

GEOTECHNICAL INVESTIGATION REPORT

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GEOTECHNICAL INVESTIGATION REPORT

1. INTRODUCTION

Meghalaya Tourism Department, Government of Meghalaya had awarded a work order vide letter no: M/D-Tour 180/2019/129 dated 11.08.2021 to RITES for preparation of a Detailed Project Report for introduction of a Passenger Ropeway between Laban Forest Nursery and Shillong View point at Shillong.

2. SCOPE OF GEO-TECH WORKS

The following activities have been carried out for the Geotechnical investigation work:

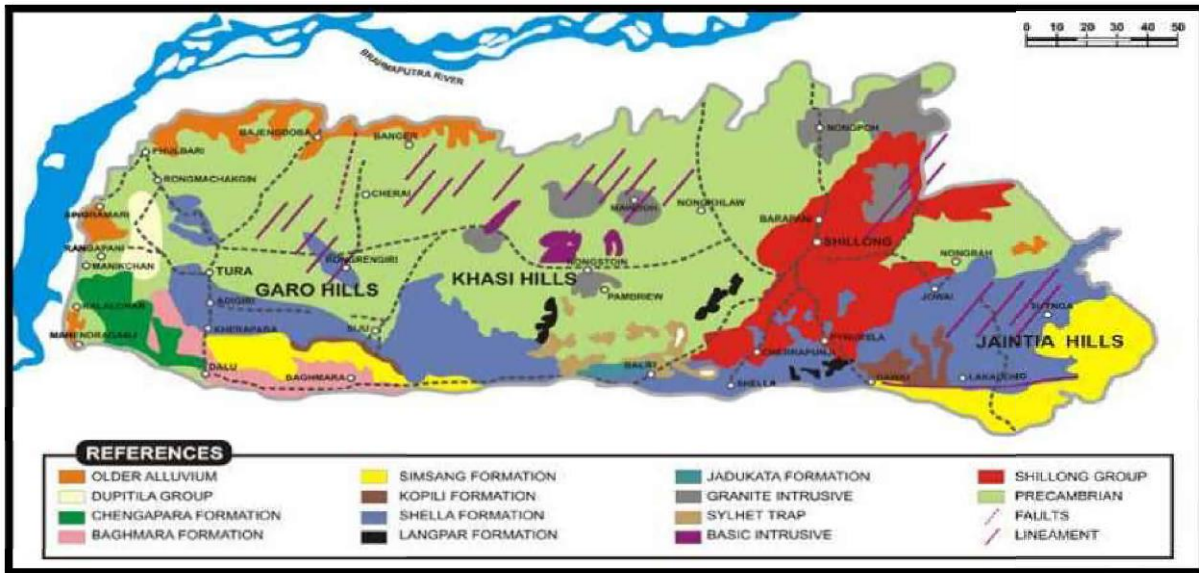
- i. Drilling of Boreholes of depth up to required depth in all types of soil from the existing ground surface, to determine the in –situ engineering properties as per IS1897 1978, Rock drilling as per IS 6926 (latest Revision) as per applicable codal requirements.
- ii. Preparation of proposed bore logs and location plan of boreholes.
- iii. Preparation of the report including assessment of the bearing capacity of the soil for design for the terminal building structure.

3. FIELD INVESTIGATION

Three no. of boreholes were sunk within the premises of the proposed project, the depth of borehole was measured from the existing ground level and hence the depth of borehole indicates depth Below Ground Level (BGL). The execution of the sub soil exploration job at site was commenced on 15.01.2022 and completed on 27.01.2022.

Schedule of boreholes in tabulated form is given below:

Bore Hole No.	Terminating Depth(m)	Water Table below EGL (m)	Date of Commencement	Date of Completion
BH-1	10.00	Not found	15.01.2022	16.01.2022
BH-2	10.00	Not found	20.01.2022	24.02.2022
BH-3	10.00	Not found	26.01.2022	27.01.2022



Geological Map of Meghalaya

4. FIELD INVESTIGATION PROCEDURE

4.1 Exploratory Boring

The provisions laid down in BIS 1892: 1979 were followed in sinking the exploratory boreholes. Boreholes were advanced into the soil by shell and augur boring to sink 150 mm diameter bore hole by using manually operated equipment. The boring was carried out by boring up to maximum depth of 10.00 m. Adequate care as per specification and Indian standard practice was taken to prevent any possible side collapse in bore hole. Disturbed representative samples of sub-surface deposits were collected from borehole, labelled depth wise and placed in polythene bags.

4.2 Rotary Core Drilling:

Conventional diamond core drilling equipment was used for drilling vertical hole up to specified depth at each location. Rotary core drilling in rock was carried out according to IS 1892-1979. This drilling technique was regarded as the most satisfactory method of assessing the character of rock formations, which lie at depth below the ground surface. Specimens of rock in the form of cylindrical cores were recovered from the drill hole by means of a core barrel. Double barrel technique was adopted according to field condition. The core barrel was provided at its lower end with a detachable shoe or core bit, which is of diamond. NX (73mm) size rotary core bits were used for the carrying out the work at site.

5. LABORATORY TESTS

The following table presents the various tests conducted at field and in Laboratory:

Field Work:

S No.	Description	Relevant IS Codes
1	Boring, Drilling work and Collections of samples.	IS: 1892-1979 IS: 2131-1981 IS: 2132-1981
2	Labelling and Packing	IS: 1892-1979
3	Standard Penetration Test (SPT)	IS: 9640-1980 IS: 2131-1981

Laboratory Test:

S No.	Description	Relevant IS Codes
1	Grain-Size Analysis	IS: 2720(Part-4)-1985
2	Liquid Limit (LL) and Plastic Limit (PL)	IS: 2720(Part-5)-1976
3	Free Swell Index	IS: 2720 (Part 40)-1977
4	Specific Gravity	IS: 2720(Part-3)-1980
5	Water Absorption and Specific Gravity of Rock	IS: 1124
6	Point Load Strength Index of Rock	IS: 8764
7	Unconfined Compressive Strength of Rock	IS: 9143

6. FOUNDATION RECOMMENDATIONS

The following table presents the findings of the soil investigation work and the recommended values of Allowable bearing capacity for different foundation sizes and depths:

Location	Foundation Size	Depth of foundation Below EGL (m)	Allowable Bearing Capacity (t/m ²)
	(m x m)		
BH-1	2.50 X 2.50	2.0	35
	3.00 X 3.00		35
	4.00 X 4.00		35
BH-2	2.00 x 2.00	1.5	30
	2.50 X 2.50		30
	3.00 X 3.00		30
	4.00 X 4.00		30
	2.50 X 2.50	2.0	35
	3.00 X 3.00		35
	4.00 X 4.00		35

BH-3	2.00 x 2.00	1.5	15
	2.50 X 2.50		15
	3.00 X 3.00		15
	4.00 X 4.00		18
	2.50 X 2.50	2.0	20
	3.00 X 3.00		20
	4.00 X 4.00		20

The detailed Geotechnical Investigation Report is Annexed with this report as Annexure-I

1.0 INTRODUCTION

PASSENGER ROPEWAY AT SHILLONG DISTT. KHASI HILL MEGHALAYA.

A subsoil investigation was necessary for the purpose of the foundation design and construction of the proposed project. Accordingly, the subsoil exploration work of three boreholes at structure location having maximum depth 10.00 m, as proposed by the project authority. During borehole exploration, disturbed/SPT samples/core samples were collected.

The present report deals with the geotechnical investigation findings at the location and the discussion on the aspects regarding bearing capacity of open foundations depending on the field and laboratory test results. However, the Foundation Designer may modulate the type of foundations and other values regarding foundation geometry and soil design parameter to meet any specific design criteria.

2.0 FIELD INVESTIGATION

Three no. of boreholes were sunk within the premises of the proposed project, the depth of borehole was measured from the existing ground level and hence the depth of borehole indicates depth below ground level (BGL). The execution of the subsoil exploration job at site was commenced on 15.01.2022 and completed on 27.01.2022.

Schedule of boreholes in tabulated form is given below:

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BH-1	10.00	Not found	15.01.2022	16.01.2022
BH-2	10.00	Not found	20.01.2022	24.02.2022
BH-3	10.00	Not found	26.01.2022	27.01.2022

3.0 GENERAL GEOLOGY

Geologically the Meghalaya plateau comprises of rocks from the oldest Precambrian gneissic complex to the Recent alluvium formations. The stratigraphic sequence is as follows.

Cretaceous –Tertiary sediments

The Sylhet trap

Lower Gondwana rocks

1. Shillong Group of rocks
2. Precambrian gneissic complex (Basement gneiss)

The Precambrian gneissic complex comprising para and orthogneisses, migmatites and the Shillong Group of rocks comprising mainly quartzites are exposed in the central, eastern and northern parts of the Meghalaya plateau. They are intruded by basic and ultrabasic intrusives and late tectonic granite plutons. The lower Gondwana rocks of Permo-Carboniferous age are recognized at the western part of Garo Hills and consists of pebble bed, sandstone, and carbonaceous shale.

The Sylhet trap of middle Jurassic age comprising mainly of basalt, rhyolites, acid tuffs, is exposed in a narrow E-W strip along the southern border of Khasi Hills. The Cretaceous – Tertiary sediments occupying southern part of the Meghalaya plateau comprises of the Khasi Group (arenaceous facies), the Jaintia Group (calcareous facies) and the youngest formation the Garo Group which is represented as Simsang, Bagmara and Chengapara formations. Besides these the Dupi Tilla group of mid-Pliocene age occurs in the western part of Garo Hills and towards south of Khasi Hills. Isolated patches of older Alluvium overlies the Tertiary rocks along the southern and western borders of the State. The recent Alluvium formation is mostly found in the river valleys of Garo & Khasi Hills Districts.

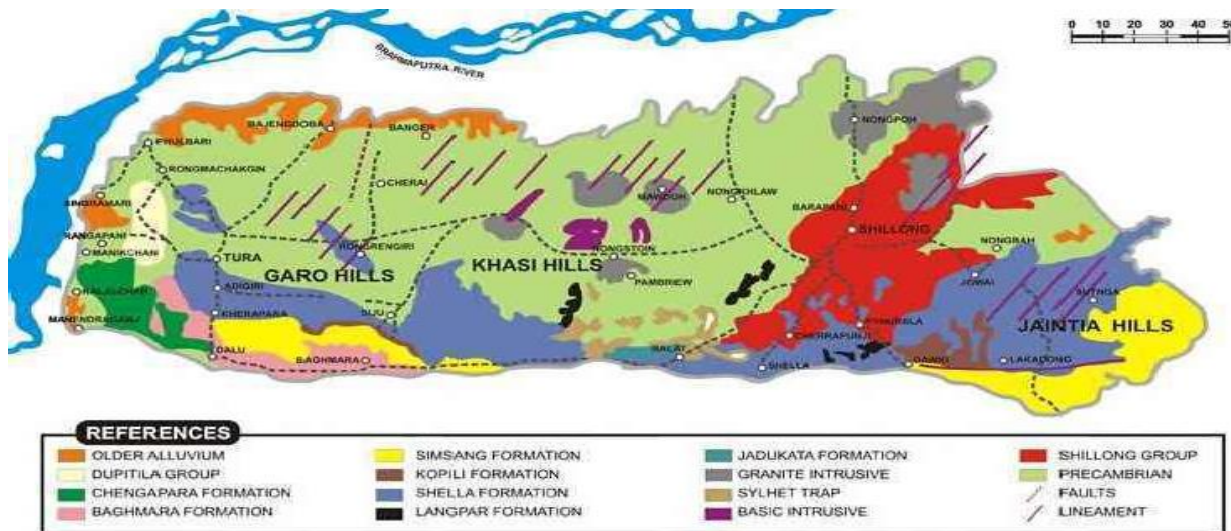


Fig.1 Geological Map of Meghalaya.

4.0 EXPLORATORY BORING

The provision laid down in BIS 1892: 1979 was followed in sinking the exploratory boreholes. Borehole was advanced into the soil by shell and auger boring to sink 150 mm diameter bore hole by using manually operated equipment. The boring was carried out by boring up to maximum depth of 10.00 m. Adequate care as per specification and Indian standard practice was taken to prevent any possible side collapse in bore hole. The details of the bore hole including field tests of Standard Penetration tests and collection of undisturbed/disturbed/SPT soil samples are given in Bore Log enclosed in Annexure. Disturbed representative samples of sub-surface deposits were collected from bore hole,

labelled depth wise and placed in polythene bags. Reference Numbers and depth of these samples are shown in Bore Log Data Sheet.

Field and Laboratory Works

Field and laboratory works associated with this investigation has been conducted as per the following specifications of the Bureau of Indian Standards (BIS):

FIELD WORK		
SI No.	Description	Relevant IS Codes
1	Boring, Drilling work and Collections of samples.	IS:1892-1979 IS:2131-1981 IS:2132-1981
2	Labeling and Packing	IS:1892-1979
3	Standard Penetration Test(SPT)	IS:9640-1980 IS:2131-1981
LABORATORY TEST		
SI No.	Description	Relevant IS Codes
4	Grain-Size Analysis	IS:2720(Part-4)-1985
5	Liquid Limit (LL) and Plastic Limit(PL)	IS:2720(Part-5)-1976
6	Free Swell Index	IS: 2720(Part40)-1977
7	Specific Gravity	IS:2720(Part-3)-1980
8	Water Absorption and Specific Gravity of Rock	IS: 1124
9	Point Load Strength Index of Rock	IS: 8764
10	Unconfined Compressive Strength of Rock	IS: 9143

5.0 ROTARY CORE DRILLING:

Conventional diamond core drilling equipment was used for drilling vertical hole up to specified depth at each location. Rotary core drilling in rock was carried out according to IS 1892-1979. This drilling technique was regarded as the most satisfactory method of assessing the character of rock formations, which lie at depth below the ground surface. Specimens of rock in the form of cylindrical cores were recovered from the drill hole by means of a core barrel. Double barrel technique was adopted according to field condition. The core barrel was provided at its lower end with a detachable shoe or core bit, which is of diamond. All rotary core bits were of NX (73mm) size.

Rock Quality Designation (RQD) of Rock	
RQD (%)	Description of Rock Quality
0-25	Very poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

Classification of Rock w.r.t. Strength	
Strength(N/mm ²)*	Term
Upto 1.25	Very weak
1.25to5.00	Weak
5.00to12.50	Moderately weak
12.50to50	Moderately strong
50to 100	Strong
100to200	Very strong
200	Extremely Strong

*Note: Based on uniaxial compression test.

Scale of Weathering of Rock Mass			
Item	Description	Grade	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 may be somewhat weaker externally than in its fresh condition.	II	90>CR>=75
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as core stones.	III	74>CR>=50
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as core stones.	IV	49>CR>=25
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V	CR<25

6.0 SAMPLING

Disturbed and undisturbed samples were collected and standard penetration test were done during boring. In addition to this, study in change of strata, ground water level, visual identification of soil such as colour, nature and stiffness were recorded during boring.

- Disturbed Sample: Disturbed/SPT samples were collected at different depths and were properly packed after collection.
- Core Sample: Core samples were collected from rock layers confirming all relevant codal provisions.

7.0 STANDARD PENETRATION TEST (SPT)

These tests were conducted in the boreholes at regular intervals or the change of strata; it was carried out by standard sampler (a split-spoon sampler) of standard design and dimension (50 mm OD and 35 mm ID, with minimum length of 450 mm). The sampler was

driven by a 63.5 kg drive weight (monkey) as per guidelines laid in IS: 2131. As per the IS code of practice for this test, the monkey was allowed to fall on the top of the drill rod from a height of 750 mm several times until the sample penetrates about 150 mm into the soil as a seating drive. The numbers of blows required to drive the spoon from 150 mm to 450 mm i.e., beyond the seating drive, were recorded and this number of blows is called 'N' value or Standard Penetration Test (SPT) value of the sub-soil at that particular depth. Where the test has been carried out on completion of a test, the split spoon sampler was brought out of the borehole and opened the same. The collected soil sample from the split spoon sampler was preserved in air tight polythene packets for classification purpose. The samples were labelled properly with the project name, borehole and the depth of sampling.

Followings are the corrections on SPT values in cohesion-less soil:

1. Due to overburden: N value for cohesion-less soil shall be corrected for overburden as per Fig. 1 of IS: 2131 (N').
2. Due to Dilatancy: The values corrected for overburden shall be corrected for dilatancy if the stratum consists of fine sand and silt below water table for values of N' greater than 15, as under (N''): $N'' = 15 + 0.5 \cdot (N' - 15)$

Typical calculation for N value correction:

BH No.-3. Depth: 1.50 m to 1.95. m. Field N = 20. Water table: Not found.

Effective OVP at the average depth: = 3.28 t/m².

From Fig 1.of IS: 2131, correction factor = 1.37.

So corrected SPT value for overburden, $N' = 1.37 \times 20 = 27.50$.

Same calculation will be valid for other N values in sandy layer. All the correction in detail is presented in a tabular form below in Table-1.

BHNo.	Start Depth (m)	End Depth (m)	Avg Depth (m)	FieldN	Effective OVP (t/m ²)	OVP Corr.Factor	Correction		Corrected N	Stratum No
							Overburden	Dilatancy		
1	1.00	1.45	1.23	52	2.33	--	--	--	8	I
2	1.00	1.10	1.05	100	2.00	1.54	154.08	--	154	III
	2.50	2.53	2.52	100	4.78	1.25	124.87	--	125	III
	4.00	4.05	4.03	100	7.65	1.09	109.15	--	109	III
	8.50	8.54	8.52	100	16.19	0.84	84.07	--	84	III
	10.00	10.06	10.03	100	19.06	0.79	78.62	--	79	III
	1.50	1.95	1.73	20	3.28	1.37	27.50	--	27	II
	3.00	3.45	3.23	22	6.13	1.17	25.64	--	26	II
	4.50	4.95	4.73	24	8.98	1.04	24.91	--	25	II

3	6.50	6.95	6.73	37	12.78	0.92	34.03	--	34	III
	7.50	7.95	7.73	46	14.68	0.87	40.18	--	40	III
	9.00	9.24	9.12	100	17.33	0.82	81.80	--	82	III
	10.00	10.37	10.19	100	19.35	0.78	78.10	--	78	III

Note: Avg. bulk density has been considered as 1.90 t/m³.

Table-1: Correction of field N values.

Stratum wise corrected “N” values are presented in tabular form given below:

Stratum No.	Stratum Description	“N” Values		
		Average	Maximum	Minimum
I	Hard, clayey silt	52	52	52
III	Medium dense, silty sand	26	27	25
IV	Dense to very dense, silty sand.	66	84	34

Note: N Value means Standard Penetration Test (SPT) Values.

8.0 STANDING WATER LEVEL(S.W.L.)

It was noticed that the ground water table was not found within explored depth.

9.0 LABORATORY TEST

Relevant laboratory tests were conducted on selected disturbed/SPT soil samples collected during the field investigation for proper identification, classification and for determining the various engineering properties including the shear strength parameters of these sub-soils deposits. Some of the routine tests were also carried out using the soil samples. In general, the following tests were carried out on representative soil samples collected from exploratory boreholes at different depth/ strata:

On Soil Sample:

- Atterberg limits (Liquid limit, Plastic limit).
- Grain size analysis (Sieve and Hydrometer).
- Specific Gravity.
- Free Swell Index.
- Chemical Test.

On Rock Sample:

1. Bulk density.
2. Specific Gravity.
3. Water absorption.
4. Point Load Strength Index.
5. Unconfined Compressive Strength of Rock.

The above mentioned laboratory tests were conducted as per the relevant Indian Standard Codes of practice and the results of these tests are furnished in the Annexure of this report. Results have been presented in the form of tables and graphs.

9.1 Atterberg Limits

Liquid limit (LL), Plastic limit (PL) of silty clay/ clayey silt samples were determined to (a) classify the soil by the unified soil classification system, (b) qualitatively assess their consistency and compressibility, and (c) obtain swelling characteristics of the soil. Soil has been considered both from disturbed and undisturbed samples collected from the exploratory boreholes.

9.2 Grain size analysis (Sieve & hydrometer)

The grain size distribution of some representative samples were determined from sieve analysis and hydrometer analysis depending upon the average grain diameter of the soil samples. The higher grained samples like sand were analyzed through sieve and the lower grain samples like fine silt and clay were analyzed through hydrometer. The results have been presented in the tables and graphs.

9.3 Specific Gravity

This test has been carried out to determine the specific gravity of fine-grained soil by density bottle method as per IS: 2720 (Part III/Sec 1) – 1980. Specific gravity is the ratio of the weight in air of a given volume of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature.

9.4 Free Swell Index

To determine the free swell index of soil as per IS: 2720 (Part XL) – 1977. Free swell or differential free swell, also termed as free swell index, is the increase in volume of soil without any external constraint when subjected to submergence in water. The values of free swell index have been reported in the Annexure part of the report.

9.5 Bulk Density of Rock Samples

Bulk density of rock core samples were determined by the procedure as per relevant Indian Standards. At least three core specimens were used for the test and the average of that value is being reported in laboratory test result column.

9.6 Specific gravity and Water Absorption of Rock Specimen

The test pieces were selected properly and were crushed or broken, and the material passing 20-mm IS Sieve and retained on 10-mm IS Sieve were used for the test. The tests were performed as per relevant procedure as stated in IS: 1124. Specific gravity of rock samples has been carried as per the procedure laid in IS 1124 and the value is reported in the annexure part of the report.

9.7 Point Load Strength Index of Rock Specimen

The cores or lumps have been selected so as to represent a true average of the rock type under consideration. The length of the core specimens between ends at their nearest points shall not be less than 1.5 times the diameter. However, the ends of core need not be finished. The tests were performed as per relevant procedure as stated in IS: 8764. Specific gravity of rock samples have been carried as per the procedure laid in IS 8764 and the value is reported in the annexure part of the report.

9.8 Unconfined Compressive Strength of Rock Specimen

The unconfined compressive strength test is primarily an index test for strength classification of rock materials. Although it may be used in the laboratory, it is mainly intended for field measurements on rock core and outcrop specimens. The apparatus used in the test is light and portable and can be used in the laboratory as well as in the field

9.9 SOIL PROFILE

The average subsoil stratification has been considered for the design. The soil stratification may, in general, has been summarized as shown in Fig 1.

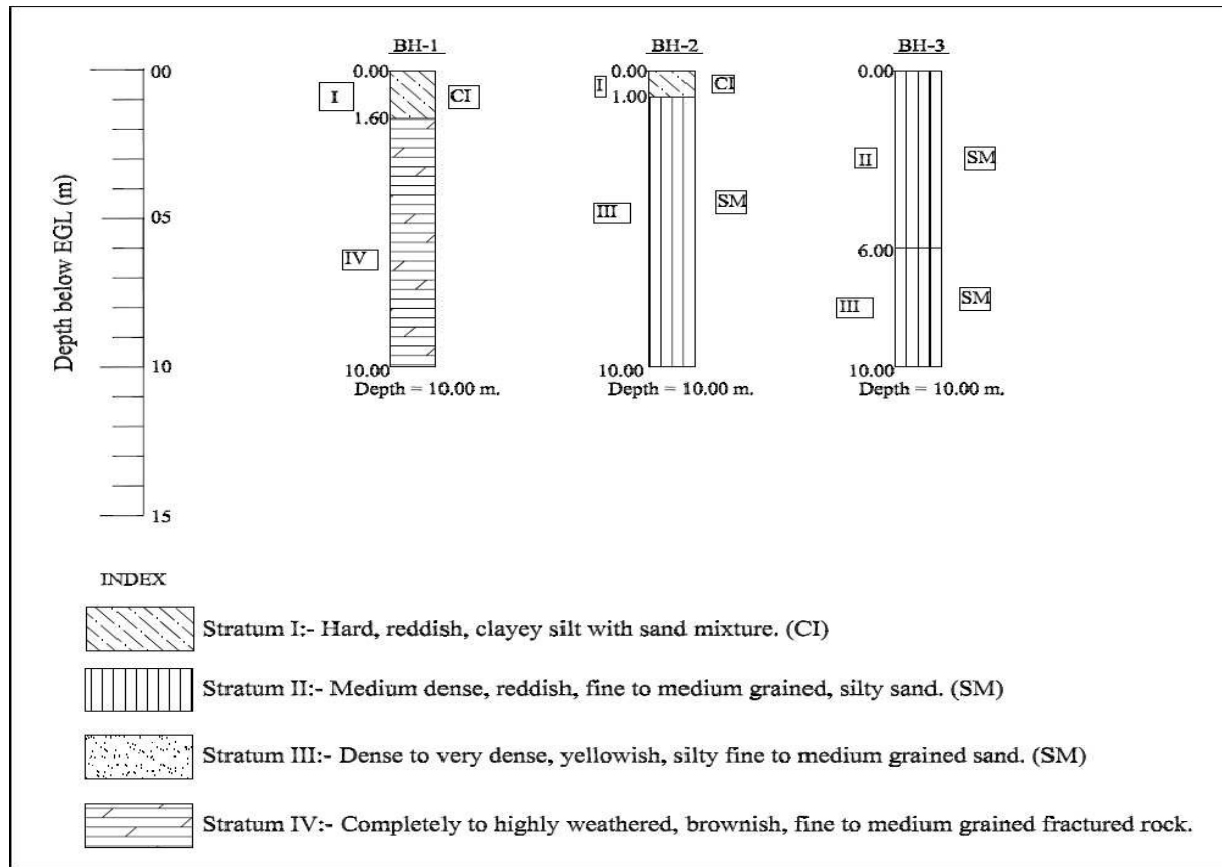
10.1 Stratum-I:

The soil in this layer consists of hard, reddish, silty clay/clayey silt with sand mixture. Average “N” value of this layer is 52. The soil samples that could be collected from this layer, shows the following average properties of the layer.

Sand (%)	13	Liquid Limit (%)	37
Silt (%)	59	Plastic Limit (%)	18
Clay (%)	28	Plasticity Index (%)	19
Specific Gravity	2.65	Free Swell Index (%)	9

Note: Average properties are based on laboratory test results only.

IS Classification: CI



Generalized Sub Soil Profile

10.2 Stratum-II:

The soil in this layer consists of medium dense, reddish, silty sand. Average corrected "N" value of this layer is 26. The soil samples that could be collected from this layer, shows the following average properties of the layer.

Sand (%)	80
Silt + Clay (%)	20
Free Swell Index (%)	NIL
Specific Gravity	2.57

Note: Average properties are based on laboratory test results only.

IS Classification: SM

10.3 Stratum-III:

The soil in this layer consists of dense to very dense, yellowish, silty sand. Average corrected “N” value of this layer is 66. The soil samples that could be collected from this layer, shows the following average properties of the layer.

Gravel (%)	4
Sand (%)	81
Silt+Clay(%)	15
Free Swell Index (%)	NIL
Specific Gravity	2.53

Note: Average properties are based on laboratory test results only.

IS Classification: SM

10.4 Stratum-IV:

This is a rock layer. It can be described as completely to highly weathered, brownish, fine to medium grained fractured rock. Followings are the average properties of the layer.

Bulk Density (gm/cc)	2.59
Specific Gravity	2.67
Water Absorption (%)	3.48
Point Load Strength Index (MPa)	5.62
Unconf. Comp. Strength (MPa)	136.62

Note: Average properties are based on laboratory test results only.

11.0 SUSCEPTIBILITY OF SUBSOIL TO LIQUEFACTION [Ref: IS 1893 (Part 1)]

The present site is under seismic zone-V. The liquefaction potential of subsoil is evaluated as per provision laid down in Indian Standard and “Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils” by Dr. Gonzalo Castro et al. published in “Journal of Geotechnical and Geo- environmental Engineering”, October’ 2001. Based on the SPT values, the liquefaction resistance of the borehole was evaluated for zone – V as per IS:1893 Part I and presented below. The ratio of $CRR/CSR \leq 1.0$ indicates that the soil is

prone to liquefaction whereas $CRR/CSR > 1.0$ or corrected $N1 > 30$ indicates the soil is non liquefiable. Based on the above, the liquefaction resistance of the subsoil is determined and presented below.

As per H. B. Seed and I.M. Idriss (1982) a clayey soil is said to be non-liquefiable if any one of the following three criteria is satisfied.

- the soil contains fine grained soils with clay contents greater than 15%,
- liquid limit greater than 35% or
- moisture contents less than 90% of the liquid limit.

In the present case, Stratum-I is having more than 15 % of clay content and liquid limit greater than 35%. So this layer is non-liquefiable. Stratum-IV is a rock layer and unlikely to be liquefiable.

Zone:V			a _{max} /g	0.36	Earthquake magnitude=							7.50			Bulk density=			1.90			
Structure Location	Avg Depth	Field N	Total OVP(t/s qm)	Effective OVP(t/sq m)	C _N	C _{HT}	C _{HW}	C _{BD}	C _{SS}	C _{RD}	(N ₁) ₆₀	FC	□	□	(N ₁) _{60CS}	r _d	CSR	CRR _{7.5}	FOS	REMARKS	
BH-1	1.00	52	1.90	0.90	Clayey silt																Non Liquefiable
BH-2	1.00	100	1.90	0.90	1.70	0.75	0.98	1.05	1.20	0.75	118.6	15	2.50	1.05	126.8	(N1)60CS>30				Non Liquefiable	
	2.50	100	4.75	2.25	1.70	0.75	0.98	1.05	1.20	0.75	118.6	15	2.50	1.05	126.8					Non Liquefiable	
	4.00	100	7.60	3.60	1.67	0.75	0.98	1.05	1.20	0.85	131.8	15	2.50	1.05	140.6					Non Liquefiable	
	8.50	100	16.15	7.65	1.14	0.75	0.98	1.05	1.20	0.95	101.0	15	2.50	1.05	108.4					Non Liquefiable	
	10.00	100	19.00	9.00	1.05	0.75	0.98	1.05	1.20	1.00	98.0	15	2.50	1.05	105.3					Non Liquefiable	
BH-3	1.50	20	2.85	1.35	1.70	0.75	0.98	1.05	1.10	0.75	21.7	20	3.61	1.08	27.1	0.99	0.49	0.34	0.696	Liquefiable	
	3.00	22	5.70	2.70	1.70	0.75	0.98	1.05	1.10	0.80	25.5	20	3.61	1.08	31.2					Non Liquefiable	
	4.50	24	8.55	4.05	1.57	0.75	0.98	1.05	1.10	0.85	27.8	20	3.61	1.08	33.6	Non Liquefiable					
	6.50	37	12.35	5.85	1.31	0.75	0.98	1.05	1.20	0.95	43.4	15	2.50	1.05	48.0	Non Liquefiable					
	7.50	46	14.25	6.75	1.22	0.75	0.98	1.05	1.20	0.95	50.3	15	2.50	1.05	55.2	Non Liquefiable					
	9.00	100	17.10	8.10	1.11	0.75	0.98	1.05	1.20	0.95	99.8	15	2.50	1.05	107.0	Non Liquefiable					
	10.00	100	19.00	9.00	1.05	0.75	0.98	1.05	1.20	1.00	99.6	15	2.50	1.05	106.9	Non Liquefiable					

Considering above conditions, it can be concluded that the soil at the present site is liquefiable up to 1.50 m around BH-3 within explored depth below EGL. Subsoil around BH-1 & BH-2 is non-liquefiable.

12.0 FOUNDATIONS

In view of the above sub-soil conditions in mind and the type of structure the aspects regarding allowable bearing capacity for open/shallow foundations have been discussed in the following paragraphs. Designer can choose the requirement depending upon the loading & geometry of the structure envisaged.

13.0 USE OF SHALLOW/OPEN FOUNDATION (Around BH-3):

Assumed foundation size = 2.50 m x 2.50 m Depth of foundation = 2.00 m.

EVALUATION OF STRENGTH AND DEFORMATION PARAMETERS:

Stratum-II

Design corrected "N" = 25. Corresponding $\Phi = 35^\circ$ [Ref: Fig. No. 1 of IS 6403]
Use, $\Phi = 28 + 15 \times Dr$. [In absence of any codal reference]

[Ref: "Foundation Analysis and Design", Fifth Edition, by J.E.Bowles, Table: 3-4, PP-162.]
 For medium dense sand, $D_r = 0.35$. Corresponding $\Phi = 33.25^\circ$ Considering the subsoil and to be on the safer side,

Use, design $C = 0.00$

kg/cm^2 & $\Phi = 32^\circ$. Relative

density = 26.67 %.

Method of analysis = Interpolation between general shear and local shear.

DETERMINATION OF BEARING CAPACITY:

The Net Ultimate Bearing Capacity is given as (As per

IS 6403): $q_d = C N_c S_c d_c + q (N_q - 1) S_q d_q +$

$0.5 B \gamma N_\gamma S_\gamma d_\gamma W$

Where,

N_c , N_q and N_γ are bearing

capacity factors, S_c , S_q and S_γ

are shape factors,

d_c , d_q and d_γ are depth factors,

And C = Cohesion

q = Effective surcharge at the base level of

foundation, B = Width of foundation,

γ = Bulk Density below foundation.

W' = Correction factor for location of water

table = 0.50. (Considering ground water level at ground level)

Considering general shear:

Relative density=70%. Corresponding $\Phi = 39^\circ$.

Cohesion, C =	0.00	kg/cm^2
Friction Angle, Φ =	39	$^\circ$
Depth of Foundation, D_f =	2.00	m
Width of Foundation., B =	2.50	m
Submerged Density, γ =	0.90	t/m^3
Water table correction=	0.50	

L/B ratio=	1				
FOS=	2.50				
N_c =	69.47	N_q =	58.02	N_{\square} =	97.13
D_c =	1.34	D_q =	1.17	D_{\square} =	1.17
S_c =	1.30	S_q =	1.20	S_{\square} =	0.80
Computed Net Ultimate Bearing Capacity=			248.74	t/m ²	
So, we have Net Safe Bearing Capacity=			99.50	t/m ²	

Considering local shear:

Relative density=20%.

Corresponding $\Phi=31^\circ$.

Using $\Phi=\tan^{-1}\{(2/3)\times\tan 31\}=22^\circ$

Cohesion, C =	0.00	kg/cm ²			
Friction Angle, \square =	22	°			
Depth of Foundation, D_f =	2.00	m			
Width of Foundation, B =	2.50	m			
Submerged Density, \square =	0.90	t/m ³			
Water table correction=	0.50				
L/B ratio=	1				
FOS=	2.50				
N_c =	17.19	N_q =	8.10	N_{\square} =	7.59
D_c =	1.24	D_q =	1.12	D_{\square} =	1.12
S_c =	1.30	S_q =	1.20	S_{\square} =	0.80
Computed Net Ultimate Bearing Capacity=			25.01	t/m ²	
So, we have Net Safe Bearing Capacity=			10.01	t/m ²	

Interpolated net safe bearing capacity = 21.19 t/m².

The above bearing capacity should be checked against settlement criteria.

SETTLEMENT CALCULATION

Width of foundation=	2.50	m	Length of foundation	=	2.50	m
D =Depth of foundation=	2.00	m	Below existing ground level			
Influence zone for settlement of foundation =			5.00	m	below founding level	
Safe bearing capacity=	21.19	t/m ²				

Stratum II:

Start depth=	2.00	m	Thickness of the stratum=	5.00	m
End depth=	7.00	m			
Foundation pressure=	21.19	t/m ²			

Immediate Settlement:

Design corrected N =	25
------------------------	----

At 10t/m²pressure, settlement for foundation = 10.00 mm

[Ref: Fig-9 of IS:8009(Part-I)]

Water table correction = 0.50 (Considering ground water level at ground level) So the corrected settlement = 20.00 mm $S_i = 42.38$ mm

Applying correction for depth factor, Corrected $S_t = 33.90$

$\frac{mmD}{(L \times B)^{0.5}} = 0.8$

Corresponding depth factor = 0.8

[Ref: Fig 12 of IS 8009 (Part I)]

Considering permissible settlement, = 50.00mm

Recommended allowable bearing capacity= 20.00

t/m² Final settlement= 32.00mm

Sample bearing capacity calculation inside rock layer around BH-1.

Assumed foundation size = 2.50 m x 2.50 m Depth of foundation = 2.00 m. From Rock Mass Rating (RMR) :

(As per Annex B, IS 13365(Part 1)-1998 & IS 12070--1987

i) For Uniaxial Compressive Strength of intact rock material = 1 MPa

0

Rating Suggested is 1

ii) For Rock Quality Designation (RQD) in between 00 % to 20 %

Rating Suggested is 3

iii) For Spacing of discontinuities <0.06 m

Rating Suggested is 5

iv) Condition of Discontinuities

5mm thick soft gauge 5 mm wide continuous discontinuity Rating Suggested is 0

v) Ground Water Condition

For Wet Ground Water

Condition Rating Suggested is

7

vi) Orientation of Discontinuities

Dip orientation for stability of raft foundation

For Fair type of joint orientation and for raft

foundation Rating Suggested is -7

So $RMR = 1+3+5+0+7+-7=30$

From Table 3 of IS 12070-1987 corresponding to RMR Allowable bearing capacity: 36.75 t/m².

Recommended allowable bearing capacity=35.00t/m².

Recommended allowable bearing capacity at borehole location i as follows:

Location	Foundation size (mxm)	Depth of foundation below EGL(m)	Net Ultimate bearing capacity (t/m ²)	Net Safe bearing capacity (t/m ²)	Anticipated Settlement (mm)	Allowable bearing capacity(t /m ²)	Final Settlement (mm)
BH-1	2.00 x2.00	1.50	153.69	61.47	--	*30.00	--
	2.50X 2.50		149.68	59.87	--	*30.00	--
	3.00X 3.00		147.00	58.80	--	*30.00	--
	4.00X 4.00		143.66	57.47	--	*30.00	--

Location	Foundation size (mxm)	Depth of foundation below EGL(m)	Net Ultimate bearing capacity (t/m ²)	Net Safe bearing capacity (t/m ²)	Anticipated Settlement (mm)	Allowable bearing capacity (t/m ²)	Final Settlement (mm)
BH-1	2.50X 2.50	2.00	RMR Method			35.00	--
	3.00X 3.00					35.00	--
	4.00X 4.00					35.00	--
BH-2	2.00 x2.00	1.50	104.55	41.82	--	*30.00	--
	2.50X 2.50		112.66	45.06	--	*30.00	--
	3.00X 3.00		121.29	48.52	--	*30.00	--
	4.00X 4.00		139.35	55.74	--	*30.00	--
	2.50X 2.50	2.00	136.88	54.75	--	*35.00	--
	3.00X 3.00		144.69	57.88	--	*35.00	--
	4.00X 4.00		161.72	64.69	--	*35.00	--
BH-3	2.00 x2.00	1.50	40.41	16.16	25.86	15.00	24.00
	2.50X 2.50		43.29	17.32	29.44	15.00	25.50
	3.00X 3.00		46.38	18.55	31.54	15.00	25.50
	4.00X 4.00		52.84	21.13	38.03	18.00	32.39
	2.50X 2.50	2.00	52.98	21.19	33.90	20.00	32.00
	3.00X 3.00		55.76	22.30	37.91	20.00	34.00
	4.00X 4.00		61.84	24.73	42.04	20.00	33.99

Note: 1. EGL means Existing Ground Level. 2. Permissible settlement is 50 mm. 3.

RMR method based on Table-3 of IS 12070. 4. *Restricted value.

14.0 CHEMICAL TESTS

Chemical tests were performed on soil and water samples for determining the pH value, Sulphate, Chloride content etc. The results are given in a tabular form below:

CHEMICAL TEST RESULTS ON SOIL SAMPLES :-

BH No.	Depth (m)	pH value	Sulphate asSO ₃ (%)	Chloride as Cl(%)
BH-1	1.00	7.26	0.014	0.055
BH-2	0.50	7.15	0.012	0.041
BH-2	3.00	7.09	0.016	0.064

Chemical test was carried out on a soil and water samples to determine the pH value, Sulphate and Chloride. It is seen that the values are within permissible limits (as per IS:456-2000) and so no special cement will be required for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for concreting.**

15.0 CONCLUSION AND GENERAL RECOMMENDATIONS

Based on the field tests and the foregoing discussion the following are summarized:

- The subsoil is characterized by a layer of hard, clayey silt at top followed by a weathered rock layer around BH-1. Around BH-2, sub soil is characterized by a hard, clayey silt followed by a very dense, silty sand layer. Around BH-3, sub soil is characterized by medium dense to dense to very dense silty sand layer and that continues up to the terminating depth of borehole.
- The present report deals with the geotechnical investigation findings at the location and the discussion on the aspects regarding bearing capacity of open foundations depending on the field and laboratory test results. However, the Foundation Designer may modulate the type of foundations and other values regarding foundation geometry and soil design parameter to meet any specific design criteria.
- Standing water level was not found within explored depth below EGL. However, ground water level is considered at ground level for design purpose.
- Susceptibility of liquefaction of the sub soil has been discussed in section 11. The site is non- liquefiable.
- Determination of recommended safe bearing capacities of open/shallow foundation has been discussed in the section 13.
- Precaution in all respect should be taken for nearby existing structures, if any. The final decision regarding the foundation will depend on the judgment of the engineer concerned.

g) Comment on the chemical nature of soil & ground water:

Chemical test was carried out on a soil and water samples to determine the pH value, Sulphate and Chloride. It is seen that the values are within permissible limits (as per IS:456-2000) and so no special cement will be required for foundation concrete. Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for concreting.

- h) No Expansive soil has been found on the site.
- i) Seismic co-efficient as per IS specification should be considered during design.

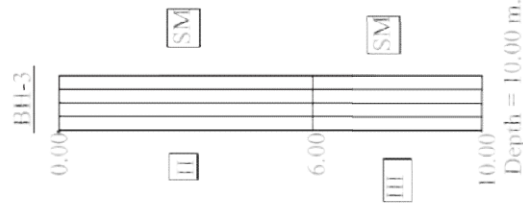
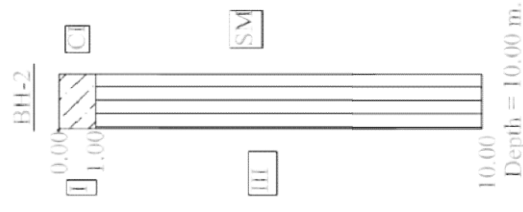
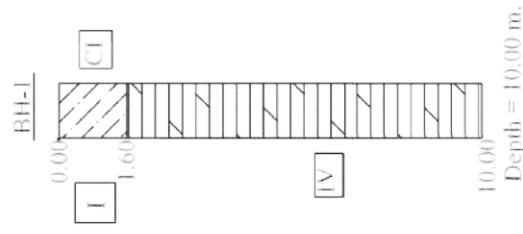
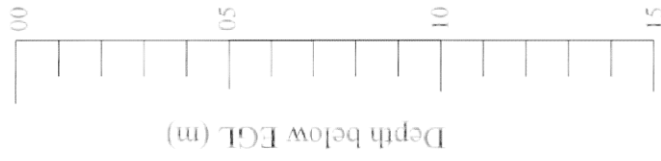
ANNEXURES

BORE / DRILL LOG																	
Project Name : Forest nursery,Madan Laban																	
LOCATION : Shillong			TYPE OF DRILLING:		Rotary				TERMINATION			10.00					
BORE HOLE NO		1	TYPE OF BIT USED:		Diamond				DEPTH (M) :								
Latitude (N) - 25.5551			ANGLE WITH THE HORIZON:		Vertical				COMMENCED ON :			15.01.2022					
Longitude(E) - 91.8693			COLLAR ELEVATION :				SWT:		Not found		COMPLETED ON :			16.01.2022			
Description of Strata	Depth (m)		Run no.	Run		TCR %	RQD %	Depth of NX Casing (m)	Drill Water		Rate (cm/min)	Nature of Sample	Depth(M)	Conducting SPT IS code 2131-1981			
	From	To		From(M)	To(M)				Loss (%)	Color				0-15 cm	15-30 cm	30-45 cm	N' Value
Hard, reddish, clayey silt with sand mixture.	0.00	1.60										DS	0.50				
												P	1.00	10	18	34	52
												P	1.60	64 Blows for 2 cm N >100			
Completely to highly weathered, brownish, fine to medium grained fractured rock.	1.60	10.00	1	1.60	2.00	Nil	Nil		Brownish grey	38							
			2	2.00	3.00	50	Nil		Brownish grey	44							
			3	3.00	4.00	26	23		Brownish grey	48							
			4	4.00	5.00	10	Nil		Brownish grey	47							
			5	5.00	6.00	11	Nil		Brownish grey	45							
			6	6.00	7.00	27	Nil		Brownish grey	49							
			7	7.00	8.00	15	Nil		Brownish grey	48							
			8	8.00	9.00	24	Nil		Brownish grey	56							
			9	9.00	10.00	28	Nil		Brownish grey	57							
Note : U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test																	

BORE-DRILLLOG																		
ProjectName:Forestnurseryupper,MadanLaban																		
LOCATION :Shillong				TYPE OFDRILLING:			Rotary					TERMINATION			10.00			
BOREHOLENO		2		TYPEOF BIT USED:			Diamond					DEPTH (M) :						
Latitude(N)- 25.5546				ANGLEWITHTHEHORIZON:			Vertical		COMMENCEDON:					20.01.2022				
Longitude(E) - 91.8703				COLLARELEVATION:					SWT:		Notfound		COMPLETEDON:			24.01.2022		
DescriptionofStrata		Depth(m)		Runno.	Run		TCR%	RQD%	DepthofNXCasing(m)	DrillWater		Rate(cnv/ min)	NatureofSample	ConductingSPT IScode 2131-1981				
		From	To		From(M)	To(M)				Loss (%)	Color			Depth(M)	0-15cm	15-30cm	30-45cm	N'value
Hard, brownish grey,clayey silt withsandand grass roots.		0.00	1.00	1 2 3 4 5 6	1.00 2.50	2.50 2.53	Nil	Nil		Brownish grey	49	DS	0.50	54Blowsfor10cmN >100				
Verydense,yellowishgrey,siltyfineto coarse sand with gravels. (Boldersfound 1mto 4moccasionally)		1.00	10.00		2.50 4.00	4.00 4.05	Nil	Nil		Brownish grey	52	P	2.50	52Blowsfor3cmN >100				
					2.50 4.00	4.00 4.05	Nil	Nil		Brownish grey	58	P	4.00	56Blowsfor5cmN >100				
					4.00 5.50	5.50 7.00	18	Nil		Brownish grey	62	P	8.50	53Blowsfor4cmN >100				
					7.00 8.50	8.50 10.06	Nil	Nil		Lightgrey	57	P	10.00	55Blowsfor6cmN >100				
					8.50 10.00	10.00 10.06	Nil	Nil		Lightgrey								
Note:U-UndisturbedSampleD-DisturbedSampleP-StandardPenetrationTest																		

BORE/DRILL LOG																	
Project Name: Nearshillong peak, UTP Location																	
LOCATION :Shillong				TYPE OF DRILLING:				Rotary/Auger				TERMINATION		10.00			
BOREHOLE NO		3		TYPE OF BIT USED:				Diamond				DEPTH (M) :					
Latitude(N) - 25.5479				ANGLE WITH THE HORIZON:				Vertical				COMMENCED ON:		26.01.2022			
Longitude(E) - 91.8742				COLLARE ELEVATION:				SWT:		Not found		COMPLETED ON:		27.01.2022			
Description of Strata	Depth(m)		Run no.	Run		TCR %	RQD %	Depth of NX Casing (m)	Drill Water		Rate (cm/min)	Nature of Sample	Conducting SPT IS Code 2131-1981				
	From	To		From (M)	To (M)				Loss (%)	Color			Depth (M)	0-15cm	15-30cm	30-45cm	N Value
Medium dense, reddish, fine to medium grained, silty sand.	0.00	6.00										DS	0.50				
Dense to very dense, yellowish, silty fine to medium grained sand.	6.00	10.00										PP	1.50	8	10	10	20
												P	3.00	9	10	12	22
												P	4.50	10	12	12	24
												P	6.50	11	17	20	37
												P	7.50	12	19	27	46
												P	9.00	18	52 Blows for 9 cm N > 100		
	10.00	23	40	54 Blows for 7 cm N > 100													
Note: U - Undisturbed Sample D - Disturbed Sample P - Standard Penetration Test																	

LABTESTRESULT																			
B.H.NO.:01					Site: Forest nursery, Madan Laban, Shillong														
Type	Depth(m)	Gravel(%)	Sand(%)	Silt(%)	Clay (%)	Natural Moisture Content(%)	Bulk Density (gm/cc)	Dry Density(gm/cc)	Liquid Limit(%)	Plastic Limit(%)	Plasticity Index(%)	IS Classification	Type of Test	Cohesion(kg/cm ²)	Angle of Friction (degree)	Sp. Gravity	E Value (kg/cm ²)	Free Swell (%)	Relative Density (%)
P	1.00	-	15.23	56.23	28.54				36.00	16.00	20.00	CI				2.64		12.00	
<u>Rock Lab test result-</u>																			
Run No.		Depth(m)		Bulk Density(g m/cc)		Water absorption (%)		Specific Gravity		Point Load Index (kg/cm ²)		Unfnd. Comp. Strength (kg/cm ²)							
3		3.00-4.00		2.56		3.26		2.65		--		136.62							
8		8.00-9.00		2.61		3.69		2.69		5.62		--							
P=SPT Sample																			



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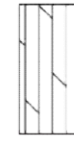
Stratum I:- Hard, reddish, clayey silt with sand mixture. (CI)



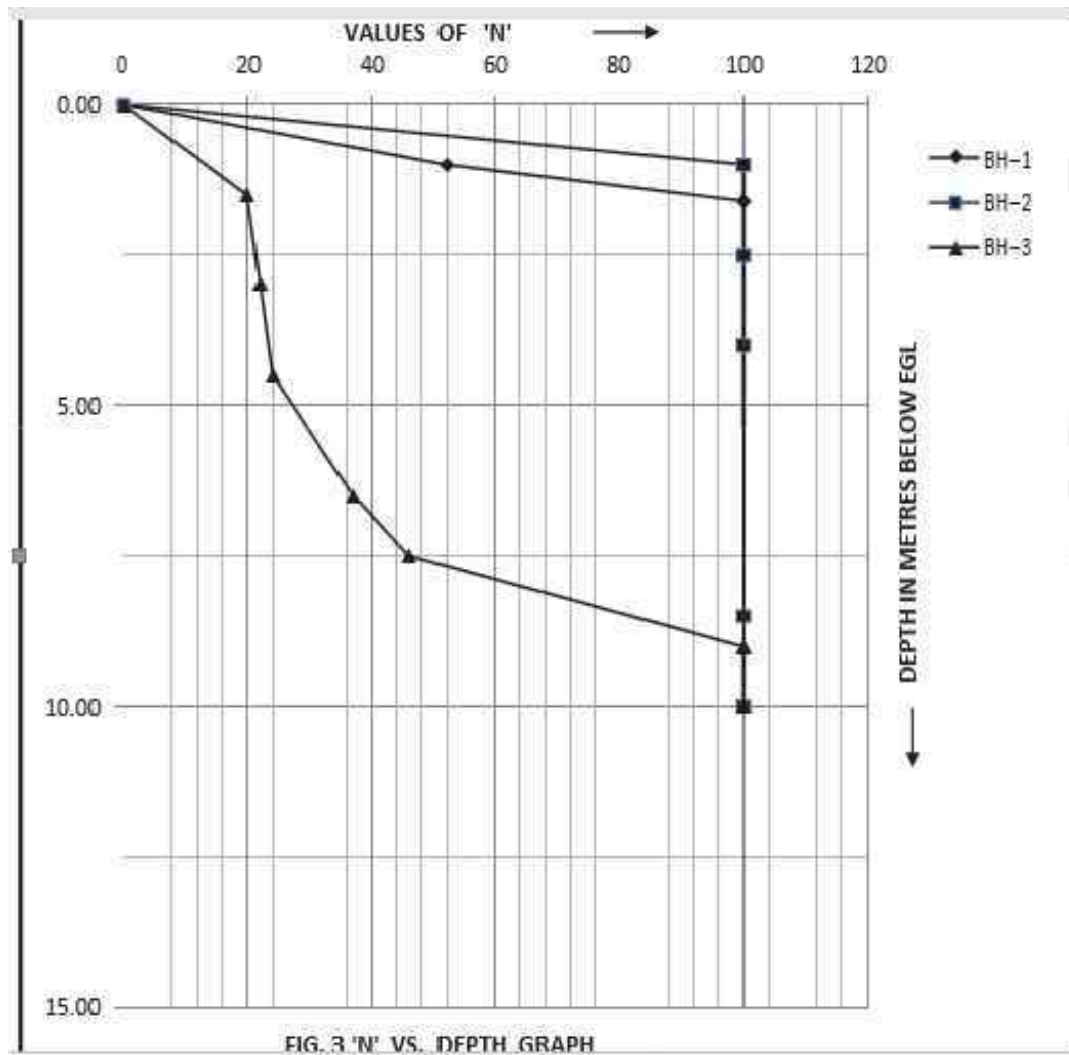
Stratum II:- Medium dense, reddish, fine to medium grained, silty sand. (SM)

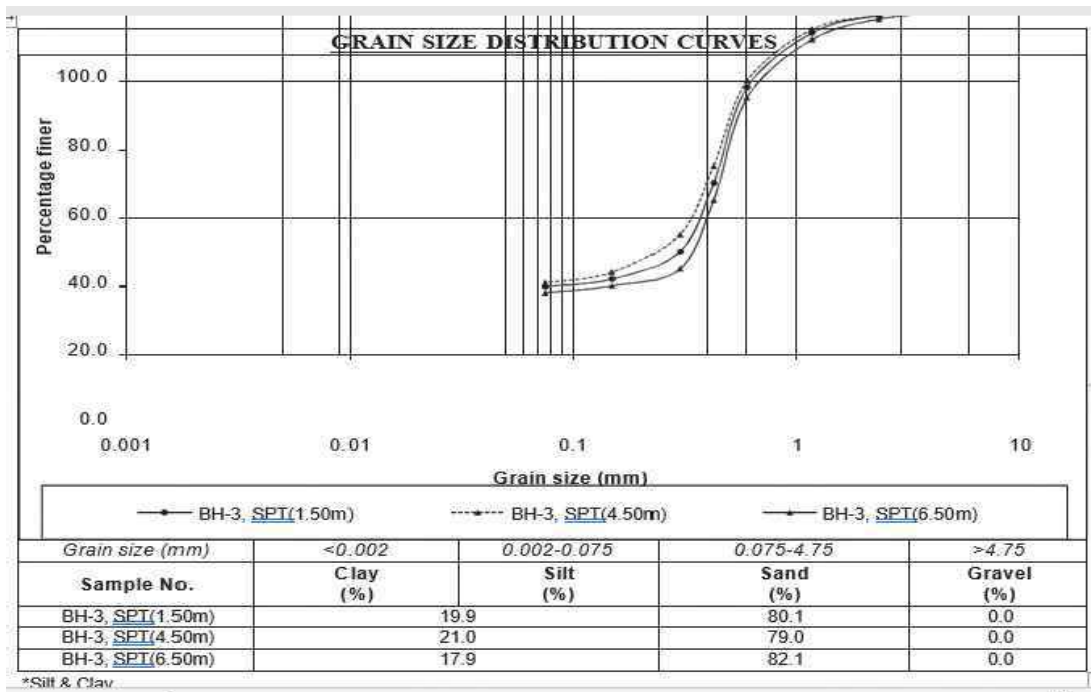
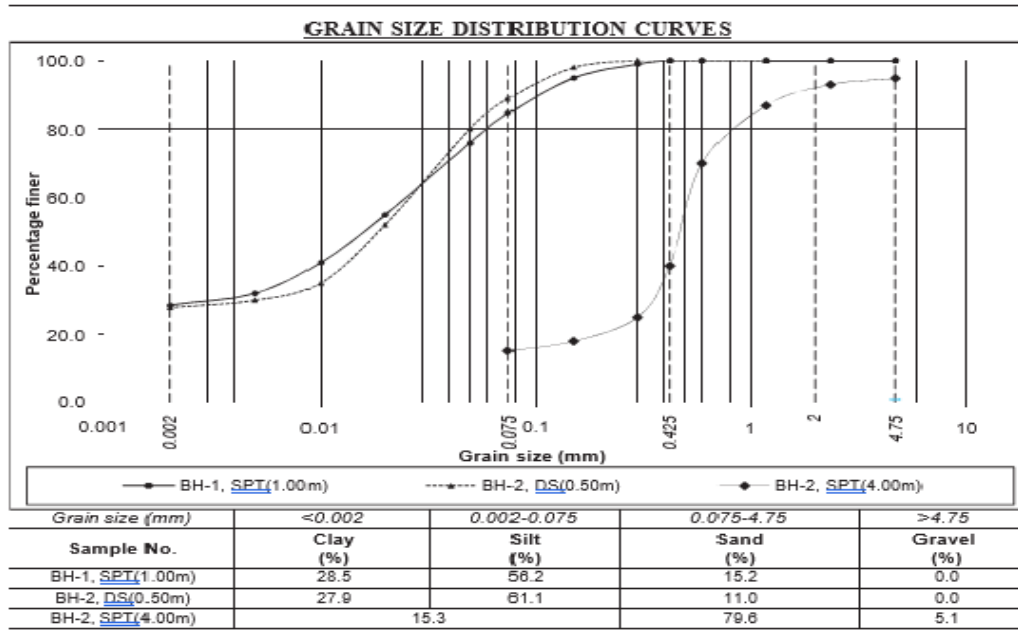


Stratum III:- Dense to very dense, yellowish, silty fine to medium grained sand. (SM)



Stratum IV:- Completely to highly weathered, brownish, fine to medium grained fractured rock.







BORE HOLE NO 1



BORE HOLE NO 3



BH-1



BH-2



BH-2



BH-3

BORE / DRILL LOG																	
Client: <u>Rites Limited (Laban Shillong)</u>					Site: <u>Forest Nursery, Madan Laban, Shillong</u>												
BORE HOLE NO. <u>01 (LTP)</u>					TYPE OF DRILLING: <u>Rotary</u>					Termination Depth: <u>10.00m</u>							
EXISTING G.L. (m): <u>15.01</u>					TYPE OF BIT USED: <u>TC, Diamond</u>					Static Water Table: <u>15.01</u>							
Latitude (N): <u>25.5651</u>					ANGLE WITH THE HORIZON: <u>Vertical</u>					Started On: <u>15.01.2022</u>							
Longitude (E): <u>91.8673</u>					COLLAR ELEVATION: <u>+15 cm</u>					Completed On: <u>16.01.2022</u>							
Description of Strata	Depth (m)		Run no.	Run		TCR %	ROD %	Drill Water		Rate (cm/min)	Nature of Sample	Depth (m)	Conducting SPT				
	From	To		From (M)	To (M)			Depth of HX Casing (m)	Loss (%)				Color	0-15 cm (Scaling Value)	15-30 cm	30-45 cm	N (SPT) Value
<u>15.01/22</u> Light Brownish Grey clayey Silty Sand with mica & fines of Roukara.	0.00	0.50	-	-	-	-	-	-	-	-	DS	0.50	-	-	-		
	1.00	1.45	-	-	-	-	-	-	-	-	P	0.45	10	18	34		
	1.60	1.62	-	-	-	-	-	-	-	-	P	0.02	64	1603	for 2 cm sample 110.		
<u>16.01/22</u> Light Brown/Grey Calcareous highly fractured micaceous Rocky Strata.																	
<u>16.01/22</u> Light Brown/Grey Calcareous highly fractured micaceous Rocky Strata.	1.60	2.00	1	1.60	2.00	NIL	NIL	-	Brown clay	38	C	0.40	-	-	-		
	2.00	3.00	2	2.00	3.00	500	NIL	-	Brown clay	44	C	1.00	-	-	-		
	3.00	4.00	3	3.00	4.00	26.0	23.0	-	Brown clay	48	C	1.00	-	-	-		
	4.00	5.00	4	4.00	5.00	10.0	NIL	-	Brown clay	47	C	1.00	-	-	-		
	5.00	6.00	5	5.00	6.00	11.0	NIL	-	Brown clay	45	C	1.00	-	-	-		
	6.00	7.00	6	6.00	7.00	27.0	NIL	-	Brown clay	49	C	1.00	-	-	-		
	7.00	8.00	7	7.00	8.00	15.0	NIL	-	Brown clay	48	C	1.00	-	-	-		
	8.00	9.00	8	8.00	9.00	24.0	NIL	-	Brown clay	56	C	1.00	-	-	-		
	9.00	10.00	9	9.00	10.00	28.0	NIL	-	Brown clay	57	C	1.00	-	-	-		
	<u>The Borehole Terminated at 10.00m depth B.G.L.</u>																

Notes : U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

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Note: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

BORE / DRILL LOG																	
Client: <u>Rites Limited (Laban, Shillong)</u>								Site: <u>Near Forest Nursery, Madan Laban, Shillong</u>									
BORE HOLE NO. <u>02</u>								TYPE OF DRILLING: <u>Rotary</u>				Termination Depth: <u>10.00m</u>					
EXISTING G.L. (m): <u>15.01</u>								TYPE OF BIT USED: <u>TC, Diamond</u>				Static Water Table: <u>Started On: 20/01/2022</u>					
Latitude (N): <u>25.5546</u>								ANGLE WITH THE HORIZON: <u>Vertical</u>				Completed On: <u>24/01/2022</u>					
Longitude (E): <u>91.8703</u>								COLLAR ELEVATION: <u>+15 cm</u>									
Description of Strata	Depth (m)		Run no.	Run		TCR %	ROD %	Drill Water		Rate (cm/min)	Nature of Sample	Depth (m)	Conducting SPT I.S.: 2131-1981				
	From	To		From (M)	To (M)			Depth of HX Casing (m)	Loss (%)				Color	0-15 cm (Scaling Value)	15-30 cm	30-45 cm	N (SPT) Value
<u>Brownish Grey clayey Silty Fine Sand with Grassroots.</u> <u>1.00m</u>	0.00	0.50	-	0.00	0.50	-	-	-	-	-	DS	0.50	-	-	-		
	1.00	1.10	-	1.00	1.10	-	-	-	-	-	P	0.10	54	blows for 10 cm sample	110.		
<u>'X' Sh' Drilling started from 1.00m depth</u>																	
<u>Highly Fractured Boulders Area.</u> <u>1.00m</u>	1.00	2.50	1	1.00	2.50	NIL	NIL	-	-	49	C	2.50	-	-	-		
	2.50	2.53	-	2.50	2.53	-	-	-	-	-	P	0.03	52	blows for 3 cm sample	110		
	2.50	4.00	2	2.50	4.00	NIL	NIL	-	-	52	C	4.00	-	-	-		
	4.00	4.05	-	4.00	4.05	-	-	-	-	-	P	0.05	56	blows for 5 cm sample	110		
<u>Brown Grey Calcareous highly fractured Rocky Strata.</u> <u>1.00m</u>	4.00	5.50	3	4.00	5.50	18.0	NIL	-	-	58	C	5.50	-	-	-		
	5.50	7.00	4	5.50	7.00	21.0	NIL	-	-	62	C	7.00	-	-	-		
	7.00	8.50	5	7.00	8.50	NIL	NIL	-	-	52	C	8.50	-	-	-		
<u>Grey Calcareous Dust Rock Strata.</u> <u>1.00m</u>	8.50	8.54	-	8.50	8.54	-	-	8.00	-	-	P	0.04	53	blows for 4 cm sample	110		
	8.50	10.00	6	8.50	10.00	NIL	NIL	-	-	57	C	10.00	-	-	-		
	10.00	10.06	-	10.00	10.06	-	-	-	-	-	P	0.06	55	blows for 6 cm sample	110.		
<u>The Borehole Terminated at 10.00m depth B.G.L.</u>																	
Note: U-Unundisturbed Sample D-Disturbed Sample P-Standard Penetration Test																	

Note: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

BORE / DRILL LOG																	
Client: <u>Rites Limited (Shillong Road way)</u>					Site: <u>near Shillong Peak & UTP location</u>												
BORE HOLE NO. <u>BH-3 (UTP)</u>					TYPE OF DRILLING: <u>Rotary / Auger</u>					Termination Depth: <u>10.00m</u>							
EXISTING G.L. (m): <u>25.5479</u>					TYPE OF BIT USED: <u>TC, Diamond</u>					Static Water Table: <u>26.01.2022</u>							
Latitude (N): <u>25.5479</u>					ANGLE WITH THE HORIZON: <u>Vertical</u>					Started On: <u>27.01.2022</u>							
Longitude (E): <u>91.8742</u>					COLLAR ELEVATION: <u>+15 cm</u>					Completed On: <u>27.01.2022</u>							
										Conducting SPT 1.5 - 2131-1981							
Description of Strata	Depth (m)		Run No.	Run		TCR %	ROD %	Depth of MC Casing (m)	Drill Water		Rate (cm/min)	Nature of Sample	Depth (m)	Conducting SPT 1.5 - 2131-1981			
	From	To		From (M)	To (M)				Loss (%)	Color				0-15 cm (Blow Value)	15-30 cm	30-45 cm	N (SPT) Value
<u>26.01.22</u> Light Brownish Grey clayey Silty Fine Sand.	0.00	0.50		0.00	0.50	-	-	-	-	-	-	DS	-	-	-	-	
<u>27.01.22</u> Terrestrial Grey clayey Silty / Silty clay with Sand mixed.	1.00	1.95		1.50	1.95	-	-	-	-	-	-	P	150	8	10	20	
	3.00	3.45		3.00	3.45	-	-	-	-	-	-	P	3.00	9	10	22	
	4.50	4.95		4.50	4.95	-	-	-	-	-	-	P	4.50	10	12	24	
	6.00	6.45		6.00	6.45	-	-	-	-	-	-	P	6.50	11	17	20	
<u>27.01.22</u> Light Brownish Grey fine to Medium / medium to coarse Sand.	7.50	7.95		7.50	7.95	-	-	-	-	-	-	P	7.50	12	19	27	
	9.00	9.24		9.00	9.24	-	-	-	-	-	-	P	9.00	18	52 blows for 9cm	54 blows for 7cm	
	10.00	10.37		10.00	10.37	-	-	-	-	-	-	P	10.00	23	40	54 blows for 7cm	
	The Borehole Terminated at 10.00m depth B.G.L.																

Note: U-Undisturbed Sample, D-Disturbed Sample, P-Standard Penetration Test

2024

Note: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

