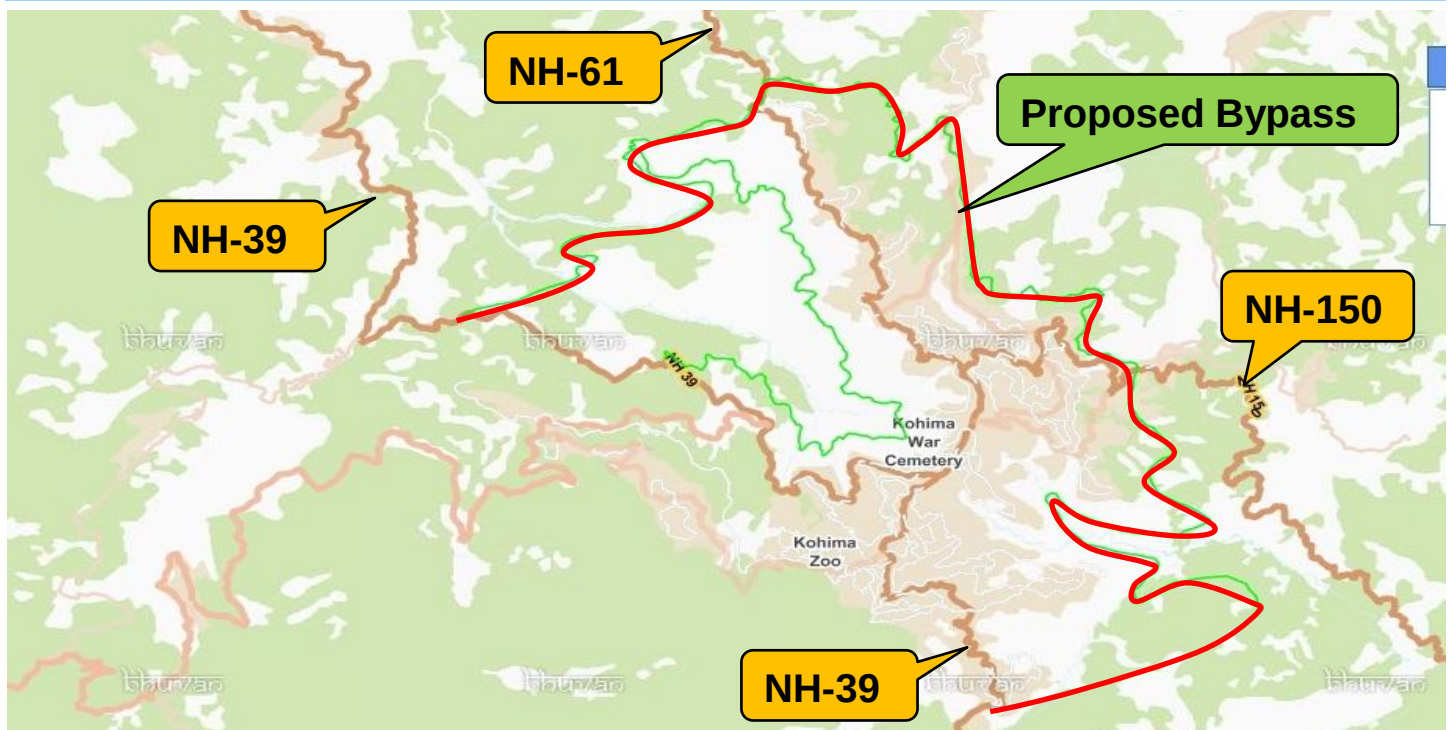


Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of **Kohima Bypass** connecting NH-39 (New NH-02), NH-150 (New NH-02), NH-61 (New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland.



FINAL DETAILED PROJECT REPORT

MATERIAL REPORT (VOLUME-III)

OCT 2018



In Association with



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Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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ABBREVIATIONS

ADT	-	Average Daily Traffic
BBD	-	Benkelman Beam Deflection
BM	-	Bench Mark
BOQ	-	Bill of Quantities
CBR	-	California Bearing Ratio
DCP	-	Dynamic Cone Penetrometer
DPR	-	Detailed Project Report
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
GDP	-	Gross domestic product
GPS	-	Global Positioning system
GTS	-	Geodetic Triangulation Survey
HDM	-	Highway Design and Maintenance
HDMQ	-	Highway Design & Maintenance Model with Congestion Analysis Capabilities.
HFL	-	High Flood Level
ICB	-	International Competitive Bidding
IDA	-	International Development Agency
IRC	-	Indian Road Congress
LA	-	Land Acquisition
LIDAR	-	Light Detection and Ranging
LCB	-	Local Competitive Bidding
MOEF	-	Ministry of Environment and Forests
M/O RT & H	-	Ministry of Road Transport and Highways
MSA	-	Million Standard Axles
NHAI	-	National Highway Authority of India
NPT	-	Net Present Value
PCU	-	Passenger Car Unit
PESS	-	Preliminary Environmental Screening Study
PIU	-	Project Implementation Unit
PPR	-	Preliminary Project Report
PQ	-	Pre-Qualification

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RAP	-	Resettlement Action Plan
RCC	-	Reinforced Cement Concrete
ROB	-	Road Over Bridge
RUB	-	Road under Bridge
SIA	-	Social Impact Assessment
TOR	-	Terms of Reference
VDF	-	Vehicle Damage Factor
WB	-	World Bank

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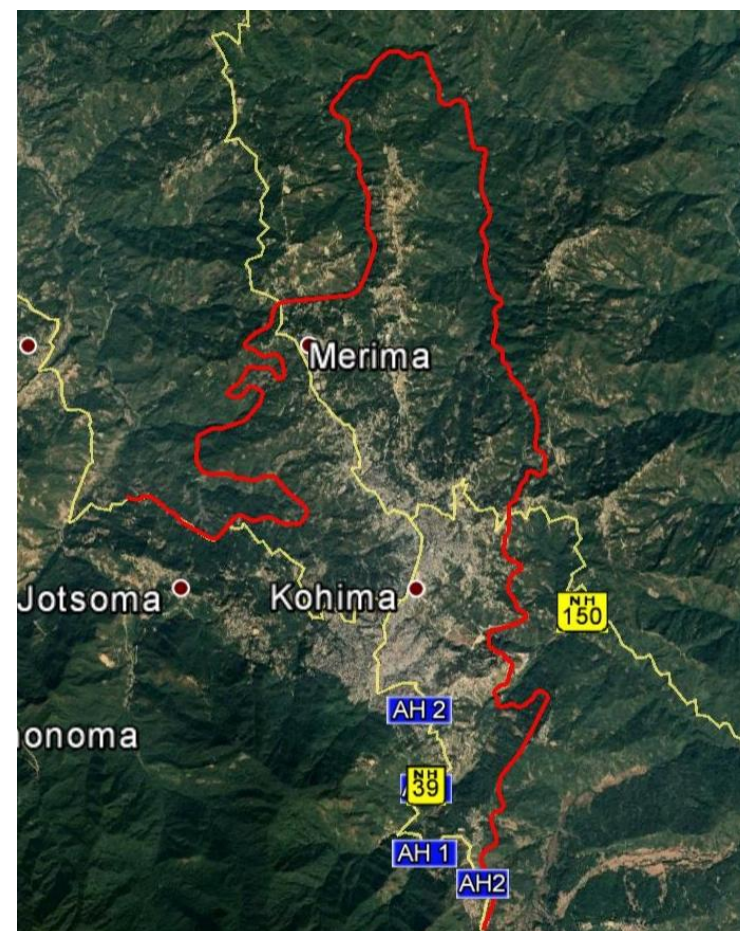
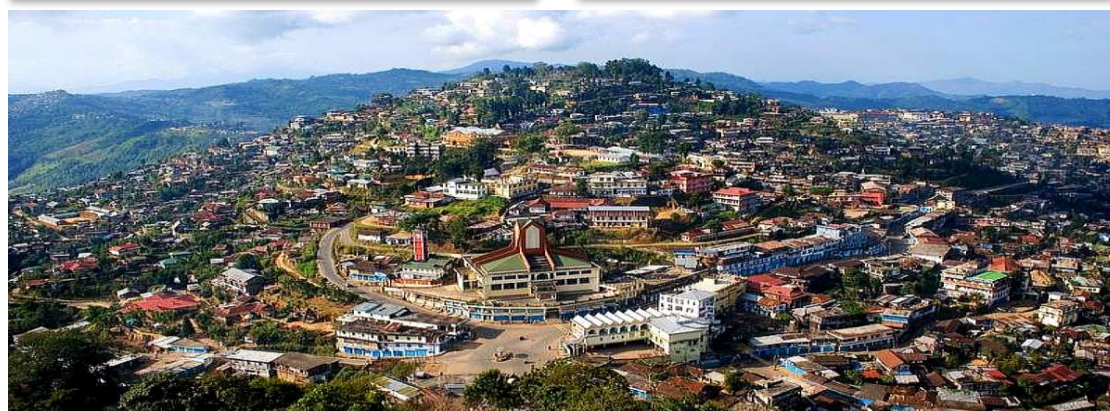
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Chapter 1- INTRODUCTION

1.0 INTRODUCTION

1.0 Location Map



1.1 Project Background

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavily congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road does not have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

The objective of soil & 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 soil & materials relevant to the project as per MoRT&H specifications.

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.

1.2 Scope of Works under Materials

The scope of work under Materials as per Terms of Reference (TOR) is as follows:-

- i) Identification of sources (including use of fly-ash/ slag), quarry sites and borrow areas;
- ii) Field and laboratory testing of the materials to determine their suitability for various components of the work and establish quality and quantity of various construction materials and recommend their use on the basis of techno-economic principles;
- iii) Preparation of mass haul diagram for haulage purposes giving quarry charts indicating the location of selected borrow areas, quarries and the respective estimated quantities;
- iv) Recommendations regarding making good, the borrow and quarry areas after the exploitation of materials for construction of works;

1.3 Chainage Referencing in case of variation from Existing Condition

Entire project is new alignment so chainage referencing is not required.

1.4 Approach to Soil & Material Survey

For soil investigation, test pit investigations were carried out at the interface of main carriageway and earthen shoulder at every 2.5 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 and borrow areas.

- a) In-situ Moisture Content
- b) Details of pavement layer composition
- c) Laboratory soil characterization (Grain size and Atterberg's 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

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. The source of materials is as given below:

1. Moorum (Granular Deposit for construction of Sub-Base) – Joytsma
2. Aggregates (For Base and wearing courses) - Joytsma
3. Sand - Dimapur
4. Water – Local

The samples collected from these identified moorum 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%

The following tests were conducted on Aggregate from Quarry:

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

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Chapter 1- INTRODUCTION

- 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
 - Soundness in case water absorption of coarser fraction is found more than 2%
- The following tests were conducted on sand samples:
- Sieve analysis and calculation of fineness modulus.

1.5 Stages of Submission

The Project has to be completed in four stages as described herein below:

1. Inception Report
2. Feasibility Report
3. Project Related Clearances
4. Detailed Project Report (DPR)

1.6 Structure of Draft Detailed Project Report

Draft Detailed Project Report (DDPR) consists of following Volumes as per TOR:-

S.No	Volume No.	Description
1	Volume-I& I/A	Main Report with Annexures
2	Volume-II (Part-II/A)	Design Report-Roads
3	Volume-II (Part-II/B)	Design Report-Bridges
4	Volume-III	Material Report
5	Volume-IV	Environmental Impact Assessment (EIA) Report and EMP
6	Volume-IV/A	Social Impact Assessment Report (SIA)
7	Volume-V	Technical Specifications
8	Volume-VI	Rate Analysis
9	Volume-VII	Cost Estimates
10	Volume-VIII	Bill of Quantities
11	Volume-IX	Drawing Volume
12	Volume-X	Civil Works Contract Agreement
13	Volume-XI	Project Clearances

Volume-III: Material Report will contain following chapters:

S.No	Chapter No.	Description
1	Chapter-0	Executive Summary

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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Chapter 1- INTRODUCTION

S.No	Chapter No.	Description
2	Chapter-1	Introduction
3	Chapter-2	Preliminary studies
4	Chapter-3	Scope of studies
5	Chapter-4	Quarry Materials for construction
6	Chapter-5	Manufactured Materials

2.0 PRELIMINARY STUDIES

2.1 General

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavily congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road does not have any major impact on the project.

2.2 Baseline Information

The horizontal alignment of the project predominantly traverses through mountaneous terrain. There are some stretches where the alignment traverses through hilly terrain.

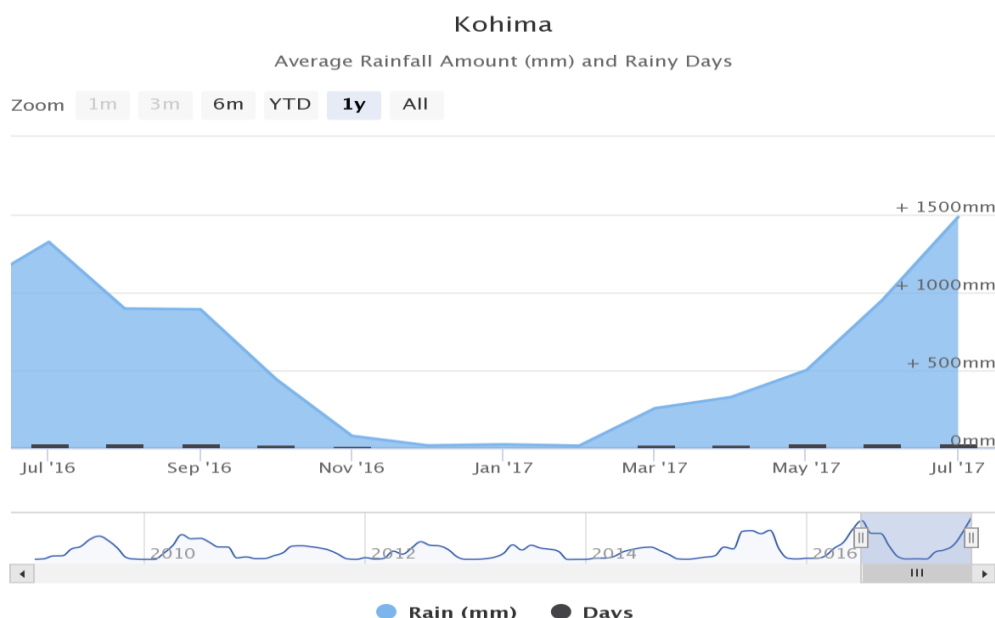
Drainage pattern in the area along the project road vary according to topography. The road drainage is toward the natural ground all along the corridor. There is hardly any lined drain present. There are 7 nos of bridges 2 underpasses and 163 nos of culverts are present on the project road.

The project road is bypass of capital city Kohima.

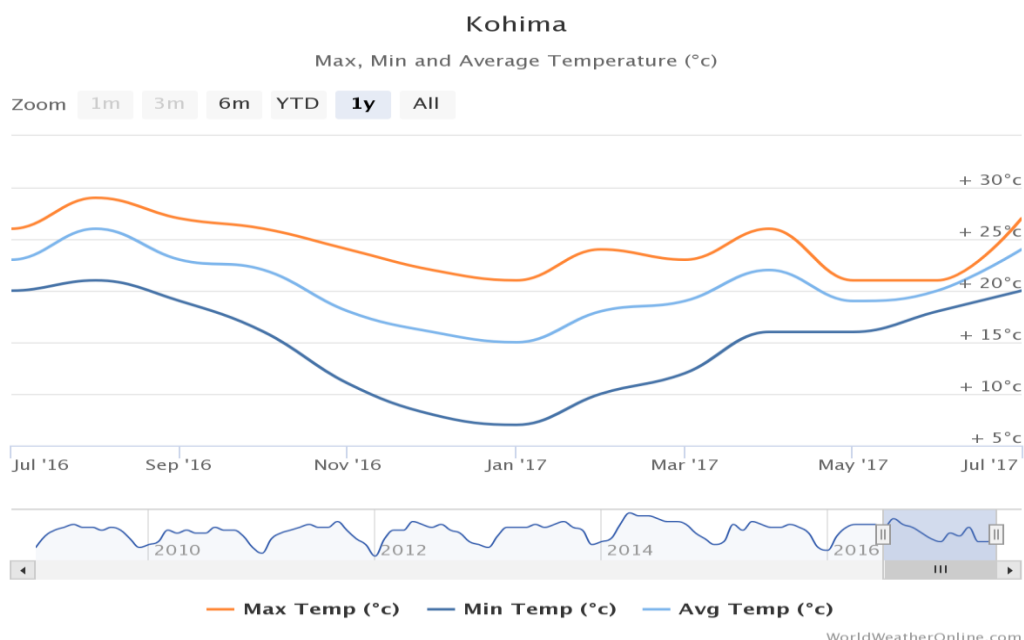
2.3 Climate

As the elevation of the district is approximately 1500 meters above sea level the climate of the district very largely depend on altitude.

Rainfall –Heavy rainfall occur during summer(heavy from June to August). Average rainfall occurs 1831mm per year.

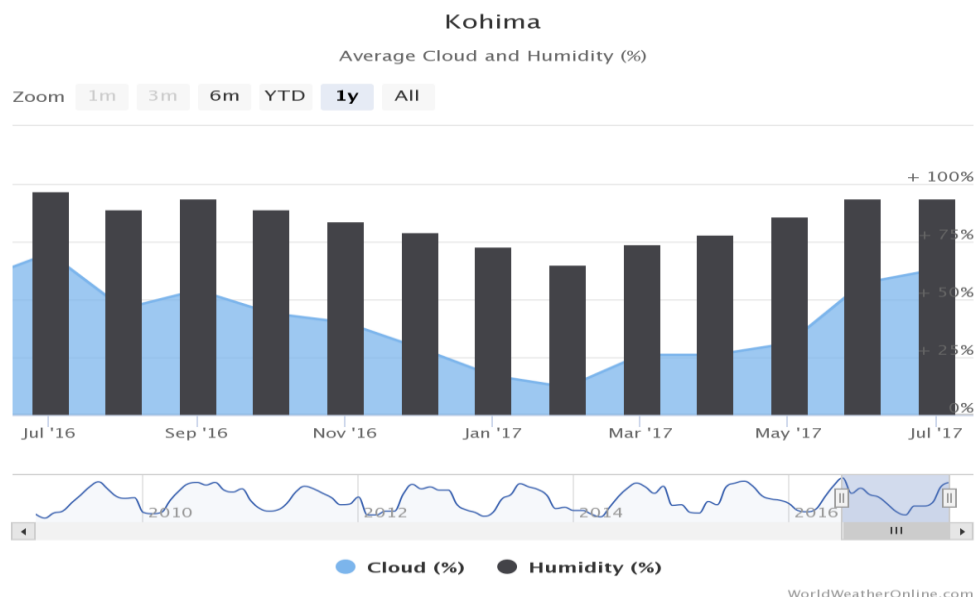


Temperature - The details of temperature recorded at the meteorological observatories in the district show that the highest temperature was 34 degree Celsius and lowest 1 degree Celsius. January is the coldest month after which the temperature begin to rise till June or July. Temperature vary with elevation.

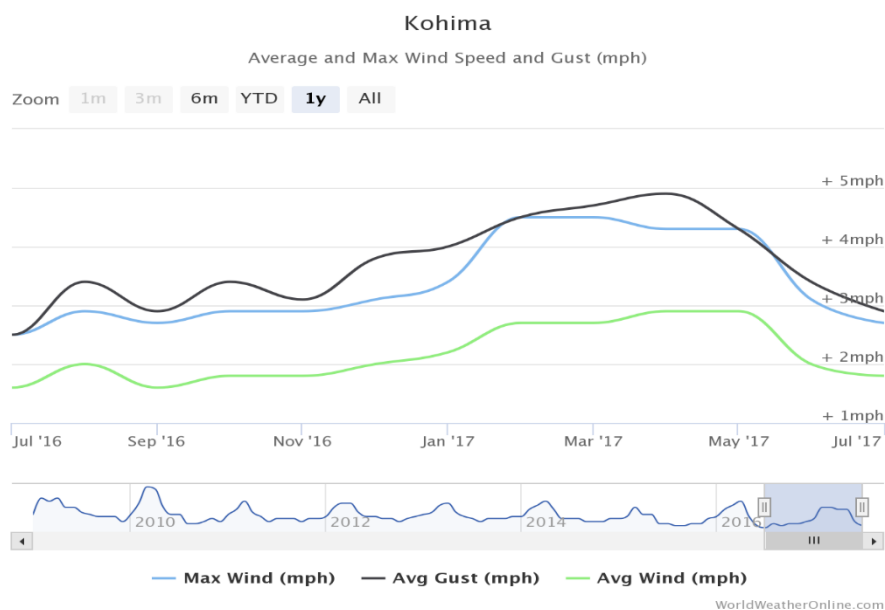


Humidity - The relative humidity is high during monsoon season, generally exceeding 70% on the average. The driest part of the year is the pre monsoon period when the humidity may drop to 35% during the afternoon. During the winter months humidity increases toward the afternoon at certain high stations.

Cloudiness - Skies are heavily clouded during the monsoon months and for short spells when the region is affected by the passage of western disturbances. During the rest of the year the skies are generally clear to lightly clouded.



Winds - Owing to the nature of terrain local affect are pronounced and when the general prevailing winds not too strong to mask these effect, there is a tendency for diurnal reversal of winds, the flow being anabatic during the day and katabatic at night, the latter being of considerable force



2.4 Tests & Specifications

The tests & Specifications are as listed below:

- (a) Physical Requirements of Coarse Aggregates (base & surface bituminous courses)

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Chapter 2- PRELIMINARY STUDIES

Test	Test Method	Requirement
Los Angles Abrasion Value	IS:2386 (Pt.4)	Max. 40%
Aggregate Impact value	IS:2386 (Pt.4)	Max. 30%
Flakiness & Elongation	IS:2386 (Pt.1)	Max. 30%
Soundness Test	IS:2386 (Pt.5)	Max. 12%
Water Absorption	IS:2386 (Pt.3)	Max. 2%

(b) Physical Requirements of Granular Sub-base.

Test	Test Method	Requirement
Water Absorption	IS:2386 (Pt.3)	Max. 2%
10% fine value test (in case found suitable for GSB)	BS:812 (Pt.111)	Min. 50KN
LL & PI	IS:2720(Pt.5)	Max. 25% & 6%
Soundness Test	IS:383	Max. 12%
CBR %	IS:2720	Min. 30%

3.0 SCOPE OF STUDIES

3.1 General

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

1. Pavement Investigations
2. Soil and Material Investigations
3. Geotechnical Investigations

The basic data and results of investigations are compiled and included as “Appendices”.

3.2 Scope of Investigations as per TOR

The scope of work under Subgrade soil as per Terms of Reference (TOR) is as follows:-

- a. Test pit investigations at the interface of main carriageway and on natural ground for widening ;
- b. Composition of Existing Pavement;
- c. Laboratory testing to ascertain the existing physical and strength condition of the sub-grade;

The scope of work under Materials as per Terms of Reference (TOR) is as follows:-

- Identification of sources (including use of fly-ash/ slag), quarry sites and borrow areas;
- Field and laboratory testing of the materials to determine their suitability for various components of the work;
- establish quality and quantity of various construction materials and recommend their use on the basis of techno-economic principles;

3.3 Methodology

3.3.1 Test Pits for Existing Subgrade

Test pit investigations were carried out at the interface of main carriageway 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.

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Chapter 3- SCOPE OF STUDIES

The pavement composition of the carriageway was measured and the thickness of each layer was recorded in the format specified in QAP.

The pavement composition is presented in Table-3.1 below.

3.3.2 Composition of Existing Pavement

Though it is a new alignment existing pavement composition detail is not available.

Table 3.1: Existing Pavement Composition

Chainage	Position of Pit	Pavement Composition			Total (mm)
		Bitumen Layer (mm)	Base Course (mm)	Sub base Course (mm)	
NIL					

3.3.3 Test Results – Existing Subgrade

Laboratory Tests on Subgrade Soil

Classification:

The soil classification of existing Subgrade clearly shows the presence of SC (Silty Clay) soil along the project area.

The summary laboratory results of subgrade samples are given in **Table – 3.2** below

The detailed laboratory test results for the Subgrade have been presented as **Appendix-3.5** of Volume-I(A) (Appendix Volume to Main Report).

3.3.4 Recommendations on Design Parameters for Existing Subgrade

The CBR (%) of Subgrade Soil along the project road is 8% to 19%. CBR of 10% is considered for design.

3.4 Geotechnical Investigation

A Geotechnical investigation has been performed at every location of abutment for bridges and several locations suggested by geologist for landslides. The result of geotechnical investigation is attached with this report as annexure.

4.0 QUARRY MATERIALS FOR CONSTRUCTION

4.1 Material Investigations

Desk study was carried out after obtaining available data, documents and information of Quarry sites was available in PWD, Nagaland

4.2 Objectives

The objective of the material survey was to:-

- (i) Locate potential sources of 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 specifications.

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

4.3 Location and Description of Aggregate Quarries

The sources of materials are as given below:

Moorum (Granular Deposit for construction of Sub-Base) - Joytsma

Aggregates (For Base and wearing courses) - Joytsma

Sand - Dimapur

Water - Local

Bitumen - Guwahati

Cement - Dimapur

Steel - Guwahati

4.4 Laboratory Tests

A) The samples collected from these identified moorum 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
 - Soundness in case water absorption of coarser fraction is found more than 2%
- C) The following tests were conducted on sand samples:
- Sieve analysis and calculation of fineness modulus.

4.5 Results & Discussions on Aggregate Quarries

Aggregates (for Base & Wearing Courses): Altogether nine aggregate samples were collected 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 can be used for bituminous works and for non-bituminous works. Test results are shown in **Table-5.1C** (attached at the end of this chapter)

4.6 Sand Quarries

Sand:The test result of sand samples shown in **Table-5.2** 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.

4.7 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 collected along the project road 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 -5.1A** 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 -5.1B** attached at the end of this chapter)

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Chapter4 - QUARRY MATERIALS FOR CONSTRUCTION

Table-5.1C: 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 sulphate) (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	Along the project road
AQ-II	Aggregate 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	Aggregate 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	Aggregate size more than 90mm				-	0.96	2.99	13.00	<95%	>95%	5.39	
AQ-IX	Aggregate size more than 90mm				-	3.96	2.55	14.72	>95%	-	71.44	

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Chapter4 - QUARRY MATERIALS FOR CONSTRUCTION

Table- 5.2: 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

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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Chapter 5- MANUFACTURED MATERIAL

5.0 MANUFACTURED MATERIALS

5.1 General

The Project road is situated in remote location of North Eastern Region of India, so, the item has to be brought from Dimapur (Nearest major town) or Assam.

5.2 Cement

Cement of Grade33, Grade 43 and Grade 53 of leading brands are available in Dimapur. Manufacturer's test/ quality certificate is needed for each consignment of all the materials received.

5.3 Steel

HYSD steel as per IS: 432 of leading brands are available in Guwahati. Manufacturer's test/ quality certificate is needed for each consignment of all the materials received.

5.4 Bitumen

Bitumen & emulsion are available in Guwahati and can be procured either from there or directly from any manufacturer of repute. Manufacturer's test/ quality certificate is needed for each consignment of all the materials received.

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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RESULT OF GEOTECHNICAL INVESTIGATION

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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SUMMARY OF DCP TEST ON SUBGRADE

Test Pit no.	Chainage	Direction	Depth Below Crust	FIELD CBR (%)	DCP CBR (%)
TP-1	Km. 0.00	UP/L	Upto 300 mm	87.57	9.45
			From 300 mm To 600 mm	83.60	
			From 600 mm To 900 mm	83.93	
TP-2	Km. 5.00	UP/L	Upto 300 mm	74.69	8.74
			From 300 mm To 600 mm	81.12	
			From 600 mm To 900 mm	80.29	
TP-3	Km. 10.0	UP/R	Upto 300 mm	78.64	8.95
			From 300 mm To 600 mm	81.61	
			From 600 mm To 900 mm	81.28	
TP-4	Km. 15.00	UP/L	Upto 300 mm	136.98	15.52
			From 300 mm To 600 mm	140.55	
			From 600 mm To 900 mm	141.40	
TP-5	Km. 20.00	UPR	Upto 300 mm	143.10	16.08
			From 300 mm To 600 mm	146.17	
			From 600 mm To 900 mm	144.81	
TP-6	Km. 25.00	UPR	Upto 300 mm	150.27	16.52
			From 300 mm To 600 mm	148.22	
			From 600 mm To 900 mm	147.54	
TP-7	Km. 30.00	UPR	Upto 300 mm	142.08	16.19
			From 300 mm To 600 mm	146.17	
			From 600 mm To 900 mm	148.90	
TP-8	Km. 35.00	UPR	Upto 300 mm	134.94	15.45
			From 300 mm To 600 mm	141.06	
			From 600 mm To 900 mm	141.06	
TP-9	Km. 40.00	UPR	Upto 300 mm	135.96	15.52
			From 300 mm To 600 mm	140.55	
			From 600 mm To 900 mm	142.42	

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -1

Km. 0.00

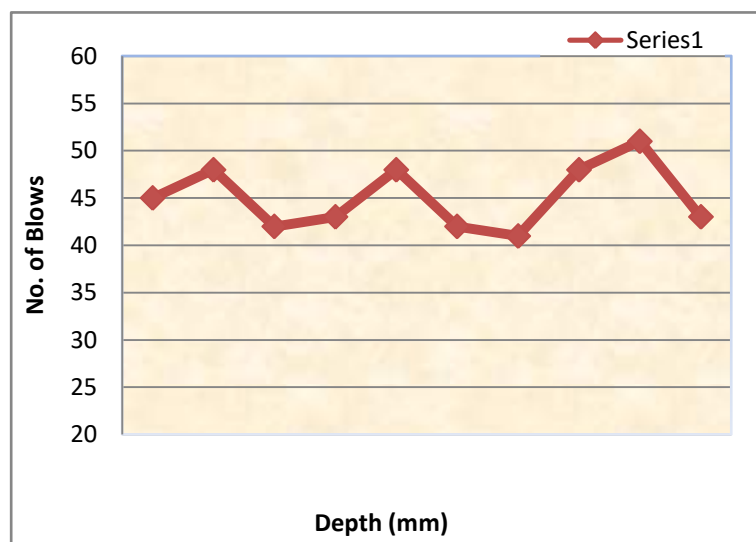
Field Moisture & Density

Date:- 17/09/2017	Depth- 1.50m
Field density (gm/cc)= 1.70 gm/cc	
Moisture % = 14.2 %	

Location:-

Km. 0.00

Starting Depth : Below Crust



Test Results			
Date:- 17/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	45	
2	300	48	93
3	450	42	
4	600	43	85
5	750	48	
6	900	42	90
7	1050	41	
8	1200	48	89
9	1350	51	
10	1500	43	94

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -2

Km. 5.00

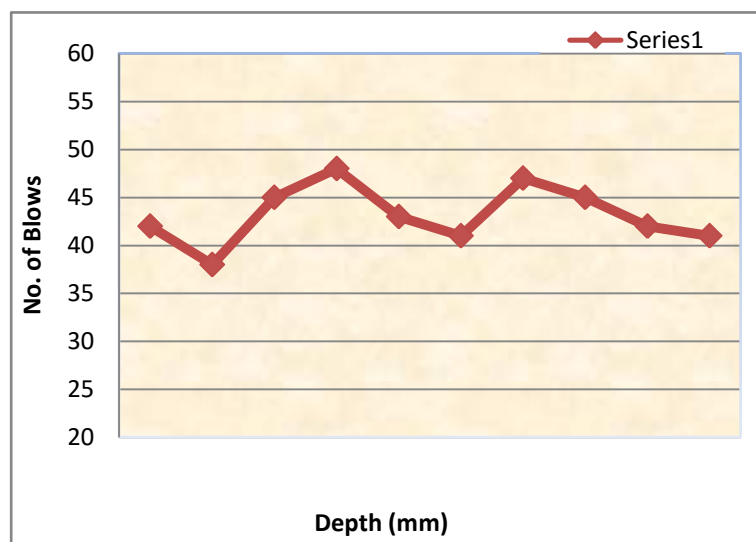
Field Moisture & Density

Date:- 17/09/2017	Depth- 1.50m
Field density (gm/cc)= 1.72 gm/cc	
Moisture % = 13.9 %	

Location:-

Km. 5.00

Starting Depth : Below Crust



Test Results			
Date:- 17/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	42	
2	300	38	80
3	450	45	
4	600	48	93
5	750	43	
6	900	41	84
7	1050	47	
8	1200	45	92
9	1350	42	
10	1500	41	83

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -3

Km. 10.0

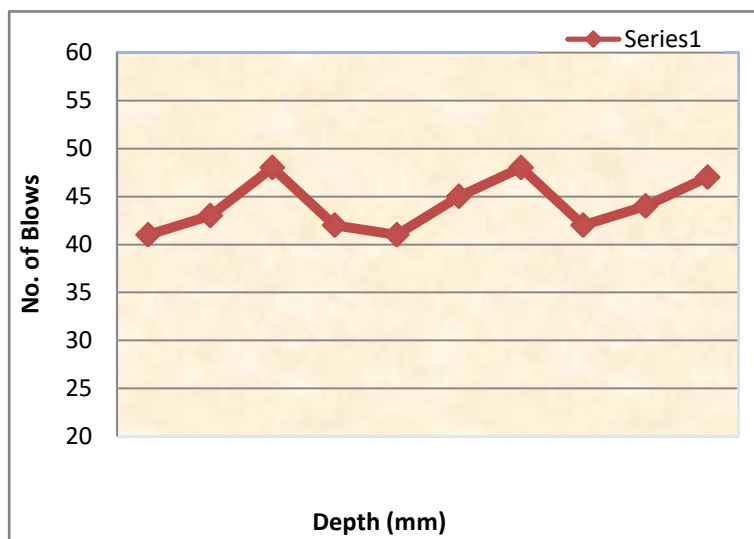
Field Moisture & Density

Date:- 18/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.80 gm/cc			
Moisture % = 11.9 %			

Location:-

Km. 10.0

Starting Depth : Below Crust



Test Results			
Date:- 18/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	41	
2	300	43	84
3	450	48	
4	600	42	90
5	750	41	
6	900	45	86
7	1050	48	
8	1200	42	90
9	1350	44	
10	1500	47	91

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -4

Km. 15.00

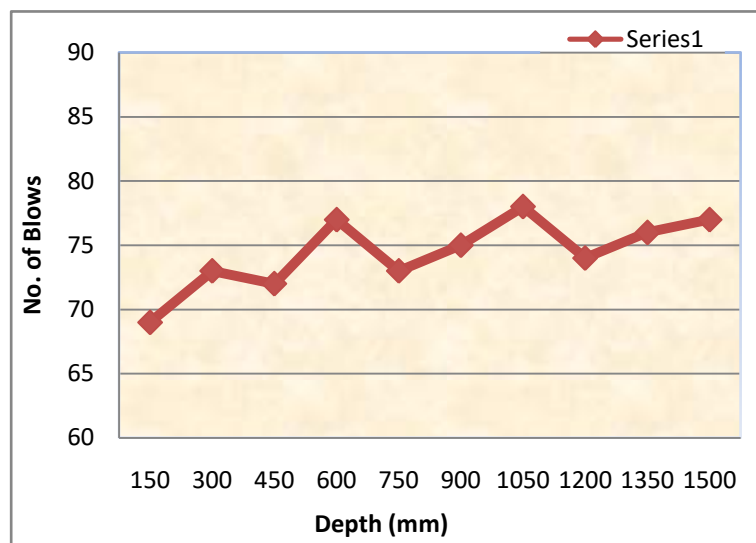
Field Moisture & Density

Date:- 18/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.69 gm/cc			
Moisture % = 14.1 %			

Location:-

Km. 15.00

Starting Depth : Below Crust



Test Results			
Date:- 18/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	69	
2	300	73	142
3	450	72	
4	600	77	149
5	750	73	
6	900	75	148
7	1050	78	
8	1200	74	152
9	1350	76	
10	1500	77	153

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -5

Km. 20.00

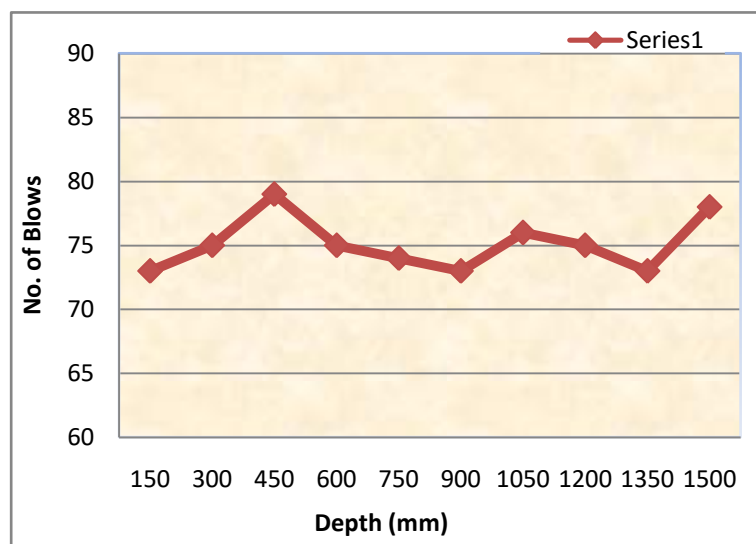
Field Moisture & Density

Date:- 16/09/2017	Depth- 1.50m
Field density (gm/cc)= 1.84 gm/cc	
Moisture % = 10.8 %	

Location:-

Km. 20.00

Starting Depth : Below Crust



Test Results			
Date:- 16/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	73	
2	300	75	148
3	450	79	
4	600	75	154
5	750	74	
6	900	73	147
7	1050	76	
8	1200	75	151
9	1350	73	
10	1500	78	151

DCP TEST REPORTS

TRIAL PIT NO -6

Km. 25.00

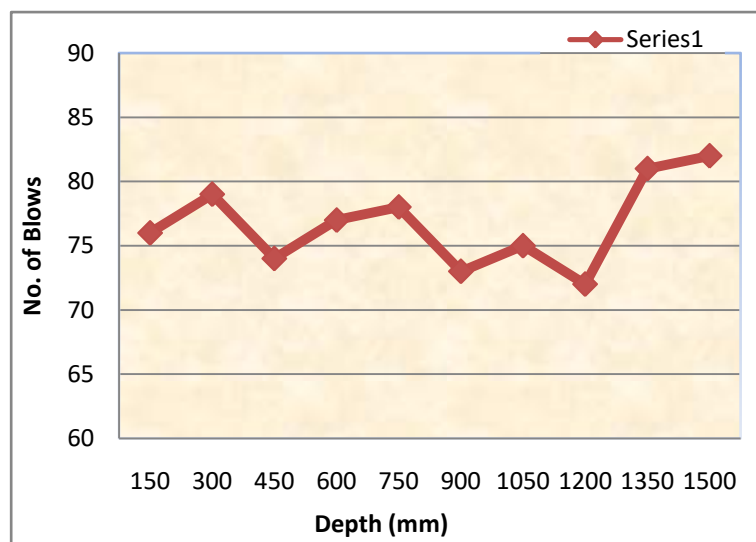
Field Moisture & Density

Date:- 16/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.87 gm/cc			
Moisture % = 10.5 %			

Location:-

Km. 25.00

Starting Depth : Below Crust



Test Results			
Date:- 16/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	76	
2	300	79	155
3	450	74	
4	600	77	151
5	750	78	
6	900	73	151
7	1050	75	
8	1200	72	147
9	1350	81	
10	1500	82	163

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -7

Km. 30.00

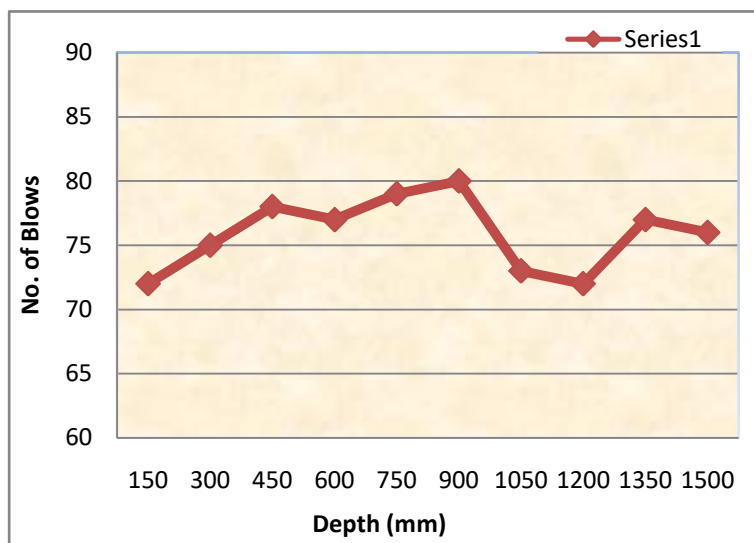
Field Moisture & Density

Date:- 15/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.88 gm/cc			
Moisture % = 10.2%			

Location:-

Km. 30.00

Starting Depth : Below Crust



Test Results			
Date:- 15/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	72	
2	300	75	147
3	450	78	
4	600	77	155
5	750	79	
6	900	80	159
7	1050	73	
8	1200	72	145
9	1350	77	
10	1500	76	153

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -8

Km. 35.00

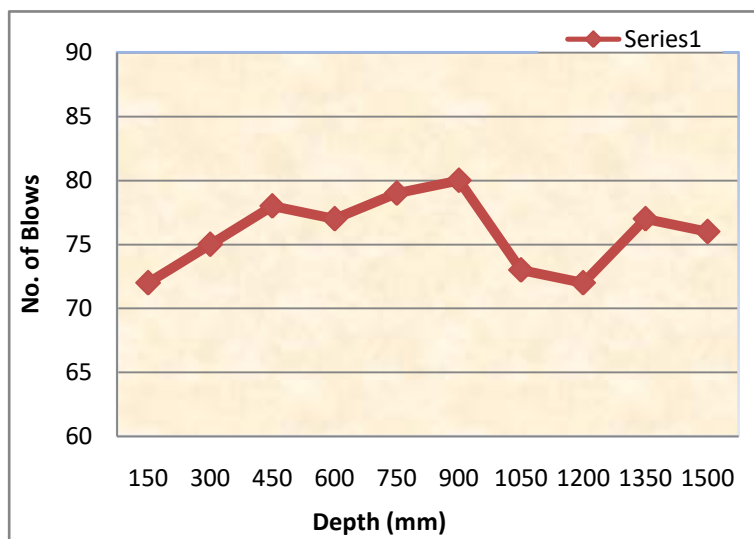
Field Moisture & Density

Date:- 15/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.88 gm/cc			
Moisture % = 10.2%			

Location:-

Km. 35.00

Starting Depth : Below Crust



Test Results			
Date:- 15/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	69	
2	300	71	140
3	450	77	
4	600	75	152
5	750	77	
6	900	79	156
7	1050	74	
8	1200	71	145
9	1350	73	
10	1500	74	147

Project: Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing preconstruction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering,Procurement and Construction (EPC) mode in the state of Nagaland

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DCP TEST REPORTS

TRIAL PIT NO -9

Km. 40.00

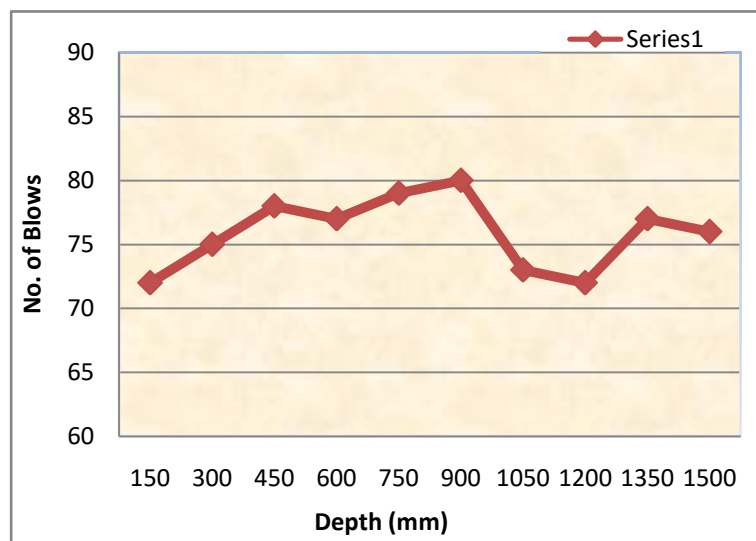
Field Moisture & Density

Date:- 15/09/2017		Depth- 1.50m	
Field density (gm/cc)= 1.88 gm/cc			
Moisture % = 10.2%			

Location:-

Km. 40.00

Starting Depth : Below Crust



Test Results			
Date:- 15/09/2017		DCPT No. - TP-1	
Starting Depth : 0.00		Wt. Fall : 8 Kg	
Sr. No	Depth (mm)	Blows (No)	N
1	150	69	
2	300	72	141
3	450	74	
4	600	76	150
5	750	74	
6	900	77	151
7	1050	75	
8	1200	74	149
9	1350	76	
10	1500	74	150

Marc Surveying System (P) L.T.D

(Topographical Survey & Civil Engineering Consultant)

2841 HBC, Sector 23, Sonapat (Haryana) 131001

Sr. No.	Sample No.	Chainage	Clay (%)	Sand (%)	Gravel (%)	OMC (%)	MDD (kN/m3)	CBR Unsoaked (%)	CBR Soaked (%)
1	Sample -1	1+000	42	29	29	11.21	20.5	14.15	9.84
2	Sample -2	2+000	50	25	25	12.02	20.21	13.08	8.32
3	Sample -3	3+000	40	30	30	10.75	20.15	14.05	9.14
4	Sample -4	4+000	45	28	28	11	20.41	14.01	8.94
5	Sample -5	5+000	50	25	25	11.7	20.23	13.08	8.52
6	Sample -6	6+000	47	27	27	11.32	20.5	15	9.08
7	Sample -7	7+000	45	28	28	11.35	20.48	13.81	8.12
8	Sample -8	8+000	50	25	25	11.7	20.1	13.09	8.42
9	Sample -9	9+000	43	28	28	10.75	20.48	14.12	8.61

SR. No.	SAMPLE NO	Chainage	SIDE	CUMULATIVE PERCENTAGE PASSING THROUGH						IS CLASSIFICATION	MDD g/cc	OMC %	ATTERBERG LIMIT			CBR VALUE AT 97 %
				75	19	4.75	2.36	0.425	0.075				LL	PL	PI	
8	KB-01	12+000	RIGHT	100	100	98	95	86	74	CI	1.89	15	40	25	15	14
9	KB-02	12+500	LEFT	100	91	63	48	38	33	SC	2	11	40	22	13	13.5
10	KB-03	13+000	RIGHT	100	100	98	95	84	73	CI	1.87	16	41	24	16	11
11	KB-04	13+500	RIGHT	100	94	78	67	54	19	SM	1.83	10	36	30	6	12.5
12	KB-05	15+000	LEFT	100	93	81	71	58	28	SM	1.92	13	18			16
13	KB-06	16+000	RIGHT	100	100	93	91	76	33	SM	1.93	13	34	25	9	15
14	KB-07	17+000	LEFT	100	100	94	91	77	67	CL	1.86	13	35	23	12	11.5
15	KB-08	19+000	RIGHT	100	92	86	85	68	23	SC	1.9	13	27	21	6	19.5
16	KB-09	25+000	RIGHT	100	100	96	89	79	71	CI	1.89	18	45	28	14	10.5
17	KB-10	27+000	LEFT	100	100	94	88	78	67	CI	1.91	15	38	23	15	11
18	KB-11	28+000	RIGHT	100	100	89	82	72	64	CI	1.88	15	39	24	15	12
19	KB-12	30+500	LEFT	100	100	89	82	72	63	CI	1.91	14	41	25	16	10

CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM
DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE
IN KOHIMA
BYPASS CONNECTING NH-39 (NEW NH-02), NH-150 (NEW NH-02),
NH-61 (NEW NH-29) AND NH-39 (NEW NH-02) ON ENGINEERING,
PROCUREMENT AND CONSTRUCTION (EPC) MODE IN THE STATE OF
NAGALAND

GEOTECHNICAL INVESTIGATION REPORT
FOR
MAJOR & MINOR BRIDGE
STRUCTURES

SUBMITTED TO
AGNITIO INFRASTRUCTURE PROJECTS PVT.LTD.

RN-73 , Kapil Muni House ,Sector 62,
Noida, G.B Nagar, Uttar Pradesh -201309

Mar 2017

PREPARED BY
MARC SURVEYING SYSTEM PVT. LTD.
2841 HBC Sector 23 Sonapat (Haryana)

131001

1.0 INTRODUCTION

- 1.1 General
- 1.2 Objectives

2.0 SITE GEOLOGY

3.0 FIELD EXPLORATION

- 3.1 Test Location
- 3.2 Borehole Drilling
- 3.3 Soil Sampling
- 3.4 Standard Penetration Test
- 3.5 Rock Coring
- 3.6 Water Level Measurement

4.0 LABORATORY TESTING

5.0 GENERAL SUBSOIL CONDITION

6.0 GEOTECHNICAL ASSESSMENT

7.0 LIMITATION OF ANALYSIS

8.0 APPENDICES

- A: Location Plan
 - B: Borehole Logs
 - C: Bearing Capacity Analysis of Open Foundation
 - D: Elastic Settlement Analysis of Open Foundation
-

1.0 INTRODUCTION

The Agnitio Infrastructure Projects Pvt. Ltd. has been assigned Preparation of Feasibility cum Detailed Project Report for proposed Bridge/High Level Bridge in Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland

It was decided to conduct the Geo-technical investigation at the proposed location of Bridges. The objective of this Detailed Geo-technical Investigation is to interpret the engineering properties of the soils/rock for the purpose of design of the foundations.

The Agnitio Infrastructure Projects Pvt. Ltd., Noida has given the work of Geotechnical Investigation for the proposed Bridges to ***Marc Surveying System Pvt. Ltd.***

The investigations, field tests, sampling and laboratory testing were conducted under the instructions of Agnitio Infrastructure Projects Pvt. Ltd.

Fieldwork including Drilling of bore holes and sample collection was carried out, during January - March 2017.

Laboratory tests were conducted on selected soil / rock samples to determine the design parameters, confirming to relevant IS specifications.

The present report presents the results of the investigation and our recommendations based on the available geotechnical data for the foundation and sub-structure design of the Proposed Bridges and culverts.

The borehole locations & RL were provided by Agnitio Infrastructure Projects Pvt. Ltd,

1.2 Objectives

The purpose of this soil investigation was to obtain relevant and essential geotechnical data within the specified scope of work at the vicinity of minor bridge structures in order to establish the shallow sub-soil condition.

2.0 SITE GEOLOGY

The Kohima Bypass section of NH-39 (New NH-02), NH-150(New NH-02),NH-61(New NH-29) and NH-39 (New NH-02) stretch is located in the Kohima district, Nagaland. Geological formation of Kohima area represents the frontal tract of the western most geotectonic framework of the Naga hill ranges known as “Naga Thrust”, striking in a NE-SW direction. Rock formations encountered are the Tertiaries underlying the Quaternary deposit which forms part of the Northern extension of Arakhan Yoma Patkai range of Indo-Burma. Kohima area represents a sub-montane valley fills of Quaternary sediments lying over the Tertiary. It consists mainly of clays and pebbles. Thickness of Quaternary sediments gradually increases towards NorthWest of Naga Hills. They represent coalescence of outwash fan deposits formed by numerous streams due to steep fall on emerging out of the Talus slopes. The rocks found in Kohima area belong to Surma, Disang, Tipam, Barail and Dihing Groups of Tertiary and consists mainly of sandstones and shales.

Schuppen Belt is defined as the western flank of Naga Hills. It is described as a narrow linear belt of imbricate thrust slices which follows the boundary of Assam valley alluvium for a distance of about 350 km along the flank of Naga-Patkai ranges. The belt is 20-25 km wide and extends for 200 km along the strike from Mishmi Thrust in the northeast to Maibong in the southwest, at the junction of Naga and Haflong-Disang thrusts.

Laisong formation of Schuppen Belt consists of hard, compact and well bedded sandstones. The sandstones show different shades of colour from white to grey and become reddish brown and pink on weathering. White kaolinitic bands are seen in association with sandstones. Two km northwest of Peren, the sandstones exhibit herringbone cross bedding which indicates periodic variation of flow direction of the transporting medium. The thickness of the formation measured along Kohima Bypass road section is 1530 metres

In a majority of tectonic blocks of Schuppen Belt, Jenam Formation is the oldest unit exposed. In the southern part of the belt, it is represented by a predominantly argillaceous sequence of dark grey siltstones, shales, thin sandstone bands, carbonaceous bands, and a number of coal seams. Small scale cross laminations and parallel bedding are characteristic

sedimentary structures of siltstones. The shales contain molluscs and carbonised plant matter at places. Around Jaluke, thin bands and streaks of coal are recorded. The thickness of this formation along Kohima Bypass road section is about 800 metres.

Surma Group is represented by Bhuban and Bokabil Formations. In Schuppen Belt, Surma Group rests uncomfortably on Barail rocks often with the characteristic basal conglomerate. The basal conglomerate of Surma Group traceable in most of the lithotectonic belts of the Schuppen Belt which shows maximum development in southern part around Zubza and Dayang rivers, where it is more than 1250 metres thick. The sandy shale and laminated siltstone of Middle Bhuban Member shows lenticular bedding, flaser bedding, wavy bedding and occasional slump structures. Middle Bhuban units are overlain by sandstone-dominated units of Upper Bhuban Member (600 m). This unit on Dimapur-Kohima road section comprises thick sandstones which exhibit ripple drift, cross lamination, wavy laminations and parallel laminations. These sedimentary structures impart a striped appearance to the sandstone of the Upper Bhuban unit. North of Kohima road section, Upper Bhuban Formation rests on the basal conglomerate and comprises hard, fine grained sandstone with abundant clay pellets. Conglomerate bands are often associated with sandstone. Stringers of coal are ubiquitous and the occurrences of coal streaks along bedding and cross bedding are quite common. Thinly bedded shales are usually associated with the sandstones. Carbonised and silicified woods are noted at places.

Tectonic blocks of the Schuppen Belt evolved along the western flank of Naga Hills. Movements along thrusts often caused rotation of post-Surma folds into steeply plunging folds in thrust blocks of Schuppen Belt. Westward translation of tectonic blocks often resulted in large scale folding of the Tertiary sediments. A spectacular example of such fault-induced recumbent fold is seen near Pherima village, on Kohima road and folding of thrust slices is the effect of Pleistocene tectonic movements.

3.0 FIELD EXPLORATION

The field exploration work comprised drilling of Seventeen (17) boreholes at major & minor bridge structures. These were carried out from 3rd January 2017 to 17th March 2017.

3.1 Test Location

The borehole locations were located at site as per the drawing provided by Agnitio Infrastructure Projects Pvt. Ltd. design consultant and enclosed in Appendix A.

3.2 Borehole Drilling

Straight rotary drilling method was employed for drilling the boreholes. The hole was advanced by rotating a drill string consisting of a series of hollow drill rods to the bottom of which was attached to a cutting bit. Cutting bits sheared off chips of the material penetrated. As the rods with the bits were rotated, a downward pressure was applied to the drill string to obtain penetration, and drilling fluid under pressure was introduced into the bottom of the hole through the hollow drill rods and passages into the bit. The drilling fluid served the dual function of cooling the rotating bit as it entered the hole and removing the cuttings from the bottom of the hole as it returned to the surface in the annular space between the drill rods and the casings or walls of the hole.

3.3 Soil Sampling

Soil samples were collected in the form of disturbed samples when drilling was in progress. All disturbed samples were normally collected after the completion of each Standard Penetration Test (see section 3.4). Disturbed soil collected in the SPT sampler was preserved in polythene covers and transported to the laboratory. One more polythene cover was provided to prevent the loss of moisture during the transit period.

3.4 Standard Penetration Test

Standard Penetration Tests (SPT) was conducted as per IS specifications. Standard Penetration Test (SPT) was normally carried out by driving a standard split spoon of 50mm diameter thick-walled sampler with a 63.5kg self-tripping automatic hammer falling through a height of 750mm along a guided rod to achieve a total penetration of 450mm. The SPT weight was mechanically lifted to the specified height and allowed to fall freely on the anvil with the use of cat-head winch with one to one and half turn of the drum. The first recorded 150mm was left out to allow for the relatively disturbed soil zone. The penetration resistance, N-Value, was taken as the number of blows required to drive the spoon sampler for the last 300mm penetration.

When the number of blows exceeded 50 to penetrate the first or second 150mm length of the sampler, the SPT N is regarded as more than 100. The test is terminated in such case and a record of penetration of the sampler under 50 blows or more is made. SPT refusal is recorded when there is no penetration of the sampler at any stage and also when a rebound of the sounding system is recorded.

Upon completion of the test, the sampler tube was removed and disassembled to provide a disturbed but representative sample. Records of the Standard Penetration Test results were included in the borehole logs (see Appendix B). The N-Value indicates the relative density of the non-cohesive soils as well as the consistency of the cohesive soils as shown in below table.

Clay		Sand	
Consistency	SPT'N" Value	Relative Density	SPT'N" Value
Very Soft	0 – 2	Very Loose	0 – 4
Soft	3 – 4	Loose	5 – 10
Medium Stiff	5 – 8	Medium Dense	11 – 30
Stiff	9 – 16	Dense	31 – 50
Very Stiff	17 – 32	Very Dense	>50
Hard	>32		

3.5 Rock Coring

Core samples are obtained by coring into the rock with a NMLC sized double tube core barrel with swivel attached to the end of a drill rod string. The double tube core barrel consists of an inner core barrel tube and an outer tube which connects to the drill rod. This barrel preserves recovered fractured and poor quality rock cores in their in-situ state. The cutting end of the core barrel is equipped with an Nx sized diamond or tungsten carbide drill bit. When coring is in progress, water is introduced downward between the inner and outer tubes to cool the bit and to wash cutting material to the ground surface. With an attached swivel system, the inner tube remains stationary while the outer tube rotates. The size of core that can be recovered is governed by the size of the drill bit. Rod strings and core barrel assembly are removed after each cutting run about 1.5m to recover the core sample. Measurements of Total Core Recovery (TCR) and Rock Quality Designation (RQD) are made on a site once core sample is recovered from the core barrel. Recovered rock cores were numbered serially and preserved in good quality sturdy wooden core boxes as specified in IS: 4078-1980. Rock classification in terms of weathering and state of fractures and strength is carried out in the following manner. Tabulations given in below explain it briefly.

RELATION BETWEEN RQD AND IN-SITU ROCK QUALITY

Rock quality is measured by frequency of natural joints in rock mass. Rock Quality Designation (RQD) is used to define state of fractures or massiveness of rock. Following table defines the quality of rock mass.

Rock Classification	RQD (%)
Excellent	91 to 100
Good	76 to 90
Fair	51 to 75
Poor	26 to 50
Very Poor	0 to 25

ROCK CLASSIFICATION IN TERMS OF WEATHERING

Terms	Description	Grade	Geologist Interpretation
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.	I	CR > 90%
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discoloured by weathering.	II	CR between 70% to 90%
Moderately Weathered	Less than half of the rock material is decomposed or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	III	CR between 51% to 70%
Highly Weathered	More than half of the rock material is decomposed or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones	IV	CR between 11% to 50%
Completely Weathered	All rock material is decomposed and / or disintegrated to soil. The original mass structure is still largely intact	V	CR between 0% to 10%
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI	CR = 0% but N >50

As per IS 4464

It should be understood that all grades of weathering may not be seen in a given rock mass and that in some cases a particular grade may be present to a very small extent. Distribution of the various weathering grades of rock material in the rock mass may be related to the porosity of the rock material and the presence of open discontinuities of all types in the rock mass.

CLASSIFICATION OF ROCK WRT COMPRESSIVE STRENGTH

Rock is also classified by strength of intact rock cores collected during drilling. Rock Unconfined Compressive strength (UCS) is used to define strength of rock. Classification of rocks given in Table 2 of Appendix-2 of IRC: 78-2000 (March 2011 amendment) is reproduced below;

Rock Type	Unconfined Compressive Strength (Mpa)
Extremely Strong	>200
Very Strong	100 to 200
Strong	50 to 100
Moderately Strong	12.5 to 50
Moderately Weak	5 to 12.5
Weak	1.25 to 5
Very Weak	<1.25

3.6 Water Level Measurement

Water level in open boreholes was recorded during the exploration period. Depth of water was normally taken before and after site work in the morning and afternoon. Water level records were included in the borehole logs (see Appendix B).

4.0 LABORATORY TESTING

A laboratory testing programme conducted on selected soil samples were carried out to determine the physical properties of various soil types encountered in the boreholes. The tests carried out included Specific Gravity and Direct Shear Test.

5.0 **GENERAL SUBSOIL CONDITION**

A total of seventeen (17) boreholes were drilled to determine the sub soil condition of the minor bridge structures. All boreholes were terminated in completely weathered rock. Summary of Boreholes Termination Depth (m) below ground level and Stratum Encountered are shown in below table.

S.No	Structure/ Proposed Chainage	Borehole NO.	Borehole Termination Depth (m) below ground level	Description of Stratum Encountered at Termination Depth
1	Major Bridge @Km 4+020	BH - A1	15	Completely Weathered Rock
		BH - A2	15	Completely Weathered Rock
2	Minor Bridge @ 9+050	BH - A1	15	Completely Weathered Rock
		BH - A2	15	Completely Weathered Rock
3	Minor Bridge @ 13+420	BH - A1	15	Completely Weathered Rock
		BH - A2	16	Completely Weathered Rock
4	Major Bridge @14+850	BH - A1	15	Completely Weathered Rock
		BH - A2	15	Completely Weathered Rock
5	Minor Bridge @ 23+620	BH - A1	15	Completely Weathered Rock
		BH - A2	15	Completely Weathered Rock
6	Flyover @ 31+850	BH - A1	15	Completely Weathered Rock
		BH - P1	15	Completely Weathered Rock
		BH - A2	15	Completely Weathered Rock
7	Major Bridge @ 35+120	BH - A1	15	Completely Weathered Rock
		BH - A2	16	Completely Weathered Rock
8	Minor Bridge @ 36+800	BH - A1	15	Completely Weathered Rock
		BH - A2	16	Completely Weathered Rock

6.0 **GEOTECHNICAL ASSESSMENT**

Considering the nature of sub-surface strata, type of proposed structures, expected scour and loads on foundations, Open foundation (Raft / Large Rectangular Footing) is recommended.

Two (2) criteria shall be considered in the design of Open foundation. The foundation loading shall be less than the safe allowable bearing capacity of the foundation soils to maintain stability and the total settlement shall not exceed a permissible limit. The smaller of

the bearing capacity values obtained according to above two criteria's, is adopted as the recommended allowable bearing capacity of open foundation.

6.1 Depth of Open Foundation in Soil

A foundation must have an adequate depth from considerations of adverse environmental influences. It must also be economically feasible in terms of overall structure. Depth of foundations in soil shall be decided as per clause 7 of IS: 1904 for special cases like; where volume change is expected / scour is expected / foundations on sloping ground / foundation on made or filled up ground / frost action is expected etc. All foundations shall extend to a depth of at least 0.5m below natural ground level. Where filled up materials are encountered, foundations should rest either on natural ground or engineered fill. Where filled material is exposed at the founding level, excavation should be carried out up to the level of natural soils. Backfill of granular materials should be placed in layers and compacted thoroughly. In case of small bridges / culverts, top of bottom slab shall extend 0.3m depth below bed level as per IRC:SP-13

6.2 Depth of Open Foundation in Rock

The founding levels should fix considering an embedment of at least 0.60 m into the sound rock and 1.50 m in to the disintegrated / weathered soft rock. As per clause 705.3.1 (a) of IRC: 78; for hard rock with an ultimate crushing strength of 125 Kg/cm² or above the depth of foundation shall be 0.60 m below rock surface and 1.50 m for soft rocks having with an ultimate crushing strength of 20 Kg/cm². In other cases the embedment of the foundations shall be decided keeping in view the overall characteristics like fissures, bedding planes, cavities, ultimate crushing strength, proposed treatment of foundation strata etc.

6.3 Bearing Capacity for Open Foundations in Soil

Bearing capacity for shallow foundations in soil has been analyzed in accordance with IS-6403 approach. The weighted average of shear parameters for various strata up to a significant influence zone of 1.5 B (B = width of the foundation) below the foundation level is used in the analysis. Considering the fluctuation of ground water, it is assumed that water table will be at existing ground level. A factor of safety of 2.5 is selected based on clause

706.3.1.1.1 of IRC 78-2014 to estimate the net safe bearing capacity from ultimate net bearing capacity.

6.4 Bearing Capacity for Open Foundations on Rock

Analysis for allowable bearing capacity on rock has been based on soil mechanics approach. The Engineer manual on rock foundations of US ARMY CORPS OF ENGINEERS (EM 1110-1-2908) recommends calculating the bearing capacity for foundations on rock by considering general shear failure with irregular failure surface through rock mass. For Calculating safe bearing capacity, Completely Weathered Rock (CWR) / Highly weathered Rock (HWR) with low core recoveries and almost Nil RQD shall be considered as dense sand as per IRC 78, Clause 706.3.1.1.2. ϕ shall be considered as 36 degree.

IS-6403 bearing capacity equation is used to estimate the allowable bearing capacity of soil/rock for open foundations.

Bearing Capacity Equation:

$$q_{ult} = C N_c S_c d_c + \gamma_1 D (N_q - 1) S_q d_q + 0.5 \gamma_2 B N_\gamma S_\gamma d_\gamma$$
$$q_{all} = q_{ult} / F.S(2.5)$$

Where q_{ult} = Ultimate Bearing Capacity

q_{all} = Safe Allowable Bearing Capacity

C = soil cohesion (kPa)

N_c, N_q, N_γ = Bearing Capacity Factor

D = Depth of Footing below ground level (m)

B = Width of Footing (m)

γ_1 = Unit weight of soil above base of footing (kN/m³)

γ_2 = Unit weight of soil below base of footing (kN/m³)

$F.S$ = Factor of Safety = 2.5

S_c , S_q and S_γ are shape factors

d_c , d_q and d_γ are depth factors

The choice of the SBC value in rock for design is a matter of engineering judgment and assessment of rock character encountered in the limited number of boreholes as reported herein. If any significant departure from the reported data is noticed during actual construction, the Geotechnical consultants may be referred for advice.

SAFE ALLOWABLE BEARING CAPACITY OF STRIP FOUNDATION FROM
BEARING CAPACITY ANALYSIS

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation(B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Safe Allowable Bearing Capacity (t/m ²)
1	Major Bridge @Km 4+020	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	35
2	Minor Bridge @ 9+050	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
3	Minor Bridge @ 13+420	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
4	Major Bridge @14+850	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
5	Minor Bridge @ 23+620	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
6	Flyover @ 31+850	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - P1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation(B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Safe Allowable Bearing Capacity (t/m ²)
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
7	Major Bridge @ 35+120	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
8	Minor Bridge @ 36+800	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90

Settlement for Open Foundations

The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure. In cohesive deposition, the post construction settlement is caused by dissipation of pore pressures and hence is time dependent so that consolidation settlement is computed for such soils using Terzaghi's one-dimensional consolidation theory. The immediate settlements in cohesionless soil are estimated using Schmertmann method.

Elastic Settlement

It is assumed that the depth of the imposed load-influenced zone of the footing is approximately two times the width of the footing below the base of the footing. Hence settlement of subsoil up to depth of 2B only is being estimated. The Schmertmann method is used to estimate the immediate/elastic settlement

Schmertmann Method

Based on a physical model of settlement, which has been calibrated using empirical data.

$$\delta = C_1 C_2 C_3 q' \sum \frac{I_e \Delta z}{E_s}$$

where

C_1 = depth factor

C_2 = secondary creep factor

C_3 = shape factor

q' = net bearing pressure

I_e = strain influence factor at midpoint of soil layer

Δz = thickness of soil layer

E_s = equivalent modulus of elasticity in soil layer

Empirical correction for depth of embedment, secondary creep, and footing shape:

$$C_1 = 1 - 0.5 \left(\frac{\sigma'_{zD}}{q'} \right)$$

$$C_2 = 1 + 0.2 \log \left(\frac{t}{0.1} \right)$$

$$C_3 = 1.03 - 0.03L/B \geq 0.73$$

where

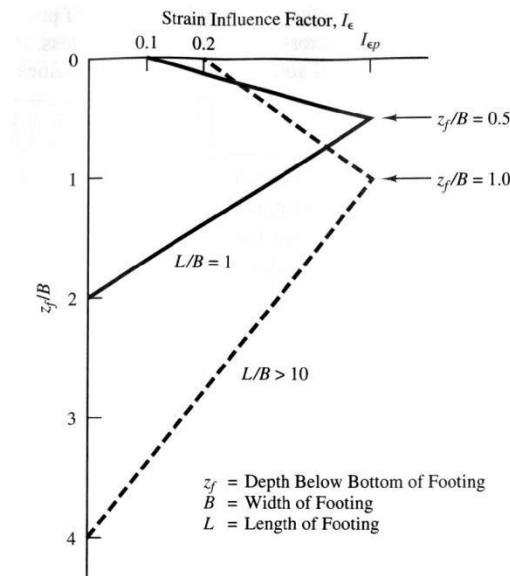
σ'_{zD} = effective vertical stress at a depth D (overburden at the level of foundation)

t = time since application of load (yr) ($t \geq 0.1$ yr)

L = foundation length

B = foundation width

Strain influence factor I_{ϵ} :



For values of L/B between 1 and 10, necessary interpolations can be made. The peak value of the strain influence factor, $I_{\epsilon p}$ is:

$$I_{\epsilon p} = 0.5 + 0.1 \sqrt{\frac{q'}{\sigma'_{zp}}} \quad (3)$$

where

σ'_{zp} = initial vertical effective stress at depth of peak strain influence factor

SAFE ALLOWABLE BEARING CAPACITY OF STRIP FOUNDATION FROM SETTLEMENT ANALYSIS

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation(B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Safe Allowable Bearing Capacity (t/m2) for 50mm settlement
1	Major Bridge @Km 4+020	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	35
2	Minor Bridge @ 9+050	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
3	Minor Bridge @ 13+420	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
4	Major Bridge @14+850	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
5	Minor Bridge @ 23+620	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
6	Flyover @ 31+850	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - P1	6	3.5	CWR	70
				4.0	CWR	80

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation(B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Safe Allowable Bearing Capacity (t/m ²) for 50mm settlement
		BH - A2	6	5.0	CWR	90
				3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
7	Major Bridge @ 35+120	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
8	Minor Bridge @ 36+800	BH - A1	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90
		BH - A2	6	3.5	CWR	70
				4.0	CWR	80
				5.0	CWR	90

RECOMMENDED SAFE ALLOWABLE BEARING CAPACITY OF OPEN FOUNDATION

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation (B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Recommended Safe Allowable Bearing Capacity (t/m ²)
1	Major Bridge @Km 4+020	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
2	Minor Bridge @ 9+050	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
3	Minor Bridge @ 13+420	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
4	Major Bridge @14+850	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
5	Minor Bridge @ 23+620	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
6	Flyover @ 31+850	BH - A1	6	3.5	CWR	40
				3.5	CWR	40
				5.0	CWR	55
		BH - P1	6	3.5	CWR	40
				5.0	CWR	55

S.No	Structure/ Proposed Chainage	Borehole NO.	Width of Foundation (B,m)	Depth of Foundation below Existing Ground Level	Foundation Bearing Strata	Recommended Safe Allowable Bearing Capacity (t/m ²)
		BH - A2	6	5.0	CWR	50
				3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
7	Major Bridge @ 35+120	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
8	Minor Bridge @ 36+800	BH - A1	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50
		BH - A2	6	3.5	CWR	40
				4.0	CWR	45
				5.0	CWR	50

7.0 Limitation of Analysis

- a) The recommendation is made based on data made available and the results of limited soil investigation works without structural information and such, the recommendation may be generalized rather than specific. Due to the complex and unfavorable nature of subsoil condition at some locations, extra care shall be exercised in adopting the geotechnical data and recommendation in this report during the final foundation design.
- b) The loading at the foundation is assumed to be uniformly distributed.
- c) The open foundation is recommended for minor structures. Pile foundation is another option and is not included in this report.
- d) The final design and decision to adopt the most appropriate type of foundation rests with the client's consulting engineer.

ANNEXURE-1

BORE HOLE LOCATION LAYOUT

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (4+020)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:	LABORATORY TEST RESULTS																			
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)		REMARKS
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	SULPHATES	
1106.560	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible		
	1.00					15	100																							
1104.060	2.00																													
1101.060	3.00	C		2.50-4.00	▼			UN-CASED	-	63	40	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial	XXXX												33.12			
	4.00	C		4.00-5.50				-	80	73				XXXX												40.75				
	5.00																										TERMINATION			
	6.00																													
	7.00																													
	8.00																													
	9.00																													
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	11.00																													
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	20.00																													
	21.00																													
NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used: Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																							CHECKED & APPROVED							

NOTES:

1. Classification of soil as per IS:1498
2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
3. Type of Machine Used: Hydraulic Feed
4. Type of Core Barrel used: Single tube
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY:

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (4+020)

Agnitio Infrastructure Projects Pvt. Ltd.

[illegible]

NOTES:

1. Classification of soil as per IS:1498
2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
3. Type of Machine Used: Hydraulic Feed
4. Type of Core Barrel used: Single tube
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (9+050)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:										LABORATORY TEST RESULTS														
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)		REMARKS				
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	SULPHATES		CRUSHING STRENGTH (MPa)			
1139.377	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible						
1136.877	1.00																																	
	2.00					30	25																											
1133.877	3.00	C		2.50-4.00		15	100	UN-CASED	-	70	45	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														20.64						
	4.00								-	82	76																	25.80						
		5.00	C		4.00-5.50																													
	6.00																												TERMINATION					
	7.00																																	
	8.00																																	
	9.00																																	
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used: Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																							CHECKED & APPROVED											

INVESTIGATION DONE BY:

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (9+050)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:										LABORATORY TEST RESULTS																															
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																						
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH				CHLORIDES	SULPHATES	CRUSHING STRENGTH (MPa)																			
						15	100																																												
1137.878	0.00	P		1.00		150						Very dense yellowish completely weathered rocks. (0.00- 3.20 m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																							
	1.00																																																		
	2.00																																																		
1134.678	3.00																																																		
1134.378	4.00	C		3.20-4.70					-	56	36	Moderately strong Hard Rocks. (3.20-6.20 m).	Grayish	Partial	XXXX													20.75																							
	5.00	C		4.70-6.20				-	76	70																																									
	6.00																																																		
	7.00																																																		
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NOTES:																																																			
1. Classification of soil as per IS:1498																																																			
2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE																																																			
3. Type of Machine Used: Hydraulic Feed																																																			
4. Type of Core Barrel used; Single tube																																																			
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																																																			
																				CHECKED & APPROVED																															

INVESTIGATION DONE BY: _____

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (13+020)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:							LABORATORY TEST RESULTS														
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	
1327.190	0.00	P		1.00			150					Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish									0.00	36	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible
1324.690	2.00																												
1321.690	3.00	C		2.50-4.00	▽		UN-CASED	-	57	37	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														20.50		
	4.00																												
	5.00	C	4.00-5.50					-	75	68																24.75			
	6.00																									TERMINATION			
	7.00																												
	8.00																												
	9.00																												
	10.00																												
	11.00																												
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used; Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																							CHECKED & APPROVED						

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (4+020)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:				LABORATORY TEST RESULTS																																						
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																					
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES		SULPHATES	CRUSHING STRENGTH (MPa)																			
1318.997	0.00	P		1.00		150					Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish						2.20	8.50	2.57	0.00	36.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																						
1316.497	2.00																												15	100																				
1013.497	3.00																												C	2.50-4.00	▼		UN-CASED	-	60	39	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial	XXXX										
	4.00	C	4.00-5.50				-	75	68				XXXX													23.62																								
	6.00																									TERMINATION																								
	7.00																																																	
	8.00																																																	
	9.00																																																	
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used; Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																							CHECKED & APPROVED																											

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (14+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:		LABORATORY TEST RESULTS																			
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	
1216.909	0.00	P		1.00			150				Very Dense Yellowish completely weathered rocks(0-2.5m)	Yellowish																Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible	
1214.409	2.00																												
1211.409	3.00	C	2.50-4.00		15	100	UN-CASED	-	63	41	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial													21.64			
	4.00	C																								26.80			
	6.00																										TERMINATION		
	7.00																												
	8.00																												
	9.00																												
	10.00																												
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used; Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																						CHECKED & APPROVED							

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (14+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:	LABORATORY TEST RESULTS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS				VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION									DETAILS OF WATER/ COLOUR ETC.	WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE				pH	CHLORIDES	SULPHATES	CRUSHING STRENGTH (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
1216.775	0.00	P		1.00			150					Very dense yellowish completely weathered rocks. (0.00- 3.2m).	Yellowish				2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (23+620)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:										LABORATORY TEST RESULTS												
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)		REMARKS		
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	SULPHATES		CRUSHING STRENGTH (MPa)	
924.297	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible				
	15					100																										
	921.797					2.00																										
918.797	3.00	C		2.50-4.00			UN-CASED	-	57	35	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														18.75					
	4.00	C		4.00-5.50					-	69																			48			
	5.00								-																							
	6.00																															
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	21.00																															
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1. Classification of soil as per IS:1498 2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used: Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																																
CHECKED & APPROVED																																

INVESTIGATION DONE BY: _____
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (23+620)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:										LABORATORY TEST RESULTS													
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS				
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES		SULPHATES	CRUSHING STRENGTH (MPa)		
920.048	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible					
	1.00					15	100																										
917.548	2.00																																
914.548	3.00	C		2.50-4.00				UN-CASED	-	55	32	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														22.75					
	4.00	C		4.00-5.50					-	81	71																						
	5.00	C		4.00-5.50					-	81	71																						
	6.00																													TERMINATION			
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CHECKED & APPROVED																																	

INVESTIGATION DONE BY: _____
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (31+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:		LABORATORY TEST RESULTS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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1345.986	0.00	P		1.00			150					Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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1340.986	3.00	C		2.50-4.00	▼		UN-CASED		-	70	50	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														33.12																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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3. Type of Machine Used: Hydraulic Feed
4. Type of Core Barrel used: Single tube
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY:

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (31+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:				LABORATORY TEST RESULTS																																						
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																					
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES		SULPHATES	CRUSHING STRENGTH (MPa)																			
1345.986	0.00	P		1.00			150					Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																						
1343.986	2.00																																																	
1340.986	3.00	C		2.50-4.00	▼		UN-CASED		-	70	46	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														33.12																						
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CHECKED & APPROVED

INVESTIGATION DONE BY:

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. P1 (31+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:								LABORATORY TEST RESULTS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. P2 (31+850)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:				LABORATORY TEST RESULTS																	
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS
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1345.986	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish					2.20	8.50	2.57	0.00	42.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible	
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1340.986	3.00	C		2.50-4.00	▽			UN-CASED	-	69	50	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial													33.12		
	4.00																												
	5.00	C		4.00-5.50				-	83	75																40.75			
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INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (35+120)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:								LABORATORY TEST RESULTS																																
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS																			
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1221.513	0.00	P		1.00			150					Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish				2.20	8.50	2.57	0.00	42	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																					
1219.013	2.00																																															
1216.018	3.00	C		2.50-4.00	▼		UN-CASED	-	56	34	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial	XXXX													22.70																					
	4.00	C	4.00-5.50		-	78		67	XXXX																																							
	5.00																																															
	6.00																																															
	7.00																																															
	8.00																																															
	9.00																																															
	10.00																																															
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	19.00																																															
	20.00																																															
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used; Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																																																
CHECKED & APPROVED																																																

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (35+020)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:		LABORATORY TEST RESULTS																																									
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)		REMARKS																							
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	SULPHATES		CRUSHING STRENGTH (MPa)																						
1221.188	0.00	P		1.00			150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish										0.00	42	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible																								
1218.688	1.00																																																				
	2.00																													15	100																						
1215.688	3.00	C		2.50-4.00			UN-CASED	-	60	32	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial															21.68	26.85																								
	4.00	C	4.00-5.50	-				78	69																																												
	5.00																																																				
	6.00																																																				
	7.00																																																				
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NOTES: 1. Classification of soil as per IS:1498 2. Abbreviation Used; D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE 3. Type of Machine Used: Hydraulic Feed 4. Type of Core Barrel used; Single tube 5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																							CHECKED & APPROVED																														

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A1 (36+800)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS								DATE COMPLETED:	LABORATORY TEST RESULTS																					
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS					VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)		REMARKS
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.									WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH		CHLORIDES	SULPHATES	
1222.518	0.00	P		1.00			150					Very Dense Yellowish completely weathered rocks(0-2.5m)	Yellowish					2.20	8.50	2.57	0.00	42	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible		
1220.018	2.00																													
1217.018	3.00	C		2.50-4.00		15	100	UN-CASED	-	63	41	Moderately strong Hard Rocks. (2.50-5.50m).	Grayish	Partial														21.64		
	4.00					C																								-
		6.00																											TERMINATION	
	7.00																													
	8.00																													
	9.00																													
	10.00																													
	11.00																													
	12.00																													
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NOTES:																							CHECKED & APPROVED							
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3. Type of Machine Used: Hydraulic Feed																														
4. Type of Core Barrel used: Single tube																														
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.																														

- NOTES:
- Classification of soil as per IS:1498
 - Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
 - Type of Machine Used: Hydraulic Feed
 - Type of Core Barrel used: Single tube
 - Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY: _____

CONSULTANT: NHIDCL

SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. A2 (36+800)

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS										DATE COMPLETED:	LABORATORY TEST RESULTS																					
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS				VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL>4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS				
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION									DETAILS OF WATER/ COLOUR ETC.	WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE				pH	CHLORIDES	SULPHATES	
1221.879	0.00	P		1.00		150					Very dense yellowish completely weathered rocks. (0.00- 3.2m).	Yellowish								2.20	8.50	2.57	0.00	42	7.26	ND	ND	NIL				
1.00																																
2.00																																
1219.379	3.00																															
1216.379	4.00	C		3.20-4.70			UN-CASED	-	56	37	Moderately strong Hard Rocks. (3.20- 6.20m).	Grayish	Partial	XXXX																22.75		
	5.00	C	4.70-6.20	-	85	74																										
	6.00																															
	7.00																															
	8.00																															
	9.00																															
	10.00																															
	11.00																															
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															CHECKED & APPROVED																	

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

Bearing capacity of foundation of different size of foundation at different depth
As per IS : 6403 -1981 Cl. 5.1.2

In case of general shear failure
qnet safe = [C Nc Sc dc ic + q(Nq-1)Sq dq iq +0.5 By Ny Sy dy iy Rw ']

In case of local shear failure
qnet safe = [0.67{C Nc Sc dc ic} + q(Nq-1)Sq dq iq +0.5 By Ny Sy dy iy Rw ']

Considering the worst case as fully submersed i.e. water table raises upto the ground surface

Where qnet safe = Safe bearing capacity
C = Cohesion B = Width of foundation
g = Bulk unit weight Y = Bulk unit weight of foundation soil

Nc ,Nq,Ng = Bearing capacity faactor dc,dq,dg = Depth factors
Sc,Sq,Sg = Shape Factors ic,iq,ig = Inclination factors

SHAPE FACTORS (IS: 6403-1981), Clause 5.1.2.1 , table-2

Shape of foundation	Sc	Sq	Sg
i) Continuous strip	1	1	1
ii) Rectangle	1+0.2(B/L)	1+0.2(B/L)	1-0.4(B/L)
iii) Square	1.3	1.2	0.8
iv) Circular	1.3	1.2	0.6

DEPTH FACTORS (IS:6403-1981), Clause 5.1.2.2

dc	1+0.2(D/B)sqrt(Nf)		
dq	for F< 10°= 1		for F > 10°= 1+0.1(Df/B)sqrtNf
dg	for F< 10°= 1		for F > 10°= 1+0.1(Df/B)sqrtNf

Now, C = 0 t/m^2 g = 2.00t/m^3 SqNf = 2.2460
ø = 42.0 gsub =1.00 t/m^3

Bearing capacity factors as per IS: 6403-1981 Table 1 Clause 5.1.1

BC Factors	General shear failure	Local shear failure
Nc =	68.492	32.215
Nq =	54.160	20.105
Ny =	83.912	24.938

Using the factor of safety = 3

Size of foundation (m)		Shape of foundation	Depth of foundation	Rw	Shape factors			Depth factors			Inclination factors			qnet safe from GSFailure t/m^2	qnet safe from LSFailure t/m^2	SBC T/m^2
B	L				Sc	Sq	Sy	dc	dq	dy	ic	iq	iy			
5	12.5	Rectnagular	3.00	0.5	1.080	1.080	0.840	1.270	1.135	1.135	---	---	---	137.117	43.06	45.71
6	12.5		3.00	0.5	1.096	1.096	0.808	1.225	1.112	1.112	---	---	---	150.062	46.89	50.02
5	12.5		3.50	0.5	1.080	1.080	0.840	1.314	1.157	1.157	---	---	---	139.831	43.91	46.61
6	12.5		3.50	0.5	1.096	1.096	0.808	1.262	1.131	1.131	---	---	---	152.587	47.68	50.86
5	12.5		4.00	0.5	1.080	1.080	0.840	1.359	1.180	1.180	---	---	---	137.803	44.76	45.93
6	12.5		4.00	0.5	1.096	1.096	0.808	1.299	1.150	1.150	---	---	---	150.423	48.47	50.14
5	12.5		4.00	0.5	1.080	1.080	0.840	1.359	1.180	1.180	---	---	---	137.803	44.76	45.93
6	12.5		4.00	0.5	1.096	1.096	0.808	1.299	1.150	1.150	---	---	---	150.423	48.47	50.14
5	12.5		4.50	0.5	1.080	1.080	0.840	1.404	1.202	1.202	---	---	---	136.286	45.62	45.43
6	12.5		4.50	0.5	1.096	1.096	0.808	1.337	1.168	1.168	---	---	---	148.788	49.26	49.60
5	12.5		4.50	0.5	1.080	1.080	0.840	1.404	1.202	1.202	---	---	---	136.286	45.62	45.43
6	12.5		4.50	0.5	1.096	1.096	0.808	1.337	1.168	1.168	---	---	---	148.788	49.26	49.60

Marc Surveying System (P) L.T.D

GEOTECHNICAL INVESTIGATION REPORT FOR TUNNEL AT HIGH COURT JUNCTION

PROJECT TITLE - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM
DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN
KOHIMA BYPASS CONNECTING NH- 39 (NEW NH- 02), NH- 150 (NEW NH- 02), NH- 61
(NEW NH- 29) AND NH- 39 (NEW NH- 02) ON ENGINEERING, PROCUREMENT AND
CONSTRUCTION (EPC) MODE IN THE STATE OF NAGALAND

SUBMITTED TO

AGNITIO INFRASTRUCTURE PROJECTS PVT.LTD.

RN-73 ,Kapil Muni House ,Sector 62,
Noida ,G.B Nagar ,Uttar Pradesh -201309
FEB 2018

INVESTIGATIONS DONE BY:

MARC SURVEYING SYSTEM (P) LTD.

(Topographical Survey & Civil Engineering Consultant)

2841 HBC, Sector 23, Sonapat (Haryana) 131001



FACTUAL REPORT ON GEOTECHNICAL
INVESTIGATION
TUNNEL AT HIGH COURT JUNCTION IN KOHIMA
BYPASS

(Laboratory Test Report on Borehole Samples)

CONTENTS

<u>CHAPTER NO.</u>	<u>DESCRIPTION</u>	<u>PAGE NO.</u>
1	INTRODUCTION	2
2.	SCOPE OF WORK	3
3.	LABORATORY TEST PROCEDURES	4
4.	SUMMARY OF TEST RESULTS	11

ANNEXURE
BORE LOG



GEOTECHNICAL INVESTIGATION
TUNNEL AT HIGH COURT JUNCTION IN KOHIMA
BYPASS
(Laboratory Test Report on Borehole Samples)

1.0 INTRODUCTION

The Kohima Bypass section of NH- 39 (New NH- 02), NH- 150(New NH- 02),NH- 61(New NH- 29) and NH- 39 (New NH- 02)stretch is located in the Kohima district, Nagaland. Geological formation of Kohima area represents the frontal tract of the western most geotectonic framework of the Naga hill ranges known as “Naga Thrust”, striking in a NE-SW direction.

The rocks found in Kohima area belong to Surma, Disang, Tipam, Barail and Dihing Groups of Tertiary and consists mainly of sandstones and shales.

The Agnitio Infrastructure Projects Pvt.Ltd. has been assigned Preparation of Feasibility cum Detailed Project Report for proposed Bridge/High Level Bridge in Kohima Bypass connecting NH- 39 (New NH- 02), NH- 150(New NH- 02), NH- 61(New NH- 29) and NH- 39 (New NH- 02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland

It was decided to conduct the Geo-technical investigation at the proposed location of Tunnel.The objective of this Detailed Geo-technical Investigation is to interpret the engineering properties of the soils/rock for the purpose of design of the foundations.

The Agnitio Infrastructure Projects Pvt.Ltd, Noida has given the work of Geotechnical Investigation for the proposed Bridges to Marc Surveying System (P) L.T.D

The investigations, field tests, sampling and laboratory testing were conducted under the instructions of Agnitio Infrastructure Projects Pvt. Ltd.

Laboratory tests were conducted on selected soil / rock samples to determine the design parameters, confirming to relevant IS specifications. ,

This report covers the details of laboratory tests completed in soil/rock samples collected from the bore holes completed for the proposed project.



2.0 SCOPE OF WORK

The scope of the laboratory works completed for the project area is broadly consisting of the following:

- Collection of representative oil/rock samples boreholes
- Conducting laboratory tests results as per relevant IS codes and guidelines laid down in the client's specification.

Rock samples collected for laboratory tests are summarized in Table A below.

Table A

S.No.	Sample No.	Bore Hole No.
1	EP-1	SS-01
2	EP-2	SS-02
3	EP-3	SS-03



3.0 LABORATORY TEST PROCEDURES

The laboratory tests are conducted in well equipped computerized laboratory and other approved laboratories under the supervision of qualified Engineers. Laboratory testing comprised of the following tests conducted as per procedures given in relevant IS codes. Laboratory test results are attached in the Annexure.

S.NO.	TEST DESCRIPTION	Reference to ISCode
1	Preparation of Rock Specimen for Lab Testinq	IS:9179- 1979
2	Water absorption of rock sample	IS:13030-1991
3	Porosity and Density of rock cores	IS:13030-1991
4	Specificgravity of rock samples	IS:13030-1991
5	Uniaxial Compressive strength Or v and Saturated	18:9143-1979
6	Modulus of Elasticity and Poisson's ratio	18:9221-1979 13:13047-1991
7	Triaxial Compression Test	18:8764-1998
8	Point LoadTest	18:10082-1981
9	Tensile Strength by Brazilian method	18:13030-1991
10	Bulk Density	IS:13030-1991
11	Void index	IS:10782-1983
12	Dynamic modulus	

The procedure followed for various laboratory Tests is described below briefly.



3.1 Tests on Rock Cores

A) Water Content of Rock Samples

Water content of the rock samples were determined on selected samples as per the relevant methods described in IS:13030-1991.

The water content shall be calculated from the following formula:

Water content, w

$$= \frac{(m_2 - m_3)}{(m_3 - m_1)} \times 100 (\text{Percent})$$

m_1 = Mass of the container with its lid at room temperature

m_2 = Mass of the container with its lid and the sample at room temperature

m_3 = Mass of the container with its lid and the sample after drying

B) Porosity and Density of Rock

Porosity of the rock samples were determined on selected samples as per the relevant methods described in IS:13030-1991.

Selected samples machined to conform closely to the geometry of right cylinder or prism. The minimum size of each specimen should either be such that its mass is atleast 50g or such that its minimum dimensions is atleast ten times the maximum grainsize, which ever is the greater. Determine the external dimension and then bulk volume V of specimen with the vernier or calipers. Place the specimen in an oven and dry at $105 \pm 3^\circ\text{C}$. Determine the dry mass, M_s of the specimen. Insert the specimen in a container of water for period of twenty hour. Remove the specimen from the container and surface dry it using a moist cloth. Determine the saturation mass, M_{sat} of the specimen.

Pore volume of the specimen $V_p =$;

P_w = density of water at temperature t .

$$\text{Dry density (pd)} = \frac{M_s}{V} \quad (\text{kg/m}^3)$$

$$\text{Porosity (n)} = \frac{V_p \times 100}{V} \quad (\text{percent})$$



C) Specific Gravity of Rock Samples

Specific gravity of the rock samples were determined on selected samples as per the relevant methods described in IS:13030.
Specific gravity of rock is determined as follow.

Where,

- G_l = Specific gravity of the liquid Use at the constant temperature.
m₁ = Mass of pycnometer bottle (1 litre capacity) in g.
m₂ = Mass of bottle and dry soil sample in g.
m₃ = mass of bottle + rock and air-free distilled water in g.
m₄ = mass of bottle when full of distilled water only in g.

D) Uniaxial Compressive Strength of a Rock Samples

UCS of the rock samples were determined on selected samples as per the relevant methods described in IS:9143-1979.

The ability of spherical seat to rotate freely shall be checked before each test.

The surfaces of the two bearings discs and the test specimen shall be wiped clean. The specimen shall be kept on the lower disc. The axis of the specimen shall be carefully aligned with the center of the thrust of the spherical seat. As the load is generally brought to bear on the specimen, the movable portion of the spherical seated disc shall be adjusted to ensure uniform seating.

Load on the specimen shall be applied continuously and without shock to produce an approximately constant rate of load or deformations such that failure will occur within 5 to 15 minutes of initiation of loading if carried to failure. Alternatively the stress rates shall be

within the limits of 0.50 MegaPascal/s to 1 megaPascal/s. Load and the axial and diametric or circumferential strains shall be measured frequently at evenly spaced load intervals during the test. The maximum load on the specimen shall be recorded in N within 1 percent.

The unconfined compressive strength of the specimen shall be calculated by dividing



the maximum load carried by the specimen during the test, by the average original cross-sectional area.

E) Modulus Of Elasticity - IS 9221: 1979

The strain gauges attached to Rock Core Specimen & the Dummy Rock Specimen for indicating strain. Load on the rock sample applied continuously by CTM with constant rate such that failure occurs within 5 to 15 minutes. At the time of loading strain measured on strain indicator machine. Then Modulus of Elasticity, $E = \text{Stress} / \text{Strain}$

F) Triaxial Compression Strength with Saturation - IS 13047: 1991

In this test the Rock Core specimen after soaking of 24 hours kept in a Triaxial test cell rubber membrane placed around the specimen. The cells filled with hydraulic oil. The axial and confining pressure applied by hydraulic oil is increased simultaneously so that axial stress and confining pressure are approximately equal. The maximum axial load and the corresponding confining pressure on the Specimen shall be recorded. The different rock core specimens at different confining pressure shall be tested and Cohesion and angle of internal friction of Rock core Specimen determined after drawing the graph.

G) Water Absorption And Porosity - IS 13030: 1991

Rock core samples were oven dried and after that dimensions were measured. Dry weight of the rock core sample is found and immersed in water for 24 hours soaking. Remove the sample and wet weight was taken.

Water absorption calculated as $[(\text{Wet weight} - \text{Dry Weight}) / \text{Volume}] \times 100$

Porosity calculated as $[(\text{Wet Weight} - \text{Dry Weight}) / \text{Dry weight}] \times 100$



H) Point Load Index Strengths 8764:1998

For rock core specimen of smaller lengths not satisfying criteria for UCS (Unconfined compressive Strength) this test was carried out. This test is done for the Rock Core Specimen having length to diameter ratio 1:4. In this test the rock core specimen is tested in loading frame. In the loading frame point load is applied through the system. Thus the Point load index strength at failure is measured. The Point Load index Strength is calculated from the following formula

$$I_s (soi) = P / (\pi D^{1.5} D^*) \text{ MN/m}^2 (\text{kgf/cm}^2)$$

Where

$I_s (soi)$ = Point load strength index (for the standard core size) in $\text{MN/m}^2 (\text{kgf/cm}^2)$

P = Failure load in $\text{N} (\text{Kgf})$

D = Core Diameter in mm

D^* = Standard core Diameter = 50 mm

I) Brazilian Test (IS: 10082 1981)

The test specimen shall be wrapped around its periphery with one layer of the adhesive paper tape and mounted squarely in the test apparatus such that the curved platens load the specimen diametrically with the axes of rotation for specimen and apparatus coincident. Load on the specimen shall be applied continuously at a constant rate such that failure in the weakest rock occurs within 15 to 30 seconds. A loading rate of 200 N/s is recommended. The maximum load on the specimen shall be recorded in Newton's with one percent accuracy. Where the testing machine is fitted with a force / displacement recorder, a record should be taken during testing so that the load for primary fracture can be precisely determined (in some cases load continues to increase after primary failure as the split specimen is still bearing load). If a goal / displacement recorder is not available on the testing machine, care shall be taken by the operator to detect the load at primary failure. At primary failure, there shall be a brief pause in the motion of the indicator needle. However, the difference between the load of primary failure and ultimate load bearing capacity is at the most only 5 percent.



J) Dynam Modulus Of Elasticity (Is-10782:1983)

Dynamic modulus of elasticity of rock cores was determined by pulse transmission technique involving measurement of transit times of compressional (longitudinal) and shear (transverse) waves for known length of the sample. Pulse generator and amplifier are used to generate pulse and amplify pulse respectively. Transmitting and receiving piezo-transducers are placed on opposite sides of test specimen. First initial delay (t_1) time is recorded on oscilloscope by bringing the transmitter and receiver in direct contact. By placing rock specimen in between the transmitting and receiving

transducers, travel time (t_2) on oscilloscope was recorded. Measure the length of rock core sample. Repeat the procedures for P-waves and S-waves.

Transit time in rock core specimen (t_{ports}) = $t_2 - t_1$

Compressional velocity, $V_p = l / t_p$

Shear velocity = $V_s = l / t_s$

Dynamic Modulus of Elasticity = $\rho \cdot V_s^2 \cdot (3V_p^2 / (4V_s^2)) \cdot t(V_p^2 - V_s^2)$

Sincerely,

Marc Surveying System (P) L.T.D
(Topographical Survey & Civil Engineering Consultant)



SUMMARY OF LABORATORY TEST RESULTS

S.NO	Sample No.	Bore Hole No.	Location	Depth of Sample(m)	Rock type	UCS(kg/cm ²)	Modulus Of Elasticity	Poisson'S Ratio	Point Load Index((Mpa)	Tensile Strength by Brazilian Method (MPA)	Triaxial Compression Test		Porosity	Water Absorption	Bulk Density(g/cc)	Void Index	Specific Gravity	Slake Durability Index	Dynamic Modulus (GPA)
											Cohesion (kg/cm ²)	F.angle							
1	EP-1	SS-01	High Court Junction	18-20	Shale	312	2.2x10 ⁵	0.11	1.53	15.2	152	36	0.4	0.03	2.4	0.04	2.4	98	22.2
2	EP-2	SS-02		20-22	Shale	347	2.5x10 ⁵	0.13	1.3	15.5	165	37	0.3	0.03	2.2	0.03	2.4	97	25.2
3	EP-3	SS-03		23-25	Shale	350	2.8x10 ⁵	0.12	2.15	15.4	158	35	0.34	0.03	2.25	0.04	2.32	98	25.3



LABORATORY TEST RESULTS



TEST RESULTS OF ROCK CORE

S.NO	Sample No.	Bore Hole No.	Depth of Sample(m)	Diameter(cm)	Height(cm)	Thickness(cm)	H/D Ratio	Correction Factor	Failure Load(Kn)	Condition of test	UCS(kg/cm ²)	Modulus Of Elasticity	Poisson'S Ratio	Point Load Index((Mpa)	Tensile Strength by Brazillian Method (MPA)	Triaxial Compression Test		Porosity	Water Absorption	Bulk Density(g/cc)	Void Index	Specific Gravity	Slake Durability Index
																Cohesi on (kg/cm ^{^2})	F.an gle						
1	EP-1	SS-01	18-20	5.45	7.56	-	1.39	0.90	52.00	Soaked	312	2.2×10^5	0.11	1.53	15.2	152	36	0.4	0.03	2.4	0.04	2.4	98
2	EP-2	SS-02	20-22	5.43	11.07	3	2.04	1.00	70.00	Soaked	347	2.5×10^5	0.13	1.3	15.5	165	37	0.3	0.03	2.2	0.03	2.4	97
3	EP-3	SS-03	23-25	5.44	10.79	-	1.98	1.00	80.00	Unsoaked	350	2.8×10^5	0.12	2.15	15.4	152	37	$\frac{0.3}{4}$	0.03	$\frac{2.2}{5}$	0.04	2.32	98



SAMPLE CALCULATION FOR MODULUS OF ELASTICITY & POISSON'S RATIO OF ROCK IS:9221

Location-Near High Court Junction

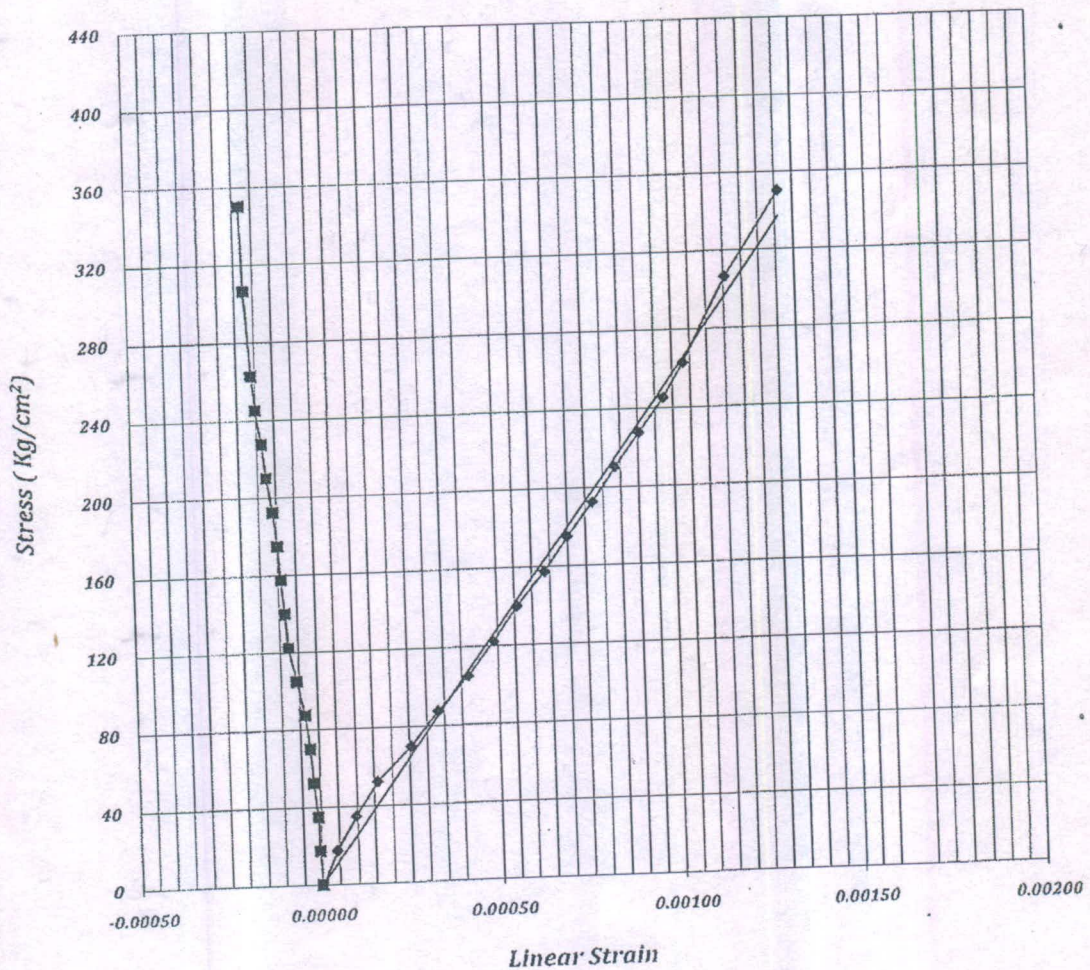
Bore Ho: SS-03

Diameter of Specimen: 5.44cm

Depth:25-28

Correction Factor: 1

Sample ID:EP-03



Modulus of Elasticity (Kg/cm²) : 2.8×10^5
 Poisson's Ratio : 0.12



SAMPLE CALCULATION TRIAXIAL COMPRESSION TEST OF ROCK CORES

Diameter of Specimen	5.44 cm	Type of Test	UU
Bore Hole no.	EP-3	Condition of Test	Unsoaked
Test Depth	25-28 m		
Area of Sample	23.24 cm ²		

serial No.	Cell Pressure(Kg/cm ²)	Failure Load	Length of Sample	Change in Length at Failure	Strain at Failure	Corrected area at Failure	Correction Factor	Axial Stress(kg/cm ²)
1	25	80	10.69	0.29	2.71	23.874	1.002	341.6
2	50	95	10.70	0.38	3.35	24.076	1.002	402.2
3	75	115	10.72	0.46	4.29	24.257	1.002	483.3



BORE LOG



SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. SS-01

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS															LABORATORY TEST RESULTS																	
DATE COMPLETED:																																
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	ROCK CORE DRILLING OBSERVATIONS				VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL > 4.75mm	% SAND 4.75-0.075mm	% SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS				
						Penetration cm	"N" VALUE		TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION									DETAILS OF WATER/ COLOUR ETC.	WATER LOSS	SYMBOLIC REPRESENTATION	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE		PH		CHLORIDES	SULPHATES	CRUSHING STRENGTH (MPa)	
	0.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish							2.2		36.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible				
	1.00					15	100																									
	2.00																															
	3.00	C		2.50-4.00				UN-CASED	-	57	37	Moderately strong Hard Rocks. (2.50- 20.00m).	Grayish	Partial							2.4	152										
	4.00																													-	75	68
	5.00																													C	4.00-20.00	
	6.00																															
	7.00																															
	8.00																															
	9.00																															
	10.00									86	71																					
	11.00																															
	12.00																															
	13.00																															
	14.00									97	81																					
	15.00																															
	16.00																															
	17.00																															
	18.00																															
	19.00									97	93																					
	20.00																															

NOTES:

1. Classification of soil as per IS:1498
2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
3. Type of Machine Used: Hydraulic Feed
4. Type of Core Barrel used: Single tube
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY:

CONSULTANT: NHIDCI



SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02), NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. SS-02

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS												DATE COMPLETED:												LABORATORY TEST RESULTS												
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL. OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COARSE ETC.	WATER LOSS	SYMBOLIC REPRESENTATION	VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL > 4.75mm	% SAND 4.75-0.075mm	% SILT 0.075-0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS					
						Penetration cm	"N" VALUE																	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH	CHLORIDES	SULPHATES				CRUSHING STRENGTH (MPa)				
0.00	1.00	P		1.00				150				Very dense yellowish completely weathered rocks. (0.00-2.50m).	Yellowish									2.20	3	2.2	165	37.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible				
2.00																																				
3.00	2.50-4.00	C				15	100	UN-CASED	-	57	37	Moderately strong Hard Rocks. (2.50- 22.00m).	Grayish	Partial																						
4.00																																				
5.00	4.00-22.00	C								75	68																									
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15.00										97	89																									
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18.00																																				
19.00																																				
20.00										96	95																									
22.00																																				

NOTES:
1. Classification of soil as per IS:1498
2. Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
3. Type of Machine Used: Hydraulic Feed
4. Type of Core Barrel used: Single tube
5. Shearing Strength Test based on Direct shear test on UD sample by UUTest.

INVESTIGATION DONE BY:
CONSULTANT: NHIDCL

CHECKED & APPROVED



SOIL INVESTIGATION DATA

Project - CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY CUM DETAILED PROJECT REPORT FOR PROPOSED BRIDGE/HIGH LEVEL BRIDGE IN KOHIMABYPASS CONNECTING NH-39 (New NH-02), NH-150 (New NH-02),NH-61 (New NH-29) and NH-39(New NH-02) on Engineering Procurement and Construction (EPC) mode in state of Nagaland

BORE HOLE NO. SS-03

Agnitio Infrastructure Projects Pvt. Ltd.

FIELD TEST RESULTS												DATE COMPLETED:												LABORATORY TEST RESULTS											
ELEVATION IN METERS	DEPTH IN m BELOW REF.	NATURE OF SAMPLING	DATE OF SAMPLING	DEPTH OF TESTING BELOW REF. LVL.	LVL OF WATER TABLE	Standard Penetration Test		DIA. OF CASING mm	TIME TAKEN FOR BORING EACH 30cm IN MINUTES	% CORE RECOVERY	% RQD	DESCRIPTION OF CORE ROCK TYPE COLOUR GRAIN SIZE TEXTURE MINERAL COMPOSITION	DETAILS OF WATER/ COLOUR ETC.	WATER LOSS	SYMBOLIC REPRESENTATION	VISUAL DESCRIPTION OF SOIL WITH IS CLASSIFICATION	% GRAVEL >4.75mm	%SAND 4.75-0.075mm	%SILT 0.075- 0.002mm	% CLAY <0.002mm	BULK DENSITY g/cc	NATURAL MOISTURE CONTENT %	SPECIFIC GRAVITY	SHEARING STRENGTH CHARACTERISTIC		CHEMICAL ANALYSIS OF WATER (mg/l)			ORGANIC MATTER %	ROCK TEST (Saturated Condition)	REMARKS				
						Penetration cm	"N" VALUE																	COHESION 'C' kg/cm2	ANGLE OF SHEARING RESISTANCE	pH	CHLORIDES	SULPHATES				CRUSHING STRENGTH (MPa)			
0.00	1.00	P		1.00		15	100	150				Very dense yellowish completely weathered rocks. (0.00-4.0 m)	Yellowish									2.25	3	2.32		35.0	7.26	ND	ND	NIL		Steps should be taken to reconcile Field & Laboratory Test Data wherever Possible			
1.00																																			
2.00																																			
3.00		C		2.50-4.00					-	57	37																								
4.00																																			
5.00		C		4.00-20.00				UN-CASED	-	75	68	Moderately strong Hard Rocks. (4.00 - 25.0m).	Grayish	Partial											158										
6.00																																			
7.00																																			
8.00																																			
9.00																																			
10.00										86	71																								
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23.00																																			
24.00																																			
25.00										97	95																								

NOTES:

- Classification of soil as per IS:1498
- Abbreviation Used: D- Disturbed Sample, C- Rock Core sample, UD- Undisturbed Sample P- SPT SAMPLE
- Type of Machine Used: Hydraulic Feed
- Type of Core Barrel used: Single tube
- Shearing Strength Test based on Direct shear test on UD sample by UUTest.

CHECKED & APPROVED

INVESTIGATION DONE BY:

CONSULTANT: NHIDCL

