

Geotechnical Investigation report for Proposed construction long term development of KEM Hospital by construction of seva Niketan /Service tower in premises of KEM Hospital, F/South Ward. Municipal Corporation of Greater Mumbai.

NOBLE GEO-STRUCTS Project No. SI 19045

September 25, 2018

Submitted to

Municipal Corporation of Greater Mumbai

By:

Noble Geo-Structs Mulund (East)

ISO 9001 : 2008
CERTIFIED

NOBLE GEO-STRUCTS

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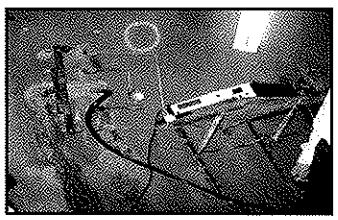

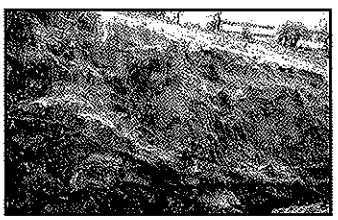
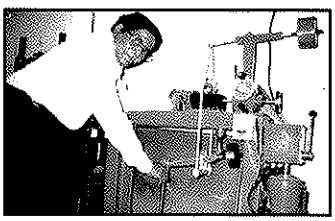

NOBLE GEO – STRUCTS

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September 25, 2018

E. E. (HIC),city-II
Office of Municipal Corporation of Greater Mumbai
3rd Floor, Engineering Hub Building,
Dr. E. Moses Road, Worli Naka, Worli,
Mumbai-400018

Sub: Long term development of KEM Hospital by Construction of Seva Niketan / Service Tower in the Premises of KEM Hospital, F/ South Ward.

Re: Geotechnical Report for KEM Hospital site
Ref: LOA issued u/n.Ch.E/BM/6511/II HIC Date July 6, 2018. NGS Project No. SI 19045.

Dear Sir:

Enclosed is our Geotechnical Engineering Report for the soil investigation work with refrence to your letter stated in the subject above.We trust that this report is responsive to your project needs. Please contact us if you have any questions or if we can be of further assistance.

We appreciate the opportunity to work with you and look forward for providing additional Geotechnical Engineering and Structural Consultancy Services in the future.

Thanking you.
Sincerely,
Noble Geo-Structs

Noble Geo-Structs Mulund (East)

R. U. Kulkarni

Dr. R. U. Kulkarni
Ph.D. (Geotechnical)

बृहन्मुंबई महानगरपालिका
प्रमुख अभियंता (इ.प.)
29 SEP 2018
वेळ:- ११,१३,१५,१७
क्र. 012913 HIC

SE Rahul Ishi/Roshan
03-10-2018
EE(HIC)C-II/

Copies Submitted: (3) Hard copy

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GEOTECHNICAL REPORT
FOR
KEM HOSPITAL SITE

NOBLE GEO-STRUCTS PROJECT NO. SI 19045
September 25, 2018

1. INTRODUCTION

Noble Geo-Structs (NGS) is pleased to submit our Geotechnical report for KEM Hospital site. This project was authorized by of Deputy chief engineer HIC Office of Municipal Corporation of Greater Mumbai on August 3, 2018.

The purpose of this report is to describe the subsurface conditions observed at the four bore holes drilled for this study, analyze and evaluate the test data, and provide recommendations with respect to

- Engineering properties and
- Foundation considerations

2. SCOPE OF WORK

The scope of work includes drilling of four bore holes, collection of samples and transportation to NGS laboratory. The scope also includes testing of samples in NGS's NABL accrediated laboratory for determining their engineering properties. Further the foundation design consideration are to be recommended.

2.1 LABORATORY TESTING

The representative soil and rock core samples meant for testing were transported to NGS's NABL accredited laboratory. Samples obtained during the field program were visually classified in the laboratory by a Geotechnical Engineer and/or a senior technician.
A testing programme was conducted on the samples, as directed by the Geotechnical Engineer in NGS's NABL accredited laboratory, as per relevant Indian Standards, in compliance with the technical specifications of the contract to aid in classification and evaluation of engineering properties required for analysis.
The laboratory tests include liquid limit, plastic limit, shrinkage limit, water content, sieve analysis, hydrometer, specific gravity on soil specimens. The laboratory tests also include unconfined compressive strength, water absorption, dry density, specific gravity, porosity on rock specimen. The scope also includes chemical tests on soil and water (pH, sulphate and chloride)

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2.2 LIST OF SPECIMENS

The following specimens are collected for determining the enigneering properties of strata to analyse foundation type.

Table 1. LIST OF SPECIMENS RECEIVED

Sr. No.	Bore	Type of Sample	Specimen Number	Depth	SPT 'N'
1	1	DS	-	1.5	-
2	1	SPT	1	3.6	14
3	1	CORE	4	6	
4	1	CORE	10	7.5	
5	1	CORE	12	9	
6	1	CORE	18	10.5	
7	2	DS	1	2	-
8	2	CORE	1	6	-
9	2	CORE	7	7.5	-
10	2	CORE	10	9	-
11	3	DS	1	2	-
12	3	SPT	1	2.6	17
13	3	CORE	12	7.5	-
14	3	CORE	15	9	-
15	3	CORE	17	10.5	-
16	4	DS	1	2	-
17	4	SPT	1	2.6	14
18	4	SPT	2	4.8	50
19	4	SPT	3	6.3	50
20	4	CORE	8	7.5	-
21	4	CORE	12	9	-
22	4	CORE	15	10.5	-

2.3 FIELD WORK

Subsurface conditions were evaluated by drilling four bore holes to depth within the proposed site location. The bore hole was drilled using calyx drilling equipment at the approximate location shown on the plan of bore hole in Appendix I.

The borehole is located with respect to the existing site features shown on the drawing provided to us without the use of surveying equipment. Boring depths were measured from the existing ground surface at the time of our field activities. The log of boring, presenting the subsurface soil descriptions, type of sampling used and additional field data are shown in the borelog Appendix II.

The soils were sampled by means of the Standard Penetration Test (SPT). This test consists of measuring the number of blows (N) required for a 63.5 kg hammer free falling 75 cm to drive a standard split-spoon sampler 12 inches into the subsurface material after being seated 30 cm. This blow count or SPT N-value is used to evaluate the stratum. Samples were removed from samplers in the field, visually classified and appropriately sealed in sample containers to preserve their in-situ moisture contents. Samples were transported to our laboratory in Mumbai, Maharashtra.

3 SUB SURFACE CONDITIONS

Sub Surface Conditions is described below for BH-1.

Layer -1 This layer consists of stiff clay of intermittent plasticity which is brownish yellow in colour. It is observed from ground level to 1.5m depth. Again stiff clay of intermittent plasticity of brownish grey in colour is observed from 1.50m to 3.60m. The standard penetration tests conducted at 2.5m and 3.5m show N- value as 12 and 14 respectively.

Layer -2 This layer consists of completely weathered basalt which is very weak , coarse grained and brownih yellow in colour. brownish grey in colour. It is observed from 1.5m to 3.5m depth . The standard penetration test conducted at 3.0m and 3.5m show N-value as 14. Again this layer which is encountered from 2.0 m to 3.5 m depth, is stiff and brownish yellow in colour. The core recovery is 20% and RQD is nil.

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Layer -3 This layer consists of highly weathered basalt which is strong ,fine to medium grained and greyish in colour with white infilling . It is observed from 4.5m to 6.0m depth. The core recovery is 44% and RQD is 28% .

Layer -4 This layer consists of slightly weathered basalt which is strong , fine grained to medium grained and greyish in colour with white infilling. It is observed from 6 m to 10.5 m at which the bore hole is terminated. The core recovery varies from 80% to 87% and RQD is in the range of 80% to 87%.

Ground Water : The ground water level is 1.22m during the boring from August 14, 2018 to August 16, 2018.

Sub Surface Conditions is described below for BH-2.

Layer -1 This layer consists of fill which is yellowish brown with silts of intermittent plasticity. It is observed from ground level to 2.0m depth.

Layer -2 This layer consists of completely weathered basalt which is very weak, coarse grained and brownish in colour. It is observed from 2.0m to 4.5m depth.The recovery is 23% and RQD is nil. Then followed by highly weathered basalt which is strong, fine to medium grained and dark greyish in colour with white infilling. It is obseerved from 4.5m to 6.0m depth. The core recovery is 39% and RQD is 29%.

Layer -3 This layer consists of slightly weathered basalt which is strong, fine grained to medium grained dark greyish in colour with white infilling . It is obsereved from 6.0 m to 9.0m at which the bore hole is terminated. The core recovery varies from 84% to 90% and RQD is in the range of 78% to 90%.

Ground Water : The ground water level is 2.0m during the boring from August 16, 2018 to August 17, 2018.

Sub Surface Conditions is described below for BH-3.

Layer -1 This layer consists of silt of high compressibility which is yellowish brown in colour. It is observed from ground level to 2.0m depth. Again this is followed by very stiff silt of intermittent and high

Layer -2 This layer consists of completely weathered basalt which is very weak , coarse grained and slightly yellowish brown in colour. It is observed from 4.5m to 6.0m depth . The core recovery 31% and RQD is

Layer -3 This layer consists of slightly weathered basalt which is moderately strong,fine to medium grained and yellowish brown in colour. It is observed from 6.0m to 7.50m depth. Then it is followed by slightly weathered basalt which is strong, fine grained and dark grey in colour. It is observed from 7.50m upto 12.0m at which the bore holeis terminated . The core recovery varies from 90% to 95% and RQD is in the range of 78% to 95%.

Ground Water : The ground water level is 1.20m during the boring from August 14, 2018 to August 16, 2018.

Sub Surface Conditions is described below for BH-4.

Layer -1 This layer consists of fill which is silt of intermittent and high compressibilty and yellowish brown in colour with gravels . It is observed from ground level to 2.0m depth.

Layer -2 This layer consists of silty sand which is medium and brownish in colour. This is observed from 2.0m to 3.0m .The standard penetration test conducted at 3.0m shows N-value as 14. Then it is followed by clayey and silty sand which is brownish grey in colour. It is observed from 3.0 om to 4.50m depth . Further it is followed by silty sand which is very dense and brownish grey incolour .The standard penetration test conducted at various depths show N-

Layer -3 This layer consists of completely weathered basalt which is moderately strong, fine to medium and yellowish brown in colour. It is observed from 6.5m to 7.5m depth. The core recovery is 62% and RQD is 0%

Layer -4 This layer consists of fresh basalt which is moderately strong , fine grained and dark grey in colour with white infillings . It is observed from 7.50m to 9.0m depth.The core recovery is

Layer -5 This layer consists of slightly weathered basalt which is moderately strong , fine to medium grained and greyish in colour with white infillings . It is observed from 9.0m to 12.0m at which the bore hole is terminated . The core recovery varies from 93% to 95% and RQD is

Ground Water : The ground water level is 1.5m during the boring from August 20, 2018 to August 21, 2018.

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4 FOUNDATION RECOMMENDATION

Four bore holes is drilled at the proposed site up to depth of 12.0 below the existing ground level. The soil profile indicates that there is a fill with clay of intermittent placitity from 1.0m to 3.0m . This is followed by weathered basalt at the shallow depth . Hence the type foundation recommended is open foundation for the proposed site .The Safe Bearing Capacity (SBC) is worked out at various depths for each bore hole and SBC is given in the table below.

The sumps may be made to an additional depth of 0.3 m at one or more corners of the foundation pits for column footings to be relatively dry (not slushy). Dewatering shall be maintained until that part of the concrete in the foundations, which comes below the ground water table level, sets.

SBC Table				
Sr.No	BH	Depth	SBC	settlement
		m	t/m^2	mm
1	1	1	5	25
2	1	2	5	25
3	1	3	5	25
4	1	4	28	25
5	1	5	40	-
6	2	1	5	25
7	2	2	5	25
8	2	3	20	25
9	2	4	28	25
10	2	5	40	-
11	3	1	5	25
12	3	2	5	25
13	3	3	10	25
14	3	4	11	25
15	3	5	28	25
16	4	1	5	25
17	4	2	5	25
18	4	3	20	25
19	4	4	28	25
20	4	5	30	-

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5 REFERENCES

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Indian Standard, IS: 2720 Part 3 (1980, Reaffirmed 2016). "Determination of specific gravity" BIS, New Delhi

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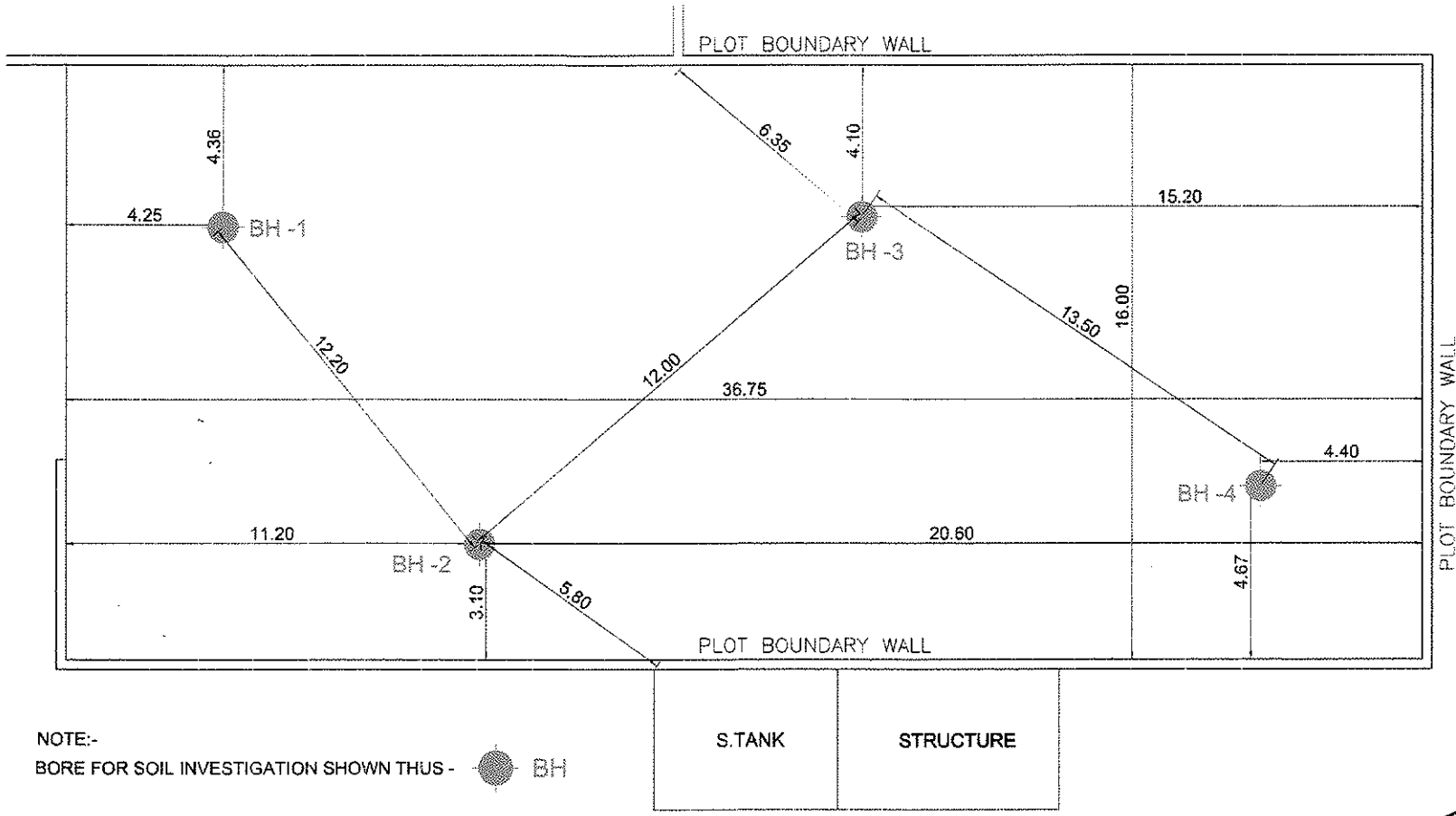
APPENDIX I

Location Plan





NOTE:-

BORE FOR SOIL INVESTIGATION SHOWN THUS - BH

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NOBLE GEO STRUCTS 103, GANESH BHUVAN, MAHATMA PHULE ROAD, MULUND (E) MUMBAI-81					CLIENT: MUNICIPAL CORPORATION OF GREATER MUMBAI.	PROJECT: SOIL INVESTIGATION FOR PROPOSED LONG TERM DEVELOPMENT OF KEM HOSPITAL BY CONSTRUCTION OF SEVA NIKETAN / SERVICE TOWER IN THE PERMISES OF KEM HOSPITAL , "F/SOUTH" WARD.	TITLE: LOCATION PLAN	DRAWING No.: NGS/MCGM/KEM-001
								DATE: 20.09.18
								DRAWN BY: ACP / CHECKED BY: RUK
	R0							
	REV.	DATE	DESCRIPTION OF REVISIONS	INITIALS				

APPENDIX II

BORELOG



APPENDIX A

Log of Borings No. BH-01

CLIENT: MUNICIPAL CORPORATION OF GREATER MUMBAI **PROJECT:** Long term development of KEM Hospital by Construction of Seva Niketan / Service Tower in the Premises of KEM Hospital, F/ South Ward.

LOCATION: KEM Hospital

Depth, m	R.L. m	Graphic Log	Description Approximate Surface Elevation: Existing Surface Elevation	Sampler Type	IS Classification	LL, %	SL, %	PI, %	G	c, kg/cm²	ϕ, degree	Penetration, cm 15	30	45	60	CR / N	RQD	Water Content / Absorption %	UCS, MPa	Porosity %
0																				
0.5				DS1		40	17	14	2.69									14.99		
1			**Clay of intermittent** plasticity stiff, yellowish brown from 0 to 1.5m and brownish grey from 1.5 to 3.6m																	
1.5				DS2																
2					CI															
2.5				SPT1		44	14	19	2.65			4	5	7	9	12		26.40		
3																				
3.5				SPT2								3	7	7	11	14				
4			**Completely weathered basalt** very weak, coarse grained, brownish yellow	STONE PIECES																
4.5																20	Nil			
5			**Highly weathered basalt** strong, fine to medium grained, greyish with white infilling	CORE 1																
5.5									2.72							44.0	28	0.2	109.0	1.03
6																				
6.5			**Slightly weathered basalt** strong, fine to medium grained, greyish with white infilling																	
7				CORE 2					2.98							86.0	86	7.4	77.6	14.53
7.5																				
8																				
8.5				CORE 3					2.9							80.0	80.0	7.1	51.0	10.45
9																				
9.5																				
10				CORE 4					2.97							87	87	0.3	84.0	10.17
10.5																				
11																				
11.5																				
12				CORE 5												93	93			

THE BOREHOLE IS TERMINATED AT DEPTH 12 m BELOW GROUND LEVEL

The insitu boundary layers shown are approximate. The actual limits may be more gradual.

REMARKS: Rotary Drilling; 150mm in soil; NX Size in rock

Ground Water Table: 1.22 m

Start Date: August 14, 2018

End Date: August 16, 2018

Abbrevation:-

LL - Liquid Limit NP - Non-Plastic,

PI - Plasticity Index, SL - Shrinkage Limit

CR- Core recovery G- Specific Gravity

RQD -Rock Quality Designation UCS - Unconfined Compressive Strength

UDS - Undisturbed sample, N- Number of blows / 30 cm penetration

SPT - Standard penetration test sample SP - stone pieces

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Project No. SI 19045 **Casing:** 3.00 m

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APPENDIX A

Log of Borings No. BH-02

CLIENT: MUNICIPAL CORPORATION OF GREATER MUMBAI

PROJECT: Long term development of KEM Hospital by Construction of Seva Niketan / Service Tower in the Premises of KEM Hospital, F/ South Ward.

LOCATION: KEM Hospital

Depth, m	R.L. m	Graphic Log	Description Approximate Surface Elevation: Existing Surface Elevation	Sampler Type	IS Classification	LL, %	SL, %	PI, %	G	c, kg/cm^2	ϕ, degree	Penetration, cm 15	30	45	60	CR / N	RQD	Water Content / Absorption %	UCS, MPa	Porosity %
0			**Fill** Silts of intermittent plasticity yellowish brown	DS	MI	46	16	19	2.68									24		
0.5																				
1																				
1.5																				
2																				
2.5			**Completely weathered basalt** very weak, course grained, brownish	Stone Pieces																
3																				
3.5																				
4																23	Nil			
4.5																				
5			**Highly weathered basalt** strong, fine to medium grained, dark greyish with white infilling	Core																
5.5									2.82							39	29	0.50	88.6	8.14
6																				
6.5			**Slightly weathered basalt** strong, fine to medium grained, dark greyish with white infilling	Core																
7									2.97							84	78	0.61	65.1	14.35
7.5																				
8				Core																
8.5									3.00							90	90	0.86	58.8	14.32
9																				
9.5				Core												95	95			
10																				
10.5				Core												97	97			
11																				

THE BOREHOLE IS TERMINATED AT DEPTH 11.00m BELOW GROUND LEVEL

The insitu boundary layers shown are approximate. The actual limits may be more gradual.

REMARKS: Rotary Drilling; 150mm in soil; NX Size in rock Barrel

Ground Water Table: 2.0 m

Start Date: August 16, 2018

End Date: August 17, 2018

Abbrevation:-

LL - Liquid Limit NP - Non-Plastic,

PI - Plasticity Index, SL - Shrinkage Limit

CR- Core recovery G- Specific Gravity

RQD -Rock Quality Designation UCS - Unconfined Compressive Strength

UDS - Undisturbed sample, N- Number of blows / 30 cm penetration

SPT - Standard penetration test sample SP - stone pieces

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Project No. SI 19045 **Casing:** 3.00 m

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APPENDIX A

Log of Borings No. BH-03

CLIENT: MUNICIPAL CORPORATION OF GREATER MUMBAI **PROJECT:** Long term development of KEM Hospital by Construction of Seva Niketan / Service Tower in the Premises of KEM Hospital, F/ South Ward.

LOCATION: KEM Hospital

Depth, m	R.L. m	Graphic Log	Description Approximate Surface Elevation: Existing Surface Elevation	Sampler Type	IS Classification	LL, %	SL, %	PI, %	G	c, kg/cm²	φ, degree	Penetration, cm 15	30	45	60	CR / N	RQD	Water Content / Absorption %	UCS, MPa	Porosity %
0			**Silt of high compressibility,** yellowish brown	DS-1	MH															
0.5																				
1				DS-2		62	19	12	2.70			-	-	-	-	-		36		-
1.5																				
2				DS-3																
2.5			**Silts of intermittent -high compressibility** very stiff, brownish grey	SPT-1	MI-MH	50	18	12	2.68			4	7	10	15	17		39		
3																				
3.5																				
4				SPT-2								6	8	12	20	20				
4.5																				
5			**Completely weathered basalt** very weak, course grained, slightly yellowish brown																	
5.5				Core												31.00	Nil			
6																				
6.5			**Slightly weathered basalt** moderately strong strong from 6m to 7.5m , fine to medium grained greyish with white infillings, beyond 7.5m strong dark grey, fine grained	Core												78.7	79			
7																				
7.5				Core					2.93							94	94	0.68	26.9	14.56
8																				
8.5																				
9				Core					2.91							90	78	0.58	101.9	8.03
9.5																				
10																				
10.5									2.96							95	95	0.48	80.1	11.16
11																				
11.5																				
12				Core																

THE BOREHOLE IS TERMINATED AT DEPTH 12.00m BELOW GROUND LEVEL.

The insitu boundary layers shown are approximate. The actual limits may be more gradual.

REMARKS: Rotary Drilling; 150mm in soil; NX Size in rock

Ground Water Table: 1.2 m

Start Date: August 14, 2018

End Date: August 16, 2018

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Project No. SI 19045 **Casing:** 3.00 m

Abbrevation:-

LL - Liquid Limit NP - Non-Plastic.

PI - Plasticity Index. SL - Shrinkage Limit

CR- Core recovery G- Specific Gravity

RQD -Rock Quality Designation UCS - Unconfined Compressive Strength

UDS - Undisturbed sample, N- Number of blows / 30 cm penetration

SPT - Standard penetration test sample SP - stone pieces

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APPENDIX A

Log of Borings No. BH-04

CLIENT: MUNICIPAL CORPORATION OF GREATER MUMBAI

PROJECT: Long term development of KEM Hospital by Construction of Seva Niketan / Service Tower in the Premises of KEM Hospital, F/ South Ward.

LOCATION: KEM Hospital

Depth, m	R.L. m	Graphic Log	Description Approximate Surface Elevation: Existing Surface Elevation	Sampler Type	IS Classification	LL, %	SL, %	PI, %	G	c, kg/cm²	f, degree	Penetration, cm 15	30	45	60	CR / N	RQD	Water Content / Absorption %	UCS, MPa	Porosity %
0			**Fill** Silts of intermittent and high compressibility yellowish brown with gravels	DS-1	MI-MH															
0.5																				
1				DS-2		50	15	11	2.70			-	-	-	-	-		43.1		
1.5																				
2																				
2.5			**Silty sand** medium, brownish grey	SPT-1	SM															
3						40	17	3	2.66			3	5	9	11	14		36.3		
3.5				UDS																
4																				
4.5																				
5			**Clayey sand - Silty sand** brownish grey	SPT-2	SM-SC	36	18	6	2.70			15	21	>50		>50		34.60		
5.5																				
6				SPT-3	SM-SC	33	17	5	2.69			15	21	>50		>50		27.85		
6.5			**Silty sands** very dense, brownish grey	SPT-4								17	21	>50		>50				
7			**Completely weathered basalt** modarately strong, fine medium, yellowish brown	Core					2.79							62	Nil	1.23	36.0	8.10
7.5																				
8			**Fresh basalt** moderately strong, fine grained, dark gray with white infillings																	
8.5				Core					3.01							93	93	0.71	50.3	12.44
9																				
9.5			**Slightly weathered basalt** moderately strong, fine to medium grained, grayish with white infillings																	
10				Core					2.99							93	81	1.03	35.0	17.63
10.5																				
11																				
11.5																				
12				Core												95	95			

THE BOREHOLE IS TERMINATED AT DEPTH 12.00 m BELOW GROUND LEVEL

The insitu boundary layers shown are approximate. The actual limits may be more gradual.

REMARKS: Rotary Drilling; 150mm in soil; NX Size in rock

Ground Water Table: 1.5 m

Start Date: August 20, 2018

End Date: August 21, 2018

Abbrevation:-

LL - Liquid Limit — NP - Non-Plastic.

PI - Plasticity Index, — SL - Shrinkage Limit

CR - Core recovery — G- Specific Gravity

RQD - Rock Quality Designation — UCS - Unconfined Compressive Strength

UDS - Undisturbed sample, N- Number of blows / 30 cm penetration

SPT - Standard penetration test sample — SP - stone pieces

Noble Geo-Structs

Project No. SI 19045 **Casing:** 4.00 m

APPENDIX III

LABORATORY TEST RESULTS



Table 3. TEST REPORT ON SOIL

Client :	MCGM
Project :	Geotechnical Report for KEM Hospital Site
Source of Samples :	Noble Geo-Structs
Number of Sample Tested :	9
Period of Test :	August 21, 2018 to August 29, 2018
The method followed	For soil IS 2720 Part 2, IS 2720 Part 3, IS 2720 Part 4, IS 2720 Part 5, IS 2720 Part 6, IS 2720 Part 13, IS 2720 Part 28
Sample Description :	Soil
Sample Quantity :	Sufficient
Sample Date of Receipt :	August 23, 2018
Sample Condition :	Acceptable

Sr. No.	Bore Hole Number	Sample ID	Depth, m	Sample type	Water Content %	IS Classification	Grain Size Analysis		Hydrometer Reading		Consistency Limits			Shrinkage Limit, %	Specific Gravity
							Gravels, %	Sand%	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %		
1	1	18/01629	0.0-1.0	DS-1	14.99	CI	5	49	33	13	40	26	14	17	2.69
2	1	18/01630	3.00-3.60	SPT-1	26.40	CI	10	30	24	36	44	25	19	14	2.65
3	2	18/01635	0.00-2.00	DS	23.55	MI	9	32	29	29	46	27	19	16	2.68
4	3	18/01674	0.00-2.00	DS-2	36.09	MH	8	18	37	37	62	50	12	19	2.70
5	3	18/01675	2.00-2.60	SPT-1	38.96	MI-MH	9	25	28	37	50	39	12	18	2.68
6	4	18/01679	0.00-2.00	DS-2	43.11	MI-MH	5	20	34	41	50	39	11	15	2.70
7	4	18/01680	2.50-3.10	SPT-1	36.33	SM	6	51	18	26	40	37	3	17	2.66
8	4	18/01681	4.50-4.80	SPT-2	34.60	SM-SC	17	56	11	16	36	30	6	18	2.70
9	4	18/01682	6.00-6.30	SPT-3	27.85	SM-SC	38	44	8	10	33	28	5	17	2.69

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Project No. : 19045

September 25, 2018

Abbrevation:- **SPT** - Standard penetration test sample **UDS** - Undisturbed sample, **DS** - Disrubed Sample
NP - Non-Plastic.

NOTE :

1) This test report refers only to the sample submitted for testing.
2) This test report is valid at the time of and under the conditions specified herein.
3) This test report may not be reproduced in part, without the permission of this laboratory.
4) Any correction invalidates this test report.
5) * Sample Not Sufficient

For Noble Geo-Structs

Mr.Mithilesh Kumar
Sr.Technical Manager

Noble Geo-Structs Mulund (East)

Table 4. ROCK TEST RESULTS

Client :	MCGM
Project:	Geotechnical Report for KEM Hospital Site
Source of Sample	Noble Geo-Structs
Number of Sample Tested	13
Sample Details	Rock Core
Period of Test:	August 21, 2018 to August 29, 2018
The method followed	For Rock - IS 9143,1124 and 13030
Sample Description	Rock Core
Sample Quantity	Sufficient
Sample Date of Receipt	August 23, 2018
Sample Condition	Acceptable

Sr. No.	Bore hole No.	Sample ID	Piece No.	Depth, m		Density, g/cc	Water Absorption, %	Specific Gravity	Porosity, %	Unconfined Compressive Strength, MPa
				From	To					
1	1	18/01631	4	4.50	6.00	2.69	0.20	2.72	1.03	108.98
2	1	18/01632	10	6.00	7.50	2.95	7.39	2.98	14.530	77.62
3	1	18/01633	12	7.50	9.00	2.87	7.05	2.90	10.450	50.96
4	1	18/01634	18	9.00	10.50	2.94	0.30	2.97	10.170	83.89
5	2	18/01636	1	4.50	6.00	2.79	0.50	2.82	8.140	88.60
6	2	18/01637	7	6.00	7.50	2.94	0.61	2.97	14.350	65.08
7	2	18/01638	10	7.50	9.00	2.97	0.86	3.00	14.320	58.80
8	3	18/01676	12	6.00	7.50	2.90	0.68	2.93	14.560	26.89
9	3	18/01677	15	7.50	9.00	2.88	0.58	2.91	8.030	101.93
10	3	18/01678	17	9.00	10.50	2.93	0.48	2.96	11.160	80.05
11	4	18/01683	8	6.30	7.50	2.76	1.23	2.79	8.100	35.99
12	4	18/01684	12	7.50	9.00	2.98	0.71	3.01	12.440	50.34
13	4	18/01685	15	9.00	10.50	2.96	1.03	2.99	17.630	34.97

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Project No. : 19045

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5) * Sample Not Sufficient

For Noble Geo-Structs

Mr.Mithilesh Kumar
Sr.Technical Manager

Noble Geo-Structs Mulund (East)

Table 5. CHEMICAL TEST RESULTS

Client :	MCGM
Project :	Geotechnical Report for KEM Hospital Site
Source of Samples :	Noble Geo-Structs
Number of Sample Tested :	4
Sample Details :	Water
Period of Test :	August 25, 2018 to August 27, 2018
IS Codes referred	IS 3025 Part 11,24,32, IS 456 IS 2720 Part 27
Date of Testing :	August 25, 2018 to August 27, 2018
Sample Quantity :	Sufficient
Sample Date of Receipt :	August 23, 2018
Sample Condition :	Acceptable

Sr. No.	Bore Hole Number	Sample Type	Depth, m	Chemical Analysis of Soil			Chemical Analysis of Water			Remarks
				pH	Chloride, %	Sulphate, %	pH	Chloride, ppm	Sulphate, ppm	
1	1	SPT-1	3.0-3.60	7.3	0.0149	0.0049	7.3	39.99	13.37	Acceptable
2	2	DS-1	0.0-1.50	7.7	0.0112	0.0039	-	-	-	Acceptable
3	3	SPT-1	2.0-2.60	7.4	0.0074	0.0027	7.2	44.99	17.15	Acceptable
4	4	SPT-3	6.0-6.30	7.6	0.0050	0.0018	7.4	64.98	23.65	Acceptable
Permissible Limits				not less than 6	0.0500	0.2000	not less than 6	500.00	400.00	-

NOBLE GEO STRUCTS

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For Noble Geo-Structs

Miss. Tejasvi Salvi

Noble Geo-Structs Mulund (East)

APPENDIX IV

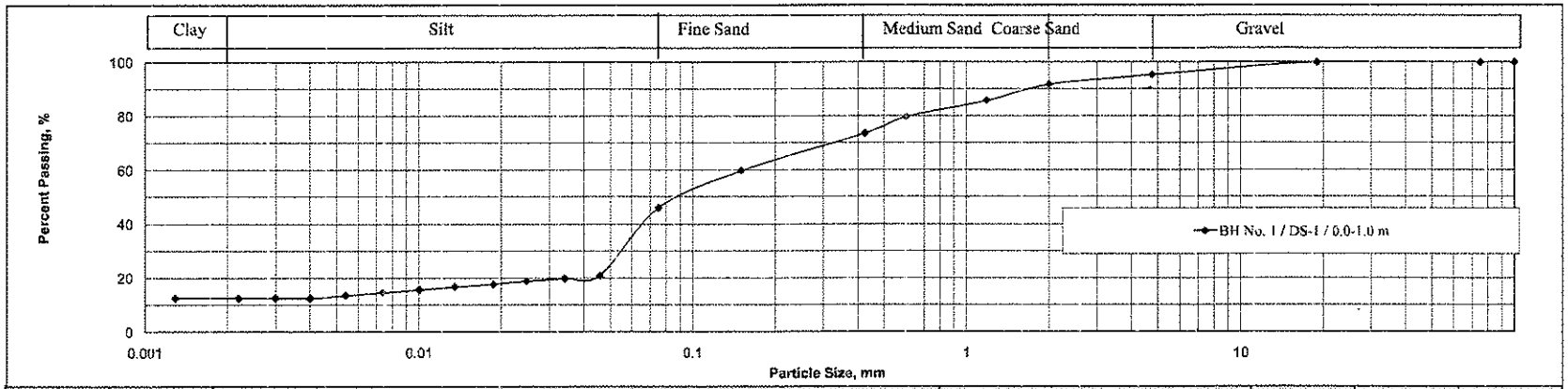
Sieve Analysis



GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 22, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
1	DS-1	0.0-1.0	5	4	18	28	32	13	40	26	14	17	2.69	CI

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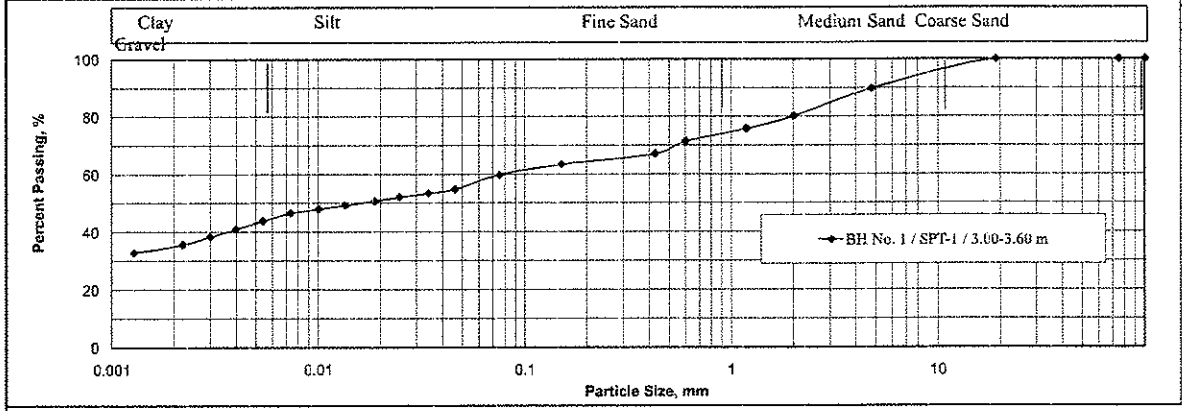
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
1	SPT-1	3.00-3.60	10	10	13	7	24	36	44	25	19	14	2.65	CI

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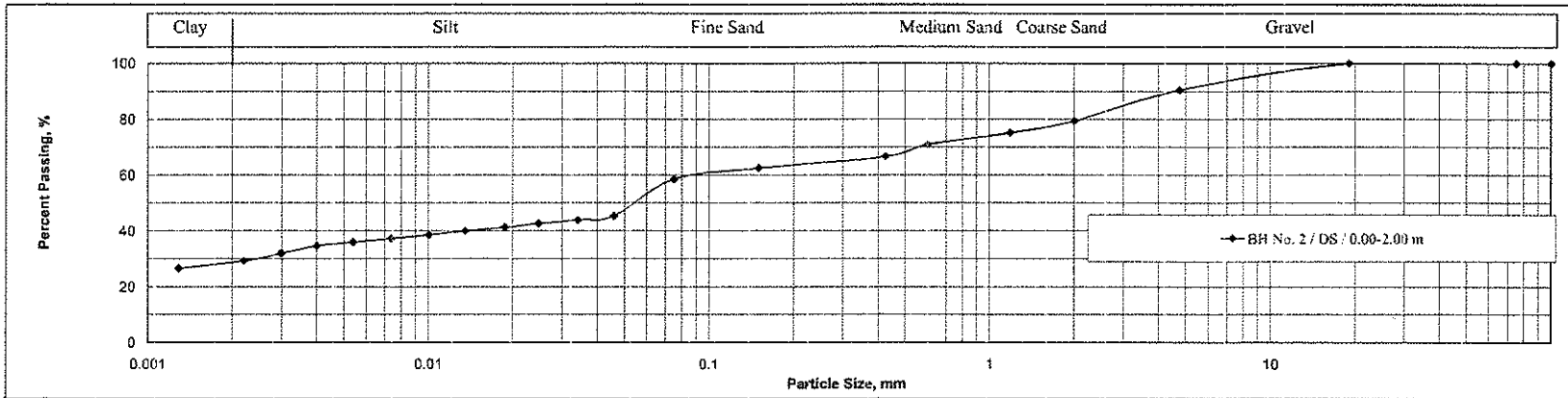
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 22, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
2	DS	0.00-2.00	9	11	13	8	29	29	46	27	19	16	2.68	MI

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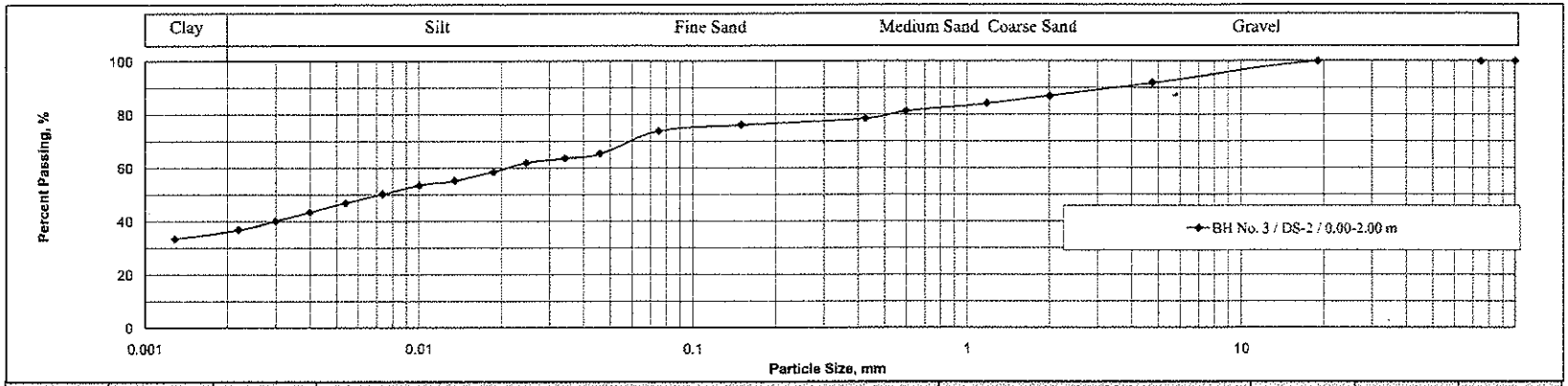
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 22, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
3	DS-2	0.00-2.00	8	5	9	5	37	37	62	50	12	19	2.70	MH

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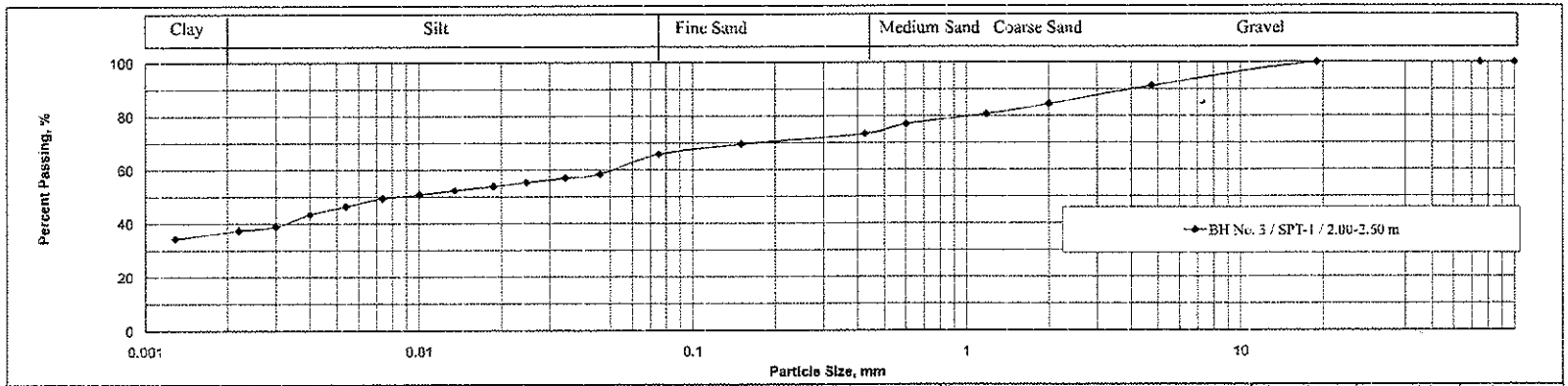
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 22, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
3	SPT-1	2.00-2.60	9	7	11	8	28	37	50	39	12	11	2.68	MI-MH

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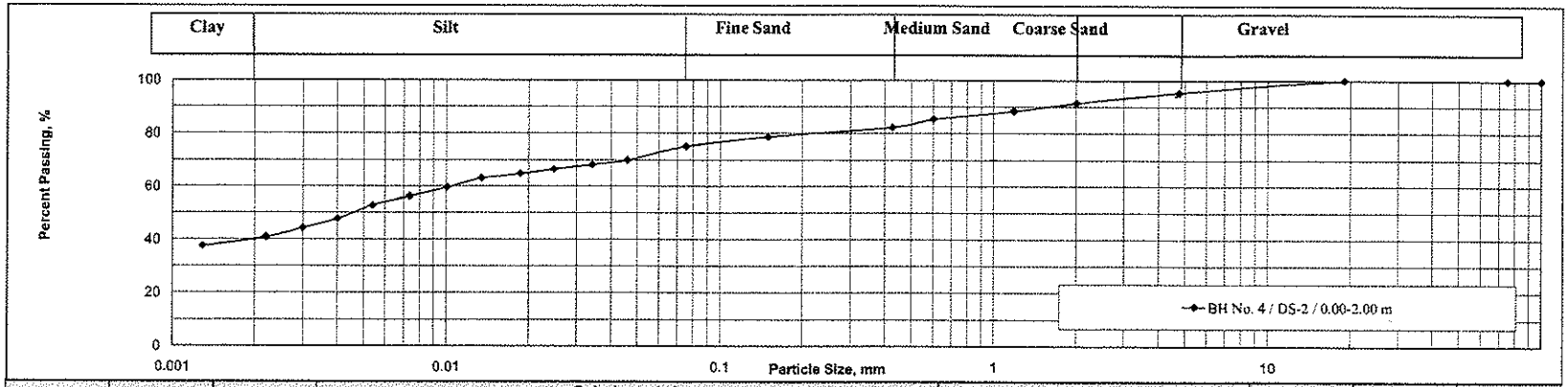
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 21, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits				Specific Gravity	IS Classification
			Gravels, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Shrinkage Limit, %		
4	DS-2	0.00-2.00	5	4	9	7	34	41	50	39	11	15	2.70	MI-MH

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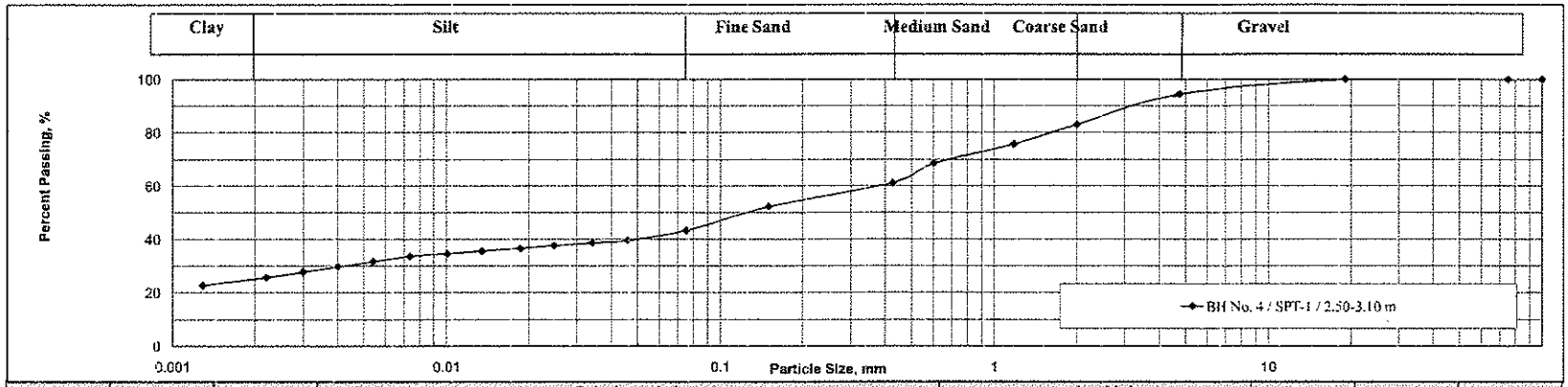
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 21, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravels, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
4	SPT-1	2.50-3.10	6	11	22	18	18	26	40	37	3	17	2.66	SM

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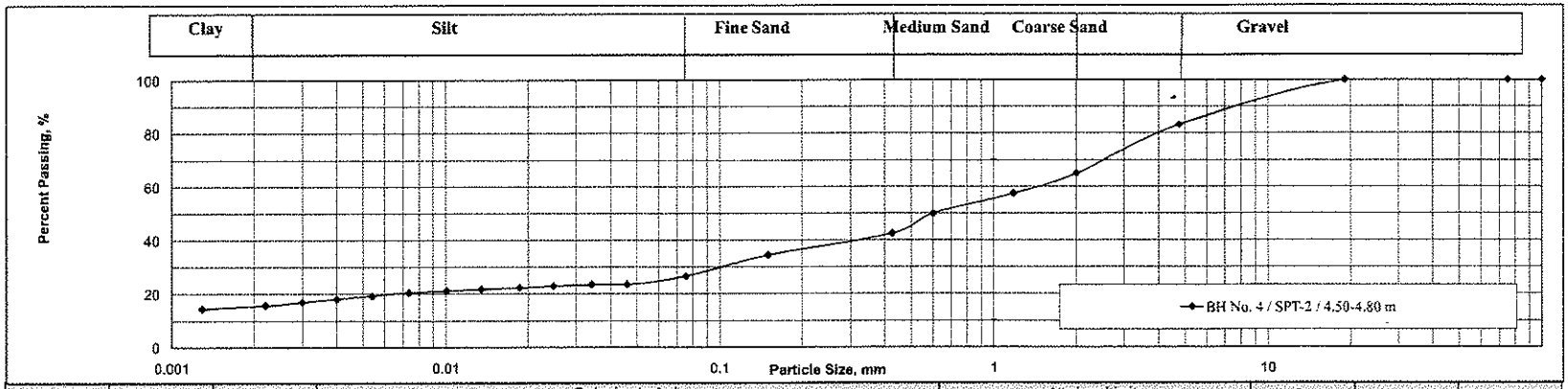
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 21, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravels, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
4	SPT-2	4.50-4.80	17	18	22	16	11	16	36	30	6	18	2.70	SM-SC

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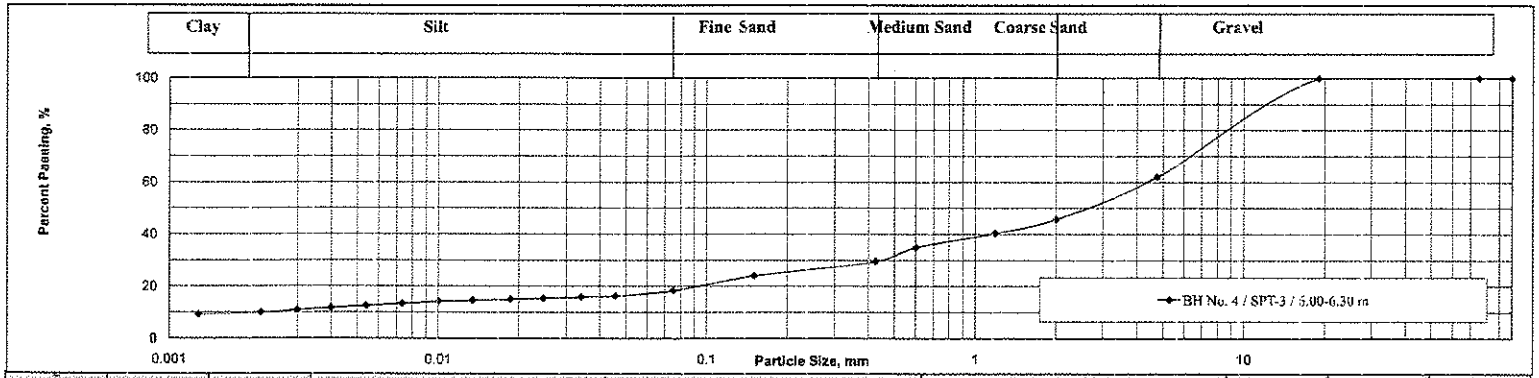
GRAIN SIZE ANALYSIS GRAPH IS 1498 (1970, REAFFIRMED 2011)

Project : Geotechnical Report for KEM Hospital Site

Location : KEM Hospital | Date : August 21, 2018



Bore Hole Number	Sample Type	Depth, m	Grain size Analysis						Atterberg Limits			Shrinkage Limit, %	Specific Gravity	IS Classification
			Gravel, %	Coarse Sand, %	Medium Sand, %	Fine Sand, %	Silt, %	Clay, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %			
4	SPT-3	6.00-6.30	38	16	16	11	8	10	33	28	5	17	2.69	SM-SC

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PROJECT NO:SI 19045

Noble Geo-Structs Mulund (East)

APPENDIX V

SAFE BEARING CAPACITY (SBC) CALCULATION



Table 7. SBC CALCULATED FROM SPT VALUES AS PER IS 6403 (1981, REAFFIRMED 2016)

BH.No.	1	
Cohesion, c	0	kN/m^2
Angle of friction, φ_G (General Shear)	29	degree
Angle of friction, φ_L (Local Shear)	20	degree
Length of Footing, L	2	m
Width of Footing, B	2	m
Depth of Foundation, D_f	1	m
SPT adopted for design	5	
Saturated Density, γ_{sat}	18	kN/m^3
$\sqrt{N_\phi} = \tan(\pi/4+\phi/2)$	1.70	
Inclination angle, α	0	

Net ultimate bearing capacity (General Shear) = $q_d = q(Nq-1)s_q d_q i_q + 1/2 B_Y N_Y s_Y d_Y i_Y W'$		
Effective surcharge at the base level of foundation, q	8.00	kN/m^2
Bearing capacity factor = N_q	16.9	
Shape factor, s_q	1.20	
Depth factor, $d_q = 1+0.1*Df / B\sqrt{N_\phi}$	1.08	
Inclination factor, i_q	1.00	
Bearing capacity factor = N_Y	20.1	
Shape factor, s_Y	0.80	
Depth factor, $d_Y = 1+0.1*Df / B\sqrt{N_\phi}$	1.08	
Inclination factor, i_Y	1.00	
W'	0.50	
Net ultimate bearing capacity = q_d	**173.82**	**kN/m^2**

Net ultimate bearing capacity (Local Shear) $q_d = q(Nq-1)s_q d_q i_q + 1/2 B_Y N_Y s_Y d_Y i_Y W'$		
Effective surcharge at the base level of foundation, q	8.00	kN/m^2
Bearing capacity factor = N_q	6.4	
Shape factor, s_q	1.20	
Depth factor, $d_q = 1+0.1*Df / B\sqrt{N_\phi}$	1.08	
Inclination factor, i_q	1.00	
Bearing capacity factor = N_Y	5.6	
Shape factor, s_Y	0.80	
Depth factor, $d_Y = 1+0.1*Df / B\sqrt{N_\phi}$	1.08	
Inclination factor, i_Y	1.00	
W'	0.50	
Net ultimate bearing capacity = q_d	**75.65**	**kN/m^2**

Interpolated Net ultimate bearing capacity, q_d	**114.91**	**kN/m^2**
Safe Bearing Capacity	**45.97**	**kN/m^2**
Immediate settlement, S_i	**10.00**	**mm**

Table 8. Immediate Settlement from Fig. 9 of IS 8001 Part I (1976, REAFFIRMED 2008)

Settlement	10	mm

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