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FINAL REPORT PART - 1 600 MW, SECI - IV SOLAR POWER PLANT

NCD/G/RPPL/4538A (1)/2023

22 April 2023

Renew Power Pvt Ltd.,

Sub : G(D) 4538A Conducting Geotechnical Investigation for the Proposed Solar Power Plant
600MW SECI - IV RAJ 600MW, Rajasthan

INTRODUCTION

ReNew Power Pvt Ltd are in the process of constructing 600 MW SECI-IV RAJ solar project at Village Bhinajpura/Hastinapur, Tehsil Bhaniyana, District Jaisalmer, Rajasthan.

SCOPE OF WORK

The stipulated scope of work for solar panels consisted of conducting boreholes down to a depth of 3m below the existing ground level in soil/refusal/rock strata at twelve locations.

This **report** is based on the geotechnical investigations results for a part of the investigations i.e. along with the results and analysis of the investigations and the recommendations thereof.

BOREHOLE INVESTIGATION :

All the twelve boreholes had been progressed down to the stipulated depth. The refusal depth, termination depths and coordinates of the four are as follows :

BHNo.	Refusal depth (m) below EGL	Termination Depth (m) below EGL	Boreholes Coordinates (m)	
			X	Y
1	2.5	3	758937.46	2940287.00
2	2.5	3	759280.39	2939930.92
3	2.5	3	759031.90	2939984.66
4	2.5	3	759384.33	2939720.30
5	2.5	3	759478.66	2939531.39
6	1.5	3	759508.73	2939342.49

BHNo.	Refusal depth (m) below EGL	Termination Depth (m) below EGL	Boreholes Coordinates (m)	
			X	Y
7	3.5	3.5	759661.66	2939153.59
8	4	4	759935.44	2938964.69
9	5	5	760158.71	2938775.79
10	3	3	760415.91	2938586.89
11	3.2	3.5	760377.25	2938397.98
12	2.2	3	760281.04	2938209.08

The results of the boreholes investigations indicate that the subsoil strata generally consists of silty sandy soils with significant percentages of gravel, pebble, conglomerate down to the depth of refusal strata below which substrata consists of highly weathered sandstone/ conglomerate down to the maximum depth investigated i.e. 5m below the existing ground level. The grain size distributions of the soil samples in the six boreholes have been presented in the form of grain size analysis curves in figs. 3a & 3b.

Ground water table had not been encountered in any of the boreholes down to the maximum depth investigated i.e. 5m below the existing ground level.

The standard penetration test values (N-values) vary between 22 and 97. The observed N-values indicate that the subsoil is in a medium dense state down to the depth of refusal strata.

The subsoil strata is **non-plastic** down to the depth of refusal strata.

The proposed structures are supporting structures for Solar Panels. Considering this, medium heavy can be anticipated on the foundations. Based on the above results and the probable loads on the foundations, the following recommendations are being made.

RECOMMENDATION :

Considering the above, the proposed structures can be supported **over Short bored piles**.

The parameters considered for the analysis of the pile capacities are given below :

S. No.	Parameter	Value
1	Effective length (m)	1.2 to 1.6
2	Cohesion (kg/cm ²)	0.05
3	Angle of shearing resistance	32°
4	Density (g/cm ³)	1.8

S. No.	Parameter	Value
5	SPT Value at pile tip	25
6	Factor of safety for pile vertical capacity	2.5

The following pile capacity can be considered for 300mm diameter and various effective lengths of piles.

Pile Dia (mm)	Pile Effective Length (m)	Pile Vertical Load Capacity (tons)	Safe Uplift Capacity of Pile (tons)	Safe Lateral Load Capacity (tons)
300	1.2	10	0.9	0.4
	1.3	10	1	0.5
	1.4	10	1.1	0.6
	1.5	10	1.2	0.7
	1.6	10	1.3	0.8

NOTE : Factor of safety for determination of uplift capacity has been considered as 2 whereas factor of safety for determination of lateral capacity has been considered as 3.
The self weight of the pile has been added for the evaluation for the pile uplift capacities.

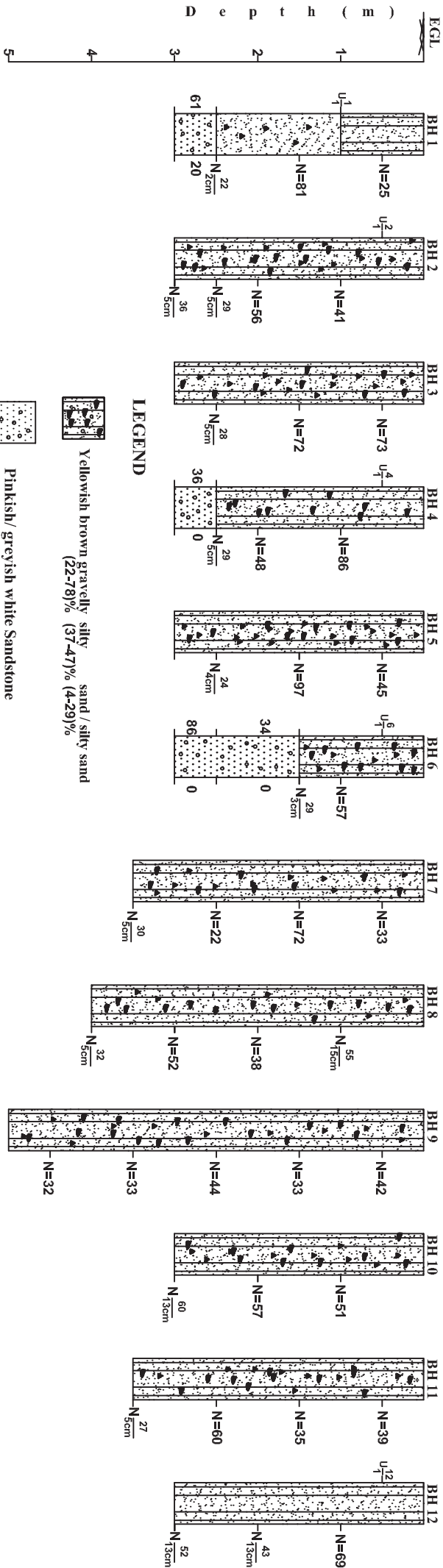
We hope you find this in order.

Thanking you,
Yours sincerely,

Y.S. Rana
Executive Consultant

encls :

1. Compile Soil Profile
2. Soil Profile Tables
3. Grain Size Analysis Curves



COMPILED SOIL/ ROCK PROFILE

SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :			Water Table : N.E.			Term. Depth : 3			B.H. No.: 1	
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg Limits		In-situ properties		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	c (kg/cm²)	φ (°)
25	0.0	Yellowish brown silty sand											
	0.5	Yellowish brown sand with silt and gravel	23	51	26	0	Non	Plastic					
	1.0								1.97	15.6			
81	1.5	Yel. brown gravelly sand with traces of silt	62	34	4	0	Non	Plastic					
	2.0								Tube	bent			
22 ----- 2cm	2.5	Refusal strata in the form of Conglomerate											

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ROCK PROFILE		Project :Proposed Solar Power Plant 600MW SECI - IV, Rajasthan											Location :					
		B.H. Size : Nx				Water Table (m): N.E.				Term. Depth (m): 3			B.H. No. : 1					
Depth (m)	Strata Description	No. of Core Pieces of Size (cm)				Core Recovery (%)				RQD (%)	Run Time (min)	Unit Weight (g/cm³)	Porosity (%)	Water Absorption (%)	Unconfined Compressive Strength (kg/cm²)	Point Load Strength (kg/cm²)	Remarks	
		<10	10-25	25-75	>75	20	40	60	80									100
2.5	Pinkish greyish whitish Sandstone	6	2	0	0					61	20	24	2.56	0.63	0.42		1716	
3.0																		

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan									
			B.H. Location :			Water Table : N.E.		Term. Depth : 3m		B.H. No.: 2		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test	
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm ³)	Water Cont (%)	Type	ϕ (°) c (kg/cm ²)
41	0.0	Yellowish brown silty sand										
	0.5								1.83	5.8		
	1.0	Yellowish brown gravelly silty sand	37	42	21	0	Non	Plastic				
	1.5								Tube	bent		
56	2.0	Yellowish brown gravelly silty sand	25	55	20	0	Non	Plastic				
29 ----- 5cm	2.5	Refusal strata in the form of Conglomerate										
36 ----- 5cm	3.0	<i>From 2.5m to 3m, Highly weathered Sandstone encountered with CR=0% and RQD=0%</i>										

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :		Water Table : N.E.			Term. Depth : 3			B.H. No.: 3		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	c (kg/cm²)	φ (°)
73	0.0	Yellowish brown gravelly silty sand	40	42	18	0	Non	Plastic	Tube	bent			
	0.5												
	1.0												
72	1.5	Yel. reddish br. gravelly silty sand	37	40	23	0	Non	Plastic	Tube	bent			
	2.0												
	2.5												
29 ----- 5cm	2.5	Refusal strata in the form of Conglomerate											
	3.0	<i>From 2.5m to 3m, Highly weathered Sandstone encountered with CR=0% and RQD=0%</i>											

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :		Water Table : N.E.		Term. Depth : 3		B.H. No.: 4				
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	c (kg/cm²)	φ (°)
86	0.0	Yellowish brown silty sand											
	0.5								1.54	2.7			
	1.0	Yellowish brown gravelly silty sand	33	42	25	0	Non	Plastic					
	1.5								Tube	bent			
	48	2.0	Yellowish brown gravelly silty sand	37	47	16	0	Non	Plastic				
29 ----- 5cm	2.5	Refusal strata in the form of Conglomerate & Sandstone											

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ROCK PROFILE		Project :Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										Location :						
		B.H. Size : Nx				Water Table (m): N.E.				Term. Depth (m): 3m			B.H. No. : 4					
Depth (m)	Strata Description	No. of Core Pieces of Size (cm)			Core Recovery (%)					RQD (%)	Run Time (min)	Unit Weight (g/cm³)	Porosity (%)	Water Absorption (%)	Unconfined Compressive Strength (kg/cm²)	Point Load Strength (kg/cm²)	Remarks	
		<10	10-25	25-75	>75	20	40	60	80	100								
2.5	Pinkish brownish grey Sandstone	7	0	0	0						36	0	24					
3.0																		

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SOIL PROFILE		Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
		B.H. Location :			Water Table : N.E.			Term. Depth : 3m		B.H. No.: 5		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test	
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm ³)	Water Cont (%)	Type	ϕ (°)
45	0.0	Yellowish brown silty sand										
	0.5	Yellowish brown gravelly silty sand	50	33	17	0	Non	Plastic				
	1.0								Tube	bent		
	1.5	Yellowish brown gravelly silty sand	37	36	27	0	Non	Plastic				
97	2.0								Tube	bent		
	2.5	Refusal strata in the form of Sandstone										
	3.0	<i>From 2.5m to 3m, Highly weathered Sandstone encountered with CR=0% and RQD=0%</i>										
24 ----- 4cm												

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ROCK PROFILE		Project :Proposed Solar Power Plant 600MW SECI - IV, Rajasthan											Location :					
		B.H. Size : Nx				Water Table (m): N.E.				Term. Depth (m): 3m			B.H. No. : 6					
Depth (m)	Strata Description	No. of Core Pieces of Size (cm)				Core Recovery (%)				RQD (%)	Run Time (min)	Unit Weight (g/cm³)	Porosity (%)	Water Absorption (%)	Unconfined Compressive Strength (kg/cm²)	Point Load Strength (kg/cm²)	Remarks	
		<10	10-25	25-75	>75	20	40	60	80	100								
1.5	Whitish pinkish brownish greyish Sandstone	9	0	0	0						34	0	35	2.76	0.59	0.43	910	
2.5		Whitish pinkish brownish greyish Sandstone	10	0	0	0						86	0	18	2.42	11.3	7.72	
3.0																		

SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :			Water Table : N.E.			Term. Depth : 3.5m		B.H. No.: 7		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	c (kg/cm²)	φ (°)
33	0.0	Yellowish brown silty sand with gravel	27	47	26	0	Non	Plastic	Tube	bent			
	0.5												
	1.0												
72	1.5	Yellowish brown gravelly silty sand	38	40	22	0	Non	Plastic	Tube	bent			
	2.0												
22	2.5	Yellowish brown gravelly silty sand	78	16	6	0	Non	Plastic	Tube	bent			
	3.0												
30 ----- 5cm	3.5	Refusal strata in the form of Highly weathered Sandstone											

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan									
			B.H. Location :			Water Table : N.E.		Term. Depth : 4m		B.H. No.: 8		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test	
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	ϕ (°)
55 15cm 38 52 32 5cm	0.0	Yellowish brown silty sand	44	43	13	0	Non	Plastic	Sample	slip		
	0.5											
	1.0	Yellowish brownish pinkish grey gravelly silty sand										
	1.5											
	2.0	Yellowish brown gravelly silty sand										
	2.5											
	3.0	Yellowish brown gravelly silty sand										
	3.5	Refusal strata in the form highly weathered Sandstone										

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :			Water Table : N.E.			Term. Depth : 5m		B.H. No.: 9		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm ³)	Water Cont (%)	Type	c (kg/cm ²)	φ (°)
42	0.0	Yellowish brown gravelly silty sand	38	52	10	0	Non	Plastic	Tube	bent			
	0.5												
33	1.0	Yellowish brown gravelly silty sand	32	39	29	0	Non	Plastic	Tube	bent			
	1.5												
44	2.0	Pinkish greyish whitish gravelly silty sand	35	43	22	0	Non	Plastic	Tube	bent			
	2.5												
33	3.0	Pinkish greyish whitish gravelly silty sand	30	49	21	0	Non	Plastic	Tube	bent			
	3.5												
32	4.0	Pinkish greyish whitish gravelly silty sand	39	45	16	0	Non	Plastic	Tube	bent			
	4.5												
	5.0								Tube	bent			

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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan									
			B.H. Location :			Water Table : N.E.		Term. Depth : 3m		B.H. No.: 10		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test	
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	ϕ (°) c (kg/cm²)
51	0.0	Yellowish brown silty sand	29	50	21	0	Non	Plastic	1.77	1.7		
	0.5											
	1.0	Yellowish brown gravelly silty sand										
	1.5											
57	2.0	Pinkish greyish whitish gravelly silty sand	33	40	27	0	Non	Plastic	Tube	bent		
	2.5											
60	3.0	Refusal strata in the form highly weathered Sandstone										
13cm												

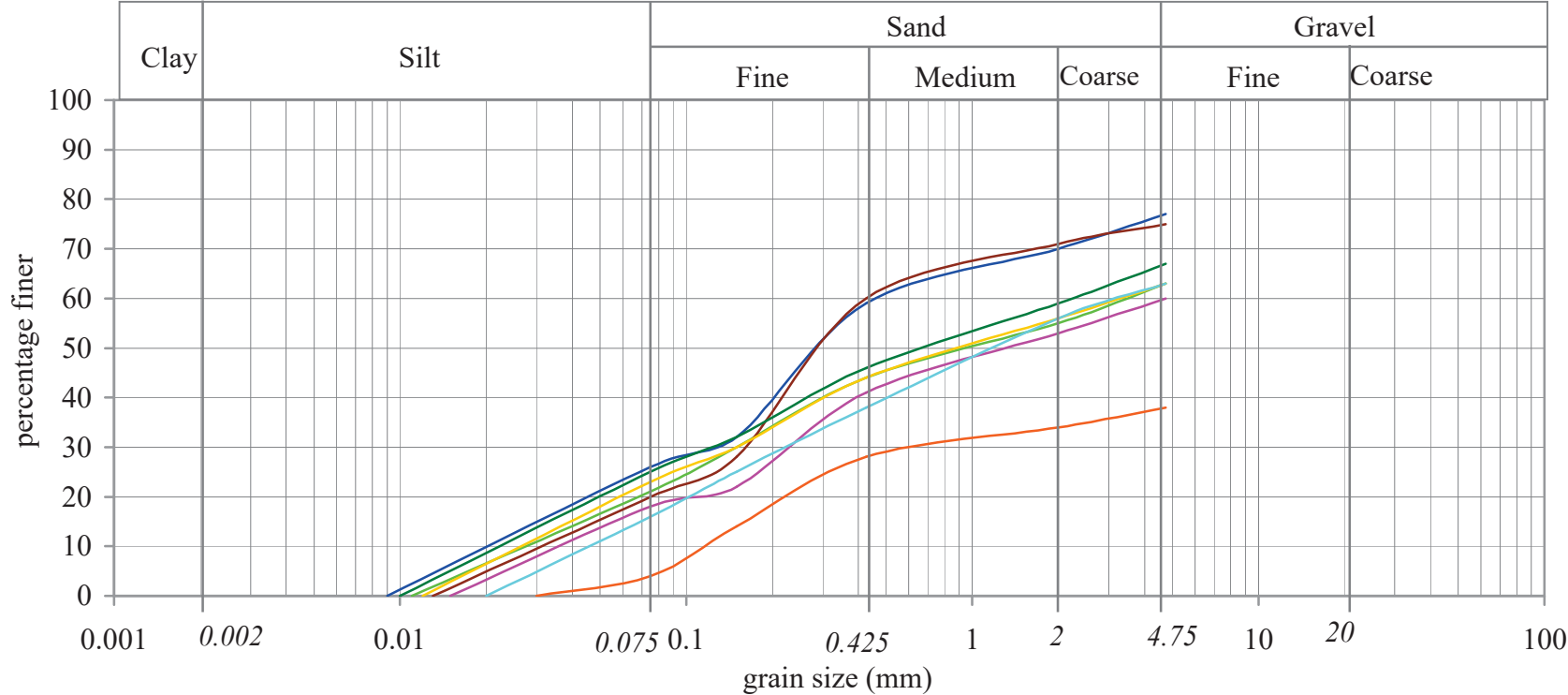
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SOIL PROFILE			Project : Proposed Solar Power Plant 600MW SECI - IV, Rajasthan										
			B.H. Location :			Water Table : N.E.			Term. Depth : 3.5m		B.H. No.: 11		
N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm³)	Water Cont (%)	Type	c (kg/cm²)	φ (°)
33	0.0	Yellowish brown silty sand	32	55	13	0	Non	Plastic	Tube	bent			
	0.5	Yellowish brown gravelly silty sand											
	1.0												
35	1.5	Yellowish brown gravelly silty sand	22	58	20	0	Non	Plastic	Tube	bent			
	2.0												
60	2.5	Yellowish brown gravelly silty sand	45	30	25	0	Non	Plastic	Tube	bent			
	3.0												
27 ----- 5cm	3.5	Refusal strata in the form of highly weathered Sandstone											

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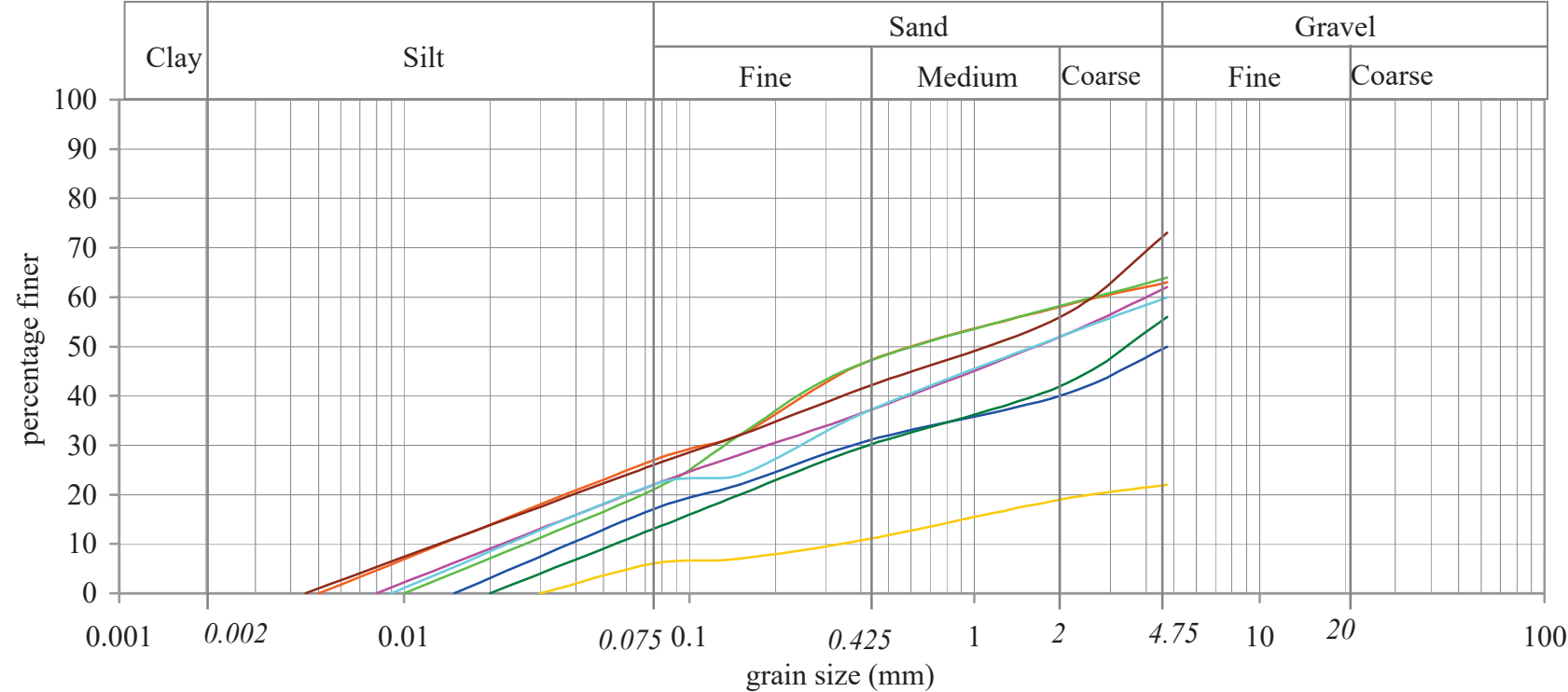
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Grain Size Analysis Curves (refer paragraph no. 7.3.1)



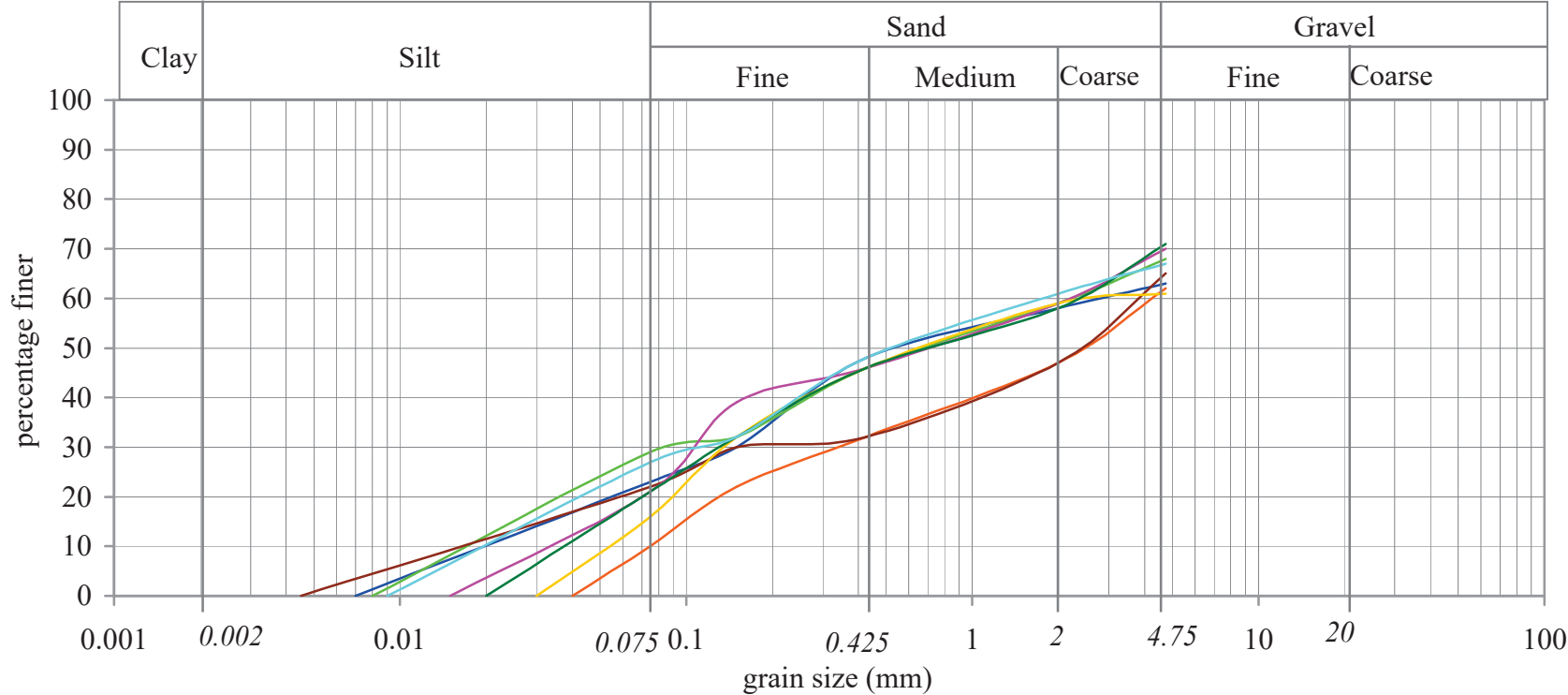
Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d ₆₀	d ₁₀	C _u
	1	0.5	Silty sand with gravel	23	51	26	0	0.425	0.021	20.2
	1	1.5	Gravelly sand with traces of silt	62	34	4	0	-	0.11	-
	2	1	Gravelly silty sand	37	42	21	0	3	0.026	115.4
	2	2	Gravelly silty sand	25	55	20	0	0.41	0.031	13.2
	3	0.5	Gravelly silty sand	40	42	18	0	4.7	0.034	138.2
	3	1.5	Gravelly silty sand	37	40	23	0	3.1	0.025	124.0
	4	1	Gravelly silty sand	33	42	25	0	2.3	0.021	109.5
	4	2	Gravelly silty sand	37	47	16	0	3.2	0.045	71.1

Grain Size Analysis Curves (refer paragraph no. 7.3.1)



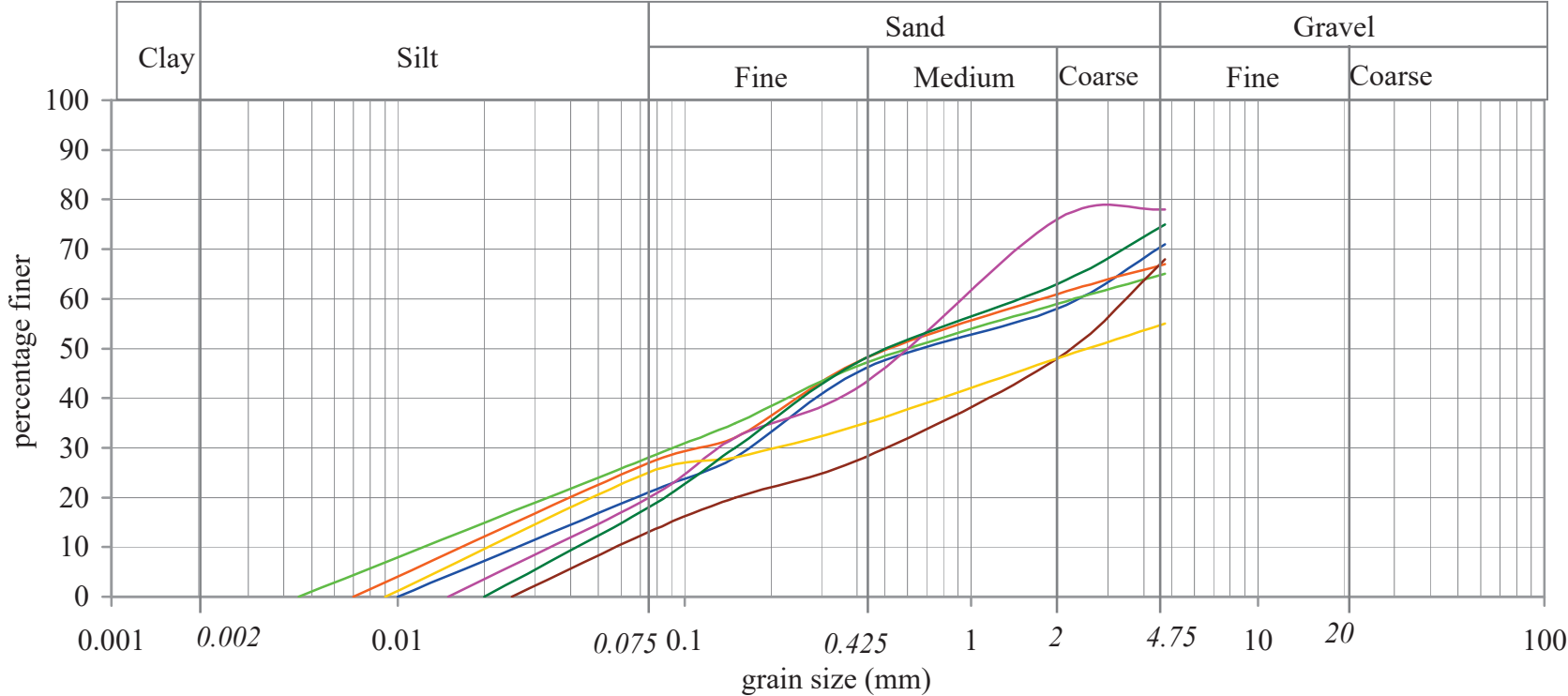
Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d ₆₀	d ₁₀	C _u
	5	0.5	Gravelly silty sand	50	33	17	0	-	0.039	-
	5	1.5	Gravelly silty sand	37	36	27	0	2.5	0.015	166.7
	6	1	Gravelly silty sand	36	43	21	0	2.5	0.025	100.0
	7	0.5	Silty sand with gravel	27	47	26	0	2.5	0.0	192.3
	7	1.5	Gravelly silty sand	38	40	22	0	3.9	0.022	177.3
	7	2.5	Gravelly silty sand	78	16	6	0	-	0.32	-
	8	1	Gravelly silty sand	44	43	13	0	-	0.045	-
	8	2	Gravelly silty sand	40	38	22	0	4.7	0.032	146.9

Grain Size Analysis Curves (refer paragraph no. 7.3.1)



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d ₆₀	d ₁₀	C _u
	8	3	Gravelly silty sand	37	40	23	0	2.6	0.019	136.8
	9	0.5	Gravelly silty sand	38	52	10	0	4.1	0.075	54.7
	9	1.5	Gravelly silty sand	32	39	29	0	2.3	0.018	127.8
	9	2.5	Gravelly silty sand	35	43	22	0	3.8	0.017	223.5
	9	3.5	Gravelly silty sand	30	49	21	0	2.3	0.032	71.9
	9	4.5	Gravelly silty sand	39	45	16	0	2.5	0.055	45.5
	10	1	Gravelly silty sand	29	50	21	0	2.3	0.036	63.9
	10	2	Gravelly silty sand	33	40	27	0	1.8	0.019	94.7

Grain Size Analysis Curves (refer paragraph no. 7.3.1)



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d ₆₀	d ₁₀	C _u
	10	1	Gravelly silty sand	29	50	21	0	2.3	0.026	88.5
	10	2	Gravelly silty sand	33	40	27	0	1.9	0.016	118.8
	10	3	Gravelly silty sand	35	37	28	0	2.4	0.013	184.6
	11	0.5	Gravelly silty sand	32	55	13	0	3.4	0.069	49.3
	11	1.5	Gravelly silty sand	22	58	20	0	0.9	0.032	28.1
	11	2.5	Gravelly silty sand	45	30	25	0	-	0.021	-
	12	1	Gravelly silty sand	25	57	18	0	1.8	0.041	43.9