

## Geotechnical Investigations

### SETTLEMENT CONSIDERATION :

For Raft Footing :-

Depth = 2.0 Mtrs

Size = 6.0 /or more mtrs

Settlement / Unit pressure for corrected  $N' = 15$  corresponding to foundation depth of 2.0 mtr & foundation width of 6.0 or more mtr calculated according to para 9.5 of IS.8009-(Part-I)-1976 and read from fig :9 p.p. 17 of the I.S. Code comes to 25.0 mm. Settlement corrected for water table

$$= \frac{25}{0.5} = 50.0 \text{ mm.}$$

Allowable settlement being 50mm.,

$$\text{allowable bearing capacity} = \frac{50}{50} = 1.000 \text{ Kg/cm}^2$$

$$= 10.0 \text{ t/m}^2$$

## Geotechnical Investigations

Depth = 3.0 Mtrs

Size = 6.0 or more mtrs

### SETTLEMENT CONSIDERATION :

#### For Raft Footing :-

Settlement / Unit pressure for corrected  $N' = 18$  corresponding to foundation depth of 3.0 mtr & foundation width of 6.0 or more mtr calculated according to para 9.5 of I.S.8009-(Part-I)-1976 and read from fig :9 p.p. 17 of the I.S. Code comes to 20 mm. Settlement corrected for water table

$$= \frac{20}{0.5} = 40.0 \text{ mm.}$$

Allowable settlement being 50mm.,

$$\text{allowable bearing capacity} = \frac{50}{40} = 1.25 \text{ Kg/cm}^2$$

$$= 12.5 \text{ t/m}^2$$

## Geotechnical Investigations

Depth = 4.5 Mtrs

Size = 6.0 or more mtrs

### SETTLEMENT CONSIDERATION:

**For Raft Footing :-**

Settlement / Unit pressure for corrected  $N' = 20$  corresponding to foundation depth of 1.5 mtr & foundation width of 6.0 or more mtr calculated according to para 9.5 of I.S.8009-(Part-I)-1976 and read from fig :9 p.p. 17 of the I.S. Code comes to 17 mm. Settlement corrected for water table

$$= \frac{17}{0.5} = 34.0 \text{ mm.}$$

Allowable settlement being 50mm.,

$$\text{allowable bearing capacity} = \frac{50}{34} = 1.470 \text{ Kg/cm}^2$$

$$= 14.7 \text{ t/m}^2$$

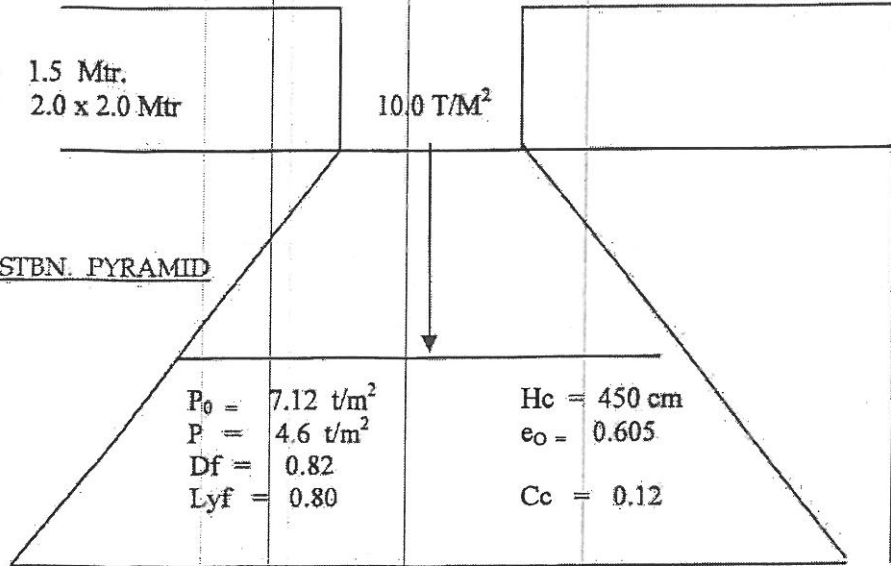
# Geotechnical Investigations

## COLUMN FOOTING

DEPTH = 1.5 Mtr.  
SIZE = 2.0 x 2.0 Mtr

10.0 T/M<sup>2</sup>

### STRESS DISTBN. PYRAMID



Settlement = < 50 mm OK

## Geotechnical Investigations

### CHEMICAL ANALYSIS OF SOIL

Bore Hole	Carbonate As Na <sub>2</sub> CO <sub>3</sub>	Sulphate as So <sub>4</sub>	Chlorides as Na Cl	Organic Matter %
1.	Nil	Nil	Nil	Nil
2.	Nil	0.004	Nil	2.5
3.	Nil	Nil	Nil	1.5
4.	Nil	0.005	Nil	1.5
5.	Nil	0.002	Nil	Nil
6.	Nil	Nil	Nil	Nil
7.	Nil	0.004	Nil	Nil
8.	Nil	0.003	Nil	1.0
9.	Nil	0.005	Nil	0.5
10.	Nil	Nil	Nil	1.0

# Geotechnical Investigations

## PH Value

### Table

Sr. No.	Parameters	Results BH-1	Results BH-2	Results BH-3	Results BH-4	Results BH-5
1.	PH Value	7.50	7.30	7.35	7.50	7.25

### Table

Sr. No.	Parameters	Results BH-6	Results BH-7	Results BH-8	Results BH-9	Results BH-10
2.	PH Value	7.35	7.45	7.25	7.50	7.30

## Sample : Testing of Samples of Soil for OMC & MDD Test Report

Sample No.-1

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.89 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 10.5 %

Sample No.-2

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.88 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 10.5 %

Sample No.-3

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.90 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 10.1 %

Sample No.-4

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.89 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 10.5 %

Sample No.-5

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.91 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 10.2 %

Sample No.-6

PROTOCOL : IS 2720 (Part -VIII)

Compaction Test Using	MDD = 1.90 g/cc
Heavy Compaction as per IS 2720 (Part -VIII)	OMC = 11.0 %

# National Soil Testing Laboratories

## Laboratories CBR Test Results

CBR - Values for Central Ware Housing Corporation at Nabha.

Sr. No.	Location	Grain Size Analysis			LL %	PL %	OMC %	MDD gm/cc	CBR Unsoaked	CBR Soaked
1	Sample No.-1 (S-1)	Gravel	Sand	Silt Clay	31.5	18.0	10.5	1.89	20.0	5.4
		3.0	8.0	12.0	77.0					
2.	Sample No.-2 (S-2)	1.0	12.0	17.0	70.0	18.5	10.5	1.88	20.5	5.5
3.	Sample No.-3 (S-3)	2.0	13.0	13.0	72.0	18.8	10.1	1.90	20.8	5.7
4.	Sample No.-4 (S-4)	1.0	10.0	20.0	69.0	18.5	10.5	1.89	21.5	5.9
5.	Sample No.-5 (R-2)	3.0	10.0	20.0	76.0	19.0	10.2	1.91	19.7	5.0
6.	Sample No.-6 (R-3)	1.0	18.0	17.0	64.0	18.7	11.0	1.90	19.8	5.3



## LABORATORY INVESTIGATIONS ON SUBGRADE SOIL SAMPLES

### 1. INTRODUCTION:-

The Job of testing of Moisture Content and testing of various other soil parameters in laboratory to determine the CBR Value of Sub Grade Soil for Improvement of the above road has been carried out by **M/s National Soil Testing & Research Laboratories, Plot No.384, Phase-II, Industrial Area, Panchkula (Hr.)**.

### 2. PURPOSE OF TESTING: -

This road is to be strengthened to cater for the increased traffic volume & provide the required crust. The Properties of sub grade soil play an important role in road design. Sub grade soil is an integral part of the road pavement structure as it support to the pavement from beneath. The main function of sub grade is to give adequate support to the pavement and for this the sub grade should possess sufficient stability under adverse climatic and load conditions.

The failure of pavement is generally attributed to the poor sub grade stability. Caused due to various reasons.

As per provision in IRC: SP: 20-2002 Chapter 5.3.1. for pavement design, the sub grade strength should be determined in terms of CBR at the most critical moisture condition likely to occur. The CBR test should be conducted on remolded samples prepared at optimum moisture content & dry density corresponding to standard proctor compaction. [(IS:2720(Part 7) - 1980)] and soaked in water for four days prior to testing, If annual rainfall is 500 mm or less & the water table is too deep, soaking for days may not be necessary,

One or two CBR tests should be done per kilometer depending on the variation of soil type. If there is no variation in soil type, mean CBR value should be adopted for the design of pavements. In case of existing roads requiring strengthening, the soil should be moulded at the existing moisture content & Field density, and soaked for four days prior to testing of CBR.

### **3. TESTS PERFORMED:-**

**The following tests were performed in the Lab.**

1. Soil gradation (IS 2720 PART IV)
2. Plasticity Index (IS 2720 PART V)
3. Standard Proctor density at optimum moisture content (IS 2720 PART VIII)
4. Un soaked & Soaked CBR at 100% of MDD and OMC (IS 2720 PART XVI)
5. Moisture Content (IS 2720 PART V)

### **4.0 GRAIN SIZE ANALYSIS:-**

**4.1 (a)** The grain size analysis is carried out to determine the particle size of soil. The components of soil which are larger in size than 4.75 mm are termed as gravel. Material between 4.75mm & 75 microns is sand and fine soil passing 75 microns sieve is silt and clay.

The quantity of sand, silt and clay present in sample plays an important role in its selection to be Used for Road.

#### 4.1(b) PROCEDURE:-

The soil sample is dried in oven.

The sieves are arranged in a manner to separate the gravel, sand, and silt/clay.

The material is sieved through these sieves and the percentage retained on each sieve is noted.

The material retained larger in size than 4.75 mm is termed as gravel.

Material between 4.75mm & 75 micron is sand.

Fine soil passing 75 micron sieve is silt and clay.

#### 4.2 Atterburg's Limits

4.2(a) The physical properties of fine grained soil, especially of clay differ very much at different moisture contents. The consistency limits are:-

- (i) **Liquid limit** may be defined as min water content at which the soil will flow under the application of very small shearing force.
  - (ii) **Plastic limit** is the minimum M.C at which the soil remains in a plastic state.
  - (iii) **Plasticity Index** is the numerical difference between Liquid Limit and Plastic limit. It thus indicates the range moisture content over which the soil is in plastic stage
- Atterburg's limits and the PI varies for different soil types and these properties are used in the identification of soil. Generally Soil having high value of LL & PI are poor as Engineering materials.

#### **4.2 (b) PROCEDURE:-**

The liquid limit test is conducted on the standard instrument with soil specimens at various moisture content, The liquid limit is taken as that moisture content where the standard groove will close under an impact of 25 blows.

The plastic limit is the water content at which the soil will begin to crumble when rolled into a thread of 3 mm diameter. The plasticity index is taken as the difference between liquid limit and plastic limit.

#### **4.3 MOISTURE DENSITY RELATIONSHIP : ( IS 2720 part VIII)**

**4.3 (a) PURPOSE:-** The sub grade soil is to be rolled and compacted at optimum moisture content to achieve the max density. The MDD varied from soil to soil. The density of soil is change by varying the moisture content under the standard compaction.

**4.2(b) PROCEDURE:-** Two degrees of compaction, light compaction (IS:2720,Part VII) and heavy compaction (IS: 2720, Part VIII) are usually specified. The former compaction also goes by the term Proctor compaction and latter by the term modified proctor.

In light compaction. The wet soil is compacted in three equal layers by the rammer of Weight 2.6 kg and free fall 31 cm with 25 evenly distributed blows on each layer. In heavy compaction, rammer weights 4.89 kg and the free fall is 45cm. Compaction is done in 5 equal layers, each being given 56 blows.

The procedure is to compact the soil with different moisture content and drawing a moisture density curve to find out the maximum dry density and the corresponding moisture content(CMC).

#### **4.4 LABORATORY CBR (IS2720 Part XVI)**

**4.4(a) PURPOSE:-** This is the penetration test used for evaluation of the stability of the soil sub grade & other flexible pavement material. The test results are correlated with flexible pavement thickness requirement for highways.

#### **4.4(b) PROCEDURE:**

The CBR test is performed on remolded soil samples in the laboratory. The moulds are prepared in laboratory compacted at OMC to proctor density as worked out in laboratory (for light compaction).

The CBR test is conducted at 100% of MDD at Optimum moisture content which is taken from the result of test conducted in the lab.

The apparatus consists of a mould 15 cm diameter with a base plate and collar, a loading frame with cylindrical plunger of 5 cm collar and diameter gauges for measuring the expansion on soaking and be penetration values. Briefly, the test consists of causing the plunger to penetrate the compacted specimen with specified surcharge in the mould at 1.25 mm/minute under 4 days soaked or un soaked condition. A load v/s penetration curve is plotted, correction is applied and the load corresponding to 2.5 and 5mm penetration value are found. This load is expressed as a percentages of the standard load at the respective are 1,370 kg 2,055 kg respectively. The CBR usually selected is at 2.5mm, penetration. For this test, only the material passing 20mm sieve is used.

#### **5. TEST RESULTS:-**

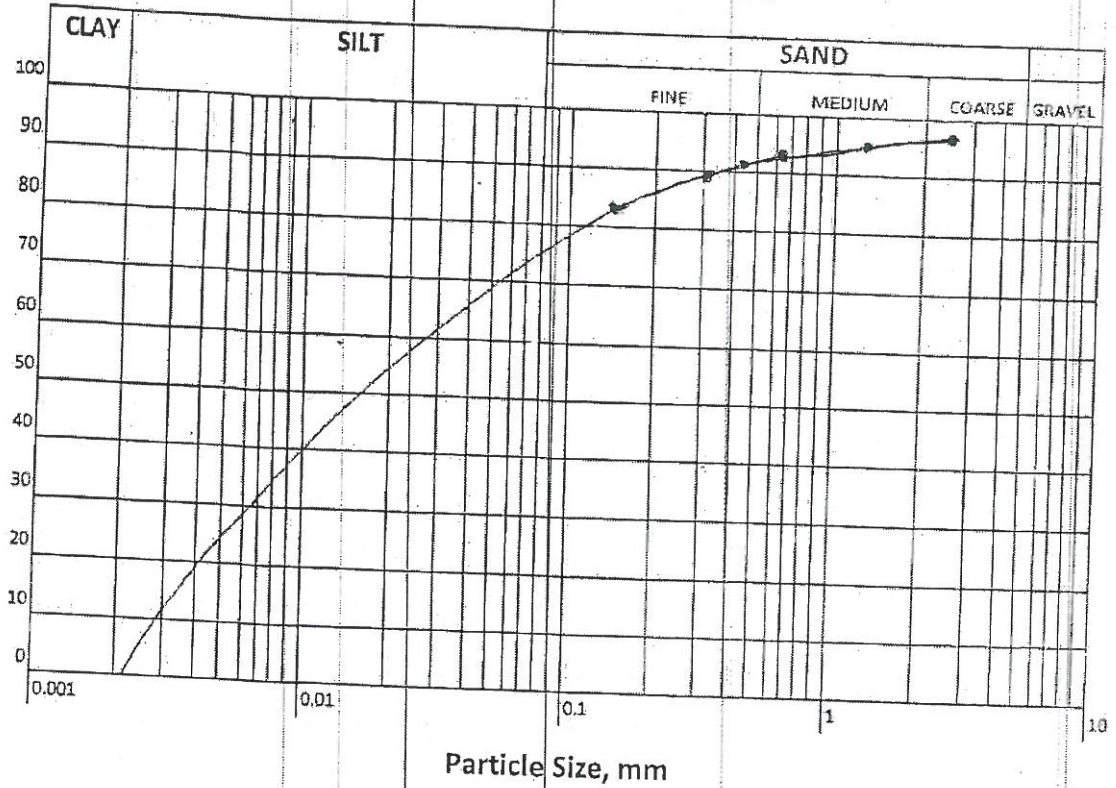
The test results are attached as **Annexure-I** to this report.

BH-1

# National Laboratories

Depth-0.75 mtr.

Graph for Sieve Analysis



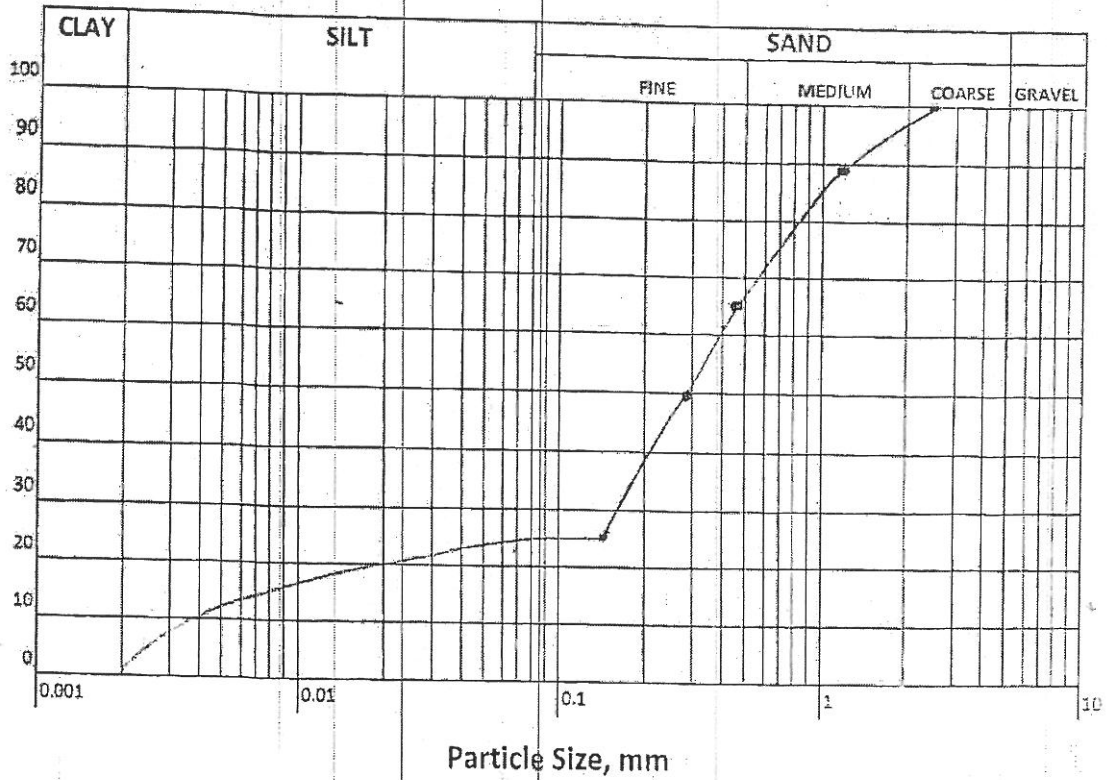
GRAIN SIZE ANALYSIS CURVES

BH-1

# National Laboratories

Depth-6.0mtrs.

## Graph for Sieve Analysis



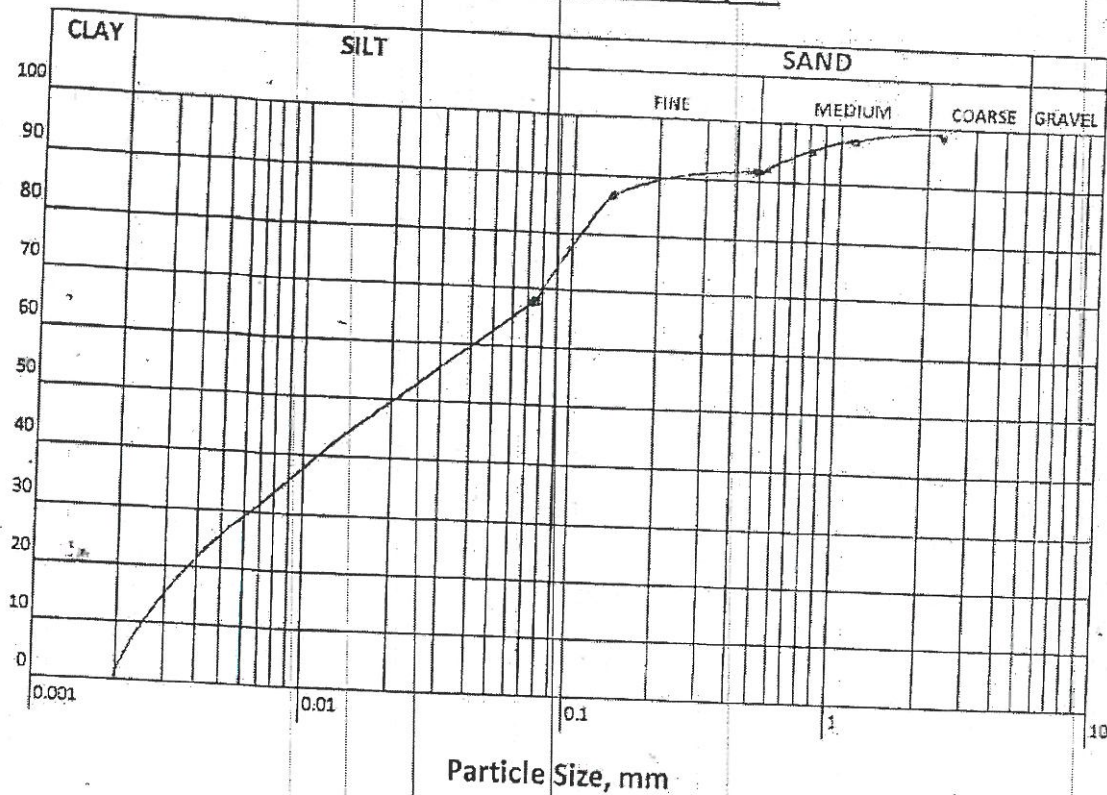
### GRAIN SIZE ANALYSIS CURVES

BH-2

# National Laboratories

Depth-1.5mtrs

Graph for Sieve Analysis



GRAIN SIZE ANALYSIS CURVES

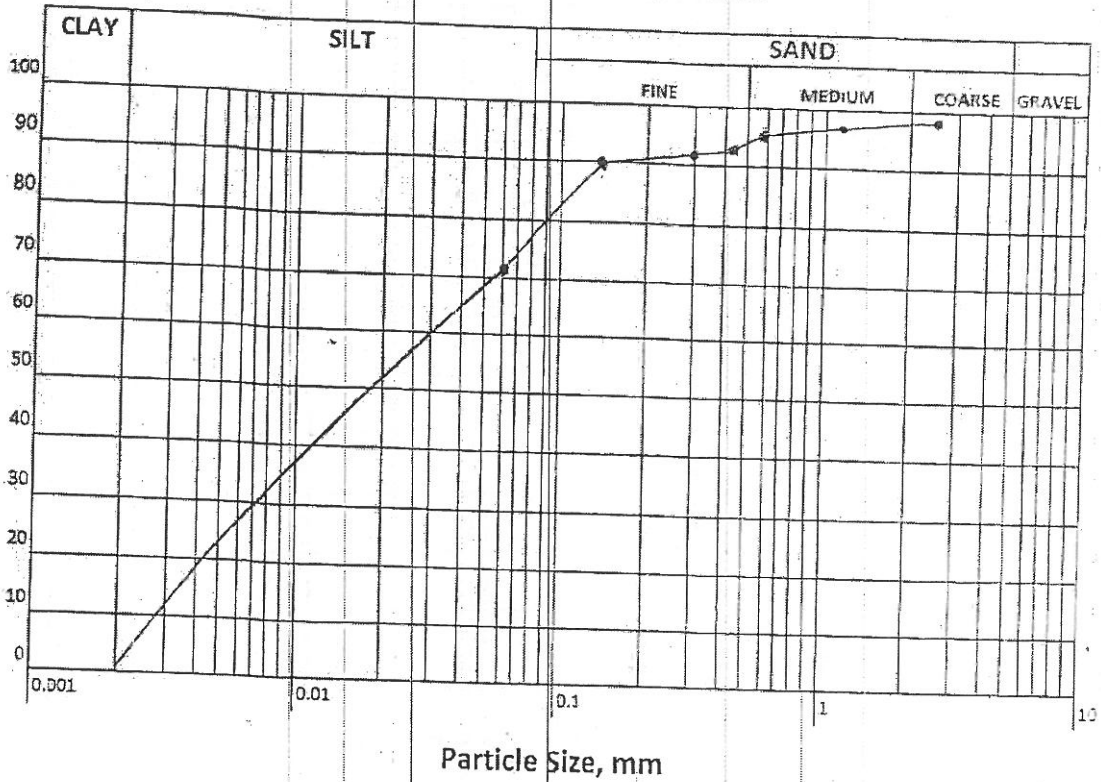


BH-2

# National Laboratories

Depth - 3.0 mtrs

Graph for Sieve Analysis



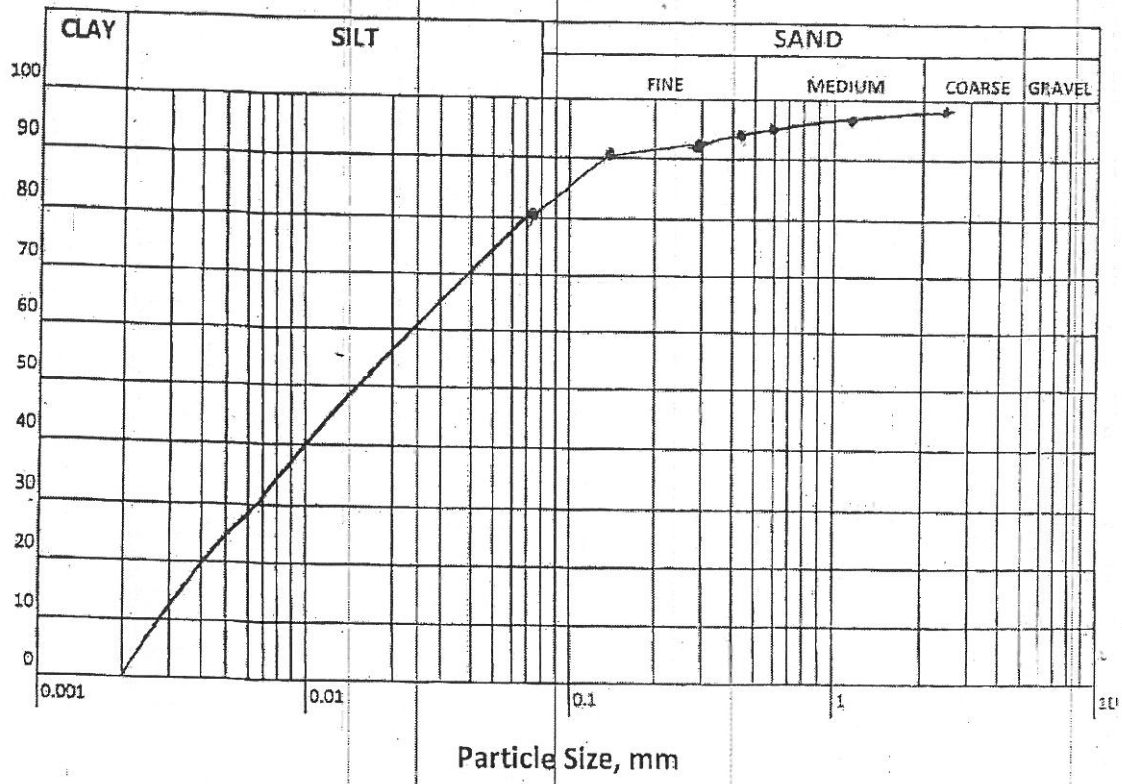
GRAIN SIZE ANALYSIS CURVES

BH-3

# National Laboratories

Depth = 4.5 mtrs

Graph for Sieve Analysis



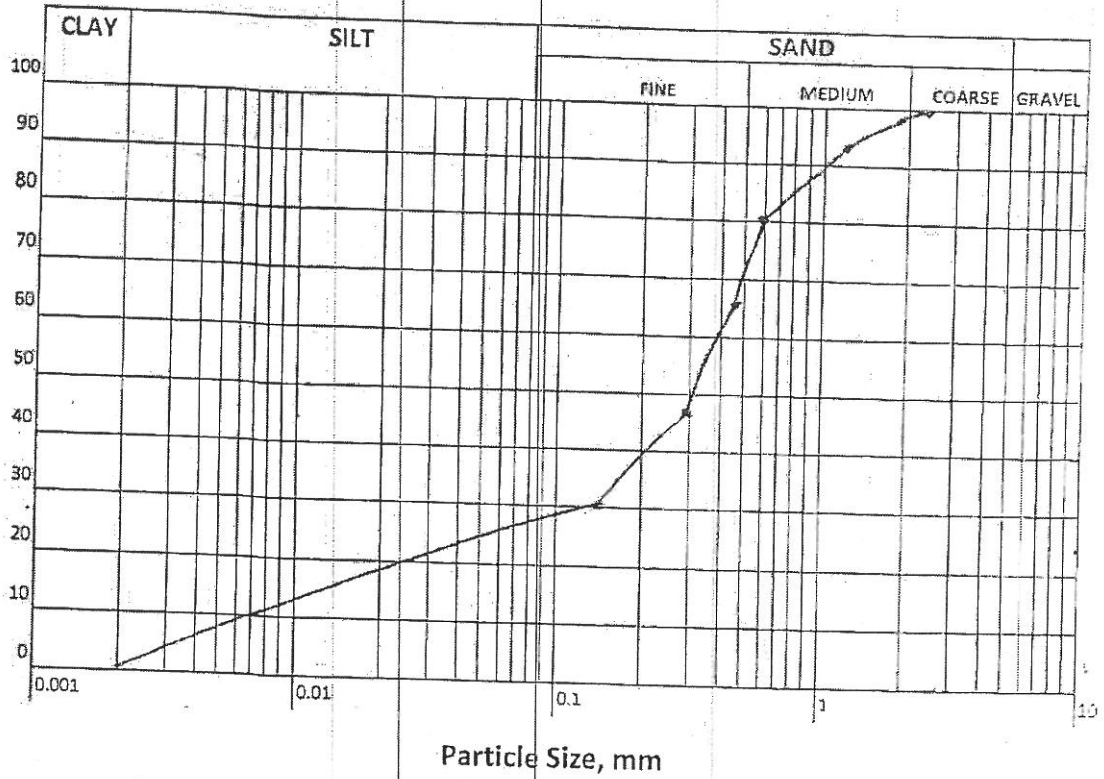
GRAIN SIZE ANALYSIS CURVES

BH-3

# National Laboratories

Depth-3.0mtr

## Graph for Sieve Analysis



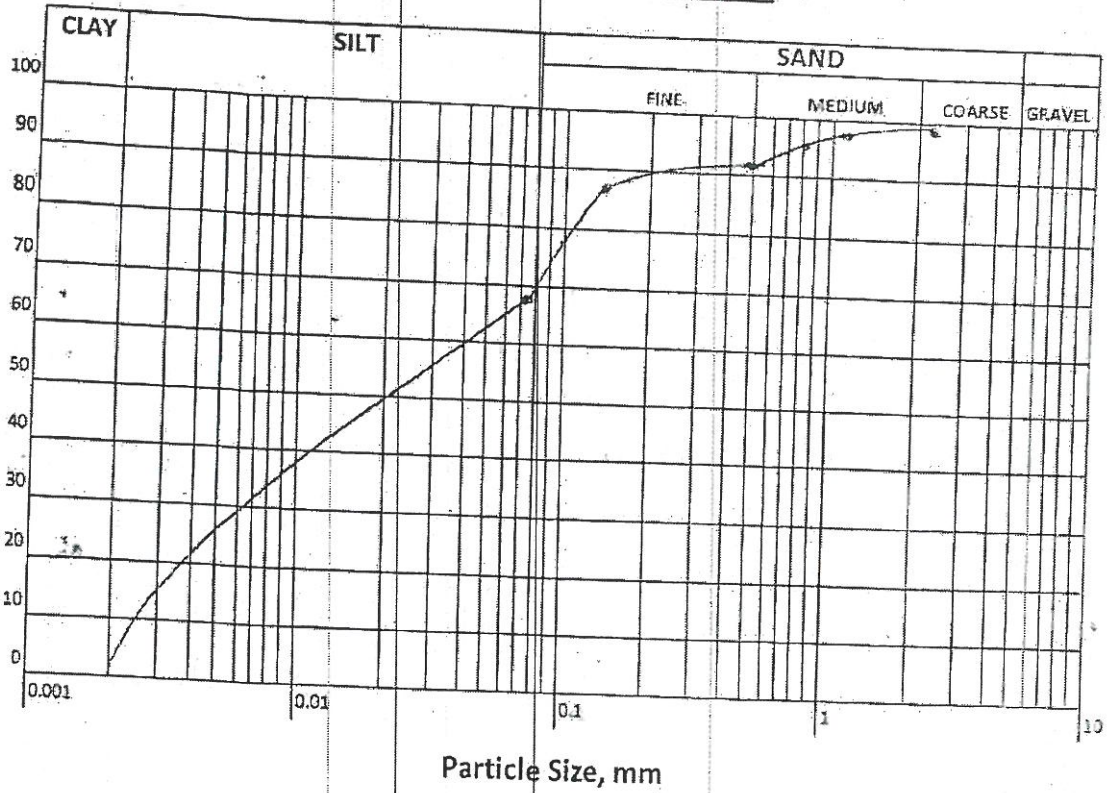
## GRAIN SIZE ANALYSIS CURVES

BH-4

# National Laboratories

Depth - 1.5 mtr.

## Graph for Sieve Analysis



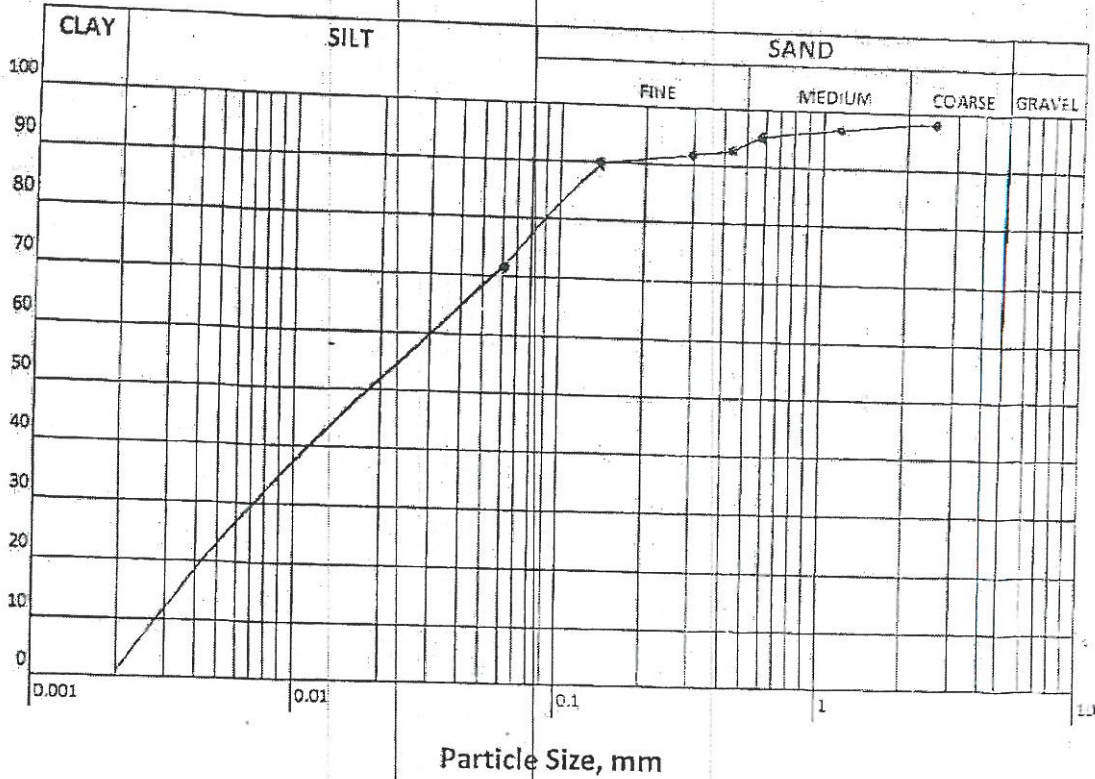
## GRAIN SIZE ANALYSIS CURVES

BH-4

# National Laboratories

Depth-3.0 mtrs.

## Graph for Sieve Analysis



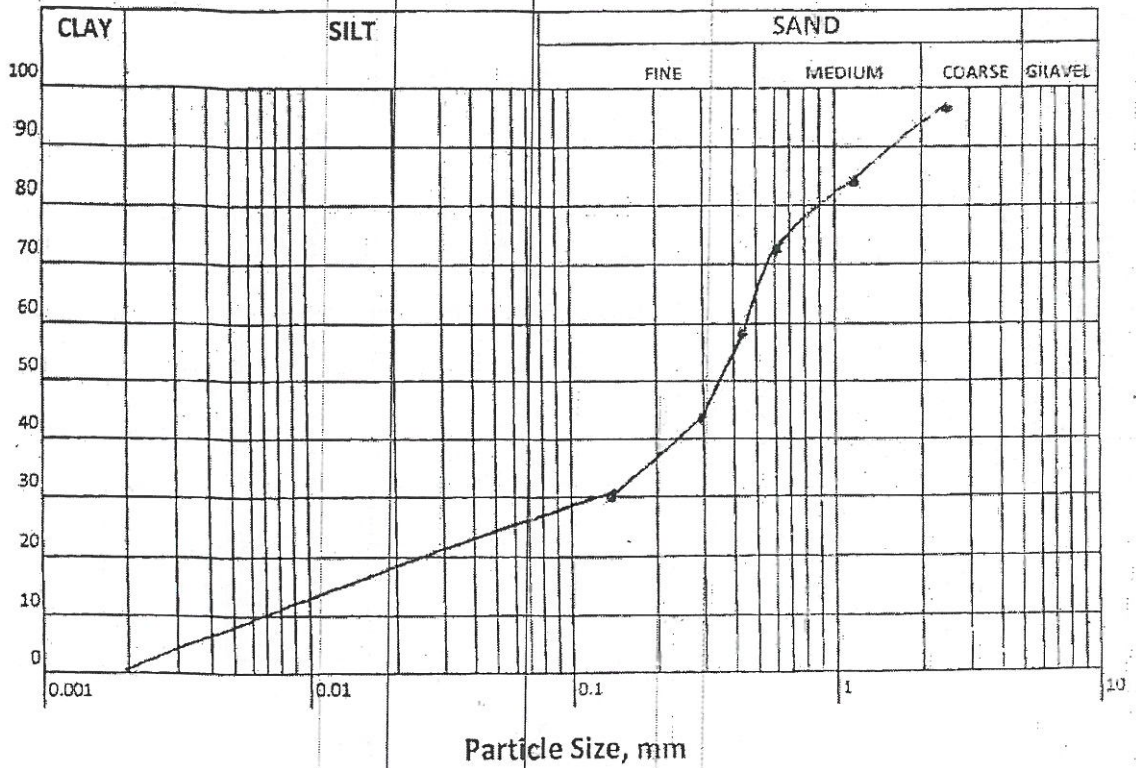
## GRAIN SIZE ANALYSIS CURVES

BH-5

# National Laboratories

Depth - 6.0 mtr

Graph for Sieve Analysis



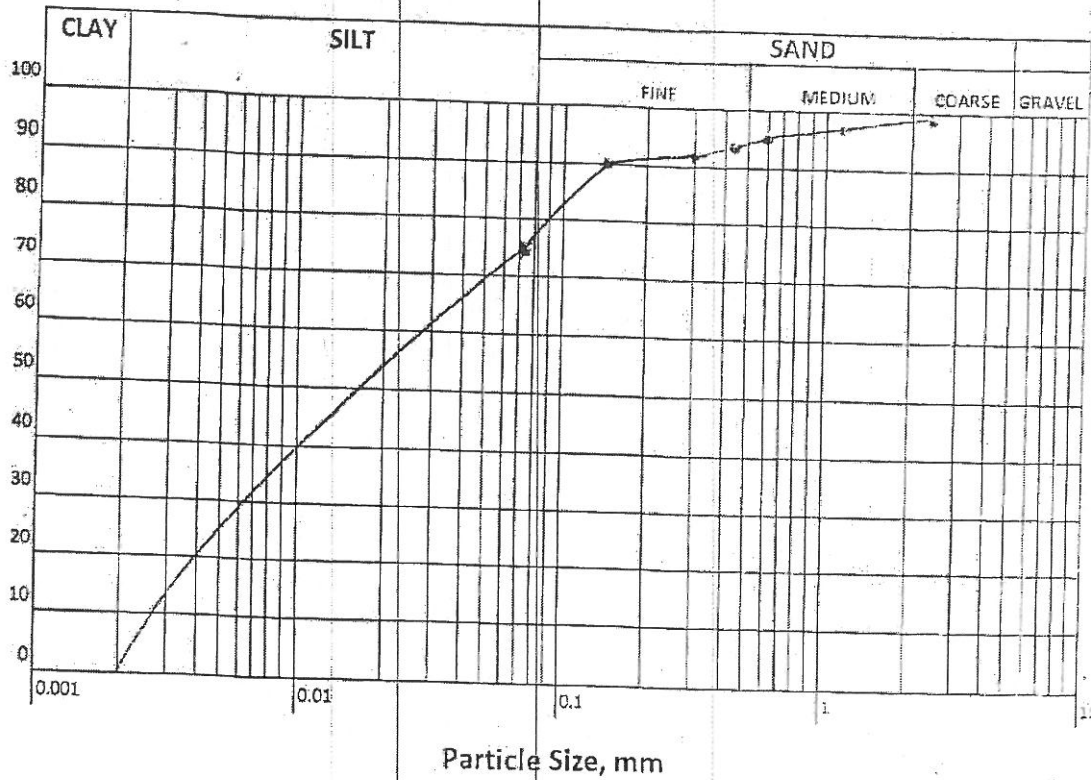
GRAIN SIZE ANALYSIS CURVES

BH-5

# National Laboratories

Depth - 10.5 mtrs.

Graph for Sieve Analysis



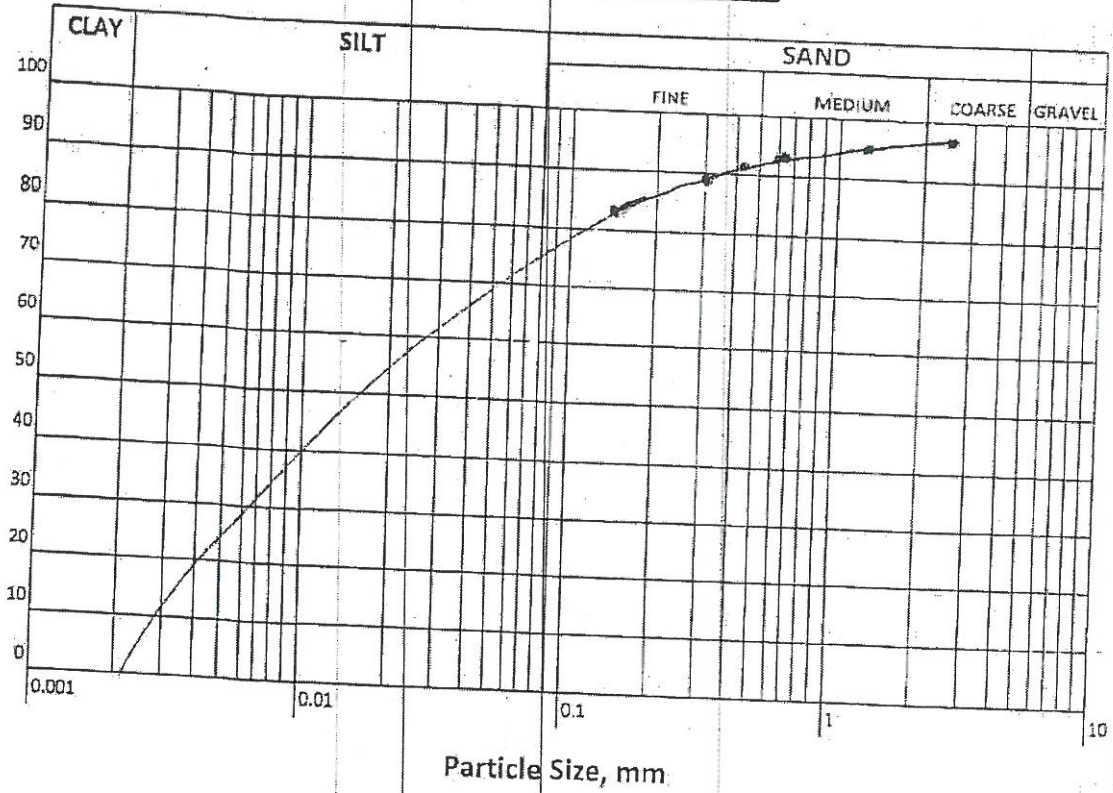
GRAIN SIZE ANALYSIS CURVES

BH-6

# National Laboratories

Depth - 0.75mtr

Graph for Sieve Analysis



GRAIN SIZE ANALYSIS CURVES

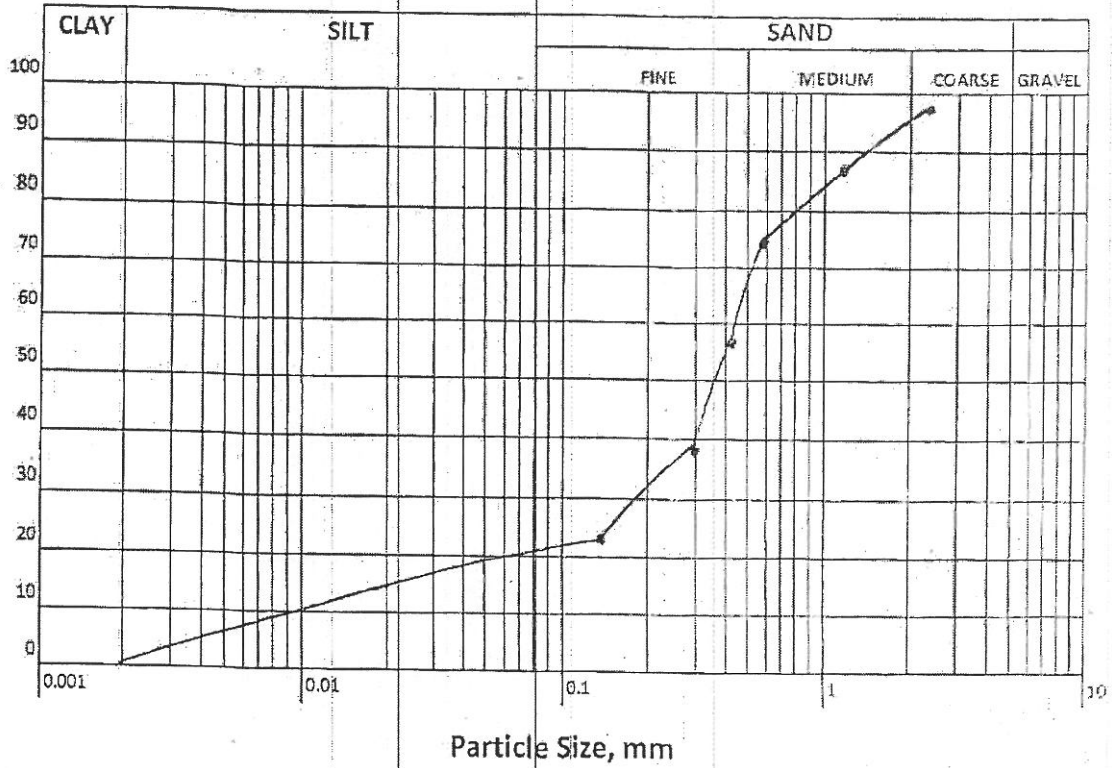


BH-6

# National Laboratories

Depth - 9.0 mtrs

Graph for Sieve Analysis



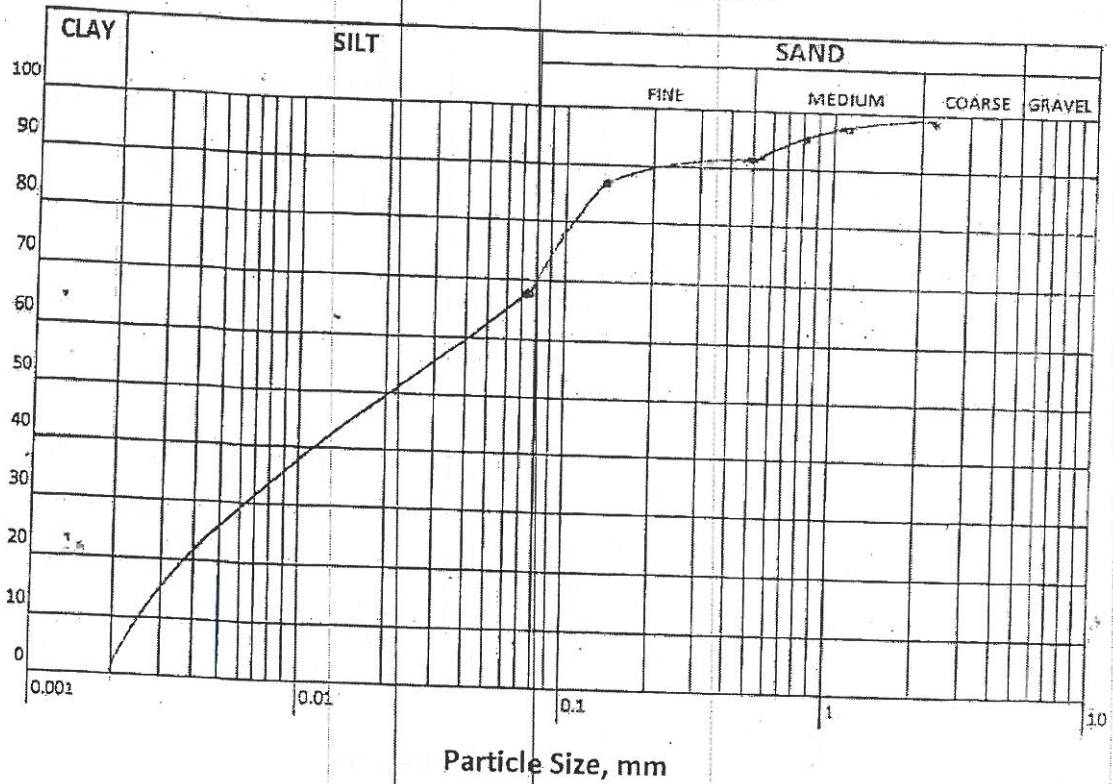
GRAIN SIZE ANALYSIS CURVES

BH-70

# National Laboratories

Depth-1.5mtrs

Graph for Sieve Analysis

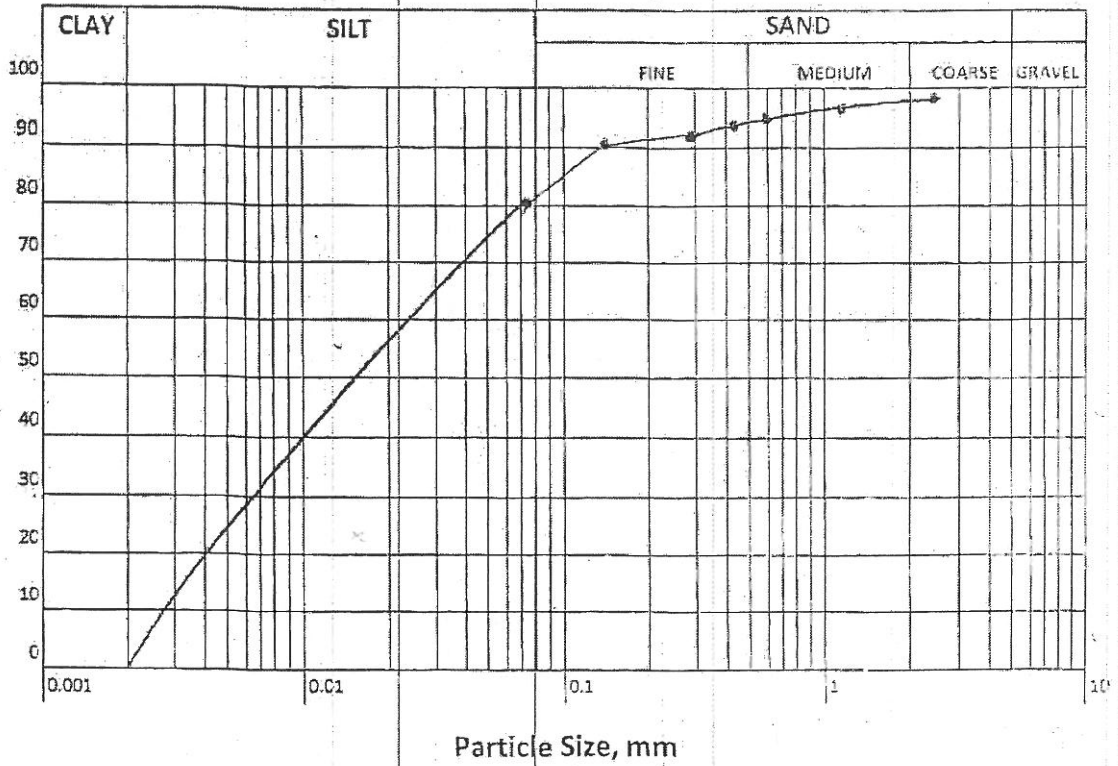


GRAIN SIZE ANALYSIS CURVES

BH-7

# National Laboratories *Depth - 7.5 mtrs.*

Graph for Sieve Analysis



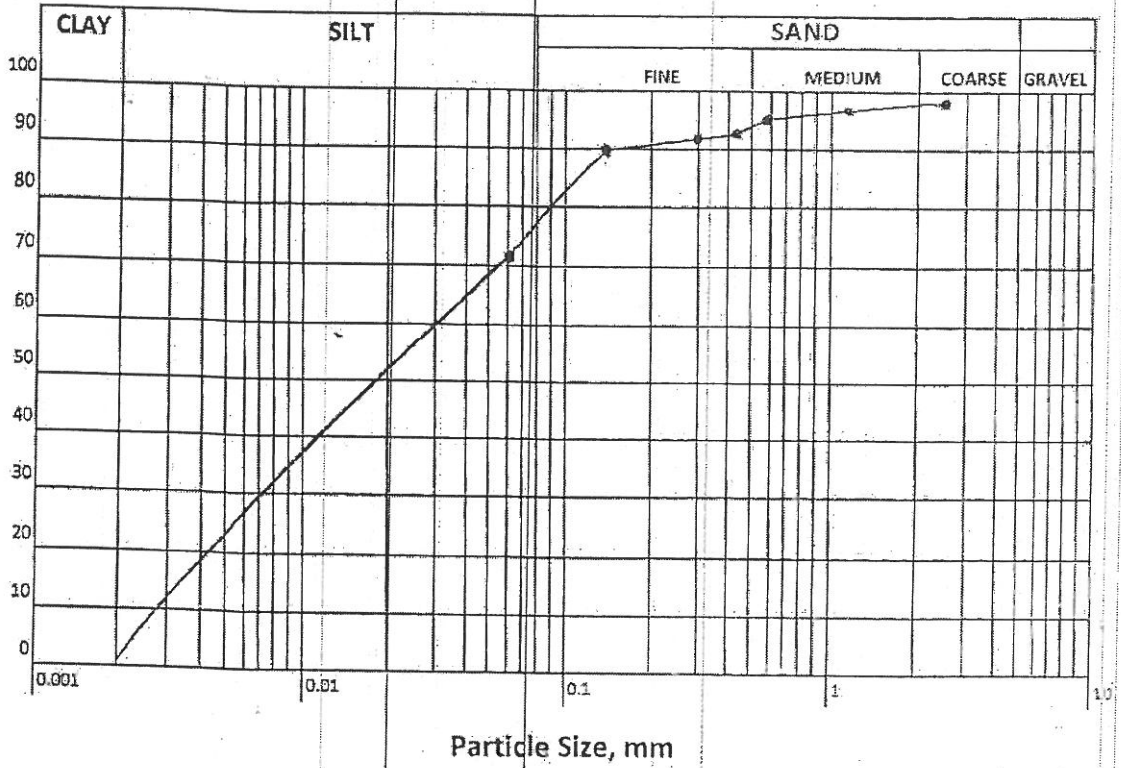
GRAIN SIZE ANALYSIS CURVES

BH-8

# National Laboratories

Depth-3.0mtr

## Graph for Sieve Analysis

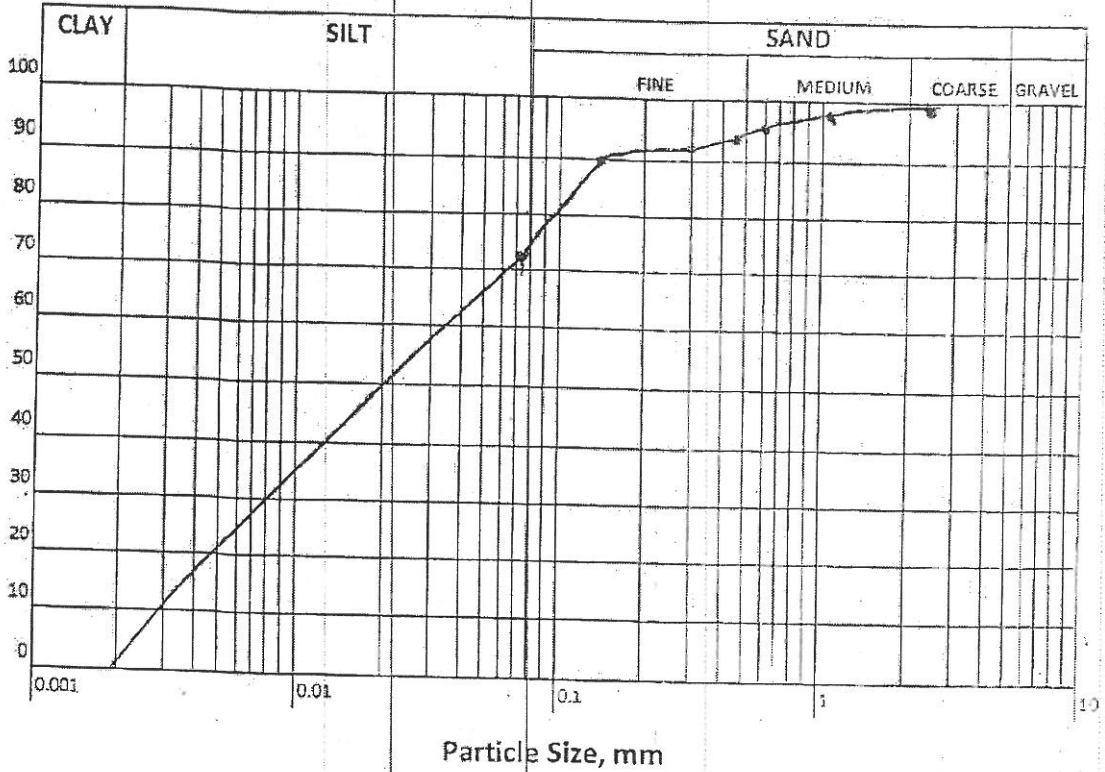


### GRAIN SIZE ANALYSIS CURVES

BH-8

# National Laboratories *Depth - 12.0 mtrs*

Graph for Sieve Analysis



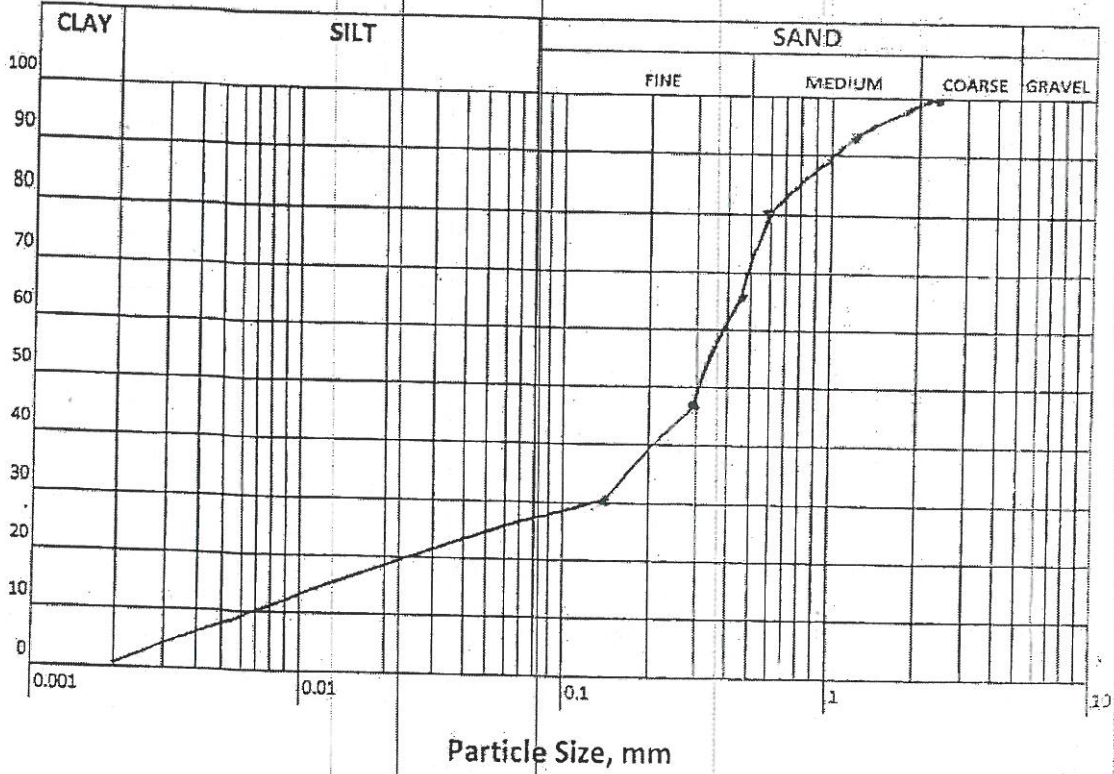
GRAIN SIZE ANALYSIS CURVES

BH-9

# National Laboratories

Depth-7.5mtrs.

Graph for Sieve Analysis



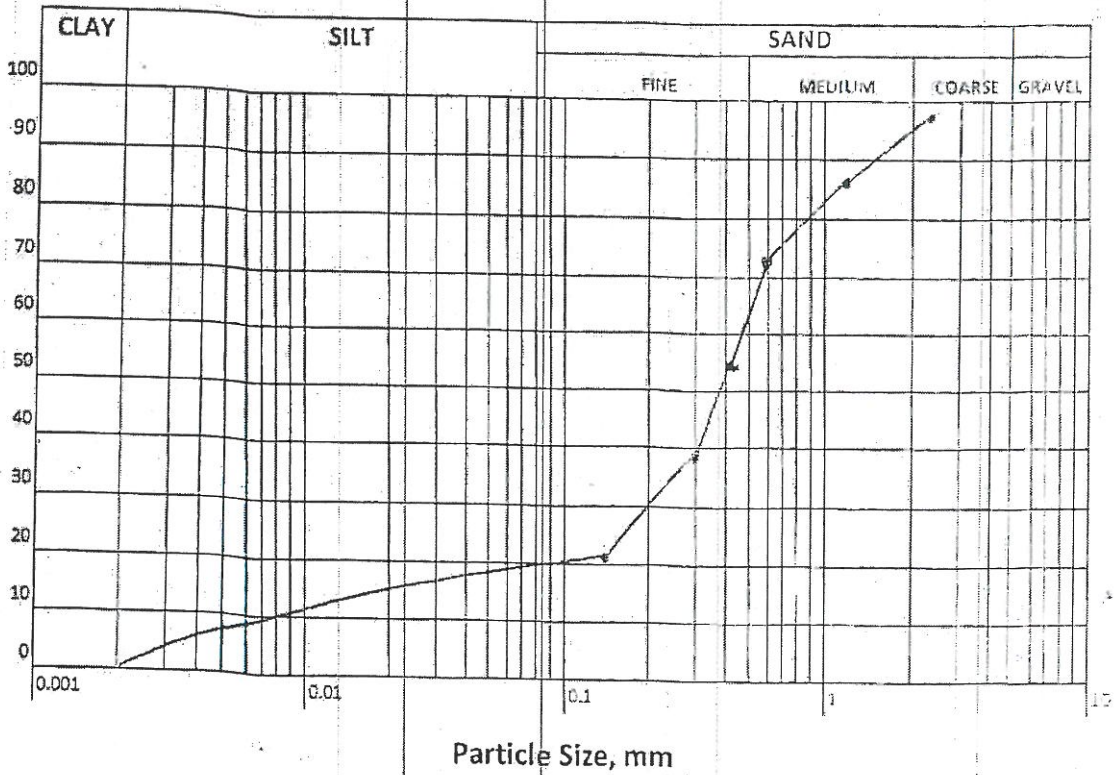
GRAIN SIZE ANALYSIS CURVES

BH-9

# National Laboratories

Depth-15.0 mtrs

Graph for Sieve Analysis

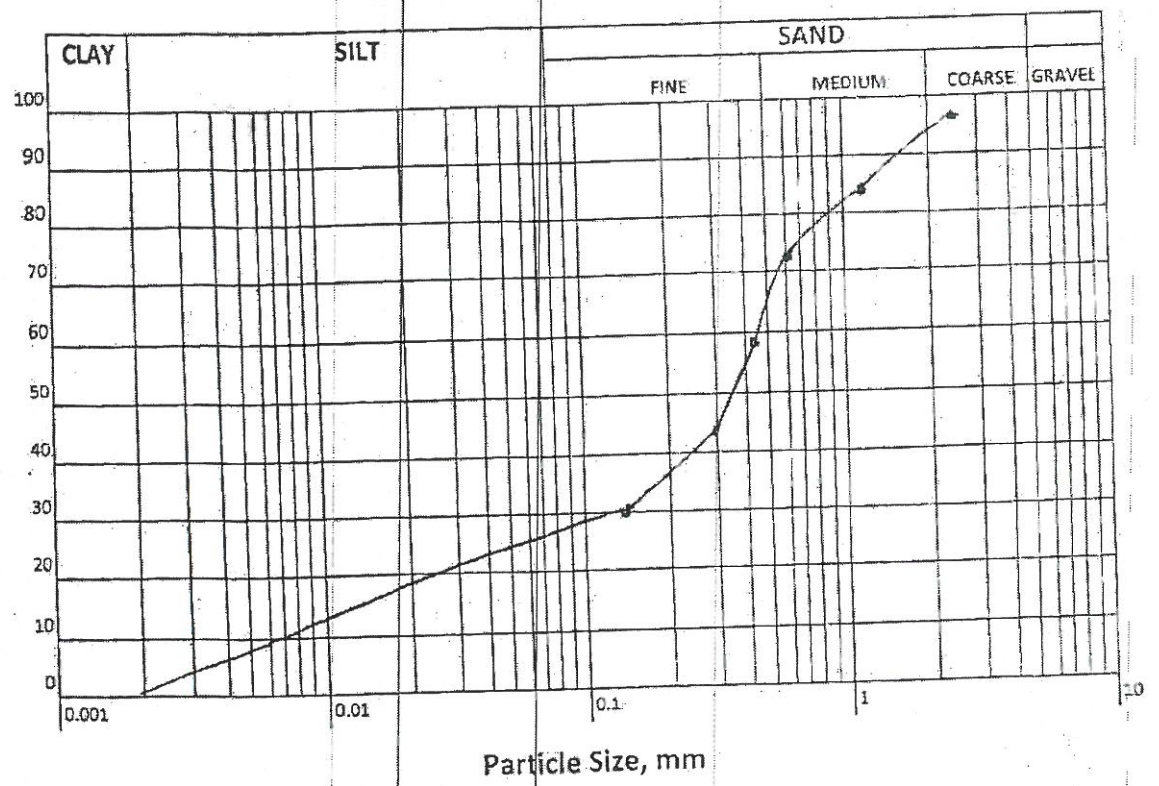


GRAIN SIZE ANALYSIS CURVES

BH-10

# National Laboratories *Depth-6.0mtrs.*

Graph for Sieve Analysis



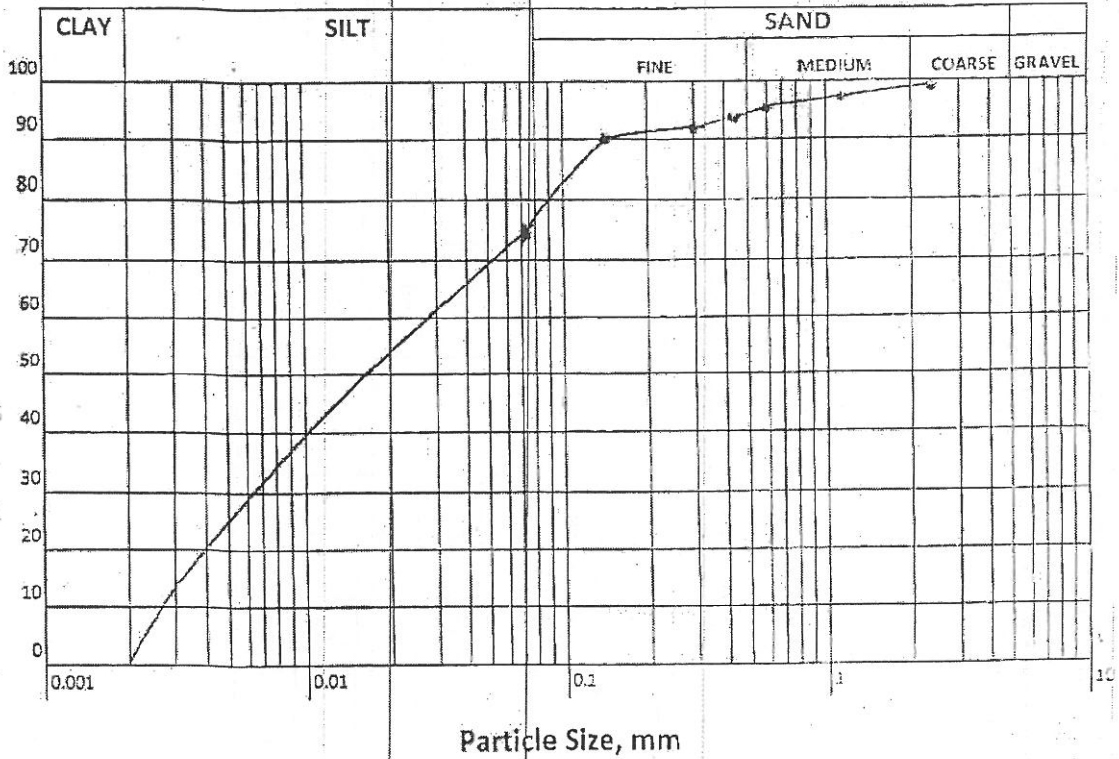
GRAIN SIZE ANALYSIS CURVES



BH-10

**National Laboratories** *Depth-10.5mtrs*

Graph for Sieve Analysis



GRAIN SIZE ANALYSIS CURVES

## National Soil Testing & Research Laboratories

BH-I  
Soil Characteristics

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	3	12	25	60	31.0 19.3	9.5	1.90	1.5	14°	0.32
1.5	CL	11	2	11	20	67	32.0 20.0	10.2	1.90	2.7	15°	0.38
3.0	CL	16	1	8	16	75	33.5 18.0	10.5	1.92	3.0	16.0°	0.43
4.5	CL	18	3	5	12	80	34.5 17.5	13.0	1.95	3.25	20.0°	0.50
6.0	SM	22	-	65	20	15	N P	14.2	1.82	NIL	31.0	-
7.5	SM	19	-	70	15	15	N P	15.0	1.85	NIL	31.5°	-
9.0	SM	22	3	70	12	15	N P	15.5	1.88	NIL	31.8°	-
10.5	CL	30	2	11	20	67	32.0 20.0	15.7	1.94	2.5	13°	0.95
12.0	CL	35	1	10	14	75	33.5 18.0	15.5	1.96	3.0	16.0°	1.0
15.0	SM	30	1	75	10	14	N P	16.0	1.90	NIL	31.5°	-
18.0	SM	32	-	70	17	13	N P	15.8	1.92	NIL	32.0°	-
22.5	SM-SP	33	5	80	10	5	N P	16.0	2.00	NIL	33.2°	-
25.0	SM-SP	35	14	76	5	5	N P	16.1	2.12	NIL	33.0°	-

## National Soil Testing & Research Laboratories

### Soil Characteristics

BH-2

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	3	12	23	62	32.5 20.0	9.5	1.90	2.0	18°	0.30
1.5	CL	10	2	11	20	67	34.0 17.7	10.8	1.90	2.5	13°	0.35
3.0	CL	16	2	8	18	72	33.5 18.0	11.2	1.92	3.0	18.0°	0.45
4.5	CL	18	--	10	15	75	34.5 17.5	11.0	1.95	3.25	20.0°	0.50
6.0	SM	20	5	65	15	15	N P	15.0	1.86	Nil	31.5°	--
7.5	SM	22	5	70	13	12	N P	14.2	1.86	Nil	31.5°	--
9.0	SM	22	1	72	15	12	N P	15.1	1.88	Nil	31.8°	--
10.5	CL	32	2	8	15	75	32.0 20.0	15.7	1.90	2.5	13°	0.95
12.0	CL	30	1	10	9	80	33.5 18.0	15.5	1.92	3.0	16.0°	1.05
15.0	SM	33	2	78	6	14	N P	15.0	1.96	Nil	31.5°	--
18.0	SM	35	2	70	15	13	N P	14.0	2.00	Nil	32.0°	--
22.5	SM-SP	33	1	88	6	5	N P	15.0	2.10	Nil	33.2°	--
25.0	SM-SP	35	5	85	5	5	N P	16.0	2.12	Nil	33.4°	--

# National Soil Testing & Research Laboratories

## Soil Characteristics

BH-3

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	5	3	12	25	60	31.5 20.0	10.5	1.90	1.4	16°	0.35
1.5	CL	12	2	11	12	75	32.0 20.4	11.5	1.90	2.5	13°	0.38
3.0	CL	15	-	15	13	72	32.5 18.5	12.5	1.92	2.75	16.0°	0.42
4.5	CL	20	3	6	11	80	34.0 18.7	13.2	1.95	3.25	20.0°	0.55
6.0	SM	20	-	75	10	15	N P	13.5	1.90	NIL	31.0	0.58
7.5	SM	22	-	70	15	15	N P	15.0	1.95	NIL	31.5°	--
9.0	SM	24	2	78	8	12	N P	15.0	1.92	NIL	31.5°	--
10.5	CL	30	2	8	15	75	32.0 20	16.5	1.94	2.5	18°	0.90
12.0	CL	34	-	10	10	80	33.5 18	17.5	1.95	3.0	26°	1.10
15.0	SM	30	2	76	8	14	N P	15.0	1.98	NIL	31.5°	--
18.0	SM	35	-	76	10	14	N P	15.2	2.05	NIL	32.5°	-
22.5	SM-SP	36	1	84	6	9	N P	15.7	2.10	NIL	33.0°	--
25.0	SM-SP	38	6	85	5	4	N P	16.0	2.10	NIL	33.5°	--

## National Soil Testing & Research Laboratories

### Soil Characteristics

BH- 4

Depth In Meter	IS Classification	N- Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	5	3	42	25	60	31.5 — 20.0	9.8	1.90	1.6	18°	0.34
1.5	CL	12	2	10	20	68	32.0 20.0	11.2	1.90	2.2	18°	0.40
3.0	CL	15	1	8	17	74	33.5 18.0	11.5	1.92	3.0	16.0°	0.44
4.5	CL	17	3	5	13	79	34.5 17.5	13.7	1.95	3.25	20.0°	0.50
6.0	SM	21	-	66	19	15	N P	13.5	1.82	NIL	31.0	--
7.5	SM	20	-	70	15	15	N P	14.0	1.85	NIL	31.5°	--
9.0	SM	23	3	70	12	15	N P	14.2	1.88	NIL	31.8°	--
10.5	CL	28	2	11	19	68	32.0 20	15.0	1.94	2.5	13°	0.98
12.0	CL	32	1	10	13	76	33.5 18	15.5	1.96	3.0	16.0°	1.0
15.0	SM	30	1	75	10	14	N P	16.0	1.90	NIL	31.5°	--
18.0	SM	31	-	70	18	12	N P	14.2	1.92	NIL	32.0°	--
22.5	SM-SP	34	5	81	10	4	N P	15.0	2.00	NIL	33.2°	--
25.0	SM-SP	36	13	78	5	4	N P	16.0	2.10	NIL	33.7°	--

# National Soil Testing & Research Laboratories

## Soil Characteristics

BH-5

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	3	12	25	60	31.5 20.0	10.1	1.90	1.8	18°	0.32
1.5	CL	11	2	11	20	67	32.0 20.0	11.5	1.90	2.5	13°	0.36
3.0	CL	17	2	8	19	71	33.5 18.0	12.4	1.92	3.0	16.0°	0.45
4.5	CL	19	--	10	13	77	34.5 17.5	13.2	1.95	3.25	20.0°	0.50
6.0	SM	20	5	65	16	14	N P	13.4	1.86	Nil	31.5°	--
7.5	SM	23	5	70	14	11	N P	13.7	1.86	Nil	31.5°	--
9.0	SM	21	1	70	16	13	N P	14.0	1.88	Nil	31.8°	--
10.5	CL	33	2	8	14	76	32.0 20.0	14.5	1.90	2.5	13°	0.96
12.0	CL	31	1	10	9	80	33.5 18	15.0	1.92	3.0	16.0°	1.05
15.0	SM	32	2	77	6	15	N P	15.2	1.96	Nil	31.5°	--
18.0	SM	36	2	76	9	13	N P	15.5	2.00	Nil	32.0°	--
22.5	SM-SP	34	5	83	5	5	N P	15.7	2.10	Nil	33.2°	--
25.0	SM-SP	37	6	84	6	4	N P	16.0	2.15	Nil	33.8°	--

## National Soil Testing & Research Laboratories

### Soil Characteristics

BH-6

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	φ in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	5	3	12	23	62	31.5 20.0	10.5	1.90	1.5	18°	0.33
1.5	CL	12	2	11	13	74	32.0 20.5	11.0	1.90	2.6	15°	0.36
3.0	CL	15	-	14	12	72	32.4 18.5	12.5	1.92	2.75	16.0°	0.42
4.5	CL	20	3	5	10	82	34.0 18.0	13.2	1.95	3.25	20.0°	0.55
6.0	SM	21	-	73	13	14	N P	13.5	1.90	NIL	31.0	0.58
7.5	SM	23	-	70	18	12	N P	15.0	1.95	NIL	31.5°	-
9.0	SM	25	2	75	10	13	N P	15.3	1.92	NIL	31.5°	-
10.5	CL	31	2	8	14	76	32.0 20.5	16.0	1.94	2.5	18°	0.90
12.0	CL	35	-	10	9	81	33.5 18.7	16.5	1.95	3.0	24°	1.10
15.0	SM	31	2	77	9	12	N P	16.2	1.98	NIL	31.5°	-
18.0	SM	36	-	76	10	14	N P	15.8	2.05	NIL	32.5°	-
22.5	SM-SP	35	1	84	6	9	N P	16.0	2.10	NIL	33.0°	-
25.0	SM-SP	39	6	86	5	3	N P	16.4	2.14	NIL	33.4°	-

# National Soil Testing & Research Laboratories

BH-7  
Soil Characteristics

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Altenburg's Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	3	12	21	64	31.5 20.0	9.5	1.90	1.8	15°	0.35
1.5	CL	12	2	10	20	68	32.0 20.2	10.4	1.90	2.5	13°	0.38
3.0	CL	17	1	8	16	75	33.5 18.4	10.7	1.92	3.0	16.0°	0.45
4.5	CL	19	3	5	13	79	34.5 17.5	11.0	1.95	3.25	23.0°	0.55
6.0	SM	21	-	67	18	15		14.0	1.82	NIL	31.0	--
7.5	SM	20	-	71	15	14	N P	14.4	1.85	NIL	31.5°	--
9.0	SM	21	3	70	14	13	N P	14.7	1.88	NIL	31.8°	--
10.5	CL	29	2	11	20	67	32.0 20.4	15.0	1.94	2.5	13°	0.95
12.0	CL	33	1	11	14	74	33.5 18	15.2	1.96	3.0	16.0°	1.0
15.0	SM	31	1	76	10	13	N P	15.7	1.90	NIL	31.5°	--
18.0	SM	32	-	70	18	12	N P	15.8	1.92	NIL	32.0°	--
22.5	SM-SP	33	5	80	10	5	N P	16.1	2.00	NIL	33.2°	--
25.0	SM-SP	35	14	76	5	4	N P	16.3	2.18	NIL	34.0°	--



# National Soil Testing & Research Laboratories

## Soil Characteristics

BH-8

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	2	11	24	63	32.0 20.0	9.8	1.90	2.0	18°	0.30
1.5	CL	10	2	11	23	64	32.0 20.5	10.5	1.90	2.5	13°	0.35
3.0	CL	16	2	8	18	72	33.5 18.5	10.7	1.92	3.0	16.0°	0.45
4.5	CL	18	--	10	15	75	34.5 17.5	11.0	1.95	3.25	20.0°	0.50
6.0	SM	21	5	66	15	14	N P	13.0	1.86	Nil	31.5°	--
7.5	SM	22	5	70	13	12	N P	14.0	1.87	Nil	31.5°	--
9.0	SM	24	1	71	15	13	N P	14.0	1.88	Nil	31.8°	--
10.5	CL	30	2	8	15	75	33.0 20.4	14.5	1.90	2.5	15°	0.95
12.0	CL	31	1	9	9	81	33.7 18.2	15.5	1.92	3.0	16.0°	1.05
15.0	SM	33	2	75	6	13	N P	15.0	1.96	Nil	31.5°	--
18.0	SM	35	2	70	7	13	N P	15.4	2.00	Nil	32.0°	--
22.5	SM-SP	34	1	83	5	5	N P	15.5	2.10	Nil	33.2°	--
25.0	SM-SP	37	6	87	4	3	N P	16.0	2.12	Nil	33.5°	--

# National Soil Testing & Research Laboratories

BH-9

Soil Characteristics

Depth In Meter	IS Classification	N-Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	5	3	12	22	63	31.5 20	10.5	1.90	1.6	15 <sup>o</sup>	0.33
1.5	CL	10	2	11	13	74	32.0 20	11.0	1.92	2.5	15 <sup>o</sup>	0.36
3.0	CL	15	-	15	12	73	32.5 18	12.5	1.92	2.75	16.0 <sup>o</sup>	0.42
4.5	CL	18	3	7	10	80	34.0 18.0	13.2	1.95	3.25	23.0 <sup>o</sup>	0.55
6.0	SM	21	-	75	10	15	N P	13.5	1.90	NIL	31.0	0.58
7.5	SM	22	-	70	15	15	N P	15.0	1.95	NIL	31.5 <sup>o</sup>	-
9.0	SM	25	2	78	8	12	N P	15.4	1.92	NIL	31.5 <sup>o</sup>	-
10.5	CL	30	2	8	15	75	32.0 20	15.5	1.94	2.5	18 <sup>o</sup>	0.90
12.0	CL	34	-	10	10	80	33.5 18	16.0	1.95	3.0	26 <sup>o</sup>	1.10
15.0	SM	31	2	77	8	13	N P	16.2	1.98	NIL	31.5 <sup>o</sup>	-
18.0	SM	33	-	76	10	14	N P	16.4	2.05	NIL	32.5 <sup>o</sup>	-
22.5	SM-SP	35	1	84	6	9	N P	15.8	2.10	NIL	33.0 <sup>o</sup>	-
25.0	SM-SP	37	6	85	5	4	N P	16.1	2.15	NIL	34.5 <sup>o</sup>	-

## National Soil Testing & Research Laboratories

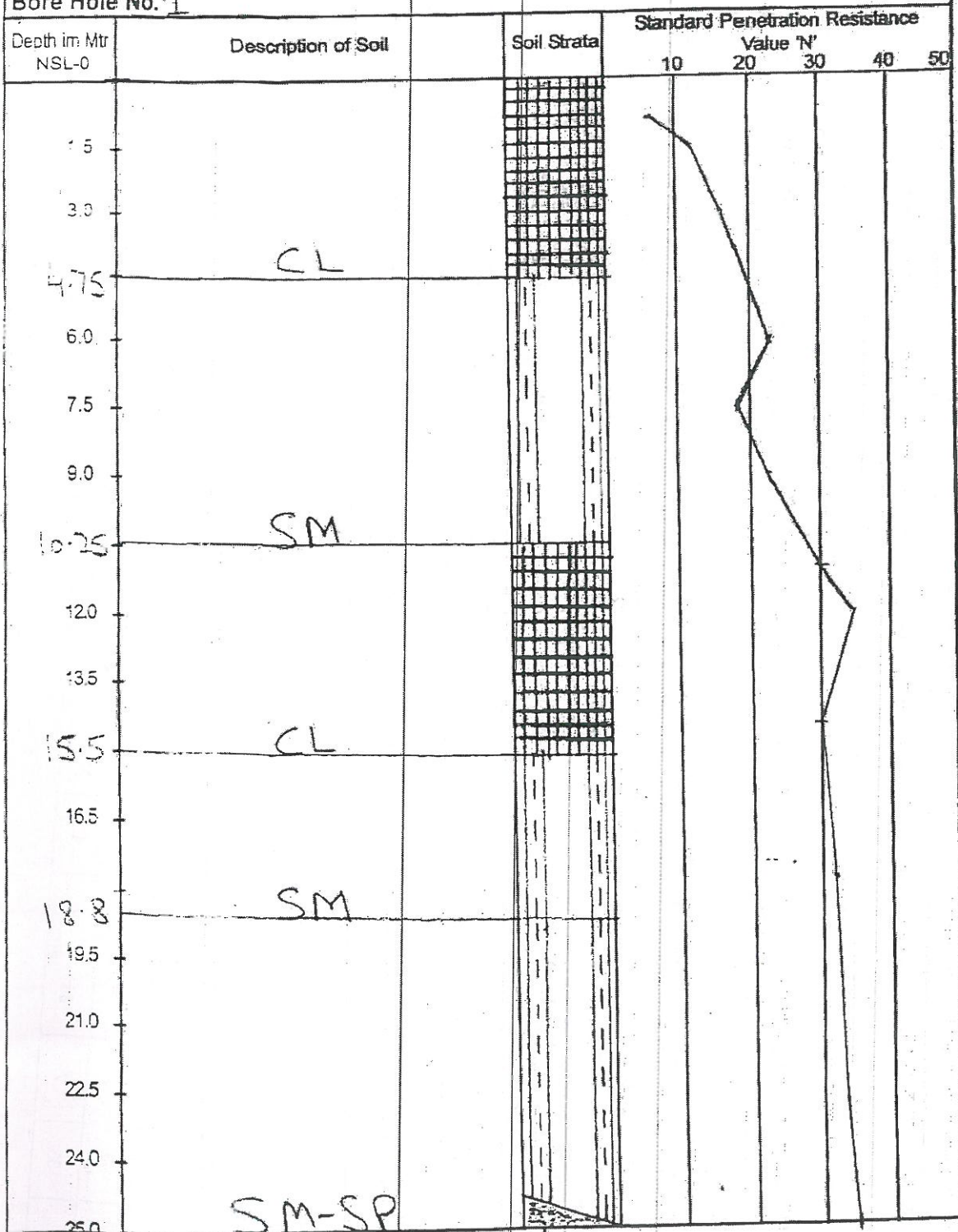
### Soil Characteristics

BH-10

Depth In Meter	IS Classification	N- Value	Gravel	Sand	Silt	Clay	Atterburg Limit LL PL %	Water Content	Bulk Density	C in T/M <sup>2</sup>	Ø in Degree	Undrained Shear Strength Kg/Cm
0.75	CL	6	3	10	21	66	31.5 20.0	9.5	1.90	1.5	18°	0.30
1.5	CL	10	2	10	20	68	32.0 20.2	11.5	1.90	2.5	13°	0.35
3.0	CL	16	2	9	19	70	33.5 18.0	12.5	1.92	3.0	16.0°	0.45
4.5	CL	18	-	10	13	77	34.5 17.5	12.0	1.95	3.25	20.0°	0.50
6.0	SM	19	5	65	18	12	N P	13.0	1.86	Nil	31.5°	-
7.5	SM	21	5	69	15	11	N P	13.5	1.86	Nil	31.5°	-
9.0	SM	24	1	73	14	12	N P	14.0	1.88	Nil	31.8°	-
10.5	CL	30	2	8	16	74	32.0 20.5	14.5	1.90	2.5	13°	0.95
12.0	CL	31	1	11	10	78	33.0 18.4	15.5	1.92	3.0	16.0°	1.05
15.0	SM	33	2	75	9	14	N P	15.0	1.96	Nil	31.5°	-
18.0	SM	35	2	70	7	13	N P	14.0	2.00	Nil	32.0°	-
22.5	SM-SP	33	1	84	10	5	N P	15.0	2.10	Nil	33.2°	-
25.0	SM-SP	35	7	86	3	4	N P	16.5	2.14	Nil	33.7°	-

# Bore Hole Chart

Bore Hole No. 1



Deptt. of Soil Mechanics

Tested by :

**National Laboratories**  
**(Test House)**

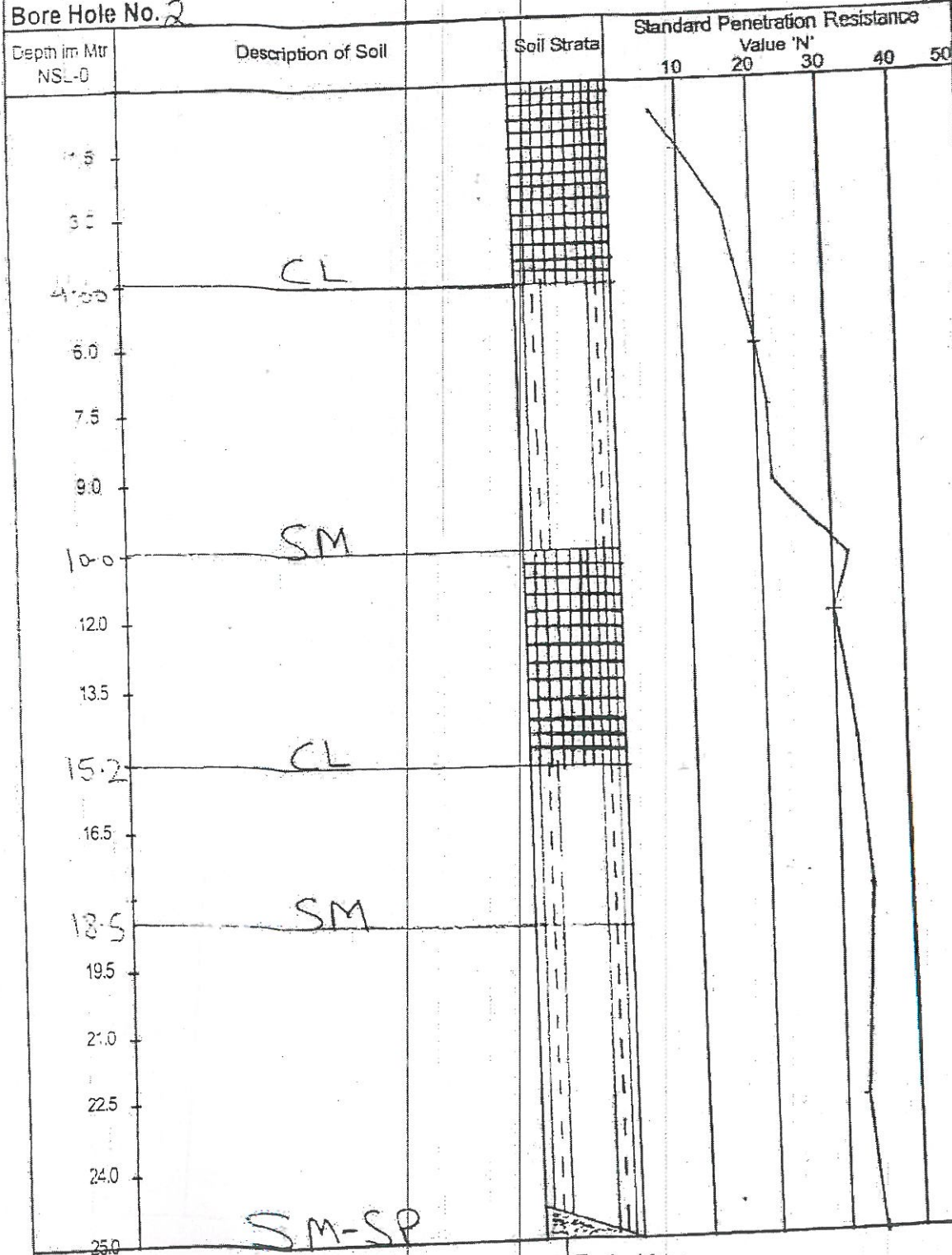
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Drawn by \_\_\_\_\_

Not to be Scale

# Bore Hole Chart

Bore Hole No. 2



Dept. of Soil Mechanics

Tested by :

**National Laboratories**  
(Test House)

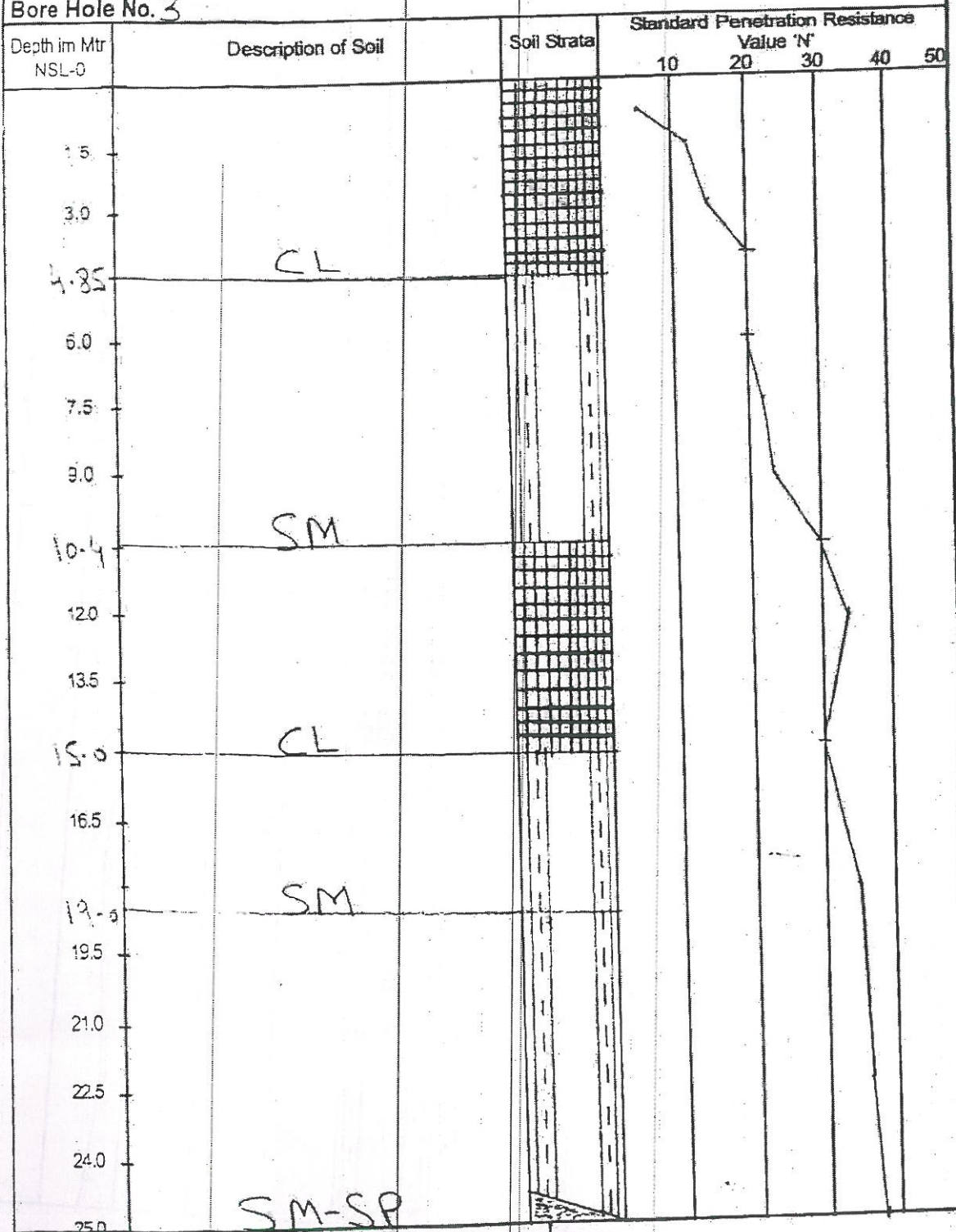
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# Bore Hole Chart

Bore Hole No. 3



Dept. of Soil Mechanics

Tested by :

**National Laboratories**  
(Test House)

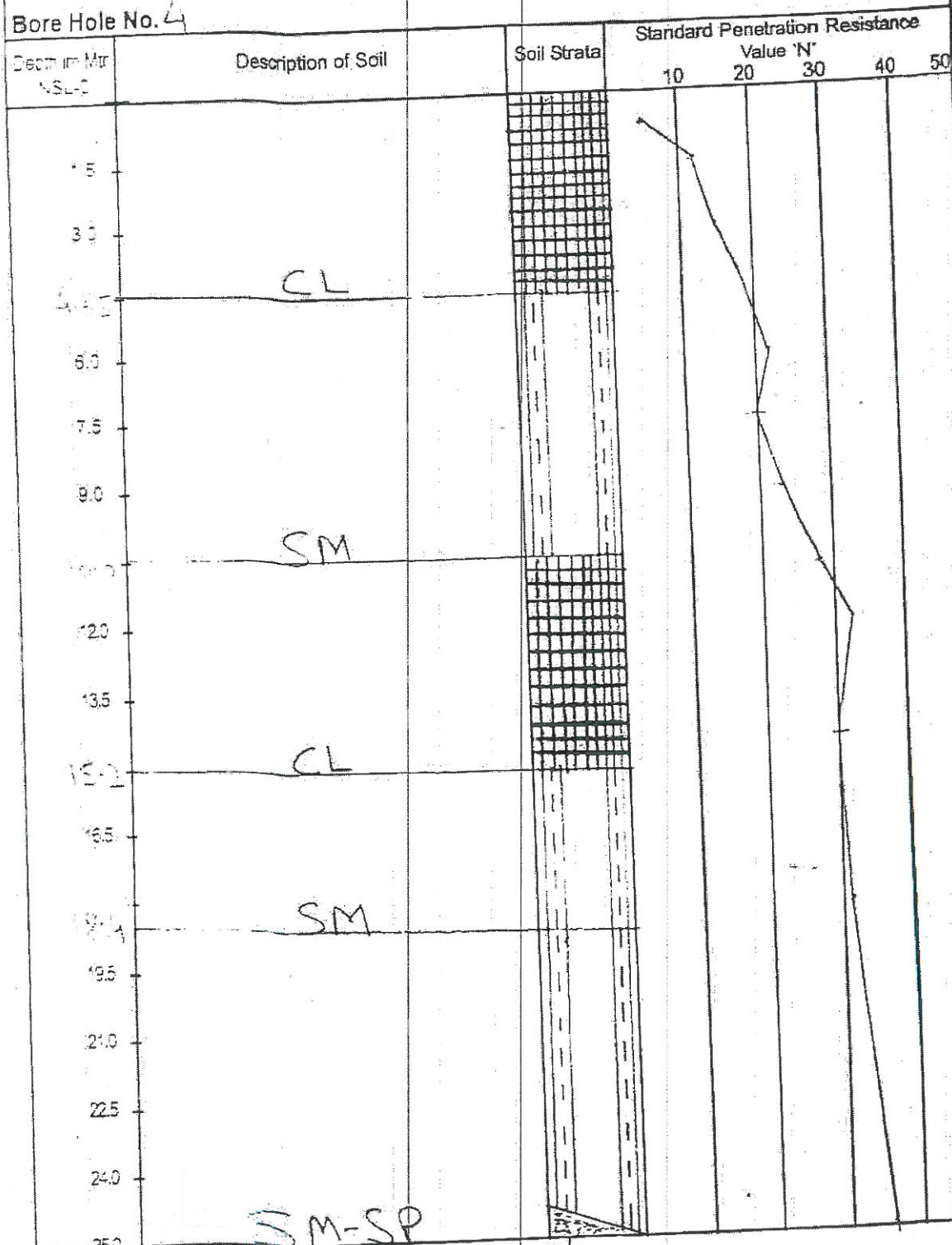
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# Bore Hole Chart

Bore Hole No. 4



Dept. of Soil Mechanics

Tested by :

**National Laboratories**  
(Test House)

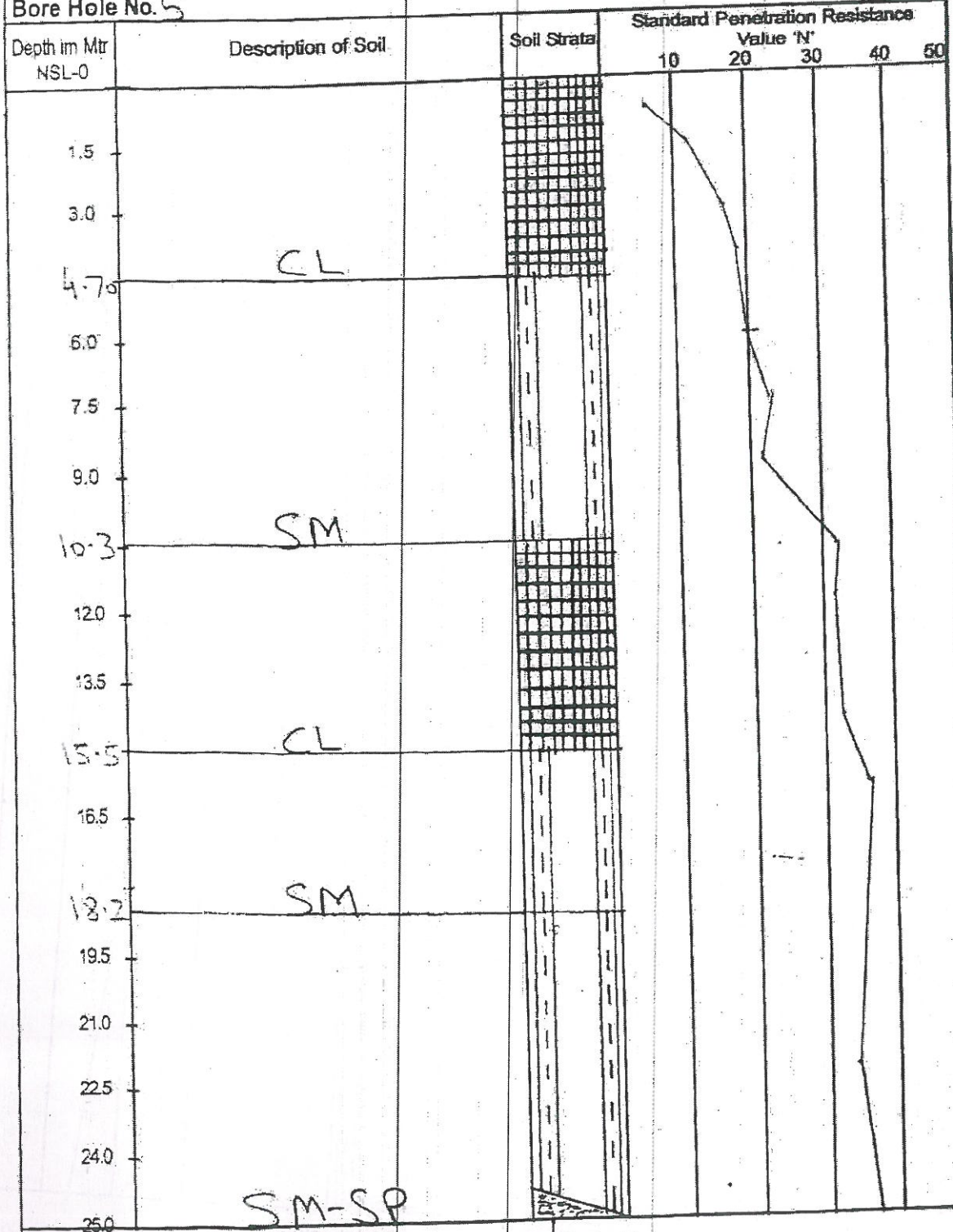
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# Bore Hole Chart

Bore Hole No. 5

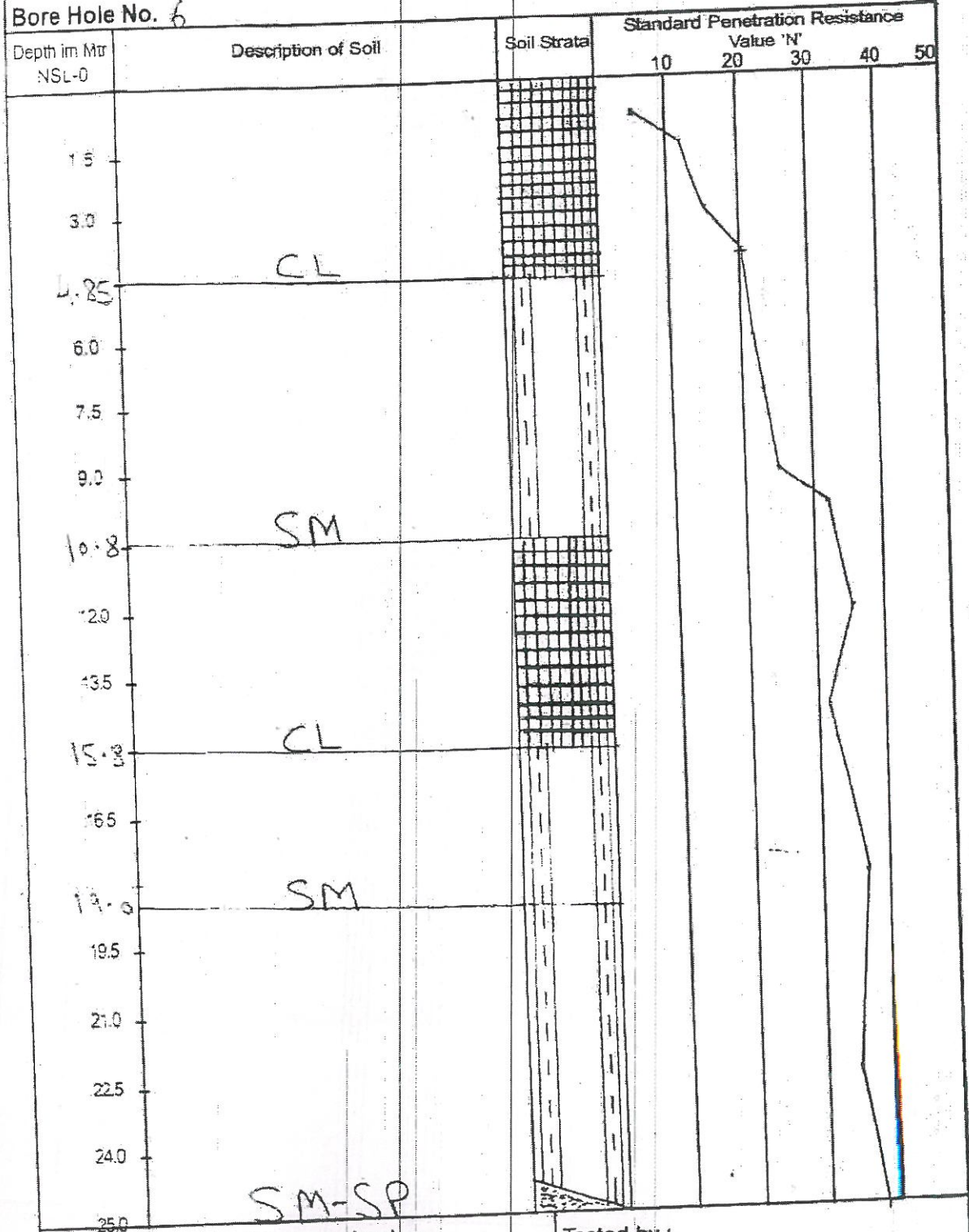


Deptt. of Soil Mechanics <b>National Laboratories</b> (Test House)	Tested by : _____
Date _____ Drawn by _____	Not to be Scale



# Bore Hole Chart

Bore Hole No. 6



Deptt. of Soil Mechanics

Tested by :

**National Laboratories**  
**(Test House)**

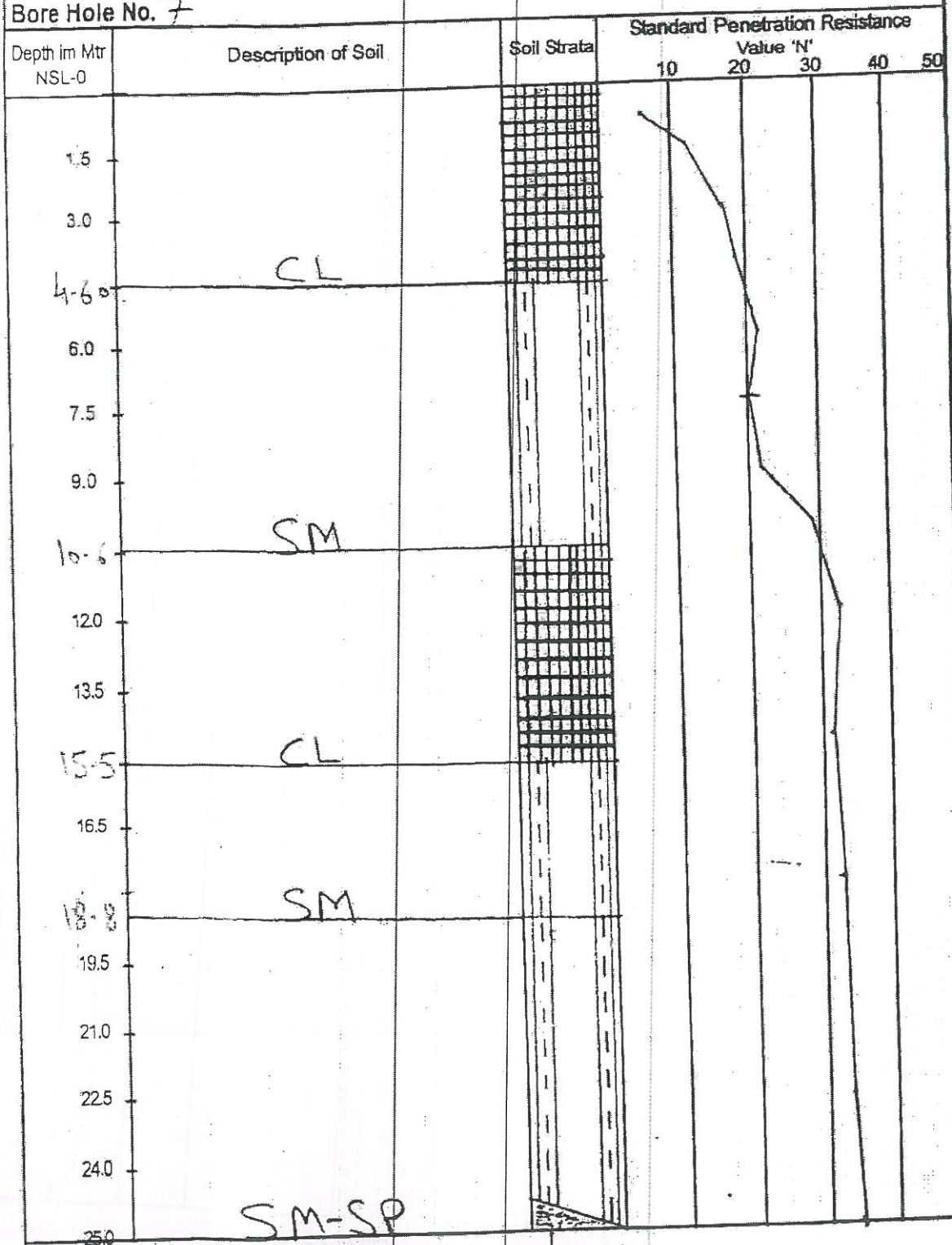
Date \_\_\_\_\_

Drawn by \_\_\_\_\_

Not to be Scale

# Bore Hole Chart

Bore Hole No. 7



Deptt. of Soil Mechanics <b>National Laboratories</b> (Test House)	Tested by: _____
Date _____ Drawn by _____	Not to be Scale