204 | | | |
| 49/90 | 49+010 (L/S) | BT | 73 | 439 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 12.09 |
| | | WBM | 138 | | | |
| | | Boulder | 228 | | | |
| 49/91 | 49+475 (R/S) | BT | 76 | 465 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 10.17 |
| | | WBM | 155 | | | |
| | | Boulder | 234 | | | |
| 49/92 | 49+985 (R/S) | BT | 77 | 467 | Yellowish, Clayey Silt with good % of Shale Pieces / Silt Stone / Clay Stone mixed. | 9.54 |
| | | WBM | 141 | | | |
| | | Boulder | 249 | | | |
| 50/93 | 50+475 (R/S) | BT | 74 | 455 | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 12.72 |
| | | WBM | 144 | | | |
| | | Boulder | 237 | | | |
| 50/94 | 50+935 (R/S) | BT | 76 | 417 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 13.36 |
| | | WBM | 143 | | | |
| | | Boulder | 198 | | | |
| 51/95 | 51+415 (L/S) | BT | 77 | 465 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 12.72 |
| | | WBM | 153 | | | |
| | | Boulder | 235 | | | |
| 51/96 | 51+900 (R/S) | BT | 71 | 449 | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt | 14.64 |
| | | BT | 92 | 481 | | 12.72 |

| Identification No. | Location (Chainage) km | Existing Crust Composition Details | mm | Total Thickness (mm) | Type of Sub-Grade Soil (Visual Identification) | Field Moisture Content (%) by Rapid Moisture Meter |
|---|---|---|---|---|---|---|
| | | WBM | 175 | | Stone / Clay Stone mixed. Yellowish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | |

Laboratory test results of sub-grade collected from DCPT test are given in table below:

**Table 1.7. Laboratory Test Results of sub-grade soil for NH-150 from km 0.000 to km 132.00 (Collected from DCPT Pit)**

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | | | Free swell Index | Field Dry Density (Core - Cutter Method) | | ( % ) of compaction (FDD VS. MDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Un soaked | | Soaked | | | | | | |
| | | Gravel (%) | Sand (%) | Silt & clay (%) | LI | PL | PI | | OMC (%) | MDD (gm/cc) | CBR (%) 2.5 MM | CBR (%) 5.0 MM | Expansion Ratio | CBR (%) 2.5 MM | CBR (%) 5.0 MM | | FMC ( % ) by Rapid Moisture Meter | FDD ( gm/cc ) | |
| 34+090 (L/S) | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 0 | 21.78 | 78.22 | 39.3 | 21.3 | 18.1 | CI | 12.2 | 1.885 | 7.53 | 6.44 | 2.41 | 3.9 | 3.4 | 13.04 | 15.27 | 1.79 | 95.12 |
| 38+985 (L/S) | Yellowish, Clayey Silt / Silty Clay with little Shale Pieces / Silt Stone / Clay Stone mixed. | 0 | 22.65 | 77.35 | 39.6 | 24.2 | 15.4 | CI | 12.2 | 1.869 | 7.67 | 6.7 | 1.93 | 3.9 | 3.4 | 15 | 10.81 | 1.78 | 94.97 |
| 43+730 (L/S) | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone | 3.16 | 38.55 | 58.29 | 31.3 | 24.4 | 6.83 | ML | 11 | 1.903 | 10.7 | 9.78 | 1.78 | 4.6 | 4 | 5.26 | 8.26 | 1.83 | 96.27 |

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | | | Free swell Index | Field Dry Density (Core - Cutter Method) | | ( % ) of compaction (FDD VS. MDD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Un soaked | | Soaked | | | | | | |
| | | Gravel (%) | Sand (%) | Silt & clay (%) | LI | PL | PI | | OMC (%) | MDD (gm/cc) | CBR (%) 2.5 MM | CBR (%) 5.0 MM | Expansion Ratio | CBR (%) 2.5 MM | CBR (%) 5.0 MM | | FMC ( % ) by Rapid Moisture Meter | FDD ( gm/cc ) | |
| | mixed. | | | | | | | | | | | | | | | | | | |
| 48+825 (R/S) | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 1.82 | 34.06 | 64.12 | 30.2 | 23.2 | 7.05 | ML | 10.8 | 1.913 | 13.3 | 12.1 | 1.43 | 5.3 | 4.7 | 7.69 | 10.17 | 1.84 | 95.92 |

LL – Liquid Limit PI – Plasticity Index FMC – Field Moisture Content
CBR – California Bearing Ratio MDD – Maximum Dry Density PL – Plastic Limit OMC – Optimum Moisture Content
FDD – Field Dry Density DD – Dry Density

## 1.5 MATERIAL INVESTIGATIONS

The objective is to identify the borrow areas, quarry details for construction material & make a general assessment on quantity and suitability of the available materials based on visual observation. Our team has made several visits to Site and also attended meeting with the various Concerned Authorities related to our project road to collect information regarding the material to be used & the availability of soil for the proposed development of the project road. The contacted authorities are as follows

- Executive Engineer Mr. S Lanu Jamir & Junior Engineer of PWD.
- Executive Engineer Mr. P.K. Azad & Junior Engineer of GREF Centre, BRO Office.
- Chief Engineer & Junior Engineer Mr. Akom of NHAI.
- Mr. Vitho Lie, Officer of L.R.O office.
- Mr. Kius, Revenue Officer of Deputy Commissioner Office.
- Mr V.Puro, Owner of Chakabama Stone Crusher.
- Mr. Juber Alam, One of the Owner of Dimapur sand Stockyard.

After having discussions about the proposed construction with the concerned persons & the local bodies, we also came to know that there are no land maps available of our project road. During the execution of the project a declaration certificate from chairmen's/ councils of different villages of our project road to be collected for successful and uninterrupted construction of proposed road. We have collected the Schedule of Rate from the PWD Authority as given in ANNEXURE MT-4. The detail discussions for identified sources of suitable natural materials & survey locations with summary of test results are given below.

### 1.5.1 Investigation of Borrow Area Soil

Earth/soil for construction of embankment fill and sub-grade is available in sufficient quantities from the land adjacent to the road and certain prominent potential extraction areas, which have been identified. These are at Chainage 1+400km, 6+650km, 12+060km, 17+650km, 24+335km, 27+240km, and 32+030km etc long NH-150. This soil is mainly available from cultivated Lands and Hillock lands along the stretch as enlisted in the table below:

**Table 1.8. Location of Borrow Area for Soil**

| Sl No BRW | Chainage (km) | | Borrow Area Number | Type of Borrow Area | Location | Side | Distance from project road (m) | Quantity Available (Cum) |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 1 | 1+400 | 1+425 | BRW-1 | Hillock | kohima | L/S | 3 | 3600 |
| 2 | 6+650 | 6+670 | BRW-2 | Hillock | kohima | R/S | 1.5 | 2880 |
| 3 | 12+060 | 12+035 | BRW-3 | Hillock | kohima | L/S | 3 | 3000 |
| 4 | 17+650 | 17+680 | BRW-4 | Hillock | kohima | L/S | 2 | 4320 |
| 5 | 24+335 | 24+370 | BRW-5 | Agricultural Field | kohima | R/S | 3.5 | 5040 |
| 6 | 27+240 | 27+265 | BRW-6 | Hillock | Chakabama | L/S | 1 | 3600 |
| 7 | 32+030 | 32+050 | BRW-7 | Hillock | Chakabama | R/S | 1.5 | 2880 |
| 8 | 38+375 | 38+400 | BRW-8 | Hillock | Chakabama | R/S | 3 | 3800 |
| 9 | 42+010 | 42+035 | BRW-9 | Hillock | R.D Block, Kikruma | R/S | 1.5 | 3600 |

| Sl No BRW | Chainage (km) | | Borrow Area Number | Type of Borrow Area | Location | Side | Distance from project road (m) | Quantity Available (Cum) |
|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | |
| 10 | 49+500 | 49+520 | BRW-10 | Hillock | R.D Block, Kikruma | R/S | 1.5 | 2900 |
| 11 | 50+735 | 50+765 | BRW-11 | Hillock | Kikruma | L/S | 1.5 | 4400 |
| 12 | 58+650 | 58+675 | BRW-12 | Hillock | Kikruma | L/S | 1 | 3530 |
| 13 | 63+000 | 63+025 | BRW-13 | Hillock | Pfutsero | L/S | 1.5 | 3615 |
| 14 | 67+679 | 67+719 | BRW-14 | Open Field | Pfutsero | L/S | 3 | 5760 |
| 15 | 74+800 | 74+820 | BRW-15 | Hillock | Pfutsero | R/S | 1.5 | 2905 |
| 16 | 77+000 | 77+030 | BRW-16 | Hillock | Mesulumi | R/S | 1.5 | 4050 |
| 17 | 82+000 | 82+025 | BRW-17 | Hillock | Mesulumi | R/S | 1.5 | 3610 |
| 18 | 86+980 | 87+005 | BRW-18 | Hillock | Chizami | R/S | 1.5 | 3670 |
| 19 | 93+350 | 93+370 | BRW-19 | Hillock | Chizami | L/S | 1 | 2880 |
| 20 | 97+500 | 97+525 | BRW-20 | Hillock | Chizami | L/S | 1 | 3800 |
| 21 | 103+595 | 103+615 | BRW-21 | Hillock | Chizami | L/S | 1 | 3100 |
| 22 | 107+450 | 107+475 | BRW-22 | Hillock | Losami | L/S | 1 | 3600 |
| 23 | 116+500 | 116+520 | BRW-23 | Hillock | Losami | L/S | 1.5 | 2890 |
| 24 | 120+100 | 120+200 | BRW-24 | Agricultural Field on both Left Hand Side & Right Hand Side | Losami | L/S & R/S | 2 | 3200 |
| 25 | 121+700 | 121+730 | BRW-25 | Hillock | Jessami | R/S | 2 | 4300 |
| 26 | 129+800 | 129+840 | BRW-26 | Hillock | Jessami | R/S | 1 | 5500 |

**Table 1.9. Laboratory Test Results of Borrow Area soil for NH-150 from km 0.000 to km 132.00 (Collected from Borrow Pit)**

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | Free swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gravel (%) | Sand (%) | Silt & Clay (%) | LL | PL | PI | | OMC (%) | MDD (gm/cc) | Soaked | | | |
| | | | | | | | | | | | Expansion Ratio | CBR (%) 2.5 mm | CBR (%) 5.0 mm | |
| 1+400 L/S | Yellowish, Clayey Silt / Silty Clay with little Shale Pieces / Silt Stone / Clay Stone mixed. | 1.88 | 29.32 | 68.80 | 33.50 | 21.22 | 12.28 | CL | 11.60 | 1.905 | 2.03 | 4.27 | 3.63 | 7.69 |
| 12+060 L/S | Yellowish, Clayey Silt / Silty Clay with some Shale Pieces / Silt Stone / Clay Stone mixed. | 0.00 | 31.84 | 68.16 | 32.80 | 21.21 | 11.59 | CL | 12.00 | 1.904 | 2.17 | 4.32 | 3.76 | 10.00 |
| 24+335 R/S | Grey / Light Yellowish, Clayey Silt with some Shale Pieces / Silt Stone / Clay Stone mixed. | 4.22 | 41.02 | 54.76 | 29.60 | 24.16 | 5.44 | ML | 10.90 | 1.926 | 1.59 | 5.10 | 4.31 | 5.26 |

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | Free swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gravel (%) | Sand (%) | Silt & Clay (%) | LL | PL | PI | | OMC (%) | MDD (gm/cc) | Soaked | | | |
| | | | | | | | | | | | Expansion Ratio | CBR (%) 2.5 mm | CBR (%) 5.0 mm | |
| 32+030 R/S | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 0.00 | 23.66 | 76.34 | 33.50 | 20.22 | 13.28 | CL | 11.30 | 1.899 | 2.70 | 3.93 | 3.46 | 7.69 |
| 42+010 R/S | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 1.58 | 25.62 | 72.80 | 36.60 | 22.21 | 14.39 | CI | 12.70 | 1.864 | 2.52 | 3.89 | 3.24 | 12.64 |
| 50+735 L/S | Reddish, Silty Clay / Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | 0.00 | 24.36 | 75.64 | 37.30 | 21.25 | 16.05 | CI | 12.10 | 1.886 | 2.49 | 3.98 | 3.40 | 13.04 |
| 58+650 L/S | Yellowish, Clayey Silt / Silty Clay with | 5.12 | 26.62 | 68.26 | 33.60 | 22.21 | 11.39 | CL | 12.30 | 1.902 | 2.27 | 4.23 | 3.56 | 10.00 |

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | Free swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gravel (%) | Sand (%) | Silt & Clay (%) | LL | PL | PI | | OMC (%) | MDD (gm/cc) | Soaked | | | |
| | | | | | | | | | | | Expansion Ratio | CBR (%) 2.5 mm | CBR (%) 5.0 mm | |
| | some Shale Pieces / Silt Stone / Clay Stone mixed. | | | | | | | | | | | | | |
| 67+679 L/S | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 4.14 | 36.62 | 59.24 | 30.80 | 24.42 | 6.38 | ML | 9.50 | 1.928 | 1.31 | 4.91 | 4.18 | 5.26 |
| 77+000 R/S | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 3.29 | 35.89 | 60.82 | 30.10 | 23.22 | 6.88 | ML | 8.50 | 1.906 | 1.35 | 5.34 | 4.73 | 5.26 |
| 87+000 R/S | Yellowish / Light Reddish, Silty Clay / Clayey Silt with little Shale Pieces / | 1.24 | 22.26 | 76.50 | 36.80 | 21.75 | 15.05 | CI | 12.10 | 1.894 | 2.67 | 3.74 | 3.17 | 13.64 |

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | Free swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gravel (%) | Sand (%) | Silt & Clay (%) | LL | PL | PI | | OMC (%) | MDD (gm/cc) | Soaked | | | |
| | | | | | | | | | | | Expansion Ratio | CBR (%) 2.5 mm | CBR (%) 5.0 mm | |
| | Silt Stone / Clay Stone mixed. | | | | | | | | | | | | | |
| 97+500 L/S | Grey, Clayey Silt with good % of Shale Pieces / Silt Stone / Clay Stone mixed. | 8.92 | 59.92 | 31.16 | 29.60 | 23.55 | 6.05 | SC-ML | 8.70 | 1.948 | 1.24 | 6.90 | 5.73 | 5.26 |
| 103+600 L/S | Yellowish, Clayey Silt with Some Shale Pieces / Silt Stone / Clay Stone mixed. | 0.00 | 37.69 | 62.31 | 33.60 | 22.12 | 11.48 | CL | 11.40 | 1.901 | 2.32 | 4.37 | 3.69 | 9.09 |
| 116+500 L/S | Grey, Clayey Silt with good % of Shale Pieces / Silt Stone / Clay Stone mixed. | 4.52 | 57.22 | 38.26 | 29.80 | 24.22 | 5.58 | SC-ML | 10.00 | 1.945 | 1.15 | 6.51 | 5.38 | 5.26 |
| 121+700 R/S | Yellowish, Silty Clay / | 0.00 | 23.35 | 76.65 | 33.20 | 22.81 | 10.39 | CL | 11.90 | 1.879 | 2.13 | 3.98 | 3.37 | 13.64 |

| Location (Km) | Visual Classification of soil | Sieve Analysis % Passing | | | Atterberg's Limit | | | Type of soil as per IS Classification 1498 of 1970 | Mod. Proctor Test | | CBR at 97% compaction level | | | Free swell Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gravel (%) | Sand (%) | Silt & Clay (%) | LL | PL | PI | | OMC (%) | MDD (gm/cc) | Soaked | | | |
| | | | | | | | | | | | Expansion Ratio | CBR (%) 2.5 mm | CBR (%) 5.0 mm | |
| | Clayey Silt with little Shale Pieces / Silt Stone / Clay Stone mixed. | | | | | | | | | | | | | |
| 129+800 R/S | Dark Grey, Clayey Silt with some Shale Pieces / Silt Stone / Clay Stone mixed. | 1.12 | 32.81 | 66.07 | 33.50 | 22.23 | 11.27 | CL | 11.60 | 1.900 | 2.16 | 4.32 | 3.66 | 10.00 |

LL – Liquid Limit PI – Plasticity Index CBR – California Bearing Ratio MDD – Maximum Dry Density
OMC – Optimum Moisture Content PL – Plastic Limit

The area along the project road was surveyed for the selection of borrow areas. The survey revealed that adequate materials are available in the borrow areas along the project road. Borrow area lead chart for the road construction is shown in figure below:

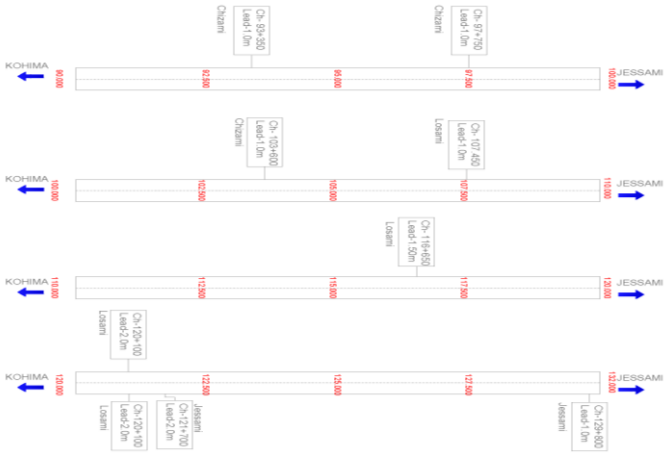


**Figure 1.2: Borrow Area Lead Chart**

**Sand Quarries:**

Good quality coarse / fine sand is available beyond the project road, which is Dhansiri River area, Dimapur. This river area is having the major sand quarries. Sand quarries operate steadily all along the year, however, with monsoon and river water level there are slight variation in this trend. We have collected samples from 5 major quarries & the test results of those samples are given in **Table 1.10**. The total quantity available is more than 100000 Cum in this river area, with a distance from the nearest end of the project road Kohima is 72km.The Rate of Fine Sand is 10/- per Cft & for Coarse sand is 36/- per Cft.

**Stone materials:**

Since, Nagaland the state has huge caches of unutilized & unexploited Natural Minerals. Vast deposits of stone are found in Chakabama, Pfutsero and Jessami which is used as construction materials. Summary of quarry locations of stone material is given in **Table 1.11.** The test results summary of the stone material is given in **Table 1.12.**

**Stone Quarries in Chakabama Area:**

Inventory survey reveals that Chakabama, with a minimum average distance of 36km from Kohima - the nearest end of the project corridor has 1 no, of major quarry location as tabulated in Table 11 with the quantity and lead distance. The Rate of 40mm is 105/Cft, 25mm is 100/Cft, 20mm is 99/Cft, 10mm is 101.54/Cft but as per the local enquiry from the quarry owner the rate of 40mm, 25mm, 20mm, & 10mm is 44/Cft, 38/Cft, 36/Cft & 35/Cft & the Owner of the quarry Pay tax to govt.. The Quarry location from the stock yard is 10km from the project road. The quarry owner shall charge Rs 6000 for 30km as transportation cost. The lead map is given in **Figure 1.3.**

**Stone Quarries in Pfutsero Area :**

Inventory survey reveals that Pfutsero, with a minimum average distance of 67km from Kohima - the nearest end of the project corridor has 4 no, of major quarry location as tabulated in Table 11 with the quantity and lead distance. The Rate of 40mm is 105/Cft, 25mm is 100/Cft, 20mm is 99/Cft,10mm is 101.54/Cft but as per the local enquiry from the

quarry owner the rate of 40mm, 25mm, 20mm, & 10mm is 42/Cft, 37/Cft, 36/Cft & 37/Cft in the four nos of quarry location & the Quarry Owner was not interested to share the Royalty. The lead map is given **in Figure 1.4.**

**Stone Quarries in Jessami Area :**

Inventory survey reveals that Pfutsero, with a minimum average distance of 132km from Kohima - starting point of the project corridor has 1 no, of major quarry location as tabulated in Table 11 with the quantity and lead distance The Rate of 40mm is 115/Cft, 25mm is 112/Cft, 20mm is 111/Cft, 10mm is 113/Cft, but as per the local enquiry from the quarry owner the rate of 40mm, 25mm, 20mm, & 10mm is 40/Cft, 39/Cft, 36/Cft & 37/Cft & the Quarry Owner was not interested to share the Royalty .The lead map is given in **Figure 1.5.**

**Table 1.10. Test results of Fine Aggregate**

| Test Result of Fine Aggregate (Sand) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Identification Number | Quarry Name / Location | Gradation Test % of Passing | | | | | | | Zone Classification | Fineness Modules | Sp. Gravity | Water Absorption (%) | Bulk Density (Loose Weight) kg/lit | Bulk Density (Compacted Weight) kg/lit | Moisture Content (%) at Bulk Density Test Time |
| | | 10 mm | 4.75 mm | 2.36 mm | 1.18 mm | 0.600 mm | 0.300 mm | 0.150 mm | | | | | | | |
| FA/01 | Dhansiri River/ Dimapur | 100.00 | 97.89 | 86.85 | 59.62 | 29.21 | 12.32 | 0.89 | I | 3.132 | 2.641 | 1.16 | 1.479 | 1.649 | 0.98 |
| FA/02 | Dhansiri River / Dimapur | 100.00 | 98.12 | 86.25 | 63.36 | 22.32 | 10.02 | 0.75 | I | 3.192 | 2.638 | 1.12 | 1.475 | 1.612 | 0.92 |
| FA/03 | Dhansiri River / Dimapur | 100.00 | 100.00 | 91.55 | 75.20 | 38.20 | 15.36 | 1.33 | II | 2.784 | 2.623 | 1.28 | 1.441 | 1.623 | 1.02 |
| FA/04 | Dhansiri River / Dimapur | 100.00 | 96.12 | 80.55 | 63.25 | 29.32 | 10.02 | 0.91 | I | 3.198 | 2.646 | 1.10 | 1.486 | 1.608 | 0.97 |
| FA/05 | Dhansiri River / Dimapur | 100.00 | 100.00 | 93.25 | 81.24 | 42.35 | 14.26 | 1.02 | II | 2.679 | 2.632 | 1.19 | 1.462 | 1.613 | 1.05 |

**Table 1.11. Quarry Location of Stone Material**

| Sl no | Chainage | Quarry name/ Owner Name | Available Course Aggregate (mm) | Capacity (Cum) | Quantity ( cum) | Distance from the project road (m) |
|---|---|---|---|---|---|---|
| 1 | 36+000 | Chakabama/ Mr V.Puro | 40,25, 20,10, Stone Dust | 10800 | 6000 | 20 |
| 2 | 64+000 | Pfutsero/ Mr. Azo | 25, 20,12.5, stone dust | 12500 | 7500 | 50 |
| 3 | 65+800 | Pfutsero/ Mr. Kezo | 40,25, 20,10, stone dust | 11300 | 6300 | 50 |
| 4 | 67+600 | Pfutsero/ Mr. Niba | 40,25, 20,10, stone dust | 10500 | 4300 | 50 |
| 5 | 69+500 | Pfutsero/ Mr. Dhanecho | 25, 20,10, stone dust | 13200 | 7600 | 40 |
| 5 | 121+000 | Jessami/ Mr Azo Minister | 40,25, 20,10, Stone Dust | 11000 | 7800 | 20 |

## Table 1.12. Test Result of Coarse Aggregate

| Identification Number | Quarry Name / Location (km) | Size of Aggregate (mm) | Gradation Test % of Passing | | | | | | | | | | | Sp. Gravity | Water Absorption (%) | Aggregate Impact Value (% | Flakiness Index (%) | Elongation Index (%) | Flakiness Index + Elongation Index (%) | Striping Value (%) | Soundness (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 40 mm | 20 mm | 12.50 mm | 10 mm | 4.75 mm | 2.36 mm | 1.18 mm | 0.600 mm | 0.300 mm | 0.150 mm | 0.075 mm | | | | | | | | |
| CA/01 | Chakabama / 36+000 | 20 | 98.1 | 73.8 | - | 8.26 | 1.15 | - | - | - | - | - | - | 2.69 | 1.26 | 13.88 | 15.39 | 27.55 | 42.94 | Area Coated >85% | 6.1 |
| | | 10 | - | - | 96.35 | 73.7 | 5.86 | 1.15 | - | - | - | - | - | 2.656 | 1.5 | 15.13 | 21.66 | 35.52 | 57.18 | Area Coated >90% | 7 |
| | | Stone Dust | - | - | - | 100 | 92.4 | 80.8 | 68 | 47.53 | 37.01 | 25.58 | 18.29 | 2.641 | 1.67 | - | - | - | - | - | - |
| CA/02 | Pfutsero / 64+000 | 20 | 100 | 74.6 | - | 9.32 | 1.02 | - | - | - | - | - | - | 2.695 | 1.39 | 14.68 | 13.55 | 24.56 | 38.11 | Area Coated >90% | 6.88 |
| | | 10 | - | - | 98.81 | 70.2 | 8.68 | 2.22 | - | - | - | - | - | 2.663 | 1.41 | 14.66 | 18.82 | 30.22 | 49.04 | Area Coated >85% | 6.45 |
| | | Stone Dust | - | - | - | 98.8 | 94.6 | 85.3 | 73.3 | 51.24 | 38.63 | 26.62 | 19.12 | 2.629 | 1.66 | - | - | - | - | - | - |
| CA/03 | Pfutsero / 65+800 | 20 | 95.1 | 82.9 | - | 6.99 | 0.97 | - | - | - | - | - | - | 2.672 | 1.29 | 14.21 | 18.62 | 17.22 | 35.84 | Area Coated >85% | 6.33 |
| | | 10 | - | - | 93.89 | 72 | 6.32 | 1.55 | - | - | - | - | - | 2.646 | 1.49 | 15.35 | 24.26 | 33.32 | 57.58 | Area Coated >90% | 7.51 |
| | | Stone Dust | - | - | - | 100 | 94 | 81.2 | 70.7 | 48.96 | 39.65 | 23.32 | 15.69 | 2.631 | 1.75 | - | - | - | - | - | - |
| CA/04 | Pfutsero / 67+600 | 20 | 100 | 81.2 | - | 10.1 | 1.88 | - | - | - | - | - | - | 2.706 | 1.5 | 15.65 | 15.52 | 20.32 | 35.84 | Area Coated | 7.67 |

| Identification Number | Quarry Name / Location (km) | Size of Aggregate (mm) | Gradation Test | | | | | | | | | | | Sp. Gravity | Water Absorption (%) | Aggregate Impact Value (% | Flakiness Index (%) | Elongation Index (%) | Flakiness Index + Elongation Index (%) | Striping Value (%) | Soundness (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | % of Passing | | | | | | | | | | | | | | | | | | |
| | | | 40 mm | 20 mm | 12.50 mm | 10 mm | 4.75 mm | 2.36 mm | 1.18 mm | 0.600 mm | 0.300 mm | 0.150 mm | 0.075 mm | | | | | | | >90% | |
| | | 10 | - | - | 100 | 80.9 | 3.68 | 0.89 | - | - | - | - | - | 2.681 | 1.68 | 16.21 | 19.96 | 27.16 | 47.12 | Area Coated >90% | 7.11 |
| | | Stone Dust | - | - | - | 100 | 91.9 | 85.7 | 71.3 | 49.63 | 40.09 | 25.62 | 17.25 | 2.652 | 1.76 | - | - | - | - | - | - |
| CA/05 | Pfutsero / 69+500 | 20 | 100 | 75.9 | - | 10.1 | 1.15 | - | - | - | - | - | - | 2.683 | 1.4 | 12.21 | 16.62 | 23.15 | 39.77 | Area Coated >91% | 6.59 |
| | | 10 | - | - | 97.52 | 77.9 | 4.96 | 1.33 | - | - | - | - | - | 2.663 | 1.33 | 11.65 | 15.52 | 30.33 | 45.85 | Area Coated >87% | 7.01 |
| | | Stone Dust | - | - | - | 100 | 95.9 | 86.6 | 73.6 | 49.66 | 38.35 | 26.65 | 18.66 | 2.642 | 1.65 | - | - | - | - | - | - |

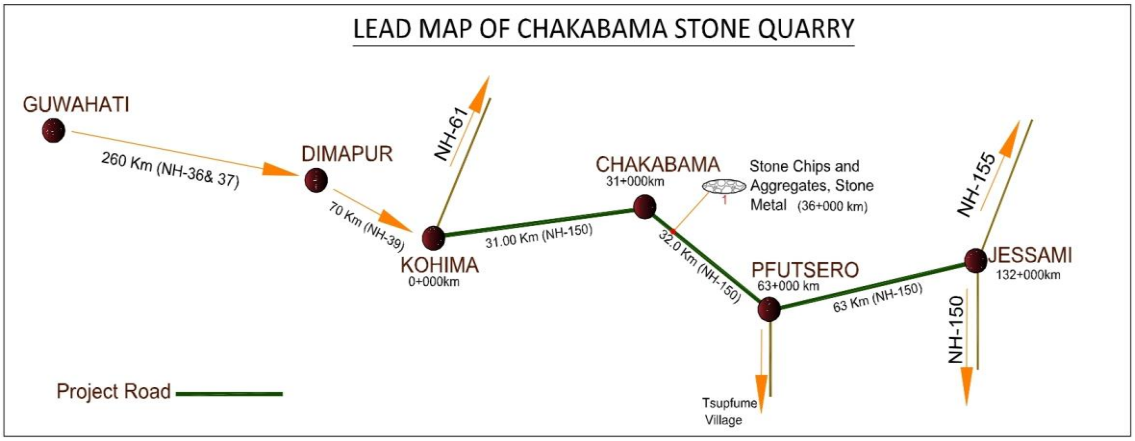


**Figure 1.3 Chakabama Lead map**

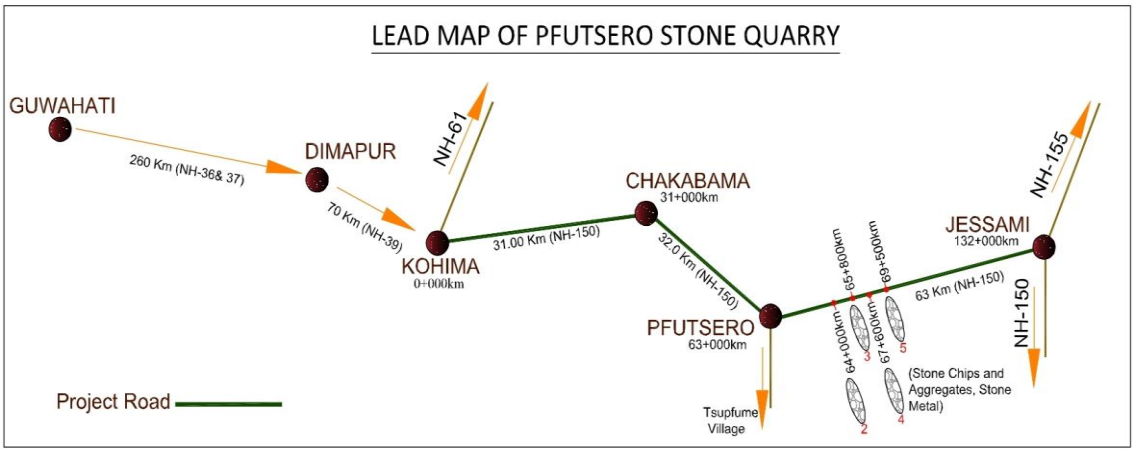


**Figure 1.4 Pfutsero Lead Map**

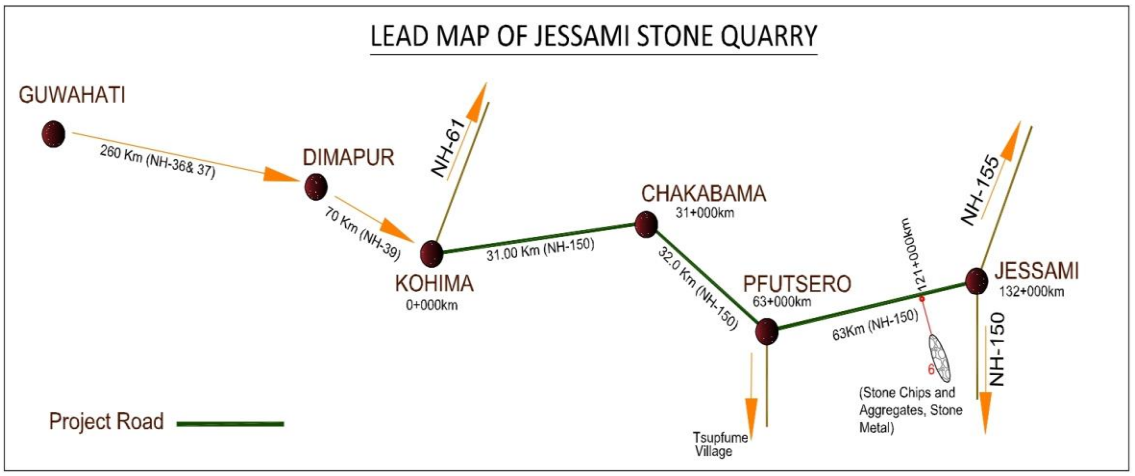


**Figure 1.5 Jessami Lead Map**

**Bitumen:**

Inventory survey reveals that Guwahati, with a distance of 330 km from Kohima-the nearest end of the project corridor where Bitumen is available in good quantity. The lead map is given in **Figure 1.6.**

**Moorum:**

Inventory survey reveals that good quality moorum is available near Tsupfume village beyond the project corridor on NH-150. Tsupfume with a 300m distance from Pfutsero town on the project road. The lead chart is given in **Figure 1.6.**

**Fly ash:**

Fly ash is readily available in Guwahati in sufficient quantity. The Lead distance of Guwahati from the nearest end Kohima, of the project corridor is 330km. The lead chart is given in **Figure 1.6.** Summary of fly ash test results are given in **Table 1.13.**

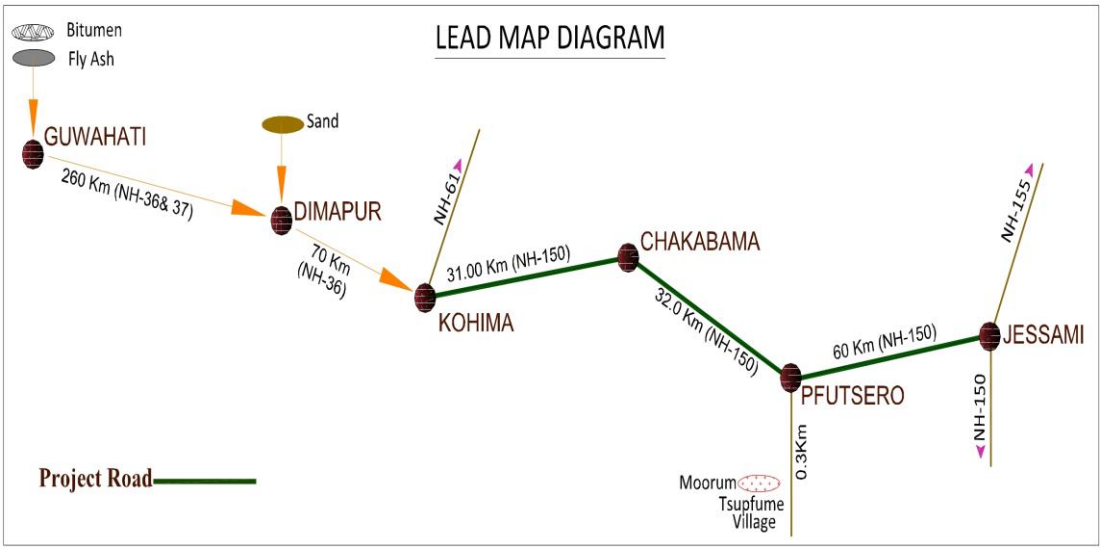


**Figure 1.6: Lead map of Sand, Moorum, Bitumen, Fly ash**

**Table 1.13. Summary of Fly Ash Test Results**

| Identification Number | Source of Place / Location | Gradation Test | | | | | | | | | | | | | Sp. Gravity | Proctor Density | | Consolidation | | | Permeability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % of Passing | | | | | | | | | Gravel Size Particles (%) | Sand Size Particles (%) | Silt Size (%) | Clay Size (%) | | OMC (%) | MDD (gm/cc) | EO | CC | Coefficient of Consolidation Cv | |
| | | 10 mm | 4.75 mm | 2.00 mm | 1.18 mm | 0.600 mm | 0.425 mm | 0.300 mm | 0.150 mm | 0.075 mm | | | | | | | | | | | |
| Flyash/ 01 | Guwahati | 100 | 100 | 100 | 100 | 100 | 100 | 97.81 | 94.22 | 86.02 | 0 | 14 | 83 | 3 | 2.11 | 26 | 1.189 | 0.71 | 0.0137 | $6.10\times10^{-7}$ | $3.30\times10^{-7}$ |
| Flyash /02 | Guwahati | 100 | 100 | 100 | 100 | 100 | 100 | 99.35 | 95.25 | 88.02 | 0 | 12 | 84 | 4 | 2.13 | 27.6 | 1.194 | 0.58 | 0.0185 | $5.6\times10^{-7}$ | $4.1\times10^{-7}$ |

## 1.6 EXHIBITS OF THE INVESTIGATIONS

Test Pit at Km 29+675 on RHS

DCPT at Km 43+730 on RHS

Measuring the existing crust composition at Km 43+730 on RHS

Test pit & DCPT at Km 48+825

Field Dry Density Test at Km 54+140

DCPT at Km 54+140

| | |
|---|---|
|  |  |
| Measurement of pavement thickness at Km 59+000 LHS | DCPT at Km 63+150 on RHS |
|  |  |
| Measurement of existing crust at Km 63+150 on RHS | DCPT at Km 86+025 on LHS |
|  |  |
| Measurement of Dry Density at Km 86+025 on LHS | Measurement of Pavement Crust thickness at Km 95+450 on RHS |

| | |
|---|---|
|  |  |
| Test pit at Km 95+450 on RHS | Test pit at Km 101+600 on RHS |
|  |  |
| Measurement of existing crust composition at KM 101+600 on RHS | DCPT at KM 107+500 on RHS |
|  |  |
| Measurement of crust composition at Km 107+500 on RHS | DCPT at Km 114+960 on RHS |

| | |
|---|---|
|  |  |
| Measurement of existing crust composition at Km 114+960 on RHS | Open field at Km 67+679 on LHS |
|  |  |
| Borrow area on hillock at Km 116+500 on LHS | Stockyard of Chakabama stone quarry at Km. 36+000 on LHS |
|  |  |
| Dhansiri river in Dimapur which is located beyond the project road with an abundance of sand. | Stockyard of sand in Dimapur with a distance of 70 Km from the nearest end of the project road Kohima. |