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NAME OF PROJECT

PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING CONSISTING OF STILT + FOUR UPPER FLOOR AT NERKUNDRAM, CHENNAI.

CLIENT

M/S VINOTH BUILDERS,
NO. 263, Z-BLOCK, 5TH AVENUE,
ANNA NAGAR,
CHENNAI – 600 040.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO.: GT- 2641

GEO MARINE CONSULTANTS PVT LTD. Chennai-41

DATE	REVISON	DESCRIPTION		AUTHORISED SIGNATORY
06/09/2023	FIRST SUBMISSION	SUBMISSION OF GEOTECHNICAL REPORT	SIGN	
			DATE	06/09/2023
			DESIGNATION	MANAGING DIRECTOR
			NAME	**DR. C.V.PRASAD**

CHAPTER-1

INTRODUCTION

1.0 PROJECT INFORMATION MATRIX:

NATURE OF PROJECT	**: RESIDENTIAL BUILDING**
STRUCTURE	**: STILT + 4 UPPER FLOORS**
PROJECT OWNER	**: M/S VINOTH BUILDERS**
PROJECT LOCATION	**: NERKUNDRAM, CHENNAI**
JOB CODE	**: GT-2641**

1.1 SCOPE OF WORK:

1.1.1 FIELD WORK:

- Conducting two soil investigation bore holes of 150 mm diameter up to the termination depth
- Conducting Standard Penetration Test (SPT) within the borehole at:
  - Every 1.0m depth interval up to 6.0m.
  - From 6.0m to 12.0m, SPT is conducted at every 1.5m depth interval
- The depth of investigation is 10.0m below the existing ground level
- Collection of disturbed soil samples at SPT location and undisturbed samples from the clayey strata with SPT-value greater than 2 to less than 15 if met within the investigation depth
- Collection of water samples if groundwater table met within the investigation depth

1.1.2 LABORATORY WORK:

- Natural Moisture Content
- Atterberg's limits
- Grain Size Analysis
- Consolidation test on undisturbed samples if applicable
- Chemical Analysis test on soil and water samples to give pH, Chlorides and Sulphates

1.2 STRUCTURE OF THE REPORT:

- Contents
- Introduction
- Investigation Methodology & Test Results
- Sub-Surface Stratification
- Foundation System
- Recommendation
- Annexure

CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 PREAMBLE:

Two soil investigation boreholes were put as per the planning of the engineer in-charge and these locations are shown in Fig.2.0.The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.1 METHODOLOGY OF FIELD WORK:

2.1.1 EQUIPMENT USED AND METHOD OF DRILLING:

All the boreholes were sunk by conventional rotary drilling rigs. For borehole Methodology followed for boring conformed to IS: 1892 -2000. Boring was progressed by the cutting action of rotating bit with water circulation and stabilizing the side of the boreholes by using casing pipes/bentonite slurry up to required depth to prevent collapse of sidewall. Boring was continued by normal boring process using MS soil cutter in soil. However Tungsten Carbide (TC) bit drilling was resorted to drill in highly weathered rock stratum where the normal boring process became slow. Diamond Core (DC) bit drilling was adopted in moderately weathered rock formations where penetration using TC bit was became slow.

2.1.2 STANDARD PENETRATION TESTS:

This is a field test to determine "Penetration Resistance of Stratum at the Test Depth". This has been conducted in the boreholes generally up to refusal depth using procedures described in IS: 2131- 2002. In this test, split spoon sampler (50.8 mm OD and 35 mm ID) has replaced driving bit. Sampler is then driven by dropping 63.5 kg hammer on top of driving collar with free fall of 75 cm. The length of sampler is 60 cm.

The tests were conducted at the depth intervals indicated in Chapter-1 (Sec.1.1.1).

2.1.3 COLLECTION OF SOIL SAMPLES:

2.1.3.1 DISTURBED SAMPLES:

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

2.1.3.2 UNDISTURBED SAMPLES:

From the soft to stiff clay layer, representative undisturbed samples were collected. These samples were used primarily to establish the compressibility parameters to estimate the settlements of shallow foundation system wherever applicable.

2.1.4 COLLECTION OF GROUND WATER SAMPLES:

One representative water sample from each borehole was collected after 24 hours of completing the borehole if water table met within the investigated depth.

NOTE ON GROUNDWATER TABLE RECORD:

- Groundwater table observation in geotechnical report is predominantly to arrive at foundation design criteria and shall not be construed as design guidelines for the design of dewatering systems
- The groundwater level indicated in the bore logs is specific to the duration of investigation and intensity of the monsoon rains during the time of investigation. Hence, the level shall be taken as guidelines only to plan the investigation for the dewatering system
- No foundation excavation or basement excavations if anticipated within the groundwater table zone shall be carried out without implementing groundwater lowering schemes

2.2 LABORATORY TESTING:

2.2.1 ON COARSE GRAINED SOIL

On the representative samples, sieve analysis tests were conducted to arrive at grain size distribution. These tests were conducted as per I.S.2720 (part 4)-1985 and the results are presented in Tables-2.1 & 2.2. The graphical representation of grainsize distribution curve for the representative samples in each bore is presented in Fig. 2.3 & 2.4.

2.2.2 ON FINE GRAINED SOIL:

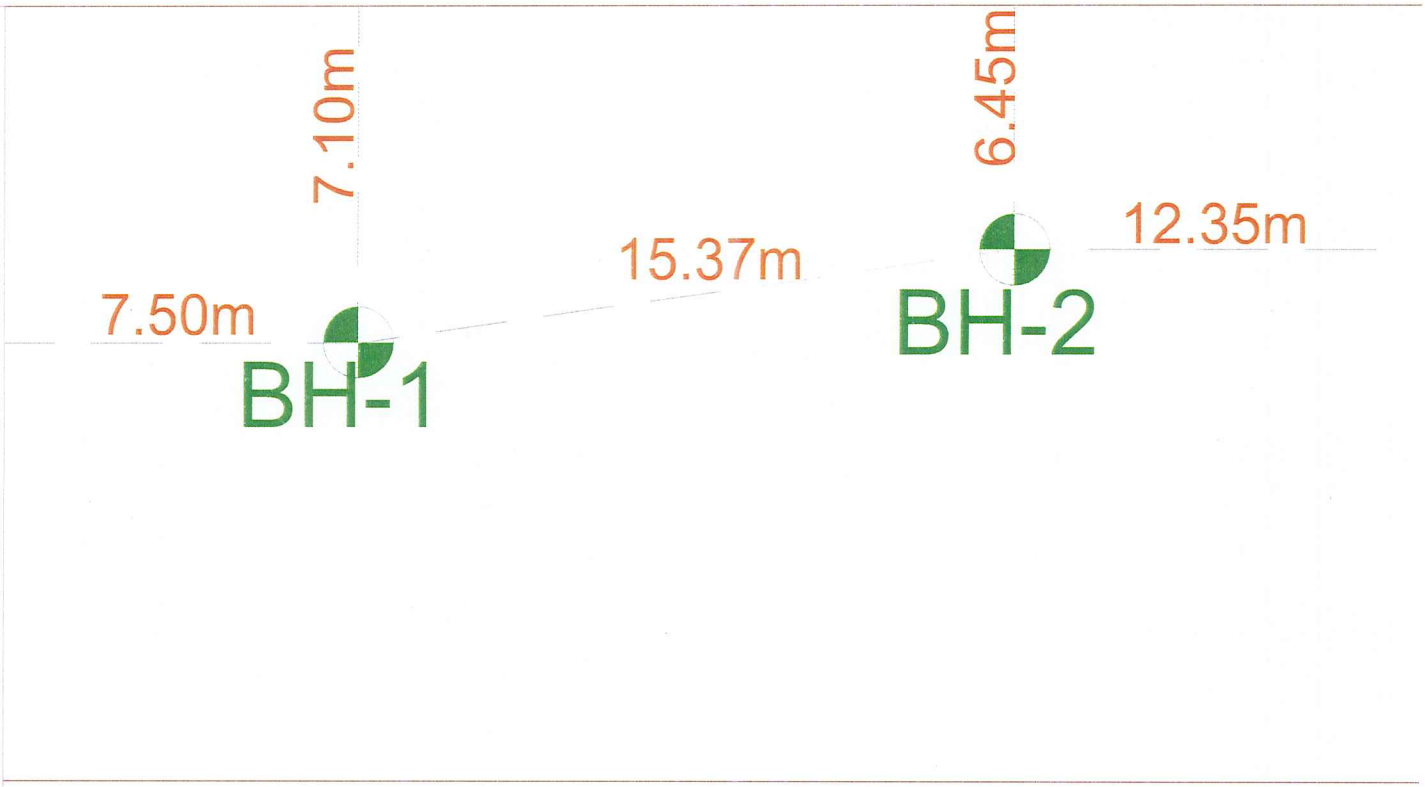
On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 & 2.2. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig. 2.5 & 2.6.

2.2.3 CHEMICAL ANALYSIS TESTS:

On representative soil and water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table - 2.3 to 2.5.

2.3 SUMMARY:

The locations of the field investigation boreholes are shown in site plan given in Fig.2.0. The average sub soil profiles encountered at each location along with their classification and engineering properties are presented in Figs.2.1 & 2.2.


House
7.10m
6.45m
12.35m
15.37m
7.50m
BH-1
BH-2

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Nerkundram, Chennai	MACHINE No.	CR-04	Free Fall Energy (%)	60	BORE START DATE	22/08/2023
STRUCTURE	Stilt + 4 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	22/08/2023
JOB CODE	GT-2641	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	1

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT Value: N80	SPT Value: N	Sample Details	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
		14	26																
		To		SC	-	-													
		14	27				2	5	8	-	13	0.50	1	SS	-0.5				
		14	36									0.95							
1		To		SC	-	-													
		14	37				2	3	6	-	9	1.25	2	SS	-1.3				Brown,Moist,Stiff,**Silty CLAY (Cl) With Sand Lenses & Mixture** Clay of Lean Plasticity
		14	42									1.70							
		To		SC	-	-													
2		14	43				6	7	7	-	14	2.00	3	SS	-2.0				
		14	47									2.45							
		To		SC	-	-													
		14	48																
3							5	8	19	-	27	3.00	4	SS	-3.0		L1	3.0	
		14	56									3.45							Brown,Moist,Poorly Graded,Pred. Fine Grains Sands,Medium Grains Sand Mix,Medium Dense,**Silty SAND (SM) With Clay Binder to Clayey Sand**
		To		SC	-	-													
		14	57																
4							13	23	41	-	64	4.00	5	SS	-4.0		L2	4.0	
		15	07									4.45							
		To		SC	-	-													
	22/08/2023	15	08																
5							20	23	37	-	60	5.00	6	SS	-5.0				
		15	22									5.45							
		To		SC	-	-													
		15	23																
6							23	28	37	-	65	6.00	7	SS	-6.0				Brown,Moist,Poorly Graded,Pred. Fine Grains Sands,Medium Grains Sand Mix,Very Dense,**Silty SAND (SM)**
		15	45									6.45							
		To		SC	-	-													
		15	49																
7																			
8							10	19	24	-	43	8.00	1	SS	-8.0		L3	8.0	
												8.45							
		16	00																
		To		SC	-	-													
9		16	04																Brown,Grey,Moist,Poorly Graded,Fine & Medium Grains Sands,Dense,**Silty SAND (SM) & Poorly Graded SAND - Silty SAND (SP-SM)**
10							19	20	25	-	45	10.00	1	SS	-10.0				
												10.45					L4	10.5	

CS - Core Sample	DS - Disturbed Sample	LOGGED	D.Venugopal	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	22/08/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m)	1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	26/08/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 10 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	1	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Nerkundram, Chennai	MACHINE No.	CR-04	Free Fall Energy (%)	60	BORE START DATE	23/08/2023
STRUCTURE	Stilt + 4 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-	BORE END DATE	23/08/2023
JOB CODE	GT-2641	FLUSHING MEDIUM	Bentonite	CO-ORDINATES E	-	TOTAL DRILL DAYS	1

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT Value: N80	SPT Value: N	Sample Details:	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
0	23/08/2023	09	25																
		To		SC	-	-													
		09	26				6	6	8	-	14	0.50	1	SS	-0.5				Brown,Moist,Fine Grains Sands Mix,Stiff,**Silty CLAY (Cl) With Sand Mixture** Clay of Medium Plasticity
		09	33									0.95							
1		To		SC	-	-											L1	1.3	
		09	34				8	11	14	-	25	1.25	2	SS	-1.3				
		09	40									1.70							
		To		SC	-	-													
2		09	45				7	11	13	-	24	2.00	3	SS	-2.0				
		09	50									2.45							
		To		SC	-	-													
		09	54																
3							6	8	10	-	18	3.00	4	SS	-3.0				Brown,Moist,Fine Grains Sands Mix,Very Stiff,**Silty CLAY (Cl) & Silty CLAY (CH)** Clay of Medium & High Plasticity
		10	04									3.45							
		To		SC	-	-													
		10	06																
4							6	9	10	-	19	4.00	5	SS	-4.0				
		10	15									4.45							
		To		SC	-	-													
		10	17														L2	5.0	
5							12	21	23	-	44	5.00	6	SS	-5.0				
		10	27									5.45							
		To		SC	-	-													
		10	29																
6							17	19	15	-	34	6.00	7	SS	-6.0				Brown,Moist,Poorly Graded,Pred. Fine Grains Sands,Medium Grains Sand Mix,Dense,**Silty SAND (SM)**
		10	36									6.45							
		To		SC	-	-													
7		10	40																
8							19	23	30	-	53	8.00	8	SS	-8.0		L3	8.0	
												8.45							
		11	00																
		To		SC	-	-													
9		11	04																Brown,Black,Moist,Poorly Graded,Fine & Medium Grains Sands,Very Dense, **Silty SAND (SM) & Poorly Graded SAND - Silty SAND (SP-SM)** **&** **Lenses of Silty CLAY (Cl)**
10							9	10	40	-	50	10.00	9	SS	-10.0				
												10.45					L4	10.5	

CS - Core Sample	DS - Disturbed Sample	LOGGED	D.Venugopal	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	23/08/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	26/08/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 10 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

CHAPTER-4

FOUNDATION SYSTEM

4.0 PREAMBLE:

In the design of foundation system, the stress-strain compatibility of the super structure, sub structure and the bearing strata should be satisfied both individually and as a combined system. In view of this, the following data are needed for the design of foundation system, defined in terms of the type of sub structure and the bearing strata characteristics.

- The super structure characteristics along with the loading pattern on the sub structure
- The sub soil characteristics that define the required substructure configuration for a safe transfer of super-structural loads to the bearing strata

Considering the above aspects of the foundation design, the suitable type of foundation system is presented below.

4.1 PROPOSED STRUCTURES:

An understanding of the proposed construction and the order of loads on the foundations is needed for choosing the appropriate foundation system. In the present case, the proposed structure is configured with stilt and four upper floors which is meant for residential occupancy. For this kind of structure, the column loads could vary between 750 kN to 2000kN.

The above mentioned loads have no bearing on the design of either sub or super structures and are mentioned just to provide an insight to choose an appropriate foundation system with respect to subsoil conditions.

4.2 SUB SOIL STRATIFICATION:

The geology of project location with respect to standard penetration test values are:

0.0m to 3.0m/5.0m	Stiff, Silty Clay
3.0m/5.0m to 10.0m	Dense & Very Dense, Silty Sand

4.3 FOUNDATION SYSTEM:

For the kind of proposed configuration and sub soil characteristics it is ideal to adopt shallow foundation system. Adopt isolated column footing located at a depth of 1.55m over a well compacted layer of sand- gravel (1:1) mix or quarry dust of 450mm thickness. The compaction can be carried out with a non-compacted layer thickness of 200mm using a plate compacter or hand rammer.

Thus, the overall depth of foundation shall be 2.0m below the existing ground level. The schematic arrangement of the foundation is shown in Fig.4.1. The footings shall be designed for a recommended allowable net safe bearing pressure of 225 kPa.

Typical computations are presented in Annexure-I.

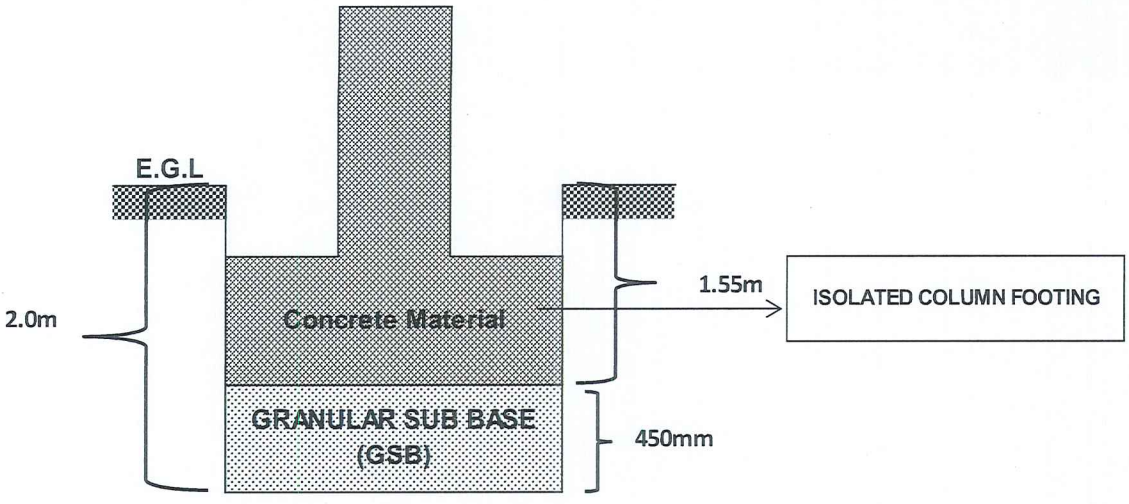


FIG.4.1 : THE SCHEMATIC ARRANGEMENT OF FOUNDATIONS

CHAPTER-5

RECOMMENDATIONS

5.1 RECOMMENDATION FOR SHALLOW FOUNDATION SYSTEM:

- For the kind of sub soil conditions open foundation system coupled with soil replacement type of ground improvement technique can be adopted.
- The depth of foundation excavation shall be 2.0m below the existing ground level and shall be back filled with either sand-gravel mix (1:1) or quarry dust of 450mm thickness laid in non-compacted layers of thickness not more than 200mm and compacted at optimum moisture content using a plate vibrator.
- The footings can be located at 1.55m over the prepared bed and shall be designed for an allowable net safe bearing pressure of 225 kPa.
- The plan size of foundation excavation shall be minimum 300mm more than the size of the footing and excavated earth shall not be used for backfilling the foundation trenches.
- All columns shall be connected with grade beams in both the directions at plinth level.
- The ground floor shall be minimum 0.6m above the natural ground and the plinth shall be filled with sand/gravel/quarry dust. This height is recommended to contain the influence of soil volume change on the flooring. In case, floor is not raised, the ground floor shall be constructed as a suspended R.C.C. slab.

5.2 GENERAL RECOMMENDATIONS:

- The chlorides content in ground water & soil-water extract is less than the permissible limit of 500 mg/l as per IS 456 Table 1.0. Hence no special reinforcement is required for the construction.
- Corresponding to the sulphate content in 2:1 Water-Soil extract and ground water use Table 4.0 of IS 456 for minimum cement content. In the present case, ordinary Portland cement (OPC) is suitable for the constructions.
- The present project site falls in seismic zone-III as per IS 1893-P-1.

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TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Shape of the Foundation	Square
Depth of Foundation Below E.G.L"Df" (m)	1.55
Soil Replacement Thickness of CNS Layer (m)	0.45
Total Depth of Foundation Excavation (m)	2.00
Breadth of Footing "B" (m)	2.00
Length of Footing "L" (m)	2.00
B/L	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data :

Type of Effective Bearing Strata :	Clay
Average Design SPT-value of the Bearing Strata	12.00
Type of Shear Failure:	General
Undrained Shear Strength (Cu)	80

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.00
Water Table Correction Factor (w')	0.50
Effective Overburden pressure at foundation level (q)	12.40
Bearing Capacity Factors:	
N_c =	5.14
N_q =	-
N_g =	-
Shape Factors:	
S_c =	1.30
S_q =	-
S_g =	-
Depth Factors :	
D_c =	1.16
D_q =	-
D_g =	-
Inclination Factor:	
I_c =	1.00
I_q =	-
I_g =	-

1.4 Ultimate Bearing Capacity (Qu) :

Qu=Cu*Nc*Sc*Dc*Ic	617.42	kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	246.97	kPa
Say Q_{safe}	**225**	**kPa**

2 Computation of Settlement for Maximum Pressure and Size of Footing: (as per IS:8009-Part-I-Ref. Eq.11) (Elastic Analysis)

The immediate elastic settlement (S_i)=	$qB(1-m^2)*I/E_s$	
q= bearing pressure	225.00	
Poission's Ratio (μ)	0.30	
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)		
Modulus of Elasticity (E_s)(500*Cu)	40000.00	
Size of footing considered for maximum settlement(m)	2.00	
Influence factor	0.95	
Rigidity Factor	0.80	
Elastic Settlement (DH_i)	7.78	mm
	<25	mm

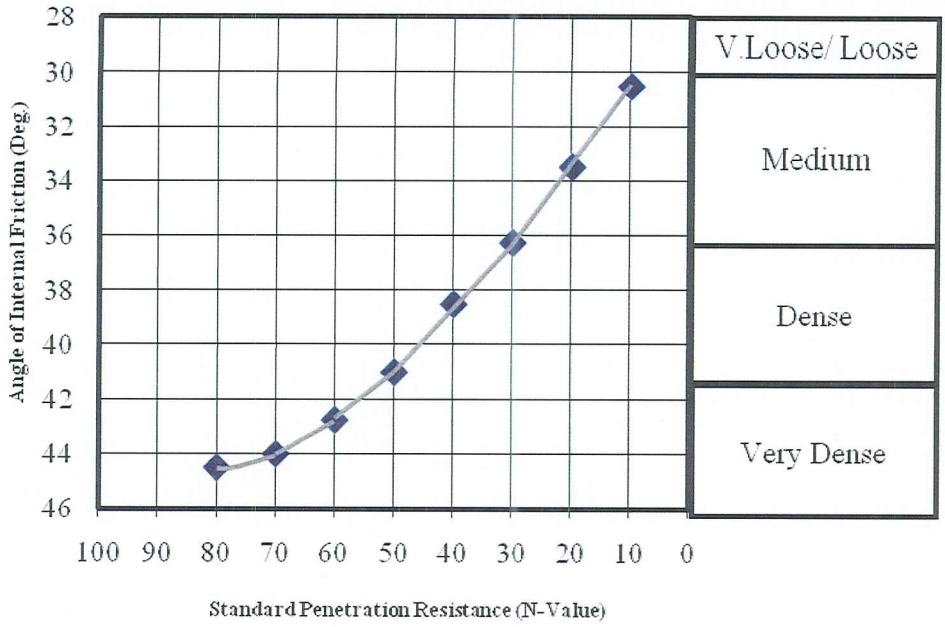


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

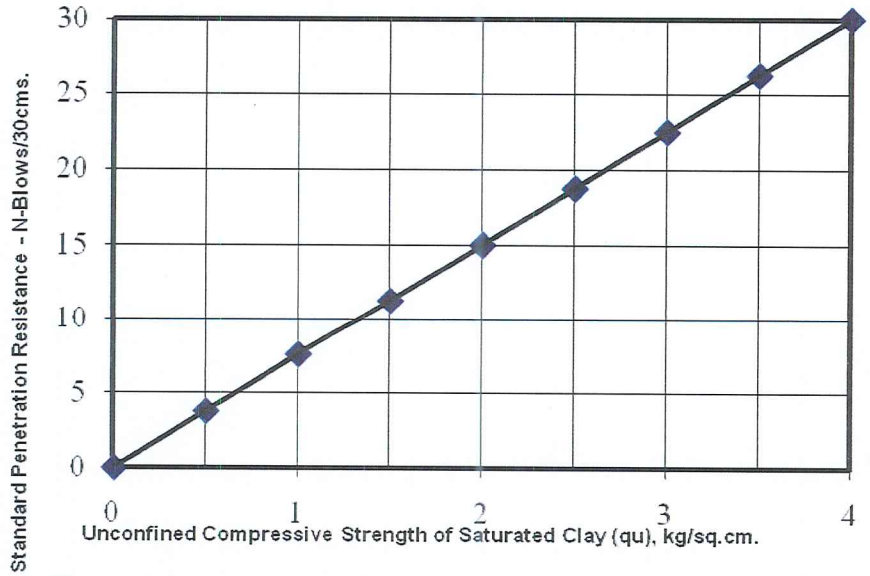


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)



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