



FIELD INVESTIGATION REPOT FOR
INTEGRATED SW MANAGEMENT SITE,
AT KARNAL, DISTT. KARNAL

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1.00 Introduction

- 1.1 The report presented herein deals with results of field and laboratory investigations carried out at Integrated Solid Waste Management Site at Meerut Road, Karnal. The investigation was carried out to prepare the site plan with contouring, to assess the nature of sub-soil strata, to evaluate the bearing capacity and other parameters for subsequently designing the foundation of proposed Structures for the project.
- 1.2 The work of Topographical Survey and soil investigations was assigned to M/s Earl Techno Consultants Pvt. Ltd, Dera Bassi Distt, Mohali. (Pb)

2.00 Scope of work

The scope of work is divided into two parts viz. Topographical Survey & Soil investigation.

- 2.1 The topographical survey is carried out to prepare site plan and contouring of the site to get the dimensions of the site & to analyze the general surface drainage slope
- 2.2 The soil investigation covers the following: -
 - 2.2.1 Conducting Standard Penetration Test (SPT) / Dynamic Cone Penetration Test (DCPT) at 2 Nos. of locations upto a depth of 10.0m or refusal whichever is earlier.
 - 2.2.2 Collecting soil samples at various depths as per requirement of the Client from the bore holes as feasible, for laboratory tests.
 - 2.2.3 Analyzing the field and laboratory observations.
 - 2.2.4 Submitting two hard copies of the soil investigations report & a soft copy recommending safe bearing capacity of soil.

3.00 Site

- 3.01 The Investigation was done at site located on Meerut Road, Karnal (HR)
The site has been earmarked with a boundary wall. It is an existing dumping site. The soil exploration was carried out at two locations within the boundary area of the site.
- 3.02 The soil exploration locations are marked in the topographical survey drawing and was finalized after discussing it with the client's representative who was with the investigating team till the investigations were over.

4.00 Ground Water table

4.01 No water table observed upto the depth of exploration. The geology of the site suggests that the ground water table is well below 100 ft from NSL.

5.00 Field Investigations

The field investigations were conducted to cover the entire scope of the job.

5.1.1 Topographical Survey

The total area surveyed was 20.54 acres. The area within the boundary wall of the site was 17.05 Acres.

5.2.1 Standard Penetration Test (SPT)

The Standard Penetration Tests were conducted at various depths in the bore holes. These tests were conducted by driving into the soil a standard split spoon sampler. This sampler was driven with the help of a hammer weighing 63.5 kg. Which was vertically guided to fall through a free height of 75cm on the driving head. This driving head was attached to a drill rod, to the other end of which the sampler was fitted. The number of blows required to penetrate the first, second and third 15 cm lengths of the sampler were noted. The number of blow(i.e. N value), as given in the data sheets of bore holes, is the numerical value for the number of blows counted during the second and third stages i.e. for a depth of 30 cms. The procedure adopted for conducting this test was as per IS: 2131. The observed N values for all the boreholes have been noted down in tables. These values were corrected for over burden pressure.

6.00 Laboratory Investigations

6.01 The laboratory tests were conducted on selected soil samples recovered from the test locations for determining the index and engineering properties of the samples. All the tests were conducted as per the relevant IS standards. The results obtained have been given in the various tables at the end of the report.

The following tests were performed on different soil samples collected from the test locations:-

- i) Bulk Density
- ii) Moisture Content
- iii) Particle size Analysis

- iv) Atterberg Limits
- v) Shear Strength Test
- vi) Permeability Test

7.00 Interpretation of Soil Strata

- i) On perusal of the strata charts (fig. 1-2) indicates the sub-soil strata at the site was fairly homogeneous in nature.
- ii) In both Bore Holes, the soil upto the depth of 3.50 m was found to be Silty Sand . Below this level, the strata was Fine Sand upto the depth of exploration.

NOTATIONS USED

NSL	-	Natural Surface Level
SSWL	-	Sub-soil Water Level
B	-	Width of Footing
L	-	Length of Footing
D	-	Depth of Footing
P	-	Effective Pressure
P_0	-	Initial Effective Pressure at mid height of layer
ΔP	-	Pressure Increment
q	-	Effective Surcharge at Base Level of foundation
P_n	-	Net Loading Intensity
q_{ult}	-	Net Ultimate Bearing capacity
q_a	-	Allowable b.c.
q_{ns}	-	Net safe b.c. against Shear Failure
N	-	SPT Value
N_n	-	Normalised SPT Value
C_N	-	Correction Factor for N-Value
N_c	-	Corrected SPT Value
CL	-	Clay of low plasticity
ML	-	Silt of low plasticity
SP	-	Poorly Graded Sand with no fines
SM	-	Silty Sand, Poorly Graded Sand-Silt Mixture
SW	-	Well Graded Sand with no fines
GW	-	Well Graded Gravels
GP	-	Poorly Graded Gravels
GM	-	Silty Gravels
GSF	-	General Shear Failure
LSF	-	Local Shear Failure
GC	-	Clayey Gravels
SC	-	Clayey Sands
MI	-	Silt of Medium Plasticity

CI	-	Clay of Medium Plasticity
MH	-	Silt of High Plasticity
CH	-	Clay of High Plasticity
$M_{c(NP)}$	-	Non Plastic Silt
ML-CI	-	Mixture of ML and CI
ϕ	-	Angle of Internal Friction
ϕ'	-	Effective Angle of Internal Friction
ϕ_m	-	Mobilised Angle of Internal Friction
N_c, N_q, N_γ	-	Bearing Capacity Factors
S_c, S_q, S_γ	-	Shape Factors
d_c, d_q, d_γ	-	Depth Factors
w	-	Moisture Content
γ	-	Bulk Unit Weight
γ_{sat}	-	Saturated Bulk Unit Weight
γ_d	-	Dry Bulk Density
γ'	-	Submerged Unit Weight
q_u	-	Unconfined Compressive Strength
C_u	-	Undrained Shear Strength
C'	-	Effective Cohesion
G	-	Specific Gravity
H	-	Thickness of Soil Layer
H_s	-	Thickness of sandy layer
B_s	-	Top width of sandy layer
ΔP_1	-	Stress increment at top of sandy layer
D_f	-	Depth factor
E_{yf}	-	Lateral yield factor
R_f	-	Rigidity factor
S_o	-	Settlement due to net unit foundation loading intensity (1 Kg/Cm ²)
S_{ob}	-	Settlement due to net unit foundation loading intensity under submerged conditions (1Kg/Cm ²)

S_t	-	Total settlement
e_0	-	Void Ratio
FOS	-	Factor of Safety
L.L.	-	Liquid Limit
P.L.	-	Plastic Limit
C_c	-	Compression Index
PI	-	Plasticity Index

DETERMINATION OF THE CORRECTED N-VALUES

BH - 1

Depth below NGL (m)	N-value observed N	Overburden pressure t/m ²	Correction factor C _N	Corrected N-value N _n
1.50	7	2.46	1.41	9.87
3.00	12	5.01	1.20	14.40
4.50	14	7.56	1.10	15.40
6.00	16	10.08	1.00	16.00
7.50	18	12.60	0.92	16.56
9.00	19	15.17	0.88	16.72
10.00	23	16.88	0.84	19.32

BH - 2

Depth below NGL (m)	N-value observed N	Overburden pressure t/m ²	Correction factor C _N	Corrected N-value N _n
1.50	6	2.49	1.40	8.40
3.00	10	4.94	1.20	12.00
4.50	12	7.39	1.10	13.20
6.00	14	9.88	1.01	14.14
7.50	17	12.37	0.92	15.64
9.00	19	14.86	0.88	16.72
10.00	26	16.58	0.85	22.10

COMPUTATION OF BEARING CAPACITY

Type and depth of foundation

For bearing capacity computations for the Isolated Footing of size 1.5m x 1.5m is considered at 2.0m below the ground level (NGL.)

Determination of Bearing Capacity

Type of foundation	Isolated Footing
Width of foundation	1.50 m
Depth of foundation	3.00 m
Governing Soil Parameters	
C	0.02 kg/cm ²
ϕ	34°
ϕ'	$\tan^{-1}(0.67 \tan \phi)$ 24.32°

(A) Shear failure Considerations:

Relevant B.C factors are

N_c'	19.92	S_c	1.30	d_c	1.29
N_q'	10.08	S_q	1.20	d_q	1.15
N_γ'	10.13	S_γ	0.80	d_γ	1.15

Net Ultimate b.c

$$q_{ult} = \frac{2}{3} C N_c' S_c d_c + q (N_q' - 1) S_q d_q + 0.5 B \gamma N_\gamma' S_\gamma d_\gamma W'$$

$$= \frac{2}{3} \times 0.20 \times 19.92 \times 1.3 \times 1.29 \times 1.0 + 4.94 \times (10.08 - 1) \times 1.2 \times 1.15 + 0.5 \times 1.5 \times 1.692 \times 10.13 \times 0.8 \times 1.15 \times 1.0$$

$$= 53.47 \text{ tm}^2$$

Net Safe b.c

$$q_{\text{net}} = 21.39 \text{ t/m}^2 \text{ (f.o.s } = 2.5)$$

(B) Settlement Consideration (IS:8009 (PART-I)-1976, REAFFIRMED 1998)

N_{60} in influence zone = 9.33

Settlement = 13.09 mm/unit Pressure

Total Settlement = 28.0 mm > 25 mm

This settlement is more than the permissible settlement.

Hence the corrected allowable b.c. is calculated as

$$\frac{21.39 \times 25}{28.0} = 19.10 \text{ t/m}^2$$

Conclusions and Recommendations

- ❖ The MDD (gm/cc) is found to be 1.822 at OMC (%) of 10.9.
- ❖ From NSL to 3.50 m, the soil is found to be Silty Sand and from 3.50 below NSL upto the depth of exploration, it is found to be Fine Sand.
- ❖ The permeability at 95% MDD is found to be 1.32×10^{-3} .
- ❖ The value of allowable B.C to be adopted for design consideration is as follows

S. No	Width of Foundation (m)	Depth from NGL (m)	Type of Foundation	$(q_a)_{\text{Net}}$ t/m ²
1	1.5	3.0	Isolated Footing	19.10

For Earl Techno Consultants Pvt Ltd


Director

TEST PIT LOG CHART AND DATA SHEET

PROJECT:- Geo-Tech Investigation for Integrated Solid Waste Management Site, Meerut Road Karnal, Distt. Karnal (Hr)

BH NO :- 1

WATER TABLE :- NIL

DEPTH FROM REF (3)		SPT (N) BLOWS 30cm		CORRECTED	STANDARD PENETRATION RESISTANCE CURVE	Symbolic Representation	I.S.C. GROUP	% MOISTURE	% KANKAR MODULES (- 80 MM FRACTION)	% SAND	% SILT (- 75 MICRON)	% CLAY HYDROMETER ANALYSIS	LI	PI	DENSITY gm/cc		SP. GRAVITY	VOID RATIO	UNCONFINED COMP. STRN kg/cm ² (C _u)	C _c Kg/cm ²	φ ⁰	REMARKS	
		OBSERVED													FIELD DRY Density gm/cc	DRY Density gm/cc							
1.50	7	9.9					SM	8.3	-	49.5	50.5	-	20.5	NP	1.78	1.64	2.68	0.63	-	0.03	32°	SILTY SAND	
3.00	12	14.4				SM	8.0	-	25.2	74.8	-	23.6	NP	1.84	1.70	2.68	0.57	-	0.0	33°	SILTY SAND		
4.50	14	15.4				SP	7.3	-	90.4	9.6	-	-	NP	-	-	-	-	-	-	-	-	-	FINE SAND
6.00	16	16.0				SP	6.9	-	89.9	10.1	-	-	NP	1.80	1.68	2.65	0.57	-	0.0	34°	FINE SAND		
7.50	18	16.6				SP	7.0	2.5	87.5	10.0	-	-	NP	-	-	-	-	-	-	-	-	-	FINE SAND
9.00	19	16.7				SP	7.4	3.3	91.3	5.4	-	-	NP	1.84	1.71	2.65	0.55	-	0.0	36°	FINE SAND		
10.00	25	19.3				SP	7.5	-	93.8	6.2	-	-	NP	-	-	-	-	-	-	-	-	-	FINE SAND

Fig. 1

TEST PIT LOG CHART AND DATA SHEET

PROJECT:- Geo-Tech Investigation for Integrated Solid Waste Management Site, Meerut Road Karnal, Distt. Karnal (Hr)

BH NO :- 2

WATER TABLE :- NIL

DEPTH FROM REF (M)	SPT (N) BLOWS 30cm		STANDARD PENETRATION RESISTANCE CURVE	Symbolic Representation	I.S.C. GROUP	% MOISTURE	% KANKAR MODULES (- 80 MM FRACTION)	% SAND	% SILT (- 75 MICRON)	% CLAY HYDROMETER ANALYSIS	LL	PI	FIELD DRY Density gm/cc	DENSITY gm/cc	SP. GRAVITY	VOID RATIO	UNCONFINED COMP. STRN Kg/Cm ² (C _u)	C Kg/Cm ²	φ ⁰	REMARKS																	
	OBSERVED	CORRECTED																																			
	LABORATORY TEST RESULTS																																				
1.50	6	8.4			SM	18.1	-	20.5	70.5	9.0	26.3	NP	1.96	1.66	2.68	0.61	-	0.02	32°	SILTY SAND																	
3.00	10	12.0																			SM	10.9	-	48.7	51.3	-	20.8	NP	1.82	1.64	2.68	0.63	-	0.02	34°		
4.50	12	13.2																			SP	7.1	-	90.4	9.6	-	-	NP	-	-	-	-	-	-	-	-	-
6.00	14	14.1																			SP	7.0	1.8	90.0	8.2	-	-	NP	1.78	1.66	2.65	0.59	-	0.0	34°	FINE SAND	
7.50	17	15.6																			SP	7.0	-	91.0	9.0	-	-	NP	-	-	-	-	-	-	-	-	-
9.00	19	16.7																			SP	7.3	2.5	90.6	6.9	-	-	NP	1.85	1.72	2.65	0.54	-	0.0	36°		
10.0	26	22.1																			SP	7.3	1.5	92.3	6.2	-	-	NP	-	-	-	-	-	-	-	-	-

Fig. 2