No. ADB/AUIIP/MEETING, MINUTES/15/2012/297

(295

Addendum No. 02

Name of work: - Design, Build and Operate (DBO) contract for Water Supply in South East Guwahati

Package number: - AUIIP/PR-2/GUW/WS/03

Sr. No.	Section	Reference	Description in Bid Document	Clause Replaced / Amended/ Added as Below
1	Technical Proposal Data Sheet	Vol -1, Section 4 Pg-49	To be provided to each design personnel named in Schedule No. 4 [*Design Personnel*]	To be provided to each **Operation personnel** named in Schedule No. **5 [Operation *Personnel*]**.
2	Employers' Technical Requirement	Clause 1447; Pg-295Section 6 Vol-2 Desilting Pumps of Intake Well	Pumps shall be suitable….2hours continuous operation. 2 Working + 1 Standby number of pumps shall be provided for operation In each well.	Pumps shall be suitable….2hours continuous operation. **1 Working** + 1 Standby number of pumps shall be provided for operation In each well.
3	Employers' Technical Requirement	Clause 255; Pg-59; Section 6 Vol-2 xviii. Raw Water Pumps	One working and one standby in each well for Phase I. Discharge of each pump (Phase I: 628 lps. and Head 21 m.)	One working and one standby in each well for Phase I. Discharge of each pump (Phase I: 628 lps. and **Head 28 m**.)
4	Social Due Diligence Report (Distribution network)	Pg-7,Table4 Appendix-II Part B; Vol-5	Proposed Pumps (Column): 10kw (3+1), 18kw (3+1), 7.5 kw (3+1), 10 kw(3+1), 75 kw (3+1)	Proposed Pumps (Column): 10kw **(2+1)**, 18kw **(2+1)**, 7.5 kw **(2+1)**, 10 kw **(2+1)**, 75 kw **(2+1)**
5	Employers' Technical Requirement	Clause 1379; Item No.1Table 89; Pump duty condition and Operating Range. Pg-283; Section 6 Vol-2	Discharge 2271 Cum per hour	Discharge **2261** Cum per hour
6	Drawings & Reports	Vol-4, Drawing List	(Two Additional Drawings)	**A)** INTAKE 12. Contour Map of Intake & WTP: AUIIP/GUW/WS/03/20 (Drawing No.) **C)** Distribution Network Drawings 9. Contour Map of SE Guwahati: AUIIP/GWSP/S_E Guwahati/Contour (Drawing No.)
7	Drawings & Reports	Vol-4, B. Reports	(Two Additional Reports)	1. Soil Investigation Report of Intake 2. Soil Investigation Report of WTP

Addl. Project Director
Assam Urban Infrastructure Investment Programme
Ganeshguri, Guwahati-5

No. ADB/AUIIP/MEETING MINUTES/IC/2012/296

Addendum No. 03

Name of work: - Design, Build and Operate (DBO) contract for Water Supply in South East Guwahati

Package number: - AUIIP/PR-2/GUW/WS/03

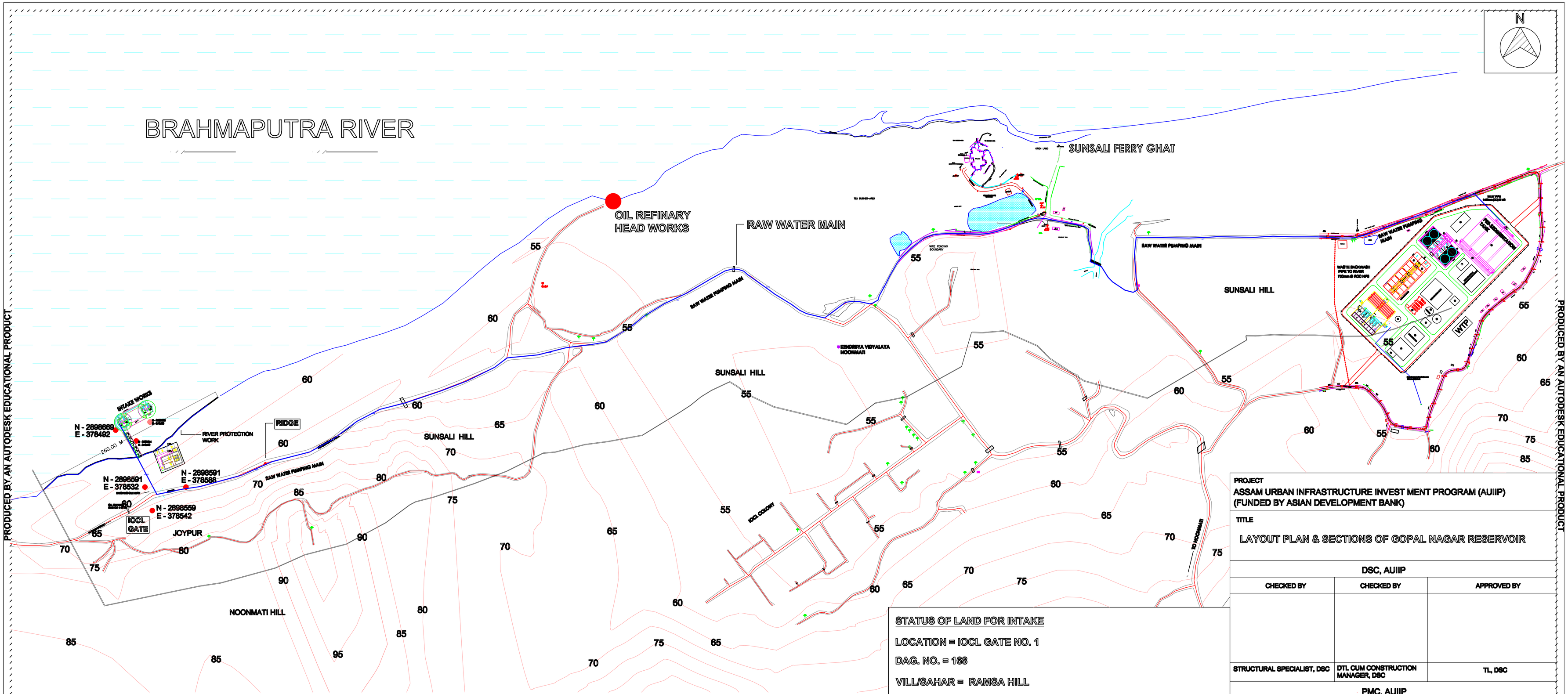
Sr. No.	Section	Reference	Description of clause in Bid Document	Clause Replaced / Amended/ Added as Below
1.	Section 4	Form No. 6 Financial Situation	a) Audited financial statements for the last three years (for the Bidder or each partner of JVCA Bidder). Firms owned by individuals, and partnerships, may submit their financial statements certified by an accountant, and supported by copies of tax returns, if audits are not required by the laws of their countries of origin. A summary of assets and liabilities in USD equivalent (at the rates of exchange current at the end of each year) for the previous three years;	a) Audited financial statements for the last three years, i.e. FY 2013-14, 2012-13 and 2011-12 (for the Bidder or each partner of JVCA Bidder). Firms owned by individuals, and partnerships, may submit their financial statements certified by an accountant, and supported by copies of tax returns, if audits are not required by the laws of their countries of origin. A summary of assets and liabilities in USD equivalent (at the rates of exchange current at the end of each year) for the previous three years;
2.	Section 4 4.3.1.	Particular Design Experience	The Bidder shall demonstrate successful experience as a prime contractor or lead partner of a JVCA contractor in the design of at least **[2] project(s)** with a design fee of USD **0.50** million involving contractor's single point responsibility for the design of works of a nature and complexity comparable to the proposed Works within the last **[5]** years.	The Bidder shall demonstrate successful experience as a prime contractor or lead partner of a JVCA contractor in the design of at least **[1] project**with a design fee of USD **0.50** million involving contractor's single point responsibility for the design of works of a nature and complexity comparable to the proposed Works within the last **[5]** years.
3.	Section 4 4.3.2.	Particular Construction Experience	Note: The final contract price of completed works will be multiplied by the following Conversion factors to arrive at the contract price equivalent to 2013 contract price (CP). Works completed in the year 2013 CPX1.00 Works completed in the year 2012 CPX1.10 Works completed in the year 2011 CPX1.20 Works completed in the year 2010 CPX1.30 Works completed in the year 2009 CPX1.40 Works completed in the year 2008 CPX1.50 Works completed in the year 2007 CPX1.60 Works completed in the year 2006 CPX1.70 Works completed in the year 2005 CPX1.80	Note: The final contract price of completed works will be multiplied by the following Conversion factors to arrive at the contract price equivalent to 2013 contract price (CP). Works completed in the year 2014CPX1.00 Works completed in the year 2013CPX1.10 Works completed in the year 2012CPX1.20 Works completed in the year 2011CPX1.30 Works completed in the year 2010CPX1.40 Works completed in the year 2009CPX1.50 Works completed in the year 2008CPX1.60 Works completed in the year 2007CPX1.70 Works completed in the year 2006CPX1.80

Addl. Project Director
Assam Urban Infrastructure Investment Programme
Ganeshguri, Guwahati-5

			Works completed in the year 2004 CPX1.90	Works completed in the year 2005CPX1.90
4.	Section 4 4.3.3.	Particular Operation Experience	The Bidder shall demonstrate that it has successful experience as a prime contractor, partner of a JVCA contractor or a subcontractor in the substantial completion of at least **2projects** of USD **0.5** million/annum as operation fee (but excluding the cost of power) involving the operation of works of equal or higher complexity as the Works detailed by the Bidder in its Contractor's Proposal during the past **[5]** years.	The Bidder shall demonstrate that it has successful experience as a prime contractor, partner of a JVCA contractor or a subcontractor in the substantial completion of at least **1 project** of USD **0.5** million/annum as operation fee (but excluding the cost of power) involving the operation of works of equal or higher complexity as the Works detailed by the Bidder in its Contractor's Proposal during the past **[5]** years.
5.	Section 6 Table 17 2.4.1 General Production experience.	Supply of Ductile Iron Pipes Documentation Required	Form EXP-1	EXP-1 andMOU with Manufacturer meeting the experience criteria as on publication of the IFTP i:e. 29 June 2015.

27/8/15

Addl. Project Director
Assam Urban Infrastructure Investment Programme
Ganeshguri, Guwahati-5



STATUS OF LAND FOR INTAKE

LOCATION = IOCL GATE NO. 1

DAG. NO. = 168

VILL/SAHAR = RAMSA HILL

STATUS = GOVT. LAND

MOUZA = ULLUBARI

AREA = 24B - 0K - 0L

PROJECT

ASSAM URBAN INFRASTRUCTURE INVEST MENT PROGRAM (AUIIP)
(FUNDED BY ASIAN DEVELOPMENT BANK)

TITLE

LAYOUT PLAN & SECTIONS OF GOPAL NAGAR RESERVOIR

DSC, AUIIP		
CHECKED BY	CHECKED BY	APPROVED BY
STRUCTURAL SPECIALIST, DSC	DTL CUM CONSTRUCTION MANAGER, DSC	TL, DSC

PMC, AUIIP		
CHECKED BY	CHECKED BY	APPROVED BY
STRUCTURAL SPECIALIST, PMC	DTL, PMC	TL, PMC

DSC	PMC	CLIENT:	REV: 02	DRAWN BY:		
M/s SHAH Technical Consultant Pvt Ltd. in association with M/s. SMEC INDIA Pvt Ltd.	Tetra Tech India Pvt Ltd. Poyry Enviroment Gmbh Vision Consulting Service Pvt Ltd.	PMU-AUIIP GOVT. OF ASSAM	SCALE: A1, NTS	DRG. NO: AUIIP/GUW/WS/03/20	SHEET NO.	DATE AUG 14

BRAHMAPUTRA RIVER

OLD INTAKE SITE

NEW INTAKE

WTP

GOPAL NAGAR RESERVOIR
RESERVOIR CAPACITY - 17 ML
TANK BOTTOM LEVEL-134 m

NORTH JYOTINAGAR RESERVOIR
TANK BOTTOM LEVEL-114 m
RESERVOIR CAPACITY -3.2 ML

KENDUGURI RESERVOIR
RESERVOIR CAPACITY -3.6 ML
TANK BOTTOM LEVEL-106 m

BONDA RIVER

JONAKINAGAR

SILSAKO BIL

HENGRABARI (JONAKI NAGAR) RESERVOIR:-

DAG NO. = 565
PLOT AREA = 2 Bigha 3 Katha 7 Lessa (0.36 Ha)
TANK BOTTOM LEVEL = 85 M
APPROACH ROAD LENGTH = 140 M

OIL PIPE LINE

RAILWAY TRACK

NABAJYOTI NAGAR
RESERVOIR-1
RESERVOIR CAPACITY = 36 x 18 x 6 Cum
= 3.2 ML
TANK BOTTOM LEVEL-121 m

BASISTHA RESERVOIR
RESERVOIR CAPACITY = 5 ML
TANK BOTTOM LEVEL = 90 m

TENDER PURPOSE ONLY

PROJECT
ASSAM URBAN INFRASTRUCTURE INVEST MENT PROGRAM (AUIIP)
(FUNDED BY ASIAN DEVELOPMENT BANK)

TITLE : CONTOUR MAP OF SOUTH EAST GUWAHATI

DSC, AUIIP		
CHECKED BY	CHECKED BY	APPROVED BY
STRUCTURAL SPECIALIST, DSC	DTL CUM CONSTRUCTION MANAGER, DSC	TL, DSC

PMC, AUIIP		
CHECKED BY	CHECKED BY	APPROVED BY
STRUCTURAL SPECIALIST, PMC	DTL, PMC	TL, PMC

DSC	PMC	CLIENT:	REV: 02	DRAWN BY:		
M/s SHAH Technical Consultant Pvt Ltd. in association with M/s. SMEC INDIA Pvt Ltd.	Tetra Tech India Pvt Ltd. Poyry Enviroment Gmbh Vision Consulting Service Pvt Ltd.	PMU-AUIIP GOVT. OF ASSAM	SCALE: A1, NTS	DRG. NO: AUIIP/GWSP/S_EG/guwahati / Contour	SHEET NO.	DATE AUG 15

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

GEOTECHNICAL INVESTIGATION WORKS
FOR
SOUTH EAST GUWAHATI WATER SUPPLY PROJECT
(AT IOCL GATE-1 NEW INTAKE WELL)

CLIENT

SHAH TECHNICAL CONSULTANTS PRIVATE LIMITED

IN ASSOCIATION WITH SMEC (INDIA) PVT.LTD.

Geo-Technical Consultant

ESS FOUNDATION PVT.LTD.

96,BARTHAKUR MILL ROAD,ULUBARI

GUWAHATI- 781007

PHONE-0361-2525404,e-mail:ess.engineers@rediffmail.com

GEOTECHNICAL INVESTIGATION WORKS
FOR
SOUTH EAST GUWAHATI WATER SUPPLY PROJECT
(AT IOCL GATE-1 NEW INTAKE WELL)

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GUWAHATI- 781007

PHONE-0361-2525404,e-mail:ess.engineers@rediffmail.com

TABLE OF CONTENT

1.0 INTRODUCTION:

Soil investigation report for proposed Water Treatment Plant for *SOUTH GUWAHATI EAST WATER SUPPLY SYSTEM* was entrusted to *ESS FOUNDATION* ***PVT.LTD*** ., 96,Barthakur Mill Road,Ulubari,Guwahati-781007.The scope of the soil investigation work consist of conducting soil investigation at ***New Intake Works Location*** upto a maximum depth of 26.10 m.Borings were included collection of core samples of rock.The formation of soil/rock layer is shown in bore hole log for various layers present at their respective depths along with their thickness.During sinking of bore holes rock cores were to be collected for laboratory tests. The core samples were be subjected to tests to obtain different properties.

2.0 LOCATION OF SITE

The intake point is inside the river on the south bank of River Brahmaputra.The site is approachable from the road abbuting Gauhati Refinary,Guwahati. The site is at present occupied by Govt. of Assam.The nearest railway station is at Guwahati approximately 12 kilometers to the SE direction. The nearest airport Lokpriya Gopinath International Airportis located approximately 45km to the west

GEOLOGY OF THE AREA

Geologically, the area falls in the lower part of the Dalling and Darjeeling series of Archean group of rocks of Sikkim and Nepal. The Daling series is a schistose group of rocks consisting flakes of mica with abundant mafic minerals. In majority of the area shows that the Phyllites carry porphyroblasts of chloride and Biotite with Quartz and Feldspar in number of places. Quartzite as quartz - veins in the Granite - gneiss has also been identified.

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SCENARIO OF SEISMIC HAZARD IN ASSAM

INTRODUCTION:

Geomorphologically, NE India is located in an earthquake prone zone (zone V) of the Indian subcontinent. In this region earthquake comes with landsliding flood and along series of smaller magnitude earthquakes. Here earthquakes of upto MM intensity IX can be expected. According to a hazard map by the Global Seismic Hazard Assessment Programme, the state can expect to have a peak gravitational acceleration (PGA) of 0.24g to 0.48g. The region where the highest PGA can be expected is along the state's border with Meghalaya, the site of the Great Indian earthquake of 1897.the area falls in zone-v

EARTHQUAKE HISTORY

Much of Assam lies in the Bramaputra River Valley, except for a few southern districts. The northern and eastern parts of this valley are bounded by the Himalayan Frontal Thrust (HFF). In the eastern parts along with the HFF, there is the arc of the Lohit and Naga thrusts. Among the large earthquakes, in this region were the events in 1897 and 1950. The 1897 earthquake is well known for the dramatic accounts of violent upthrow during the shock.

SIGNIFICANT EARTHQUAKES IN ASSAM

Both instrumented and non-instrumented events may be listed below. Reported magnitudes are listed for instrumented events while the maximum observed intensities are listed for non-instrumented shocks. Some of the latter might also have magnitudes assigned to them by various authors, in which case the reference is stated.

EARTHQUAKES DURING NON-INSTRUMENTAL PERIOD IN ASSAM 1548, 1596,1601, 1642, 1663, 1696, 1756, 1772, 1838, & 1841.

EARTHQUAKE DURING INSTRUMENTAL PERIOD IN ASSAM 1869, 1897, 1923, 1930,1943, 1947, 1950, 1985, 1984 &1988.

Reported magnitudes for instrumented events are given below

SI.NO	Date	Magnitude	Epicentre
1	**10 th January 1869**	7.5	9.4 Kms North of Kumbhir (Assam)
2	**12 June 1897**	8.7	14 Kms ESE of Sangsik (Meghalaya)
3	**9th september 1923**	7.1	South Meghalaya
4	**2nd July 1930**	7.1	3.9 kms NNW of Dabigiri (Meghalaya)
5	**21 st January 1941**	6.5	Near Tezpur,Assam
6	**23 rd October 1943**	7.2	13.6 kms E of Hojai (Assam)
7	**29th July 1947**	7.7	Arunachal Pradesh
8	**15th August 1950**	8.7	20.7 kms NW of Tajobam,Arunachal Pradesh
9	**21st March 1954**	7.7	Manipur Burma border
10	**1st July 1957**	7.0	Indo Burma border
11	**31st December 1984**	6.0	SSE of Silchar
12	**6th August 1988**	7.3	Indo Burma border

The 1897 earthquake is the 2nd largest earthquake in the recorded history.The earthquake originated on a south-southwest dipping fault,named the oldham fault,bounding the North-Western section of the Shillong Plateau.During the event,the total slip on this fault,amounted to 16 m. which is among the greatest for any known earthquake.The towns of Dhubri,Goalpara,Guwahati and kuch Bihar in Assam and West Bengal was heavily damaged.At Guwahati is located in an earthquake prone zone(zone v as per IS:1893-2002),the earth subsided along the Brahmaputra and several sand vents were formed.The Brahmaputra is also reported to have risen by several mtrs. and even reversed its flow during the shock. The earthquake 15th August 1950 was the 6th largest earthquake of the recorded history.

Though it hit in a mountainous region along India's international border with China, 1500 people were killed and the drainage of the region was greatly affected. The resultant floods were the cause of most of the fatalities aftermath of this earthquake. The initial shock was followed by thousands of aftershocks, some of which were big earthquakes enough to be reckoned. It had a magnitude of 8.7 and struck a relatively sparsely populated region along the Indo-China border. This earthquake is often referred to as the "Assam Earthqake of 1950".It was also felt throughout Bangladesh, Bhutan and Myanmar. Damage occurred in the entire region as far as Kolkata. It was felt across a wide area of the subcontinent, over an area totalling 4.5 million square miles.

3.0 FIELD INVESTIGATION

The details of field work,location,bore hole no. RL,water level and the dates of commencement and completion are tabulated below:

Location	B.H No.	Depth (m)	RL (m)	RL of Water level (m)	Date	
					starting	Completion
South East Guwahati water supply System (New Intake well location)	1	12.60	28.686	40.686	3/2/2015	7/2/2015
	2	26.10	28.686	40.686	18/01/2015	30/01/2015

A) Methodology:

i) Boring operation :

The 150 mm dia bore holes were extended to the termination depth by rotary core drilling technique using diamond bits.Drilling was done with standard L&T rotary drilling machine mounted over 6 m x 6 m **burge** floating over the river Brahmaputra and properly anchoring at the bed level of the river as per IS:6926-1973.In this method the hole is advanced by rotating a system consisting of a series of hollow drill rods to the bottom of which is attached a double tube core barrel with diamond coring bit by means of a diesel operated engine.When the rod with the coring bit is rotated downward pressure is applied to the system for penetration in the rocky strata and water under pressure is introduced into the bottom of the hole through the hollow drill rods.Water served the dual function of cooling the bit as it enters the hole and carrying the cuttings from the bottom of the hole on its return journey to the surface. Seamless flush jointed steel casing of NX sizes were used to prevent any caving and water loss from holes and they were inserted simultaneously with the advancement of drilling operation.Rock core samples were collected in standard NX size barrel and stored as per IS:4464-1967 and IS:4078-1967.

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iii) Standard Penetration Test

Standard Penetration test is performed in the boreholes at intervals 1.50 m or change of strata. The standard split spoon sampler, attached to a string of drill rods was lowered to the bottom of the hole and allowed to rest under self weight. The drill rods were connected to driving assembly which consisted of a hoisting equipments, a drive weight (Hammer) of 63.5 Kg, and a guide to ensure a 75 cm free fall of hammer on an anvil. The number of hammer blows that were required to penetrate the sampler through three runs of 150 mm each were recorded. Initial driving of 150 mm was disregarded and the number of blows required to drive the sampler through the remaining 300 mm is called BLOW COUNT or PENETRATION NUMBER,N. At the end of the test, the sampler was withdrawn and the **soil** extracted for subsequent **testing** in the laboratory . If the penetration was less than 30 cm for 100 blows, it is considered as refusal and the actual penetration was recorded.All the bore holes are sunk with winch.However,rising of hammer SPT is done manually.Hence there will not be any inertial loss and the efficiency of hammer blows should be considered as 100%.

iv) Sub soil water level

The sub soil water level is noted when sruct in.There is termed as observed water level.Static water level is noted after 24 hours of removal of casing and shown in the profile.

4.0 *LABORATORY TESTING*

The following laboratory tests were carried out to ascertain the properties of the sub-soil.

i) Water Absorption Test

ii) Porosity of rock

iii) Density of Rock

iv) Uniaxial compression of Rock

5.0 DISCUSSION AND RECOMMENDATION :

i) The sub soil formation in this are has been investigated by sinking two bore holes explored upto a maximum depth of 12.60 m below the existing ground level.location of the bore holes are shown in the site plane provided in annexure-A.The bore hole logs,graphical representation of field 'N' values with depth,tabulated laboratory test results,graphs are provided in Annexure-A.

ii) Bor Hole location - BH-01 :

From field and laboratory investigations it is found that the geological formation consists of three layers,the details of each layers are labulated below.

Layer No.	Layer Description	Thickness of layer (m)
1	Silty sand	1.70
2	Sand stone	1.50
3	Granite	9.40

iii) Bor Hole location - BH-02 :

From field and laboratory investigations it is found that the geological formation consists of two layers,the details of each layers are labulated below.

Layer No.	Layer Description	Thickness of layer (m)
1	Silty sand	1.20
2	Granite	24.90

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RECOMMENDED BEARING CAPACITY :

BORE HOLE NO.	DEPTH (M)	NET SAFE BEARING CAPACITY (kg/cm^2)
1	1.70	43.54
	3.20	124.42
	4.70	127.03
	6.90	136.86
	9.30	131.65
	11.10	135.04
2	4.20	143.10
	7.30	144.09
	11.60	151.09
	14.00	153.17
	16.90	145.13
	19.00	156.09
	21.90	155.05
	24.20	156.83

ANNEXURE - A

CHEMICAL ANALYSIS OF SUB-SOIL WATER:

Bh No - 1

SI.No.	Parameters	Results	Limitations
1	P^H Value	6.8	6.5 to 8
2	Chlorides (as Cl)	74	0 to 250
3	Sulphate (as SO4)	69	0 to 200

Bh No - 2

SI.No.	Parameters	Results	Limitations
1	P^H Value	6.75	6.5 to 8
2	Chlorides (as Cl)	83	0 to 250
3	Sulphate (as SO4)	68	0 to 200

The above results show that the strata is quite safe for *Concrete & Reinforcement* for the site.

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RESULTS OF LABORATORY TEST ON ROCK SAMPLES

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	FORMATION OF CORE	COLOUR	WATER ABSORPTION	POROSITY	DENSITY (gm/cc)	UNIAXIAL COMP (SOAKED) (Kg/cm^2)	REMARKS
1	1	1.70	Core	Sand Stone	White	0.30%	1.03	2.58	217.72	-
	2	3.20	Core	Granite	White	0.18 %	0.95	2.63	622.10	-
	3	4.70	Core	Granite	White	0.20 %	0.94	2.62	635.14	-
	4	6.90	Core	Granite	White	0.17 %	0.98	2.63	684.30	-
	5	9.30	Core	Granite	White	0.19 %	1.01	2.63	658.23	-
	6	11.10	Core	Granite	White	0.18 %	0.96	2.62	675.19	-

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RESULTS OF LABORATORY TEST ON ROCK SAMPLES

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	FORMATION OF CORE	COLOUR	WATER ABSORPTION	POROSITY	DENSITY (gm/cc)	UNIAXIAL COMP (SOAKED) (Kg/cm^2)	REMARKS
2	1	4.20	Core	Granite	White	0.19%	1.20	2.59	715.50	-
	2	7.30	Core	Granite	White	0.21%	1.01	2.61	720.45	-
	3	11.60	Core	Granite	White	0.20%	0.96	2.63	755.45	-
	4	14.00	Core	Granite	White	0.24%	0.98	2.61	765.85	-
	5	16.90	Core	Granite	White	0.18%	0.95	2.63	725.63	-
	6	19.00	Core	Granite	White	0.21%	0.99	2.62	780.44	-
	7	21.90	Core	Granite	White	0.17%	0.98	2.63	775.25	-
	8	24.20	Core	Granite	White	0.18%	0.97	2.62	784.15	-

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WATER PERCOLATION / PACKER TEST REPORT

BORE HOLE NO.	DATE	TEST NO.	PRESSURE IN Kg/cm^2	READING IN LTR.		TOTAL WATER LOSS (ltr.)	DURATION (Minutes)	WATER SWIVEL HEAD (m)	DIA. OF BORE HOLE (mm)	TEST SECTION (m)
				FROM	TO					
1			1	345.00	345.20	0.20	5.00			
			2	346.00	346.40	0.40	5.00			
	5/2/2015	1	3	348.00	348.50	0.50	5.00	19.40	75.31	3.10
			4	350.00	350.80	0.80	5.00			
			5	352.00	353.10	1.10	5.00			
			1	360.00	360.30	0.30	5.00			
			2	362.00	362.40	0.40	5.00			
	7/2/2015	2	3	364.00	364.40	0.40	5.00	25.40	75.31	3.10
			4	366.00	366.70	0.70	5.00			
			5	368.00	369.00	1.00	5.00			

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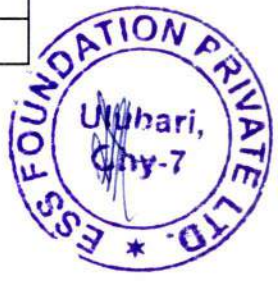
WATER PERCOLATION / PACKER TEST REPORT

BORE HOLE NO.	DATE	TEST NO.	PRESSURE IN Kg/cm^2	READING IN LTR.		TOTAL WATER LOSS (ltr.)	DURATION (Minutes)	WATER SWIVEL HEAD (m)	DIA. OF BORE HOLE (mm)	TEST SECTION (m)
				FROM	TO					
2			1	203.00	205.40	2.40	5.00			
			2	207.00	209.90	2.90	5.00			
	19/01/2015	1	3	212.00	215.30	3.30	5.00	17.80	75.31	3.10
			4	216.00	219.80	3.80	5.00			
			5	221.00	225.10	4.10	5.00			
			1	230.00	230.60	0.60	5.00			
			2	232.00	233.10	1.10	5.00			
	20/01/2015	2	3	235.00	236.90	1.90	5.00	20.90	75.31	3.10
			4	239.00	241.50	2.50	5.00			
			5	243.00	246.20	3.20	5.00			
			1	250.00	251.00	1.00	5.00			
			2	253.00	254.00	1.00	5.00			
	22/01/2015	3	3	256.00	257.60	1.60	5.00	25.20	75.31	3.10
			4	260.00	262.00	2.00	5.00			
			5	265.00	268.00	3.00	5.00			
			1	270.00	270.00	0.00	5.00			
			2	272.00	273.20	1.20	5.00			
	23/01/2015	4	3	275.00	277.00	2.00	5.00	30.00	75.31	3.10
			4	280.00	282.20	2.20	5.00			
			5	284.00	286.90	2.90	5.00			



WATER PERCOLATION / PACKER TEST REPORT

BORE HOLE NO.	DATE	TEST NO.	PRESSURE IN Kg/cm^2	READING IN LTR.		TOTAL WATER LOSS (ltr.)	DURATION (Minutes)	WATER SWIVEL HEAD (m)	DIA. OF BORE HOLE (mm)	TEST SECTION (m)
				FROM	TO					
2			1	290.00	290.90	0.90	5.00			
			2	293.00	294.20	1.20	5.00			
	26/01/2015	5	3	296.00	297.50	1.50	5.00	32.60	75.31	3.10
			4	300.00	302.00	2.00	5.00			
			5	305.00	307.70	2.70	5.00			
			1	310.00	310.50	0.50	5.00			
			2	312.00	313.00	1.00	5.00			
	28/01/2015	6	3	314.00	315.30	1.30	5.00	35.50	75.31	3.10
			4	317.00	318.70	1.70	5.00			
			5	320.00	322.20	2.20	5.00			
			1	325.00	325.60	0.60	5.00			
			2	327.00	328.10	1.10	5.00			
	31/01/2015	7	3	330.00	331.40	1.40	5.00	39.70	75.31	3.10
			4	332.00	335.00	3.00	5.00			
			5	336.00	338.70	2.70	5.00			

Ulubari,
Ghy-7

BORE HOLE LOG DATA SHEET

Bore Hole No.: 01 N=2898691.001,E= 378529.068

No. of SP Test	-	Samples	Nos.	Commencement Date :	3/2/2015
No. of Vane(V) Test	-	Core collected	6	Completion Date :	7/2/2015
Length of Casing	3 m	Penetrometer (SPT)	-	Bore Hole Diameter :	150 mm
SPT done By	-	Disturbed	-	Level of Ground :	RL-28.600
Method of Boring	Drilling	Water Sample	1	Water Struct at :	1.70 m below GL
				Standing Water Level :	40.686

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
Silty Sand		From 1.20 m to 26.10 m is solid rock layer.Hence SPt could not be done	Refer core details in Annexure -01	0.0-1.70
Sand stone				1.70-3.20
				3.20-4.70
Granite				4.70-6.90
				6.90-9.30
				9.30-11.10
				11.10-12.60

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BORE HOLE LOG DATA SHEET

Bore Hole No.: 02 N=2898698.0677,E= 378547.7780

No. of SP Test	-	Samples	Nos.	Commencement Date :	18/01/2015
No. of Vane(V) Test	-	Core collected	15	Completion Date :	30/01/2015
Length of Casing	-	Penetrometer (SPT)	-	Bore Hole Diameter :	150 mm
SPT done By	-	Disturbed	-	Level of Ground :	RL-28.600
Method of Boring	Drilling	Water Sample	1	Water Struct at :	1.50 m below GL
				Standing Water Level :	40.686

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
Silty Sand		From 1.70 m to 12.60 m is solid rock layer.Hence SPt could not be done	Refer core details in Annexure -02	0.0-1.20
				1.20-4.20
				4.20-6.10
				6.10-7.30
				7.30-9.40
				9.40-11.60
Granite				11.60-13.10
				13.10-14.00
				14.00-16.40
				16.40-16.90
				16.90-18.00
				18.00-1900
Granite				19.00-19.90
				19.90-21.90
				21.90-24.20
				24.20-26.10

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ANNEXURE-01

FIELD REPORT

SITE - New Intake Point

BORE HOLE NO.01

Date	Drilling		Total Run	Core Recovery (m)	% of Core	R.Q.D.		R.Q.D. %	Water colour	Water loss (ltr.)	Formation	Ground water level	Remarks
	From (m)	To (m)				No. of 10cm	Length m						
3/2/2015	0.00	1.70	1.70	NIL	-	-	-	-	Grey	-	Silty sand	Above 12.0 m from bed level	
3/2/2015	1.70	3.20	1.50	0.20	13.33	-	-	-	White	FULL	Sand stone		
4/2/2015	3.20	4.70	1.50	1.00	66.67	3	0.61	40.67	Milky White	FULL	Granite		
5/2/2015	4.70	6.90	2.20	2.13	96.82	8	1.5	68.18	Milky White	NIL	Granite		
6/2/2015	6.90	9.30	2.40	2.40	100.00	5	2.24	93.33	Milky White	NIL	Granite		
7/2/2015	9.30	11.10	1.80	1.75	97.22	7	1.23	68.33	Milky White	NIL	Granite		
7/2/2015	11.10	12.60	1.50	1.50	100.00	5	1.5	100.00	Milky White	NIL	Granite		

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ANNEXURE-02

FIELD REPORT

SITE - New Intake Point

BORE HOLE NO.02

Date	Drilling		Total Run	Core Recovery (m)	% of Core	R.Q.D.		R.Q.D. %	Water colour	Water loss (ltr.)	Formation	Ground water level	Remarks
	From (m)	To (m)				No. of 10cm	Length m						
18/01/2015	0.00	1.20	1.20	NIL	-	-	-	-	Ash	-	Silty sand	Above 12.0 m from bed level	
19/01/2015	1.20	4.20	3.00	1.36	45.33	4	0.97	32.33	Milky White	NIL	Granite		
20/01/2015	4.20	6.10	1.90	0.52	27.37	2	0.28	14.74	Milky White	NIL	Granite		
20/01/2015	6.10	7.30	1.20	1.17	97.50	3	0.61	50.83	Milky White	NIL	Granite		
21/01/2015	7.30	9.40	2.10	2.10	100.00	7	1.90	90.48	Milky White	NIL	Granite		
22/01/2015	9.40	11.60	2.20	2.17	98.64	3	2.12	96.36	Milky White	NIL	Granite		
22/01/2015	11.60	13.10	1.50	1.02	68.00	3	0.51	34.00	Milky White	NIL	Granite		
23/01/2015	13.10	14.00	0.90	0.81	90.00	4	0.72	80.00	Milky White	NIL	Granite		
23/01/2015	14.00	16.40	2.40	2.37	98.75	9	2.22	92.50	Milky White	NIL	Granite		
24/01/2015	16.40	16.90	0.50	0.50	100.00	1	0.5	100.00	Milky White	NIL	Granite		
25/01/2015	16.90	18.00	1.10	1.05	95.45	4	0.66	60.00	Milky White	NIL	Granite		
26/01/2015	18.00	19.00	1.00	0.93	93.00	4	0.93	93.00	Milky White	NIL	Granite		
27/01/2015	19.00	19.90	0.90	0.90	100.00	4	0.9	100.00	Milky White	NIL	Granite		
28/01/2015	19.90	21.90	2.00	2.00	100.00	4	1.89	94.50	Milky White	NIL	Granite		
29/01/2015	21.90	24.20	2.30	2.16	93.91	6	1.84	80.00	Milky White	NIL	Granite		
30/01/2015	24.20	26.10	1.90	1.86	97.89	8	1.86	97.89	Milky White	NIL	Granite		

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ANNEXURE-02

FIELD REPORT

SITE - New Intake Point

BORE HOLE NO.02

Date	Drilling		Total Run	Core Recovery (m)	% of Core	R.Q.D.		R.Q.D. %	Water colour	Water loss (ltr.)	Formation	Ground water level	Remarks
	From (m)	To (m)				No. of 10cm	Length m						
18/01/2015	0.00	1.20	1.20	NIL	-	-	-	-	Ash	-	Silty sand	Above 12.0 m from bed level	
19/01/2015	1.20	4.20	3.00	1.36	45.33	4	0.97	32.33	Milky White	NIL	Granite		
20/01/2015	4.20	6.10	1.90	0.52	27.37	2	0.28	14.74	Milky White	NIL	Granite		
20/01/2015	6.10	7.30	1.20	1.17	97.50	3	0.61	50.83	Milky White	NIL	Granite		
21/01/2015	7.30	9.40	2.10	2.10	100.00	7	1.90	90.48	Milky White	NIL	Granite		
22/01/2015	9.40	11.60	2.20	2.17	98.64	3	2.12	96.36	Milky White	NIL	Granite		
22/01/2015	11.60	13.10	1.50	1.02	68.00	3	0.51	34.00	Milky White	NIL	Granite		
23/01/2015	13.10	14.00	0.90	0.81	90.00	4	0.72	80.00	Milky White	NIL	Granite		
23/01/2015	14.00	16.40	2.40	2.37	98.75	9	2.22	92.50	Milky White	NIL	Granite		
24/01/2015	16.40	16.90	0.50	0.50	100.00	1	0.5	100.00	Milky White	NIL	Granite		
25/01/2015	16.90	18.00	1.10	1.05	95.45	4	0.66	60.00	Milky White	NIL	Granite		
26/01/2015	18.00	19.00	1.00	0.93	93.00	4	0.93	93.00	Milky White	NIL	Granite		
27/01/2015	19.00	19.90	0.90	0.90	100.00	4	0.9	100.00	Milky White	NIL	Granite		
28/01/2015	19.90	21.90	2.00	2.00	100.00	4	1.89	94.50	Milky White	NIL	Granite		
29/01/2015	21.90	24.20	2.30	2.16	93.91	6	1.84	80.00	Milky White	NIL	Granite		
30/01/2015	24.20	26.10	1.90	1.86	97.89	8	1.86	97.89	Milky White	NIL	Granite		

ESS FOUNDATION PRIVATE LTD. Uttara, City-7

REPORT

ON

GEO-TECHNICAL INVESTIGATION FOR SOUTH GUWAHATI EAST WATER SUPPLY PROJECT

PREPARED BY

ESS FOUNDATION PVT.LTD.

BARTHAKUR MILL ROAD , ULUBARI,

GUWAHATI - 781007

DIAL NO : 0361 - 2525404, 94351-10953

R E P O R T

O N

GEO-TECHNICAL INVESTIGATION FOR SOUTH GUWAHATI EAST WATER SUPPLY PROJECT

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1. INTRODUCTION

1.1 General

The soil investigation work was carried out during the month of August - 2012 at the Proposed site for ***South Guwahati East Supply Project*** . Besides boring, Standard Penetration Tests at specified intervals were also performed as per I.S. specifications,undisturbed as well as disturbed samples,rock samples were collected from the bore-holes for classification of soil, shear strength tests and all other relevent tests were performed to determine the safe bearing capacity of the soil.

1.2. Objective :

The objective of the **report** is restricted to the collection of factual information during the investigation period and submission of laboratory tests results,so as to sequence,extent of **soil** stratification,bearing capacity of soil,to ascertain the design parameters for the foundations from the recommended safe bearing capacity of **foundation soil**.

1.3 Planning And Soil Exploration :

On the basis of nature of work it was decided to carry out **soil** exploration in order to :

b) Obtain **soil** samples, both representative disturbed and undisturbed wherever necessary for classification and other laboratory tests for determining engineering properties of **soil** strata.

c) Obtain soundings of penetration resistance by standard Penetration test in the bore holes.

1.4 Design criteria For Footings :

i) Footing must be safe against **shear failure** of supporting **soil**.

ii) Footing must not settle more than **permissible limit of settlement.**

Net safe bearing capacity 'qns' is obtained by using the S.P.T value of **foundation** & the relevant shear parameters of **soil**. Factor of safety of 2.5 is applied on ultimate bearing capacity as recommended by B.I.S. Net loading intensity 'qns' is obtained by using physical characteristics of **foundation** & relevant compressibility characteristics of the underlying **soil** . The settlement so obtained shall be with in permissible limits as **per** BIS recommendations.

The computed values i.e. **'qns' as the allowable bearing capacity for designing foundations of structure** is adopted after settlement criteria is satisfied or within the permissible limit .

1.5 Sub soil water level

The sub soil water level is encountered at various bore holes as shown in Bore Hole logs.

2. DETAILS OF FIELD WORK

2.1 Boring operation & Sampling :

150 mm dia hole was advanced at the location Using shell and auger/Drilling method.

150 mm nominal dia flush steel casing was advanced with the boring and the full length of the bore hole was encased at each location.

2.2 Disturbed and Undisturbed Sample :

Disturbed and undisturbed **soil** samples were obtained depending upon the nature of **soil** from different depths in the bore hole. The undisturbed samples were collected in sampling tubes. The ends of the tubes are sealed with molten wax to prevent evaporation. These samples were subsequently tested in the laboratory so as to determine the various index and engineering proportion of various sub **soil** strata met in the bore holes.

2.3 Standard Penetration Test

Standard Penetration test was performed in the boreholes. The standard split spoon sampler, attached to a string of drill rods was lowered to the bottom of the hole and allowed to rest under self weight. The drill rods were connected to driving assembly which consisted of a hoisting equipments, a drive weight (Hammer) of 65 Kg, and a guide to ensure a 75 cm free fall of hammer on an anvil. The number of hammer blows that were required to penetrate the sampler through three runs of 150 mm each were recorded. Initial driving of 150 mm was disregarded and the number of blows required to drive the sampler through the remaining 300 mm is called BLOW COUNT or PENETRATION NUMBER,N. At the end of the test, the sampler was withdrawn and the **soil** extracted for subsequent **testing** in the laboratory . If the penetration was less than 30 cm for 100 blows, it is considered as refusal and the actual penetration was recorded.

Correction of 'N' value :

In case of Sandy **soil** & Non plastic silts, the observed SPT values, designated as 'N', are to be corrected to account for the following two effects.

(i) Correct to account for the effect of overburden pressure.

N' = Cn x N

Cn' is overburden pressure correction and is calculated from the figure No. 1 given on page No. 8 in IS : 2131-1981.

(ii) Correction due to submergence Correction.

N'' = 15 + (N'-15)/2 provided N' is >15 where 'N'' is the final corrected value where ever both the overburden and submergence corrections are necessary the overburden correction is applied first correction of N values of Bore Hole.

3.0 LABORATORY TESTS :

3.1 Index Properties

All the relevant classification on the samples obtained from the bore holes were carried out in the laboratory. The index properties obtained from such classification tests at different depths in the bore holes are reported.

3.2 DISTURBED SOIL SAMPLES:

Disturbed **soil** sample collected in field have been tested in laboratory and preparation of sample for the under mentioned tests have been done in accordance with I.S.2720-(Part-I)-1983.

1. Sieve analysis test as **per** I.S. Specification No. 2720 --(Part-IV).

2. Atterburg limit test (L.L. & P.I.) as **per** I.S. Specification No. 2720 --(Part-II).

3. Natural moisture content as **per** I.S.Specification No.2720 – (Part-IV).

4. Particle size analysis test as **per** I.S.Specification No. 2720-(Part-VI).

5. Wet density test as **per** I.S.Specification No 2720- (Part-VI).

6. Dry density test as **per** I.S.Specification No. 2720- (Part-VI)

7. Specific Gravity test as **per** I.S.Specification No-2720-(Part-III)-Sec.2.

3.3 UNDISTURBED SOIL SAMPLES:

Undisturbed **Soil** samples have been prepared in accordance with I.S. Specification No. 2720-(Part-I)- 1983 and tested as follows:-

1. Sieve analysis test as **per** I.S. Specification No. 2720 --(Part-IV).

2. Atterburg limit test (L.L. & P.I.) as **per** I.S. Specification No. 2720 --(Part-II).

3. Natural moisture content as **per** I.S.Specification No.2720 – (Part-IV).

4. Particle size analysis test as **per** I.S.Specification No. 2720-(Part-VI).

5. Wet density test as **per** I.S.Specification No 2720- (Part-VI).

6. Dry density test as **per** I.S.Specification No. 2720- (Part-VI)

7. Specific Gravity test as **per** I.S.Specification No-2720-(Part-III)-Sec.2.

8. Triaxial compression test and determination of shear parameter

(C & Ø as **per** I.S. XII) & I.S. 2720 – (part – XIII).

9. Consolidation test conducted as **per** I.S Specification No. 2720-(Part-XV).

Calculation of bearing capacity is governed generally by I.S. Specification No . 8009-)Part-I)-1976, I.S.No.2720- (Part – II)- 1980, I.S. No 6403-1981, I.S. 1904-1978 and I.S. 1080-1985 and other relevant I.S. Codes as well as based on assessment and latest developments.

DELETERIOUS CHEMICALS:

The nature of strata was fairly identical through the site therefore one representative **soil** sample from each location was prepared & tested for deleterious chemicals which may effective the concrete & reinforcement the results are given in tabular form.

Part - 3

AT RAW WATER PUMPING MAIN ALIGNMENT

BORE HOLE LOG DATA SHEET

Bore Hole No.: 09

No. of SP Test	6	Samples	Nos.	Commencement Date :	28/08/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	29/08/2012
Length of Casing	3.0	Penetrometer (SPT)	6	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	6	Level of Ground :	RL-51.959 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.159 m

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm)	SAMPLES REF. NO.	SAMPLES DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
Clay grey in colour		2 2 4	SPT-01	1.00 - 1.50 m
		N = 6	UDS-01	1.50 - 2.00 m
				2.00 - 2.50 m
		2 4 4	SPT-02	2.50 - 3.00 m
		N = 8	UDS-02	3.00 - 3.50 m
Clay yellow in colour				3.50 - 4.00 m
		2 2 3	SPT-03	4.00 - 4.50 m
		N = 8		4.50 - 5.00 m
				5.00 - 5.50 m
Clay grey in colour		4 5 5	SPT-04	5.50 - 6.00 m
		N = 10	UDS-03	6.00 - 6.50 m
				6.50 - 7.00 m
Clay yellow in colour		3 5 6	SPT-05	7.00 - 7.50 m
		N = 11		7.50 - 8.00 m
				8.00 - 8.50 m
Clay grey in colour		5 6 7	SPT-06	8.50 - 9.00 m
		N = 13		9.00 - 9.50 m

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BORE HOLE LOG DATA SHEET

Bore Hole No.: 10

No. of SP Test	6	Samples	Nos.	Commencement Date :	30/08/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	31/08/2012
Length of Casing	3.0	Penetrometer (SPT)	6	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	6	Level of Ground :	RL-51.644 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.644 m

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm)	SAMPLES REF. NO.	SAMPLES DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
Clay grey in colour		1 1 2	SPT-01	1.00 - 1.50 m
		N = 3	UDS-01	1.50 - 2.00 m
				2.00 - 2.50 m
		3 5 7	SPT-02	2.50 - 3.00 m
		N = 12	UDS-02	3.00 - 3.50 m
				3.50 - 4.00 m
		4 7 8	SPT-03	4.00 - 4.50 m
		N = 15		4.50 - 5.00 m
				5.00 - 5.50 m
Clay yellow in colour		4 7 7	SPT-04	5.50 - 6.00 m
		N = 14	UDS-03	6.00 - 6.50 m
				6.50 - 7.00 m
		5 7 8	SPT-05	7.00 - 7.50 m
		N = 15		7.50 - 8.00 m
				8.00 - 8.50 m
Clay ash in colour		4 4 5	SPT-06	8.50 - 9.00 m
		N = 9		9.00 - 9.50 m

CHEMICAL ANALYSIS OF SOIL:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content	Reaction to acid
1	6.8	65	64	19	Nil
2	6.7	66	61	21	Nil
3	6.7	67	59	23	Nil

CHEMICAL ANALYSIS OF SUB-SOIL WATER:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content
1	6.5	66	61	32
2	6.6	68	64	27
3	6.6	65	62	23

The above results show that the strata is quite safe for ***Concrete & Reinforcement*** for the site.

INTERPRETATION OF TEST RESULTS:

The exact choice of type of **foundation** shall depend on the relative economics and practical considerations.

The safe load carrying capacity of a bored cast in-situ concrete pile in cohesive soil layer shall be governed by IS: 2911 (Part I/Sec2) - 1979 code of practice for determination of allowable pile load capacitye of pile **foundation** for structural safety of Structures.

STANDARD PENETRATION TEST

The field S.P.T is corrected for both Over burden pressure and for dilatancy (As per IS:2131-1982)

B.H No.	Depth (m)	Over burden Pressure kg/cm^2	No. of Blows Recorded at field for Penetration			N-value	Corrected N-value
			15 cm	30 cm	45 cm		
9	1.5	0.150	2	2	4	6	9
	3.0	0.300	2	4	4	8	11
	4.5	0.450	2	2	3	5	6
	6.0	0.600	4	5	5	10	11
	7.5	0.750	3	5	6	11	12
	9.0	0.900	5	6	7	13	13
10	1.5	0.150	1	1	2	3	5
	3.0	0.300	3	5	7	12	16
	4.5	0.450	4	7	8	15	17
	6.0	0.600	4	7	7	14	16
	7.5	0.750	5	7	8	15	16
	9.0	0.900	4	4	5	9	9

PILE LOAD CAPACITY

The safe load carrying capacity of concrete bored cast in-situ piles (Qs) in cohesive soil has been calculated out using the following formula as per IS: 2911 (Part I/Sec2) - 1979

$$Qs = (Ap\ Nc\ Cp + \alpha\ C'\ As) / F$$

Where Ap = cross sectional area of pile toe in cm^2

Nc = bearing capacity factor

Cp = average cohesion at pile tip in kg / cm^2

α = reduction factor

C' = average cohesion throughout the length of pile in kg / cm^2

As = surface area of pile shaft in cm^2

F = factor of safety

For Borehole No. 9

L = Length of pile = 900 cm

Lne = Non-effective length of pile = 150 cm

Le = Effective length of pile = 900 - 150 = 750 cm

D = 40 cm

Ap = (3.1415 / 4) x 40^2 = 1,256.64 cm^2

As = 3.1415 x 40 x 750 = 94,247.78 cm^2

Cp = 0.560 kg / cm^2

C' = 0.480 kg / cm^2

Nc = 9

α = 0.5

F = 2.5

Qs = (1,256.64 x 9 x 0.56 + 0.5 x 0.48 x 94,247.78) / 2.5

= 11581.17 kg = 11.58 ton

RECOMMENDATION:

From field and laboratory investigations, it is found that the soil is clayey in nature and in loose state,so the soil is unsuitable for shallow foundation.From the structural point of view it is recommended to addopt pile foundation which is tabulated below as per requirement of pile capacity.

Length of Pile = 9.0 m from cutoff level)

Type of Pile	B.H No.	Diameter Of Pile (cm)	Pile Load Capacity (ton)	Recommended Pile Load Capacity (ton)	
				40 cm dia.	60 cm dia.
Cast-in-situ R.C.C Bored Concrete Pile	9	40.00	10.55 ??	10.00	17.00
		60.00	17.65		
Cast-in-situ R.C.C Bored Concrete Pile	10	40.00	11.58		
		60.00	19.27		

However,the theoretical load carrying capacity of pile is to be verified by conducting load test on pile.

RESULTS OF LABORATORY TEST

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
9	1	1.50	DS	33.53	1.41	1.88	0.89	2.66	40.55	28.36	12.19	-	6.00	25.00	69.00	-	-
	2	2.00	UDS	32.18	1.44	1.90	0.85	2.66	40.18	26.43	13.75	-	4.00	26.00	70.00	0.33	-
	3	3.00	DS	34.56	1.40	1.88	0.90	2.66	38.65	28.95	9.70	-	5.00	23.00	72.00	-	-
	4	3.50	UDS	33.08	1.45	1.93	0.83	2.66	39.78	29.78	10.00	-	3.00	22.00	75.00	0.39	-
	5	4.50	DS	37.85	1.39	1.92	0.91	2.66	39.40	27.45	11.95	-	6.00	24.00	70.00	-	-
	6	6.00	DS	37.32	1.40	1.92	0.91	2.67	40.22	26.98	13.24	-	3.00	25.00	72.00	-	-
	7	6.50	UDS	34.18	1.42	1.91	0.87	2.66	40.68	28.10	12.58	-	6.00	26.00	68.00	0.42	-
	8	7.50	DS	36.23	1.41	1.92	0.89	2.66	38.76	27.36	11.40	-	5.00	26.00	69.00	0.46	-
	9	9.00	DS	37.30	1.40	1.92	0.91	2.67	37.29	28.14	9.15	-	7.00	23.00	70.00	0.54	-

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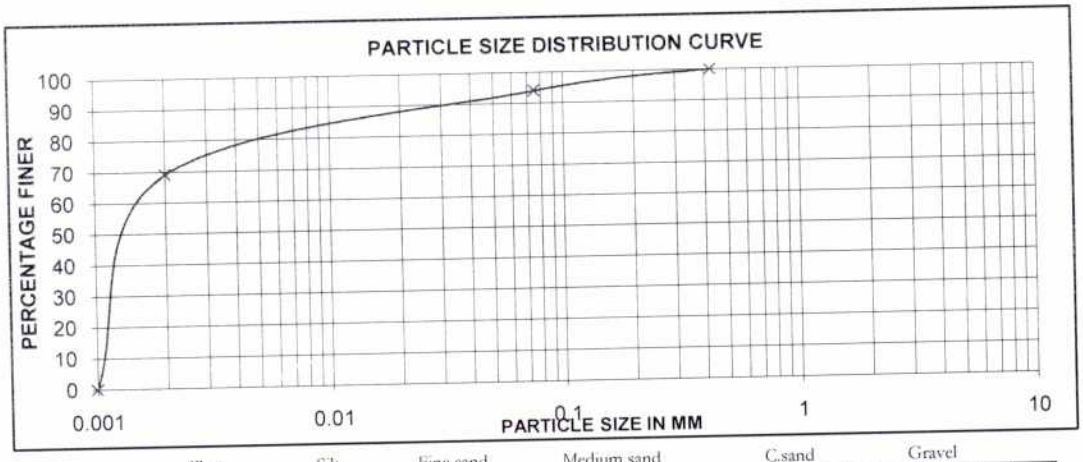
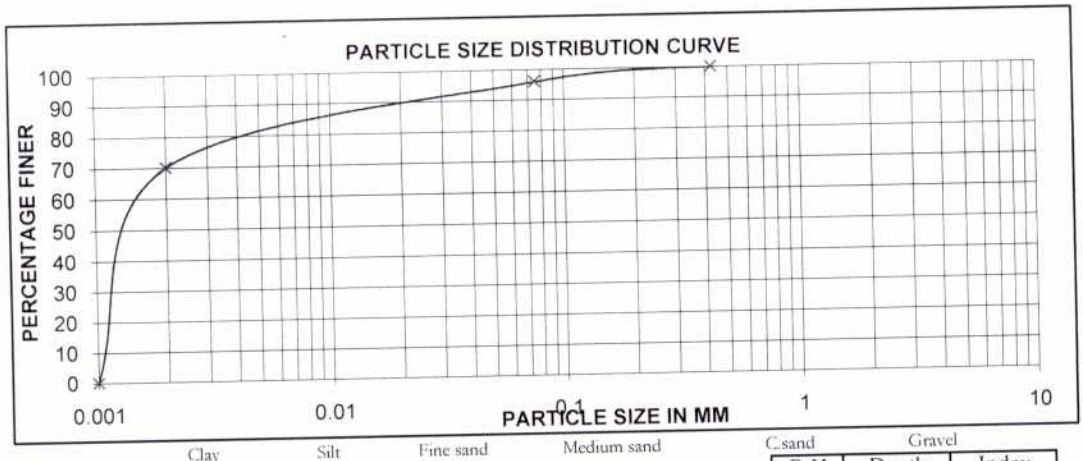
Ghy-7

RESULTS OF LABORATORY TEST

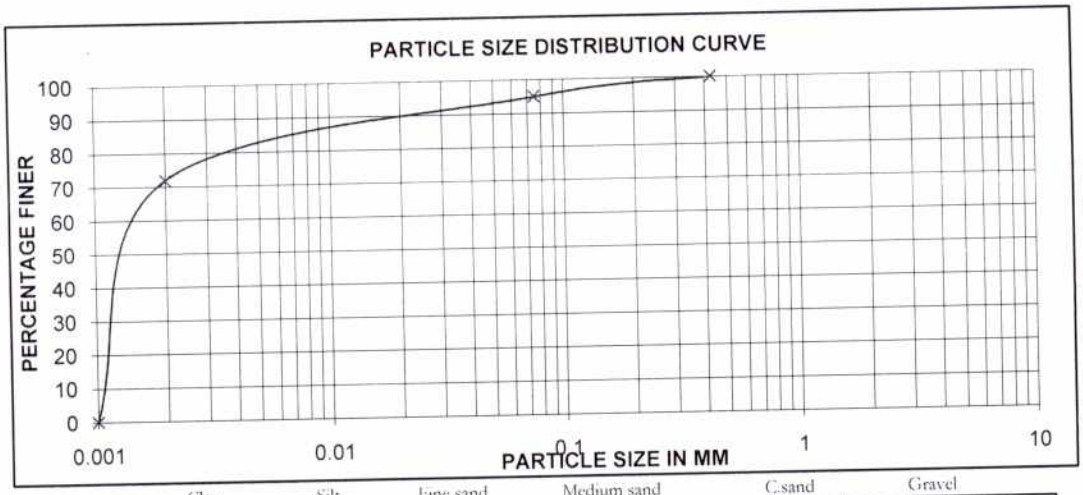
BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
10	1	1.50	DS	30.32	1.44	1.88	0.85	2.67	-	-	-	-	97.00	2.00	1.00	-	28^o
	2	3.00	DS	31.96	1.45	1.91	0.84	2.66	39.11	29.53	9.58	-	4.00	25.00	71.00	-	-
	3	3.50	UDS	30.59	1.48	1.93	0.80	2.66	37.22	27.15	10.07	-	4.00	27.00	69.00	0.37	-
	4	4.50	DS	37.05	1.42	1.95	0.88	2.67	39.30	26.33	12.97	-	3.00	25.00	72.00	-	-
	5	5.00	UDS	35.43	1.43	1.94	0.86	2.66	40.18	28.93	11.25	-	9.00	23.00	68.00	0.45	-
	6	6.00	DS	34.51	1.43	1.93	0.85	2.66	38.76	27.81	10.95	-	1.00	24.00	75.00	-	-
	7	6.50	UDS	32.84	1.44	1.91	0.86	2.67	37.29	26.39	10.90	-	4.00	25.00	71.00	0.53	-
	8	7.50	DS	34.26	1.45	1.95	0.83	2.66	38.55	27.08	11.47	-	8.00	22.00	70.00	-	-
	9	9.00	DS	30.66	1.47	1.92	0.82	2.67	37.28	27.15	10.13	-	5.00	25.00	70.00	-	-
	10	9.50	UDS	31.22	1.47	1.93	0.82	2.67	38.20	27.08	11.12	-	7.00	24.00	69.00	0.56	-



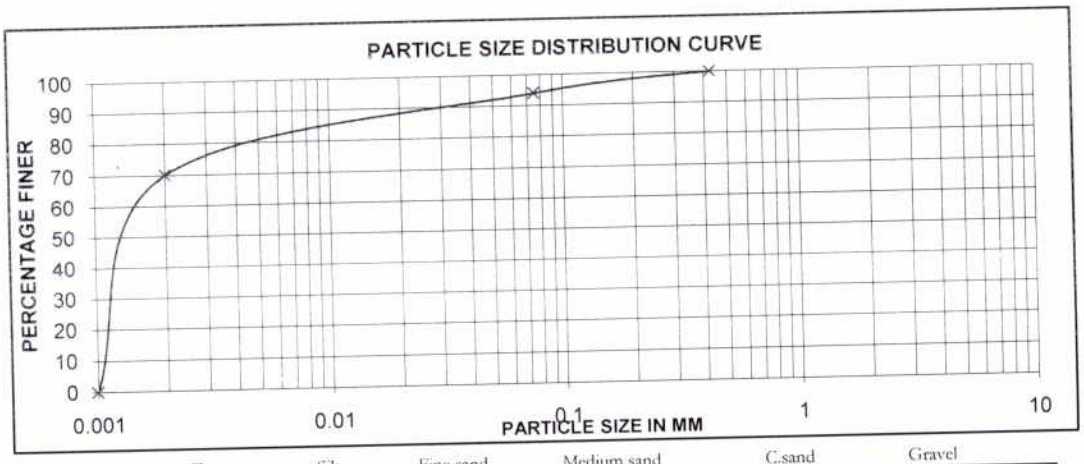
B.H	Depth	Index
9	1.5	



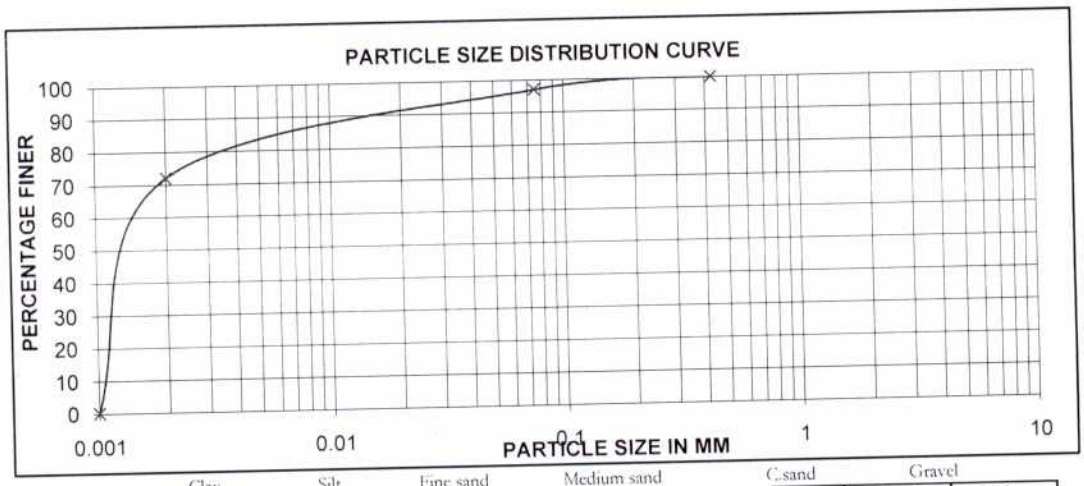
B.H	Depth	Index
9	2.0	



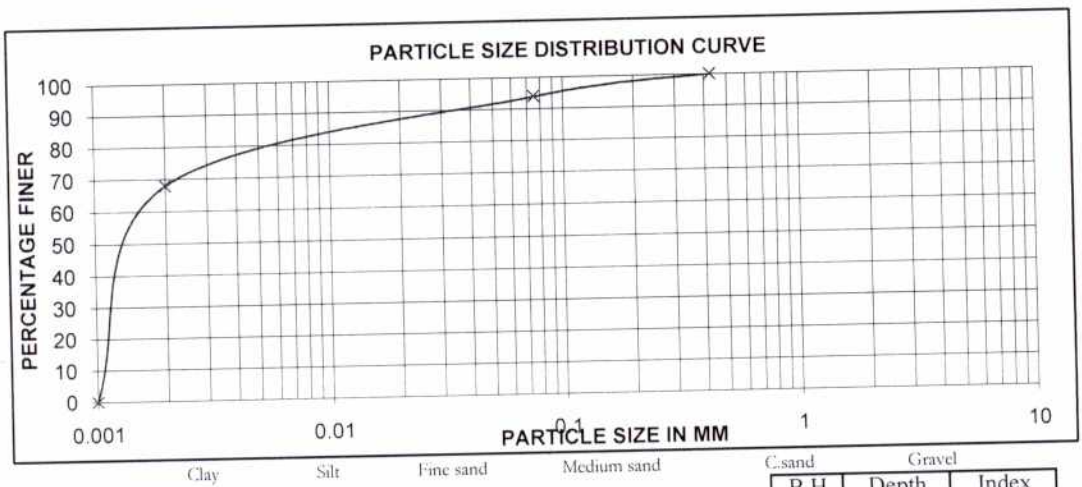
B.H	Depth	Index
9	3.0	



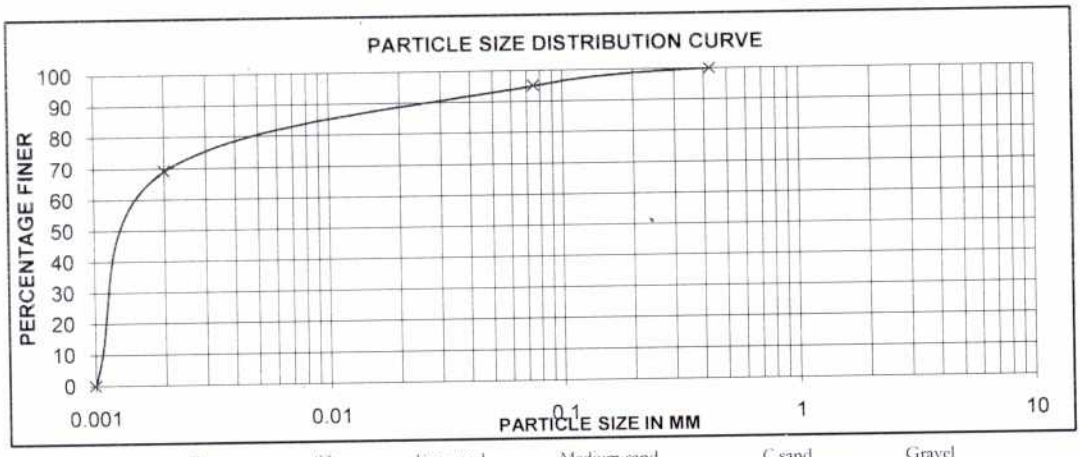
B.H	Depth	Index
9	4.5	



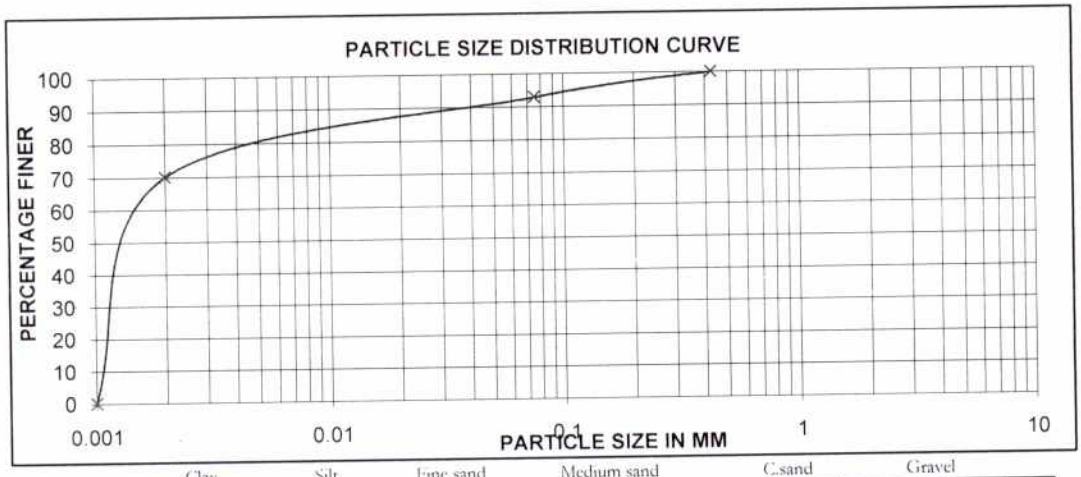
B.H	Depth	Index
9	6.0	



B.H	Depth	Index
9	6.5	



B.H	Depth	Index
9	7.5	



B.H	Depth	Index
9	9.0	

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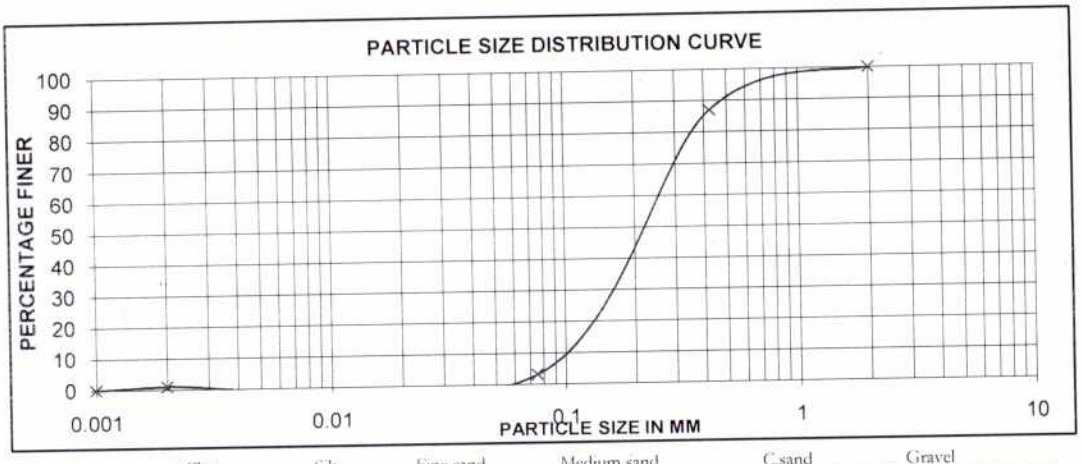
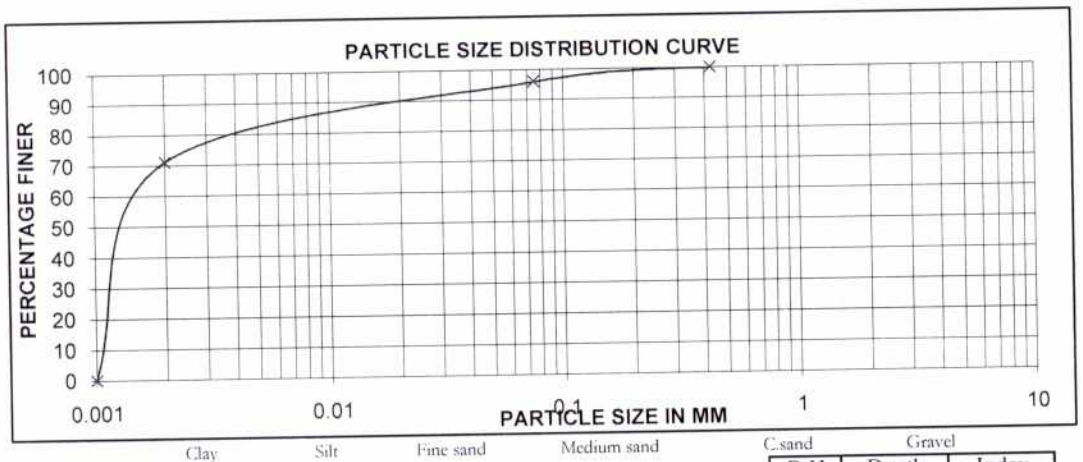
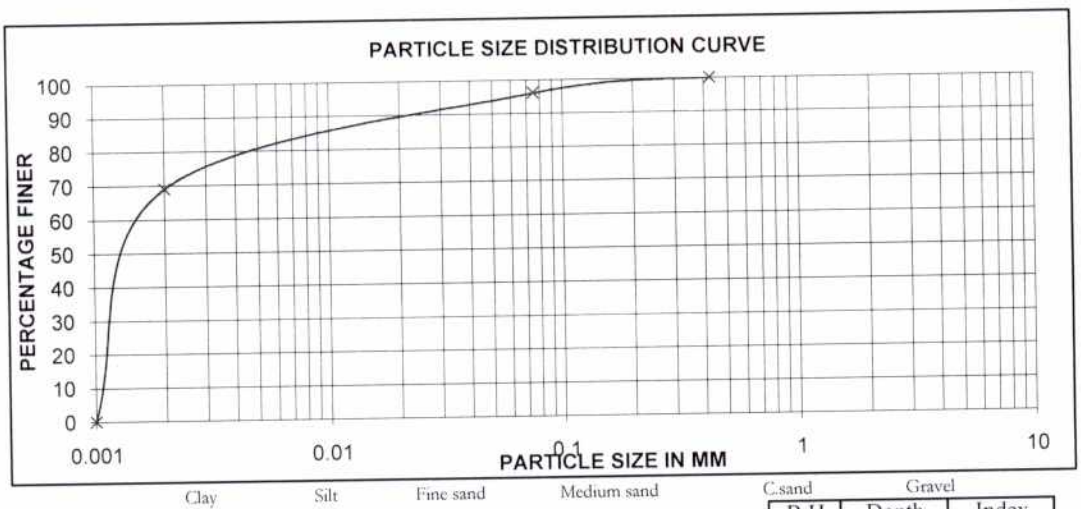


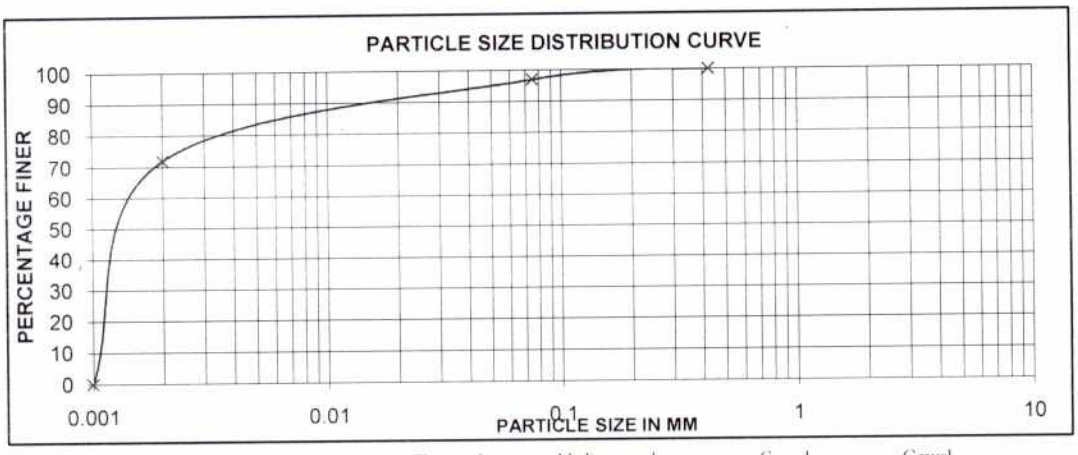
B.H	Depth	Index
10	1.5	



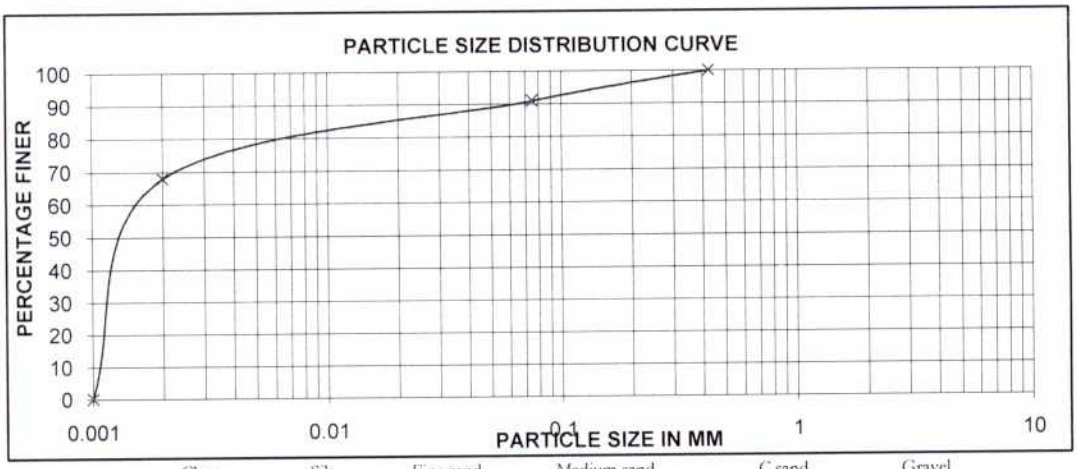
B.H	Depth	Index
10	3.0	



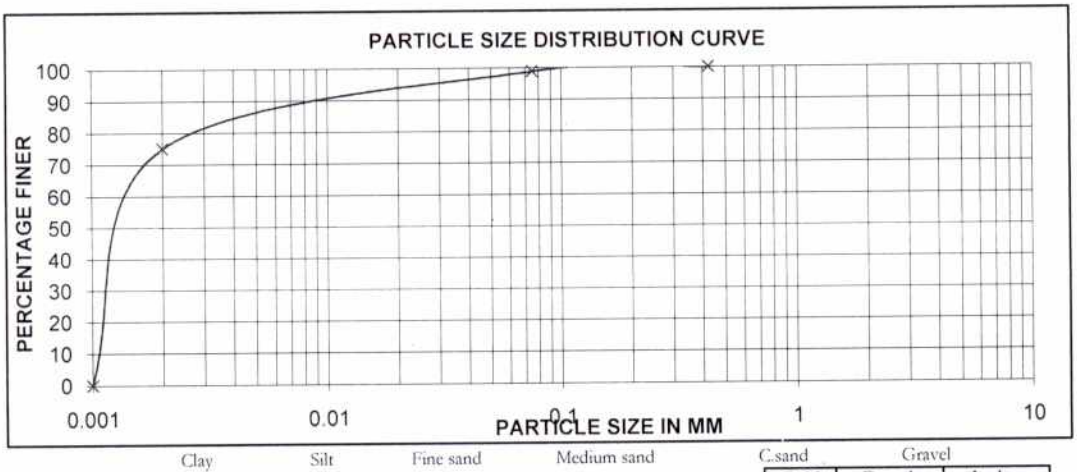
B.H	Depth	Index
10	3.5	



B.H	Depth	Index
10	4.5	

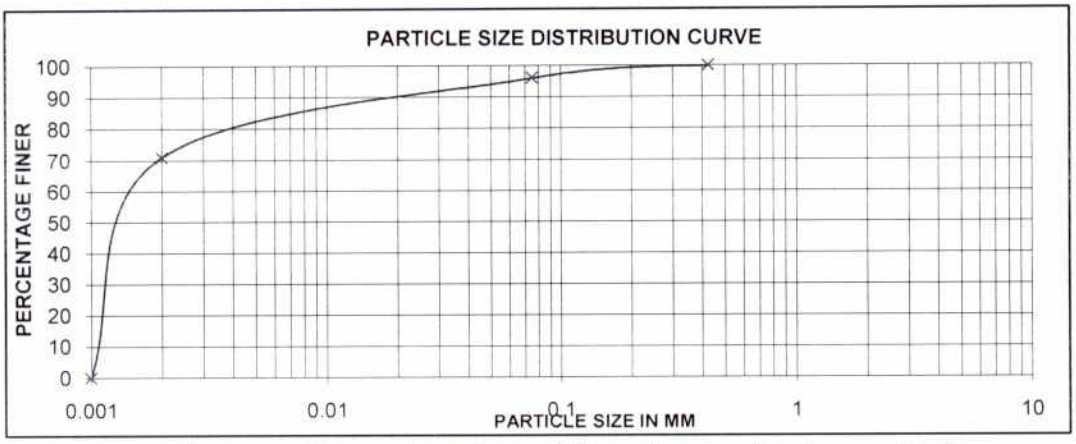


B.H	Depth	Index
10	5.0	

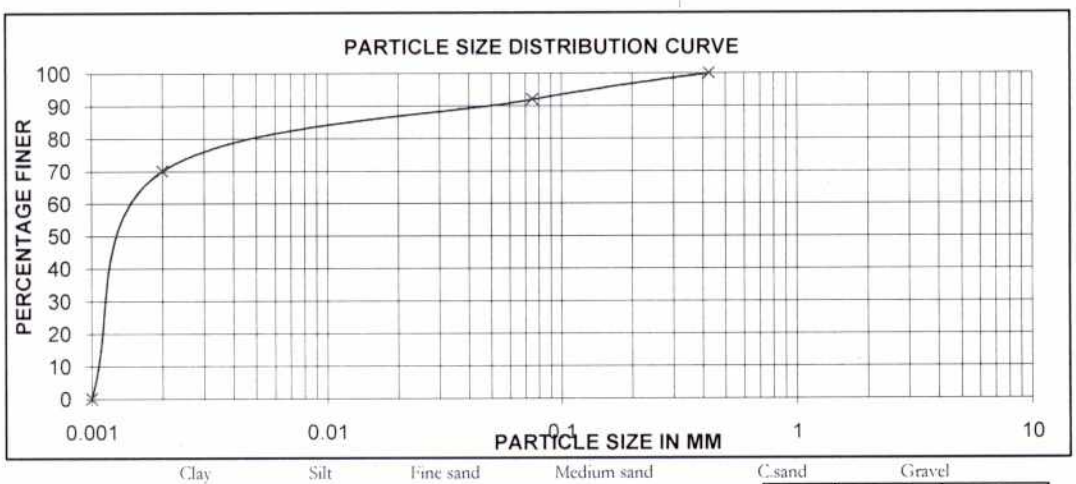


B.H	Depth	Index
10	6.0	

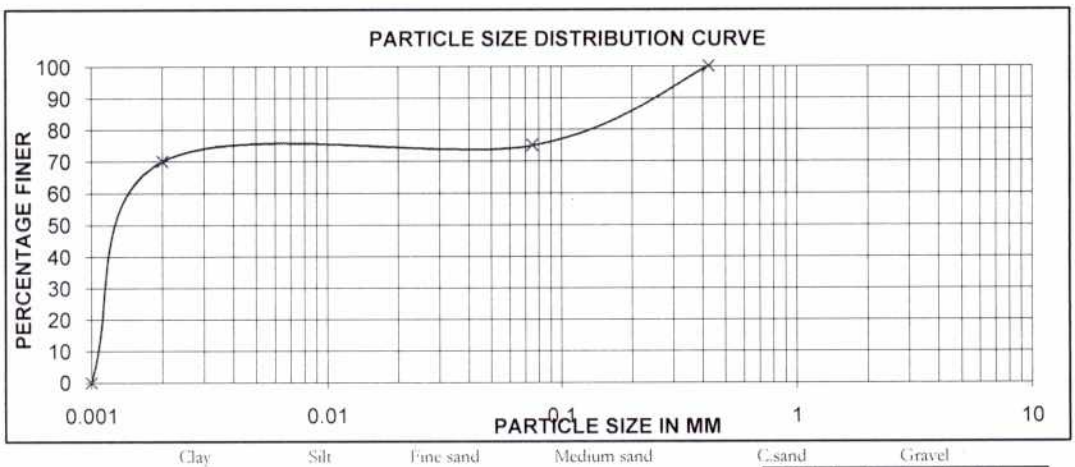
FOUNDATION PRIVATE LTD.



B.H	Depth	Index
10	6.5	

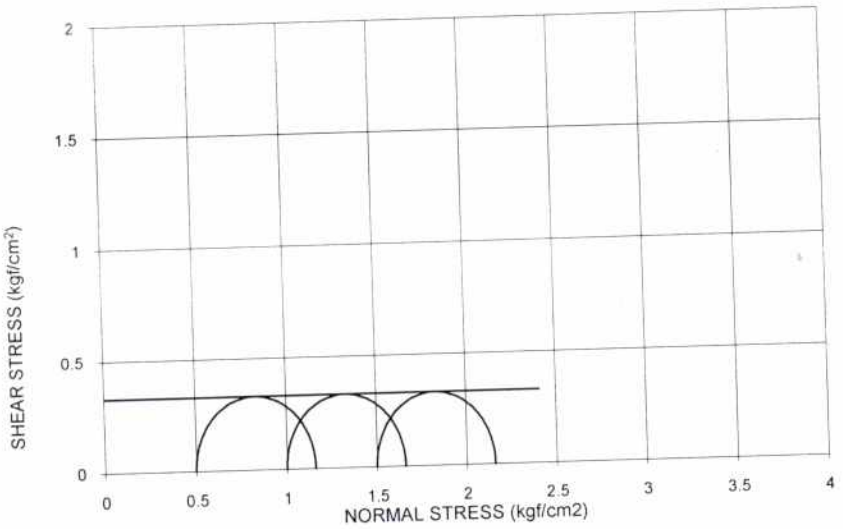


B.H	Depth	Index
10	7.5	



B.H	Depth	Index
10	9.0	

SHEAR TEST GRAPH



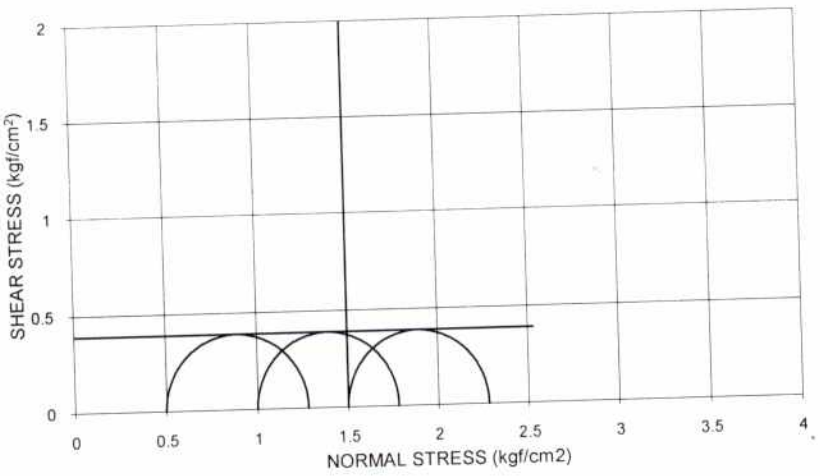
BH NO: 9

DEPTH: 2.0 m

C = 0.33 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



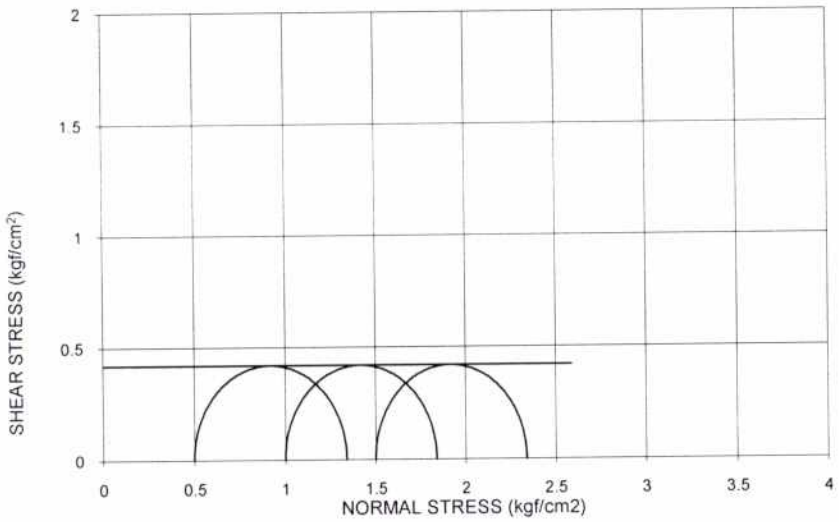
BH NO: 9

DEPTH: 3.5 m

C = 0.39 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



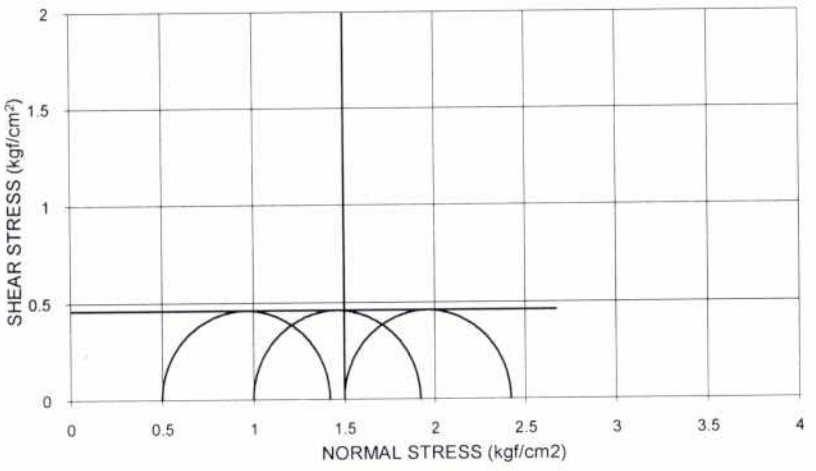
BH NO: 9

DEPTH: 6.5 m

C = 0.42 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



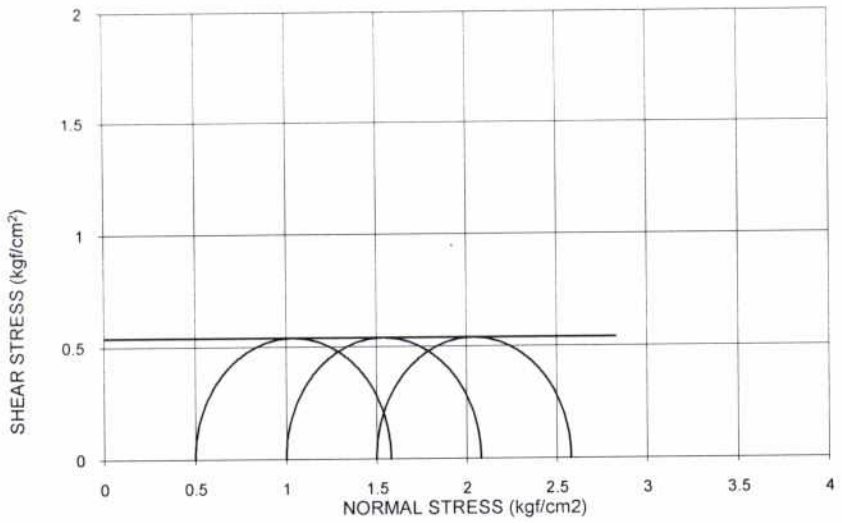
BH NO: 9

DEPTH: 7.5 m

C = 0.46 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 9

DEPTH: 9.0 m

C = 0.54 kgf/cm^2

Φ = 0.0 °

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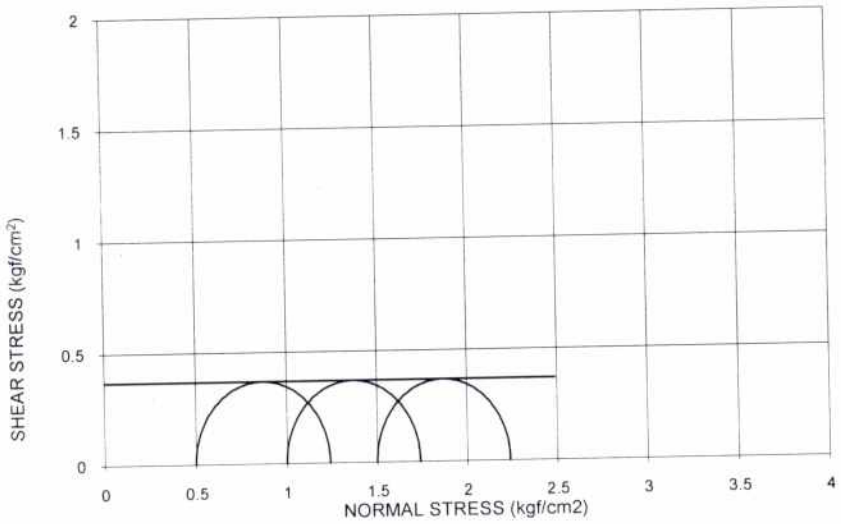
SHEAR TEST GRAPH



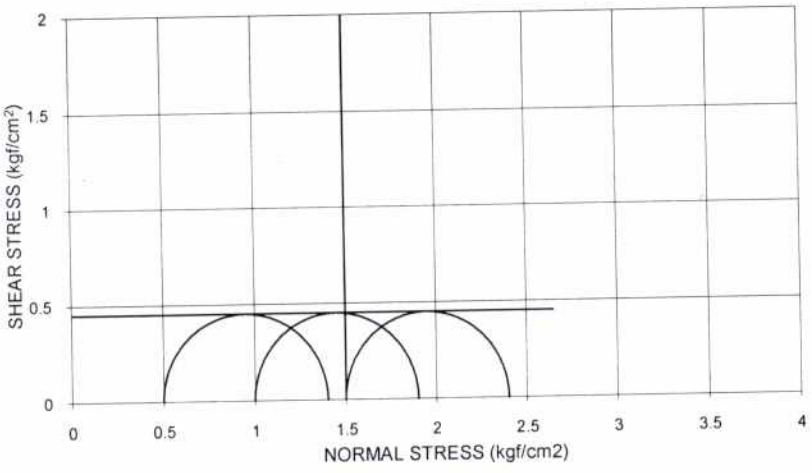
BH NO: 10

DEPTH: 3.5 m

C = 0.37 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 10

DEPTH: 5.0 m

C = 0.45 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH

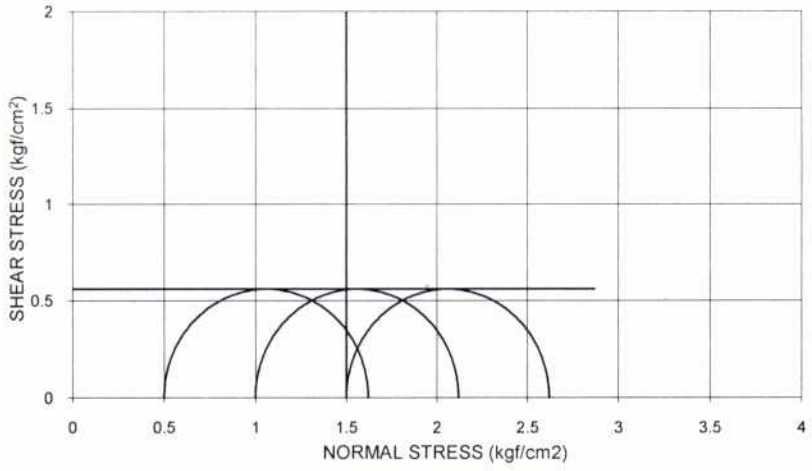
BH NO: 10

DEPTH: 6.5 m

C = 0.53 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



BH NO: 10

DEPTH: 9.5 m

C = 0.56 kgf/cm^2

Φ = 0.0 °

Part - 4

AT RIVER PROTECTION WORKS LOCATION

BORE HOLE LOG DATA SHEET

Bore Hole No.: 07

No. of SP Test	2	Samples	Nos.	Commencement Date :	24/08/2012
No. of Vane(V) Test	-	Undisturbed (UDS)	1	Completion Date :	30/08/2012
Length of Casing	3.0	Penetrometer (SPT)	2	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	2	Level of Ground :	RL-50.002 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-48.082 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
Clay mixed with silt		1 1 1	SPT-01	1.00 - 1.50 m
		N = 2	UDS-01	1.50 - 2.00 m
				2.00 - 2.50 m
		5 13 28	SPT-02	2.50 - 3.00 m
Clay mixed with silt		N = 41		3.00 - 3.50 m
				3.50 - 4.00 m
				4.00 - 4.50 m
				4.50 - 5.00 m
				5.00 - 5.50 m
				5.50 - 6.00 m
				6.00 - 6.50 m
				6.50 - 7.00 m
Rock				7.00 - 7.50 m
				7.50 - 8.00 m
				8.00 - 8.50 m
				8.50 - 9.00 m
				9.00 - 9.50 m
				9.5 - 10.00 m
				10.00-10.50 m

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BORE HOLE LOG DATA SHEET

Bore Hole No.: 08

No. of SP Test	6	Samples	Nos.	Commencement Date :	18/08/2012
No. of Vane(V) Test	-	Undisturbed (UDS)	1	Completion Date :	23/08/2012
Length of Casing	3.0	Penetrometer (SPT)	6	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	6	Level of Ground :	RL-48.500 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-47.700 m

DESCRIPTION	SYMBOL	N-VALUE Each 15 cm	SAMPLES REF. NO.	SAMPLES DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
		1 1 2	SPT-01	1.00 - 1.50 m
		N = 3	UDS-01	1.50 - 2.00 m
				2.00 - 2.50 m
		2 2 3	SPT-02	2.50 - 3.00 m
Clay grey in colour		N = 5		3.00 - 3.50 m
				3.50 - 4.00 m
		2 3 3	SPT-03	4.00 - 4.50 m
		N = 6		4.50 - 5.00 m
				5.00 - 5.50 m
		2 3 4	SPT-04	5.50 - 6.00 m
		N = 7		6.00 - 6.50 m
				6.50 - 7.00 m
		4 4 5	SPT-05	7.00 - 7.50 m
		N = 9		7.50 - 8.00 m
				8.00 - 8.50 m
		13 19 23	SPT-06	8.50 - 9.00 m
Clay mixed with silt grey in colour		N = 42		9.00 - 9.50 m
				9.5 - 10.00 m
				10.00-10.50 m
				10.50-11.00 m
				11.00-11.50 m
				11.50-12.00 m
Rock				12.00-12.50 m
				12.50 -13.00 m
				13.00-13.50 m
				13.50-14.00 m
				14.00-14.50 m
				14.50-15.00 m

CHEMICAL ANALYSIS OF SOIL:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content	Reaction to acid
1	6.8	63	59	17	Nil
2	6.8	65	62	19	Nil
3	6.7	67	60	21	Nil

CHEMICAL ANALYSIS OF SUB-SOIL WATER:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content
1	6.7	65	58	35
2	6.7	64	61	33
3	6.7	66	64	29

The above results show that the strata is quite safe for ***Concrete & Reinforcement*** for the site.

FOUNDATION PARAMETERS.

Allowable Bearing capacity values are based on the following parameters :

Square footings.

Depth of footings (D_f) = 3.0 metre.

Size of footings (B) = 2.0 metre.

The safe load carrying capacity of a bored cast in-situ concrete pile in cohesive soil layer shall be governed by IS: 2911 (Part I/Sec2) - 1979 code of practice for determination of allowable pile load capacitye of pile **foundation** for structural safety of Structures.

STANDARD PENETRATION TEST

The field S.P.T is corrected for both Over burden pressure and for dilatancy (As per IS:2131-1982)

B.H No.	Depth (m)	Over burden Pressure kg/cm^2	No. of Blows Recorded at field for Penetration			N-value	Corrected N-value
			15 cm	30 cm	45 cm		
7	1.5	0.150	1	1	2	3	5
	3.0	0.300	5	13	28	41	35
8	1.5	0.150	1	1	2	3	5
	3.0	0.300	2	2	3	5	7
	4.5	0.450	2	3	3	6	7
	6.0	0.600	2	3	4	7	8
	7.5	0.750	4	4	5	9	10
	9.0	0.900	13	19	23	42	29

COMPUTATION OF ALLOWABLE BEARING CAPACITY

A)Based on Standard Penetration Resistance value:

q_{ns} = $((q (N_q-1) s_q d_q i_q + 0.5 B \gamma N_\gamma s_\gamma d_\gamma i_\gamma W') / F) \times 10\ t / m^2$

Where

N_q, N_γ = Bearing capacity factors

s_q, s_γ = Shape factors

For square footing s_q = 1.2 s_γ = 1

B = Width dia of foundation in cm

$d_q = d_\gamma$ = Depth factors = 1.00 for $\phi < 10^0$

= $1 + 0.1 (D_f / B) \times \text{sqrt} (N_\phi)$ for $\phi > 10^0$

ϕ = Angle of shearing resistance of soil in degrees

N_ϕ = $\tan^2 (45^0 + \phi / 2)$

D_f = Depth of foundation in cm

N_ϕ = $\tan^2 (45^0 + \phi / 2)$ = 1

i_q = Inclination factors = $(1- (\alpha / 90))^2$

i_γ = Inclination factor = $(1- (\alpha / \phi))^2$

α = Inclination of the load to the vertical in degrees

q = Effective surcharge at the base level of foundation in kgf / cm^2

γ = Bulk unit weight of foundation soil in kgf / cm^3

W' = Water table correction factor

F = Factor of safety

For BH.NO - 7

At depth D_f = 300 cm

Average N -value = (5 + 35) / 2 = 20.00

For N = 20 ϕ = 33.32° ϕ_{cor} = 30.51° Say 30°

For ϕ = 30° N_q = 18.40 N_γ = 22.40

S_q = 1.2 S_γ = 0.80

$d_q = d_\gamma$ = 1+ 0.1 (300 / 200) x tan (45 + 30 / 2) = 1.26

α = 0° $i_\gamma = i_q$ = 1.00

γ = 0.002 Kgf/cm^2

γ' = 0.001 Kgf /cm^2

q = 0.001 x 300 = 0.30 kgf/cm^2

W' = 0.5

F = 2.5

q_{ns} = {(0.30 x (18.4 -1) x1.20 x1.26 x 1.00 + 0.50 x 200 x 0.002 x 22.40 x 0.8 x 1.26 x 1.00 x 0.5)/2.5} x 10

= 40.60 t/m^2

B) FROM C-Ø VALUE :

For bearing capacity the following formula has been adopted as per I.S: 6403 - 1981.

q_s = (c 5.14 s_c d_c i_c) / F) x 10 t / m^2 (when $\phi = 0$)

For Local Shear Failure

q_s = ((2/3 c N'_c s_c d_c i_c + q (N'_q-1) s_q d_q i_q + 0.5 B γ N'_γ s_γ d_γ i_γ W') / F) x 10 t / m^2

For Borehole No. 7

B = 300 cm

At depth D_f = 300 cm

ϕ = 33.00 ° ϕ_{cor} = 29.85 ° Say 29 ° C = 0.00

For ϕ = 29 ° N_q = 16.44 N_γ = 19.33

s_q = 1.20 s_γ = 0.80

d_q=d_γ = 1 + 0.1(300 / 300) x tan (45 + 29 / 2) = 1.17

s_c = 1.30

d_c = 1 + 0.2 (300 / 300) x tan (45) = 1.20

α = 0 ° i_q=i_γ = 1.00 = ic

γ = 0.00200 kgf / cm^3

γ' = 0.00100 kgf / cm^3 q = 0.001 x 300 = 0.300 kgf / cm^2

W' = 0.50

F = 3

q_s = {2/3 x 0.00 X 0.00 X 1.30 X 1.20 X 1.00 + 0.300 x (16.44 - 1) x 1.20 x 1.17 x 1.00 + 0.50 x 300 x 0.00200 x 19.33 x 0.8 x 1.17 x 1.00 x 0.5}/ 3 x 10

= 30.72 t / m^2

PILE LOAD CAPACITY

The safe load carrying capacity of a bored cast in-situ concrete pile passing through clayey soil layer and resting on granular soil has been worked out by using the following formular as per IS: 2911 (Part I/Sec 2) - 1979

$Q_s = ((Ap(0.5\ D\ \gamma\ N_\gamma + P_D\ N_q) + \alpha\ C'\ As) / F) / 1000$ t

Where A_p = Cross sectional area of pile stem at toe level in cm^2

D = Stem diameter in cm

γ = Effective unit weight of soil at pile toe in kgf / cm3

P_D = Effective overburden pressure at pile toe in kgf / cm^2

$N\gamma$ & N_q = Bearing capacity factors depending upon the angle of internal friction f at toe

α = Reduction factor

C' = Average cohesion of the soil along the pile stem in kgf / cm^2

A_s = Surface area of the stem in cm^2

F = Factor of safety

PILE LOAD CAPACITY CALCULATION

For Borehole No. 8

Length of pile = 1100 cm

D = 40 cm

Effective pile length for overburden pressure = 20 x 40 = 800 cm

γ = 0.001 kgf/cm^2

P_D = 0.80 kgf / cm^2

ϕ = 45 ^{o}

N_γ = 271.75

N_q = 347.0

α = 0.5

C' = 0.360 kgf / cm^2

Ap = (3.1415 / 4) x 40^2 = 1,256.64 cm^2

Effective shaft length = 950 cm

As = 119,380.52 cm^2

F = 2.5

Qs = ((1,256.64 x (0.5 x 40 x 0.001 x 271.75 + 0.8 x 347) + 0.5 x 0.36 x 119,380.52) / 2.5) / 1000

= 150.86 ton

RECOMMENDATION:

From field and laboratory investigations, the following recommendations have been made for the purpose of design of foundation.

A) *In the area tentitively covered by Bore Hole No.07,the rock formation is found 3.0 m below the ground surface which is suitable for shallow foundation and economic.So it is recommended to lay the foundation in this area over rock bed surface considering net safe bearing capacity 30.0 t/m^2 for design of foundation.*

B) *In the area which is covered by Bore Hole No.08,the rock bed is found nearly 11.0 m beneath the ground surface and from the structural point of view Pile foundation is required forthis area. So it is recommended to addopt pile foundation which is tabulated below as per requirement of pile capacity.*

Length of Pile = 11.0 m from cutoff level)

Type of Pile	B.H No.	Diameter Of Pile (cm)	Pile Load Capacity (ton)	Recommended Pile Load Capacity (ton)	
				40 cm dia.	60 cm dia.
Cast-in-situ R.C.C Bored Concrete Pile	8	40.00	150.86	150.00	493.00
		60.00	493.05		

However,the theoretical load carrying capacity of pile is to be verified by conducting load test on pile.

RESULTS OF LABORATORY TEST

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
7	1	1.50	DS	32.10	1.42	1.88	0.87	2.66	40.55	28.62	11.93	-	7.00	26.00	67.00	-	-
	2	2.00	UDS	31.67	1.44	1.89	0.85	2.65	39.87	27.84	12.03	-	11.00	27.00	62.00	0.21	-
	3	3.00	DS	18.36	1.61	1.91	0.65	2.67	-	-	-	-				-	33^{o}

Tests on Rock Samples

SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	FORMATION OF CORE	COLOUR	WATER ABSORPTION	POROSITY	DENSITY (gm/cc)	UNIAXIAL COMP (Kg/cm^2)	REMARKS
1	3.50	Core	Soft sand stone	Yellow	0.34 %	1.01	3.17	1426.40	-
2	4.50	Core	Soft sand stone	Yellow	0.33 %	1.03	3.25	1432.67	-
3	6.00	Core	Soft sand stone	Yellow	0.30 %	1.01	3.11	1444.32	-
4	7.50	Core	Granite	Yellow	0.21 %	1.07	3.08	1879.44	-
5	9.00	Core	Granite	White	0.23 %	1.09	3.31	1924.38	-

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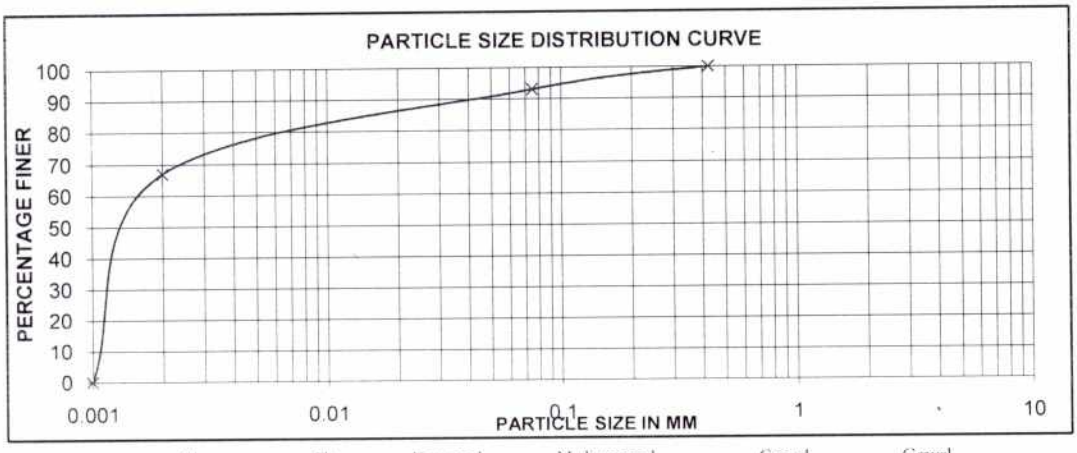
RESULTS OF LABORATORY TEST

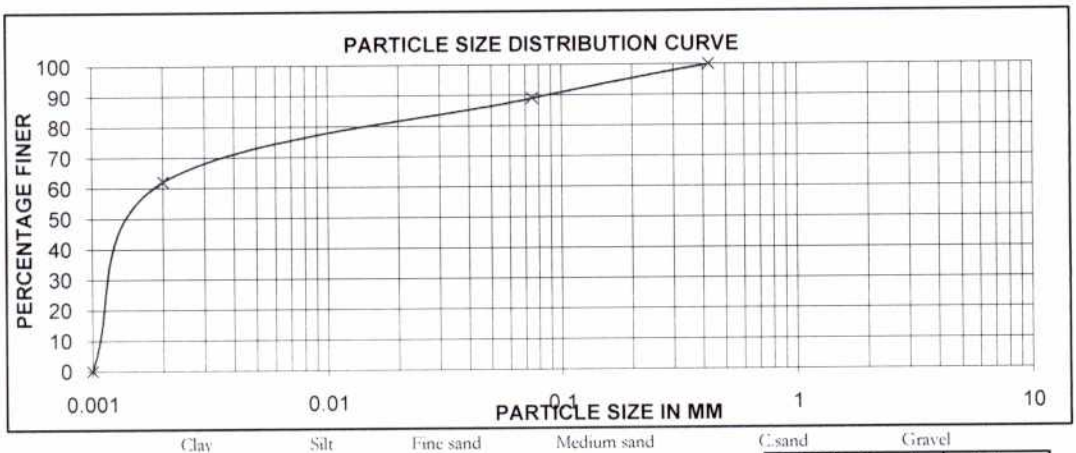
BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
8	1	1.50	DS	42.68	1.32	1.89	1.01	2.66	39.23	28.71	10.52	-	5.00	24.00	71.00	-	-
	2	3.00	DS	43.17	1.32	1.89	1.01	2.66	38.72	27.11	11.61	-	3.00	28.00	69.00	0.28	-
	3	4.50	DS	45.72	1.29	1.88	1.06	2.66	39.15	28.30	10.85	-	6.00	24.00	70.00	0.33	-
	4	6.00	DS	36.79	1.38	1.89	0.93	2.67	40.13	26.33	13.80	-	5.00	24.00	71.00	0.36	-
	5	7.50	DS	36.21	1.39	1.90	0.91	2.66	37.88	27.21	10.67	-	6.00	26.00	68.00	0.39	-
	6	9.00	DS	33.49	1.43	1.91	1.94	2.67	-	-	-	-	12.00	23.00	65.00	0.43	-

Tests on Rock Samples

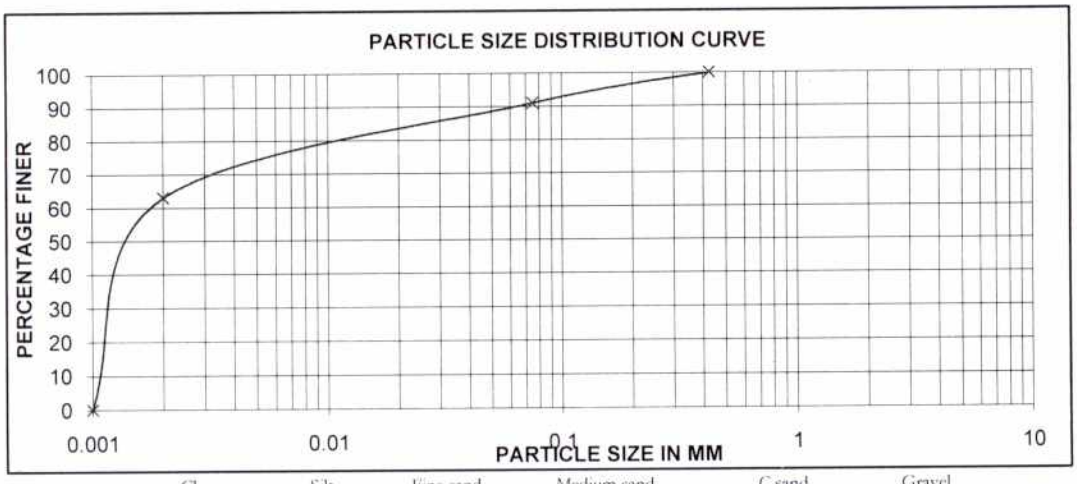
SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	FORMATION OF CORE	COLOUR	WATER ABSORPTION	POROSITY	DENSITY (gm/cc)	UNIAXIAL COMP (Kg/cm^2)	REMARKS
1	10.50	Core	Soft sand stone	Yellow	0.34 %	1.02	3.16	997.45	-
2	12.00	Core	Soft sand stone	Yellow	0.48 %	1.04	3.20	713.20	-
3	13.50	Core	Soft sand stone	Yellow	0.44 %	1.03	3.03	835.51	-
4	15.00	Core	Granite	White	0.22 %	1.08	3.22	1956.58	-



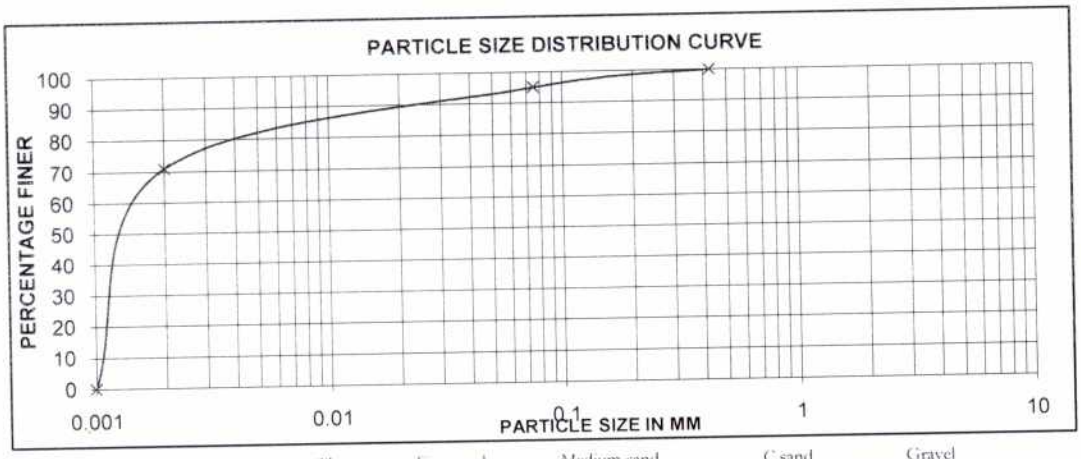
B.H	Depth	Index
7	1.5	



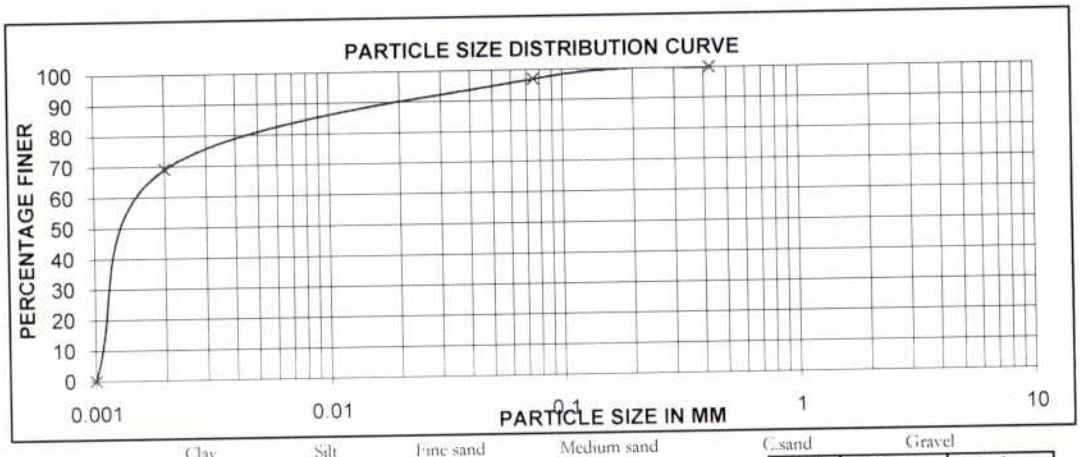
B.H	Depth	Index
7	2.0	



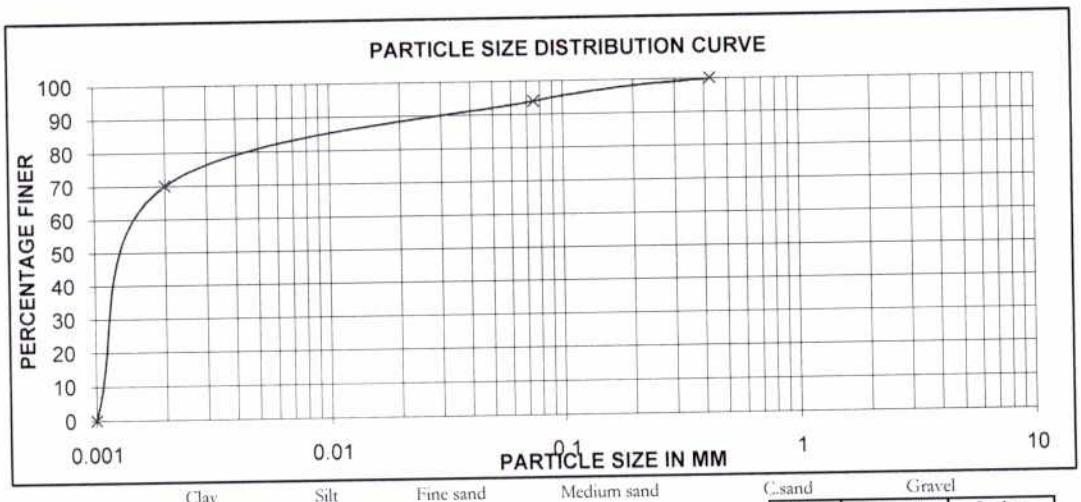
B.H	Depth	Index
7	3.0	



B.H	Depth	Index
8	1.5	



B.H	Depth	Index
8	3.0	



B.H	Depth	Index
8	4.5	

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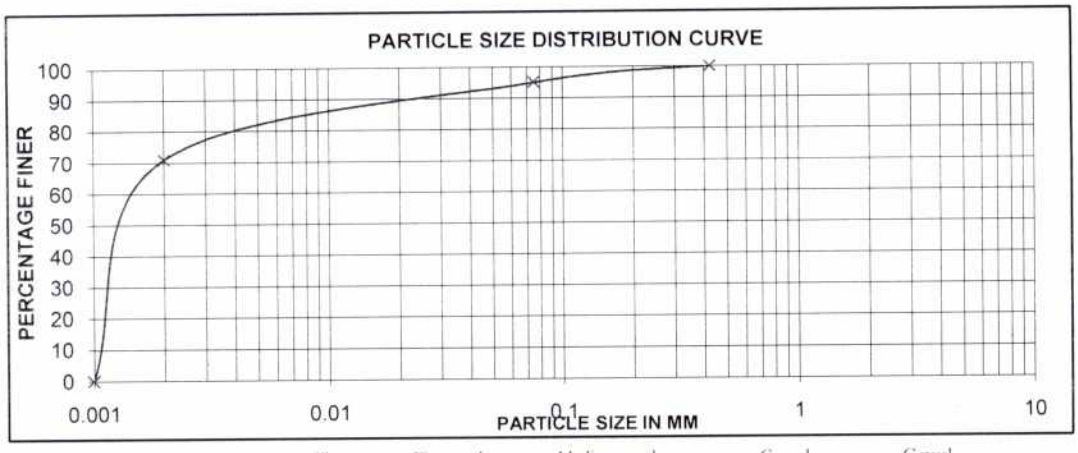
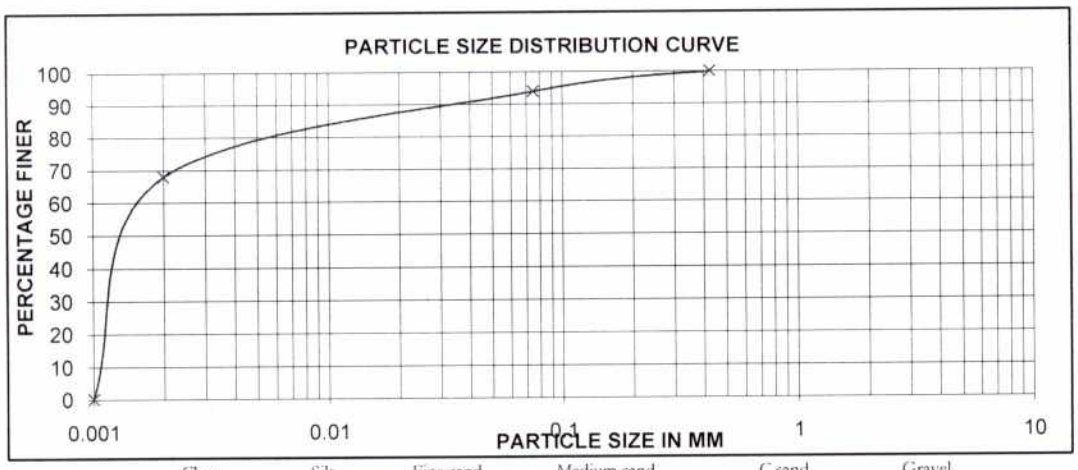
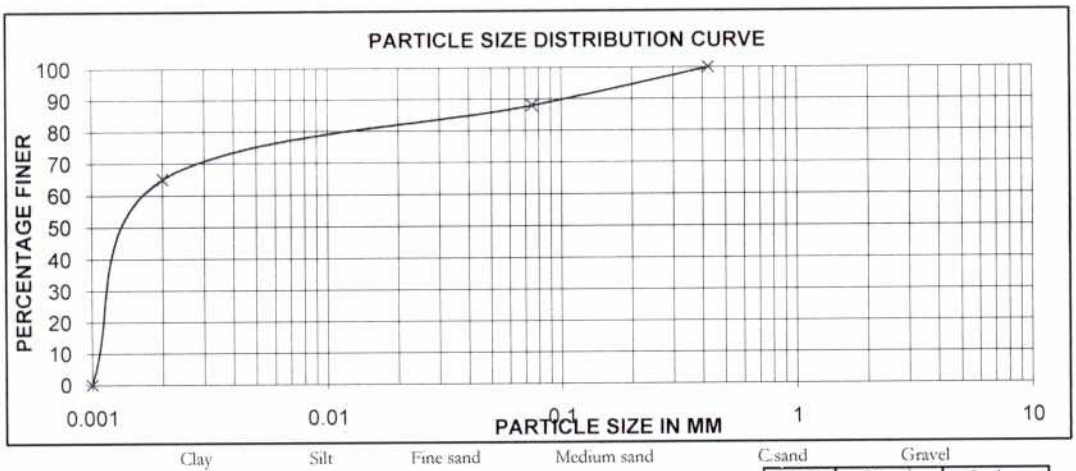


B.H	Depth	Index
8	6.0	

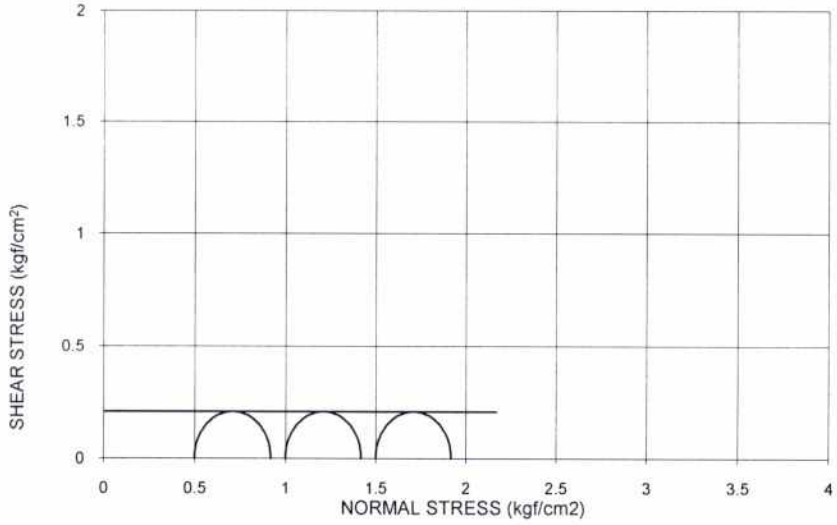


B.H	Depth	Index
8	7.5	



B.H	Depth	Index
8	9.0	

SHEAR TEST GRAPH



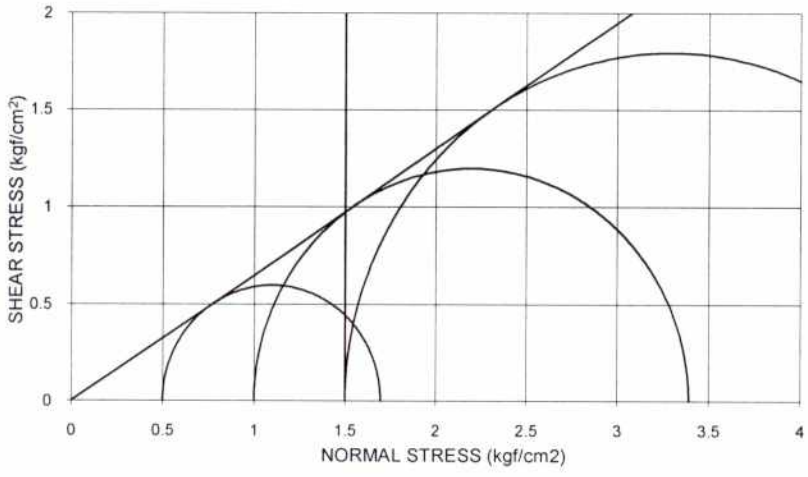
BH NO: 7

DEPTH: 2.0 m

C = 0.21 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 7

DEPTH: 3.0 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{O}

SHEAR TEST GRAPH

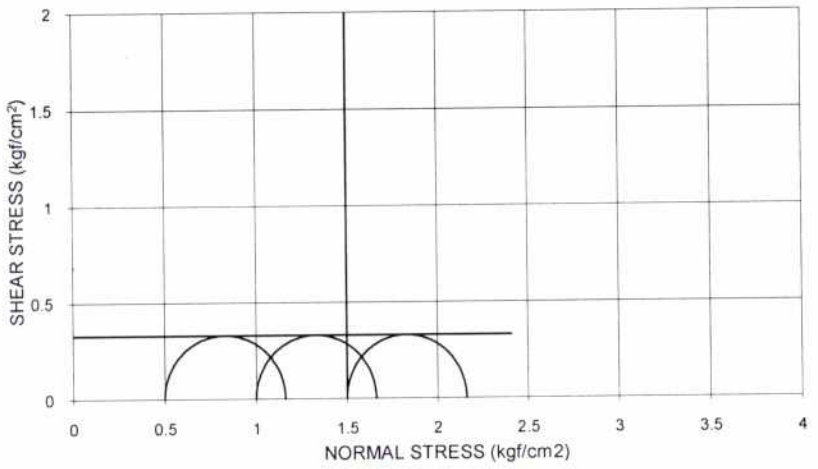
BH NO: 8

DEPTH: 3.0 m

C = 0.28 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



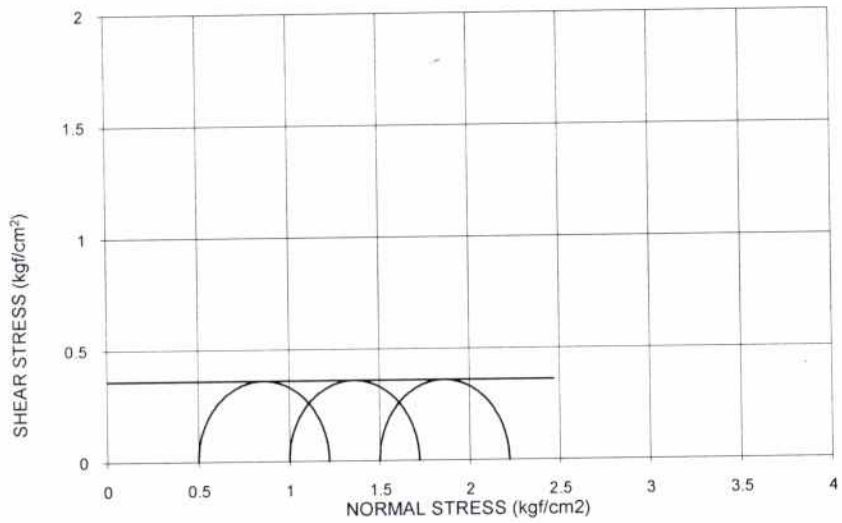
BH NO: 8

DEPTH: 4.5 m

C = 0.33 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



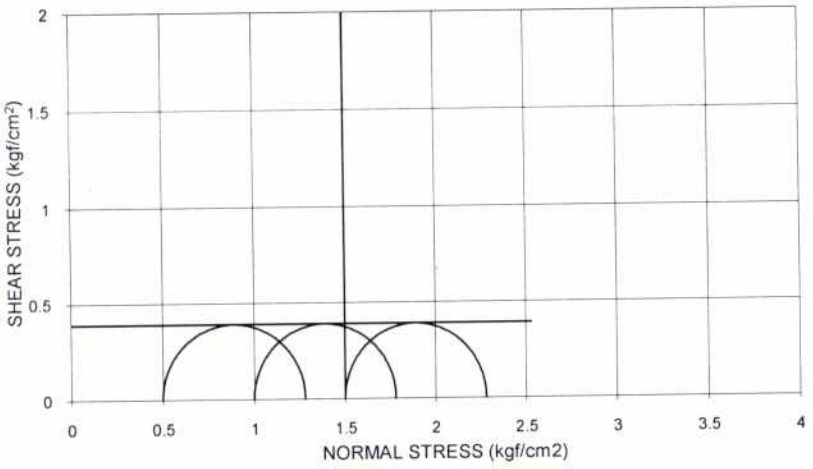
BH NO: 8

DEPTH: 6.0 m

C = 0.36 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



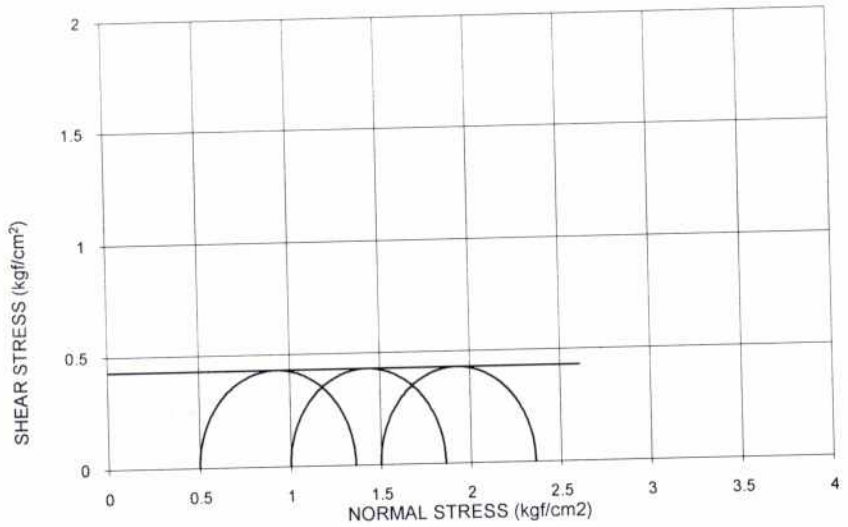
BH NO: 8

DEPTH: 7.5 m

C = 0.39 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 8

DEPTH: 9.0 m

C = 0.43 kgf/cm^2

Φ = 0.0 °

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Part - 6

AT WATER TREATMENT PLANT LOCATION (SUNSALI VILLAGE)

BORE HOLE LOG DATA SHEET

Bore Hole No.: 11

No. of SP Test	11	Samples	Nos.	Commencement Date :	1/9/2012
No. of Vane(V) Test	-	Undisturbed (UDS)	3	Completion Date :	4/9/2012
Length of Casing	3.0	Penetrometer (SPT)	11	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	11	Level of Ground :	RL-49.735 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-49.735 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
Clay black in colour		1 1 1	SPT-01	1.00 - 1.50 m
		N = 2		1.50 - 2.00 m
				2.00 - 2.50 m
		1 1 1	SPT-02	2.50 - 3.00 m
		N = 2		3.00 - 3.50 m
				3.50 - 4.00 m
Fine sand grey in colour		1 1 2	SPT-03	4.00 - 4.50 m
		N = 3		4.50 - 5.00 m
				5.00 - 5.50 m
		1 1 2	SPT-04	5.50 - 6.00 m
		N = 3		6.00 - 6.50 m
				6.50 - 7.00 m
		1 1 1	SPT-05	7.00 - 7.50 m
		N = 3		7.50 - 8.00 m
				8.00 - 8.50 m
		1 2 2	SPT-06	8.50 - 9.00 m
Clay black in colour		N = 4	UDS-01	9.00 - 9.50 m
				9.50 - 10.00 m
		1 1 1	SPT-07	10.00 - 10.50 m
		N = 2	UDS-02	10.50 - 11.00 m
				11.00 - 11.50 m
		1 2 2	SPT-08	11.50 - 12.00 m
		N = 4	UDS-03	12.00 - 12.50 m
				12.50 - 13.00 m
		1 2 3	SPT-09	13.00 - 13.50 m
		N = 5		13.50 - 14.00 m
				14.00 - 14.50 m
Clay black in colour		1 4 4	SPT-10	14.50 - 15.00 m
		N = 8		15.00 - 15.50 m
				15.50 - 16.00 m
Sand yellow in colour		Refusal	SPT-11	16.00 - 16.50 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 12

No. of SP Test	11	Samples	Nos.	Commencement Date :	5/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	12/9/2012
Length of Casing	3.0	Penetrometer (SPT)	11	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	11	Level of Ground :	RL-49.500 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-49.500 m

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm)	SAMPLES REF. NO.	SAMPLES DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
Silty Clay black in colour		1 1 1	SPT-01	1.00 - 1.50 m
		N = 2		1.50 - 2.00 m
				2.00 - 2.50 m
		1 1 1	SPT-02	2.50 - 3.00 m
		N = 2		3.00 - 3.50 m
				3.50 - 4.00 m
		1 1 1	SPT-03	4.00 - 4.50 m
		N = 2		4.50 - 5.00 m
				5.00 - 5.50 m
		1 1 2	SPT-04	5.50 - 6.00 m
		N = 3		6.00 - 6.50 m
				6.50 - 7.00 m
		1 2 2	SPT-05	7.00 - 7.50 m
		N = 4		7.50 - 8.00 m
				8.00 - 8.50 m
		1 1 2	SPT-06	8.50 - 9.00 m
Clay black in colour		N = 3	UDS-01	9.00 - 9.50 m
				9.50 - 10.00 m
		8 11 14	SPT-07	10.00 - 10.50 m
		N = 25	UDS-02	10.50 - 11.00 m
				11.00 - 11.50 m
		7 9 12	SPT-08	11.50 - 12.00 m
		N = 21	UDS-03	12.00 - 12.50 m
				12.50 - 13.00 m
		5 8 12	SPT-09	13.00 - 13.50 m
		N = 20		13.50 - 14.00 m
				14.00 - 14.50 m
		4 6 6	SPT-10	14.50 - 15.00 m
		N = 12		15.00 - 15.50 m
				15.50 - 16.00 m
Clay ash in colour		4 6 8	SPT-11	16.00 - 16.50 m
		N = 14		

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BORE HOLE LOG DATA SHEET

Bore Hole No.: 12

No. of SP Test	11	Samples	Nos.	Commencement Date :	5/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	12/9/2012
Length of Casing	3.0	Penetrometer (SPT)	11	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	11	Level of Ground :	RL-49.500 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-49.500 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				16.50 -17.00 m
				17.00 - 17.50 m
Clay ash in colour		5 5 6	SPT-12	17.50 - 18.00 m
		N = 11		18.00 - 18.50 m
				18.50 - 19.00 m
		11 20 22	SPT-13	19.00 - 19.50 m
		N = 42		19.50 - 20.00 m
				20.00 m 20.50 m
Sand yellow in colour		12 15 23	SPT-14	20.50 - 21.00 m
		N = 8		21.00 - 21.50 m
				21.50 - 22.00 m
		12 31 38	SPT-15	22.00 - 22.50 m
		N = 69		22.50 - 23.00 m
				23.00 - 23.50 m
		Refusal	SPT-16	23.50 - 24.00 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 13

No. of SP Test	10	Samples	Nos.	Commencement Date :	18/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	19/9/2012
Length of Casing	3.0	Penetrometer (SPT)	10	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	10	Level of Ground :	RL-48.468 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.468 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
				1.00 - 1.50 m
				1.50 - 2.00 m
				2.00 - 2.50 m
				2.50 - 3.00 m
				3.00 - 3.50 m
				3.50 - 4.00 m
		1 1 1	SPT-01	4.00 - 4.50 m
		N = 2		4.50 - 5.00 m
Clay black in colour				5.00 - 5.50 m
		1 2 2	SPT-02	5.50 - 6.00 m
		N = 4		6.00 - 6.50 m
				6.50 - 7.00 m
		1 1 2	SPT-03	7.00 - 7.50 m
		N = 3		7.50 - 8.00 m
				8.00 - 8.50 m
		1 1 1	SPT-04	8.50 - 9.00 m
		N = 2	UDS-01	9.00 - 9.50 m
				9.50 - 10.00 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 13

No. of SP Test	10	Samples	Nos.	Commencement Date :	18/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	19/9/2012
Length of Casing	3.0	Penetrometer (SPT)	10	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	10	Level of Ground :	RL-48.468 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.468 m

DESCRIPTION	SYMBOL	N-VALUE Each 15 cm	SAMPLES REF. NO.	SAMPLES DEPTH (m)
		1 2 2	SPT-05	10.00 - 10.50 m
		N = 4	UDS-02	10.50 - 11.00 m
				11.00 - 11.50 m
		1 2 3	SPT-06	11.50 - 12.00 m
		N = 5	UDS-03	12.00 - 12.50 m
				12.50 - 13.00 m
		7 13 16	SPT-07	13.00 - 13.50 m
		N = 29		13.50 - 14.00 m
				14.00 - 14.50 m
		16 8 9	SPT-08	14.50 - 15.00 m
		N = 17		15.00 - 15.50 m
				15.50 - 16.00 m
Sand ash in colour		17 20 24	SPT-09	16.00 - 16.50 m
		N = 44		16.50 -17.00 m
				17.00 - 17.50 m
		Refusal	SPT-10	17.50 - 18.00 m

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BORE HOLE LOG DATA SHEET

Bore Hole No.: 14

No. of SP Test	10	Samples	Nos.	Commencement Date :	21/9/2012
No. of Vane(V) Test	1	Undisturbed (UDS)	3	Completion Date :	21/9/2012
Length of Casing	3.0	Penetrometer (SPT)	10	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	10	Level of Ground :	RL-48.694 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.694 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
				1.00 - 1.50 m
				1.50 - 2.00 m
				2.00 - 2.50 m
				2.50 - 3.00 m
				3.00 - 3.50 m
				3.50 - 4.00 m
				4.00 - 4.50 m
				4.50 - 5.00 m
Clay black in colour				5.00 - 5.50 m
		1 1 2	SPT-01	5.50 - 6.00 m
		N = 3		6.00 - 6.50 m
				6.50 - 7.00 m
		1 2 3	SPT-02	7.00 - 7.50 m
		N = 5		7.50 - 8.00 m
				8.00 - 8.50 m
		1 2 2	SPT-03	8.50 - 9.00 m
		N = 4	UDS-01	9.00 - 9.50 m
				9.50 - 10.00 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 14

No. of SP Test	10	Samples	Nos.	Commencement Date :	21/9/2012
No. of Vane(V) Test	1	Undisturbed (UDS)	3	Completion Date :	21/9/2012
Length of Casing	3.0	Penetrometer (SPT)	10	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	10	Level of Ground :	RL-48.694 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.694 m

DESCRIPTION	SYMBOL	N-VALUE Each 15 cm	SAMPLES REF. NO.	SAMPLES DEPTH (m)
		2 3 4	SPT-04	10.00 - 10.50 m
		N = 7	UDS-02	10.50 - 11.00 m
				11.00 - 11.50 m
		3 4 4	SPT-05	11.50 - 12.00 m
		N = 8	UDS-03	12.00 - 12.50 m
Clay black in colour				12.50 - 13.00 m
		3 6 8	SPT-06	13.00 - 13.50 m
		N = 14		13.50 - 14.00 m
				14.00 - 14.50 m
		7 8 11	SPT-07	14.50 - 15.00 m
		N = 19		15.00 - 15.50 m
				15.50 - 16.00 m
		14 17 22	SPT-08	16.00 - 16.50 m
		N = 39		16.50 -17.00 m
Sand ash in colour				17.00 - 17.50 m
		16 20 23	SPT-09	17.50 - 18.00 m
		N = 43		18.00 - 18.50 m
				18.50 - 19.00 m
		Refusal	SPT-10	19.00 - 19.50 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 15

No. of SP Test	12	Samples	Nos.	Commencement Date :	23/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	24/9/2012
Length of Casing	3.0	Penetrometer (SPT)	12	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	12	Level of Ground :	RL-48.546 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.546 m

DESCRIPTION	SYMBOL	N-VALUE	SAMPLES	
		Each 15 cm	REF. NO.	DEPTH (m)
				0.0 - 0.50 m
				0.50 - 1.00 m
		0 0 1	SPT-01	1.00 - 1.50 m
		N = 1		1.50 - 2.00 m
				2.00 - 2.50 m
		1 1 1	SPT-02	2.50 - 3.00 m
		N = 2		3.00 - 3.50 m
				3.50 - 4.00 m
		1 1 1	SPT-03	4.00 - 4.50 m
		N = 2		4.50 - 5.00 m
Clay black to ash in colour				5.00 - 5.50 m
		1 1 2	SPT-04	5.50 - 6.00 m
		N = 3		6.00 - 6.50 m
				6.50 - 7.00 m
		1 2 2	SPT-05	7.00 - 7.50 m
		N = 4		7.50 - 8.00 m
				8.00 - 8.50 m
		1 2 2	SPT-06	8.50 - 9.00 m
		N = 4	UDS-01	9.00 - 9.50 m
				9.50 - 10.00 m

BORE HOLE LOG DATA SHEET

Bore Hole No.: 15

No. of SP Test	12	Samples	Nos.	Commencement Date :	23/9/2012
No. of Vane(V) Test	2	Undisturbed (UDS)	3	Completion Date :	24/9/2012
Length of Casing	3.0	Penetrometer (SPT)	12	Bore Hole Diameter :	150 mm
SPT done By	M	Disturbed	12	Level of Ground :	RL-48.546 m
Method of Boring	Drilling	Water Sample	1	Water Struct at :	
				Standing Water Level :	RL-51.546 m

DESCRIPTION	SYMBOL	N-VALUE Each 15 cm	SAMPLES REF. NO.	SAMPLES DEPTH (m)
Clay black to ash in colour		2 3 6	SPT-06	10.00 - 10.50 m
		N = 9	UDS-02	10.50 - 11.00 m
				11.00 - 11.50 m
		2 3 4	SPT-07	11.50 - 12.00 m
		N = 7	UDS-03	12.00 - 12.50 m
				12.50 - 13.00 m
		3 5 6	SPT-08	13.00 - 13.50 m
		N = 14		13.50 - 14.00 m
				14.00 - 14.50 m
		4 7 7	SPT-09	14.50 - 15.00 m
		N = 14		15.00 - 15.50 m
				15.50 - 16.00 m
Sand ash in colour		10 13 15	SPT-10	16.00 - 16.50 m
		N = 28		16.50 -17.00 m
				17.00 - 17.50 m
		14 19 20	SPT-11	17.50 - 18.00 m
		N = 39		18.00 - 18.50 m
				18.50 - 19.00 m
		Refusal	SPT-12	19.00 - 19.50 m

CHEMICAL ANALYSIS OF SOIL:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content	Reaction to acid
1	6.7	62	55	23	Nil
2	6.7	61	59	19	Nil
3	6.7	64	61	17	Nil

CHEMICAL ANALYSIS OF SUB-SOIL WATER:

Sample No.	P^H Value	Chlorides (as CI)	Sulphate (as SO4)	Other organic Content
1	6.6	62	56	29
2	6.6	63	58	25
3	6.7	65	61	28

The above results show that the strata is quite safe for ***Concrete & Reinforcement*** for the site.

INTERPRETATION OF TEST RESULTS:

The exact choice of type of **foundation** shall depend on the relative economics and practical considerations.

The safe load carrying capacity of a bored cast in-situ concrete pile in cohesive soil layer shall be governed by IS: 2911 (Part I/Sec2) - 1979 code of practice for determination of allowable pile load capacitye of pile **foundation** for structural safety of Structures.

STANDARD PENETRATION TEST

The field S.P.T is corrected for both Over burden pressure and for dilatancy (As per IS:2131-1982)

B.H No.	Depth (m)	Over burden Pressure kg/cm^2	No. of Blows Recorded at field for Penetration			N-value	Corrected N-value
			15 cm	30 cm	45 cm		
11	1.5	0.150	1	1	1	2	3
	3.0	0.300	1	1	1	2	3
	4.5	0.450	1	1	2	3	4
	6.0	0.600	1	1	2	3	3
	7.5	0.750	1	1	2	3	3
	9.0	0.900	1	2	2	4	4
	10.5	1.050	1	1	1	2	2
	12.0	1.200	1	2	2	4	4
	13.5	1.350	1	2	3	5	5
	15.0	1.500	1	4	4	8	7
	16.5	1.650	Refusal			100	50
12	1.5	0.150	1	1	1	2	3
	3.0	0.300	1	1	1	2	3
	4.5	0.450	1	1	1	2	2
	6.0	0.600	1	1	2	3	3
	7.5	0.750	1	2	2	4	4
	9.0	0.900	1	1	2	3	3
	10.5	1.050	8	11	14	25	20
	12.0	1.200	7	9	12	21	17
	13.5	1.350	5	8	12	20	17
	15.0	1.500	4	6	6	12	11
	16.5	1.650	4	6	8	14	12
	18.0	1.800	5	5	6	11	9
	19.5	1.950	11	20	22	42	24
	21.0	2.100	12	15	23	38	22
	22.5	2.250	12	31	38	69	33
	24.0	2.400	Refusal			100	44

STANDARD PENETRATION TEST

The field S.P.T is corrected for both Over burden pressure and for dilatancy (As per IS:2131-1982)

B.H No.	Depth (m)	Over burden Pressure kg/cm^2	No. of Blows Recorded at field for Penetration			N-value	Corrected N-value
			15 cm	30 cm	45 cm		
13	1.5	0.150	-	-	-	-	-
	3.0	0.300	-	-	-	-	-
	4.5	0.450	1	1	1	2	2
	6.0	0.600	1	2	2	4	5
	7.5	0.750	1	1	2	3	3
	9.0	0.900	1	1	1	2	2
	10.5	1.050	1	2	2	4	4
	12.0	1.200	1	2	3	5	5
	13.5	1.350	7	13	16	29	21
	15.0	1.500	16	8	9	17	15
	16.5	1.650	17	20	24	99	50
	18.0	1.800	Refusal			100	49
14	1.5	0.150	-	-	-	-	-
	3.0	0.300	-	-	-	-	-
	4.5	0.450	-	-	-	-	-
	6.0	0.600	1	1	2	3	3
	7.5	0.750	1	2	3	5	5
	9.0	0.900	1	2	2	4	4
	10.5	1.050	2	3	4	7	7
	12.0	1.200	3	4	4	8	8
	13.5	1.350	3	6	8	14	13
	15.0	1.500	7	8	11	19	16
	16.5	1.650	14	17	22	39	24
	18.0	1.800	16	20	23	43	25
	19.5	1.950	Refusal			100	47

STANDARD PENETRATION TEST

The field S.P.T is corrected for both Over burden pressure and for dilatancy (As per IS:2131-1982)

B.H No.	Depth (m)	Over burden Pressure kg/cm^2	No. of Blows Recorded at field for Penetration			N-value	Corrected N-value
			15 cm	30 cm	45 cm		
15	1.5	0.150	-	-	1	1	2
	3.0	0.300	1	1	1	2	3
	4.5	0.450	1	1	1	2	2
	6.0	0.600	1	1	2	3	3
	7.5	0.750	1	2	2	4	4
	9.0	0.900	1	2	2	4	4
	10.5	1.050	2	3	3	6	6
	12.0	1.200	2	3	4	7	7
	13.5	1.350	3	5	6	11	10
	15.0	1.500	4	7	7	14	12
	16.5	1.650	10	13	15	99	50
	18.0	1.800	14	19	20	100	49
	19.5	1.950	Refusal			100	47

PILE LOAD CAPACITY

The safe load carrying capacity of a bored cast in-situ concrete pile passing through clayey soil layer and resting on granular soil has been worked out by using the following formular as per IS: 2911 (Part I/Sec 2) - 1979

$Q_s = ((Ap(0.5\ D\ \gamma\ N_\gamma + P_D\ N_q) + \alpha\ C'\ As) / F) / 1000$ t

Where A_p = Cross sectional area of pile stem at toe level in cm^2

D = Stem diameter in cm

γ = Effective unit weight of soil at pile toe in kgf / cm3

P_D = Effective overburden pressure at pile toe in kgf / cm^2

$N\gamma$ & N_q = Bearing capacity factors depending upon the angle of internal friction f at toe

α = Reduction factor

C' = Average cohesion of the soil along the pile stem in kgf / cm^2

A_s = Surface area of the stem in cm^2

F = Factor of safety

PILE LOAD CAPACITY CALCULATION

For Borehole No. 15

Length of pile = 1950 cm

D = 40 cm

Effective pile length for overburden pressure = 20 x 40 = 800 cm

γ = 0.001 kgf/cm^2

P_D = 0.80 kgf / cm^2

ϕ = 33 °

N_γ = 35.19

N_q = 34.0

α = 0.5

C' = 0.310 kgf / cm^2

Ap = (3.1415 / 4) x 40^2 = 1,256.64 cm^2

Effective shaft length = 1800 cm

As = 226,194.67 cm^2

F = 2.5

Qs = ((1,256.64 x (0.5 x 40 x 0.001 x 35.19 + 0.8 x 34) + 0.5 x 0.31 x 226,194.67) / 2.5) / 1000

= 28.05 ton

RECOMMENDATION:

From field and laboratory investigations, it is found that the hard strata is encountered at various depth in various bore hole locations and it is vaies from 6.0 m -19.50 m which is consist od sand .From the structural point of view it is recommended to addopt pile foundation which is tabulated below as per requirement of pile capacity.

Length of Pile = 19.50 m from cutoff level)

Type of Pile	Diameter Of Pile (cm)	Pile Load Capacity (ton)	Recommended Pile Load Capacity (ton)	
			40 cm dia.	60 cm dia.
Cast-in-situ R.C.C Bored Concrete Pile	40.00	28.05	28.00	68.00
	60.00	68.37		

However,the theoretical load carrying capacity of pile is to be verified by conducting load test on pile.

PERMEABILITY TEST

A. CONSTANT HEAD

OBJECTIVE

To determine the coefficient of permeability of a soil using constant head method.

Need and Scope

The knowledge of this property is much useful in solving problems involving yield of water bearing strata, seepage through earthen dams, stability of earthen dams, and embankments of canal bank affected by seepage, settlement etc.

Planning and organization:

1. Preparation of the soil sample for the test
2. Finding the discharge through the specimen under a particular head of water.

Definition of coefficient of permeability

The rate of flow under laminar flow conditions through a unit cross sectional are of porous medium under unit hydraulic gradient is defined as coefficient of permeability.

B.H No.	Depth (m)	Co-efficient of Permeability (cm/sec)
1	3.00	5.55×10^{-4}
2	3.00	5.37×10^{-4}

RESULTS OF LABORATORY TEST

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
11	1	1.50	DS	31.22	1.42	1.86	0.88	2.67	38.32	28.33	9.99	-	5.00	25.00	70.00		-
	2	3.00	DS	32.10	1.42	1.88	0.87	2.66	39.10	27.08	12.02	-	5.00	23.00	72.00	0.19	-
	3	4.50	DS	24.22	1.52	1.89	0.75	2.67	-	-	-	-	98.00	1.00	1.00	-	28°
	4	6.00	DS	29.42	1.44	1.87	0.84	2.66	37.41	26.39	11.02	-	5.00	27.00	68.00	0.21	-
	5	7.50	DS	30.42	1.44	1.88	0.85	2.66	-	-	-	-	4.00	25.00	71.00	0.27	-
	6	9.00	DS	28.39	1.48	1.90	0.80	2.67	-	-	-	-	5.00	22.00	73.00	0.29	-
	7	10.50	DS	33.12	1.41	1.88	0.90	2.68	-	-	-	-	4.00	27.00	69.00	0.31	-
	8	12.00	DS	31.40	1.44	1.89	0.87	2.69	-	-	-	-	4.00	28.00	68.00	0.32	-
	9	13.50	DS	31.26	1.46	1.91	0.83	2.67	-	-	-	-	4.00	24.00	72.00	0.31	-
	10	15.00	DS	24.89	1.55	1.93	0.73	2.67	-	-	-	-	5.00	22.00	73.00	0.33	-
	11	16.50	DS	18.32	1.68	1.99	0.59	2.67	-	-	-	-	97.00	2.00	1.00	-	33°

RESULTS OF LABORATORY TEST

BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
12	1	1.50	DS	35.75	1.37	1.86	0.95	2.67	40.22	29.21	11.01	-	5.00	25.00	70.00		-
	2	3.00	DS	33.43	1.41	1.88	0.89	2.66	38.12	28.78	9.34	-	4.00	24.00	72.00	0.18	-
	3	4.50	DS	32.22	1.43	1.89	0.87	2.67	38.96	26.22	12.74	-	4.00	27.00	69.00	0.19	-
	4	6.00	DS	36.83	1.37	1.87	0.95	2.67	39.22	26.38	12.84	-	4.00	25.00	71.00	0.21	-
	5	7.50	DS	29.78	1.45	1.88	0.84	2.66	-	-	-	-	5.00	23.00	72.00	0.26	-
	6	9.00	DS	27.19	1.49	1.90	0.79	2.67	-	-	-	-	3.00	25.00	72.00	0.28	-
	7	10.50	DS	20.71	1.56	1.88	0.71	2.67	-	-	-	-	7.00	26.00	67.00	0.41	-
	8	12.00	DS	21.42	1.56	1.89	0.72	2.67	-	-	-	-	6.00	25.00	69.00	0.46	-
	9	13.50	DS	27.37	1.50	1.91	0.78	2.67	-	-	-	-	6.00	23.00	71.00	0.53	-
	10	15.00	DS	26.75	1.52	1.93	0.75	2.67	-	-	-	-	6.00	22.00	72.00	0.41	-
	11	16.50	DS	24.98	1.56	1.95	0.71	2.67	-	-	-	-	5.00	22.00	73.00	0.43	-
	12	18.00	DS	15.95	1.70	1.97	0.57	2.67	-	-	-	-	98.00	1.00	1.00	0.39	-
	13	19.50	DS	21.04	1.64	1.99	0.62	2.67	-	-	-	-	98.00	1.00	1.00	-	31^o
	14	21.00	DS	15.19	1.74	2.01	0.53	2.67	-	-	-	-	97.00	2.00	1.00	-	32^o
	15	22.50	DS	13.87	1.78	2.03	0.50	2.68	-	-	-	-	98.00	1.00	1.00	-	32^o
	16	24.00	DS	12.77	1.82	2.05	0.47	2.68	-	-	-	-	98.00	1.00	1.00	-	33^o

RESULTS OF LABORATORY TEST

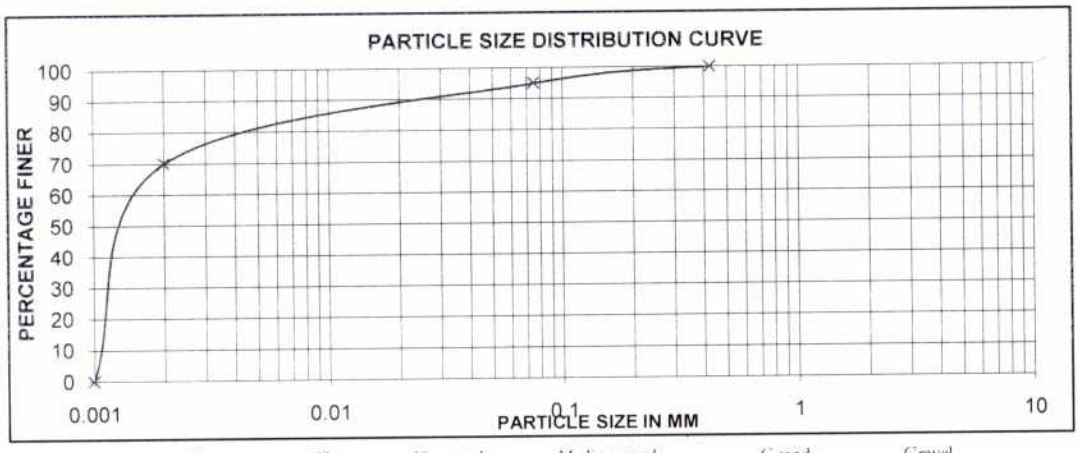
BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
13	1	1.50	DS	45.23	1.28	1.86	1.08	2.67	38.79	27.25	11.54	-	4.00	21.00	75.00		-
	2	3.00	DS	41.05	1.33	1.88	1.00	2.66	39.81	26.38	13.43	-	3.00	23.00	74.00	0.18	-
	3	4.50	DS	42.13	1.33	1.89	1.01	2.67	40.22	28.11	12.11	-	10.00	20.00	70.00	0.21	-
	4	6.00	DS	47.20	1.27	1.87	1.09	2.66	39.65	26.37	13.28	-	5.00	26.00	69.00	0.26	-
	5	7.50	DS	49.86	1.25	1.88	1.12	2.66	-	-	-	-	6.00	23.00	71.00	0.29	-
	6	9.00	DS	42.81	1.33	1.90	1.01	2.67	-	-	-	-	6.00	24.00	70.00	0.28	-
	7	10.50	DS	35.47	1.39	1.88	0.93	2.68	-	-	-	-	5.00	26.00	69.00	0.33	-
	8	12.00	DS	33.19	1.42	1.89	0.90	2.69	-	-	-	-	6.00	23.00	71.00	0.32	-
	9	13.50	DS	20.01	1.61	1.93	0.67	2.68	-	-	-	-	96.00	2.00	2.00	0.59	-
	10	15.00	DS	18.29	1.65	1.95	0.62	2.67	-	-	-	-	98.00	1.00	1.00	0.56	-
	11	16.50	DS	17.23	1.68	1.97	0.59	2.67	-	-	-	-	98.00	1.00	1.00	-	32°
	12	18.00	DS	15.44	1.72	1.99	0.55	2.68	-	-	-	-	98.00	1.00	1.00	-	33°

RESULTS OF LABORATORY TEST

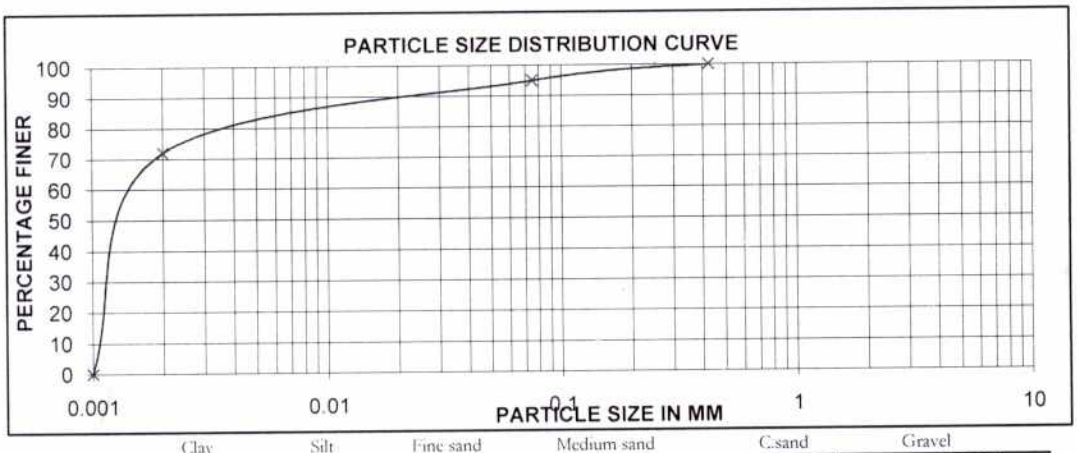
BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
14	1	1.50	DS	42.13	1.30	1.85	1.05	2.67	37.21	26.55	10.66	-	3.00	25.00	72.00	-	-
	2	3.00	DS	41.87	1.33	1.88	1.01	2.66	38.65	27.08	11.57	-	5.00	24.00	71.00	0.08	-
	3	4.50	DS	36.41	1.39	1.89	0.93	2.67	39.25	26.33	12.92	-	5.00	25.00	70.00	0.14	-
	4	6.00	DS	32.16	1.41	1.87	0.88	2.66	37.18	25.43	11.75	-	4.00	27.00	69.00	0.17	-
	5	7.50	DS	30.41	1.44	1.88	0.85	2.66	-	-	-	-	6.00	22.00	72.00	0.23	-
	6	9.00	DS	32.01	1.45	1.91	0.85	2.67	-	-	-	-	4.00	25.00	71.00	0.27	-
	7	10.50	DS	28.13	1.47	1.88	0.83	2.68	-	-	-	-	6.00	22.00	72.00	0.30	-
	8	12.00	DS	29.41	1.48	1.91	0.82	2.69	-	-	-	-	5.00	22.00	73.00	0.29	-
	9	13.50	DS	30.42	1.48	1.93	0.81	2.68	-	-	-	-	6.00	26.00	68.00	0.48	-
	10	15.00	DS	31.13	1.49	1.95	0.80	2.67	-	-	-	-	5.00	25.00	70.00	0.59	-
	11	16.50	DS	23.14	1.61	1.98	0.66	2.67	-	-	-	-	95.00	3.00	2.00	-	32^o
	12	18.00	DS	21.51	1.64	1.99	0.64	2.68	-	-	-	-	93.00	3.00	4.00	-	32^o
	13	19.50	DS	18.33	1.68	1.99	0.60	2.69	-	-	-	-	97.00	1.00	2.00	-	33^o

RESULTS OF LABORATORY TEST

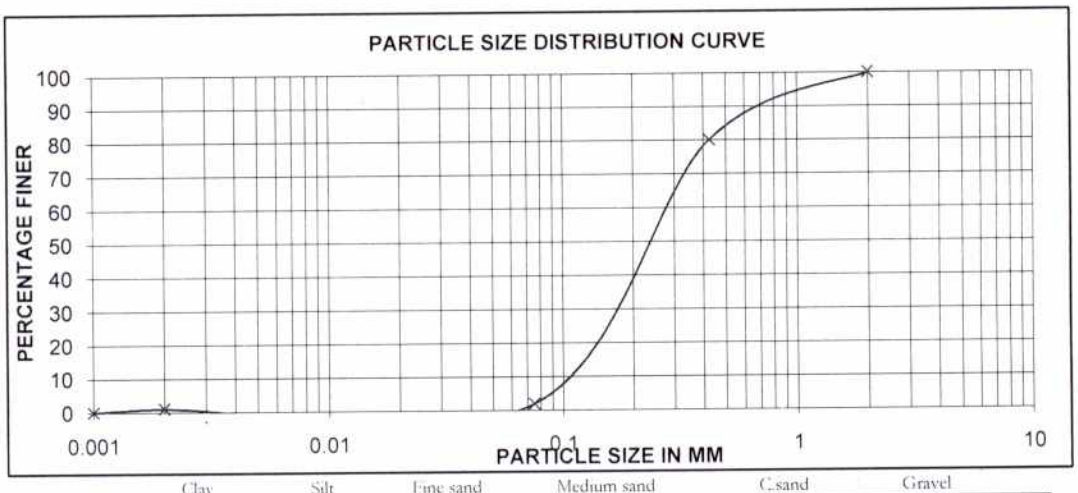
BORE HOLE NO.	SAMPLE NO.	DEPTH IN METERS	BRIEF DESCRIPTION	WATER CONTENT (%)	DENSITY		VOID RATIO	SP.GRAVITY	LIMITS (%)			GRAIN SIZE ANALYSIS (%)				SHEAR TEST	
					DRY (gm/cc)	WET (gm/cc)			LIQUID	PLASTIC	PLASTICITY INDE	Gravel	Sand	Silt	Clay	c (kg/cm^2)	ϕ Degree
15	1	1.50	DS	41.23	1.32	1.87	1.02	2.67	40.22	27.36	12.86	-	5.00	24.00	71.00	-	-
	2	3.00	DS	43.58	1.31	1.88	1.03	2.66	39.80	25.64	14.16	-	4.00	24.00	72.00	0.18	-
	3	4.50	DS	33.13	1.42	1.89	0.88	2.67	40.11	27.31	12.80	-	5.00	22.00	73.00	0.21	-
	4	6.00	DS	30.19	1.44	1.88	0.84	2.66	38.79	26.88	11.91	-	5.00	25.00	70.00	0.25	-
	5	7.50	DS	29.46	1.45	1.88	0.83	2.66	-	-	-	-	6.00	22.00	72.00	0.29	-
	6	9.00	DS	28.11	1.48	1.89	0.81	2.67	-	-	-	-	6.00	21.00	73.00	0.31	-
	7	10.50	DS	30.42	1.47	1.92	0.82	2.68	-	-	-	-	5.00	24.00	71.00	0.33	-
	8	12.00	DS	29.63	1.47	1.91	0.83	2.69	-	-	-	-	5.00	25.00	70.00	0.36	-
	9	13.50	DS	28.69	1.50	1.93	0.79	2.68	-	-	-	-	4.00	23.00	73.00	0.42	-
	10	15.00	DS	26.29	1.55	1.96	0.72	2.67	-	-	-	-	5.00	26.00	69.00	0.48	-
	11	16.50	DS	21.42	1.64	1.99	0.63	2.67	-	-	-	-	96.00	2.00	2.00	-	32°
	12	18.00	DS	22.13	1.63	1.99	0.64	2.68	-	-	-	-	95.00	2.00	3.00	-	33°
	13	19.50	DS	20.57	1.65	1.99	0.63	2.69	-	-	-	-	98.00	1.00	1.00	-	33°



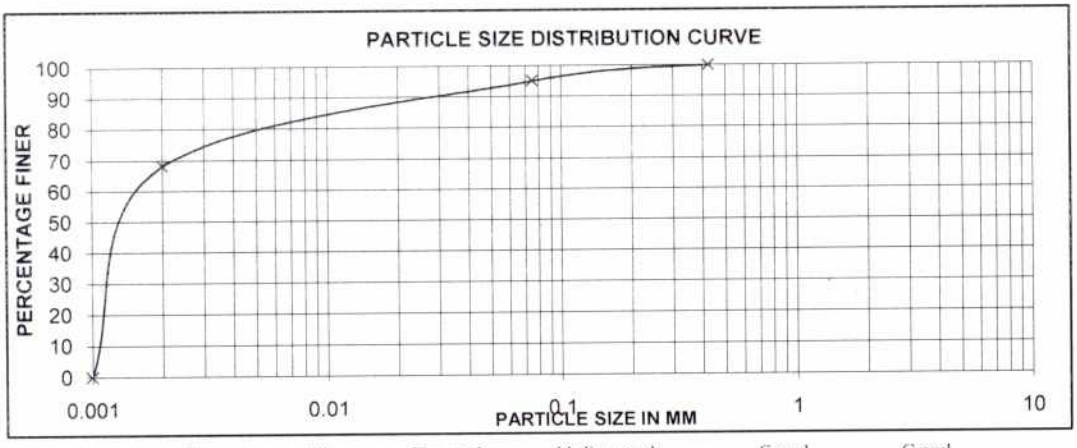
B.H	Depth	Index
11	1.5	X



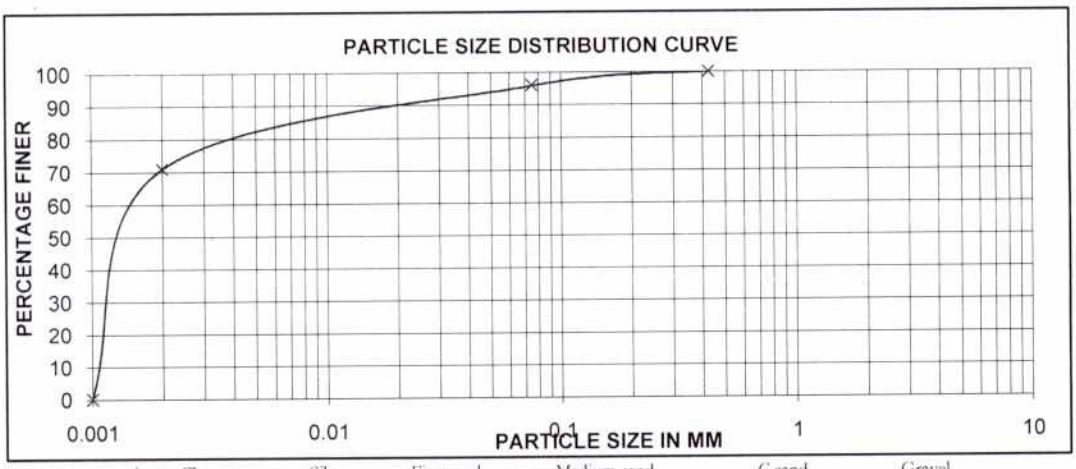
B.H	Depth	Index
11	3.0	X



B.H	Depth	Index
11	4.5	X



B.H	Depth	Index
11	6.0	



B.H	Depth	Index
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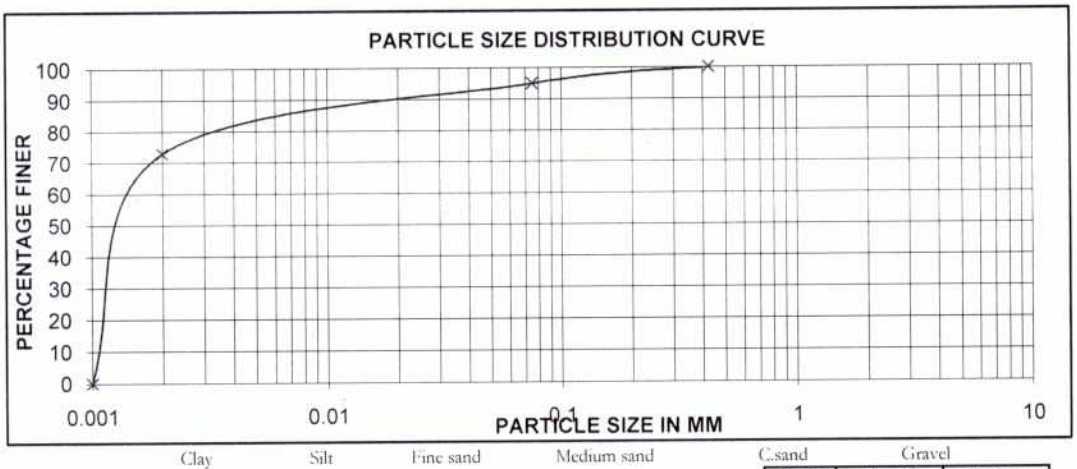
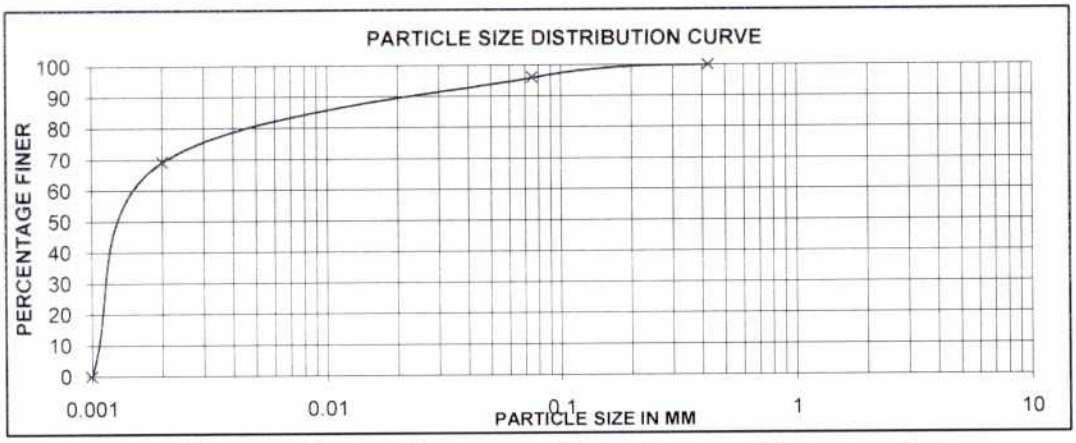


B.H	Depth	Index
11	9.0	



B.H	Depth	Index
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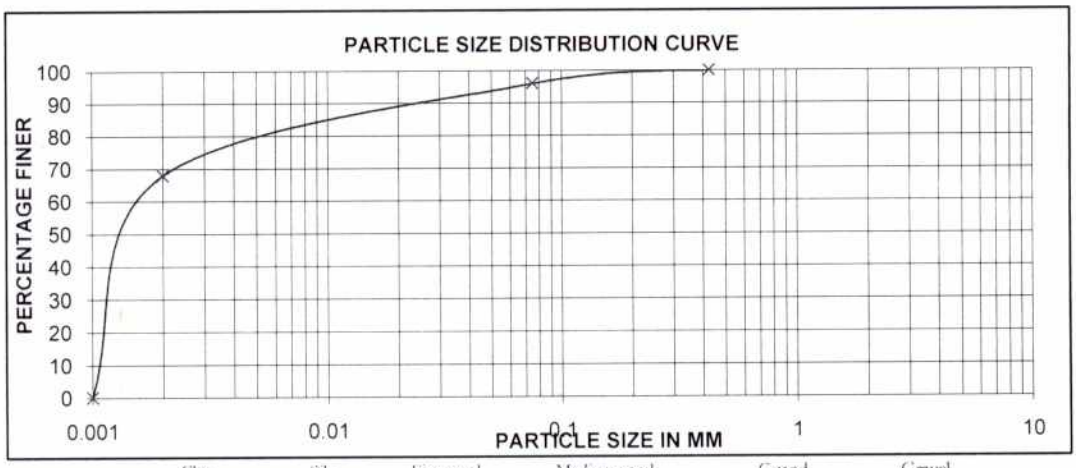

B.H	Depth	Index
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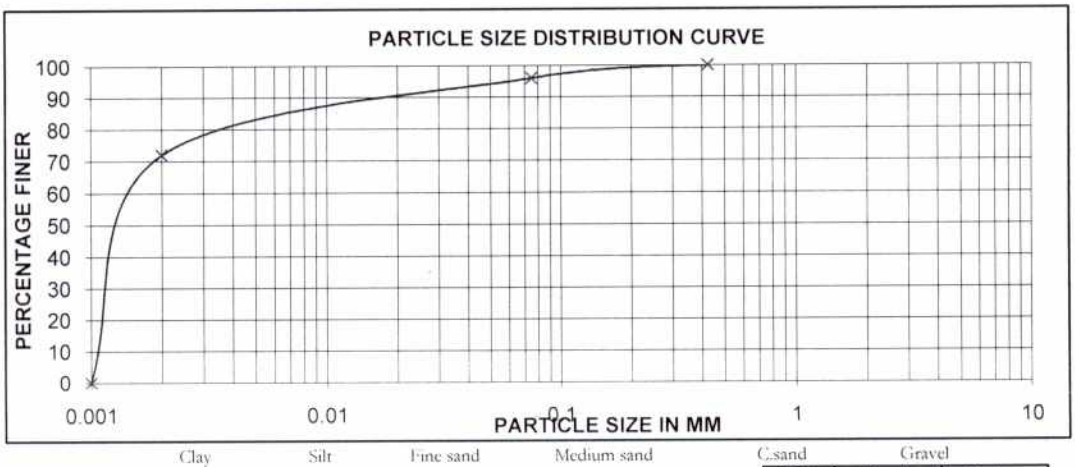

B.H	Depth	Index
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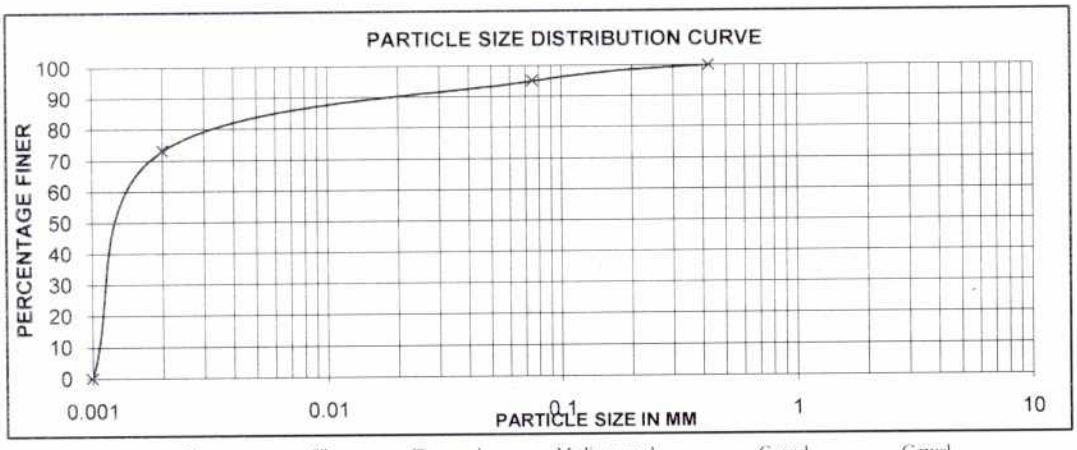

B.H	Depth	Index
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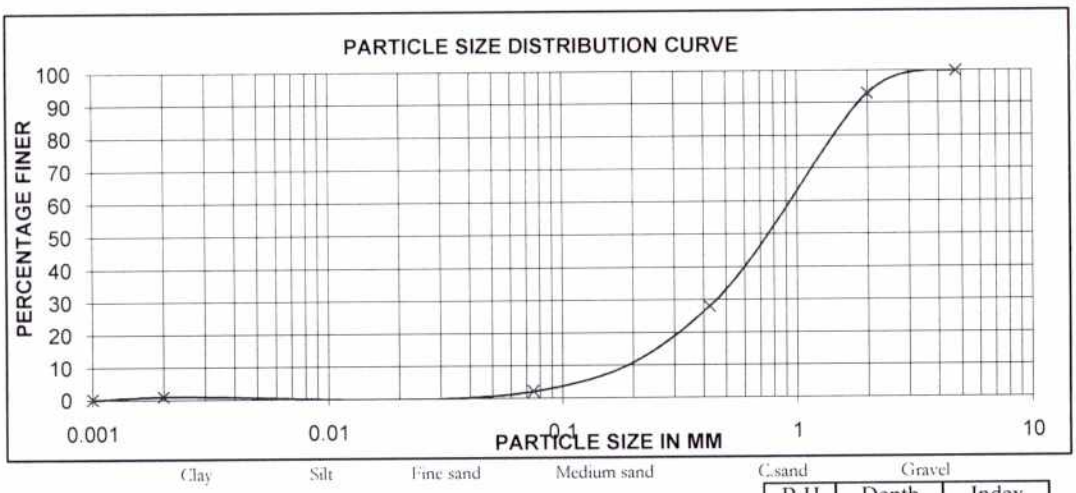

B.H	Depth	Index
11	16.5	

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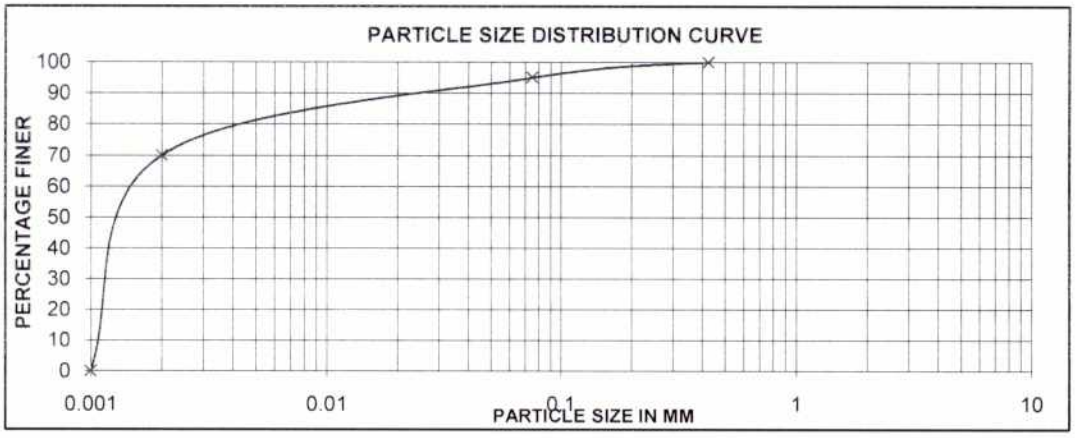
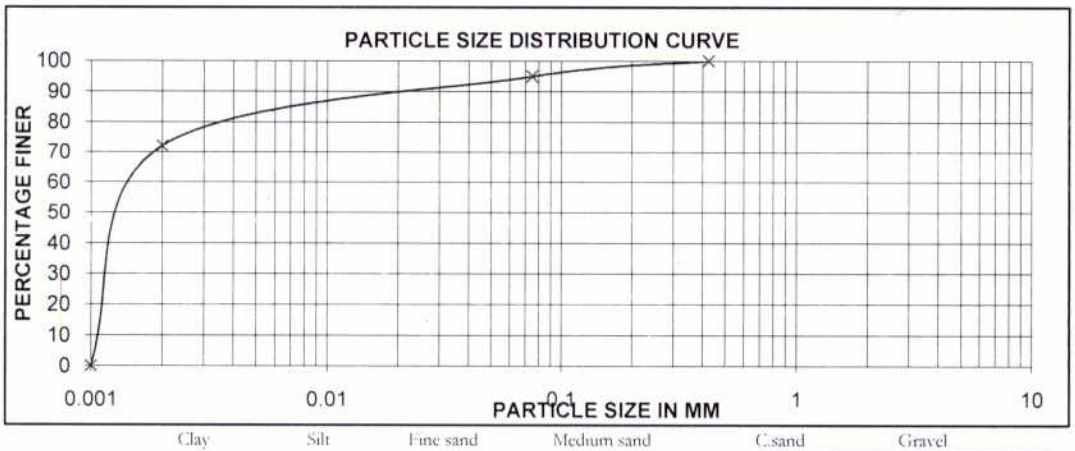
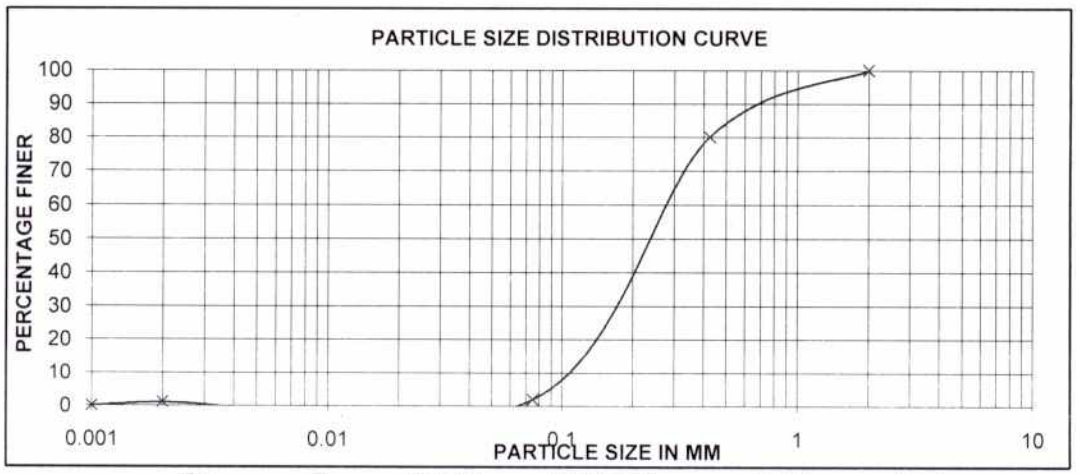


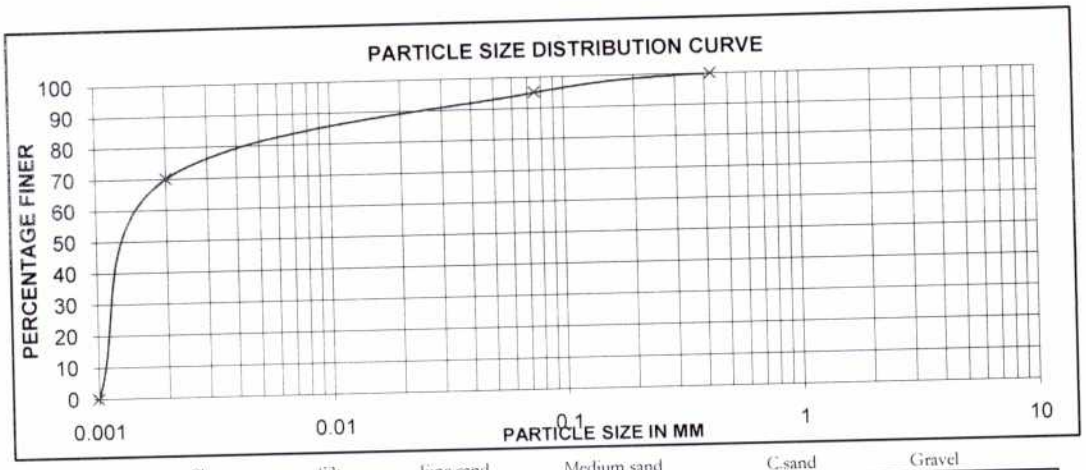
B.H	Depth	Index
11	1.5	✕



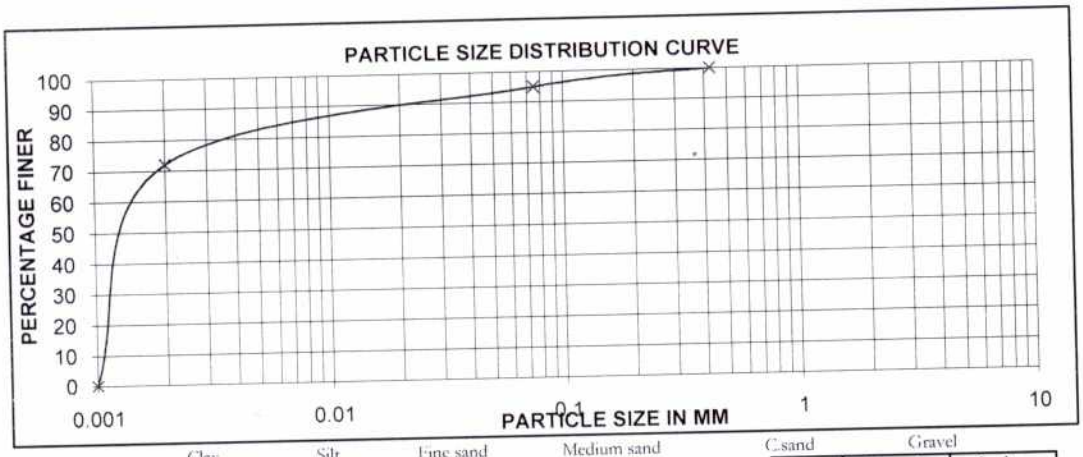
B.H	Depth	Index
11	3.0	✕



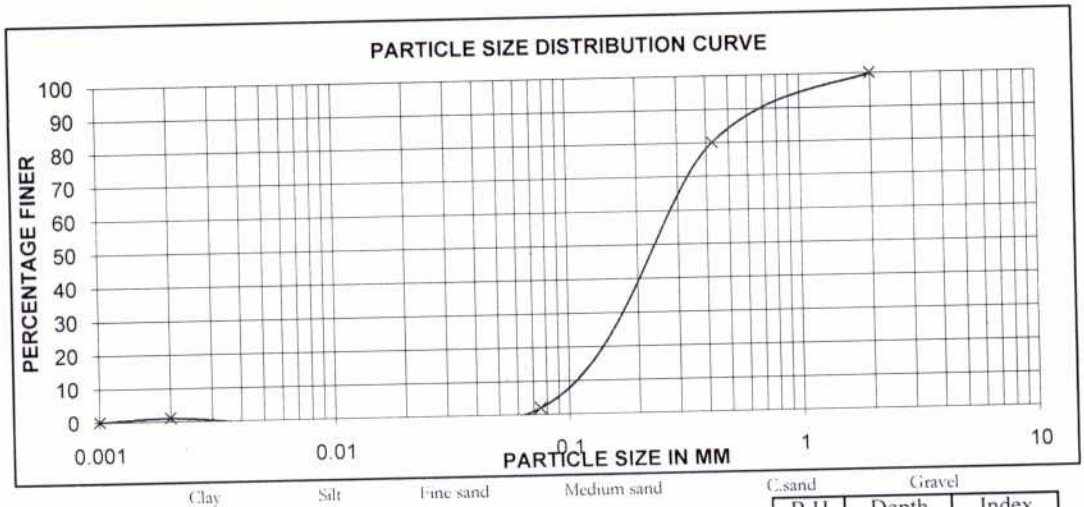
B.H	Depth	Index
11	4.5	✕



B.H	Depth	Index
12	1.5	

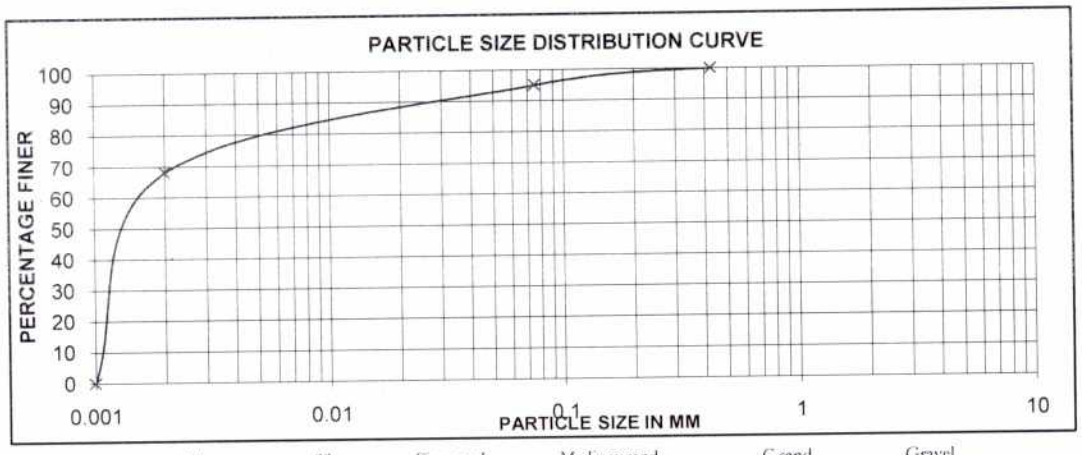


B.H	Depth	Index
12	3.0	



B.H	Depth	Index
12	4.5	

FOUNDATION PRIVATE LTD.



B.H	Depth	Index
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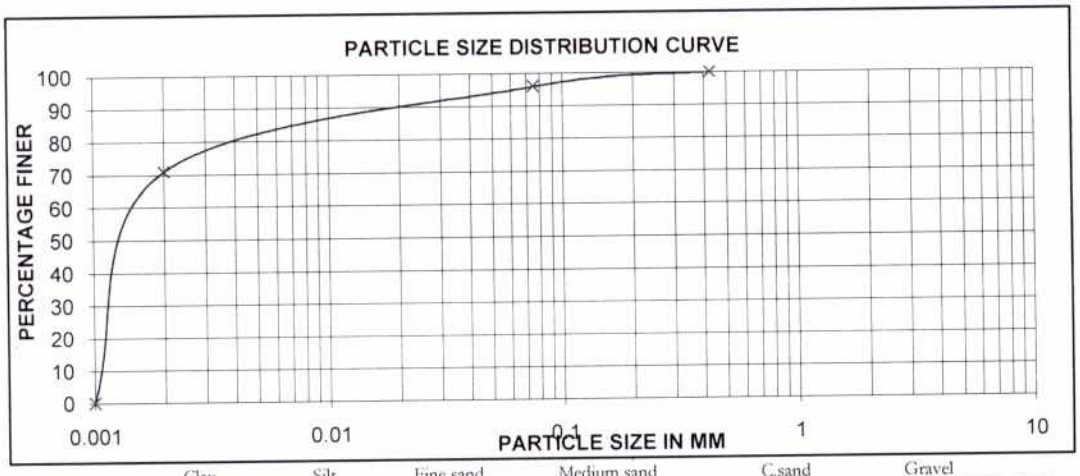

B.H	Depth	Index
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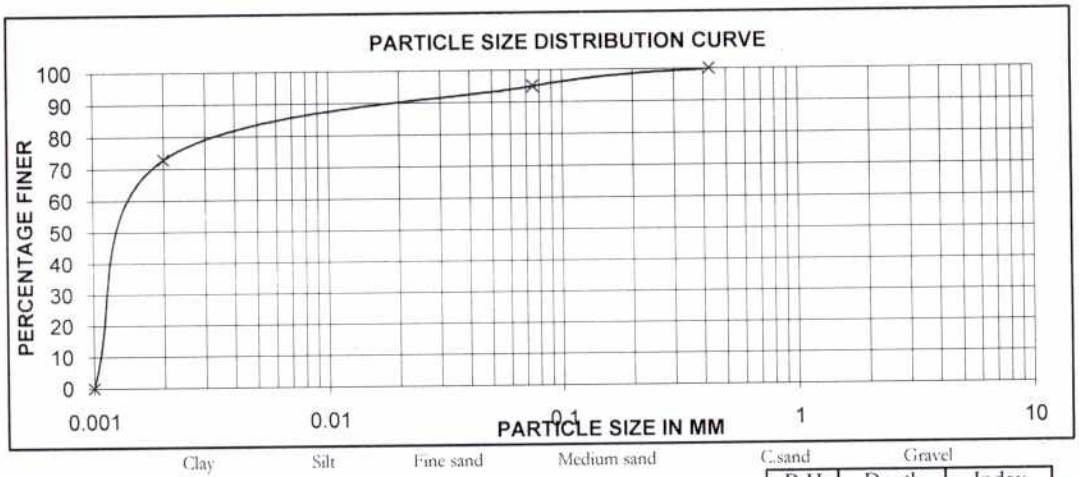
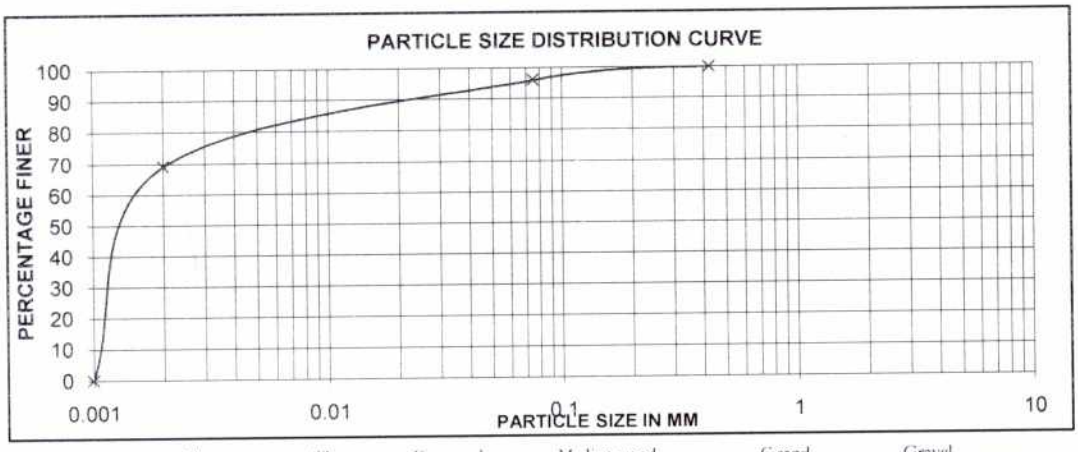


B.H	Depth	Index
12	9.0	



B.H	Depth	Index
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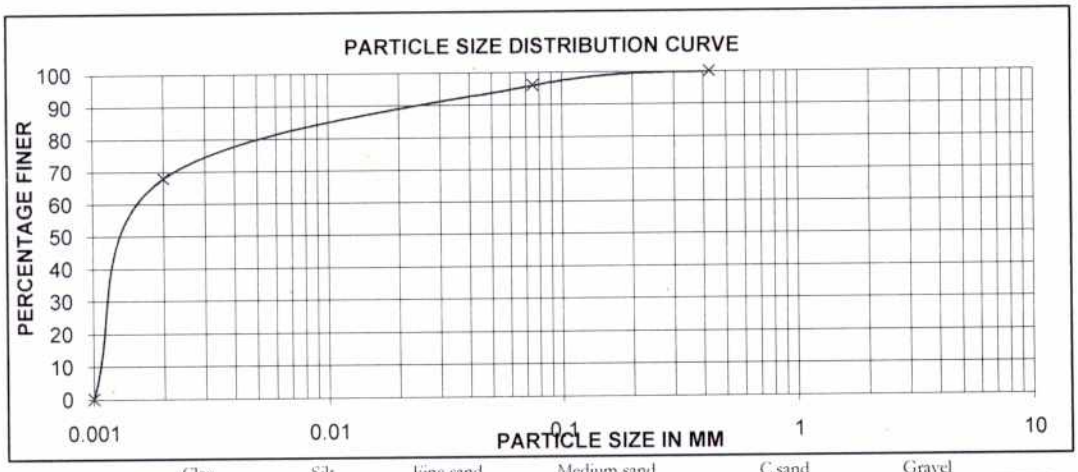
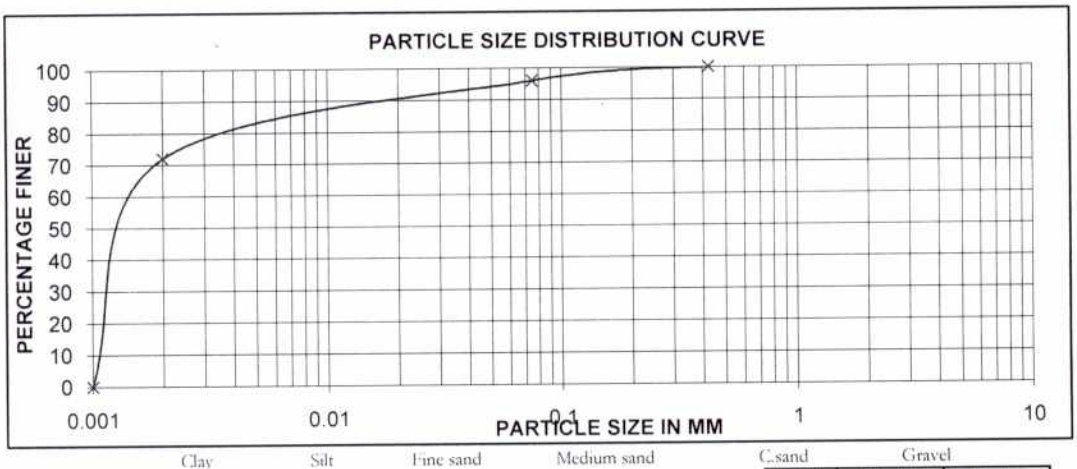


B.H	Depth	Index
12	12.0	



B.H	Depth	Index
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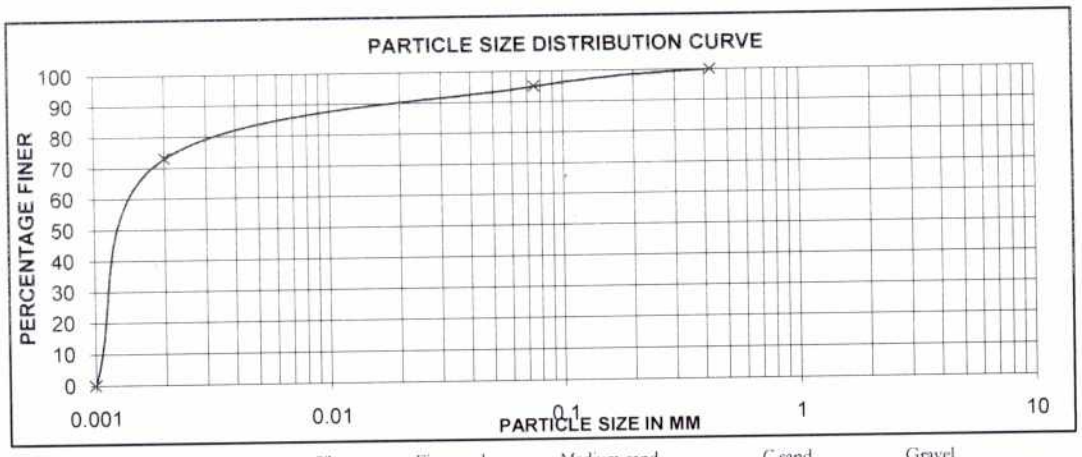

B.H	Depth	Index
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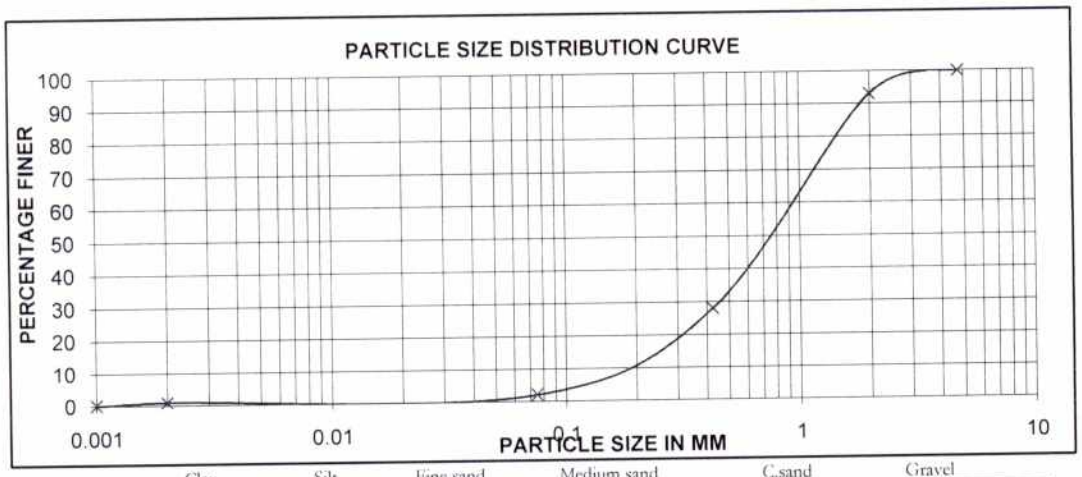

B.H	Depth	Index
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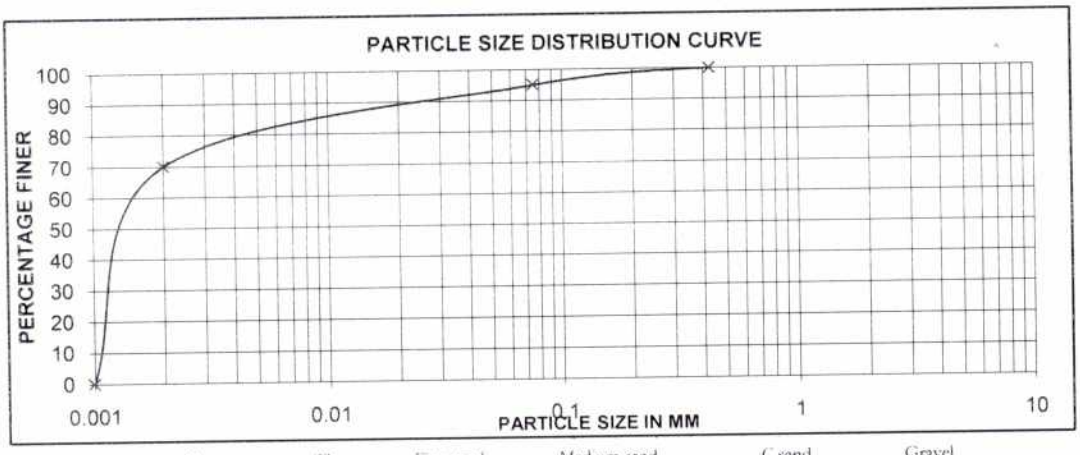
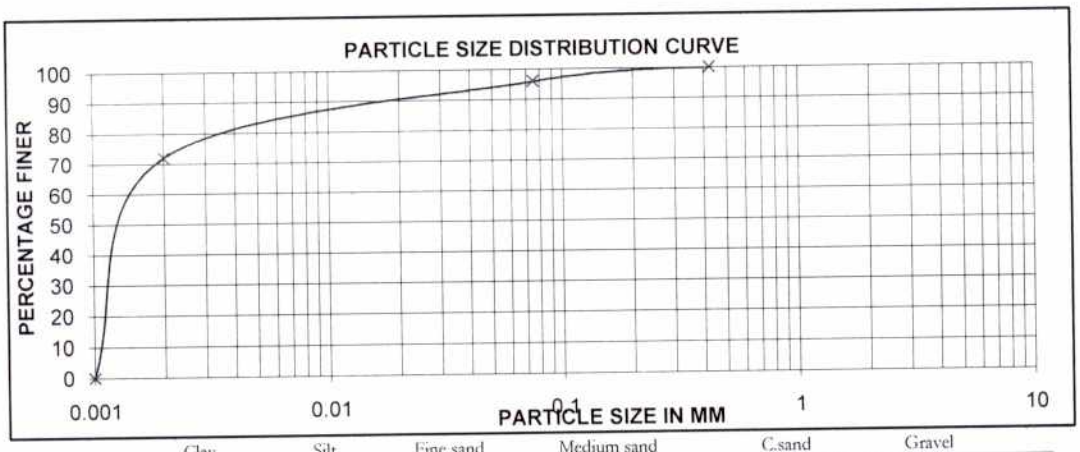
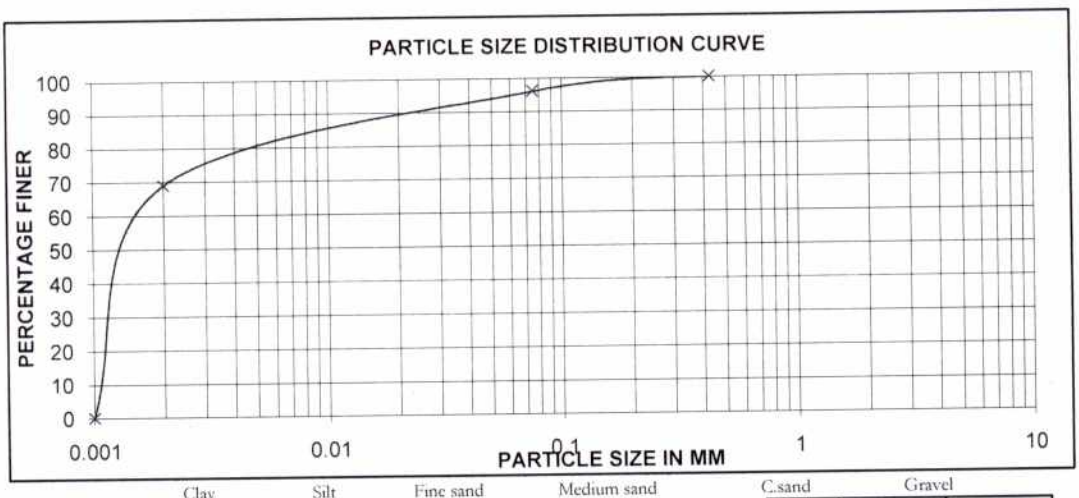


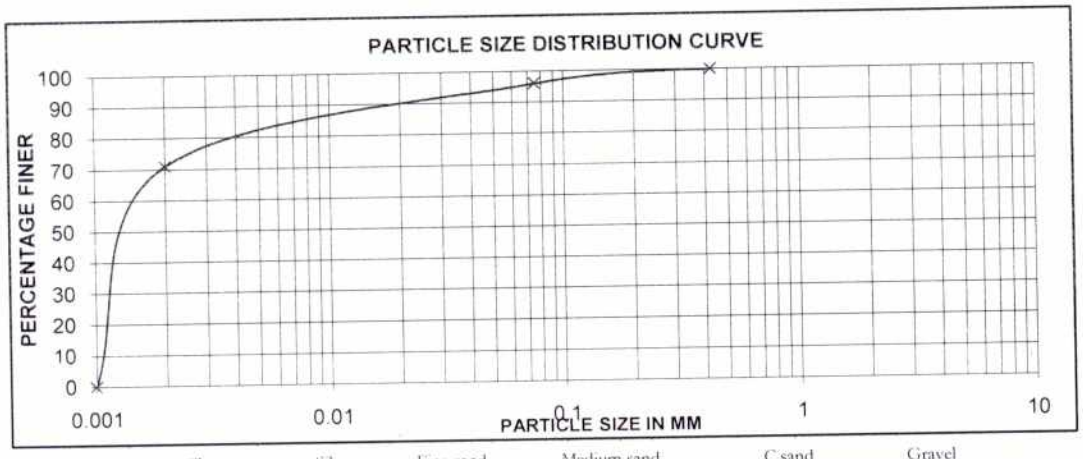
B.H	Depth	Index
13	1.5	



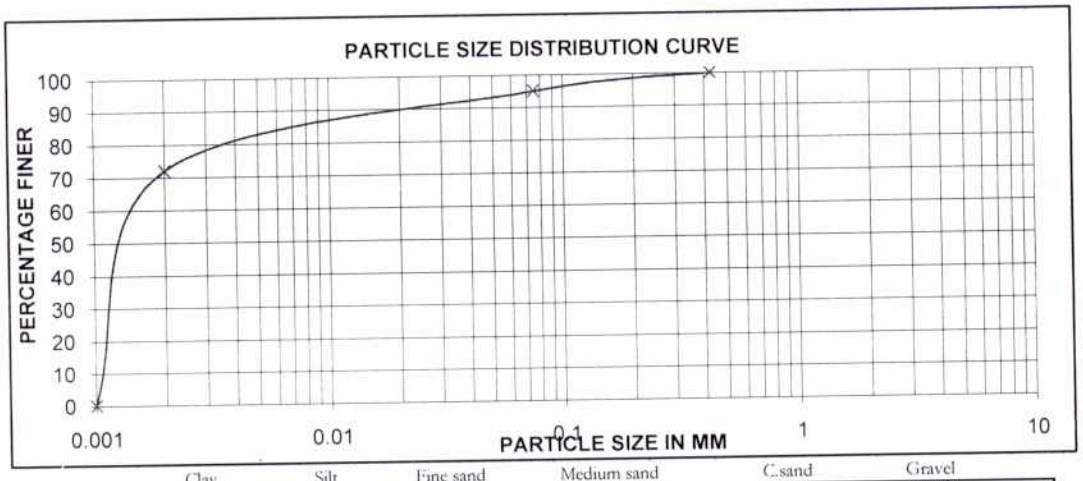
B.H	Depth	Index
13	3.0	



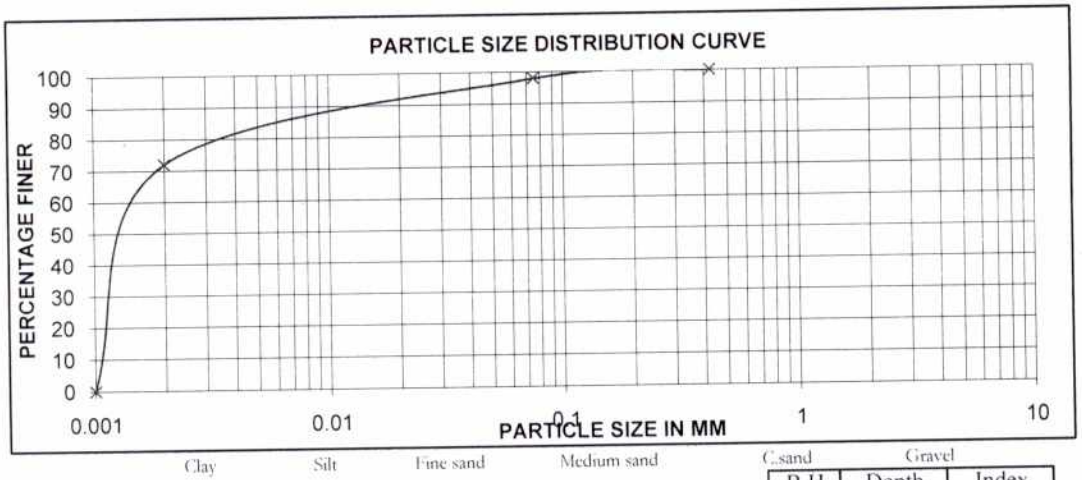
B.H	Depth	Index
13	4.5	



B.H	Depth	Index
13	6.0	



B.H	Depth	Index
13	7.5	



B.H	Depth	Index
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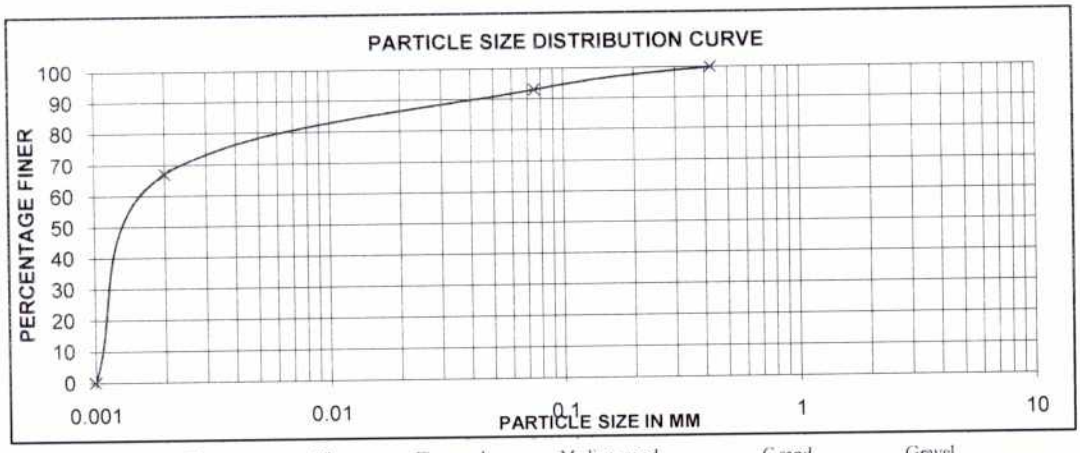

B.H	Depth	Index
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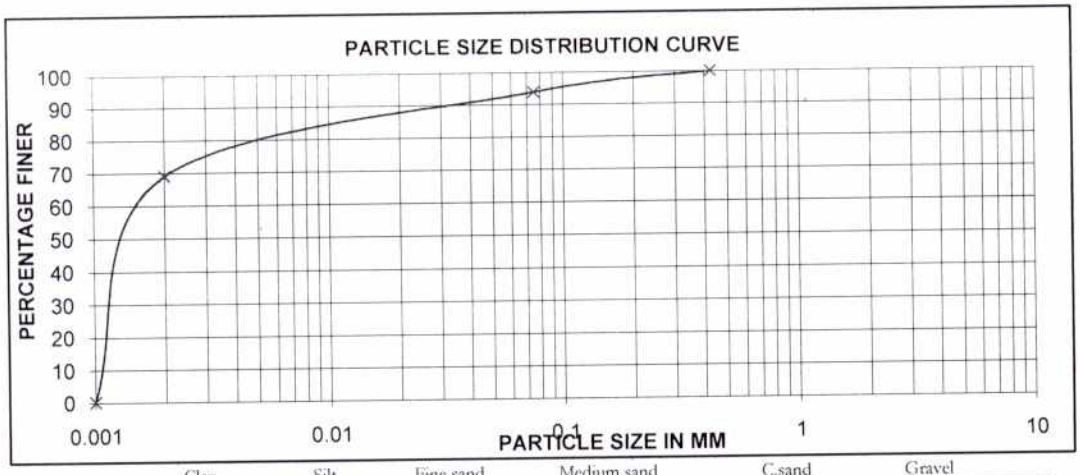

B.H	Depth	Index
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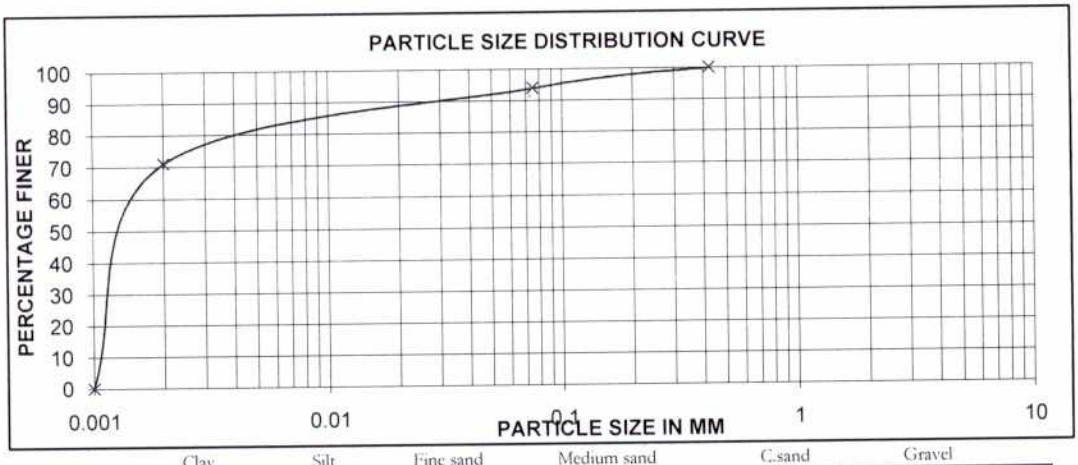
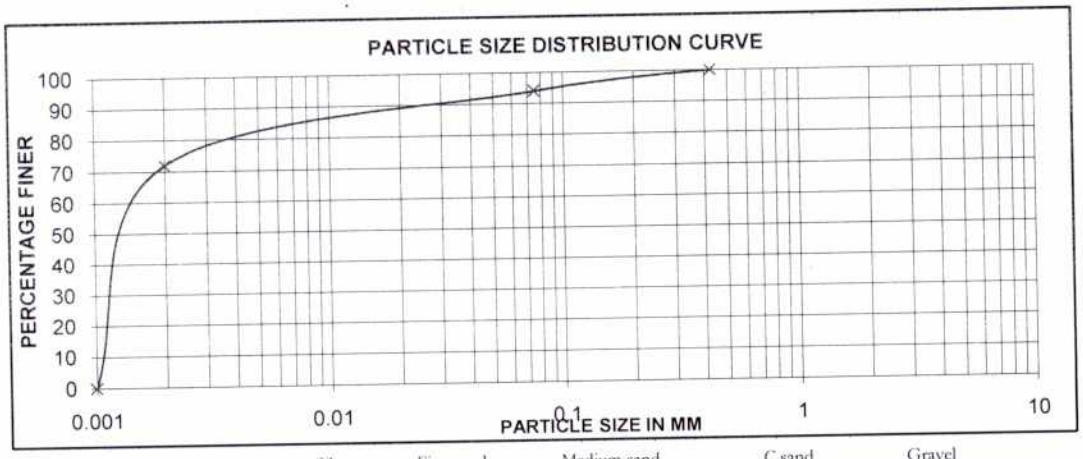


B.H	Depth	Index
13	13.5	

FOUNDATION ENGINEERING PRIVATE LTD.



B.H	Depth	Index
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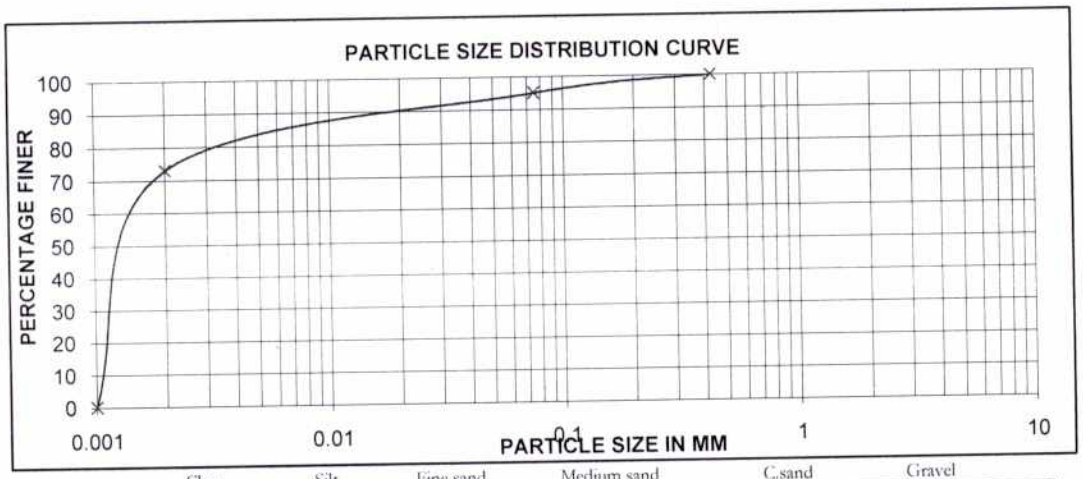

B.H	Depth	Index
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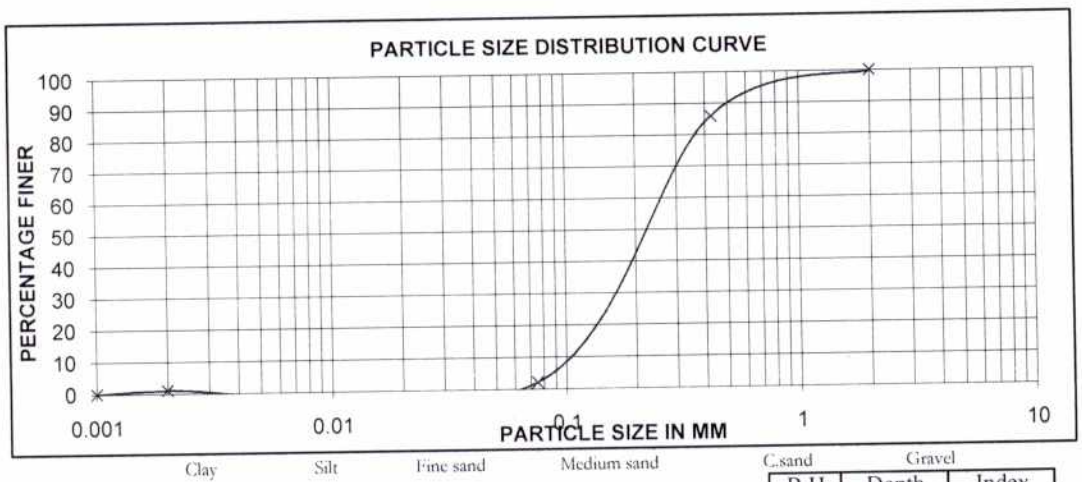

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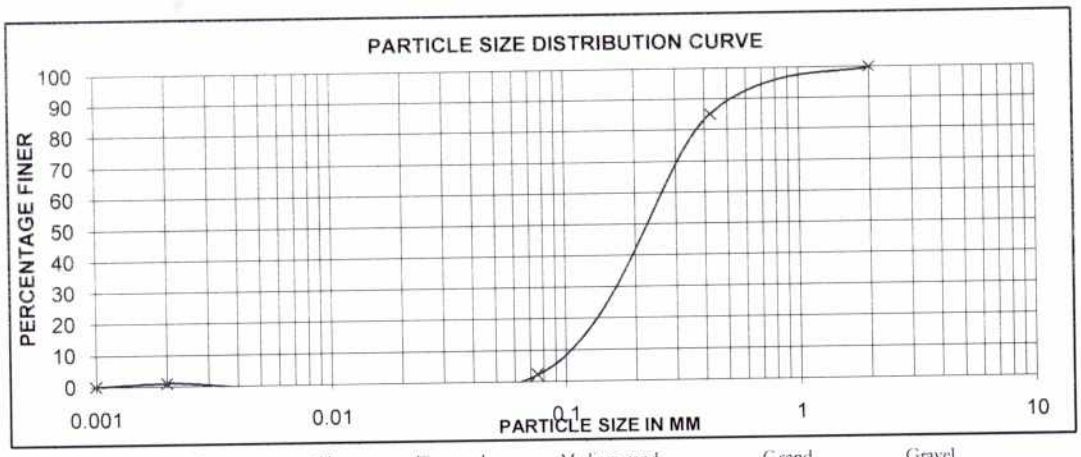

B.H	Depth	Index
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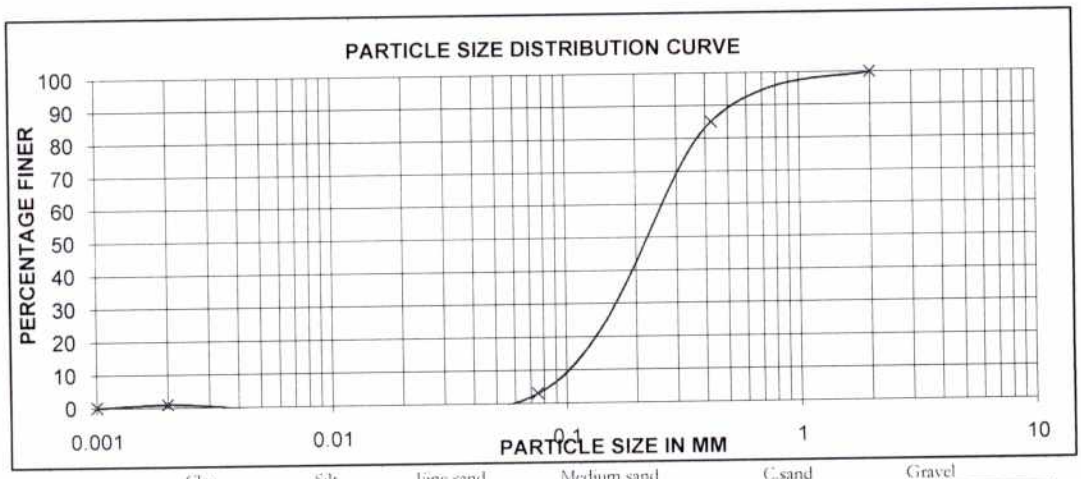

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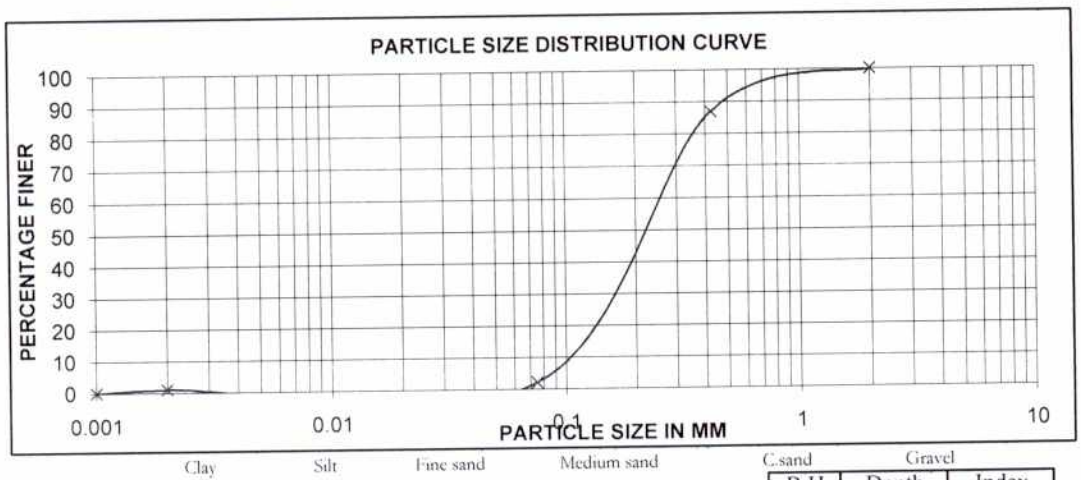

B.H	Depth	Index
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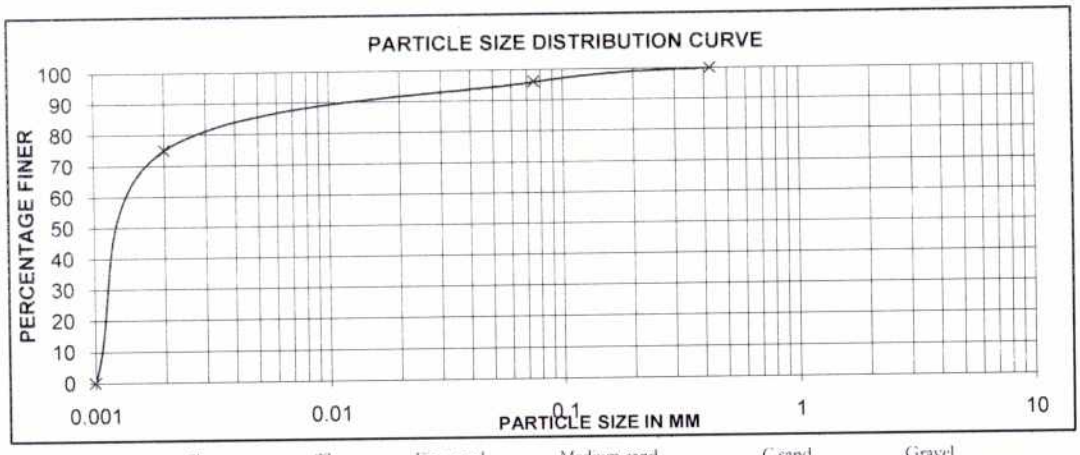

B.H	Depth	Index
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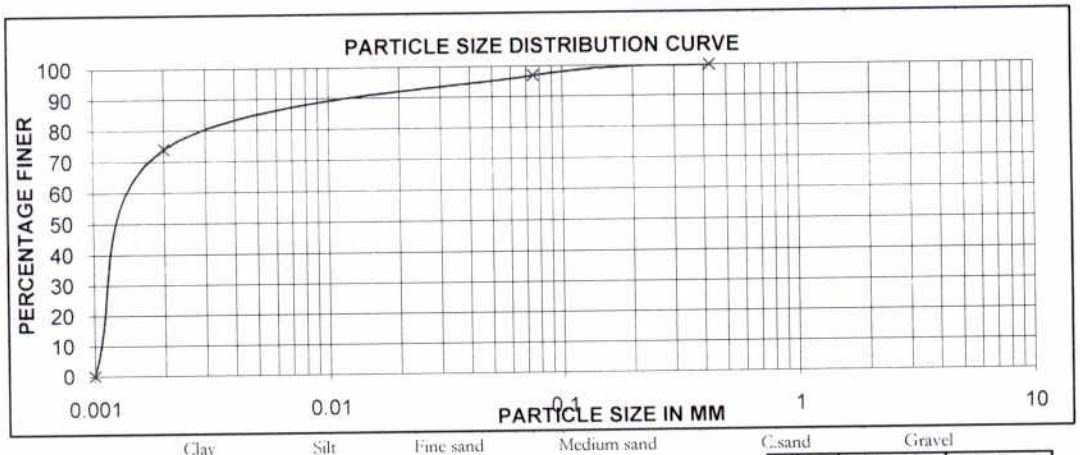

B.H	Depth	Index
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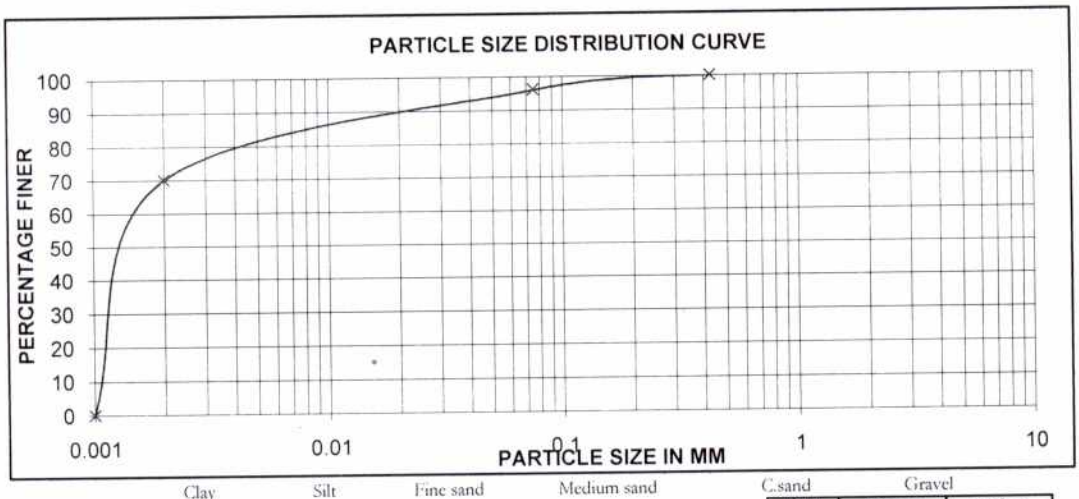

B.H	Depth	Index
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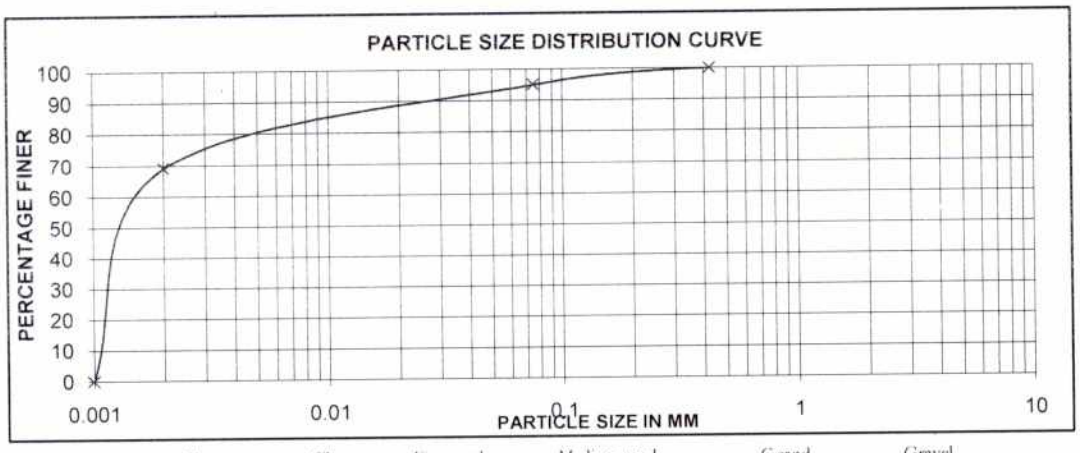

B.H	Depth	Index
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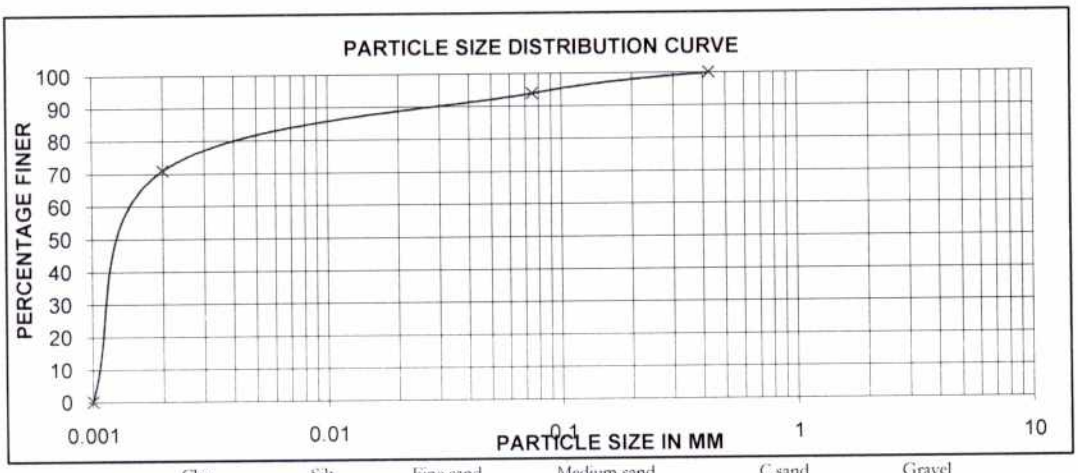

B.H	Depth	Index
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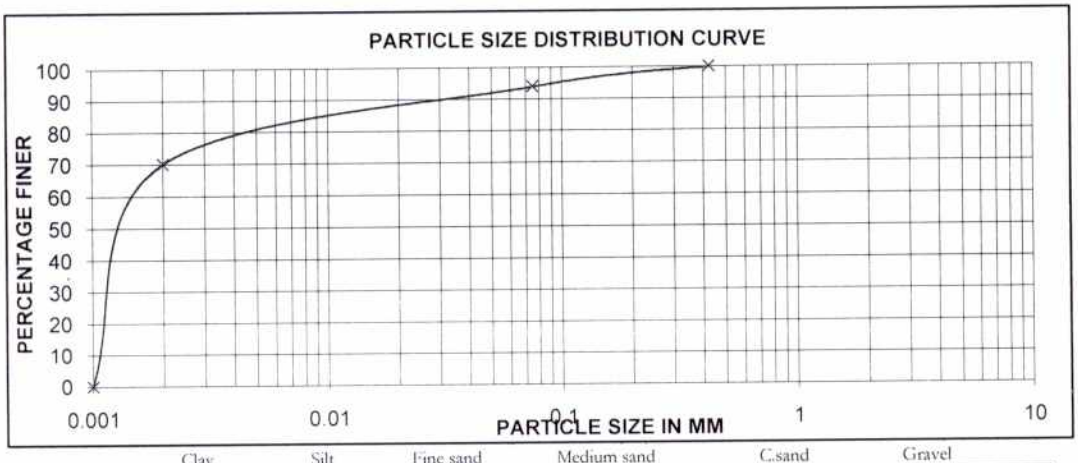

B.H	Depth	Index
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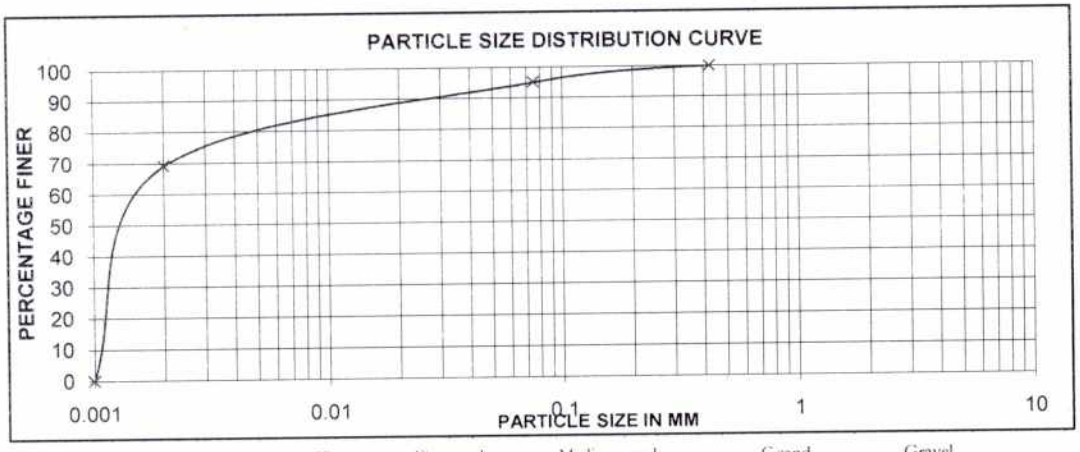

B.H	Depth	Index
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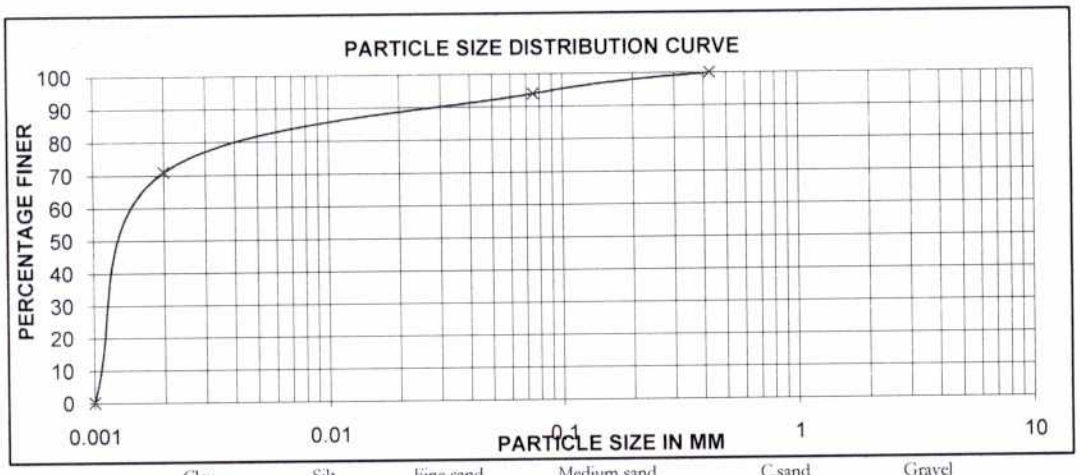
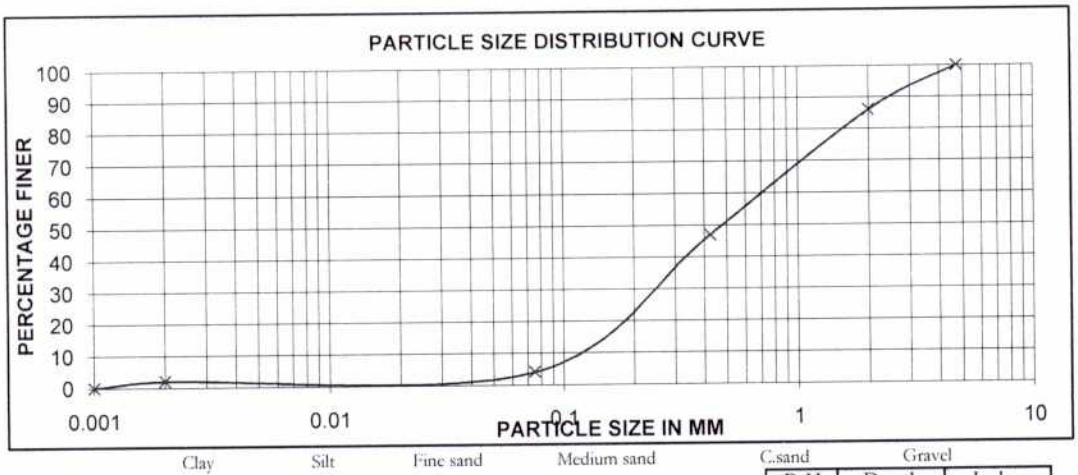
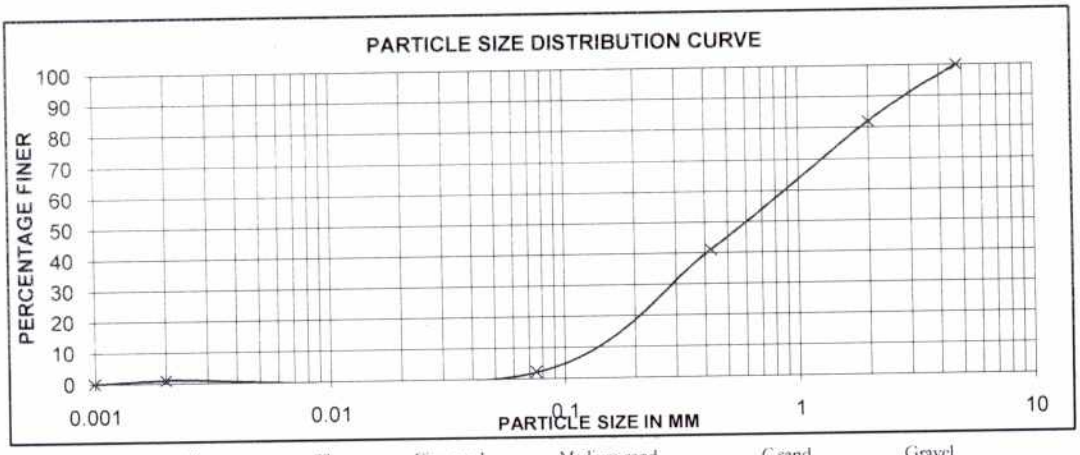


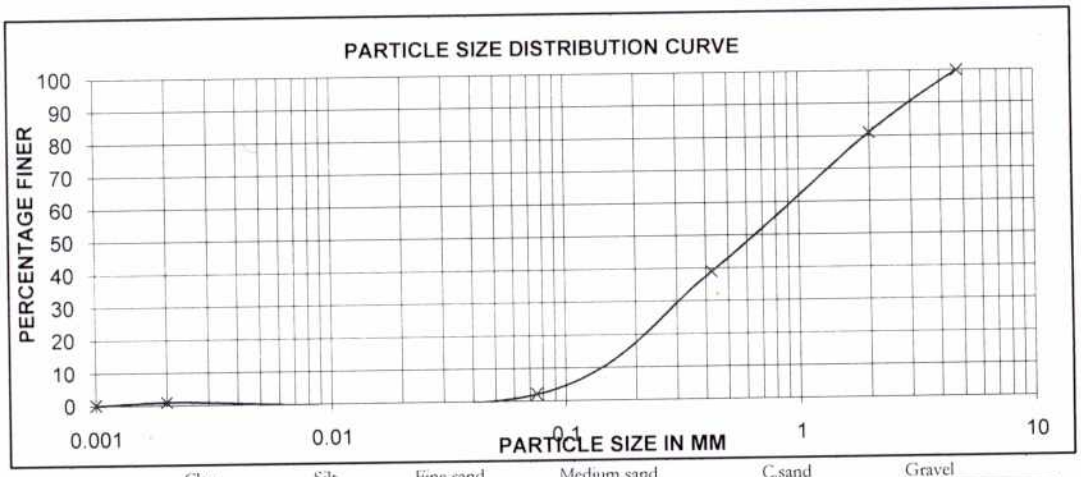
B.H	Depth	Index
14	12.0	



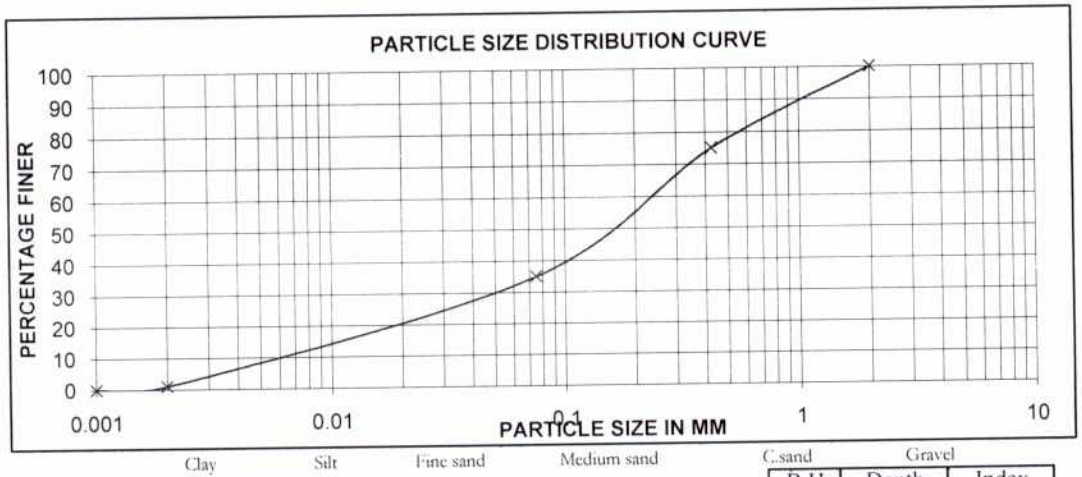
B.H	Depth	Index
14	13.5	



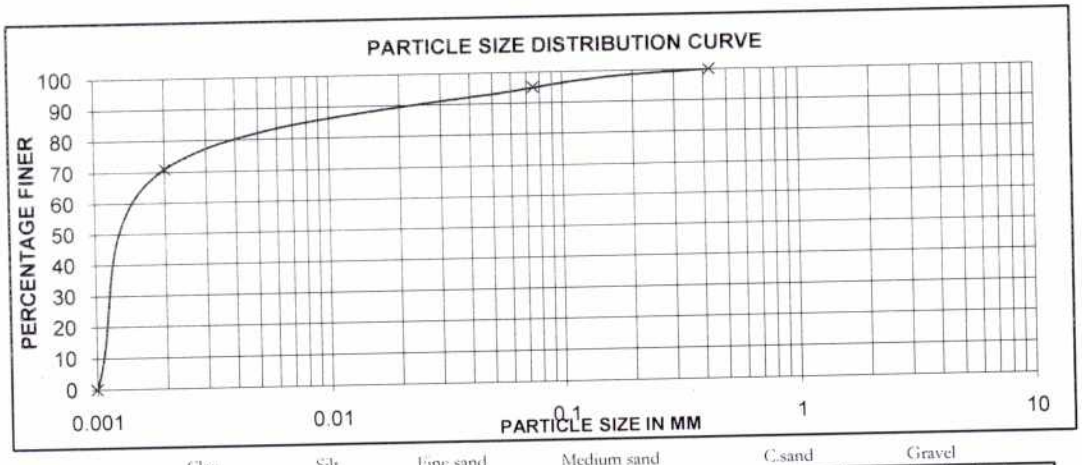
B.H	Depth	Index
14	15.0	



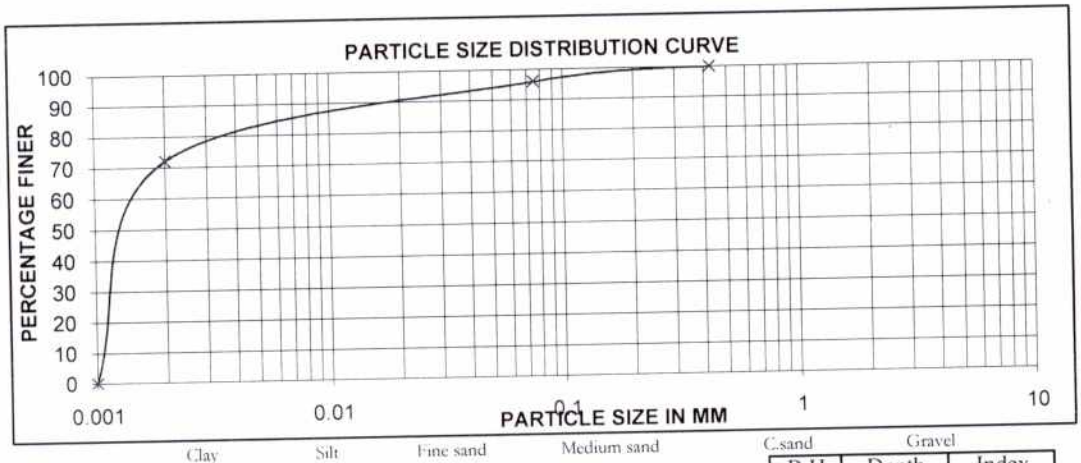
B.H	Depth	Index
14	16.5	



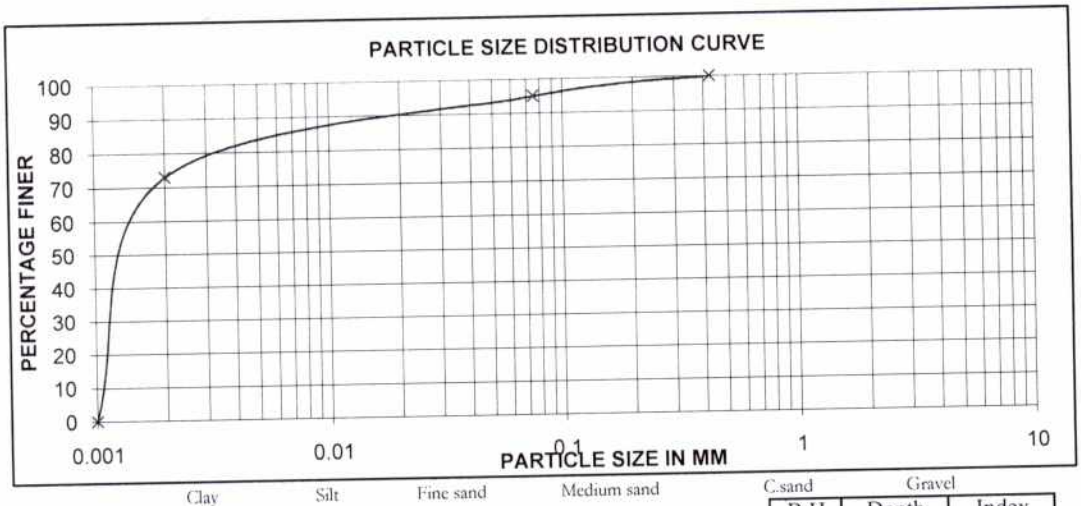
B.H	Depth	Index
14	18.0	



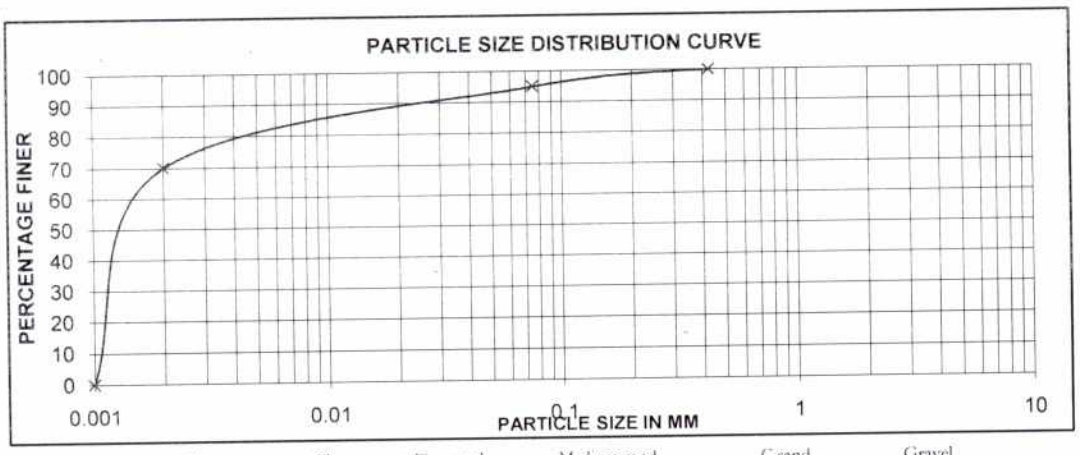
B.H	Depth	Index
15	1.5	



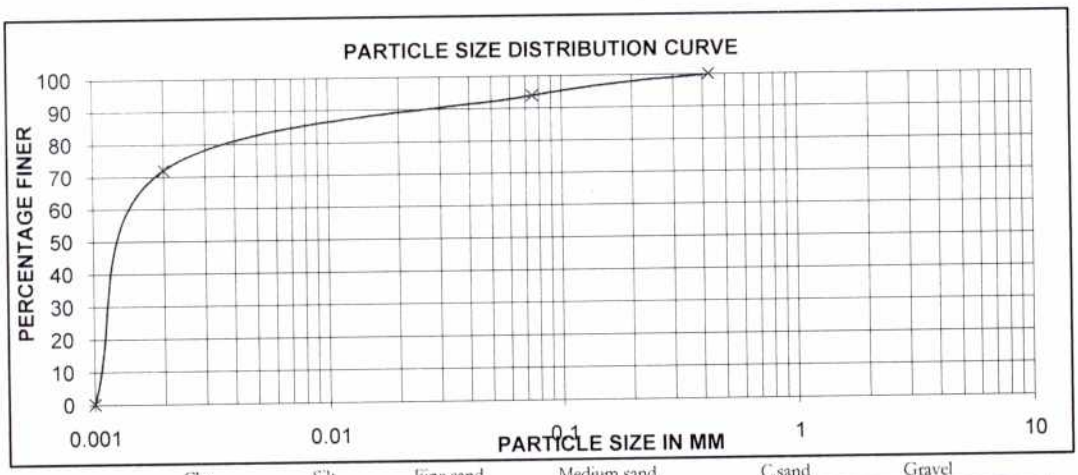
B.H	Depth	Index
15	3.0	



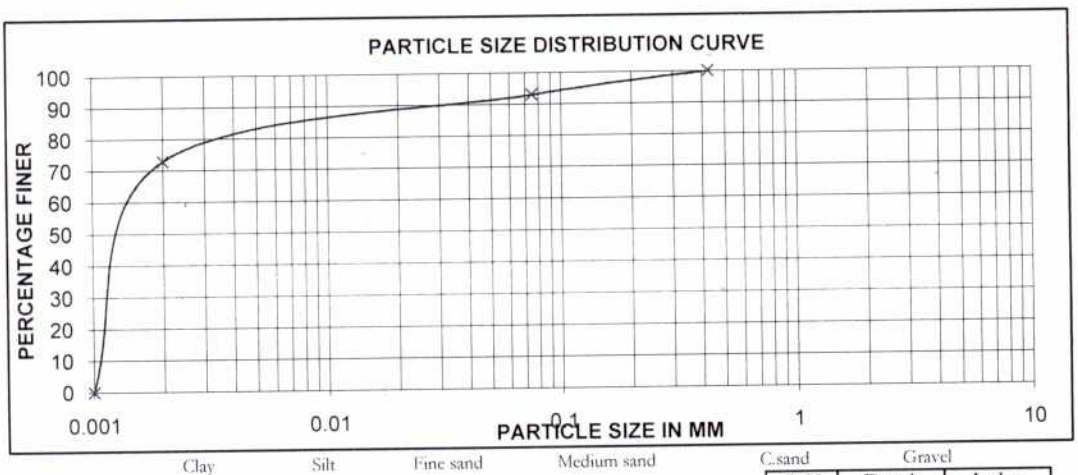
B.H	Depth	Index
15	4.5	



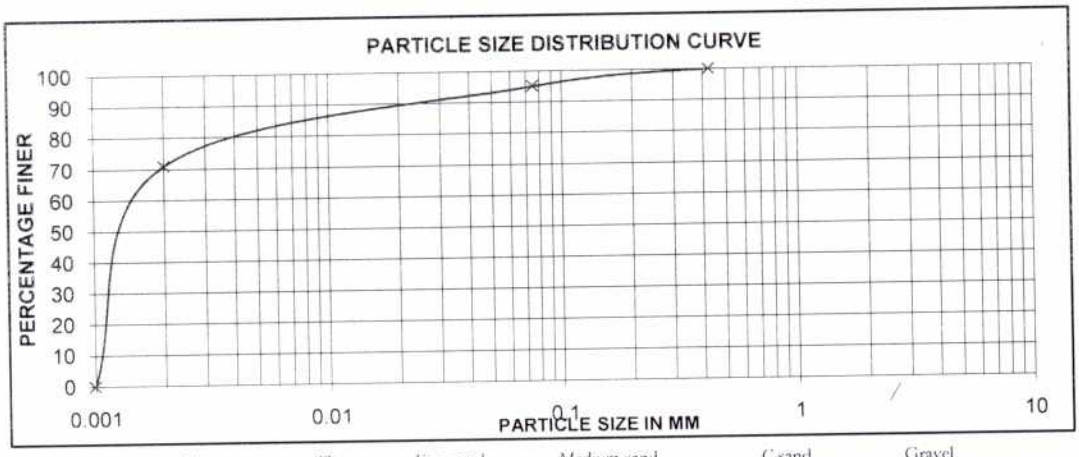
B.H	Depth	Index
15	6.0	



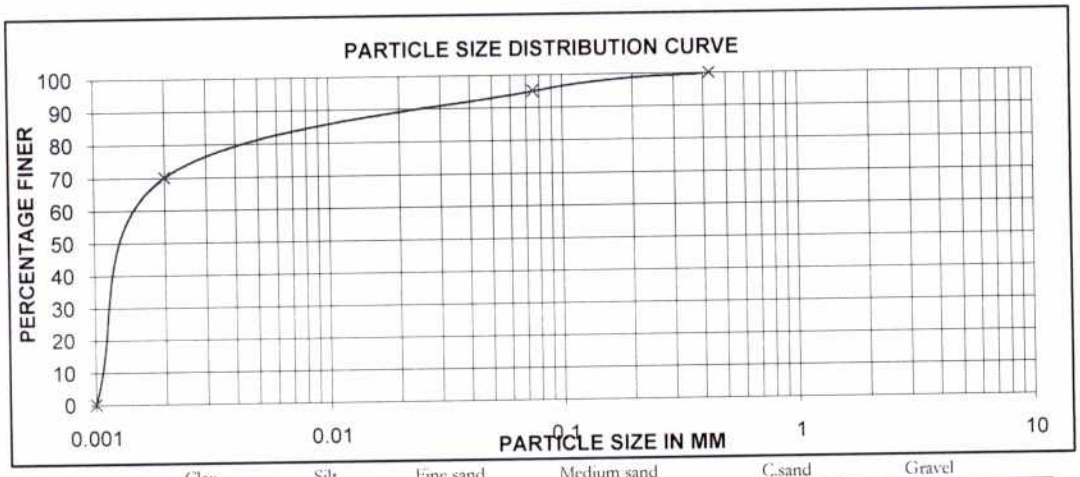
B.H	Depth	Index
15	7.5	



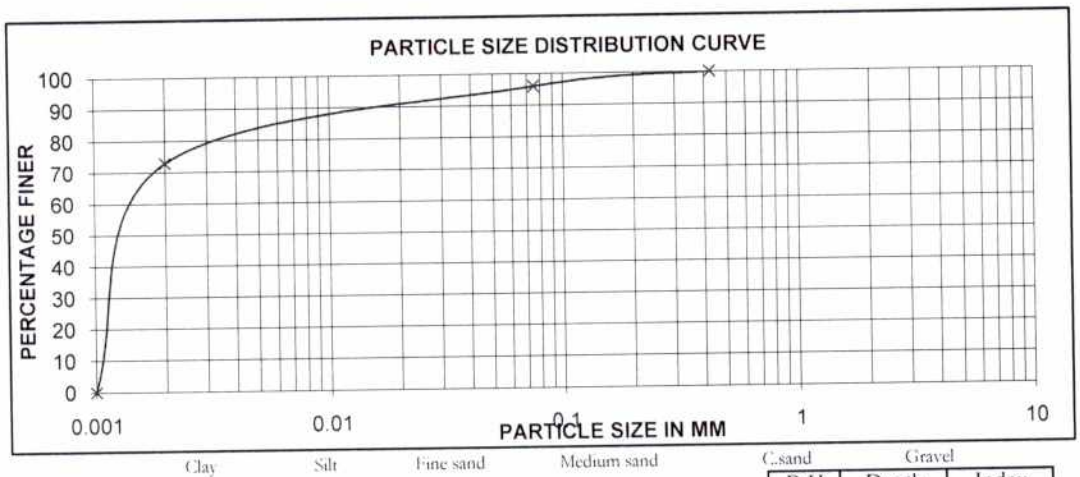
B.H	Depth	Index
15	9.0	



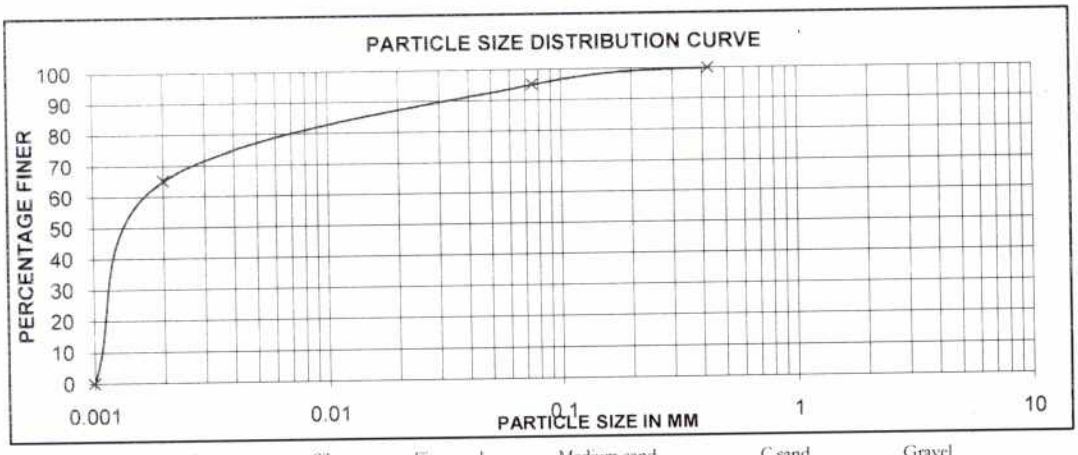
B.H	Depth	Index
15	10.5	



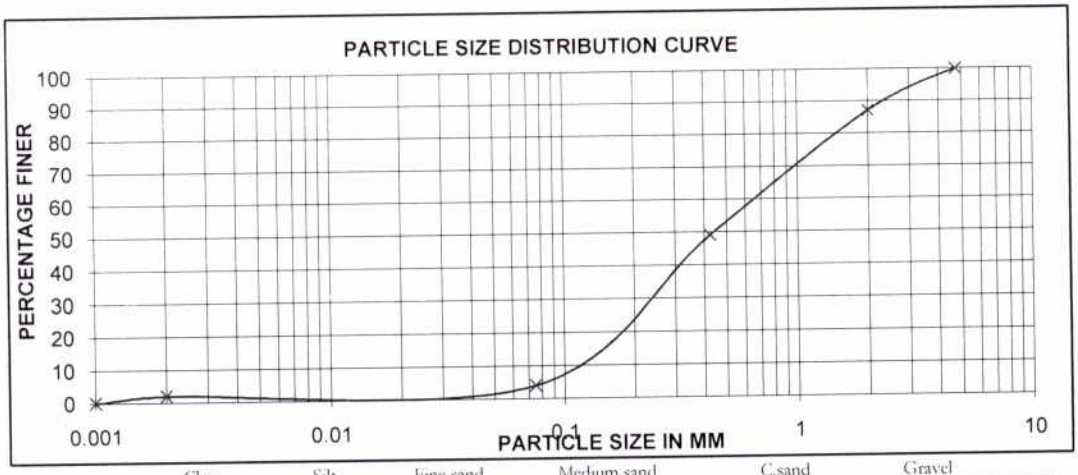
B.H	Depth	Index
15	12.0	



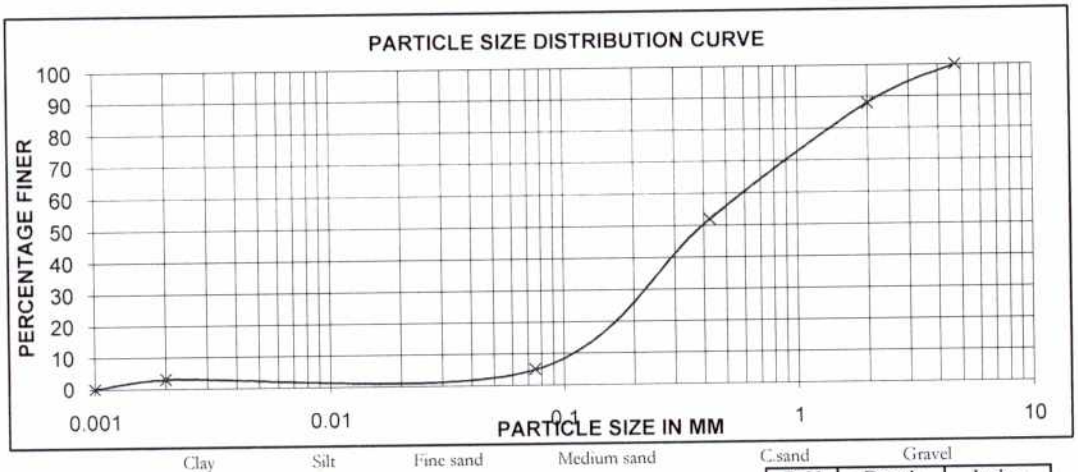
B.H	Depth	Index
15	13.5	



B.H	Depth	Index
15	15.0	

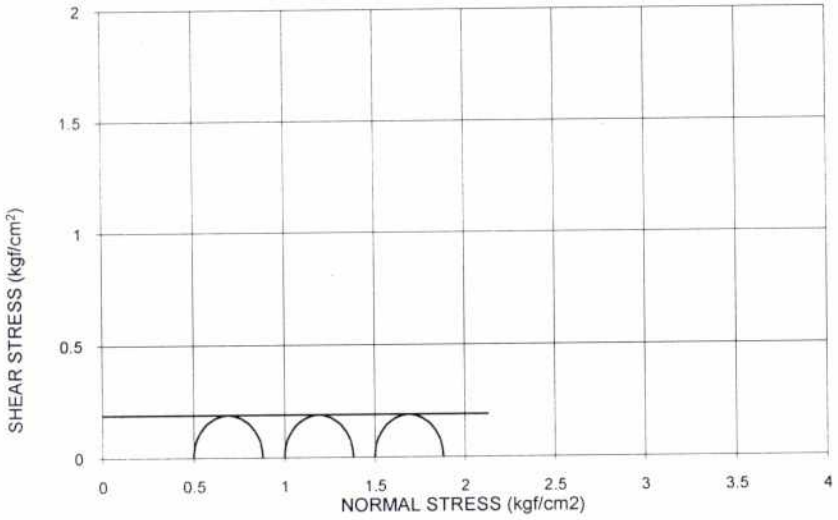


B.H	Depth	Index
15	16.5	



B.H	Depth	Index
15	18.0	

SHEAR TEST GRAPH



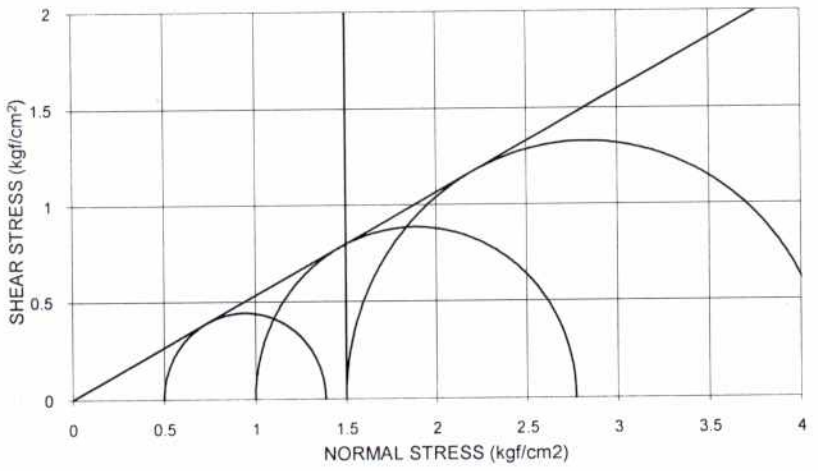
BH NO: 11

DEPTH: 3.0 m

C = 0.19 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



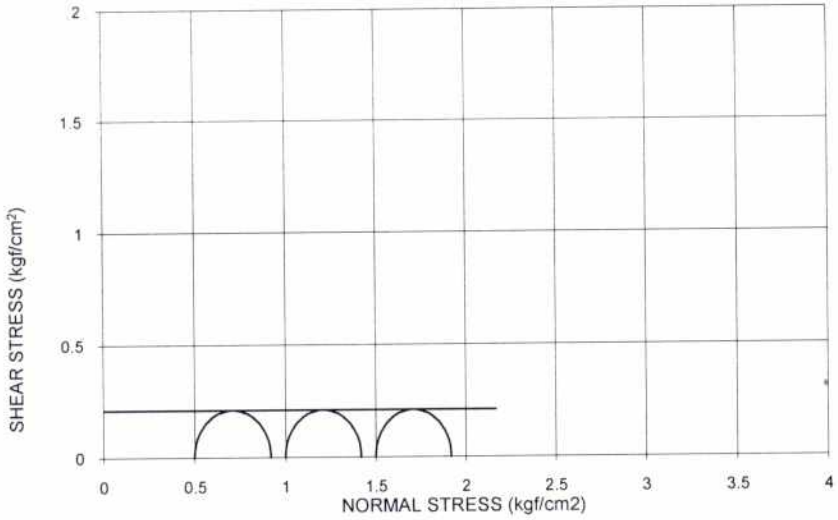
BH NO: 11

DEPTH: 4.5 m

C = 0.00 kgf/cm^2

Φ = 28.0 ^{O}

SHEAR TEST GRAPH



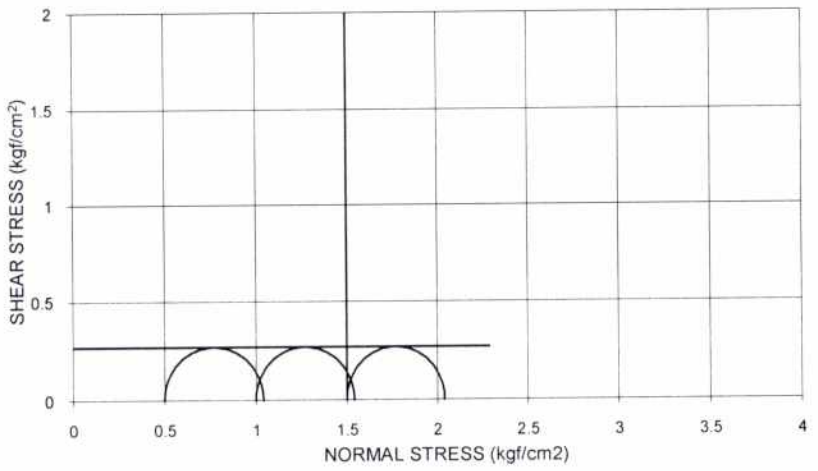
BH NO: 11

DEPTH: 6.0 m

C = 0.21 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



BH NO: 11

DEPTH: 7.5 m

C = 0.27 kgf/cm^2

Φ = 0.0 °

FOUNDATION PRIVATE LTD.

SHEAR TEST GRAPH

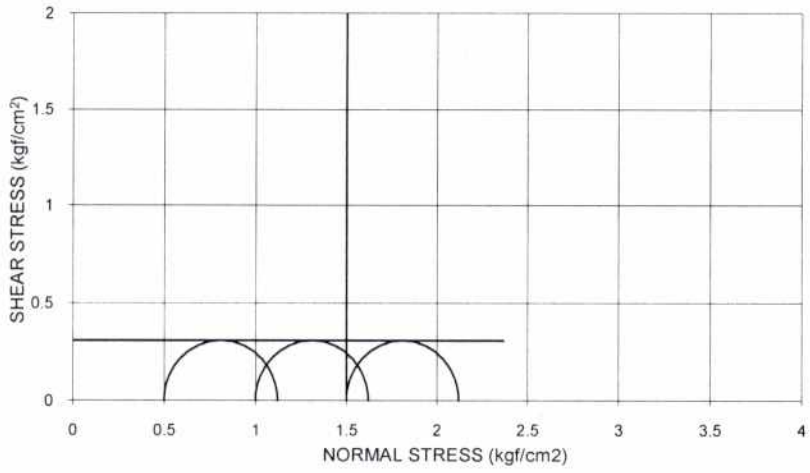
BH NO: 11

DEPTH: 9.0 m

C = 0.29 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 11

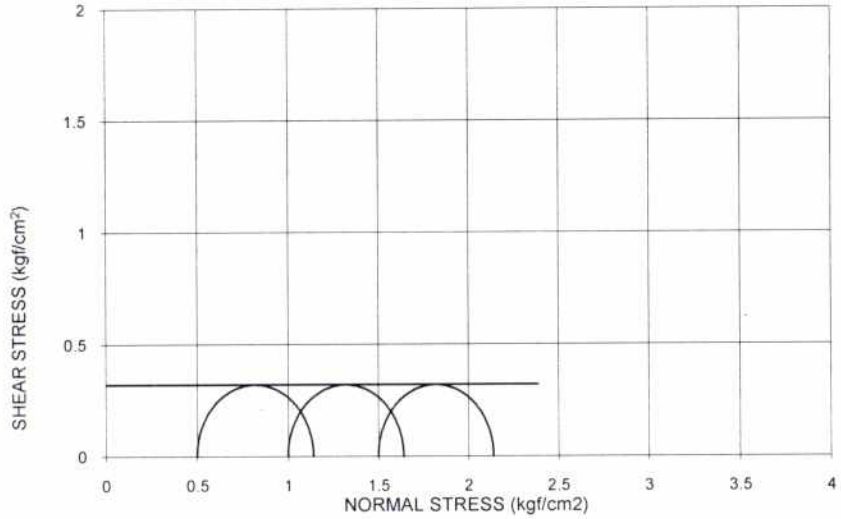
DEPTH: 10.5 m

C = 0.31 kgf/cm^2

Φ = 0.0 ^{O}

ESS FOUNDATION PRIVATE LTD.

SHEAR TEST GRAPH



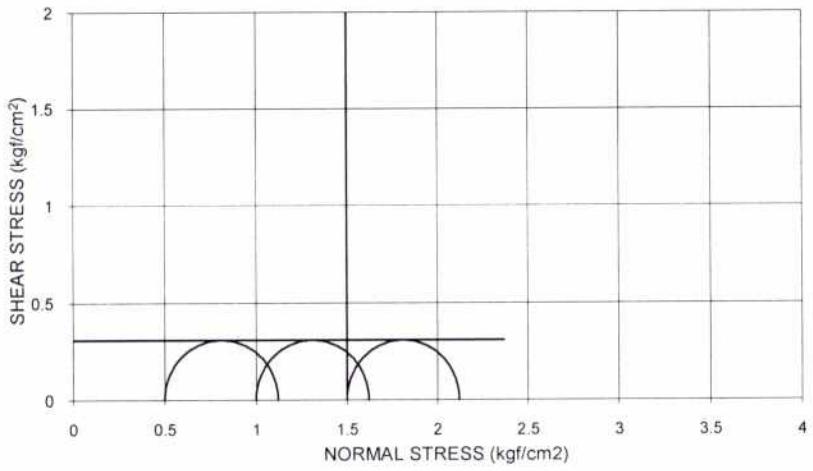
BH NO: 11

DEPTH: 12.0 m

C = 0.32 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



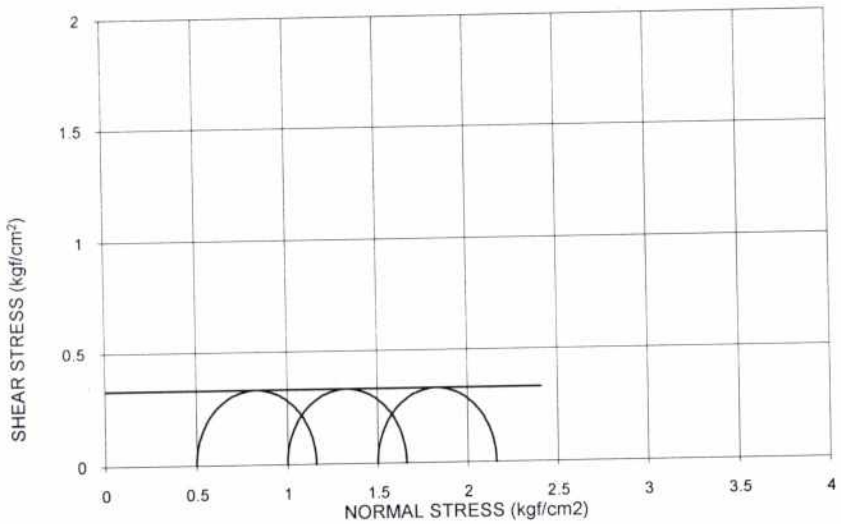
BH NO: 11

DEPTH: 13.5 m

C = 0.31 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



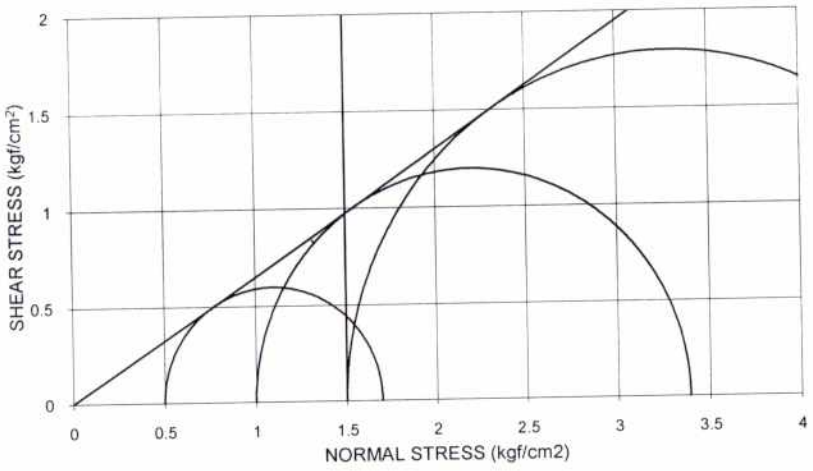
BH NO: 11

DEPTH: 15.0 m

C = 0.33 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



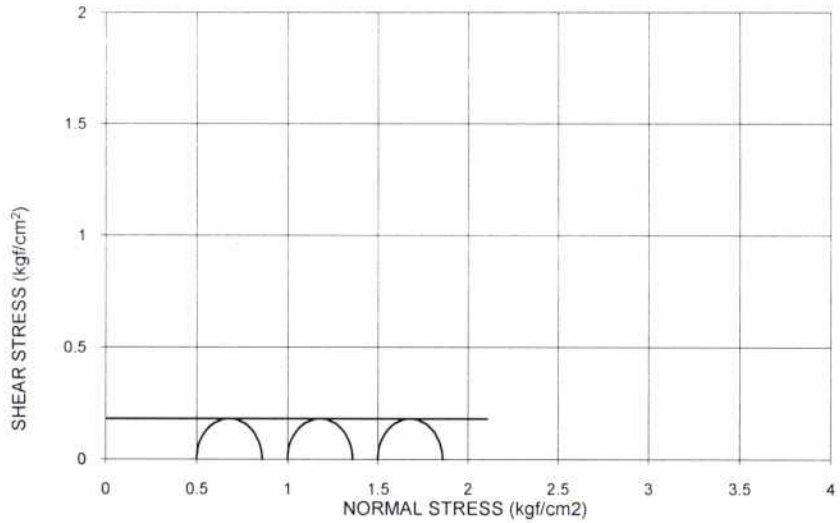
BH NO: 11

DEPTH: 16.5 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{O}

SHEAR TEST GRAPH



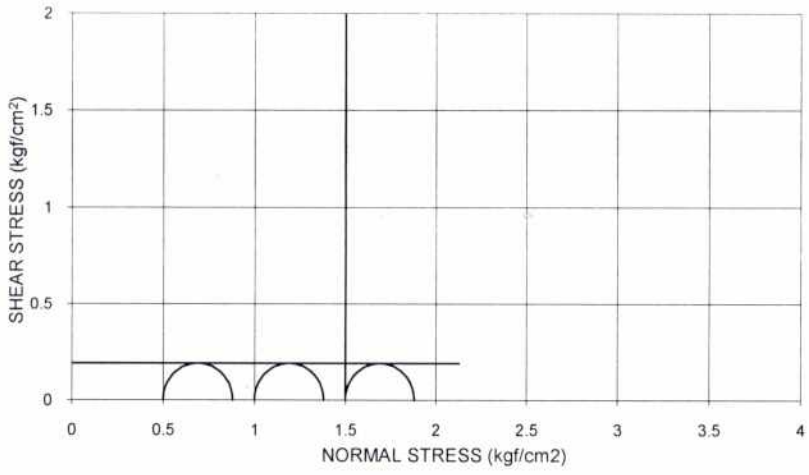
BH NO: 12

DEPTH: 3.0 m

C = 0.18 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



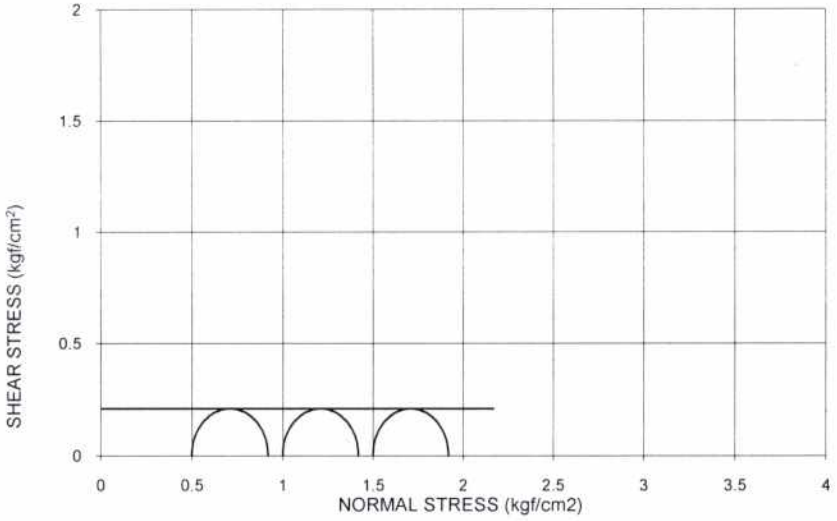
BH NO: 12

DEPTH: 4.5 m

C = 0.19 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



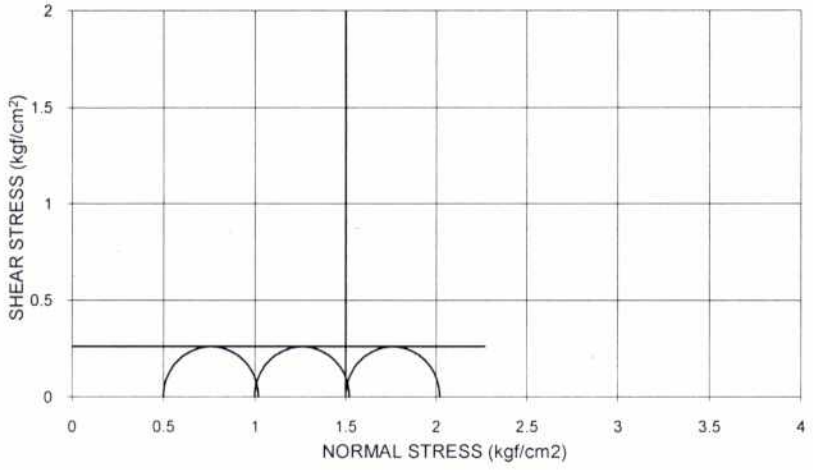
BH NO: 12

DEPTH: 6.0 m

C = 0.21 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



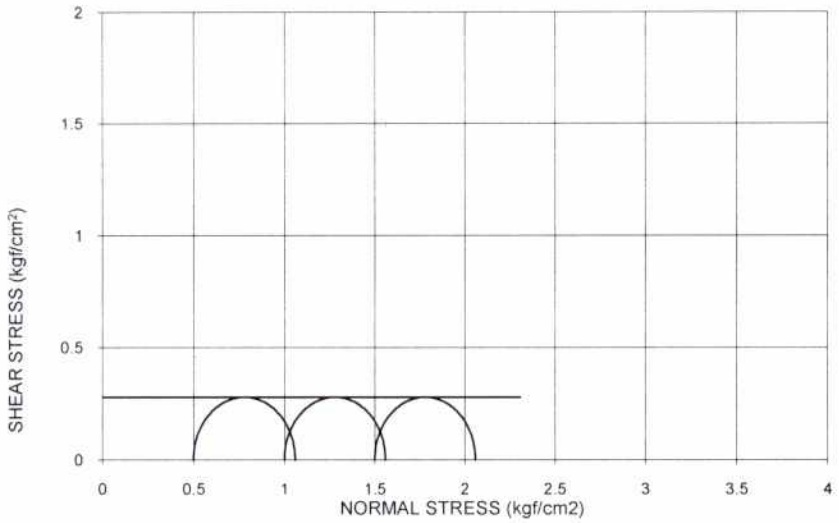
BH NO: 12

DEPTH: 7.5 m

C = 0.26 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



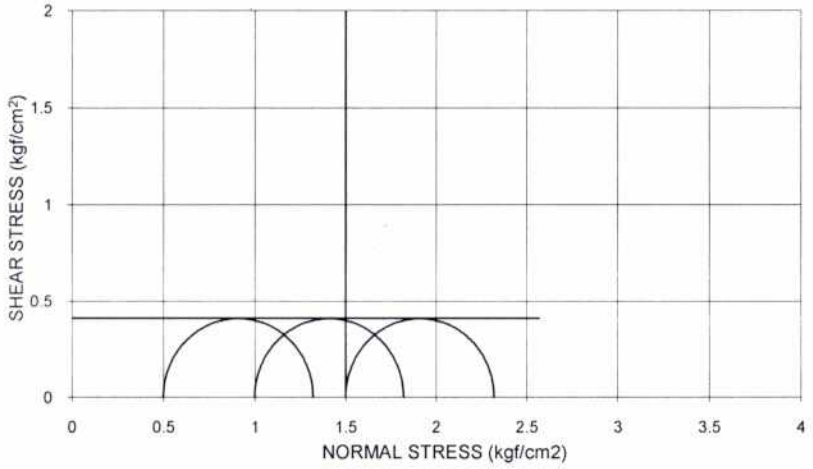
BH NO: 12

DEPTH: 9.0 m

C = 0.28 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



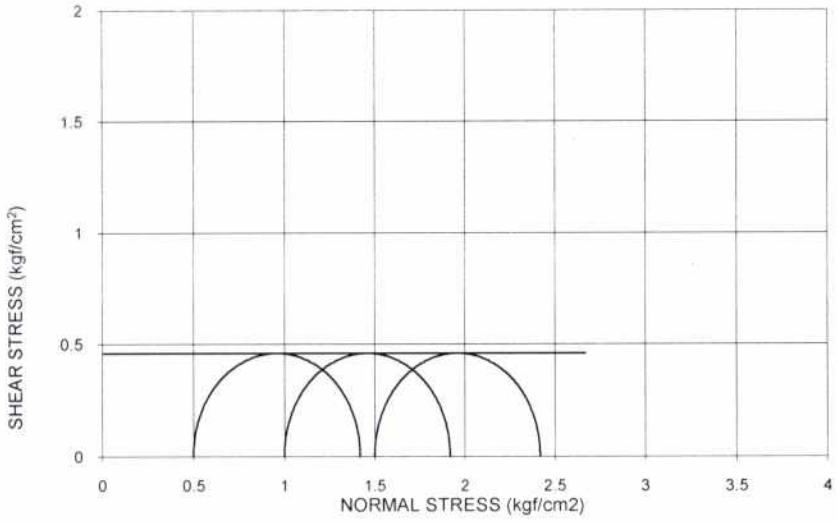
BH NO: 12

DEPTH: 10.5 m

C = 0.41 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



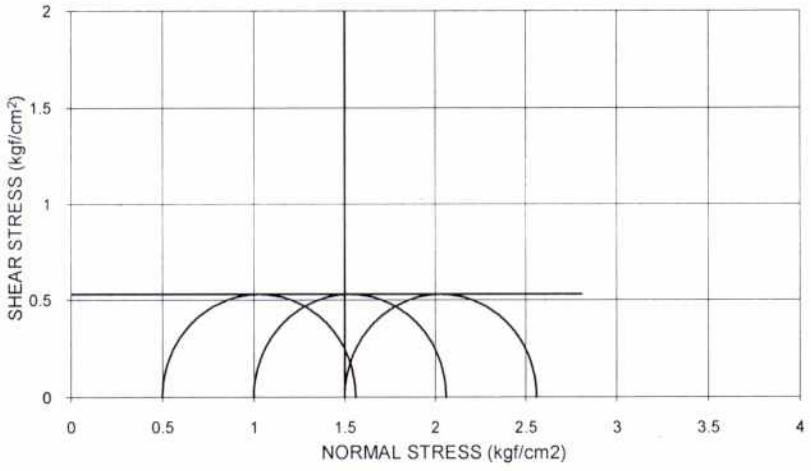
BH NO: 12

DEPTH: 12.0 m

C = 0.46 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



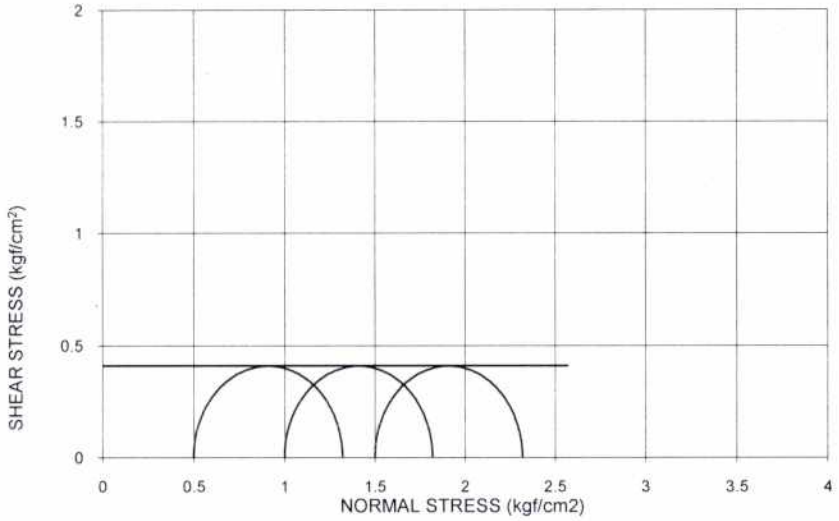
BH NO: 12

DEPTH: 13.5 m

C = 0.53 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



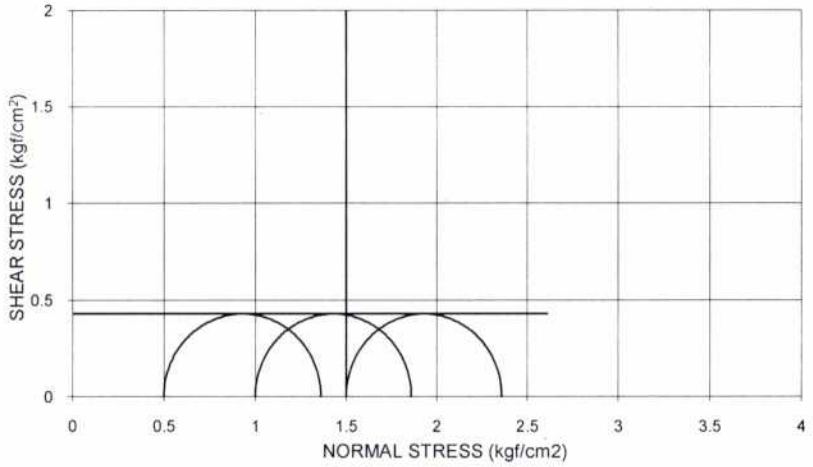
BH NO: 12

DEPTH: 15.0 m

C = 0.41 kgf/cm²

Φ = 0.0 °

SHEAR TEST GRAPH



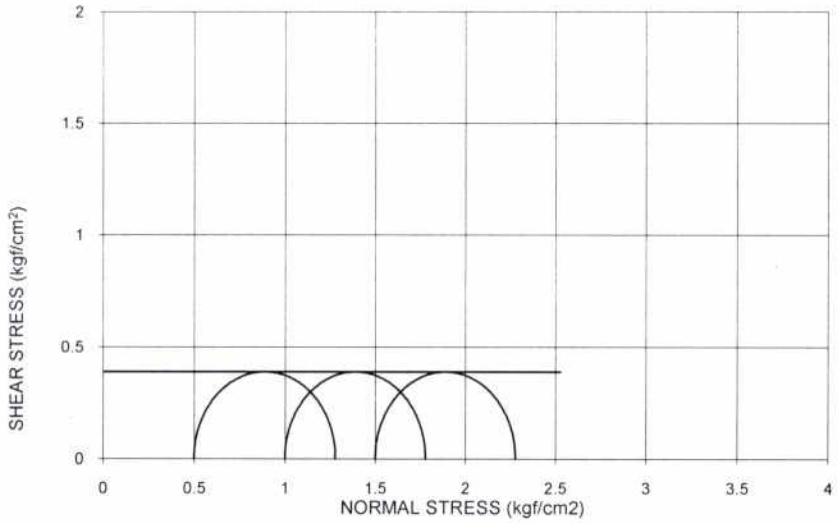
BH NO: 12

DEPTH: 16.5 m

C = 0.43 kgf/cm²

Φ = 0.0 °

SHEAR TEST GRAPH



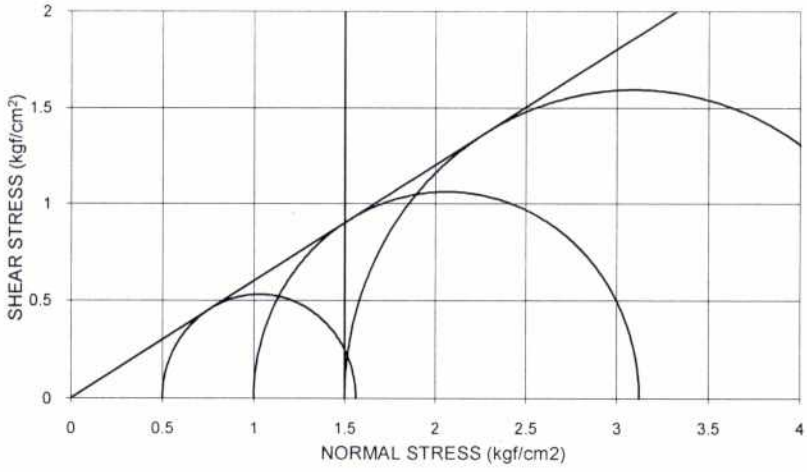
BH NO: 12

DEPTH: 18.0 m

C = 0.39 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



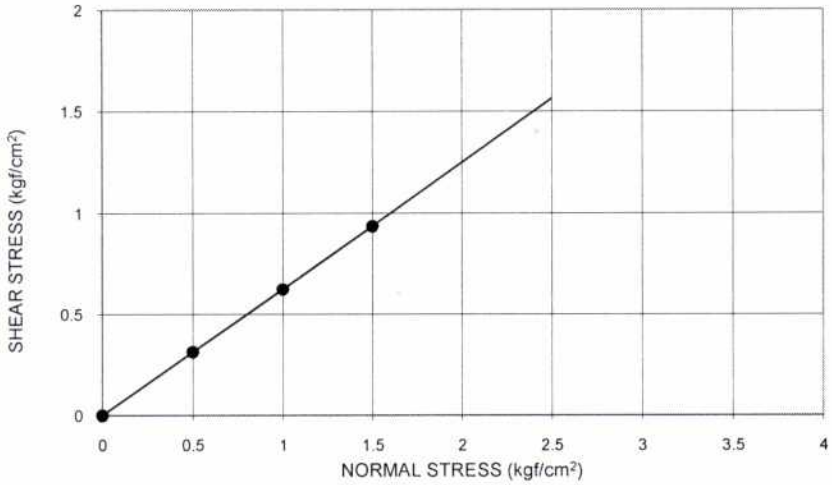
BH NO: 12

DEPTH: 19.5 m

C = 0.00 kgf/cm^2

Φ = 31.0 °

SHEAR TEST GRAPH



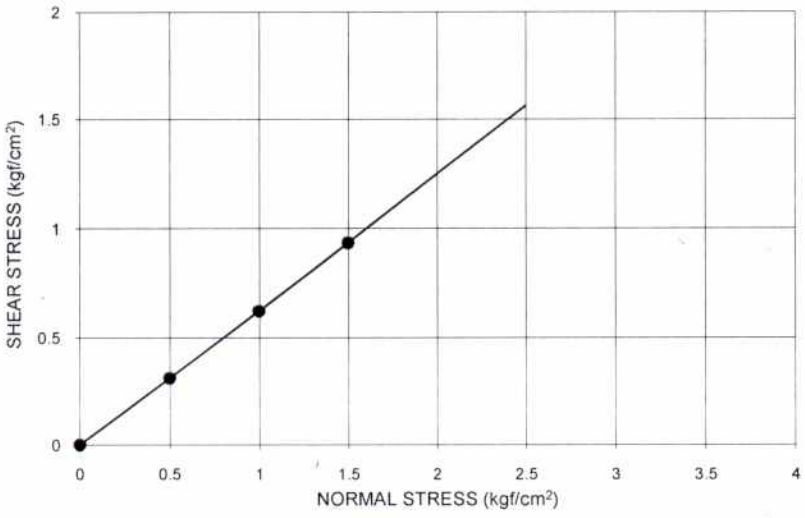
BH NO: 12

DEPTH: 21.0 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{o}

SHEAR TEST GRAPH



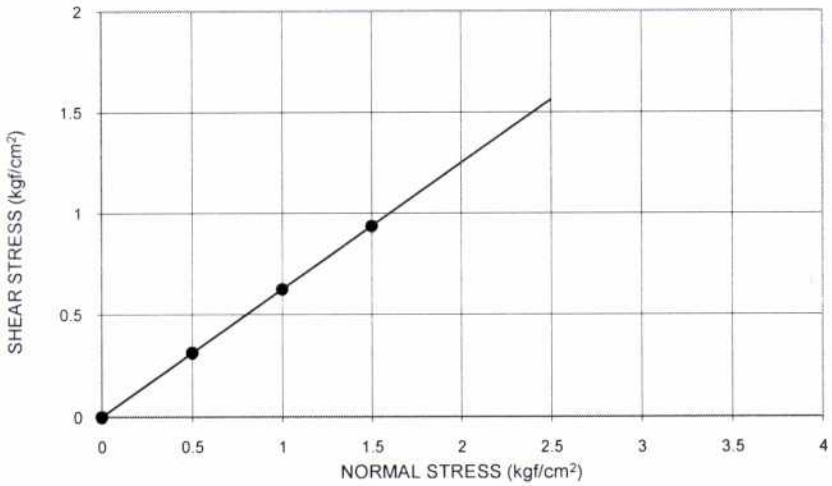
BH NO: 12

DEPTH: 22.5 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{o}

SHEAR TEST GRAPH



BH NO: 12

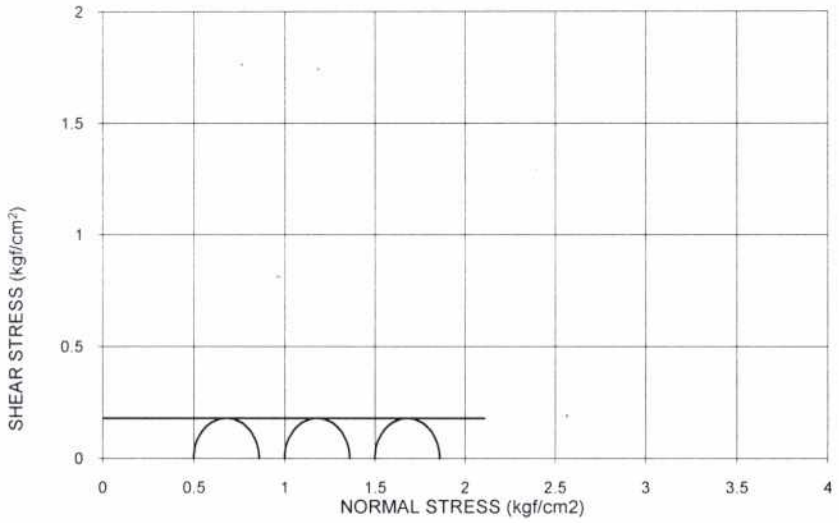
DEPTH: 24.0 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{o}

SHEAR TEST GRAPH

SHEAR TEST GRAPH



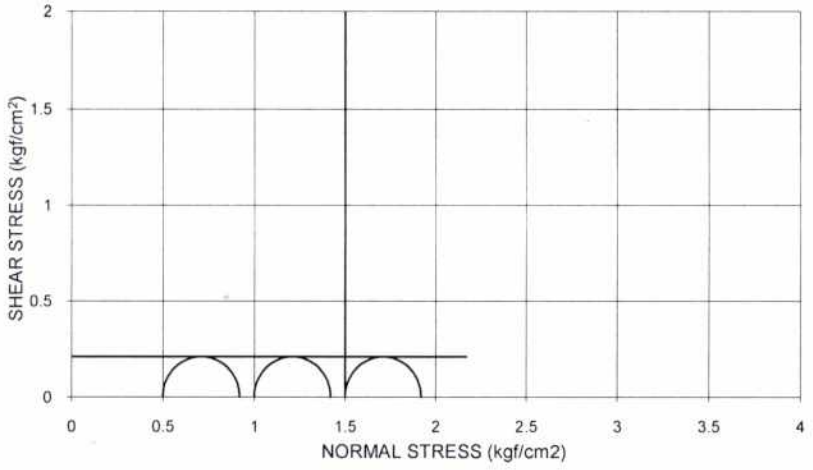
BH NO: 13

DEPTH: 3.0 m

C = 0.18 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



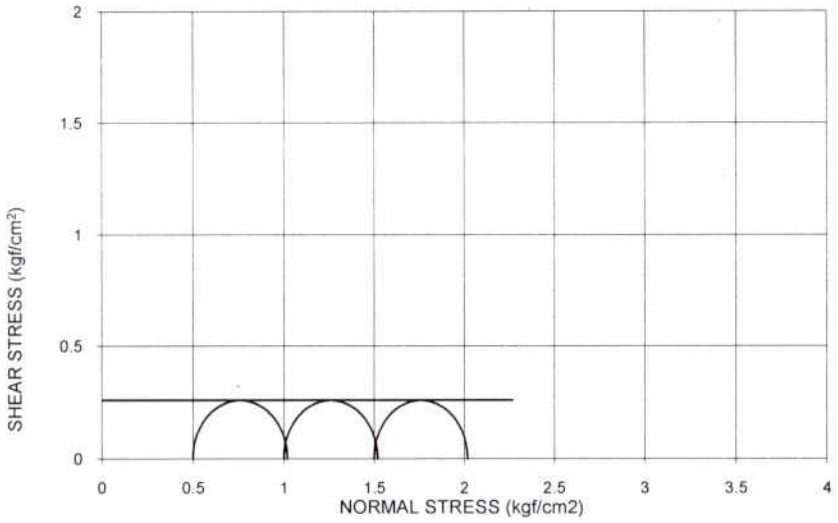
BH NO: 13

DEPTH: 4.5 m

C = 0.21 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



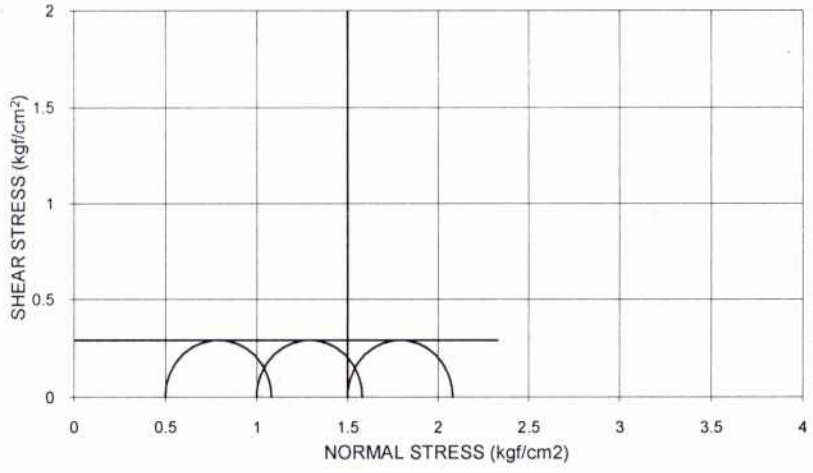
BH NO: 13

DEPTH: 6.0 m

C = 0.26 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



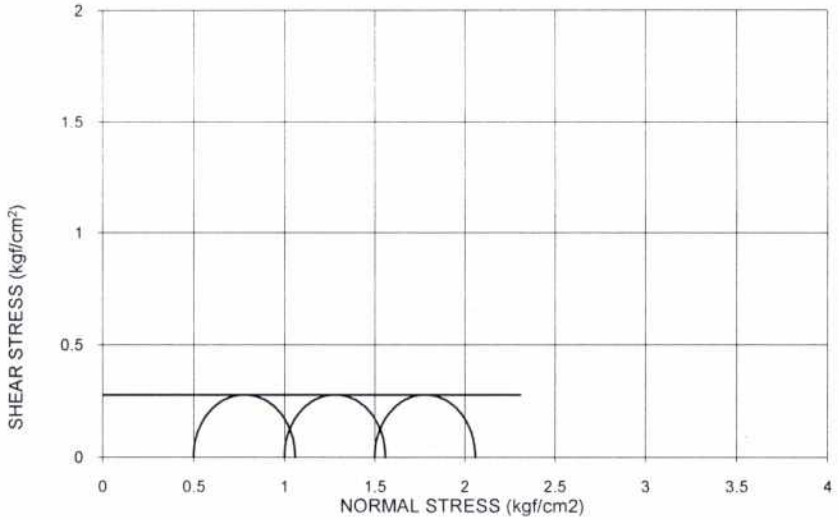
BH NO: 13

DEPTH: 7.5 m

C = 0.29 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



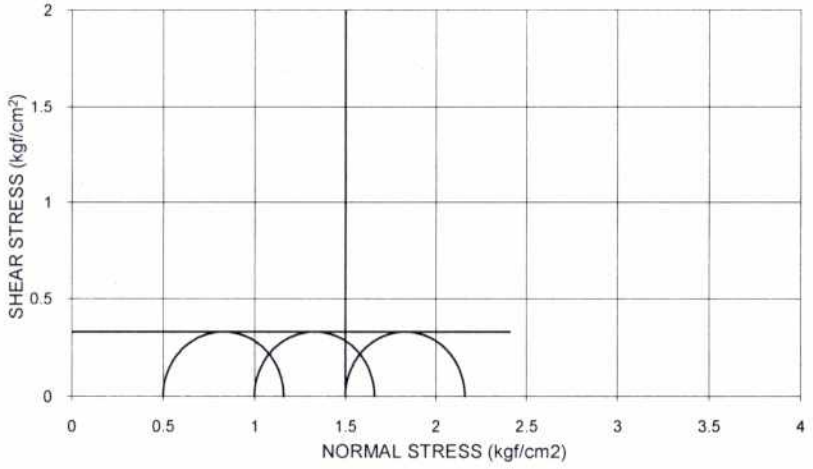
BH NO: 13

DEPTH: 9.0 m

C = 0.28 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



BH NO: 13

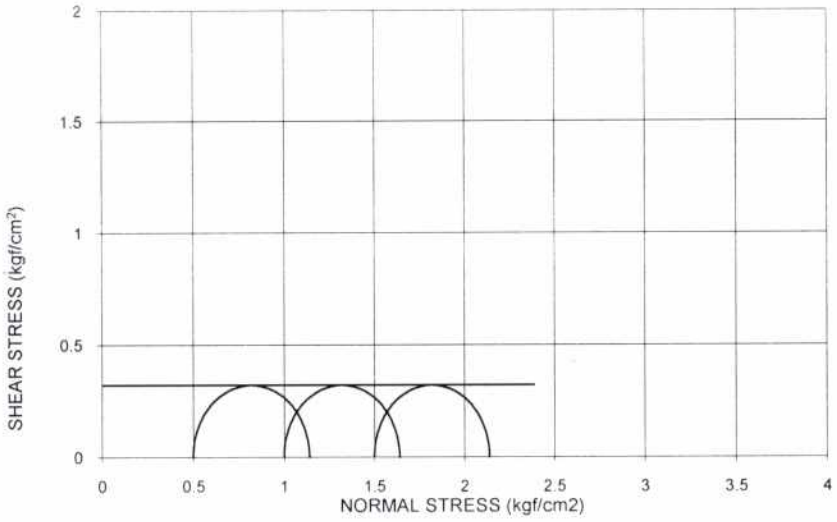
DEPTH: 10.5 m

C = 0.33 kgf/cm^2

Φ = 0.0 °

ESS FOUNDATION PRIVATE LTD.

SHEAR TEST GRAPH



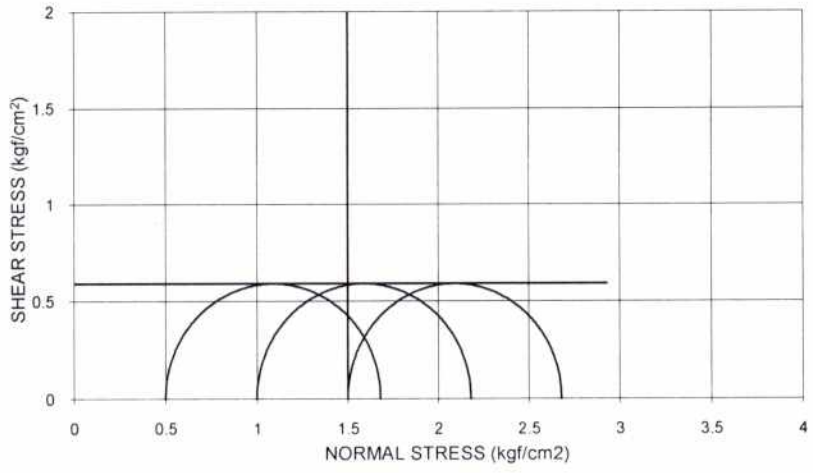
BH NO: 13

DEPTH: 12.0 m

C = 0.32 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



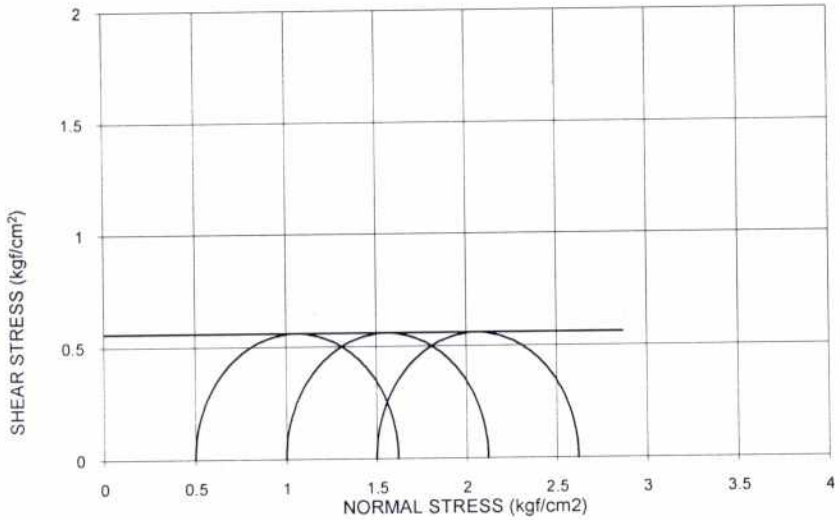
BH NO: 13

DEPTH: 13.5 m

C = 0.59 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



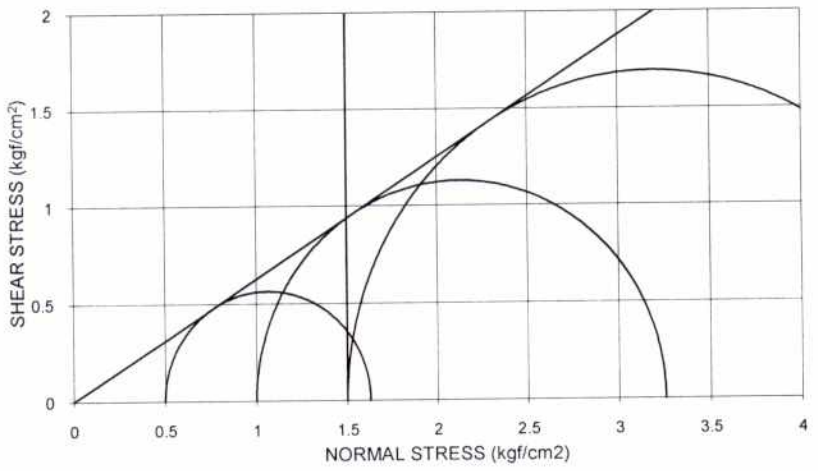
BH NO: 13

DEPTH: 15.0 m

C = 0.56 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



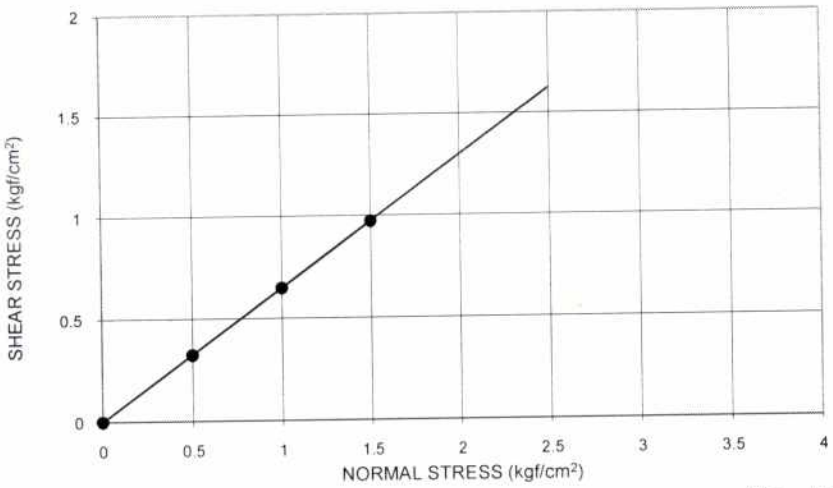
BH NO: 13

DEPTH: 16.5 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{O}

SHEAR TEST GRAPH



BH NO: 13

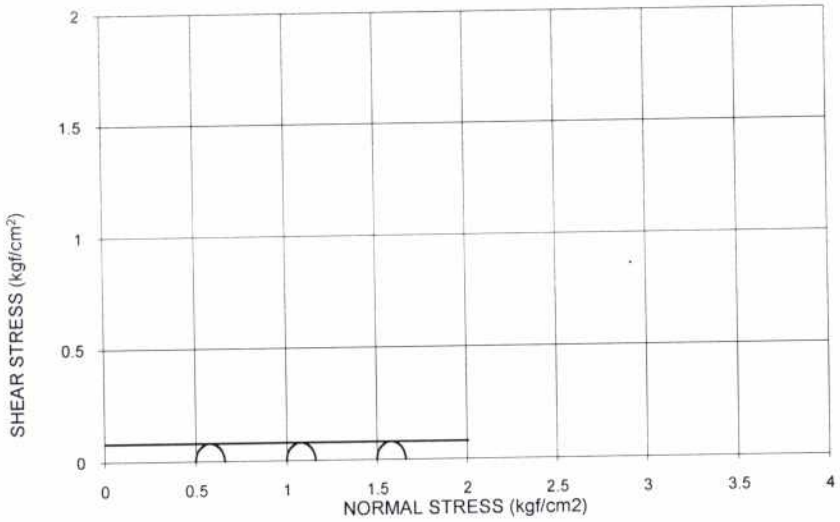
DEPTH: 18.0 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{o}

SHEAR TEST GRAPH

SHEAR TEST GRAPH



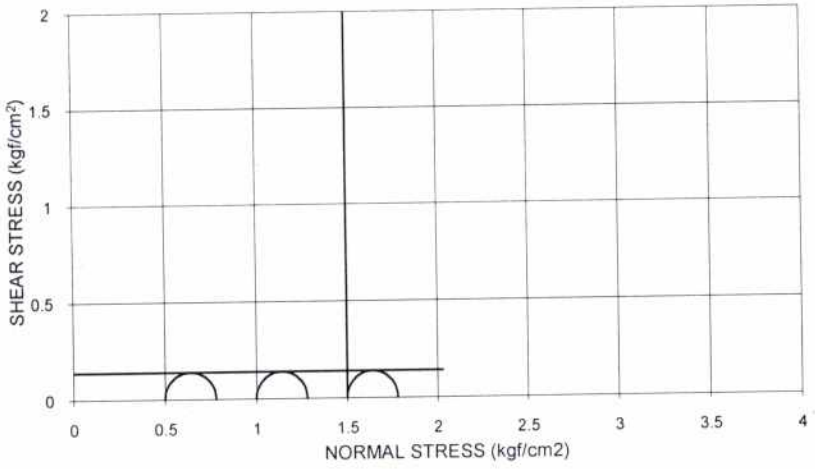
BH NO: 14

DEPTH: 3.0 m

C = 0.08 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 14

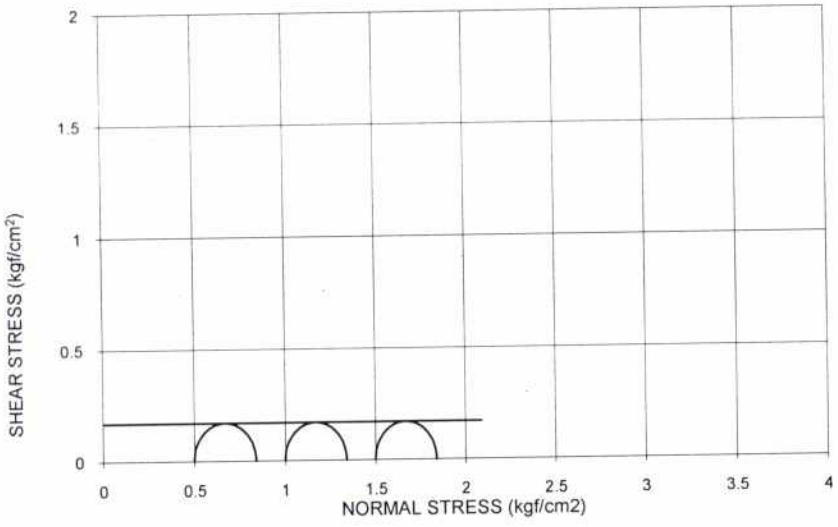
DEPTH: 4.5 m

C = 0.14 kgf/cm^2

Φ = 0.0 ^{O}

ESS FOUNDATION PVT. LTD.

SHEAR TEST GRAPH



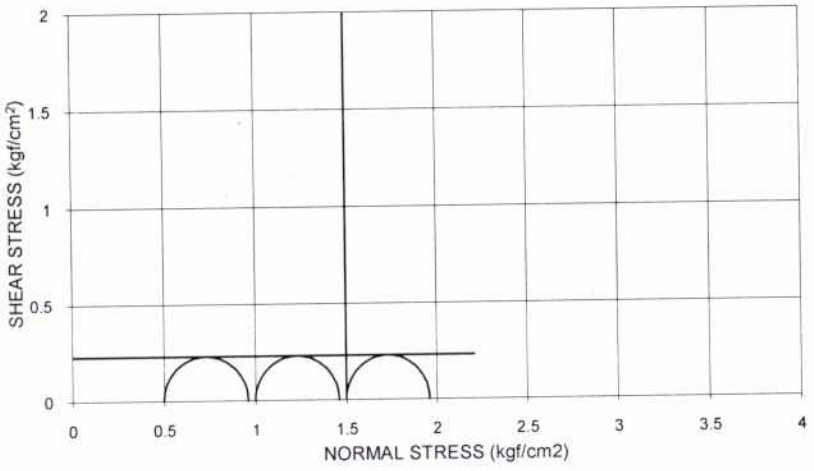
BH NO: 14

DEPTH: 6.0 m

C = 0.17 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



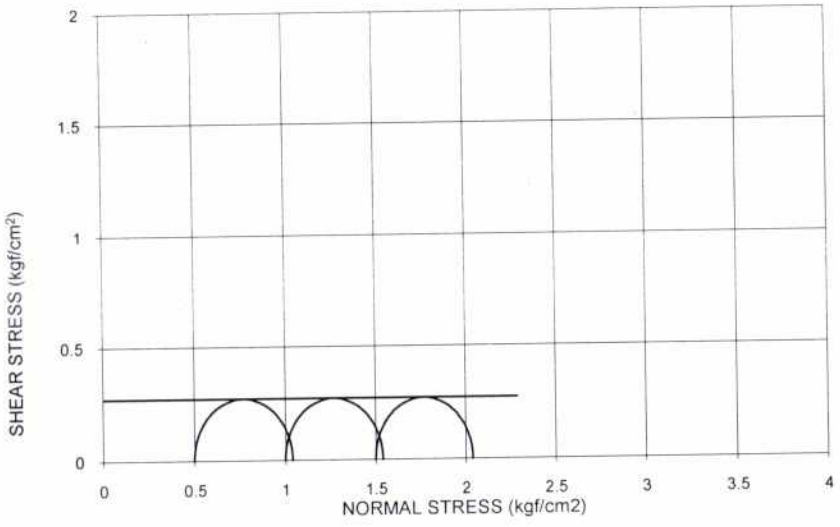
BH NO: 14

DEPTH: 7.5 m

C = 0.23 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



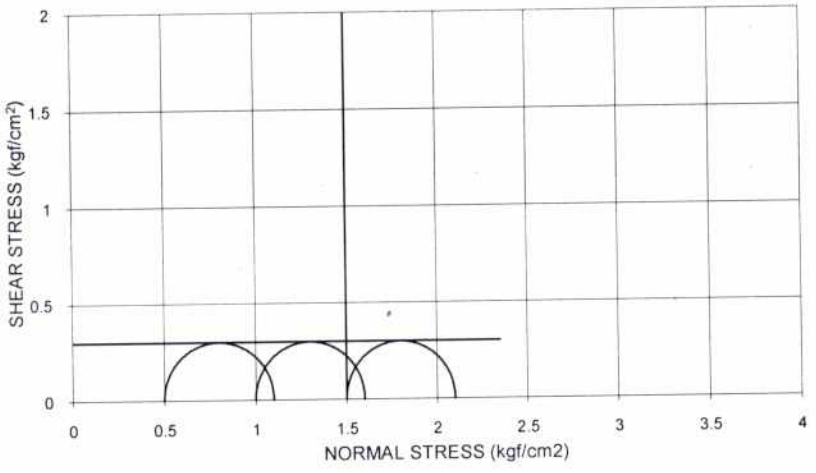
BH NO: 14

DEPTH: 9.0 m

C = 0.27 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



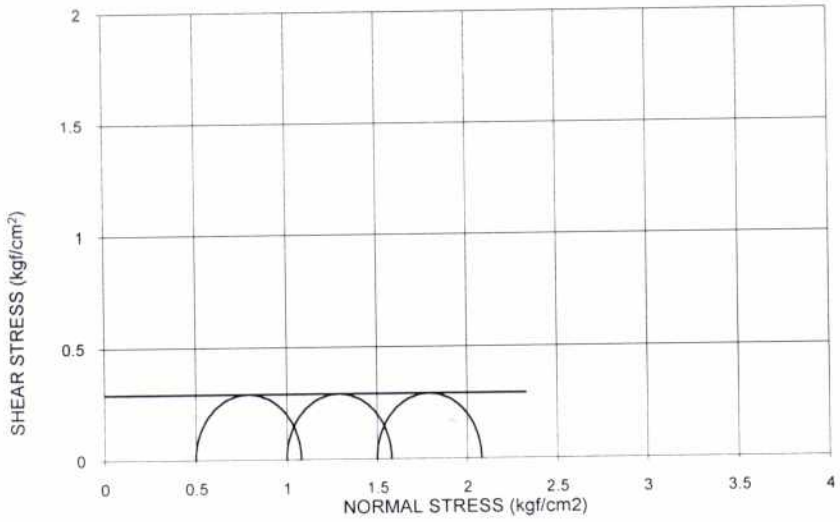
BH NO: 14

DEPTH: 10.5 m

C = 0.30 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



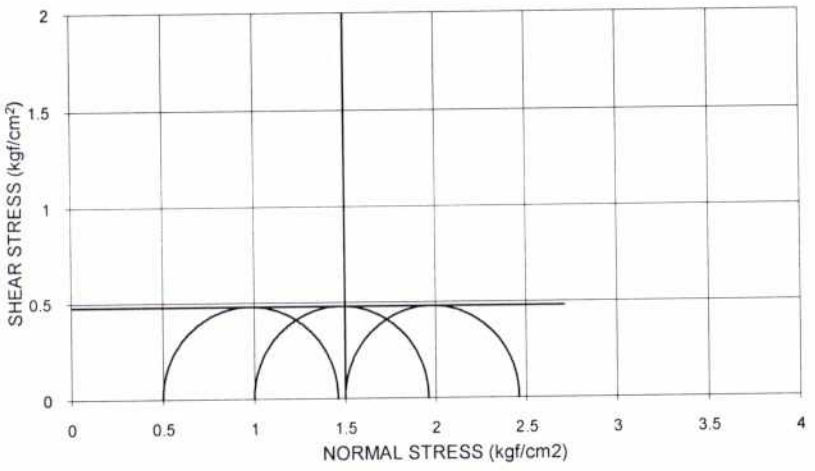
BH NO: 14

DEPTH: 12.0 m

C = 0.29 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



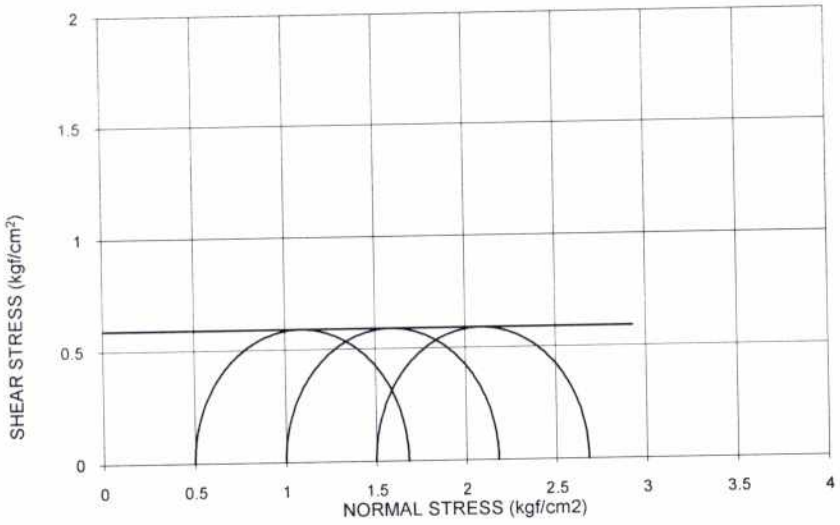
BH NO: 14

DEPTH: 13.5 m

C = 0.48 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



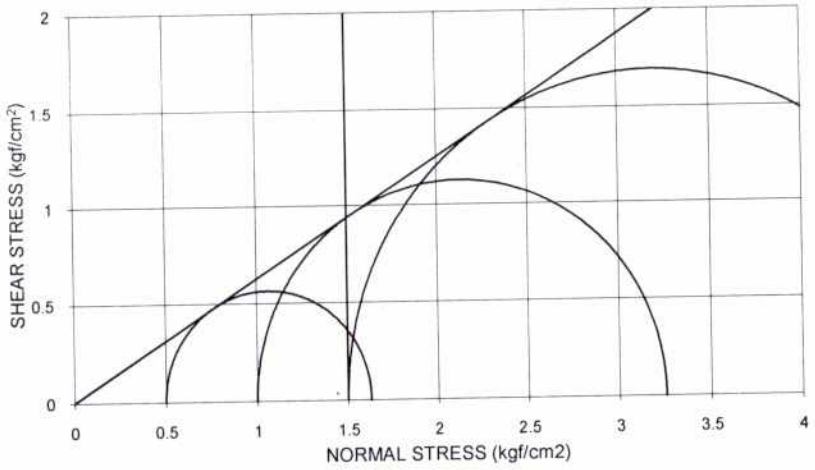
BH NO: 14

DEPTH: 15.0 m

C = 0.59 kgf/cm^2

Φ = 0.0 °

SHEAR TEST GRAPH



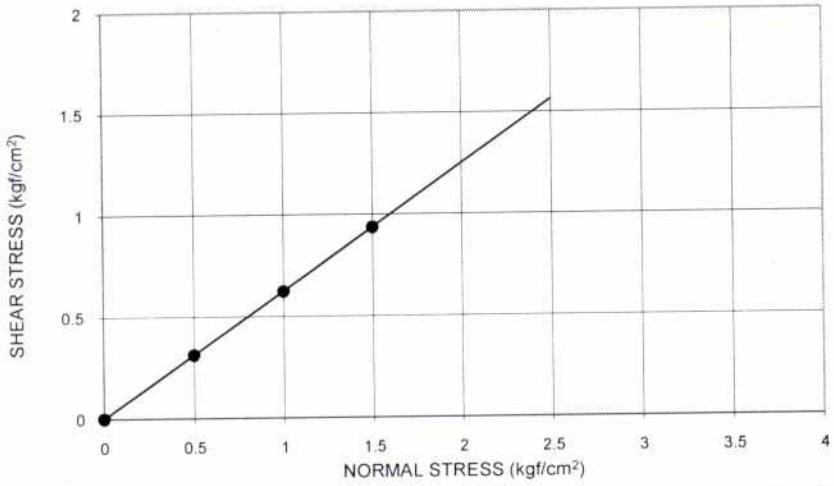
BH NO: 14

DEPTH: 16.5 m

C = 0.00 kgf/cm^2

Φ = 32.0 °

SHEAR TEST GRAPH



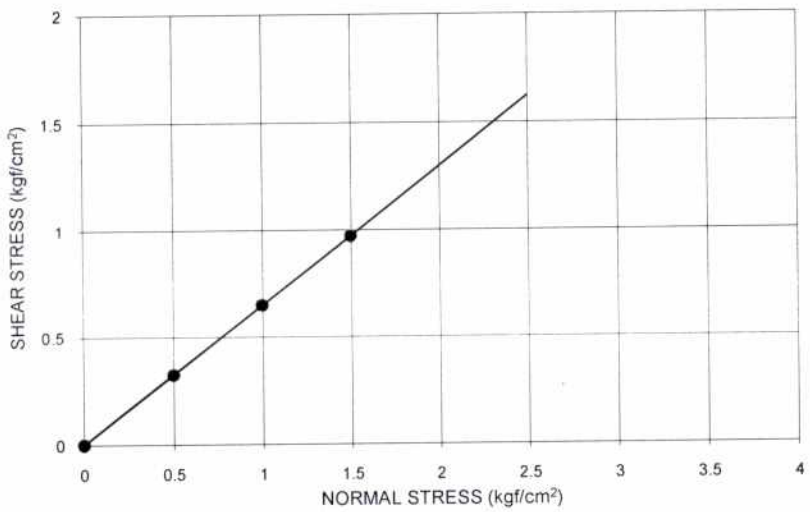
BH NO: 14

DEPTH: 18.0 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{o}

SHEAR TEST GRAPH



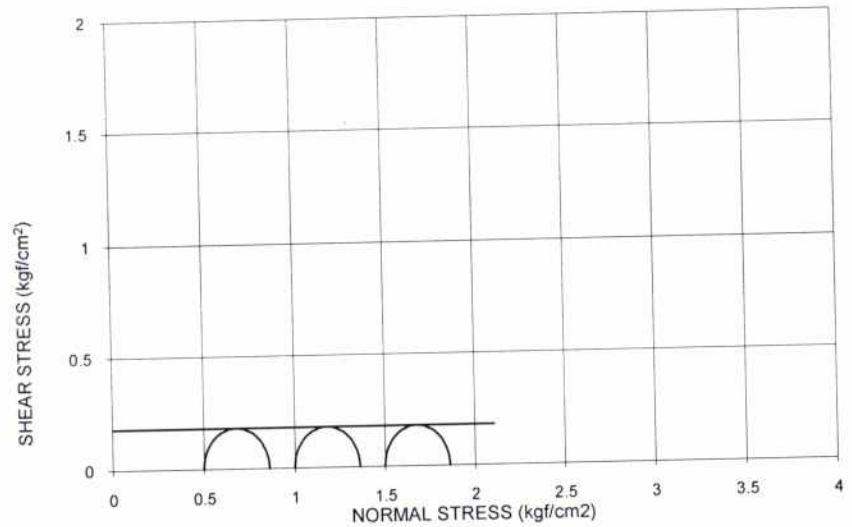
BH NO: 14

DEPTH: 19.5 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{o}

SHEAR TEST GRAPH



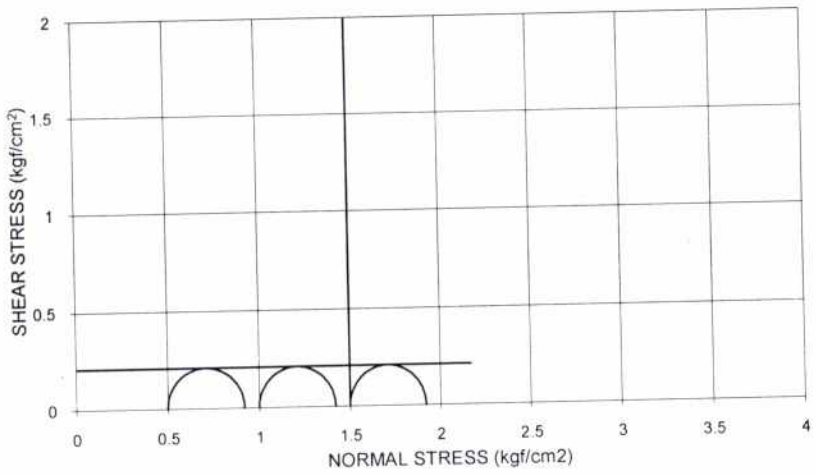
BH NO: 15

DEPTH: 3.0 m

C = 0.18 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



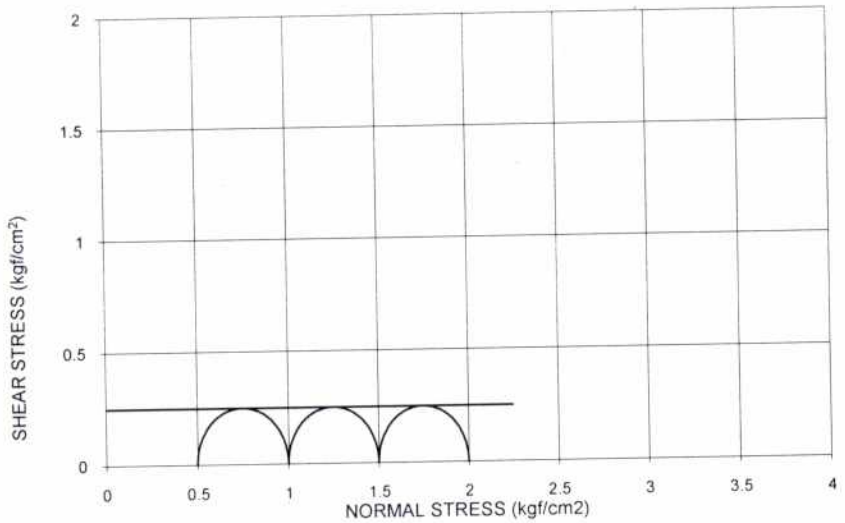
BH NO: 15

DEPTH: 4.5 m

C = 0.21 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



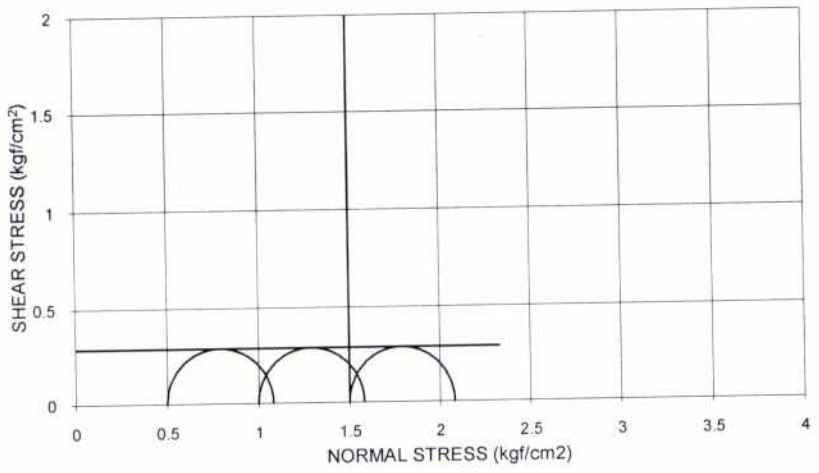
BH NO: 15

DEPTH: 6.0 m

C = 0.25 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



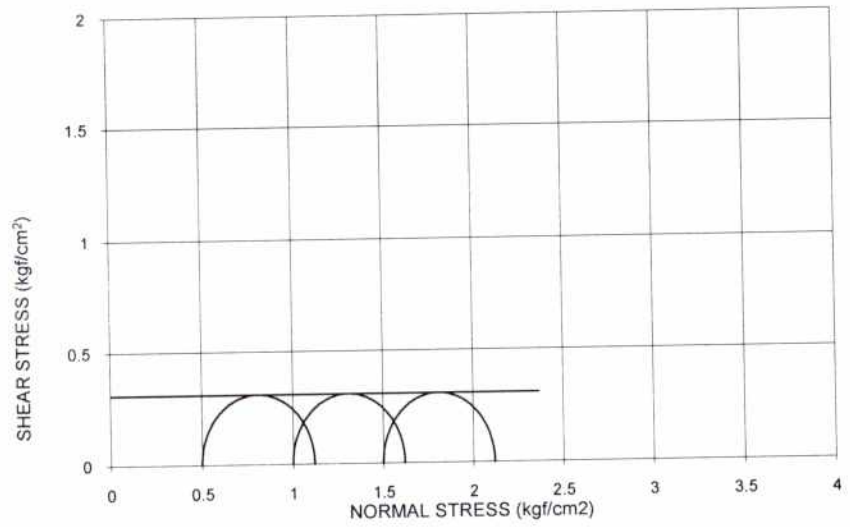
BH NO: 15

DEPTH: 7.5 m

C = 0.29 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



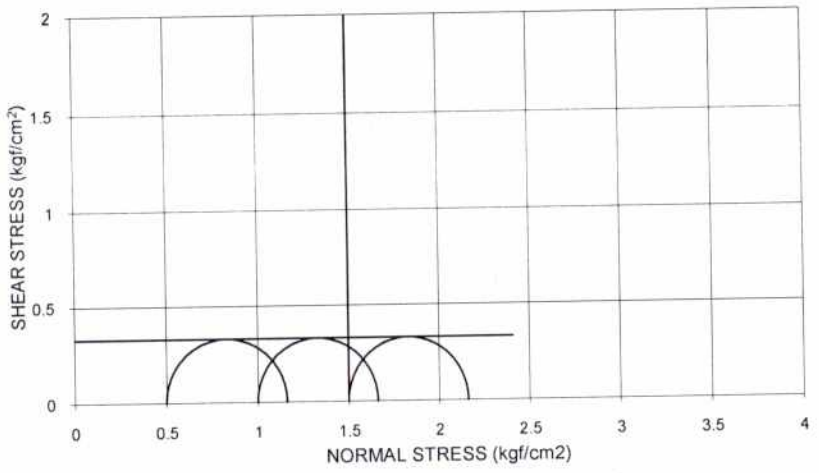
BH NO: 15

DEPTH: 9.0 m

C = 0.31 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



BH NO: 15

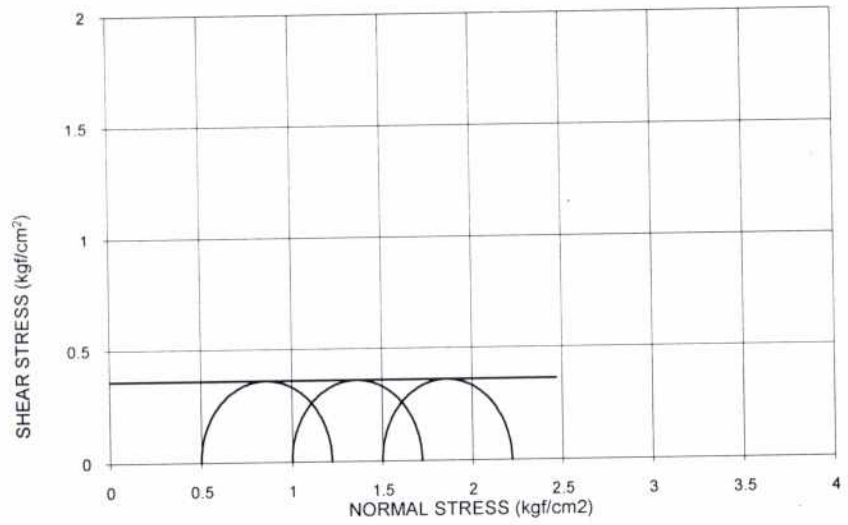
DEPTH: 10.5 m

C = 0.33 kgf/cm^2

Φ = 0.0 ^{O}

FOUNDATION PRIVATE LTD.

SHEAR TEST GRAPH



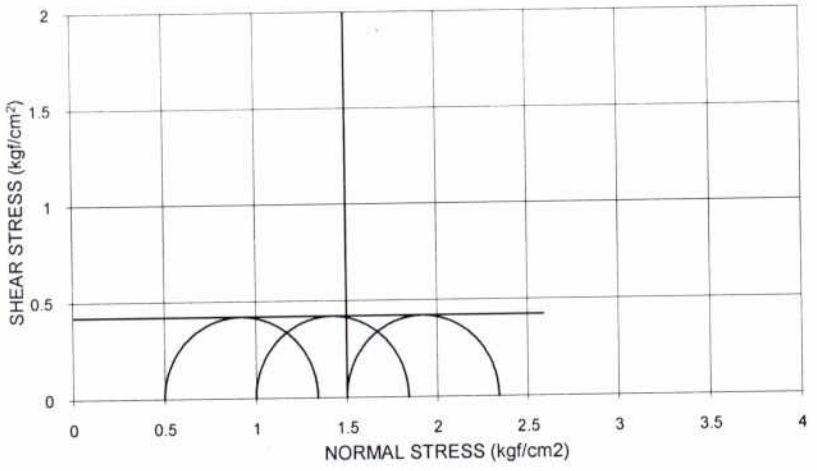
BH NO: 15

DEPTH: 12.0 m

C = 0.36 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



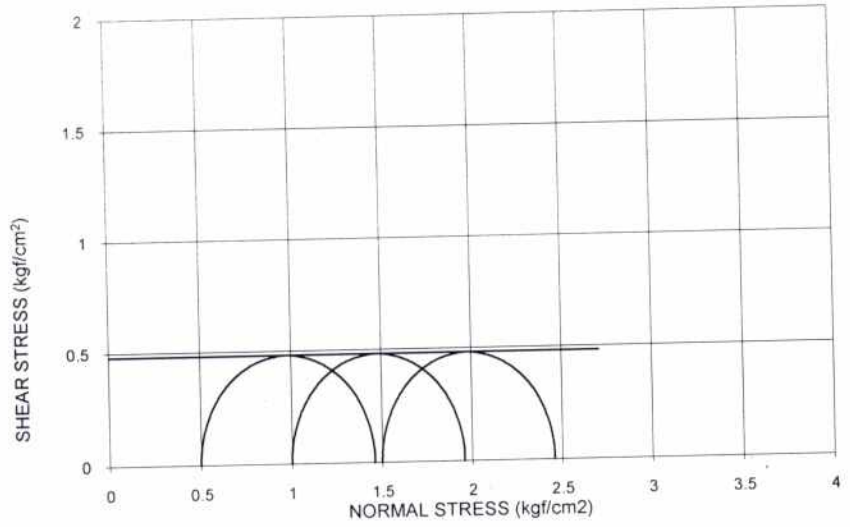
BH NO: 15

DEPTH: 13.5 m

C = 0.42 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



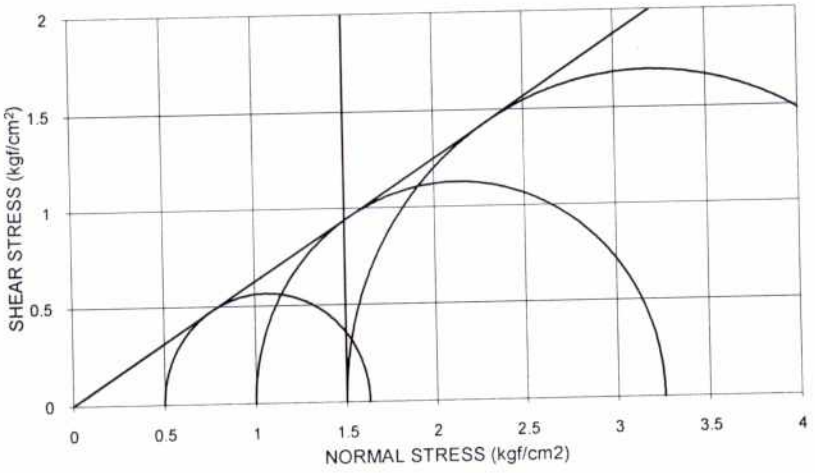
BH NO: 15

DEPTH: 15.0 m

C = 0.48 kgf/cm^2

Φ = 0.0 ^{O}

SHEAR TEST GRAPH



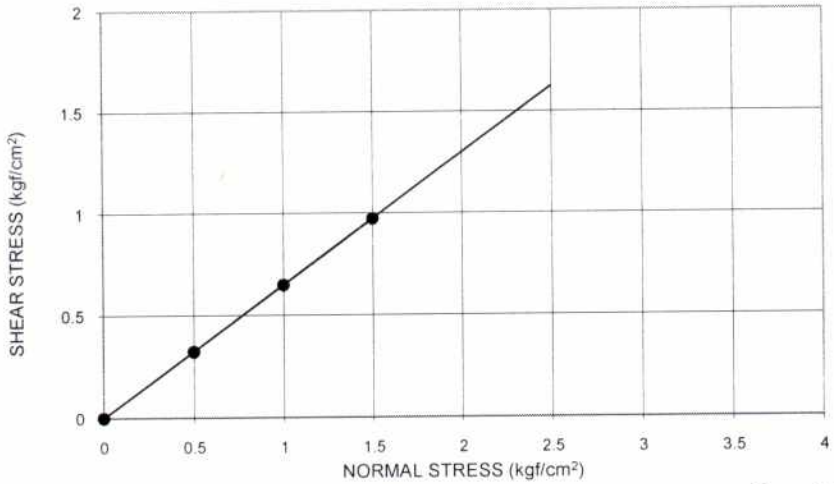
BH NO: 15

DEPTH: 16.5 m

C = 0.00 kgf/cm^2

Φ = 32.0 ^{O}

SHEAR TEST GRAPH



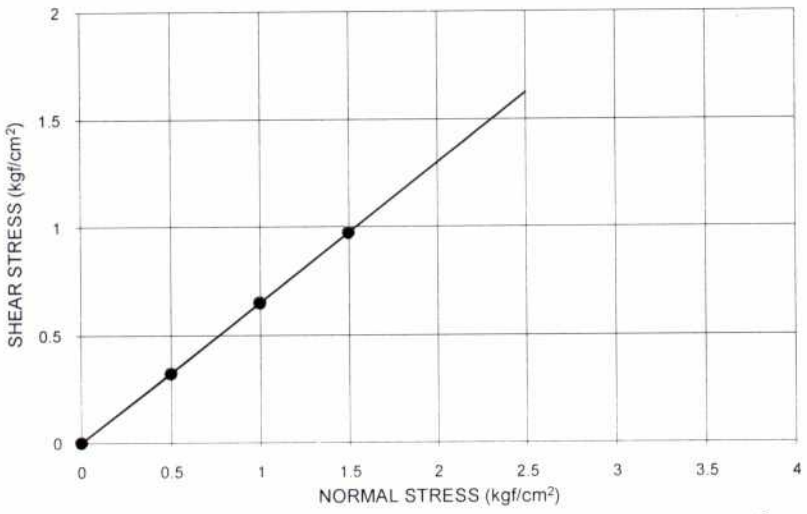
BH NO: 15

DEPTH: 18.0 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{o}

SHEAR TEST GRAPH



BH NO: 15

DEPTH: 19.5 m

C = 0.00 kgf/cm^2

Φ = 33.0 ^{o}