REPORT OF GEOTECHNICAL INVESTIGATION FOR PROPOSED PROJECT INSTALLATION OF WELL FLUID PROCESSING TRAIN-B & ASSOCIATED EQUIPMENT AT CPF BHASKAR FIELD, PANDAD – TAMSA ROAD, TAL. KHAMBHAT, DIST. ANAND, GUJARAT

(GETS/2024/REPORTS/2389, DATE: 20.06.2024)

CLIENT:

GOURAV TRADING COMPANY

AHMEDABAD

Prepared By:

Geostruct Engineering & Testing Services

8-sahajanand co-op industrial estate, Munjmahuda, Baroda-390020

Mo.No. 9099012025 / 0265-2341590, 2358415

Email: info@geostruct.co.in // www.geostruct.co.in

TABLE OF CONTENTS

SR.NO.	CONTENT	PAGE NO.
1	INTRODUCTION	1
2	SCOPE OF WORK	1
3	FIELD WORK	1 – 2
4	LABORATORY TEST	2
5	SOIL PROPERTIES	2 – 4
6	FOUNDATION ANALYSIS	4 – 5
7	RECOMMEDATIONS	5 – 6
	FIELD AND LABORATORY TEST DATA	**PLATES**
8	LOCATION PLAN	1
9	BORELOG	2
10	RESULT SHEET	3

GEOSTRUCT
ENGINEERING AND TESTING SERVICES
8, Sahajanand Ind. Estate, Munjmahuda, Padra road, Vadodara – 390020. Phone: 9099012025, 9099050338
Email: info@geostruct.co.in, geostruct.engg@gmail.com, Website: www.geostruct.co.in
PAN: AABFG5352N • GSTIN: 24AABFG5352N1ZB

GETS/2024/REPORTS/2389 Date: 20.06.2024

REPORT OF GEOTECHNICAL INVESTIGATION FOR PROPOSED PROJECT INSTALLATION OF WELL FLUID PROCESSING TRAIN-B & ASSOCIATED EQUIPMENT AT CPF BHASKAR FIELD, PANDAD – TAMSA ROAD, TAL. KHAMBHAT, DIST. ANAND, GUJARAT

1.0 INTRODUCTION

SUN PETROCHEMICALS PRIVATE LIMITED is planning to Installation of well Fluid processing train-B & Associated equipment @ CPF Bhaskar field, Pandad-Tamsa road, Tal. Khambhat, Dist. Anand. They have awarded work of geotechnical investigation of proposed project site to us.

2.0 SCOPE OF WORK

1. Drilling two bore holes up to 10m depth and collection of UDS and conducting SPT at regular interval.
2. Carry out laboratory testing on soil samples to evaluate engineering properties
3. Analyzing all field and laboratory data in order to develop engineering recommendations for foundation design and construction.

3.0 FIELD WORK

The field work was commenced on 10.06.2024 and completed on 11.06.2024.

3.1 Exploratory Boreholes and Location

The Summary of boreholes drilled is given in Table 1.

Table 1: Summary of Bore Holes

BH No.	Termination Depth of Bore Hole (m)	Ground water table below EGL (m)
BH-1	10.0	3.3
BH-2	10.0	3.0

All the test locations are shown in Plate 1. Bore logs are given as Plate 2 to 3.

3.1.1 Standard penetration test (SPT)

SPT is conducted as per IS 2131 – 1981 at specified intervals. In a SPT test, standard split spoon sampler is driven at the bottom of the borehole. The penetration resistance in terms of blows for 30cm penetration of the split spoon sampler is measured as 'N' Value. The blows are imparted by a standard weight of 63.5 kg falling through a height of 75cm. The resistance is measured for 15cm, 30cm, and 45cm penetrations. The resistance measured for first 15cm is ignored since

those blows are considered as seating blows due to the loosening of the strata. The resistance of next 30cm is recorded as standard penetration value 'N'. If the sampler is driven less than 45cm (total) then the penetration resistance is given for the last 30cm of penetration. The observed SPT – N values for each borehole is given in bore logs attached as Plate 2 to 3.

3.1.2 Disturbed samples

Disturbed representative samples are collected, logged, labeled and placed in polythene bags.

3.1.3 Undisturbed samples

Undisturbed soil samples are collected in 75mm diameter (ID) thin walled sampler (Shelby tube) from each borehole. The sampler used for the sampling had smooth surface and appropriate area ratio and cutting edge angle thereby minimising disturbance of soil during sampling.

4.0 LABORATORY TESTS

The laboratory testing of soil samples is carried out in our own laboratory as per relevant IS standards

	TESTS ON SOIL & ROCK SAMPLES	**TEST METHOD**
a)	Grain Size Distribution (Sieve Analysis)	IS 2720 (Part 4)
b)	Atterberg's limits (liquid limit and plastic limit)	IS 2720 (Part 5)
c)	Engineering Classification of Soil	IS 1498
d)	Specific Gravity	IS 2720 (Part 3)
e)	Field Dry Density & Field Moisture Content	IS 2720 (Part 2 & 29)
f)	Tri-axial Shear test (for c & Φ) - Tuu	IS 2720 (Part 11)
g)	Differential Free swell index test	IS 2720 (Part 40)
h)	Consolidation Test	IS 2720 (Part 15)

5.0 SOIL PROPERTIES

5.1 Executive summary of soil stratifications

BH No.	Stratum	Depth (m)	Description of Strata	SPT N Value
BH 1 & 2	-	0.0 – 0.5	Filled up soil in BH-2	
	I-a	0.0/0.5 – 3.5/4.0	Brownish silty clay of medium plasticity and of stiff to very stiff consistency	12 – 18
	I-b	3.5/4.0 – 10.0	Grey silty clay of medium plasticity and of very stiff to hard consistency	17 – 36

5.2 Ground water table

Water table was encountered at 3.0 – 3.3m depth below existing ground level during the sub soil exploration work carried out in the month of June 2024.

5.3 Soil Properties

Laboratory test results for various strata are given in Plate 4.

Table 2: Range values of Sub-soil Properties

Stratum →	**Brownish / Grey silty clay**
Depth, m	**0.0 – 10.0**
Grain size analysis	
Gravel (%)	00 – 02
Sand (%)	04 – 21
Silt and clay (%)	77 – 94
Atterberg's limit	
Liquid limit (%)	35 – 43
Plastic limit (%)	20 – 22
Plasticity index (%)	14 – 21
Soil classification	CI
Field bulk density (g/cc)	1.83 – 1.93
Field dry density (g/cc)	1.45 – 1.52
Field moisture content (%)	25.0 – 28.3
Triaxial shear test - Tuu	
Cohesion (kg/cm^2)	0.74 – 0.80
Angle of internal friction (deg)	03 - 05
Specific Gravity	2.55 – 2.62
Consolidation Characteristics	
Compression Index, Cc	0.11
Pre-compression Pressure, kg/cm^2	1.6 – 1.7
Coeff. Of Vol.change.cm^2/kg (Pressure range of 2 – 4kg/cm^2)	0.0103 – 0.0114
Free Swell index, %	10 – 40

5.4 Chemical Analysis and Environmental Conditions

Soil and water samples from boreholes are collected and analyzed for pH, sulphate and chloride. The results of chemical analysis of soil and water samples are as shown in Table 3(a) and 3(b) below.

Table 3(a): Chemical Analysis of Soil Samples

Bore hole No.	Depth m	pH	Sulphate SO_3 (%)	Chloride (Cl), (%)
BH-2	1.5	8.5	0.010	0.16

Table 3(b): Chemical Analysis of Water Samples

Bore hole No.	pH	Sulphate SO_3 mg/l	Chloride (Cl), (mg/l)
BH-2	7.93	10	1700
IS 456 :2000 requirement Table-1	6 to 9	< 400	< 500

6.0 FOUNDATION ANALYSIS

6.1 OPEN FOUNDATION

The following formula is used for calculating ultimate net bearing capacity in the case of open foundation and raft foundation (Ref: IS: 6403 - 1981):

$$q_{net\ safe} = \frac{1}{F}[C N_c S_c d_c + q(N_q - 1) S_q d_q + 0.5 B \gamma N_r S_r d_r R_w]$$

Where,

c = cohesion in t/sq m
ϕ = angle of internal friction
γ = effective unit weight of soil (g/cc)
N_c, N_q, N_γ = bearing capacity factors which are a function of ϕ
$q_{net\ safe}$ = safe net bearing capacity of soil based on the shear failure criterion.
q = overburden pressure,
R_w = water table correction factor
S_c, S_q, S_r = Shape factors,
d_c, d_q, d_r = Depth Factor

Shape Factor	**S_c**	**S_q**	**S_r**
Continuous strip	1.00	1.00	1.00
Rectangular	1+0.2 B/L	1+0.2 B/L	1-0.4 B/L
Square	1.3	1.2	0.8
Circle	1.3	1.2	0.6

For $\phi \leq 10$, $d_c = 1 + 0.2\frac{D_f}{B}\tan\left(45 + \phi/2\right)$ $d_q = d_r = 1$

For $\phi > 10$, $d_q = d_r = 1 + 0.1\frac{D_f}{B}\tan\left(45 + \phi/2\right)$

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Cohesion (kg/cm^2) C	0.74
Angle of Internal Friction (Degree)	0.00
Dry Density (g/cc)	1.45
Bulk Density (g/cc)	1.86
Specific Gravity	2.55
Coefficient of volume change mv (kg/cm2)	0.0114
Factor of Safety	2.5
Void ratio (Computed)	0.76
Type of Shear Failure Considered	Local
Water table effect	At NGL

The net safe bearing capacity for various sizes of individual rigid footings having vertical static load intensity is given in Table 4.

Table 4: Summaries of SBC & SBP for open/shallow foundations

Type and Size of Footing (m x m)	Depth below EGL (m)	Net Safe Bearing Capacity Based on shear parameters (t/m^2)	Allowable bearing pressure for **50mm** settlement **(Sc)** (t/m^2)	Recommended allowable bearing capacity for **50mm** settlement (t/m^2)
1.5 x 1.5	2.0	16.7	25.0+	**16.7**
2.0 x 2.0	2.0	15.8		**15.8**
3.0 x 3.0	2.0	15.0		**15.0**

.

7.0 RECOMMENDATIONS

1.0 Shallow/Open foundations:

The net safe bearing capacity and safe bearing pressure considering laboratory shear and settlement parameters for shallow/open foundation is given in Table 4. The recommended value of allowable bearing pressure shall be for static vertical loading only.

For minor / lightly loaded foundations not sensitive to settlements having load intensity 5.0t/sq-m shall be placed at 1.0m below FGL on compacted filled up soil.

Foundation Level Preparation: The exposed foundation bearing surface should be compacted using light manual rammer/compactor so that the founding soils shall not remain disturbed / loosened. The

surface should then be protected from disturbances due to construction activities so that the foundations may bear on the natural undisturbed ground.

2.0 Water table was observed at 3.0 – 3.3m depth below existing ground level, during the sub soil exploration work carried out in the month of June 2024. For SBC analysis, effect of water level is considered at EGL.

3.0 Fill and compaction: Brownish silty clayey are low swelling characteristic hence it is suitable for filling purpose. The fill should be placed in layers not exceeding 20cm in thickness and at a moisture content ±2 per cent of the optimum moisture content. It should be compacted to at least 95 per cent of maximum dry density as per Standard Proctor Compaction Test (IS: 2720-Part 7) with suitable compaction method.

4.0 Chemical Analysis and Environmental Conditions:

a. pH values in soil show alkaline nature of the ground. Sulphate contents in soil show that site falls under Class 1 as per IS 456: 2000.

b. In ground water sulphate & chloride content are exceed permissible limit as per IS 456:2000. It is suitable for construction purpose.

c. The site is assigned 'Severe' environmental exposure considering local environment & Chemical Industry. Ordinary portland cement or Portland pozzolana Cement or Portland slag cement shall be used for concrete.

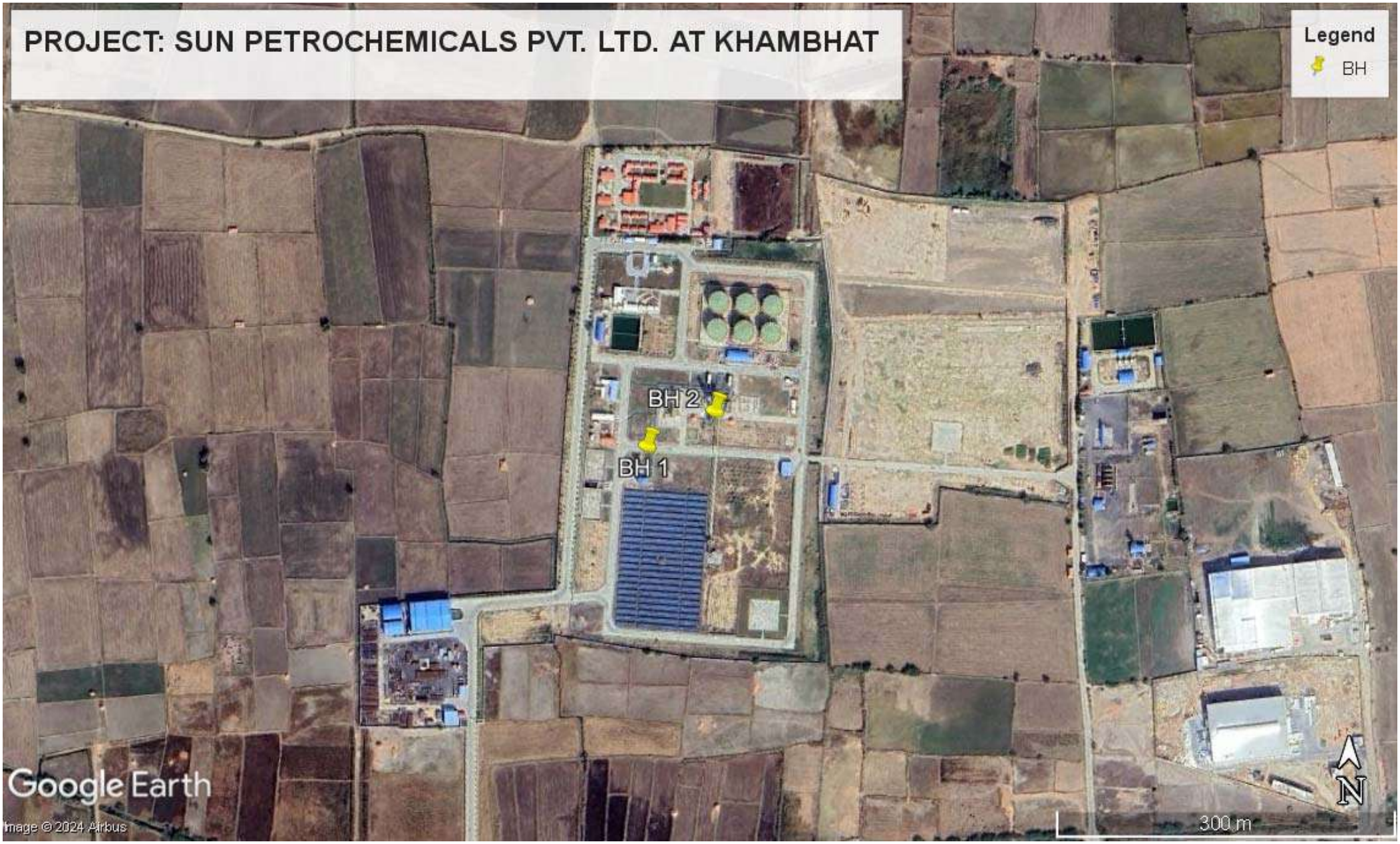
   For Severe exposure condition: Min. cement content 320kg/cum and minimum grade of concrete M30 with maximum free water-cement ratio of 0.45 shall be used or if higher cement content / grade of concrete is specified in contract specifications, it shall be followed.

d. A clear concrete cover over the reinforcement steel of at least 50mm shall be provided for all foundations or if higher clear cover over reinforcement is specified in contract specifications, it shall be followed.

5.0 Excavation: Temporary open cut excavations to about 2.0 m depth for foundation construction may be cut using side slopes of 0.5(H):1.0(V). Such excavations are expected to remain stable except during rains. If excessive sloughing or caving is observed or for deep excavations, the slopes may be flattened further to ensure stability. However, local judgment shall be made by engineer in-charge at the time of execution.

6.0 In case the proposed structures are located away from the test locations and / or the actual sub-soil conditions during excavation for various foundations are found different from what has been reported above, additional investigations would be needed prior to taking up of actual construction work at site.

Authorized Sign: HIMAKSHI PATEL


PROJECT: SUN PETROCHEMICALS PVT. LTD. AT KHAMBHAT
Legend
BH
BH 2
BH 1
Google Earth
Image © 2024 Airbus
N
300 m

BORE LOG

PLATE: 2

PROJECT : Installation of well fluid processing train-B & Asso. equipment at CPF Bhaskar field At Sun Petrochemicals Pvt. Ltd., Khambhat

Bore hole no: 1	Diameter: 150 mm
Location / Co-ordinate. Hot Oil Train -B	Soil Sampler Used: Tube / SPT
Gr R.L.: -	Type of Boring: Manual Drilling
Ground Water Level : At 3.3 m	Date : 10.06.2024

Depth (m)	Description of Strata	Thk of strata (m)	Symbol	Sampling Details			SPT Value 'N' blows				GRAPHICAL REPRESENTATION
				Depth		Type	A	B	C	B+C	10 20 30 40 50 60 70
				From	To						
				0.00	0.50	DS					
1											
	Stiff			1.50	1.95	UDS					
	Brownish silty clay	3.5									
2	of medium plasticituy										
3				3.00	3.40	SPT	5	7	5	12	
4											
				4.50	4.95	UDS					
	Hard										
5	Grey silty clay	6.5									
	of medium plasticity										
6											
				6.50	6.90	SPT	9	14	22	36	
7											
				7.50	7.90	UDS					
8											
9				9.00	9.45	SPT	6	11	23	34	
10											

SPT N - STANDARD PENETRATION TEST VALUE UDS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE

REMARK : TERMINATED 10.0 M

GEOSTRUCT ENGINEERING & TESTING SERVICES

BORE LOG

PLATE: 3

PROJECT : Installation of well fluid processing train-B & Asso. equipment at CPF Bhaskar field At Sun Petrochemicals Pvt. Ltd., Khambhat

Bore hole no: 2	Diameter. 150 mm
Location / Co-ordinate: Opp. to Existing Process unit Train -B	Soil Sampler Used: Tube / SPT
Gr R.L.: -	Type of Boring: Manual Drilling
Ground Water Level : At 3 0m	Date : 10.06.2024 to 11.06.2024

Depth (m)	Description of Strata	Thk of strata (m)	Symbol	Sampling Details			SPT Value 'N' blows				GRAPHICAL REPRESENTATION						
				Depth		Type	A	B	C	B+C	10	20	30	40	50	60	70
				From	To												
	Filled up soil	0.5		0.00	0.50	DS											
1																	
				1.50	1.95	UDS											
2	Very stiff Brownish silty clay of medium plasticituy	3 5															
3				3.00	3.40	SPT	6	8	10	18							
4																	
				4.50	4.95	UDS											
5																	
	Very stiff Grey silty clay of medium plasticity	6 0															
6				6.00	6.45	SPT	5	7	10	17							
7																	
				7.50	7 90	UDS											
8																	
9																	
				9.50	9.95	SPT	7	8	10	18							
10																	

SPT N - STANDARD PENETRATION TEST VALUE UDS = UNDISTURBED SOIL SAMPLE DS = DISTURBED SOIL SAMPLE

REMARK : TERMINATED 10.0 M

GEOSTRUCT ENGINEERING & TESTING SERVICES

SOIL CHARACTERISTICS

PLATE : 4

PROJECT : Installation of well fluid processing train-B & Asso. equipment at CPF Bhaskar field At Sun Petrochemicals Pvt. Ltd., Khambhat

Lab No.	Bore Hole No.	Depth In mt.	Natural Density		Natural water content	Grain Size Analysis				Atterbergs Limits			Soil Group	Shear Parameters			Free Swell Index	Spec-fic Gravity	Consolidation Test		
			field density	dry density		Gravel	Sand	Silt & Clay		LL	PL	PI		Types of tests	Cohesion	Angle of int. friction			Compression index	Pre-com. Pressure	Co.efficient of vol.Change
			g/cc	g/cc	%	%	%	%	%	%	%	%			Kg/cm2	Deg.	%		Cc	Pc Kg/cm2	mv (cm2/kg)
24/1476/1/																					
1/2		0.5				2	21	--- 77 ---		37.0	21.5	15.6	CI				20.0				
1/1	BH-1	3.0	1.86	1.45	28.32	2	4	--- 94 ---		38.5	21.0	17.5	CI	Tuu	0.77	5	10.0	2.55	0.11	1.60	0.0103
1/3		4.5				0	8	--- 92 ---		35.6	20.8	14.9	CI								
1/4		7.5				0	14	--- 86 ---		36.1	21.3	14.8	CI								
2/1	BH-2	1.5	1.83	1.46	25.08	2	11	--- 87 ---		42.5	21.9	20.5	CI				40.0				
2/2		4.5	1.90	1.48	28.12	0	10	--- 90 ---		36.0	21.5	14.5	CI	Tuu	0.74	5		2.62	0.11	1.70	0.0114
2/3		7.5	1.93	1.52	27.15	0	12	--- 88 ---		35.2	20.9	14.3	CI	Tuu	0.80	3					

* LL - Liquid limit , PL - Plastic limit , PI - Plasticity index , Tuu - Unconsolidated Undrain Triaxial Shear Test