FINAL REPORT ON:

GEOTECHNICAL INVESTIGATION FOR ENVIRONMENTAL REGULATORY TRAINING INSTITUTE AT NIMLI VILLAGE, TIJARA ALWAR, RAJASTHAN

Submitted to:

M/s. Nilayam Housing Pvt. Ltd.
4, Windmill Place
Aya Nagar Village
New Delhi-110047

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1.0 INTRODUCTION

1.1 Project Description

M/s. Centre for Science & Environment is planning to develop Environmental Regulatory Training Institute at Nimli, Alwar, Rajasthan spread over an area of 10.3 Acres. Some 3-4 storeyed buildings without basement alongwith Dining Block, Administrative Block and Teaching Block with one basement and other structures for various facilities shall be constructed on site.

A layout plan showing the locations of our field investigations is presented on Fig. No.1

1.2 Purposes of Study

The overall purposes of this study are to investigate the stratigraphy at the site and to develop geotechnical recommendations for foundation design and construction. To accomplish these purposes, the study was conducted in the following phases:

(a) drilling ten boreholes to 15.0 m depth or refusal, whichever is earlier in order to determine site stratigraphy and to collect disturbed and undisturbed soil samples for laboratory testing;

(b) testing selected soil samples in the laboratory to determine pertinent index and engineering properties of the soils; and

1.3 Details of Test Locations

The details of borehole numbers and locations, ground elevations, co ordinates and borehole termination depths are presented below:

Borehole No./ Locations	Ground Elevation, RL, m	Coordi-nates, m	Borehole Termination	
			Depth, m	RL, m
BH-1 (Near nallah and Workers village)	289.5	3880711.0 N 690018.5 E	15.45	274.1
BH-2 (Support Staff Residences)	289.1	3880733.0 N690078.0 E	15.45	273.7

Borehole No./ Locations	Ground Elevation, RL, m	Coordi-nates, m	Borehole Termination	
			Depth, m	RL, m
BH-3 (Hostel Block)	291.8	3880744.5N 690043.5 E	15.45	276.3
BH-4 (Kitchen and Dining Hall)	301.3	3880739.0 N 690043.5 E	3.10	298.2
BH 5 (Administrative Block)	301.4	3880717.0 N 690241.5 E	15.45	285.9
BH 6 (Teaching Block)	302.5	3880677.0 N 690245.5 E	15.45	287.0
BH 7 (Staff Residence)	302.5	3880651.0 N 690187.0 E	15.45	287.0
BH-8 (Directors Residence)	296.2	3880632.5 N 690119.0 E	15.45.	280.7
BH-9 (Open Area)	295.9	3880632.5 N 690018.5 E	15.45.	280.4
BH-10 (Open Area)	294.3	3880688.5 N 690130.5 E	15.45.	278.8

* Levels read off from contour drawing given to us

2.0 FIELD INVESTIGATIONS

2.1 Soil Borings

The borings were progressed using a shell and auger to the specified depth or refusal, whichever is encountered earlier. The diameter of the borehole was 150 mm. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance with IS:1892-1979.

Standard Penetration Tests (SPT) were conducted in the boreholes at 1.5 m intervals by connecting a split spoon sampler to 'A' rods and driving it by 45 cm using a 63.5 kg hammer falling freely from a height of 75 cm. The tests were conducted in accordance with IS:2131-1981.

The number of blows for each 15 cm of penetration of the split spoon sampler was recorded. The blows required to penetrate the initial 15 cm of the split spoon for seating the sampler is ignored due to the possible presence of loose materials or cuttings from the drilling operation. The cumulative number of blows required to penetrate the balance 30 cm of the 45 cm sampling interval is termed the SPT value or the 'N' value.

The 'N' values are presented on the soil profile for each borehole. Refusal to further boring penetration was considered when the 'N' values exceed 100 or when practical refusal to further penetration by shell and auger was encountered.

Disturbed samples were collected from the split spoon after conducting SPT. The samples were preserved in transparent polythene bags. Undisturbed samples were collected at 3.0 m interval by attaching 100 mm diameter thin walled 'Shelby' tubes and driving the sampler using a 63.5 kg hammer in accordance with IS:2132-1986. The tubes were sealed with wax at both ends. All samples were transported to our NABL accredited laboratory at Delhi for further examination and testing.

2.2 Groundwater

Groundwater level was measured in the boreholes 24 hours after drilling and sampling was completed. The measured water levels are recorded on the individual soil profiles.

3.0 LABORATORY TESTS

The laboratory testing has been carried out in our NABL accredited laboratory. The quality procedures in our laboratory conform to ISO/IEC-17025-2005.

The laboratory testing programme was aimed to verify the field classifications and developing parameters for engineering analysis. All testing was performed in accordance with the current applicable IS specifications. The following tests were conducted on selected soil samples recovered from the boreholes:

Laboratory Test		IS : Code Referred
Bulk Density		By calculations
Natural Moisture Content		IS : 2720 (Part-2)-1973
Specific Gravity		IS : 2720 (Part-3)-1980
Atterberg Limits		IS : 2720 (Part-5)-1985
Grain Size Analysis		IS : 2720 (Part-4)-1985
Unconsolidated Undrained Triaxial Shear Test		IS : 2720 (Part-11)-1993
Consolidated Drained Direct Shear Test		IS : 2720 (Part-13)-1986
Chemical Analysis* of soil to determine	pH value	IS : 2720 (Part-26)-1987
	Sulphates	IS : 2720 (Part-27)-1977
	Chlorides	IS : 3025 (Part-32)-1993

*outside NABL scope

All test results are presented on the individual soil profiles as well as on the illustrations section of this report. A note on our NABL accreditation together with estimate in uncertainty of laboratory measurements is presented on Table 13.

4.0 GENERAL SITE CONDITIONS

4.1 Site Details

The project site is approached from Tijara- Firozpur Jhirka Road which is situated on the north – east of the plot.

The project site is at the edge of the Thar Desert. Sand dunes are present over an irregular rocky deposit. The ground levels are varying by over 9-10 m.

A seasonal nallah enters the plot from north- west side and is passing across the site on the west of the plot and goes down to the south. Presently the nallah is dry.

On the south-west side, a hillock of the Aravali Range is present.

4.2 Site Stratigraphy

The soils at the site are aeolean in nature and consist of silty fine sand from ground surface to about 9-14.0 m depth underlain by sandy silt / clayey silt to the final explored depth of 15.45 m At BH 4 silty fine sand is met underlain by rock.

The site stratigraphy encountered at each borehole location is summarized below with borehole Nos., locations, surface elevations, range of SPT 'N'-values and co-ordinates.

Borehole No./ Locations	RL, m		Site Stratigraphy	Range of N-values
	From	To		
BH-1 (Near nallah and Workers village)	289.5	284.5	Silty fine sand	28-78
	284.5	283.5	Sandy Silt	-
	283.5	278.5	Silty fine sand	42-65
	278.5	274.1	Sandy silt	43-61
BH-2 (Support Staff Residences)	289.1	284.1	Silty fine sand	15-26
	284.1	278.1	Silty fine sand	33-51
	278.1	273.7	Sandy silt	36-56
BH-3 (Hostel Block)	291.8	286.8	Silty fine sand	11-18
	286.8	285.8	Sandy Silt	-
	285.8	282.8	Silty fine sand	9-17
	282.8	276.3	Sandy Silt/Clayey Silt	54-79
BH-4 (Kitchen and Dining Hall)	301.3	299.3	Silty fine sand	12-24
	299.3	298.3	Gravel mixed with sand	-
	298.3	298.2	Rock (Quartzite)	Ref/10 cm
BH 5 (Administrative Block)	301.4	299.4	Silty fine sand	13-29
	299.4	298.4	Sandy silt	-
	298.4	296.9	Silty fine sand	63
	296.9	285.9	Sandy silt /Clayey silt	72-96

* Levels read off from contour drawing given to us

Borehole No./ Locations	RL, m		Site Stratigraphy	Range of N-values
	From	To		
BH 6 (Teaching Block)	302.5	300.5	Silty fine sand	41-56
	300.5	297.5	Sandy silt	73-87
	297.5	296.5	Silty Fine Sand	-
	296.5	293.5	Sandy silt	76-80
	293.5	291.5	Silty Fine Sand	91-107
	291.5	287.0	Sandy silt /Clayey silt	91-105
BH 7 (Staff Residence)	302.5	300.5	Silty fine sand	17-35
	300.5	288.5	Silty fine sand	43-103
	288.5	287.0	Sandy Silt	98
BH-8 (Directors Residence)	296.2	293.2	Silty fine sand	17-33
	293.2	280.7	Sandy silt / Clayey silt	57-103
BH-9 (Open Area)	295.9	293.9	Siltu fine sand	11-19
	293.9	287.9	Siltu fine sand	41-72
	287.9	280.4	Sandy silt	37-73
BH-10 (Open Area)	294.3	292.3	Silty fine sand	20-24
	292.3	291.3	Sandy silt	-
	291.3	289.8	Silty fine sand	27
	289.8	288.3	Sandy silt	91
	288.3	285.3	Silty Fine Sand	60-74
	285.3	280.8	Sandy Silt	82-108
	280.3	278.8	Silty fine sand	53-68

* Levels read off from contour drawing given to us

Detailed description of the materials encountered at the borehole locations is presented on the individual soil profiles on Tables 1 and 10. Chemical test results are presented on Table11. Engineering terms used for describing soils are explained on Table12. A summary of the borehole profiles is illustrated on Fig.2. SPT values are plotted on Fig.3.

4.3 Groundwater

Based on our measurements in the completed boreholes, groundwater was not met to the final explored depth of 15.0 m during the period of our field investigation (May-June, 2012). The HFL of the Nallah should be ascertained to the highest water level for design.

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

5.1 General

A suitable foundation for any structure should have an adequate factor of safety against exceeding the bearing capacity of the supporting soils. Also the vertical movements due to compression of the soils should be within tolerable limits for the structure. We consider that foundation designed in accordance with the recommendations given herein will satisfy these criteria.

5.2 Liquefaction Potential

As per IS:1893-2002, liquefaction during earthquakes is likely in fine sand (SP) below water table for SPT values less than 15 to 5 m depth and less than 25 below 10 m depth

.

Dune sand is encountered all over the project site. The soils at the site consist of silty fine sand from ground surface to the final explored depth of 12.45 m. Groundwater was not met to the final explored depth of 12.0 m during our field investigation (May-June, 2012)

On review of all the soil parameters like in-situ density, dry density, SPT values, soil gradations, groundwater conditions etc., we are of the opinion that liquefaction is not likely to occur at this site during earthquakes.

According to Fig.1 of IS: 1893 (Part-1)-2002 showing seismic zones, the site falls under Zone-IV. The design for seismic forces should be done considering the design parameters for Zone-IV.

5.3 Foundation Type and Depth

We recommend that open foundations may be used to support the structural loads of the buildings bearing at 1.0-4.0 m depth below the final finished level surrounding the respective building. These are tabulated as under:

Borehole No and Location	Range of Existing Ground Level within the Building Line, RL, m**	Final Finished Level, RL, m
BH1(Near Nallah and Workers Village)	288.6-290.4	289.5*
BH 2 (Support Staff Residence)	288.5-293.4	289.5
BH 3 (Hostel Block)	288.5-293.4	291.5
BH 4 (Kitchen and Dining Hall)	299.0-301.7	302.5
BH 5 (Administrative Block)	300.7-302.5	303.4
BH 6 (Teaching Block)	300.9-303.8	304.0
BH 7 (Staff Residences)	300.4-303.2	302.5
BH 8 (Director General's Residence)	294.2-298.1	297.7
BH 9 (Open Area)	289.0-296.6	295.9*
BH 10 (Open Area)	292.5-296.6	294.3*

* Existing Ground Level at the Borehole Location. ** As read off from Contour Map

An interconnecting plinth beam should be provided to restrict differential settlement and to give rigidity to the structure.

5.4 Open Foundations

Bearing capacity analysis for open foundations has been done in general accordance with IS:6403-1981. Soil parameters used for foundation analysis for different locations and depths are as follows:

Borehole Nos.	Depth, m	'c' (T/m^2)	'ϕ'	Failure Conditions	N_c	N_q	N_α
BH-1,BH-6 and BH-10	1.5 -2.5	0	30	General Shear	30.14	18.40	22.40
BH-6 (Basement)	4.0	0	32	General Shear	35.49	23.18	30.21
BH-2,BH-3,BH-7 and BH-8	1.5-2.5	0	30	Average of Local and General	30.14	18.40	22.40
BH-5 and BH-9	1.5-2.5	0	30	General Shear	30.14	18.40	22.40
BH-5 (Basement)	4.0	0	30	General Shear	30.14	18.40	22.40
BH-4 (Basement)	3.0	0	33	General Shear	38.64	26.09	35.19

where:

c = cohesion intercept
ϕ = angle of internal friction
Υ = effective unit weight of soil
N_c, N_q, N_γ = Bearing capacity factors which are a function of ϕ.

The bearing capacity equation used is as follows:

$$q_{net\ safe} = \frac{1}{F}\left[cN_c\zeta_c\, d_c + p(N_q-1)\,\zeta_q d_q + 0.5\, B\Upsilon N_\gamma \zeta_\gamma\, d_\Upsilon R_w\right]$$

where:

$q_{net\ safe}$ = safe net bearing capacity of soil based on the shear failure criterion.
p = overburden pressure
R_w = water table correction factor taken as 0.60 to account for saturation of soil during rains.
F = Factor of safety, taken as equal to 2.5 in accordance with IS: 1904-1986.

$\zeta_c, \zeta_q, \zeta_\gamma$= Shape factors. For Strip footings, $\zeta_c = \zeta_q = \zeta_\gamma = 1$
For Square footing, $\zeta_c = 1.3$, $\zeta_q = 1.2$, $\zeta_\gamma = 0.6$

d_c, d_q, d_γ= Depth factors
For $\phi \leq 10$, $d_c = 1 + 0.2 \tan(45 + \phi/2)\, D/B$, $d_q = d_\gamma = 1$
For $\phi > 10$, $d_q = d_\gamma = 1 + 0.1 \tan(45 + \phi/2)\, D/B$

For the soil conditions encountered at this site, an average of local and general shear failure conditions has been used for analysis for BH-2, BH-3, BH-7 and BH-8 locations. For other locations general shear condition has been used.

Appropriate values have been substituted into the bearing capacity equation given above to compute the safe net bearing capacity. The values have been checked to determine the settlement of the foundation under the safe bearing pressure. The allowable bearing pressure has been taken as the lower of the two values computed from the bearing capacity shear failure criterion as well as that computed from the tolerable settlement criterion.

Settlement analysis has been performed based on the SPT values in accordance with Clause 9.1.4 of IS 8009 (Part 1) - 1976 Fig.9. As per IS 1904-1986, the tolerable total settlement is taken as 50 mm.

We recommend the following value of net allowable bearing pressure for open foundations at 1.5-4.0 m depths below the final finished level of the respective building.

Locations	Foundation Embedment Depth below final finished level, RL, m	Recommended Net Allowable Bearing, Pressure, T/m^2		Corresponding Allowable Gross Bearing Pressure, T/m^2		Proposed Modulus of Subgrade Reaction, kg/cm^3
		40 mm Settlement	50 mm Settlement	40 mm Settlement	50 mm Settlement	
BH1(Near Nallah and Workers Village)	1.5(288.0)	16.8	21.0	19.3	23.5	2.0
	2.5(287.0)	19.2	24.0	23.5	28.3	2.5

Locations	Foundation Embedment Depth below final finished level, RL, m	Recommended Net Allowable Bearing, Pressure, T/m^2		Corresponding Allowable Gross Bearing Pressure, T/m^2		Proposed Modulus of Subgrade Reaction, kg/cm^3
		40 mm Settlement	50 mm Settlement	40 mm Settlement	50 mm Settlement	
BH 2 (Support Staff Residence)	1.5(288.0)	10.8	13.5	13.3	16.0	1.4
	2.5(287.0)	13.2	16.5	17.5	20.8	1.7
BH 3 (Hostel Block)	1.5(290.0)	10.8	13.5	13.3	16.0	1.4
	2.5(289.0)	13.2	16.5	17.5	20.8	1.7
BH 4 (Kitchen and Dining Hall)	3.0(299.5) and below	24.0	30.0	29.1	35.1	5.0
BH 5 (Administrative Block)	1.5(301.9)	16.8	21.0	19.3	23.5	2.0
	2.5(300.9)	20.8	26.0	25.1	30.3	2.8
	4.0(299.4)	24.0	30.0	30.9	36.9	3.5
BH 6 (Teaching Block)	1.5(302.5)	16.8	21.0	19.3	23.5	2.0
	2.5(301.5)	19.2	24.0	23.5	28.3	2.5
	4.0(300.0)	24.0	30.0	30.9	36.9	3.5
BH 7 (Staff Residences)	1.5(301.0)	10.8	13.5	13.3	16.0	1.4
	2.5(300.0)	13.2	16.5	17.5	20.8	1.7
BH 8 (Director General's Residence)	1.5(296.2)	10.8	13.5	13.3	16.0	1.4
	2.5(295.2)	13.2	16.5	17.5	20.8	1.7
BH 9 (Open Area)	1.5(294.4)	16.8	21.0	19.3	23.5	2.0
	2.5(293.4)	20.8	26.0	25.1	30.3	2.8
BH 10 (Open Area)	1.5(292.8)	16.8	21.0	19.3	23.5	2.0
	2.5(291.8)	19.2	24.0	23.5	28.3	2.5

The above recommended values include a bearing capacity safety factor of 2.5. The appropriate value of net bearing pressure may be selected based on permissible settlement criterion. Net bearing pressures for foundations at intermediate depths may be interpolated linearly between the values given above.

In order to restrict the influence of adjacent footings on each other (for isolated footing), the lateral edge-to-edge spacing between the foundations should at least be equal to “0.8B” where ”B” is the width of the larger footing. In case this criterion cannot be satisfied, combined footings or raft foundations may be provided.

5.5 Definition of Gross and Net Bearing Pressure

By definition, the net allowable bearing pressure is the intensity of loading which gives the safety against both the shear failure criteria as well as settlement criteria.

For the purposes of this report, the net allowable bearing pressure should be calculated as the difference between total load on the foundation and the weight of the soil overlying the foundation divided by the effective area of the foundation. The gross bearing pressure is the total pressure at the foundation level including overburden pressure and surcharge load. The following equations may be used -

$$q_{net} = [(P_s + W_f + W_s) / A_f] - S_v$$
$$q_{gross} = q_{net} + S_v = (P_s + W_f + W_s) / A_f$$

where:

q_{net} = net allowable bearing pressure
q_{gross} = gross bearing pressure
P_s = superimposed static load on foundation
W_f = weight of foundation
W_s = weight of soil overlying foundation
A_f = effective area of foundation
S_v = overburden pressure at foundation level prior to excavation for foundation.

It may please be noted that safe bearing pressures recommended in this report refer to ***“net values”***. The gross bearing may be computed by adding the overburden pressure to the net bearing pressure. Advantage of gross bearing pressure may be taken while designing the basements. Fill placed above EGL should be treated as a surcharge load.

5.6 Basement Design

The basement should be designed to resist lateral earth pressure and hydrostatic pressure. Groundwater was not met at the time of our field investigation (May-June,2012). Therefore, hydrostatic uplift is unlikely. For the worst condition, we suggest that a hydrostatic uplift equivalent to 1 m head of water may be considered for the purpose of design. The basement floor slab should be checked to ensure that it can withstand the consequent hydrostatic uplift force.

The basement should be designed to resist lateral earth pressure as well as hydrostatic thrust. For design purpose, we suggest the following values of co-efficient of earth pressures for the active, passive and at rest condition:

k_a = Co-efficient of active earth pressure = 0.33
k_p = Co-efficient of passive earth pressure =3.00
k_o = Co-efficient of earth pressure at rest =0.50

A suitable safety factor should be applied on the passive earth pressures in the design.

6.0 FOUNDATION CONSTRUCTION CONSIDERATIONS

6.1 Excavations

Temporary excavations through soil to about 3-4 m depth may be cut using side slopes of 1-vertical on 0.8 to 1.0 horizontal. If excessive sloughing or caving occurs, the slopes may be flattened further to ensure stability.

6.2 Fill Placement and Compaction

The site for each building will be graded within the building line to achieve final finished level at that location. The natural soils at the site are suitable for use as fill materials to raise the site grade.

Fill should be placed in layers not exceeding 15-20 cm in thickness at a moisture content of ± 1 percent of the optimum moisture content. It should be compacted to at least 95 percent of maximum density determined as per the standard Proctor compaction test (IS: 2720-Part 7).

6.3 Foundation Level Preparation

The area shall be excavated up to the foundation level. All loose soils should be removed and the exposed foundation bearing surface should be watered and compacted properly using rammers / rollers.

The surface should then be protected from disturbances due to construction activities so that the foundations may bear on the natural undisturbed ground. For open foundations, we recommend the placement of a 75 to 100 mm thick “blinding layer” of lean concrete to facilitate placement of reinforcing steel and to protect the soils from disturbance.

In case mechanical means like excavators are deployed for excavations, the excavations should be carried out up to 0.5 m above the proposed level. The last 0.5 m depth of excavation should be carried out manually, so that the founding soils are not disturbed / loosened.

6.4 Chemical Attack

Chemical test results are presented on Table 11. The results indicate that the soil contains about 0.09~0.11 percent sulphates and 0.01~0.04 percent chlorides. The pH value of soil is about 8.2~8.5 indicating slightly alkaline condition.

IS: 456-2000 recommends that precautions should be taken against chemical degradation of concrete if

- the sulphates content of the soils exceeds 0.2 percent, or
- the groundwater contains more than 300mg per litre of sulphates (SO_3).

Comparing the test results with these specified limits, the sulphate content of the soils is less than the specified limit. Groundwater is too deep to be of concern. The soils at the site fall in Class I classification as described on IS 456-2000, which indicates a mild potential for corrosion.

In our opinion, the soils at site are not aggressive to concrete. We recommend the following measures as a good practice to limit the potential for chemical attack:

(1) For open foundations concrete should contain minimum cement content of 280 kg/m^3. Ordinary Portland cement or any other cement type may be used.

(2) Water cement ratio in foundation concrete should not exceed 0.55.

(3) A clear concrete cover over the reinforcement steel of at least 40mm should be provided for open foundations.

(4) Foundation concrete should be densified adequately using a vibrator so as to form a dense impervious mass.

6.5 Variability in Subsurface Conditions

Subsurface conditions encountered during construction may vary somewhat from the conditions encountered during the site investigation. In case significant variations are encountered during construction, we request to be notified so that our engineers may review the recommendations in this report in light of these variations.

7.0 SUMMARY OF PRINCIPAL FINDINGS AND RECOMMENDATIONS

M/s. Cengrs Geotechnica Pvt. Ltd. conducted a geotechnical investigation for the proposed Environmental Regulatory Training Institute at Nimli, Alwar, Rajasthan for M/s. Centre for Science & Environment. The Institute is spread over an area of 10.3 Acres. The scope of investigation includes ten boreholes to 15 m depth.

The surficial soils at the site are aeolean in nature and consist of silty fine sand underlain by sandy silt / clayey silt. Rock (quartzite) was met at BH-4. Groundwater was not met to the maximum depth drilled during our field investigation (May-June, 2012).

We recommend that open foundations may be used to support the structural loads of the buildings bearing at 1.0-4.0 m depth below

the final finished level surrounding the respective building. Our recommended net and gross bearing pressures for the various buildingss are presented in Section 5.4 of this report.

8.0 CLOSURE

We appreciate the opportunity to perform this investigation for you and have pleasure in submitting this report. Please contact us when we can be of further service to you.

for **CENGRS GEOTECHNICA PRIVATE LIMITED**

(RAVI SUNDARAM)
DIRECTOR

(SANJAY GUPTA)
MANAGING DIRECTOR

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 1

TERMINATION DEPTH 15.45 m

Table No: 1a

Location : See Fig No. 1

Surface Elevation 289.50 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	289.50	0.00	DS1		Medium dense to very dense brown silty fine sand (SM)														
	289.00	0.50			- medium dense, 0.0 to 1.5 m														
28	289.00	0.50	SPT1																
	288.55	0.95																	
43	288.00	1.50	SPT2		- dense, 1.5 to 3.0 m														
	287.55	1.95																	
	287.25	2.25	UDS1		- with traces of gravel, 2.0 to 3.0 m	3	74	23	0				2.65	1.93	1.75	9.9	0.5	0	31.6°
	286.95	2.55															1.0		
56	286.50	3.00	SPT3		- very dense, 3.0 to 5.0 m												1.5		
	286.05	3.45															(DS)		
78	285.00	4.50	SPT4																
	284.55	4.95			(5.0m)														
	284.25	5.25	UDS2		Very dense brown sandy silt with traces of gravel, low plastic (CL)	2	21	75	2					1.77	1.59	11.7			
	283.95	5.55			(6.0m)														
53	283.50	6.00	SPT5		Very dense brown silty fine sand (SM)														
	283.05	6.45			- with traces of gravel, 6.0 to 8.0 m														
61	282.00	7.50	SPT6																
	281.55	7.95																	
	281.25	8.25	UDS3			0	74	26	0					1.79	1.64	9.5	0.5	0	34.3°
	280.95	8.55															1.0		
																	1.5		
42	280.50	9.00	SPT7		- with traces of gravel, 9.0 to 11.0 m												(DS)		
	280.05	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 1b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 1

TERMINATION DEPTH 15.45 m

Table No: 1b

Location : See Fig No. 1

Surface Elevation 289.50 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
65	279.00	10.50	SPT8		Very dense brown silty fine sand (SM)														
	278.55	10.95			(11.0m)														
	278.25	11.25	UDS4		Very dense brown sandy silt, low plastic (CL)	0	44	56	0					1.71	1.51	13.1			
	277.95	11.55																	
61	277.50	12.00	SPT9		- with traces of gravel, 12.0 to 15.45 m														
	277.05	12.45																	
43	276.00	13.50	SPT10																
	275.55	13.95																	
	275.25	14.25	UDS5							34.4	17.4	17.0		1.97	1.72	14.2			
	274.95	14.55																	
52	274.50	15.00	SPT11																
	274.05	15.45			(15.45m)														

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 2

TERMINATION DEPTH 15.45 m

Table No: 2a

Location : See Fig No. 1

Surface Elevation 289.11 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	289.11	0.00	DS1		Medium dense to dense brown silty fine sand (SM)														
	288.61	0.50			- medium dense, 0.0 to 6.0 m														
15	288.61	0.50	SPT1																
	288.16	0.95																	
23	287.61	1.50	SPT2																
	287.16	1.95																	
	286.86	2.25	UDS1			0	69	30	1					1.77	1.70	4.5			
	286.56	2.55																	
26	286.11	3.00	SPT3																
	285.66	3.45																	
21	284.61	4.50	SPT4																
	284.16	4.95																	
	283.86	5.25	UDS2			0	80	20	0				2.65	1.82	1.60	13.7	0.5	0	32.5°
	283.56	5.55															1.0		
																	1.5		
33	283.11	6.00	SPT5		- dense, 6.0 to 11.0 m												(DS)		
	282.66	6.45																	
43	281.61	7.50	SPT6																
	281.16	7.95																	
					- with pebbles and gravels (SM-GP), 8.0 to 9.0 m														
	280.86	8.25	DS2																
	280.56	8.55																	
49	280.11	9.00	SPT7																
	279.66	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 2b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 2

TERMINATION DEPTH 15.45 m

Table No: 2b

Location : See Fig No. 1

Surface Elevation 289.11 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
51	278.61	10.50	SPT8		Very dense brown silty fine sand with traces of gravel (SM)														
	278.16	10.95			(11.0m)														
	277.86	11.25	UDS3		Dense to very dense brown sandy silt with traces of gravel, low plastic (CL)	2	21	75	2					1.85	1.52	21.6	0.5	0	31.7°
	277.56	11.55			- dense, 11.0 to 15.0 m												1.0		
36	277.11	12.00	SPT9														1.5 (DS)		
	276.66	12.45																	
45	275.61	13.50	SPT10																
	275.16	13.95																	
	274.86	14.25	UDS4							34.9	15.6	19.3		1.88	1.66	13.3			
	274.56	14.55																	
56	274.11	15.00	SPT11		- very dense, 15.0 to 15.45 m														
	273.66	15.45			(15.45m)														

DS : Drained Direct Shear Test

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 3

TERMINATION DEPTH 15.45 m

Table No: 3a

Location : See Fig No. 1

Surface Elevation 291.76 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	291.76	0.00	DS1		Medium dense brown silty fine sand (SM)														
	291.26	0.50																	
18	291.26	0.50	SPT1																
	290.81	0.95																	
17	290.26	1.50	SPT2																
	289.81	1.95																	
	289.51	2.25	UDS1		- with gravel, 2.0 to 3.0 m	10	77	13	0					1.78	1.67	6.4	0.5	0	34.5°
	289.21	2.55															1.0		
																	1.5		
14	288.76	3.00	SPT3														(DS)		
	288.31	3.45																	
11	287.26	4.50	SPT4																
	286.81	4.95																	
					(5.0m)														
	286.51	5.25	UDS2		Medium dense brown sandy silt with traces of gravel, low plastic (CL)	2	12	81	5					1.83	1.59	15.0			
	286.21	5.55																	
					(6.0m)														
9	285.76	6.00	SPT5		Loose to medium dense brown silty fine sand (SM)														
	285.31	6.45																	
					- loose, 6.0 to 7.5 m														
17	284.26	7.50	SPT6		- medium dense, 7.5 to 9.0 m														
	283.81	7.95																	
	283.51	8.25	UDS3			0	74	26	0				2.65	1.83	1.67	9.5	0.5	0	33.5°
	283.21	8.55															1.0		
					(9.0m)												1.5		
71	282.76	9.00	SPT7		Very dense brown sandy silt with traces of gravel, low plastic (CL)												(DS)		
	282.31	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 3b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 3

TERMINATION DEPTH 15.45 m

Table No: 3b

Location : See Fig No. 1

Surface Elevation 291.76 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
79	281.26	10.50	SPT8		Very dense brown sandy silt, low plastic (CL)														
	280.81	10.95																	
	280.51	11.25	UDS4							29.8	18.7	11.2		1.95	1.75	11.3	1,3 (UUT)	1.80	8.3°
	280.21	11.55																	
54	279.76	12.00	SPT9																
	279.31	12.45																	
58	278.26	13.50	SPT10																
	277.81	13.95			(14.0m)														
	277.51	14.25	UDS5		Hard brown clayey silt with traces of gravel, medium plastic (MI)					39.4	23.5	16.0		1.99	1.77	12.4			
	277.21	14.55			(15.0m)														
78	276.76	15.00	SPT11		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	276.31	15.45			(15.45m)														

UUT : Unconsolidated Undrained Triaxial Shear Test

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 4

TERMINATION DEPTH: 3.10 m

Table No: 4

Location : See Fig No. 1

Surface Elevation: 301.28 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	301.28	0.00	DS1		Medium dense brown silty fine sand (SM)														
	300.78	0.50																	
12	300.78	0.50	SPT1																
	300.33	0.95																	
24	299.78	1.50	SPT2																
	299.33	1.95			(2.0m)														
	299.03	2.25	DS2		Dense gravel mixed with sand (GP-SP-SM)	86	10	5	0										
	298.73	2.55			(3.0m)														
Ref*/ 10cm	298.28	3.00	SPT3		Rock formation														
	298.18	3.10			(3.10m)														

** 'Ref' refers to refusal (N>100) within the first 15 cm of seating penetration.

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 5

TERMINATION DEPTH 15.45 m

Table No: 5a

Location : See Fig No. 1

Surface Elevation 301.38 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	301.38	0.00	DS1		Medium dense brown silty fine sand (SM)														
	300.88	0.50																	
13	300.88	0.50	SPT1																
	300.43	0.95																	
29	299.88	1.50	SPT2																
	299.43	1.95			(2.0m)														
	299.13	2.25	UDS1		Dense brown sandy silt, low plastic (CL)	0	42	58	0				2.64	1.78	1.53	16.7			
	298.83	2.55			(3.0m)														
63	298.38	3.00	SPT3		Very dense brown silty fine sand (SM)														
	297.93	3.45			(4.5m)														
72	296.88	4.50	SPT4		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	296.43	4.95																	
	296.13	5.25	UDS2							30.0	18.6	11.4		2.02	1.72	17.5	1,3 (UUT)	1.10	9.1°
	295.83	5.55																	
84	295.38	6.00	SPT5																
	294.93	6.45																	
97	293.88	7.50	SPT6																
	293.43	7.95																	
	293.13	8.25	UDS3							30.1	21.3	8.8		1.94	1.61	20.5			
	292.83	8.55																	
96	292.38	9.00	SPT7																
	291.93	9.45																	

UUT : Unconsolidated Undrained Triaxial Shear Test

(Cont'd on Table No. 5b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 5

TERMINATION DEPTH 15.45 m

Table No: 5b

Location : See Fig No. 1

Surface Elevation 301.38 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
78	290.88	10.50	SPT8		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	290.43	10.95			(11.0m)														
	290.13	11.25	UDS4		Hard brown clayey silt with traces of gravel, medium plastic (MI)					39.7	22.3	17.4		2.01	1.70	18.1	1,3 (UUT)	1.10	10.5°
	289.83	11.55			(12.0m)														
89	289.38	12.00	SPT9		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	288.93	12.45																	
95	287.88	13.50	SPT10																
	287.43	13.95																	
	287.13	14.25	UDS5							34.9	21.2	13.8		1.98	1.70	16.8			
	286.83	14.55																	
96	286.38	15.00	SPT11																
	285.93	15.45			(15.45m)														

UUT : Unconsolidated Undrained Triaxial Shear Test

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 6

TERMINATION DEPTH 15.45 m

Table No: 6a

Location : See Fig No. 1

Surface Elevation 302.50 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	302.50	0.00	DS1		Dense to very dense brown silty fine sand (SM) - dense, 0.0 to 1.5 m														
	302.00	0.50																	
41	302.00	0.50	SPT1																
	301.55	0.95																	
56	301.00	1.50	SPT2		- very dense, 1.5 to 2.0 m														
	300.55	1.95			(2.0m)														
	300.25	2.25	UDS1		Very dense brown sandy silt with traces of gravel, low plastic (CL)	2	37	55	6					1.87	1.67	11.9	1,3 (UUT)	1.90	6.9°
	299.95	2.55																	
73	299.50	3.00	SPT3																
	299.05	3.45																	
87	298.00	4.50	SPT4																
	297.55	4.95			(5.0m)														
	297.25	5.25	UDS2		Very dense brown silty fine sand (SM)	0	80	20	0				2.66	1.86	1.71	9.0			
	296.95	5.55			(6.0m)														
76	296.50	6.00	SPT5		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	296.05	6.45																	
80	295.00	7.50	SPT6																
	294.55	7.95																	
	294.25	8.25	UDS3			4	43	49	4					1.79	1.70	5.6	1,3 (UUT)	2.00	7.5°
	293.95	8.55			(9.0m)														
91	293.50	9.00	SPT7		Very dense brown silty fine sand with traces of gravel (SM)														
	293.05	9.45																	

UUT : Unconsolidated Undrained Triaxial Shear Test

(Cont'd on Table No. 6b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 6

TERMINATION DEPTH 15.45 m

Table No: 6b

Location : See Fig No. 1

Surface Elevation 302.50 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
107	292.00 291.55	10.50 10.95	SPT8		Very dense brown silty fine sand with traces of gravel (SM) (11.0m)														
	291.25 290.95	11.25 11.55	UDS4		Very dense brown sandy silt with traces of gravel, low plastic (CL)	1	25	72	2					1.93	1.67	16.1			
94	290.50 290.05	12.00 12.45	SPT9																
105	289.00 288.55	13.50 13.95	SPT10		(14.0m)														
	288.25 287.95	14.25 14.55	UDS5		Hard brown clayey silt with traces of gravel, medium plastic (MI) (15.0m)					38.2	20.1	18.1		1.99	1.77	12.3			
91	287.50 287.05	15.00 15.45	SPT11		Very dense brown sandy silt with traces of gravel, low plastic (CL) (15.45m)														

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 7

TERMINATION DEPTH 15.45 m

Table No: 7a

Location : See Fig No. 1

Surface Elevation 302.54 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	302.54	0.00	DS1		Medium dense to very dense brown silty fine sand (SM)														
	302.04	0.50			- medium dense, 0.0 to 1.5 m														
17	302.04	0.50	SPT1																
	301.59	0.95																	
35	301.04	1.50	SPT2		- dense, 1.5 to 4.5 m														
	300.59	1.95																	
	300.29	2.25	UDS1			0	80	20	0					1.78	1.67	6.8			
	299.99	2.55																	
43	299.54	3.00	SPT3		- with traces of gravel, 3.0 to 5.0 m														
	299.09	3.45																	
53	298.04	4.50	SPT4		- very dense, 4.5 to 14.0 m														
	297.59	4.95																	
	297.29	5.25	UDS2			0	80	20	0					1.83	1.68	8.8	0.5	0	32.8°
	296.99	5.55															1.0		
																	1.5		
74	296.54	6.00	SPT5		- with traces of gravel, 6.0 to 14.0 m												(DS)		
	296.09	6.45																	
87	295.04	7.50	SPT6																
	294.59	7.95																	
	294.29	8.25	UDS3			2	60	37	1				2.66	1.86	1.70	9.5			
	293.99	8.55																	
99	293.54	9.00	SPT7																
	293.09	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 7b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 7

TERMINATION DEPTH 15.45 m

Table No: 7b

Location : See Fig No. 1

Surface Elevation 302.54 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
96	292.04	10.50	SPT8		Very dense brown silty fine sand with traces of gravel (SM)														
	291.59	10.95																	
	291.29	11.25	UDS4			4	58	37	1					1.94	1.77	9.6	0.5 1.0 1.5 (DS)	0	36.6°
	290.99	11.55																	
94	290.54	12.00	SPT9																
	290.09	12.45																	
103	289.04	13.50	SPT10																
	288.59	13.95			(14.0m)														
	288.29	14.25	UDS5		Very dense brown sandy silt, low plastic (CL)	0	29	71	0					2.01	1.79	12.3			
	287.99	14.55																	
98	287.54	15.00	SPT11		- with traces of gravel, 15.0 to 15.45 m														
	287.09	15.45			(15.45 m)														

DS : Drained Direct Shear Test

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 8

TERMINATION DEPTH 15.45 m

Table No: 8a

Location : See Fig No. 1

Surface Elevation 296.19 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	296.19	0.00	DS1		Medium dense to dense brown silty fine sand (SM)														
	295.69	0.50			- medium dense, 0.0 to 1.5 m														
17	295.69	0.50	SPT1																
	295.24	0.95																	
33	294.69	1.50	SPT2		- dense, 1.5 to 3.0 m														
	294.24	1.95																	
	293.94	2.25	UDS1			0	80	20	0				2.66	1.74	1.57	10.7	0.5	0	33.9°
	293.64	2.55			(3.0m)												1.0		
																	1.5		
63	293.19	3.00	SPT3		Very dense brown sandy silt with traces of gravel, low plastic (CL)												(DS)		
	292.74	3.45																	
57	291.69	4.50	SPT4																
	291.24	4.95			(4.5m)														
	290.94	5.25	UDS2		Hard brown clayey silt, medium plastic (MI)					38.7	22.0	16.8		1.84	1.61	14.2			
	290.64	5.55			(6.0m)														
75	290.19	6.00	SPT5		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	289.74	6.45																	
73	288.69	7.50	SPT6																
	288.24	7.95																	
	287.94	8.25	UDS3											1.96	1.68	17.1	0.5	0	33.1°
	287.64	8.55															1.0		
																	1.5		
103	287.19	9.00	SPT7														(DS)		
	286.74	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 8b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 8

TERMINATION DEPTH 15.45 m

Table No: 8b

Location : See Fig No. 1

Surface Elevation 296.19 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
93	285.69	10.50	SPT8		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	285.24	10.95																	
	284.94	11.25	UDS4							30.6	22.0	8.6		1.97	1.76	12.0			
	284.64	11.55																	
98	284.19	12.00	SPT9																
	283.74	12.45																	
88	282.69	13.50	SPT10																
	282.24	13.95																	
	281.94	14.25	UDS5							32.0	22.2	9.9		2.02	1.72	17.7			
	281.64	14.55																	
102	281.19	15.00	SPT11																
	280.74	15.45			(15.45 m)														

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 9

TERMINATION DEPTH: 15.45 m

Table No: 9a

Location : See Fig No. 1

Surface Elevation: 295.94 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	295.94	0.00	DS1		Medium dense to very dense brown silty fine sand (SM)														
	295.44	0.50			- medium dense, 0.0 to 3.0 m														
11	295.44	0.50	SPT1																
	294.99	0.95																	
19	294.44	1.50	SPT2																
	293.99	1.95																	
	293.69	2.25	UDS1			0	83	17	0					1.77	1.65	7.1			
	293.39	2.55																	
41	292.94	3.00	SPT3		- dense, 3.0 to 7.5 m														
	292.49	3.45			- with traces of gravel, 3.0 to 5.0 m														
43	291.44	4.50	SPT4																
	290.99	4.95																	
	290.69	5.25	UDS2			0	61	39	0				2.67	1.82	1.73	5.1	0.5	0	34.5°
	290.39	5.55															1.0		
																	1.5		
46	289.94	6.00	SPT5		- with traces of gravel, 6.0 to 8.0 m												(DS)		
	289.49	6.45																	
72	288.44	7.50	SPT6		- very dense, 7.5 to 8.0 m														
	287.99	7.95																	
					(8.0m)														
	287.69	8.25	UDS3		Very dense brown sandy silt with traces of gravel, low plastic (CL)	4	22	68	6					1.84	1.60	15.3			
	287.39	8.55																	
73	286.94	9.00	SPT7																
	286.49	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 9b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 9

TERMINATION DEPTH 15.45 m

Table No: 9b

Location : See Fig No. 1

Surface Elevation 295.94 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
63	285.44 284.99	10.50 10.95	SPT8		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	284.69 284.39	11.25 11.55	UDS4							34.7	20.5	14.2		2.15	1.87	15.2	1,3 (UUT)	1.90	7.4°
37	283.94 283.49	12.00 12.45	SPT9																
57	282.44 281.99	13.50 13.95	SPT10																
	281.69 281.39	14.25 14.55	UDS5							34.7	16.2	18.5		2.01	1.75	15.0			
52	280.94 280.49	15.00 15.45	SPT11		(15.45 m)														

UUT : Unconsolidated Undrained Triaxial Shear Test

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 10

TERMINATION DEPTH 15.45 m

Table No: 10a

Location : See Fig No. 1

Surface Elevation 294.29 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
	294.29	0.00	DS1		Medium dense brown silty fine sand (SM)														
	293.79	0.50																	
20	293.79	0.50	SPT1																
	293.34	0.95																	
24	292.79	1.50	SPT2																
	292.34	1.95			(2.0m)														
	292.04	2.25	UDS1		Medium dense brown sandy silt with traces of gravel, low plastic (CL)	3	22	73	2					1.76	1.49	17.8			
	291.74	2.55			(3.0m)														
27	291.29	3.00	SPT3		Medium dense brown silty fine sand (SM)														
	290.84	3.45			(4.5m)														
91	289.79	4.50	SPT4		Very dense brown sandy silt with gravel, low plastic (CL)														
	289.34	4.95																	
	289.04	5.25	UDS2			9	22	68	1				2.67	1.94	1.68	15.2			
	288.74	5.55			(6.0m)														
74	288.29	6.00	SPT5		Very dense brown silty fine sand with traces of gravel (SM)														
	287.84	6.45																	
60	286.79	7.50	SPT6																
	286.34	7.95																	
	286.04	8.25	UDS3			4	69	26	1					1.86	1.61	15.6	0.5	0	34.2°
	285.74	8.55			(9.0m)												1.0		
																	1.5		
82	285.29	9.00	SPT7		Very dense brown sandy silt with traces of gravel, low plastic (CL)												(DS)		
	284.84	9.45																	

DS : Drained Direct Shear Test

(Cont'd on Table No. 10b)

* Outside NABL scope

SOIL PROFILE

Project : Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

BH.No: 10

TERMINATION DEPTH 15.45 m

Table No: 10b

Location : See Fig No. 1

Surface Elevation 294.29 m

WATER TABLE : Not Met

JOB NO. **212073-A**

Certificate No.T-1741

N-Value*	Reduced Level, m	Depth (m)	Sample No.	Symbol	SOIL DESCRIPTION	Grain Size Analysis: Gravel %	Sand %	Silt %	Clay %	Atterberg Limits: Liquid %	Plastic %	Plasticity Index %	Specific Gravity	Natural Density gms/cm^3	Dry Density gms/cm^3	Moisture Content %	Triaxial Test: Confining Pressure Kg/cm^2	Cohesion Intercept Kg/cm^2	Angle of Internal Friction
83	283.79 283.34	10.50 10.95	SPT8		Very dense brown sandy silt with traces of gravel, low plastic (CL)														
	283.04 282.74	11.25 11.55	UDS4							29.6	18.8	10.9		1.97	1.77	11.6			
108	282.29 281.84	12.00 12.45	SPT9																
					(13.5m)														
53	280.79 280.34	13.50 13.95	SPT10		Very dense brown silty fine sand with traces of gravel (SM)														
	280.04 279.74	14.25 14.55	UDS5																
68	279.29 278.84	15.00 15.45	SPT1																
					(15.45 m)														

* Outside NABL scope

SOIL-WATER EXTRACT :

Borehole No.	Depth, (m)	Sulphate Content (SO_3), %	Chloride Content, %	pH Value
1	2.25	0.11	0.03	8.2
2	5.25	0.10	0.02	8.3
3	2.25	0.10	0.03	8.4
5	5.25	0.09	0.02	8.3
6	2.25	0.10	0.03	8.4
7	5.25	0.11	0.04	8.3
8	2.25	0.09	0.01	8.3
9	5.25	0.10	0.02	8.5
10	2.25	0.10	0.03	8.4

REQUIREMENTS FOR CONCRETE EXPOSED TO SULPHATE ATTACK AS PER IS : 456-2000, CLAUSES 8.2.2.4 AND 9.1.2, TABLE 4, PAGE-19

Class	Concentration of Sulphates, expressed as SO_3 In-Soil-Water Extract (Total) Percent	In Groundwater (mg/l)
1	Traces (<0.2)	Less than 300
2	0.2 to 0.5	300-1200
3	0.5 to 1.0	1200-2500
4	1.0 to 2.0	2500-5000
5	> 2.0	> 5000

CLASSIFICATION OF CHLORIDE CONDITIONS IN GROUNDWATER*

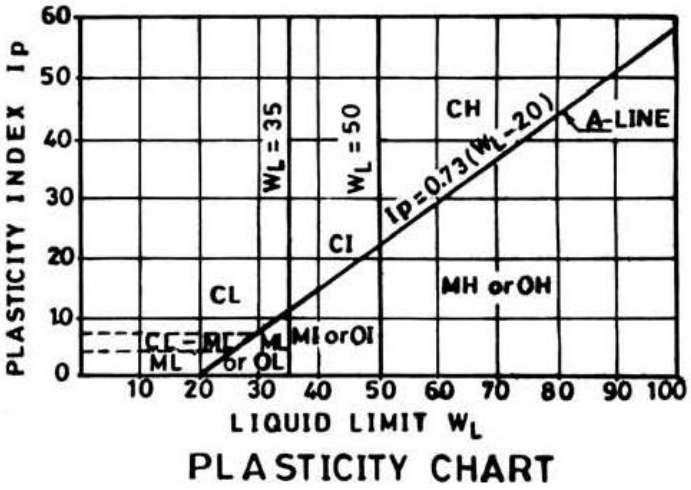
Classification	Chloride Limits	
	Temperate Climate	Tropical Climate
Negligible	0-2000 ppm	Not Applicable
Moderate	2000-10,000 ppm	0-2000 ppm
High	More than 10,000 ppm	2000-20,000 ppm
Very High	Generally not applicable	Only if considerably in excess of 20,000 ppm

*SOURCE : INSTITUTION OF CIVIL ENGINEERS, LONDON (1979)

	CENGRS GEOTECHNICA PVT. LTD.	Job No.: 212073-A	Table No. 12

PLASTICITY OF CLAY

Plasticity	Liquid Limit
Low Plastic	< 35
Medium Plastic	35 to 50
High Plastic	> 50



PLASTICITY CHART

CONSISTENCY OF COHESIVE SOILS

Consistency	Cohesion Intercept, kg/sq.cm	SPT (N) Value
Very Soft	< 0.1	0 to 2
Soft	0.1 to 0.25	2 to 4
Firm/Medium	0.25 to 0.5	4 to 8
Stiff	0.5 to 1.0	8 to 15
Very Stiff	1.0 to 2.0	15 to 30
Hard	> 2.0	> 30

DENSITY CONDITION OF GRANULAR SOILS

Density Descriptor	SPT (N) Value	Static Cone Tip Resistance kg/sq.cm
Very Loose	0 to 4	< 20
Loose	4 to 10	20 to 40
Medium Dense	10 to 30	40 to 120
Dense	30 to 50	120 to 200
Very dense	> 50	> 200

DEGREE OF EXPANSION OF FINE GRAINED SOILS

Liquid Limit	Plasticity Index	Shrinkage Index	Free Swell Percent	Degree of Expansion	Degree of Severity
20 - 35	< 12	< 15	< 50	Low	Non-critical
35 - 50	12 - 23	15 -30	50 -100	Medium	Marginal
50 - 70	23 - 32	30 - 60	100 - 200	High	Critical
70 - 90	> 32	> 60	> 200	Very High	Severe

ENGINEERING DESCRIPTION OF SOILS

NABL ACCREDITED LABORATORY

Our laboratory is accredited to **National Accreditation Board for Testing and Calibration Laboratories (NABL)**, New Delhi. The quality procedures in our laboratory conform to the International Standard **ISO/IEC: 17025-2005.**

The accreditation assures our clients of work quality in conformance with international norms and practices. It authorizes us to use the NABL logo on test results.

To maintain the necessary level of quality and reliability in all measurements on a continual basis, we indulge in the following:

- Use of calibrated equipment, regular maintenance and good housekeeping are a part of our work culture.
- Inter-laboratory comparison, proficiency testing and replicate testing, continuing education - ensure uniform quality of results.
- Internal Audit of quality procedures is done by our qualified ISO 17025 auditors to maintain the requisite standards. NABL conducts external audit.

UNCERTAINTY

Every measurement entails an uncertainty. It is well known that no measuring instrument can determine the true value of any measurement. The cumulative effect of factors such as sensitivity of equipment, accuracy in calibration, human factors and environmental conditions will determine the overall uncertainty in the parameter determined from these measurements.

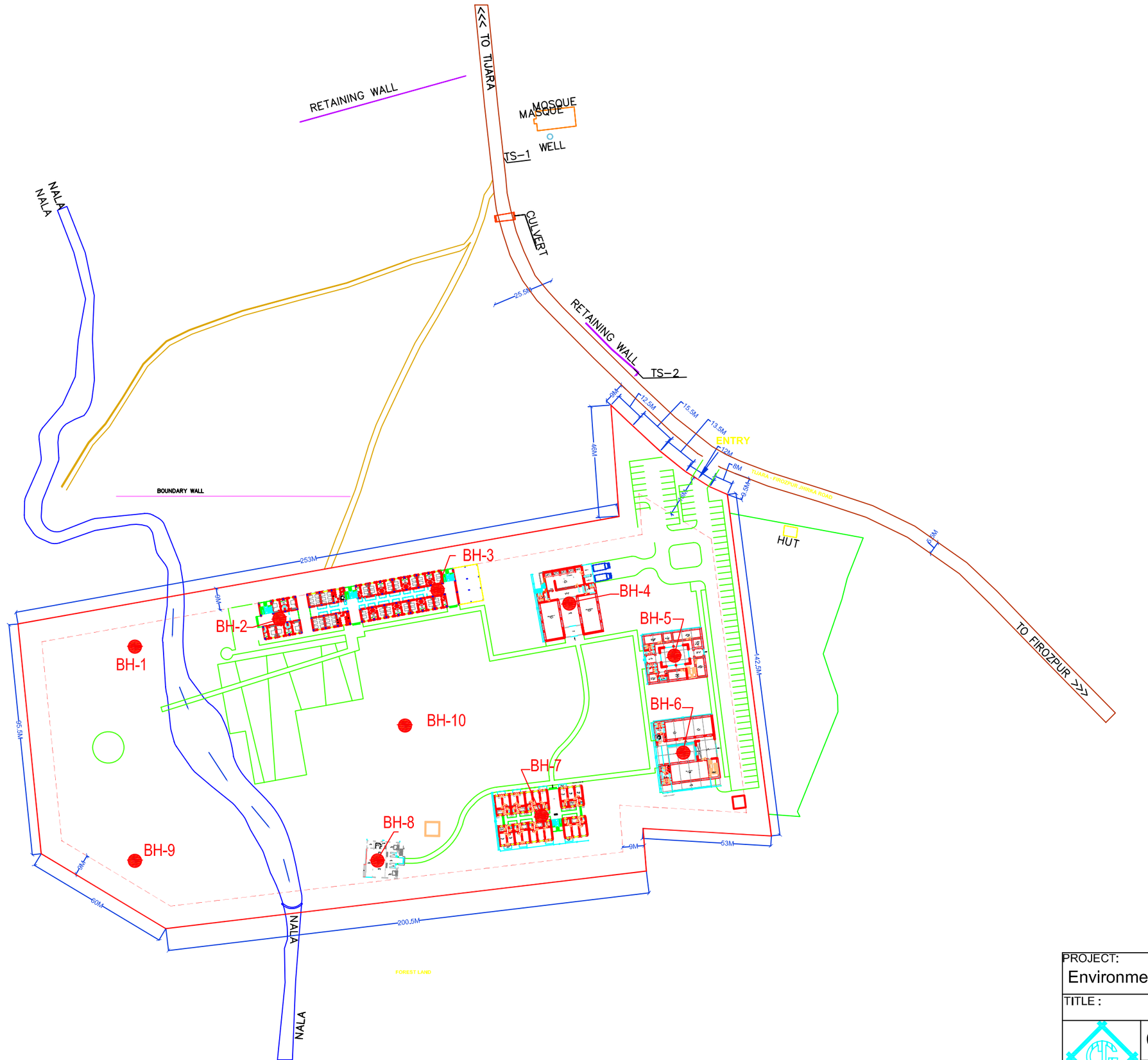
As a part of our commitment to our clients, we have worked out the uncertainty in the parameters reported by our laboratory. Although this does not form a part of our contract agreement, we present below our statistical estimate of uncertainty of various parameters based on our most recent evaluation (Feb., 2012).

Test / Parameter		Uncertainty*
Moisture Content		± 0.26 %
Bulk & Dry Density		± 0.004 g/cc
Specific Gravity		± 0.08
Liquid Limit		± 0.59 %
Plastic Limit		± 0.27 %
Shrinkage Limit		± 0.26 %
Unconfined Compression	c	± 0.185 kg/cm^2
UU Triaxial Test	c	± 0.09 kg/cm^2
	ϕ	± 0.5°
Std/Mod Proctor Compaction	MDD	± 0.03 g/cc
	OMC	± 0.26 %
Laboratory CBR		± 0.31%

Test / Parameter		Uncertainty*	
Free Swell Index, %		± 2.20 %	
Swell Pressure		± 0.43 %	
Consolidation	c_{c1}	± 0.0003	
	c_{c2}	± 0.003	
	m_v	± 0.0003 cm^2/kg	
	p_c	± 0.15 kg/cm^2	
CD Direct Shear Test	ϕ	± 0.61°	
Soil Gradation	Coarse grained soils	± 0.8% of particle size	
	Fine grained soils	± 1.5% of particle size	
Coefficient of Permeability		± 1.3 % of value	
Rock		Crushing Strength	± 0.80 % of value
		Point Load Strength Index	± 0.1 % of value

* at 95 percent confidence level for coverage factor of 2

UNCERTAINTY IN LABORATORY MEASUREMENTS



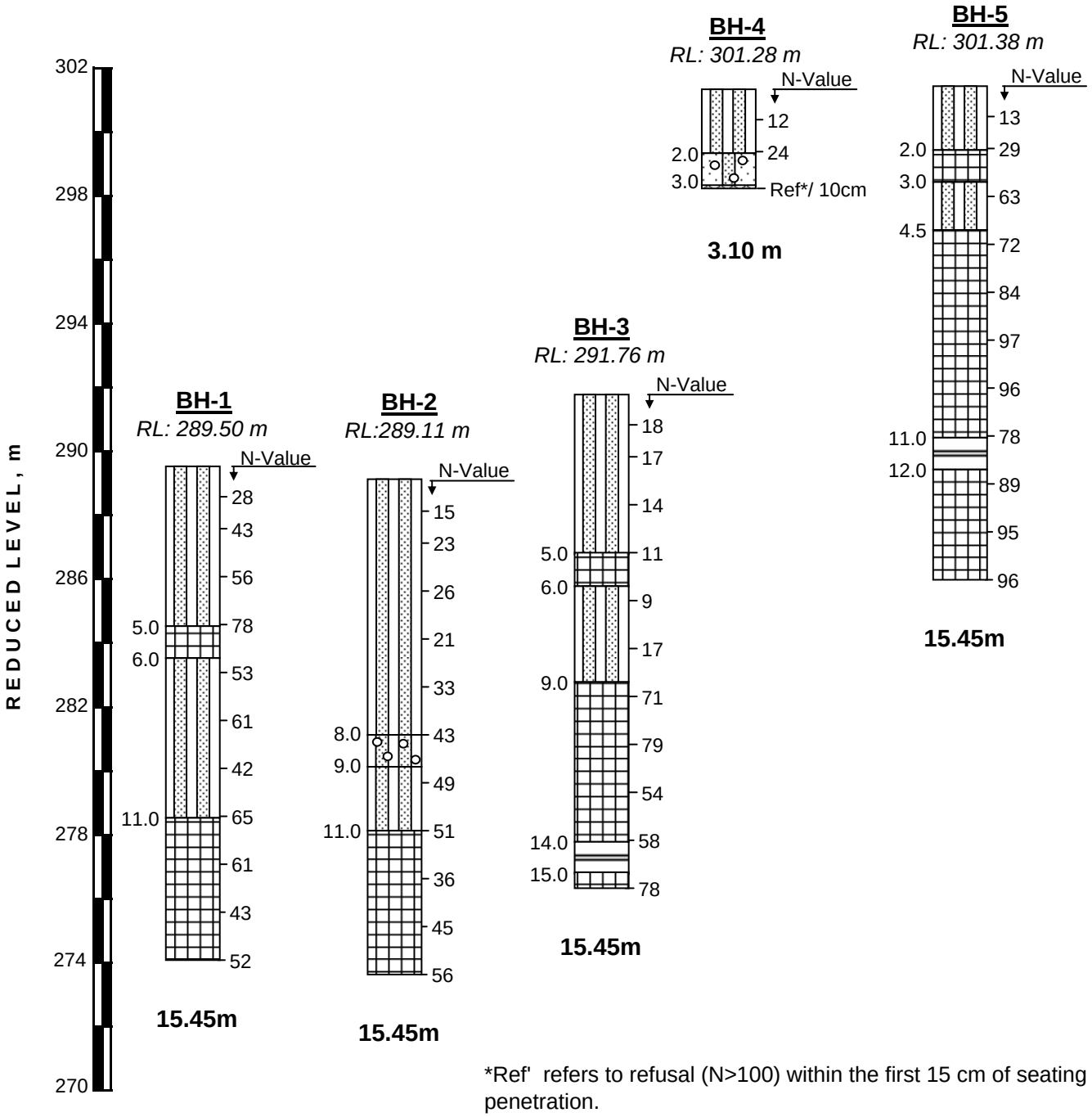
Legend

- Borehole (BH)

PROJECT:	Environmental Regulatory Training institute at Nimli, Alwar (RJ)
TITLE :	PLAN OF FIELD INVESTIGATION
	CENGRS GEOTECHNICA PVT. LTD.
JOB. No. :	212073-A
FIG. NO. :	1

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

CENGRS GEOTECHNICA PVT. LTD.	Job.No.: 212073-A	Fig No.: 2a



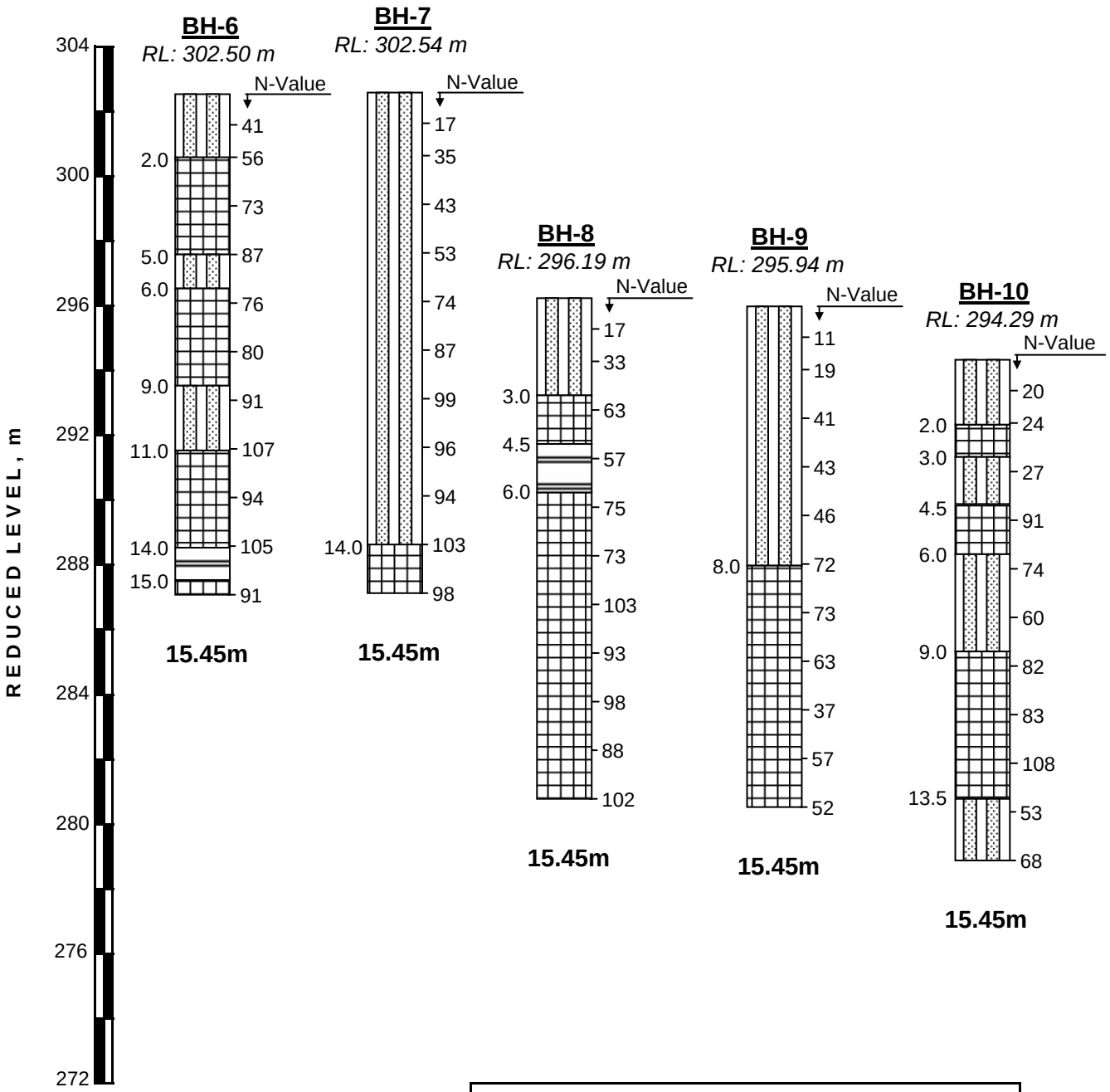
*Ref' refers to refusal (N>100) within the first 15 cm of seating penetration.

LEGEND	
SYMBOL	DESCRIPTION
	Sandy silt (CL)
	Silty fine sand (SM)
	Pebbles and gravels (SM-GP)
	Gravel mixed with sand (GP-SP-SM)
	Rock

Summary of Borehole Profiles

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

CENGRS GEOTECHNICA PVT. LTD.	Job.No.: 212073-A	Fig No.: 2b



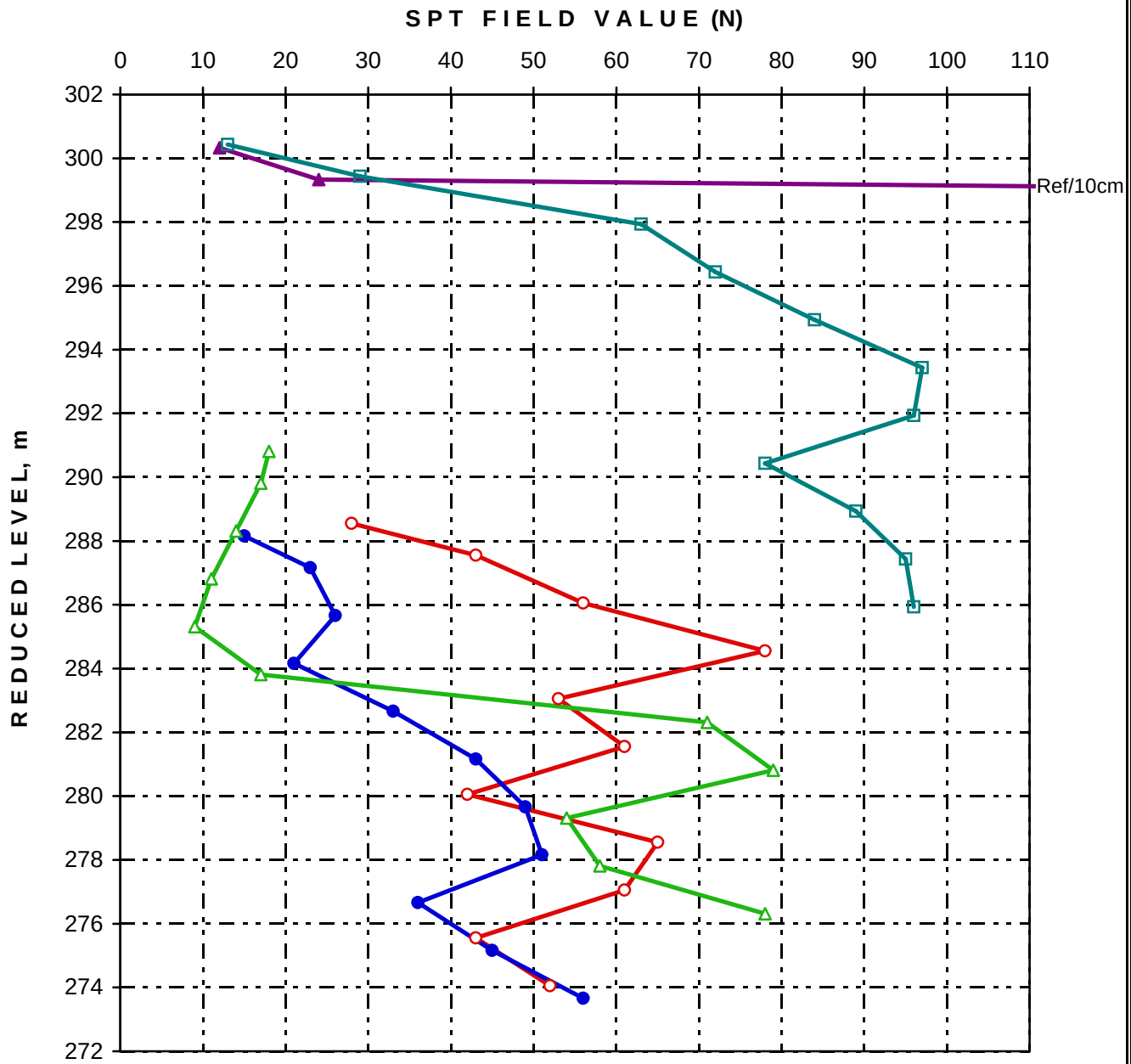
LEGEND	
SYMBOL	DESCRIPTION
	Sandy silt (CL)
	Silty fine sand (SM)
	Clayey silt (MI)

Summary of Borehole Profiles

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-A	Fig No. 3a

STANDARD PENETRATION TEST



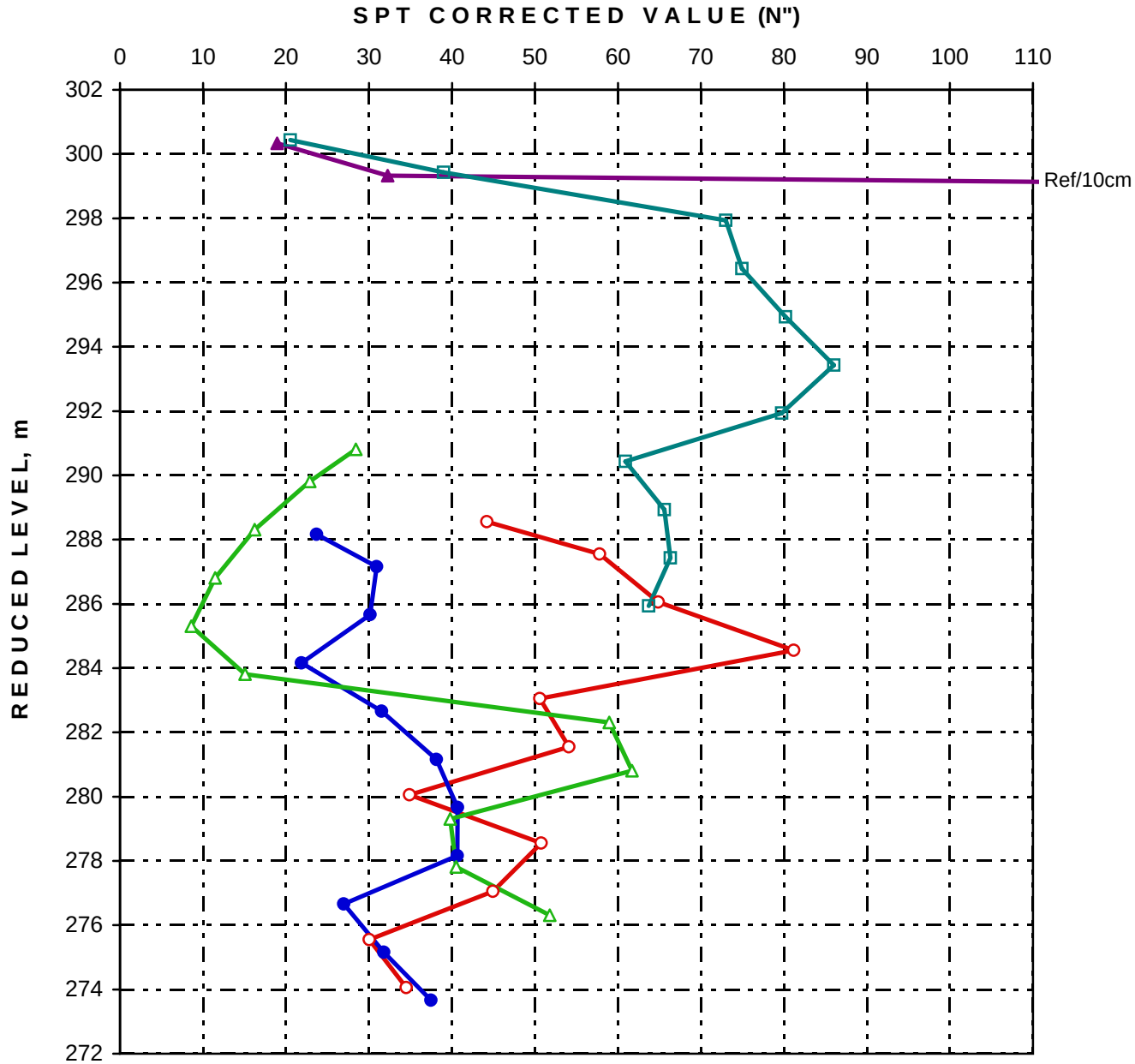
LEGEND		
Symbol	BH.No.	Reduced Level,m
	1	289.504
	2	289.111
	3	291.760
	4	301.282
	5	301.384

Standard Penetration Test Results (Field Values)

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-A	Fig No. 3b

STANDARD PENETRATION TEST



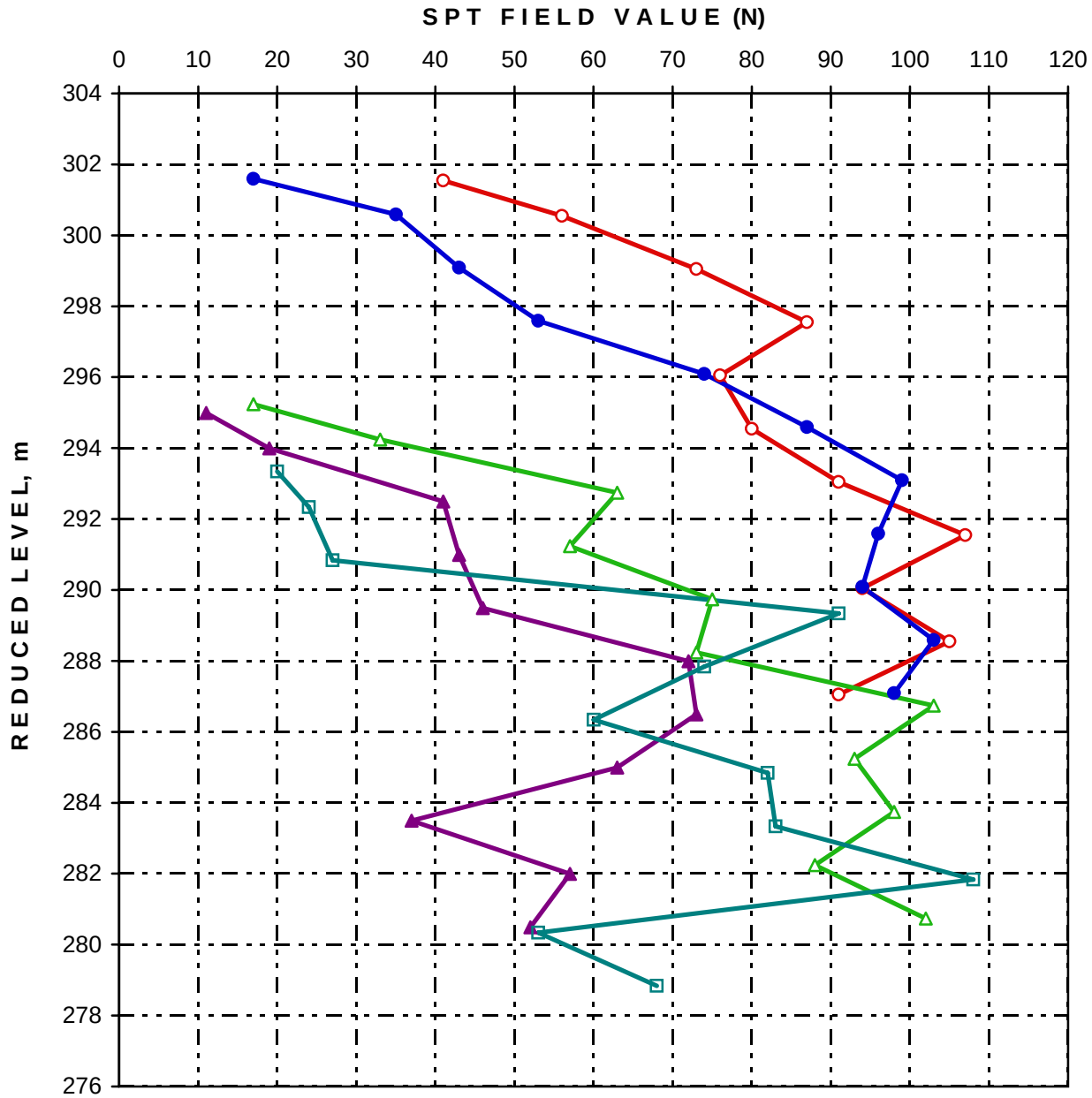
LEGEND		
Symbol	BH.No.	Reduced Level,m
	1	289.504
	2	289.111
	3	291.760
	4	301.282
	5	301.384

Standard Penetration Test Results (Corrected Values)

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-A	Fig No. 3c

STANDARD PENETRATION TEST



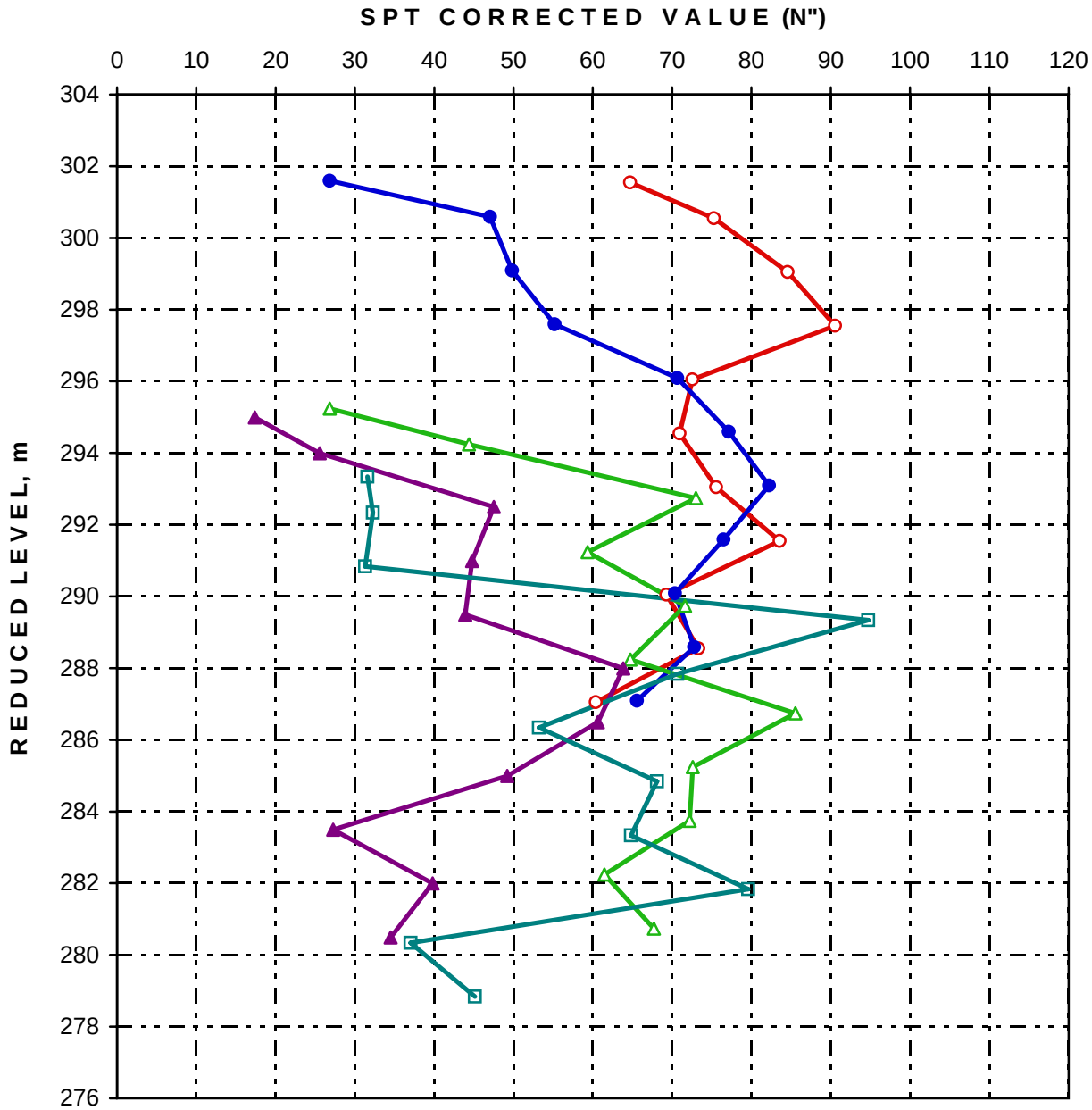
LEGEND		
Symbol	BH.No.	Reduced Level,m
	6	302.498
	7	302.540
	8	296.189
	9	295.942
	10	294.288

Standard Penetration Test Results (Field Values)

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

CENGRS GEOTECHNICA PVT. LTD.	Job No. 212073-A	Fig No. 3d

STANDARD PENETRATION TEST



LEGEND		
Symbol	BH.No.	Reduced Level,m
	6	302.498
	7	302.540
	8	296.189
	9	295.942
	10	294.288

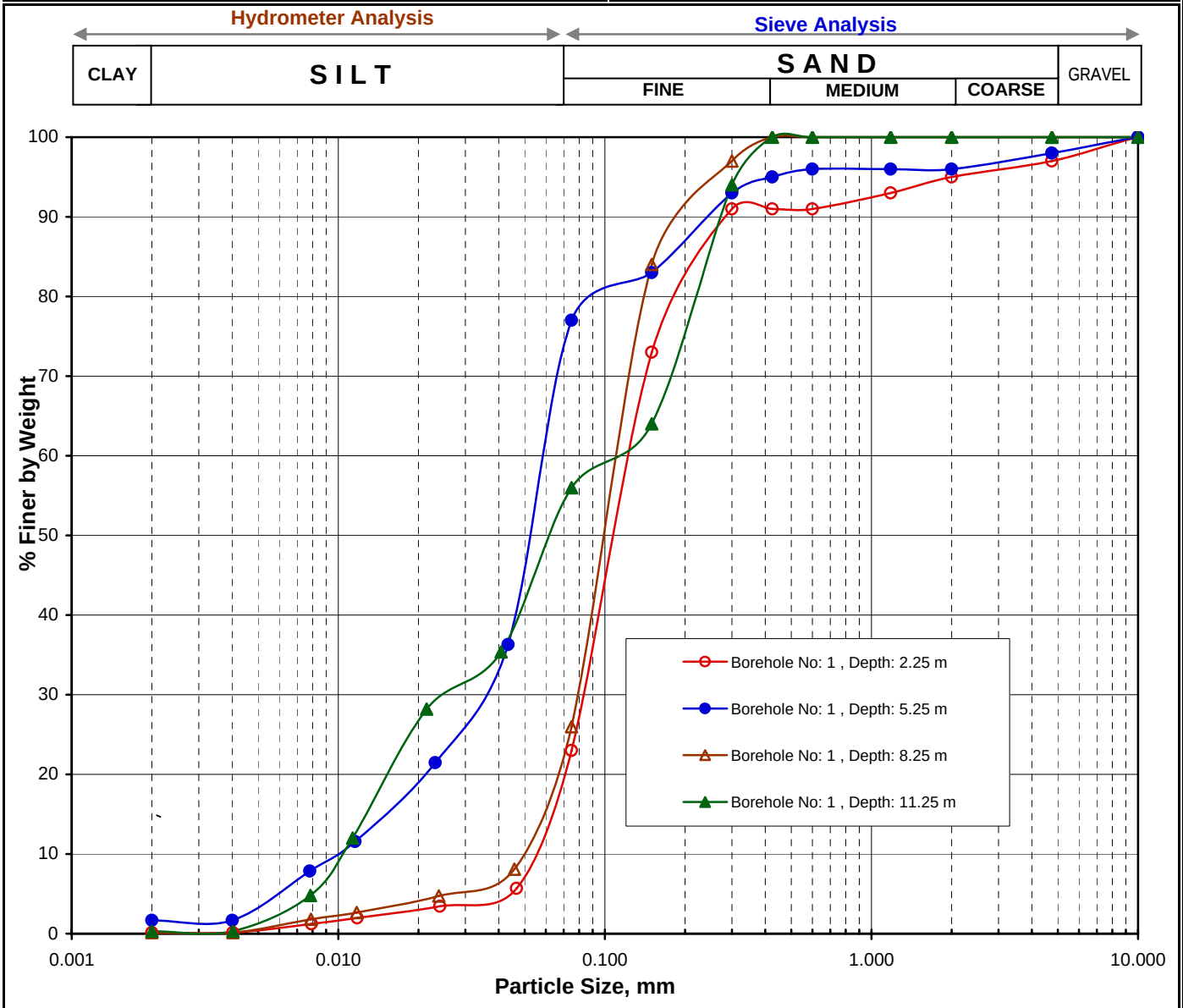
Standard Penetration Test Results (Corrected Values)

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 4	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-1	2.25	Silty fine sand with traces of gravel (SM)	3	74	23	0	0.131	0.088	1.5
BH-1	5.25	Sandy silt with traces of gravel (CL)	2	21	75	2	0.075	0.012	6.5
BH-1	8.25	Silty fine sand (SM)	0	74	26	0	0.150	0.075	2.0
BH-1	11.25	Sandy silt (CL)	0	44	56	0	0.150	0.011	13.2

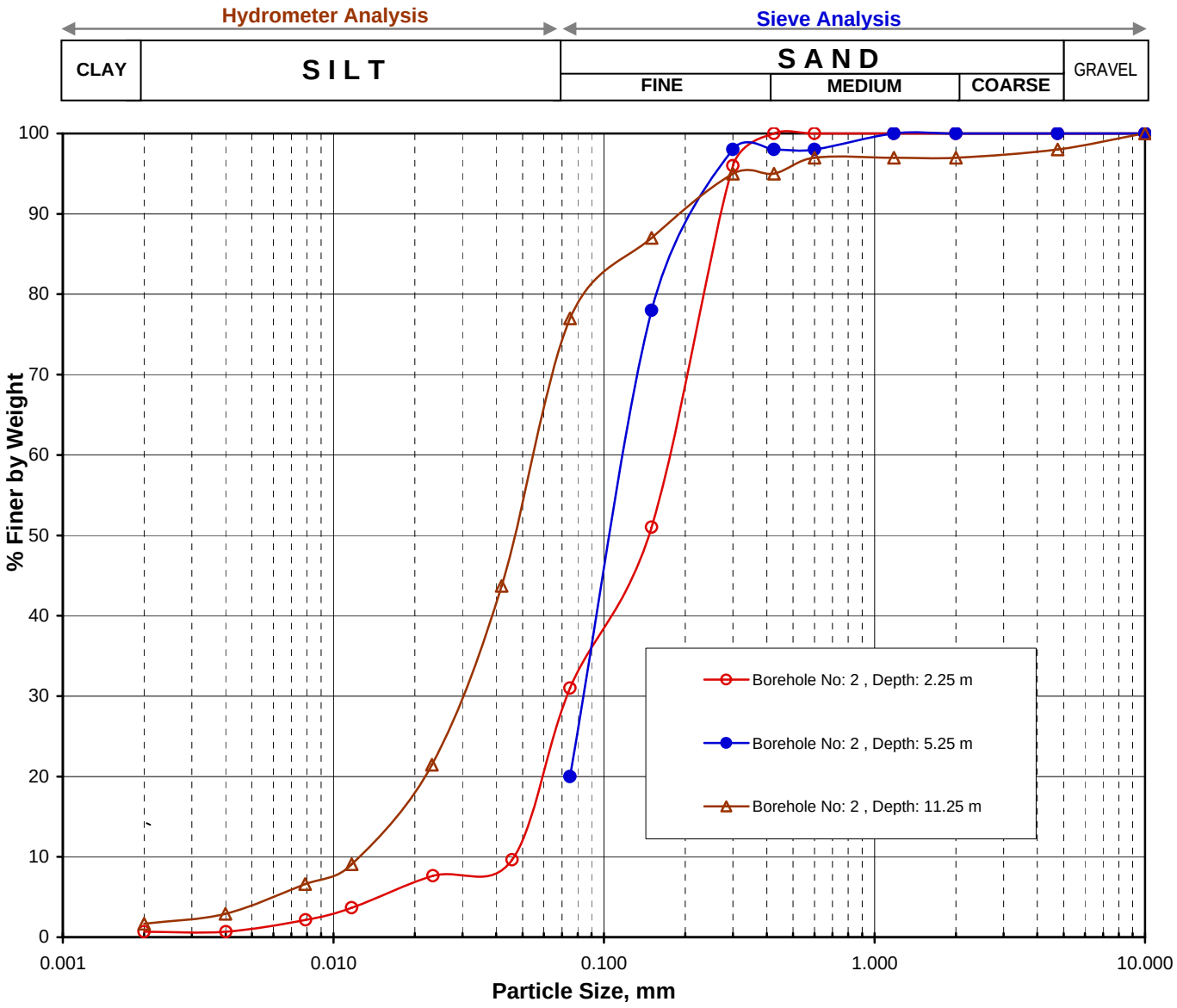


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 5	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-2	2.25	Silty fine sand (SM)	0	69	30	1	0.180	0.053	3.4
BH-2	5.25	Silty fine sand (SM)	0	80	20	0	0.150		
BH-2	11.25	Sandy silt with traces of gravel (CL)	2	21	75	2	0.075	0.015	4.9

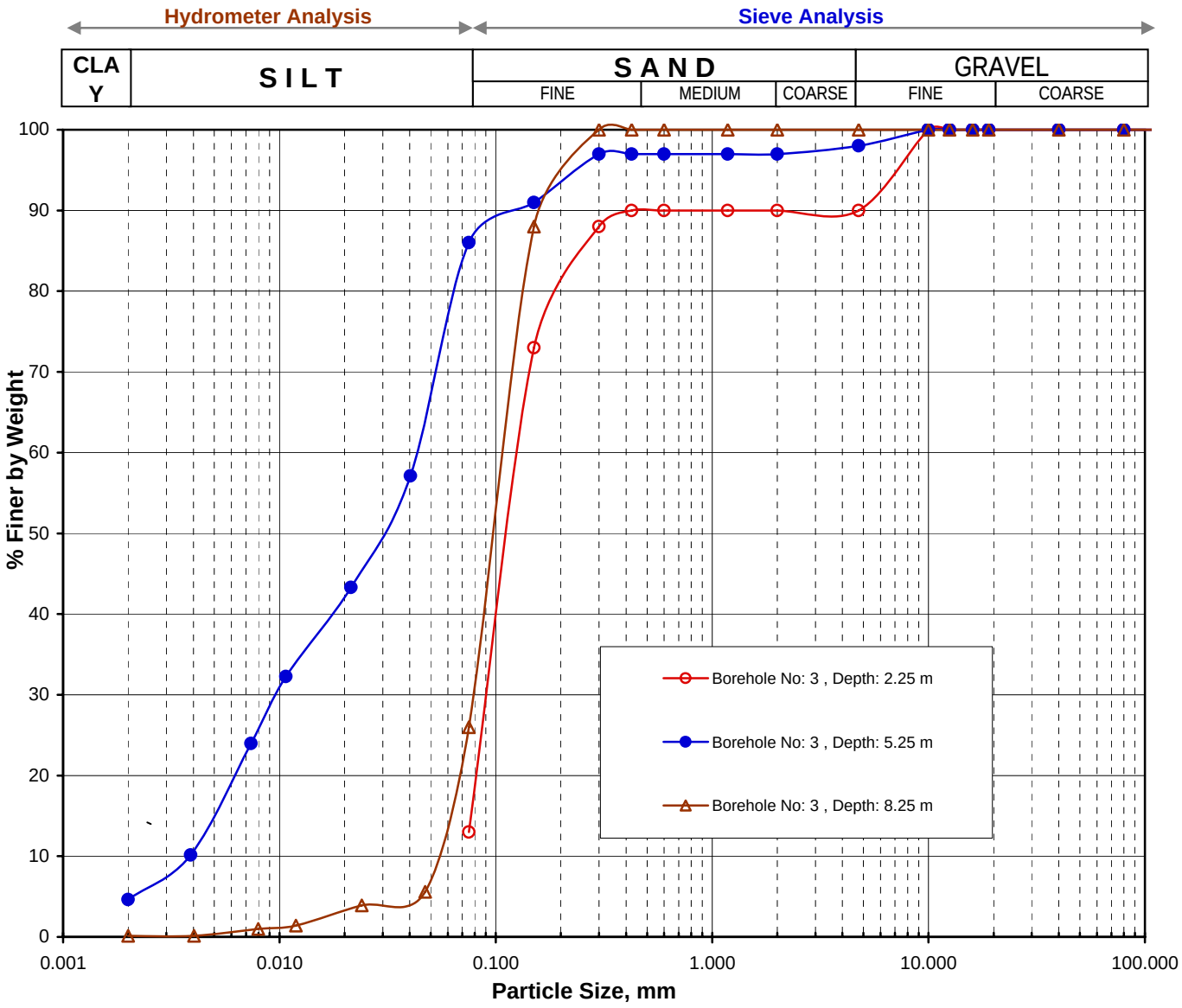


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 6	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-3	2.25	Silty fine sand with gravel (SM)	10	77	13	0	0.134		
BH-3	5.25	Sandy silt with traces of gravel (CL)	2	12	81	5	0.055	0.004	14.1
BH-3	8.25	Silty fine sand (SM)	0	74	26	0	0.150	0.075	2.0

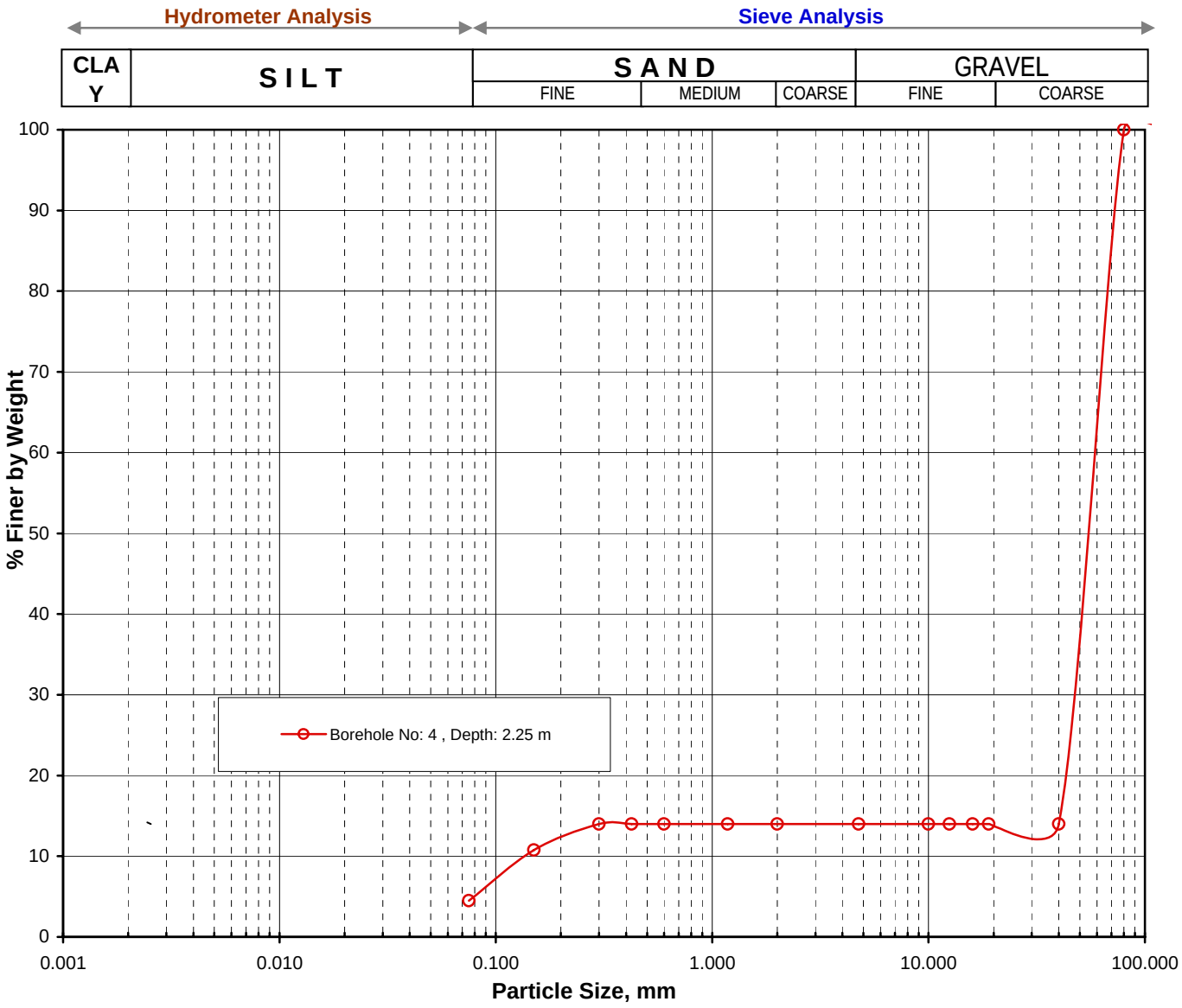


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 7	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-4	2.25	Gravel mixed with sand (GP-SP-SM)	86	10	5	0	61.395	0.141	435.4

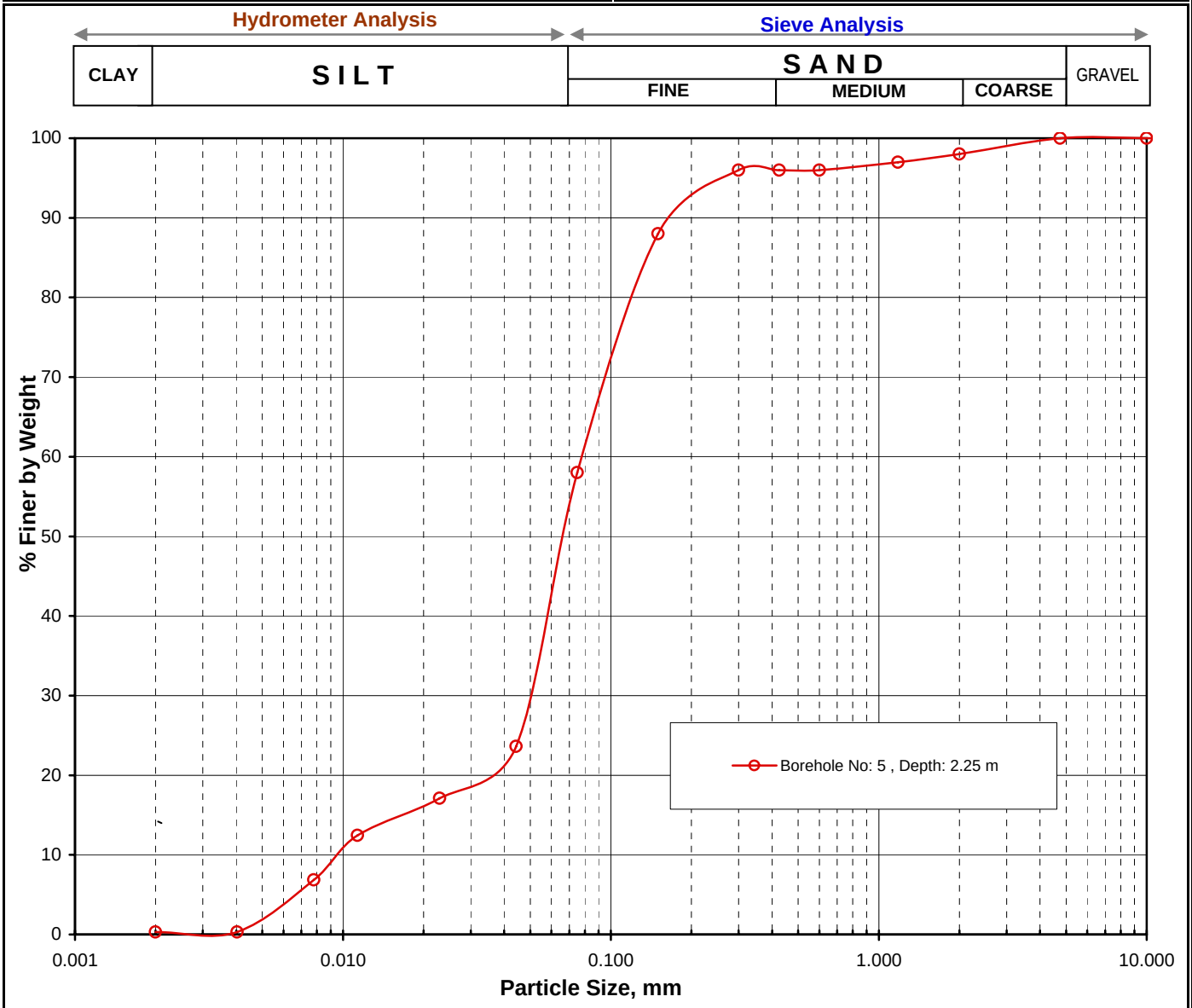


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 8	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-5	2.25	Sandy silt (CL)	0	42	58	0	0.080	0.010	8.0

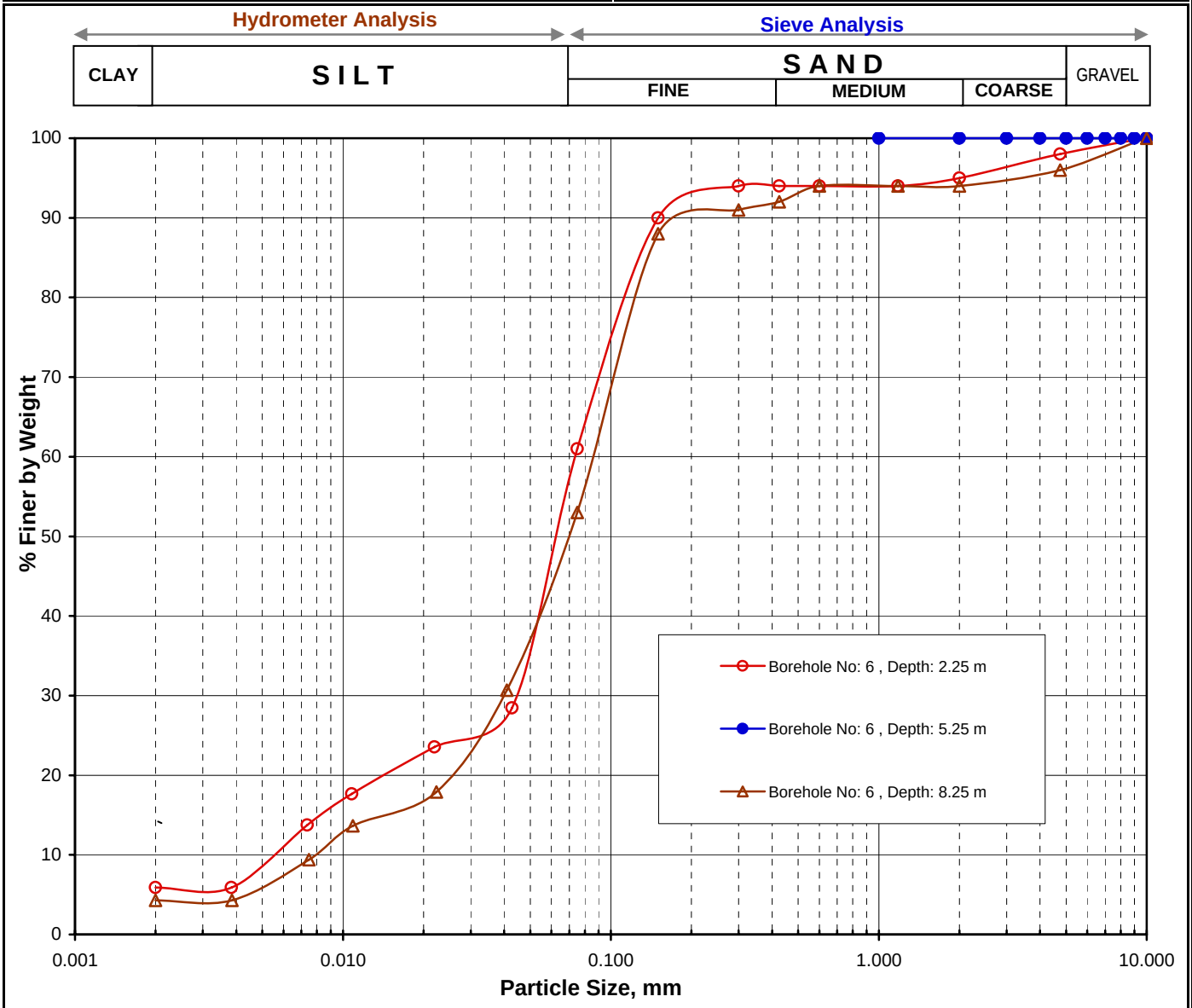


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 9	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-6	2.25	Sandy silt with traces of gravel (CL)	2	37	55	6	0.075	0.006	13.2
BH-6	5.25	Silty fine sand (SM)	0	80	20	0	0.300		
BH-6	8.25	Sandy silt with traces of gravel (CL)	4	43	49	4	0.150	0.009	16.8
BH-6	11.25	Sandy silt with traces of gravel (CL)	1	25	72	2	0.075	0.008	9.7

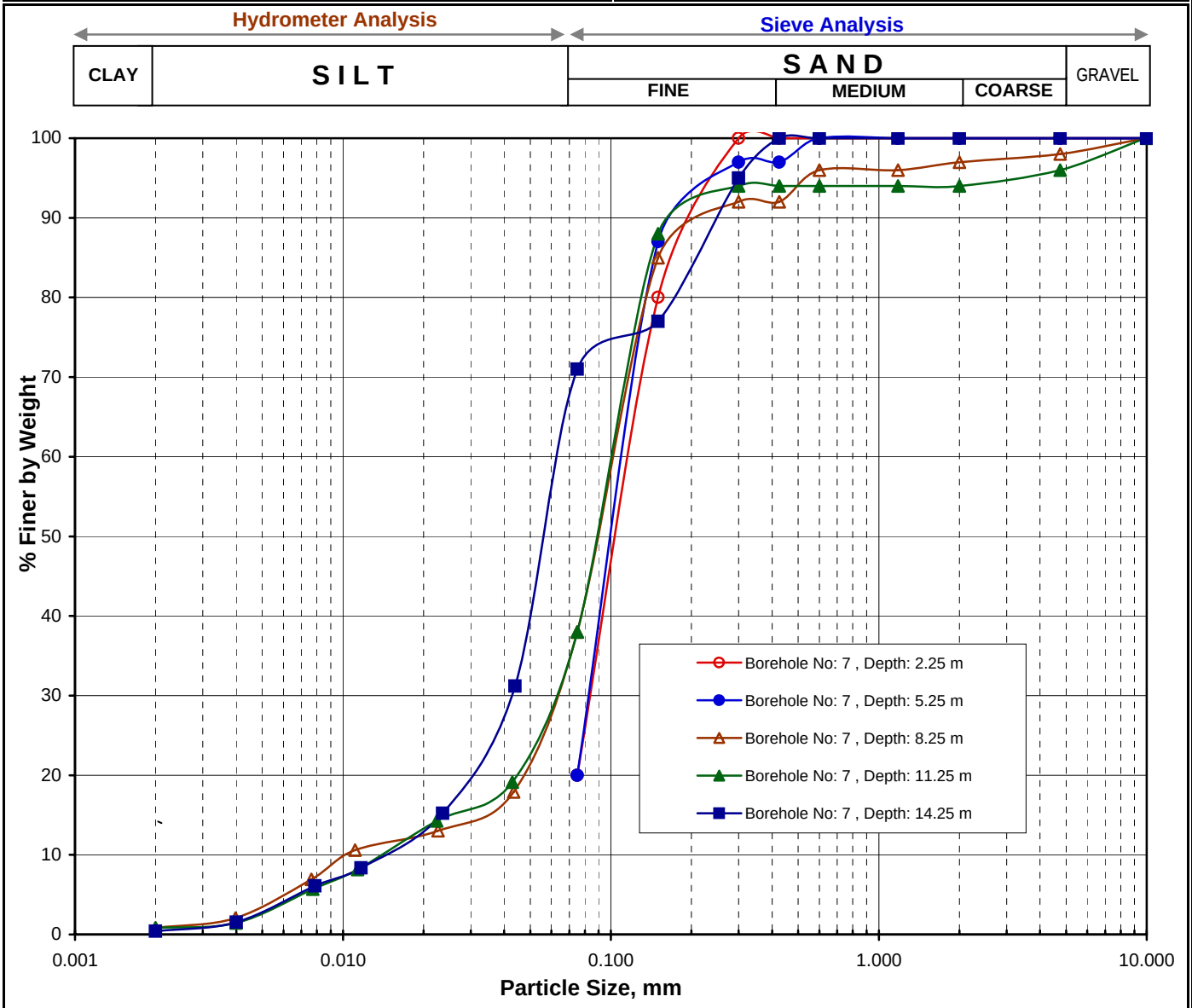


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 10	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-7	2.25	Silty fine sand (SM)	0	80	20	0	0.125		
BH-7	5.25	Silty fine sand (SM)	0	80	20	0	0.150		
BH-7	8.25	Silty fine sand with traces of gravel (SM)	2	60	37	1	0.150	0.011	13.5
BH-7	11.25	Silty fine sand with traces of gravel (SM)	4	58	37	1	0.150	0.015	10.3
BH-7	14.25	Sandy silt (CL)	0	29	71	0	0.075	0.015	4.9

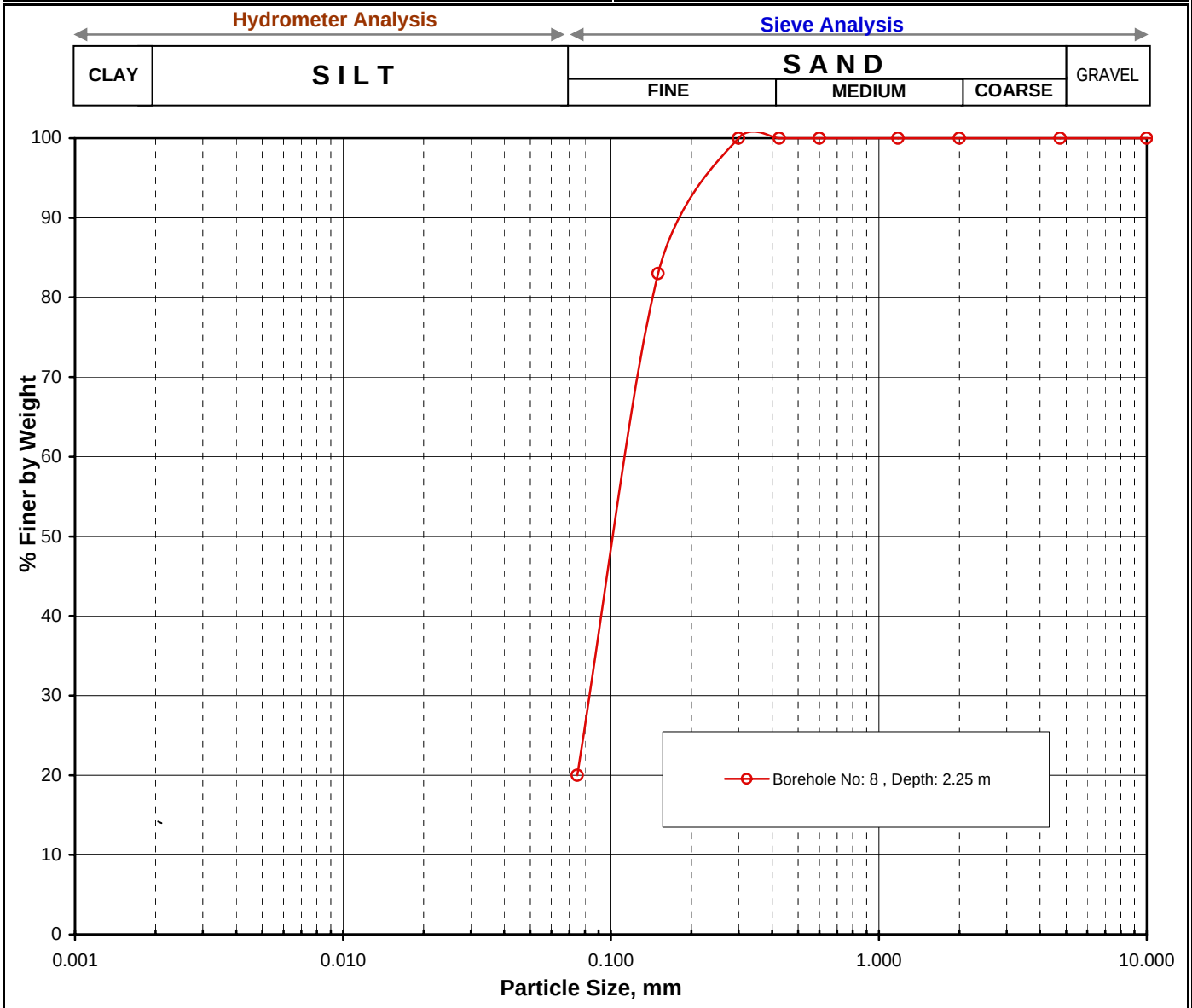


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 11	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-8	2.25	Silty fine sand (SM)	0	80	20	0	0.123		

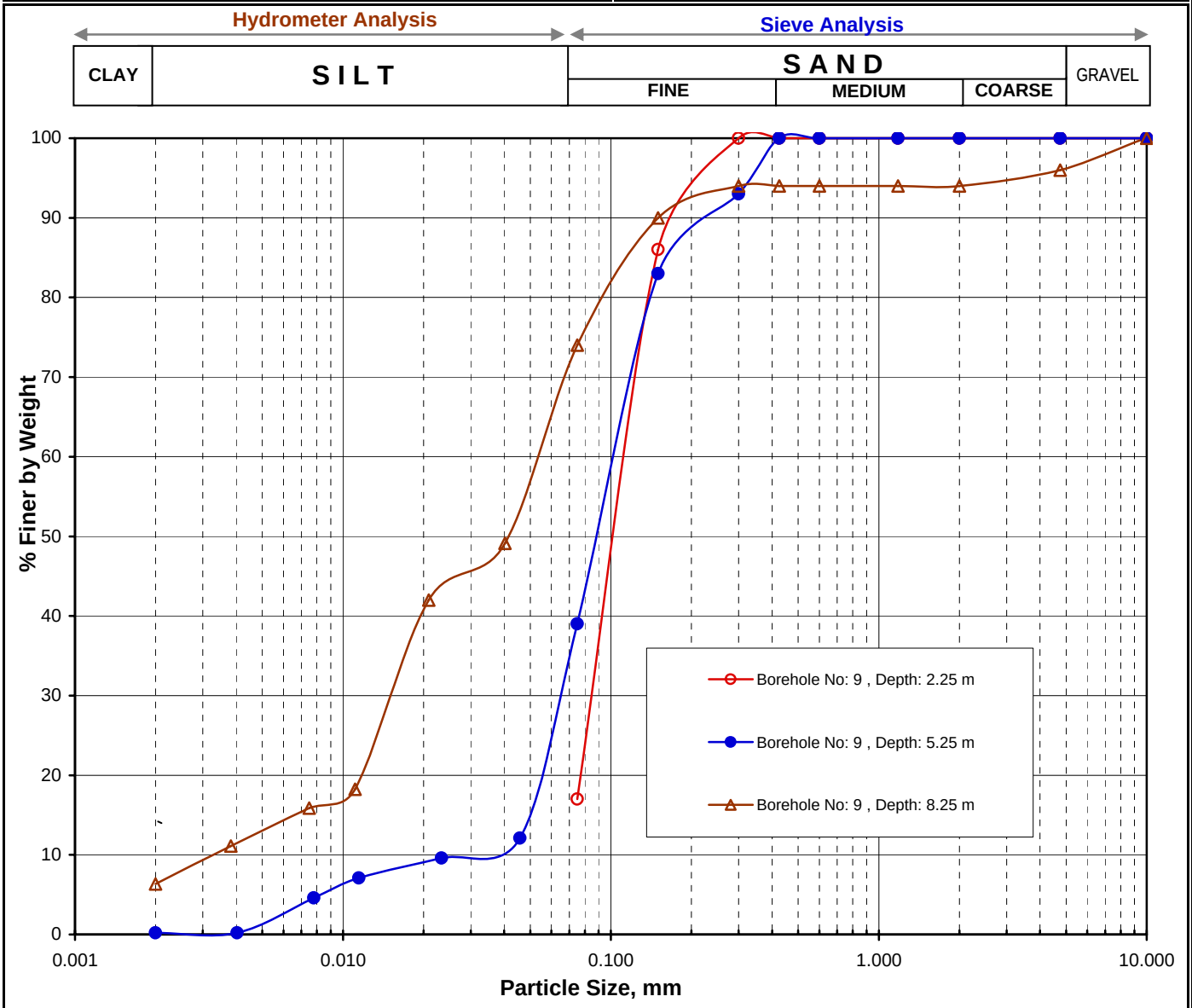


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 12	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-9	2.25	Silty fine sand (SM)	0	83	17	0	0.122		
BH-9	5.25	Silty fine sand (SM)	0	61	39	0	0.150	0.032	4.6
BH-9	8.25	Sandy silt with traces of gravel (CL)	4	22	68	6	0.075	0.004	19.6

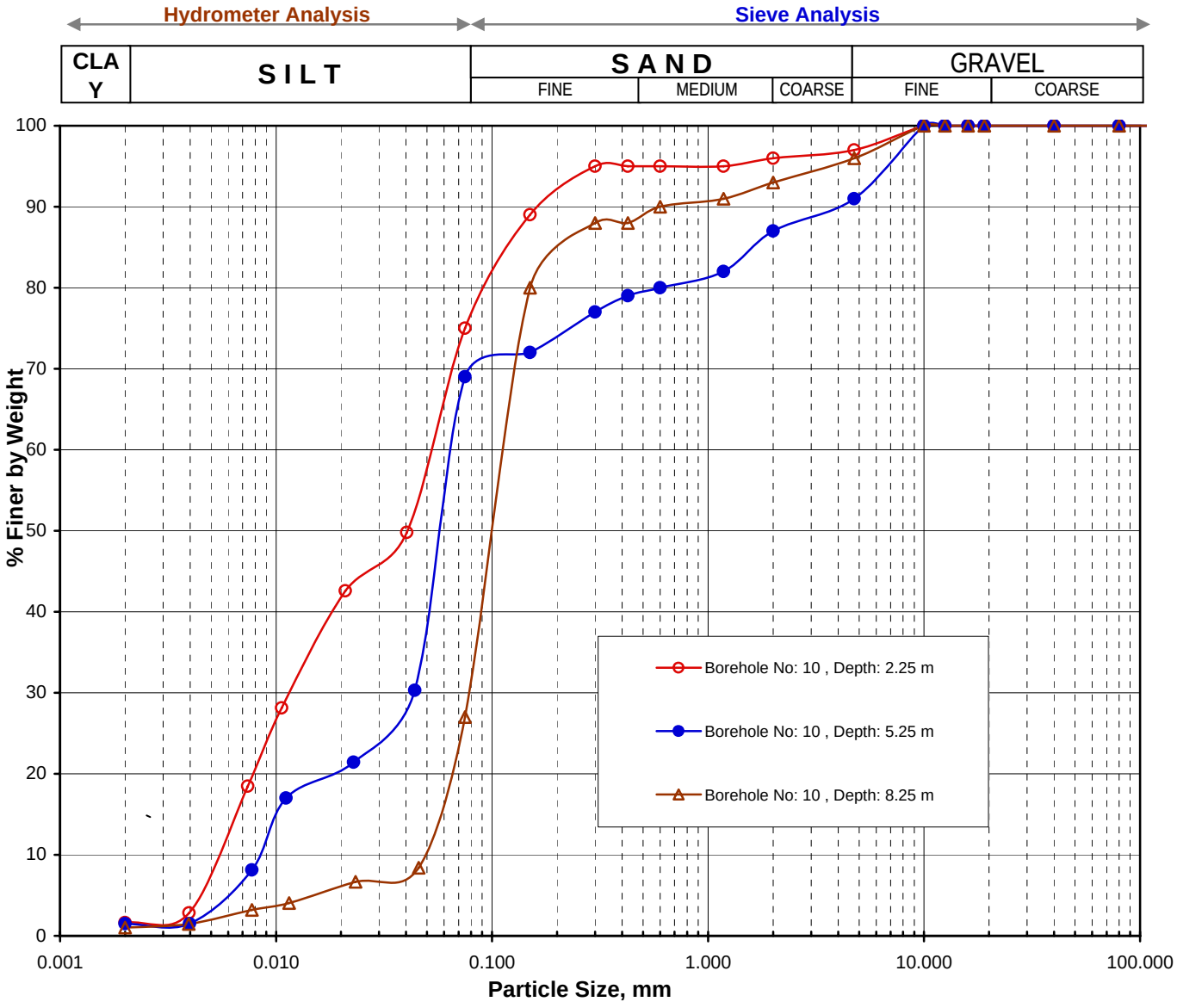


Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig. No. 13	Certificate No.T-1741

Grain Size Analysis : IS : 2720 (Part 4) - 1985

SAMPLE DETAILS			TEST RESULTS						
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u
BH-10	2.25	Sandy silt with traces of gravel (CL)	3	22	73	2	0.078	0.005	14.3
BH-10	5.25	Sandy silt with gravel (CL)	9	22	68	1	0.075	0.009	8.3
BH-10	8.25	Silty fine sand with traces of gravel (SM)	4	69	26	1	0.150	0.063	2.4



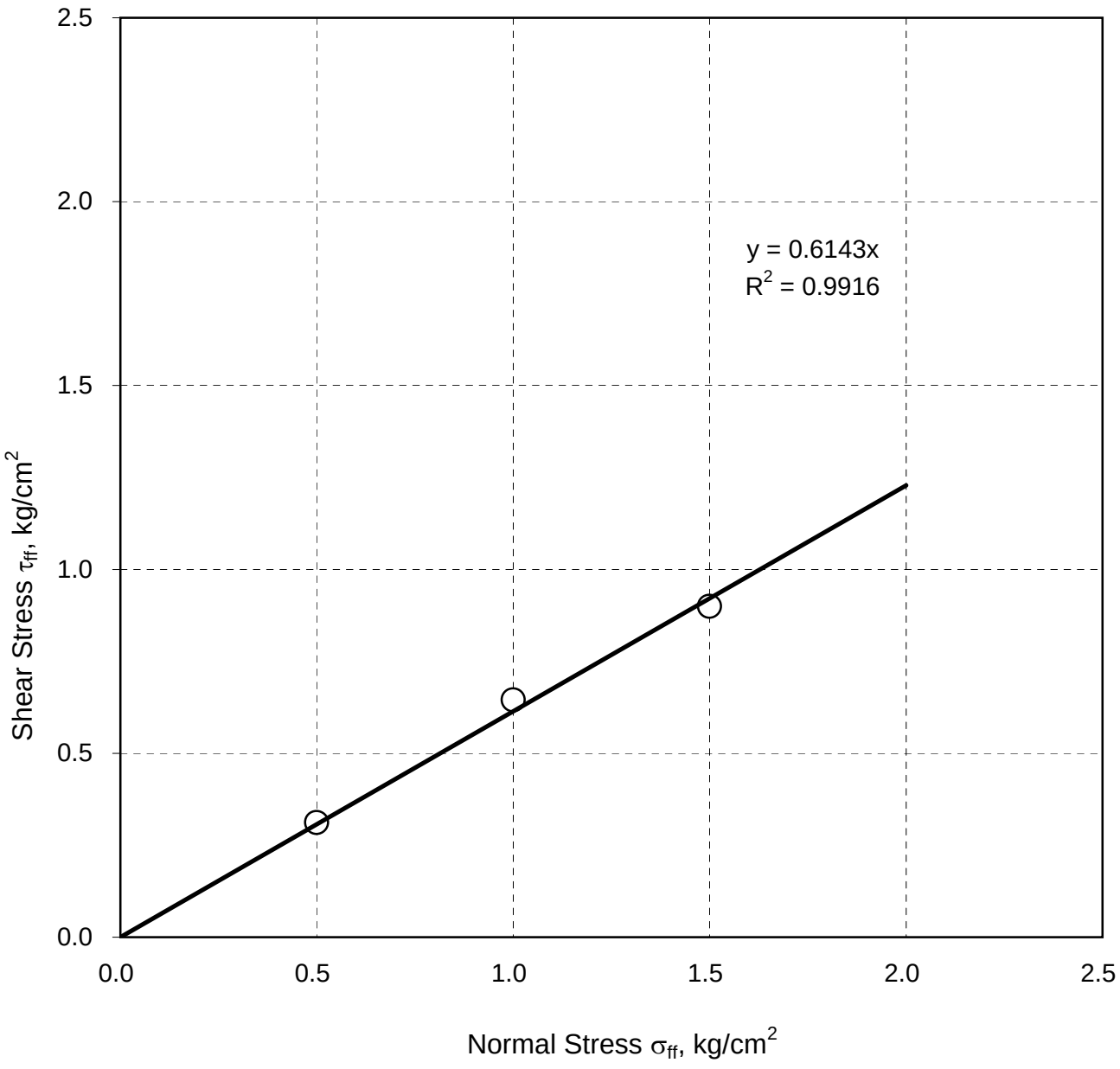
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 14	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 1	**Sample Depth: 2.25 m**	*Sample Description: Silty fine sand with traces of gravel*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS1	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	31.6
Dry Density of Soil (g/cm^3):	1.61		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

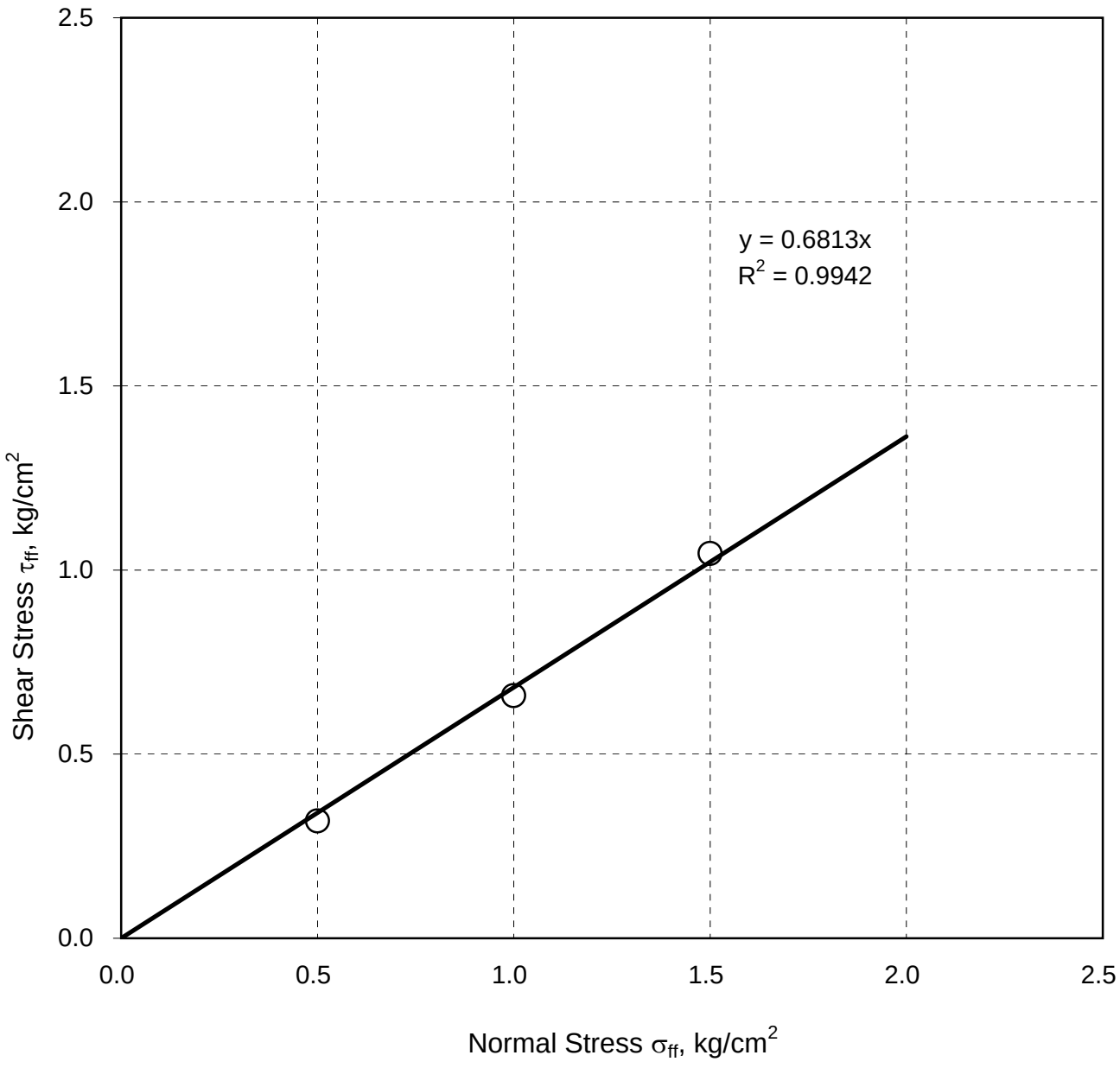
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 15	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 1	**Sample Depth: 8.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS	
Sample No.:	UDS3
Type of Sample:	Remoulded
Dry Density of Soil (g/cm^3):	1.60
Moisture Content (%):	Saturated

TEST RESULTS	
Cohesion Intercept, c (kg/cm^2):	0.00
Angle of Internal Friction, ϕ (degrees):	34.3



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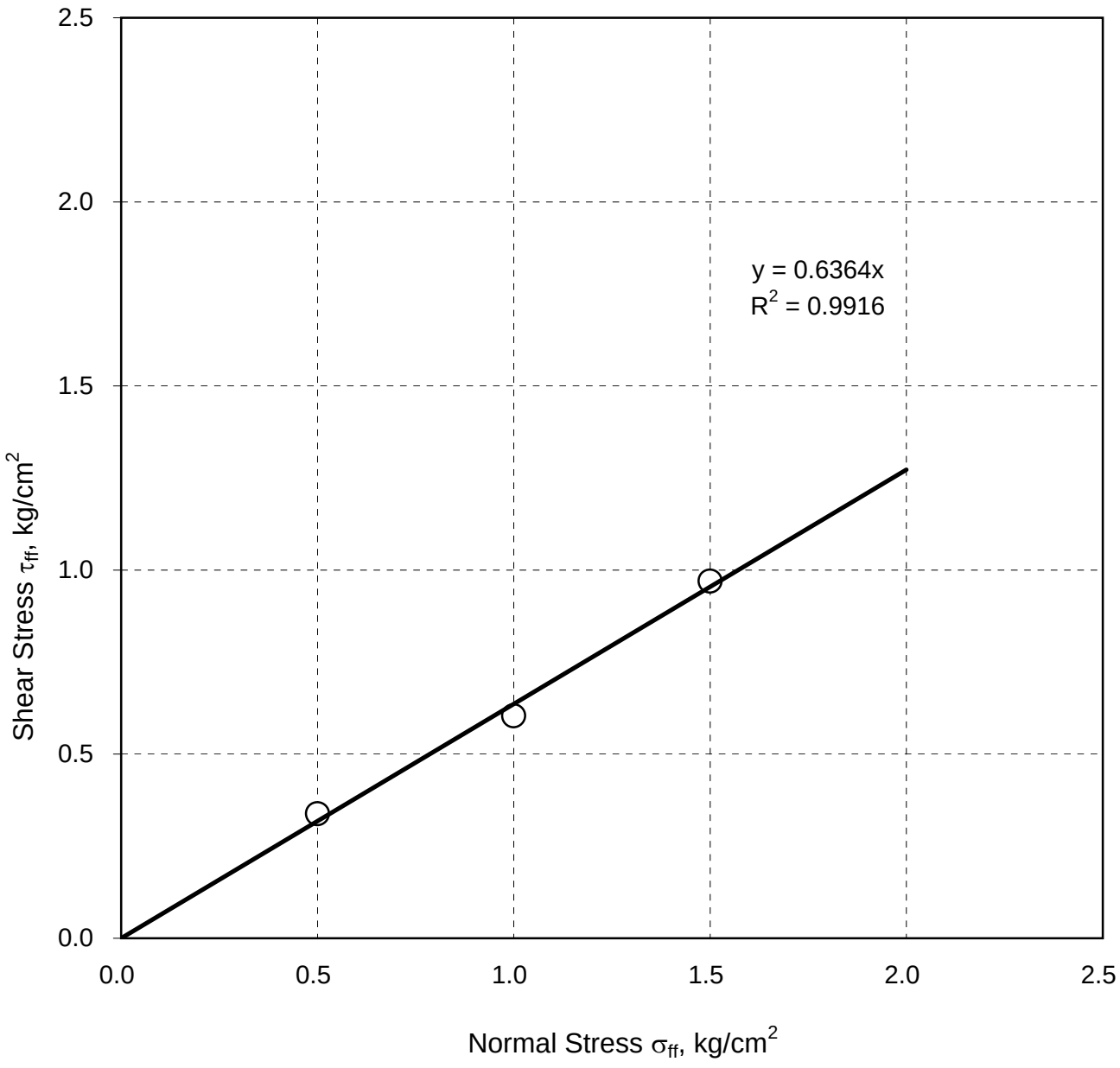
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 16	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 2	**Sample Depth: 5.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS2	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	32.5
Dry Density of Soil (g/cm^3):	1.60		
Moisture Content (%):	Saturated		



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Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

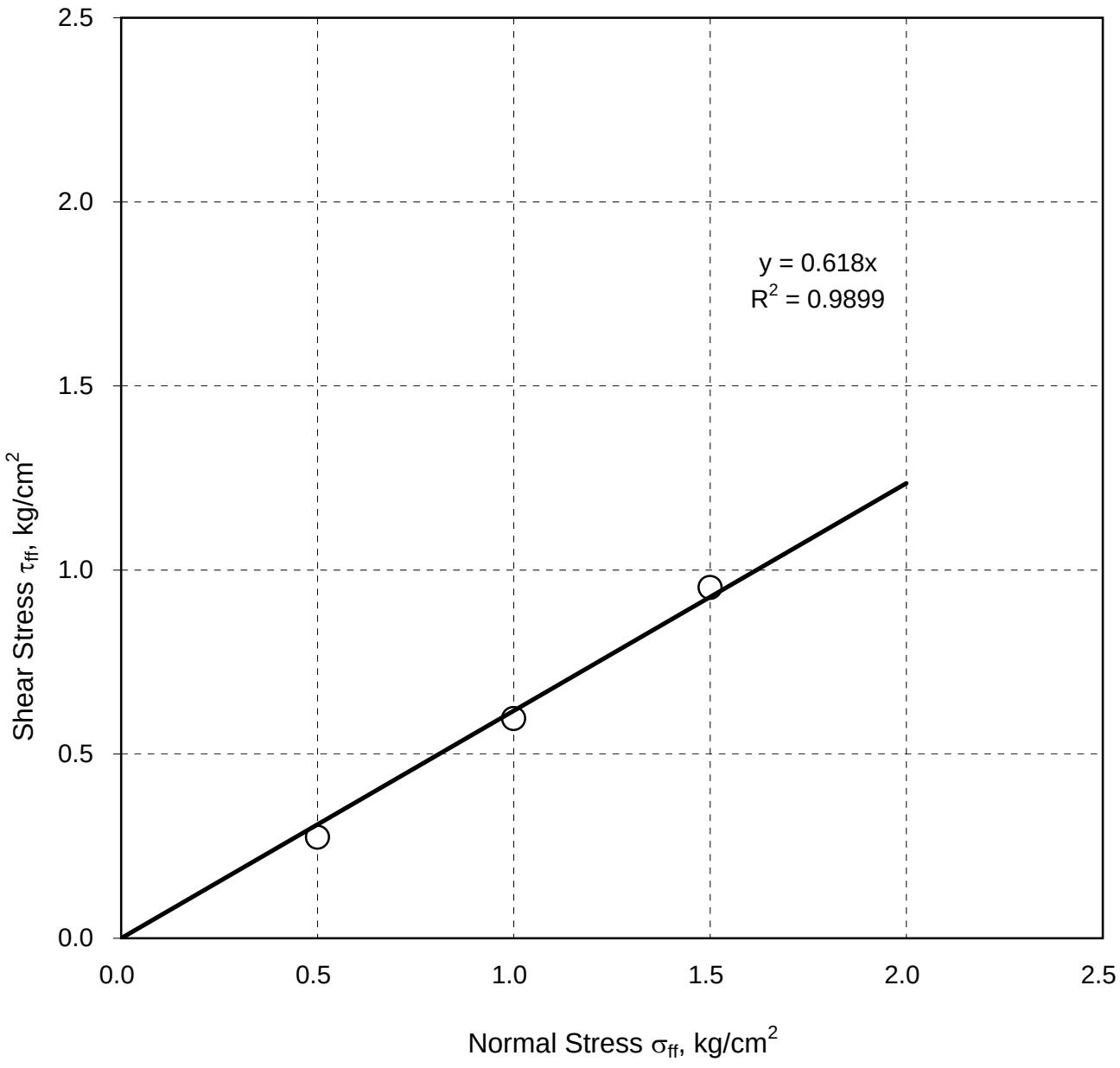
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 17	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 2	**Sample Depth: 11.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	
Sample No.:	UDS4
Type of Sample:	Remoulded
Dry Density of Soil (g/cm^3):	1.52
Moisture Content (%):	Saturated

TEST RESULTS	
Cohesion Intercept, c (kg/cm^2):	0.00
Angle of Internal Friction, ϕ (degrees):	31.7



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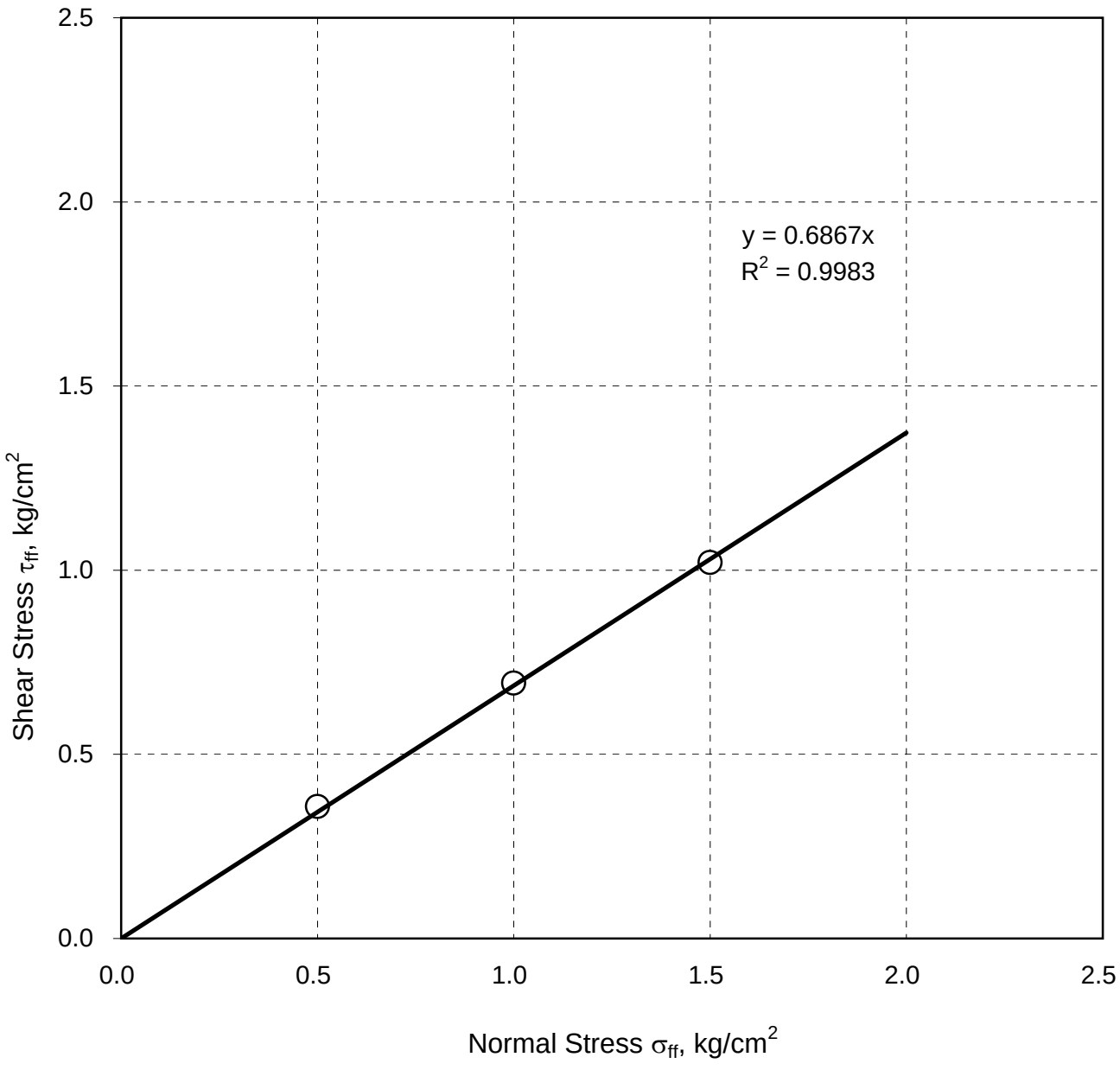
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 18	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 3	**Sample Depth: 2.25 m**	*Sample Description: Silty fine sand with gravel*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS1	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	34.5
Dry Density of Soil (g/cm^3):	1.61		
Moisture Content (%):	Saturated		



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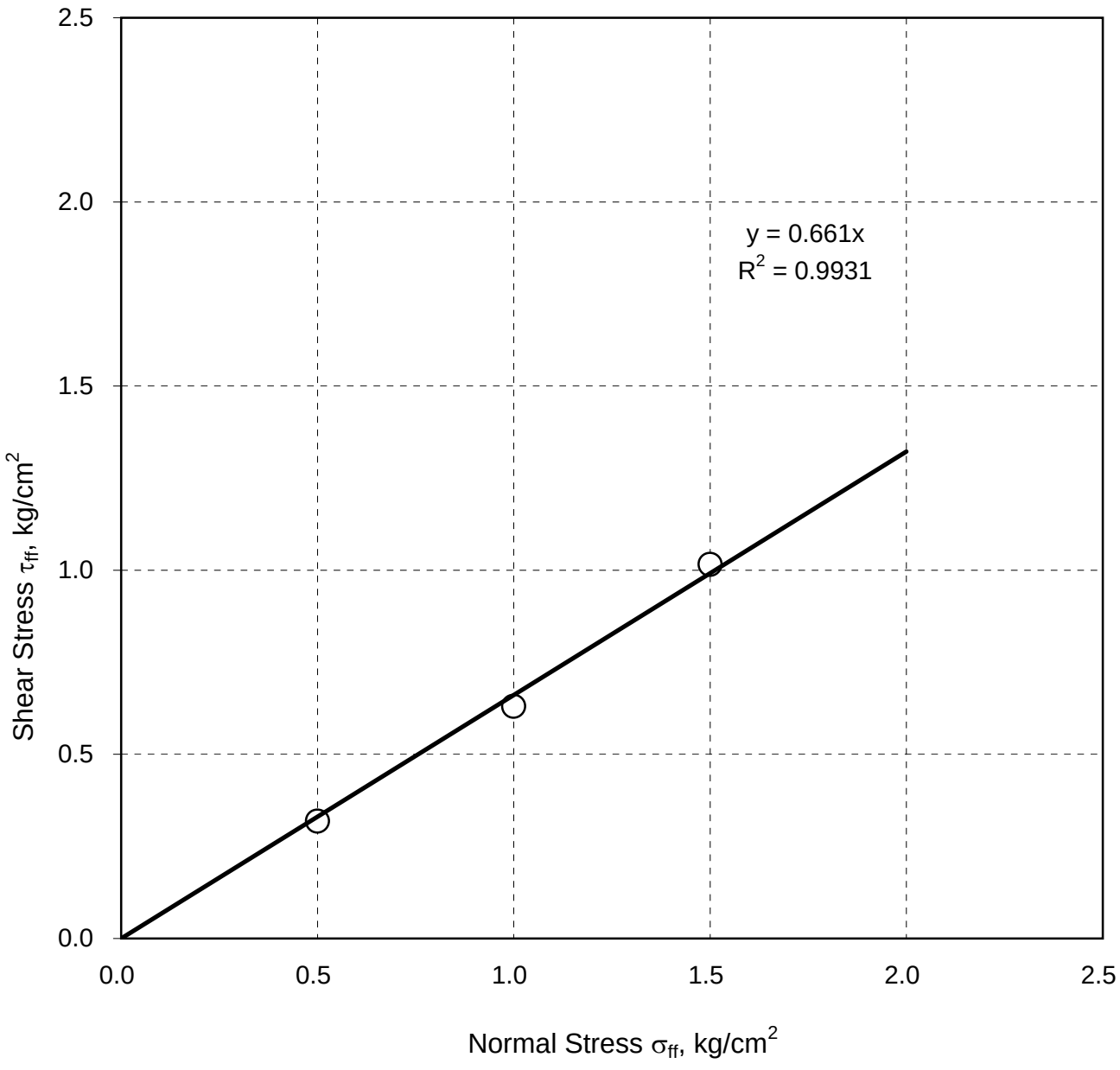
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 19	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 3	**Sample Depth: 8.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS3	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	33.5
Dry Density of Soil (g/cm^3):	1.62		
Moisture Content (%):	Saturated		



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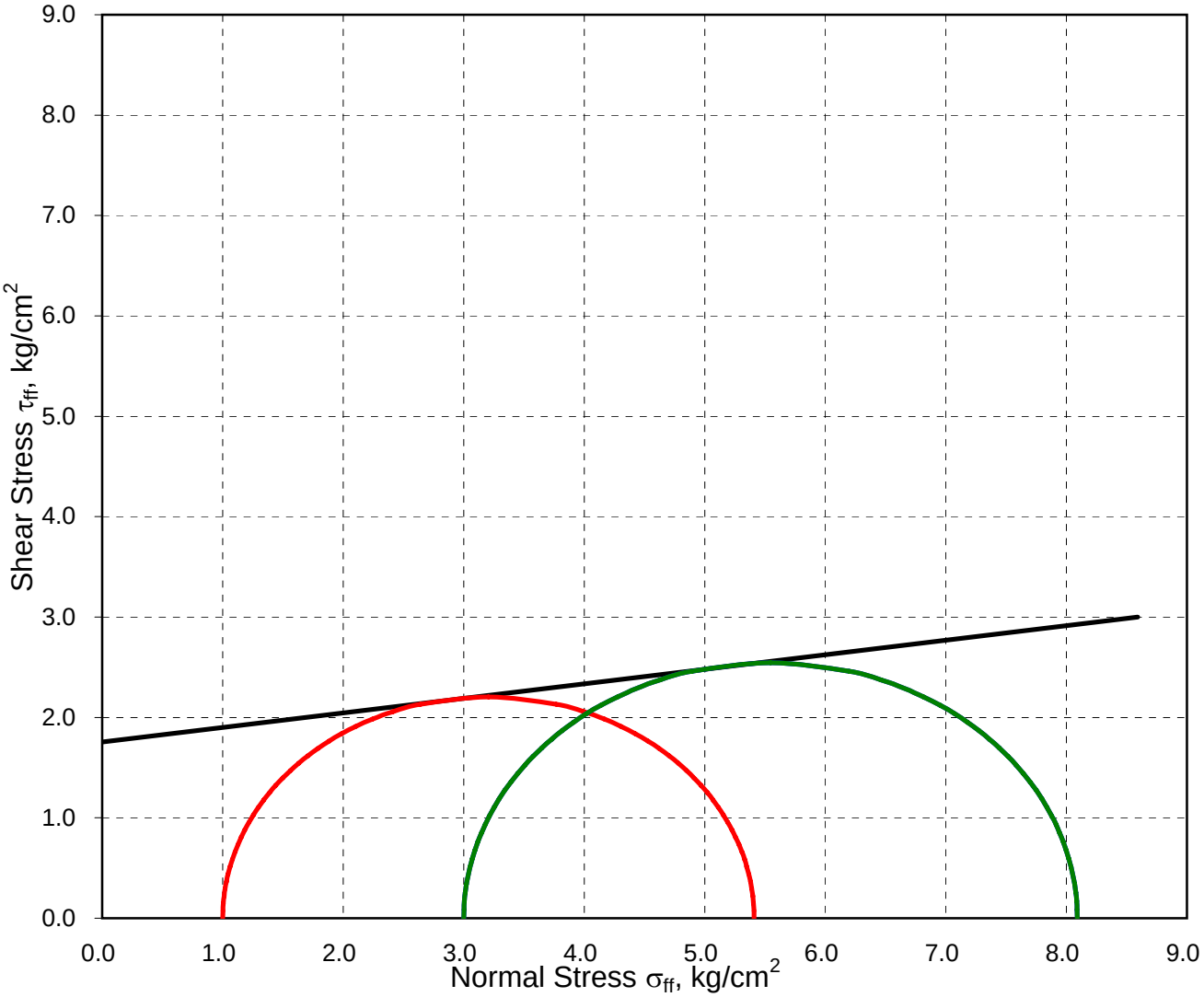
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 20	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-3 **Sample Depth: 11.25 m** *Sample Description: Sandy Silt*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS4	UDS4	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	4.41	5.09	
	Failure Strain, ε_f (%):	10.5	10.5	
	Cohesion Intercept, c:	**1.80**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**8.3**	**degrees**	



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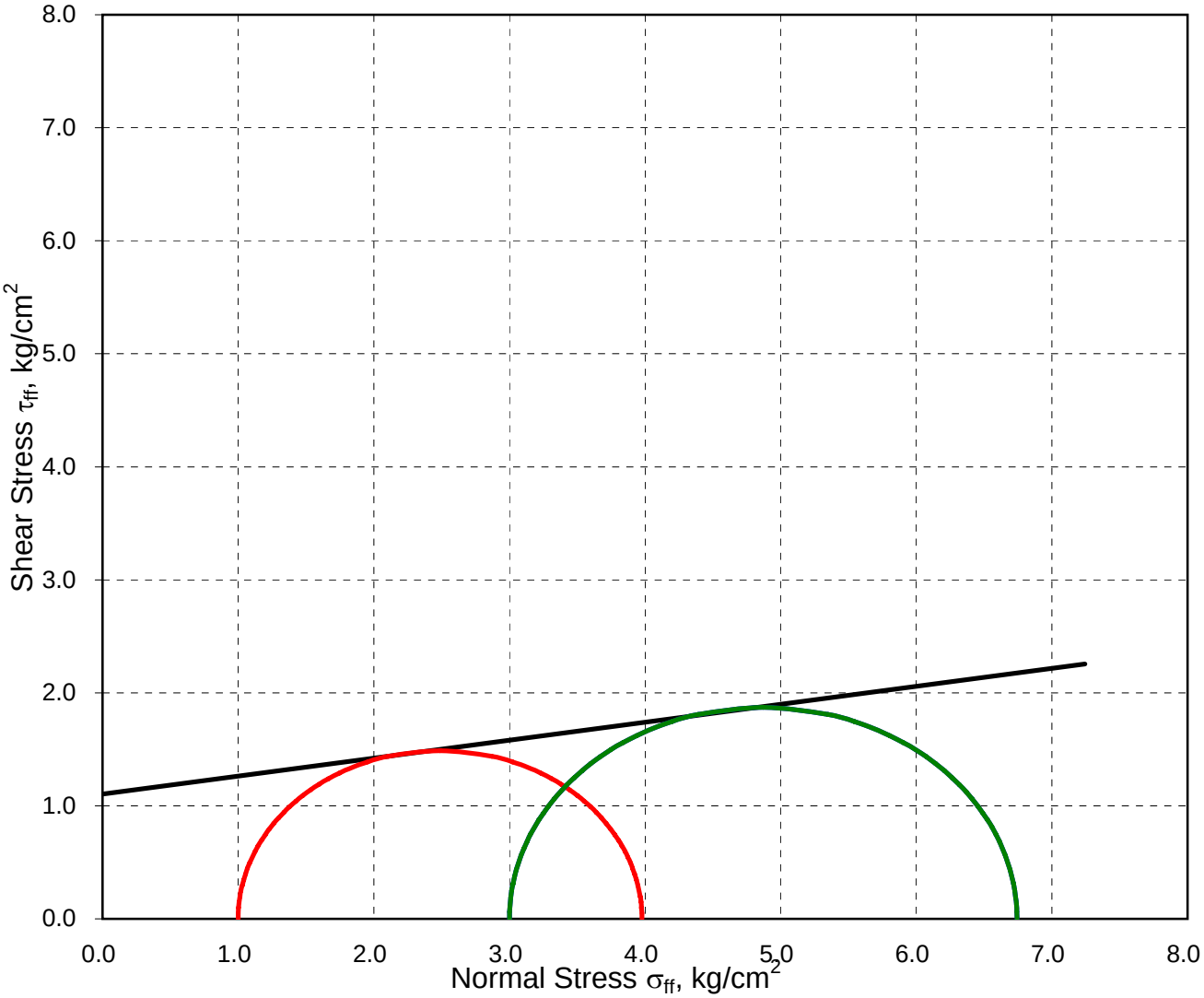
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 21	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-5	**Sample Depth: 5.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS2	UDS2	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	2.98	3.74	
	Failure Strain, ε_f (%):	6.6	9.2	
	Cohesion Intercept, c:	**1.10**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**9.1**	**degrees**	



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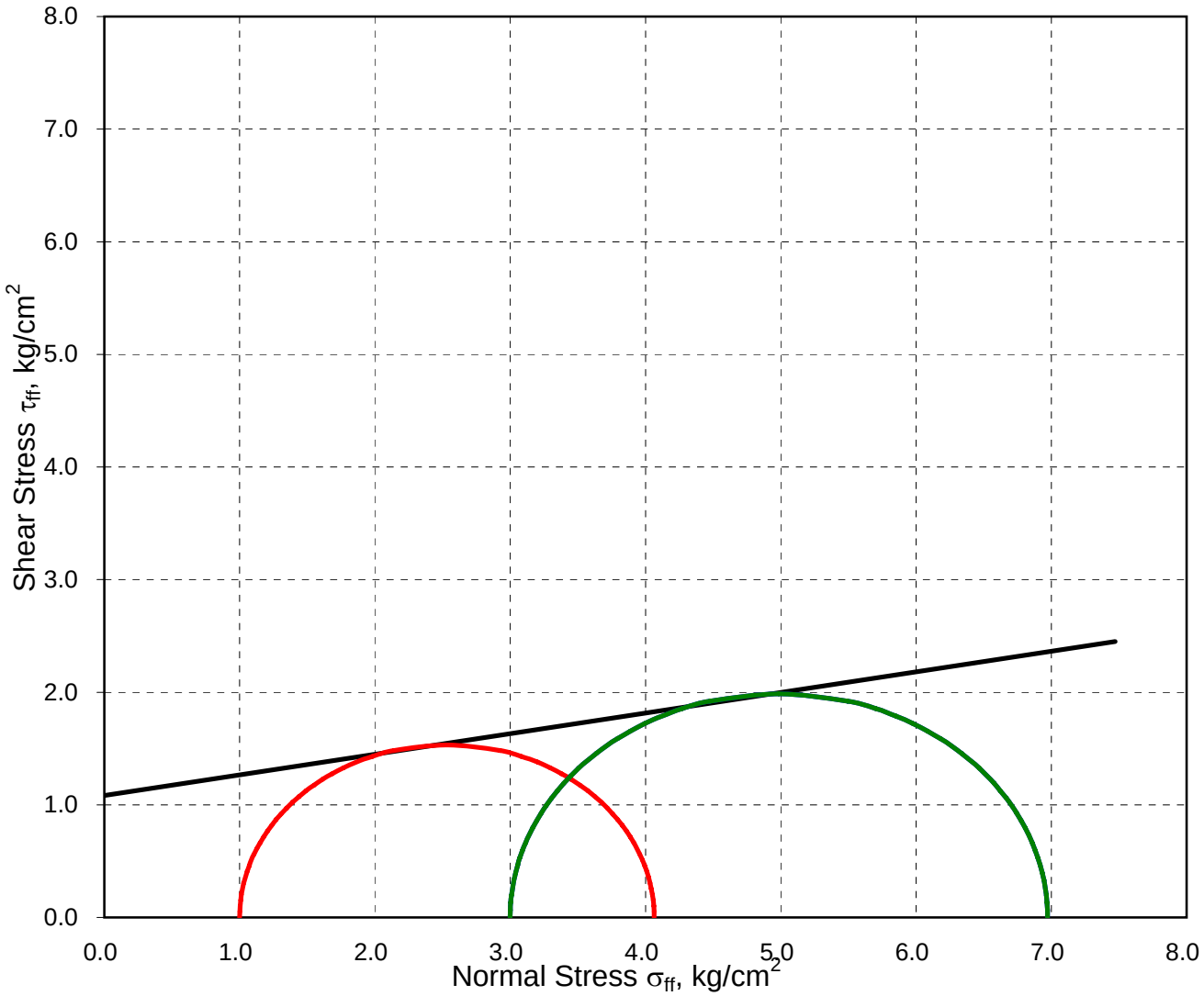
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 22	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-5	**Sample Depth: 11.25 m**	*Sample Description: Clayey silt with traces of gravel*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS4	UDS4	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	3.06	3.97	
	Failure Strain, ε_f (%):	17.1	10.5	
	Cohesion Intercept, c:	**1.10**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**10.5**	**degrees**	



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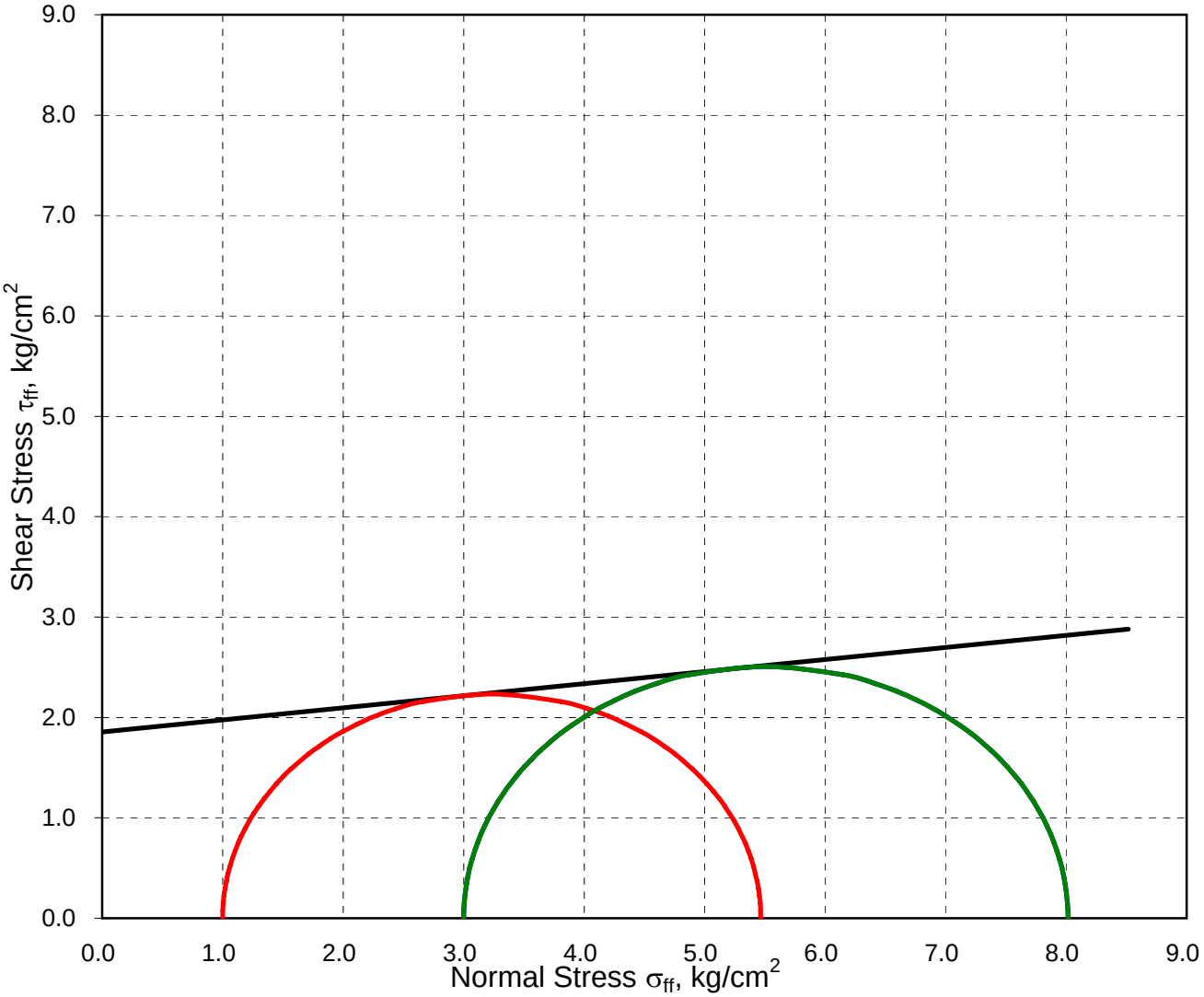
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 23	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-6	**Sample Depth: 2.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS1	UDS1	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	4.47	5.02	
	Failure Strain, ε_f (%):	10.5	11.8	
	Cohesion Intercept, c:	**1.90**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**6.9**	**degrees**	



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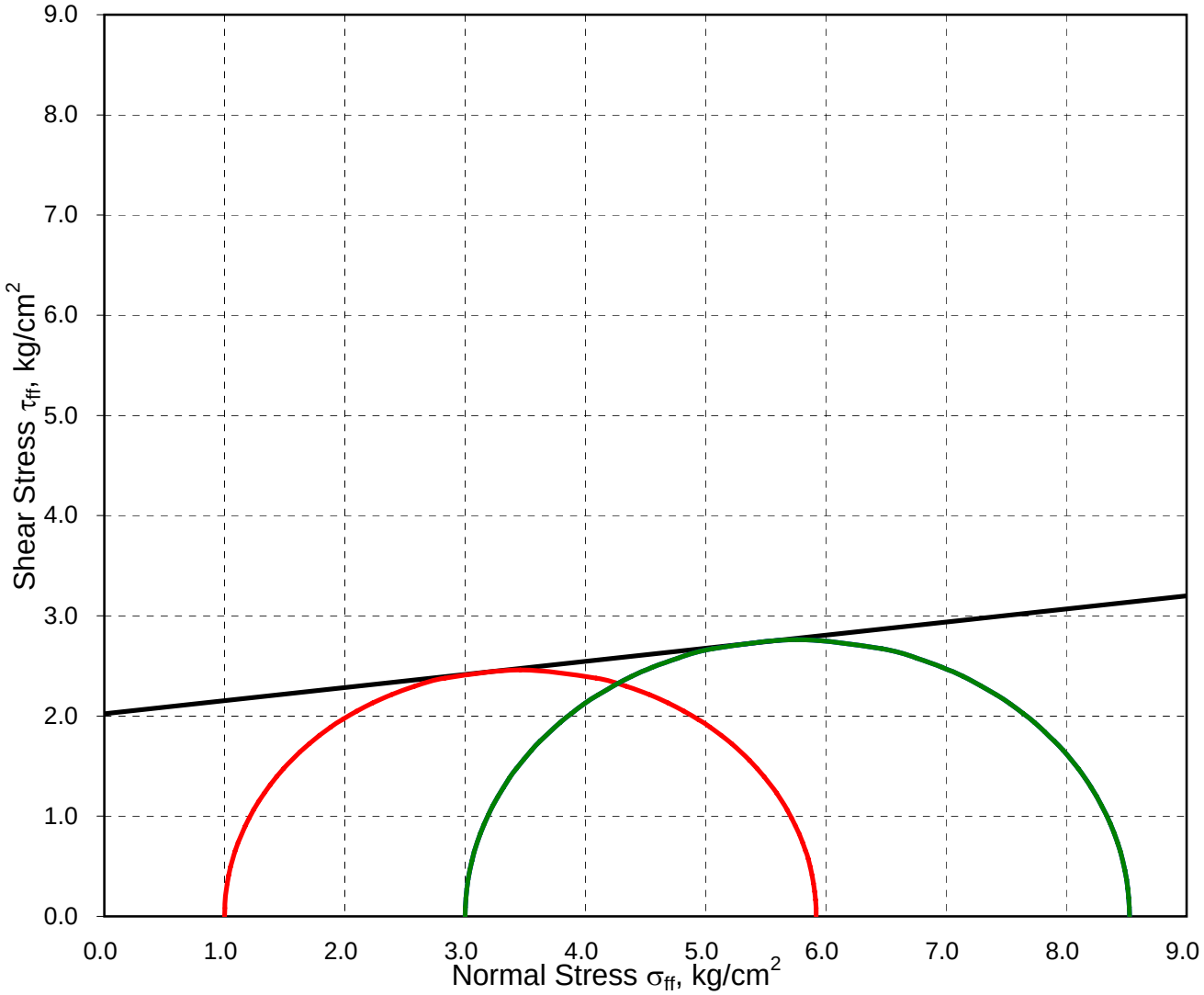
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 24	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-6	**Sample Depth: 8.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS3	UDS3	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	4.92	5.53	
	Failure Strain, ε_f (%):	10.5	10.5	
	Cohesion Intercept, c:	**2.00**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**7.5**	**degrees**	



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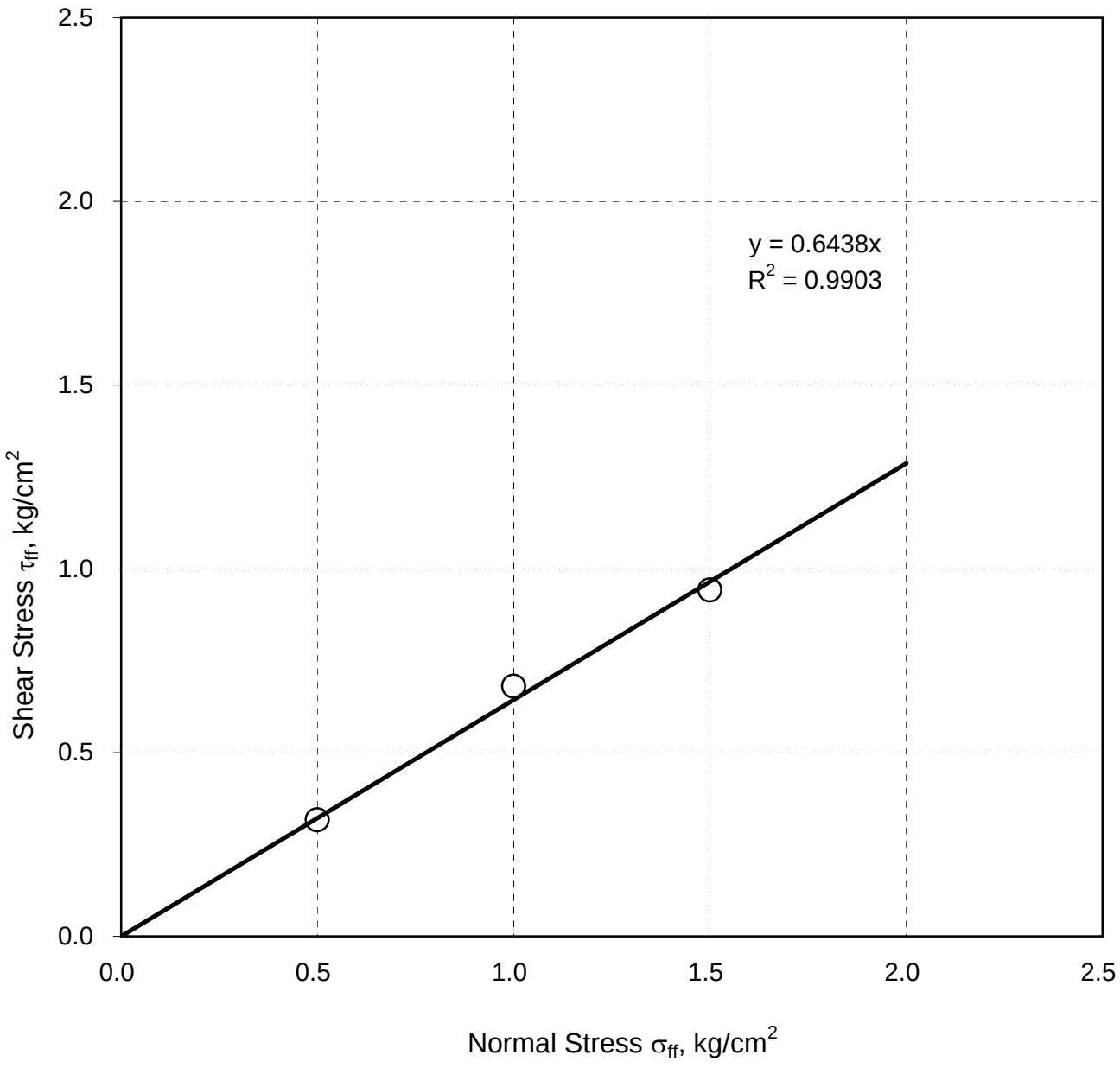
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 25	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 7	**Sample Depth: 5.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS2	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	32.8
Dry Density of Soil (g/cm^3):	1.60		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

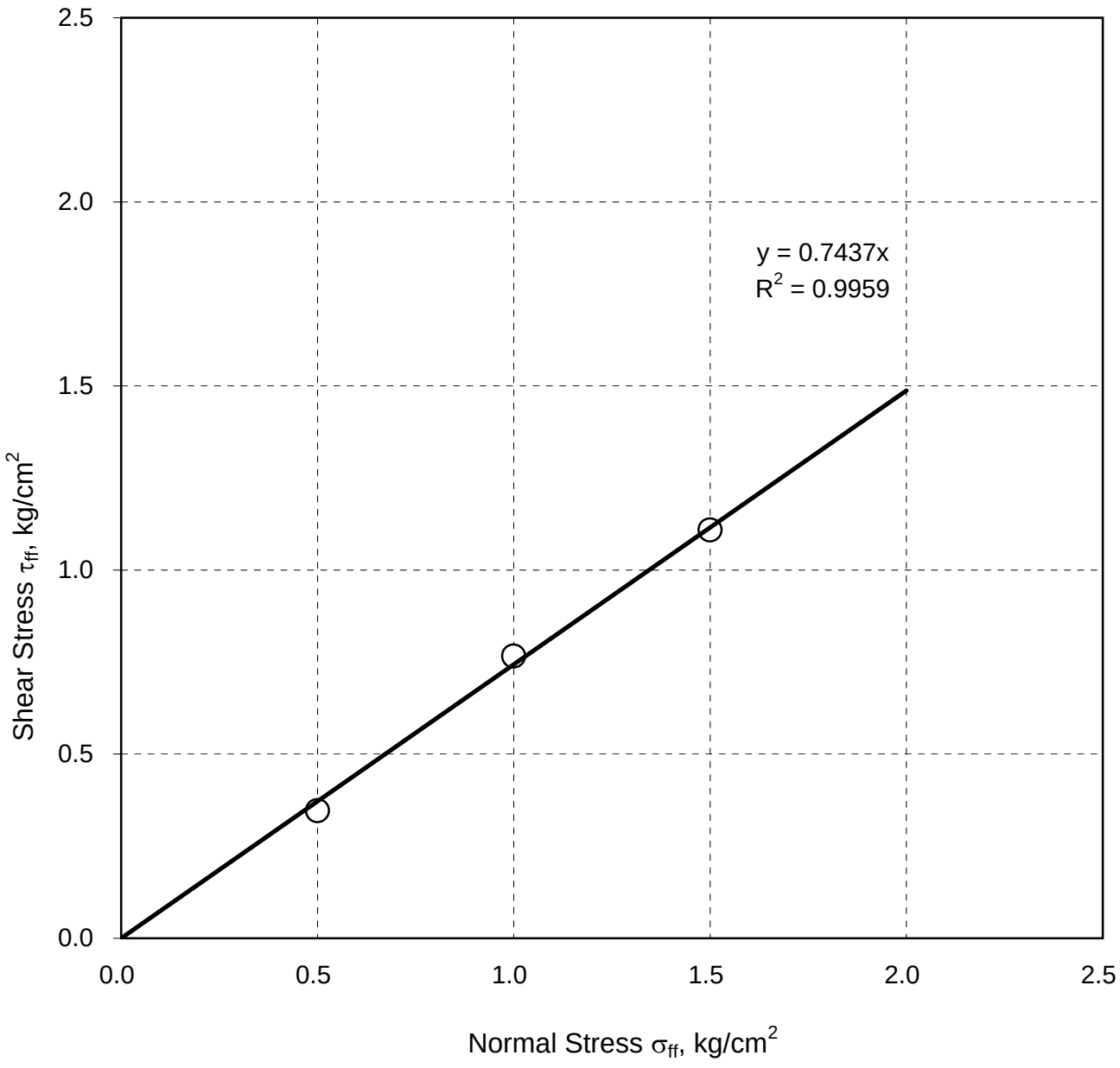
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 26	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 7	**Sample Depth: 11.25 m**	*Sample Description: Silty fine sand with traces of gravel*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS4	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	36.6
Dry Density of Soil (g/cm^3):	1.62		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

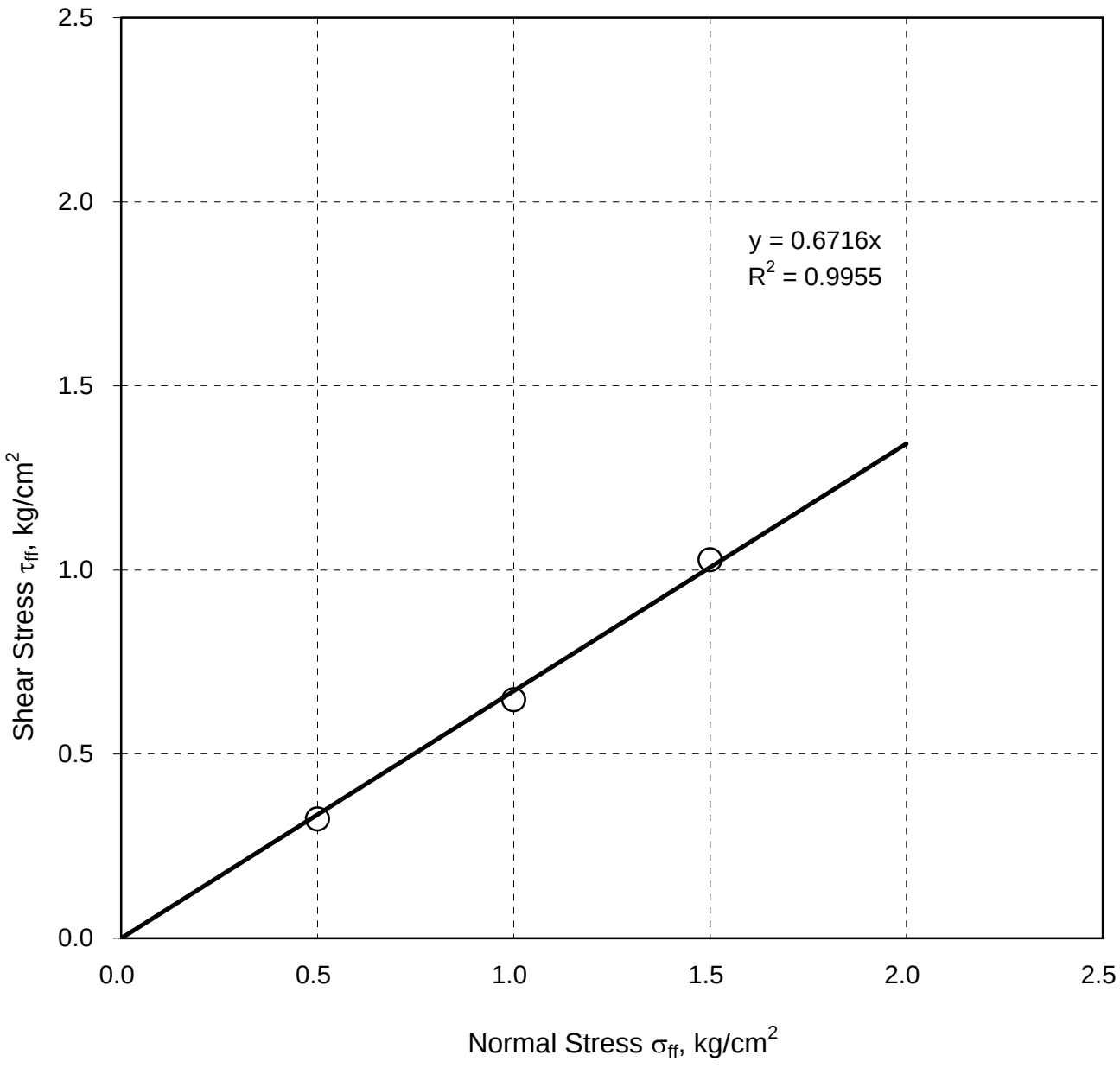
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 27	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 8	**Sample Depth: 2.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS1	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	33.9
Dry Density of Soil (g/cm^3):	1.57		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

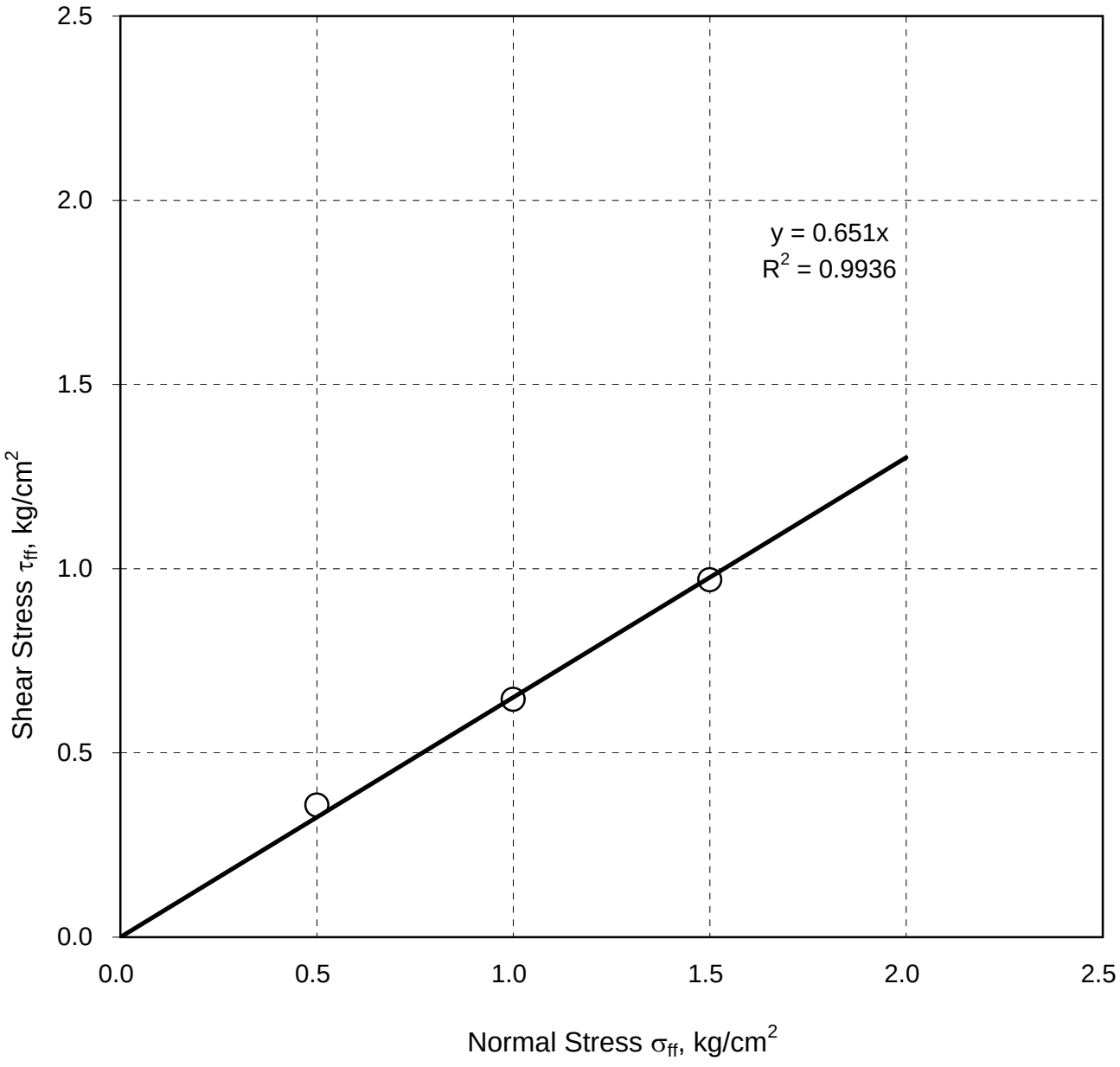
	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 28	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 8	**Sample Depth: 8.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	
Sample No.:	UDS3
Type of Sample:	Remoulded
Dry Density of Soil (g/cm^3):	1.60
Moisture Content (%):	Saturated

TEST RESULTS	
Cohesion Intercept, c (kg/cm^2):	0.00
Angle of Internal Friction, ϕ (degrees):	33.1



Mohr-Coulomb Failure Envelope

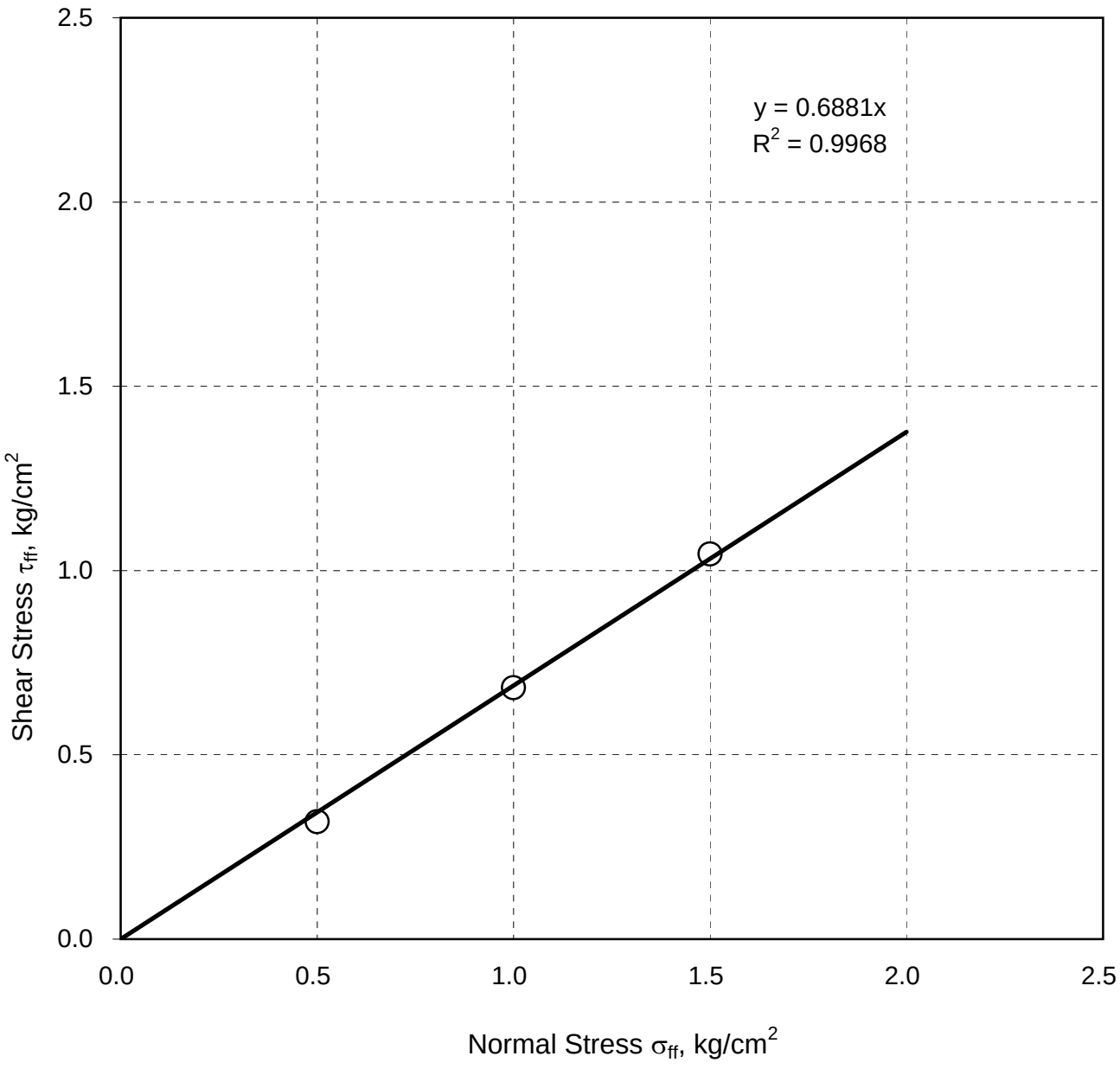
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 29	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 9	**Sample Depth: 5.25 m**	*Sample Description: Silty fine sand*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS2	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	34.5
Dry Density of Soil (g/cm^3):	1.61		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

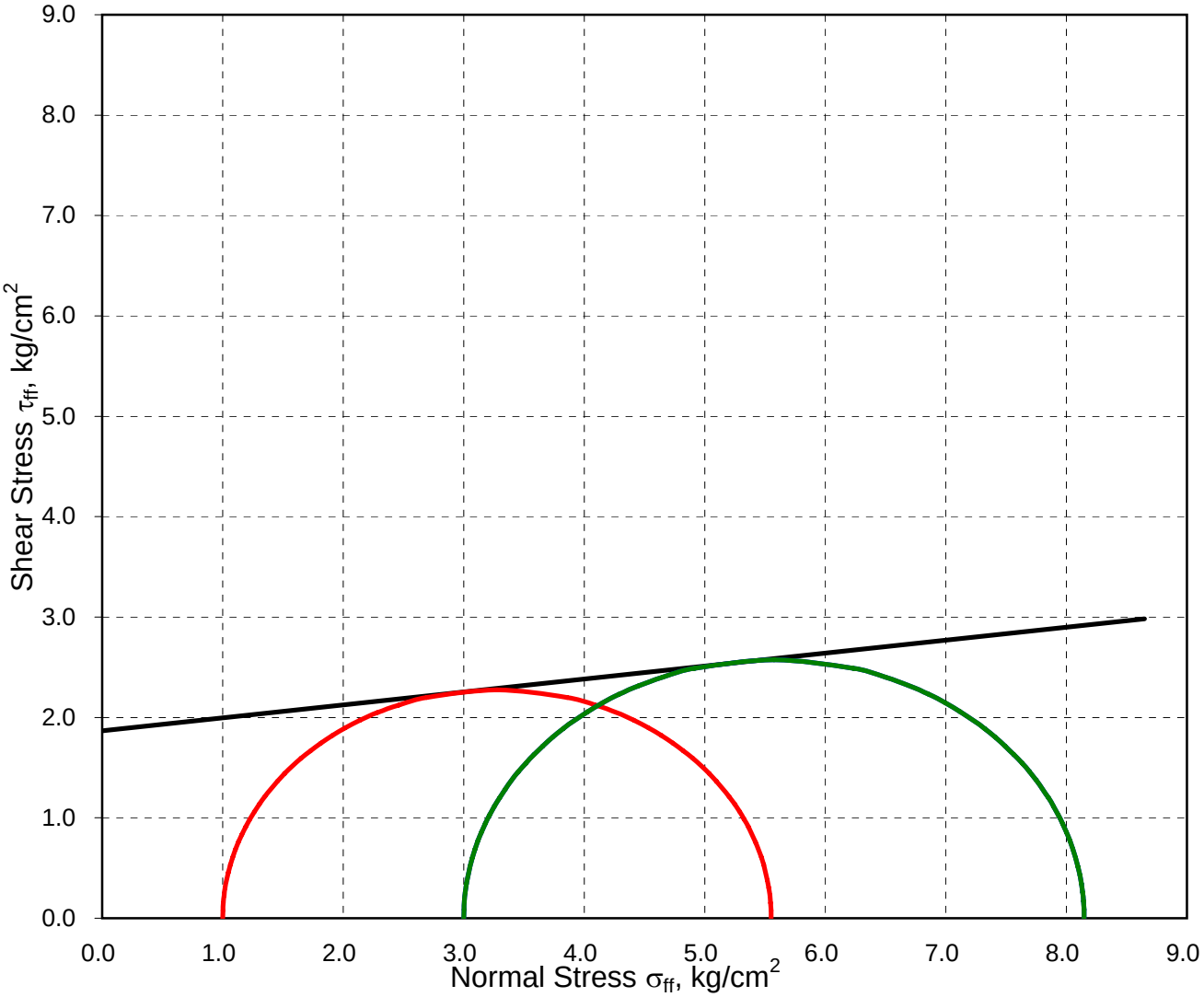
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 30	Certificate No.T-1741

Unconsolidated Undrained Triaxial Test on an Undisturbed Soil Sample

Borehole: BH-9	**Sample Depth: 11.25 m**	*Sample Description: Sandy silt with traces of gravel*

SAMPLE DETAILS	Confining Pressure, σ_0 (kg/cm^2):	1.0	3.0	
	Sample No.:	UDS4	UDS4	
	Sample Type:	Undisturbed	Undisturbed	
	Initial diameter (cm):	3.80	3.80	
	Initial Length (cm):	7.6	7.6	
TEST RESULTS	Peak Deviator Stress, $(\sigma_3-\sigma_1)_f$ (kg/cm^2):	4.55	5.15	
	Failure Strain, ε_f (%):	9.2	10.5	
	Cohesion Intercept, c:	**1.90**	**kg/cm^2**	
	Angle of Internal Friction, ϕ:	**7.4**	**degrees**	



Mohr-Coulomb Failure Envelope

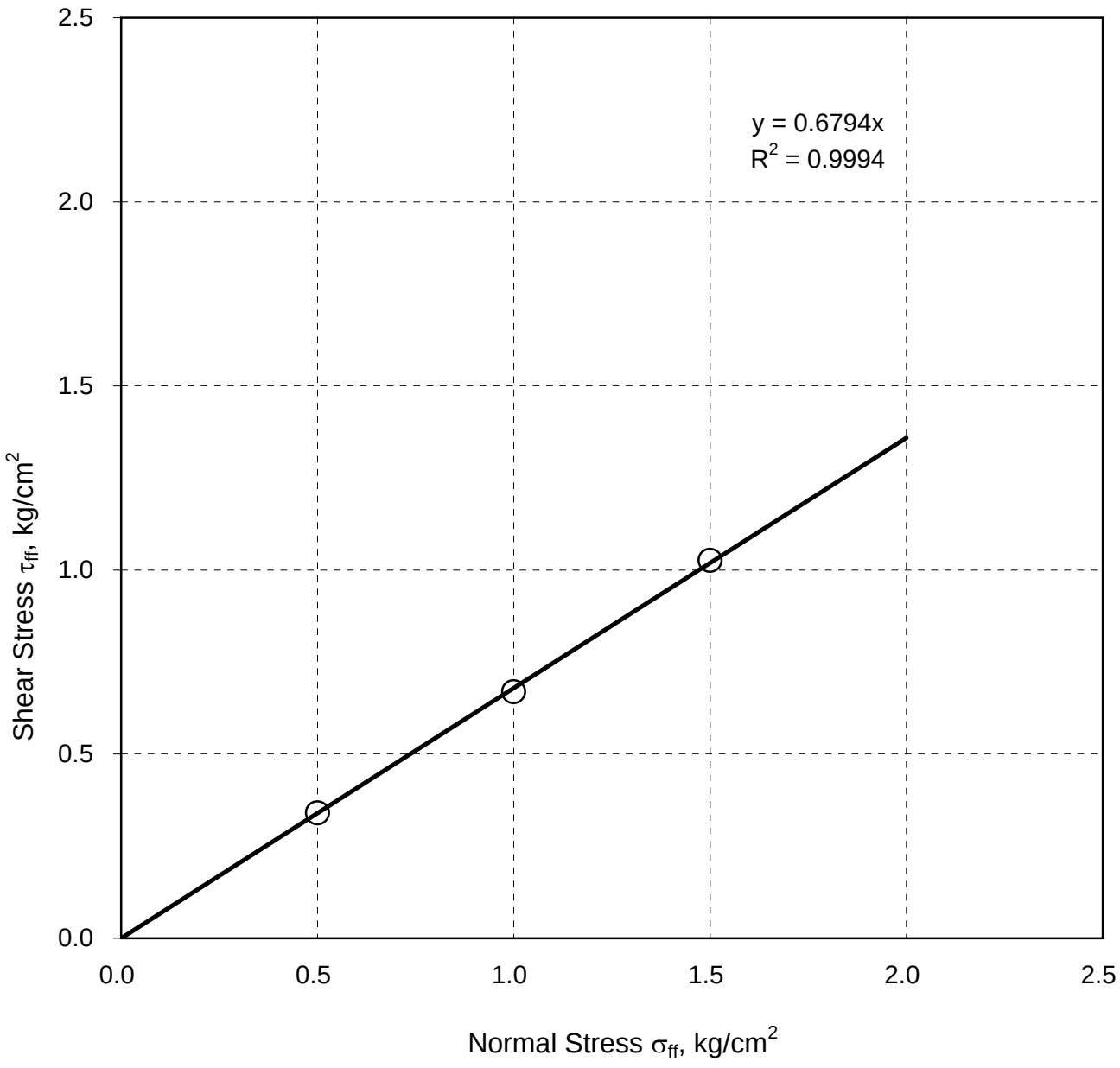
Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

	LABORATORY: CENGRS GEOTECHNICA PVT. LTD. An ISO /IEC: 17025-2005 accredited Laboratory	Job No.: 212073-A	Fig No.: 31	Certificate No.T-1741

Drained Direct Shear Test on Soil

Borehole No: 10	**Sample Depth: 8.25 m**	*Sample Description: Silty fine sand with traces of gravel*

SAMPLE DETAILS		TEST RESULTS	
Sample No.:	UDS3	Cohesion Intercept, c (kg/cm^2):	0.00
Type of Sample:	Remoulded	Angle of Internal Friction, ϕ (degrees):	34.2
Dry Density of Soil (g/cm^3):	1.61		
Moisture Content (%):	Saturated		



Mohr-Coulomb Failure Envelope

Environmental Regulatory Training Institute at Nimli, Alwar (RJ)

TYPICAL CALCULATIONS

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-1, BH-6 & BH-10

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cNc\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity — c = cohesion intercept
q = overburden pressure — B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor — FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 30.0 degrees GENERAL SHEAR FAILURE
c' = 0.00 T/m^2 ϕ'= 21.1 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 30.14 N_q = 18.40 N_γ = 22.40
Local Shear Failure : N_c' = 15.87 N_q' = 7.11 N_γ' = 6.24

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	3.0	1.70
3.0	6.0	1.80
6.0	9.0	1.90
9.0	12.0	2.00

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET
R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60
Depth factor to be considered ? Y
For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 1.5 m
FAILURE CRITERIA : **GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
2.0	**2.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00				28.7		**28.7**	31.3
3.0	**3.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00				32.6		**32.6**	35.1
2.0	**2.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.17	1.09	1.09				46.9		**46.9**	51.1
3.0	**3.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.12	1.06	1.06				49.7		**49.7**	54.0

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-6 Basement

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cN_c\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity; c = cohesion intercept
q = overburden pressure; B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor; FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 32.0 degrees GENERAL SHEAR FAILURE
c' = 0.00 T/m^2 ϕ'= 22.6 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 35.49 N_q = 23.18 N_γ = 30.21
Local Shear Failure : N_c' = 17.59 N_q' = 8.33 N_γ' = 7.77

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	2.5	
2.5	3.0	1.70
3.0	6.0	1.80
6.0	9.0	1.90
9.0	12.0	2.00

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET

R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60

Depth factor to be considered ? Y

For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 2.5 m

FAILURE CRITERIA : **GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
2.0	**2.0**	*Square*	**4.0**	0.60	1.30	1.20	0.80	1.27	1.14	1.14				43.9		**43.9**	46.5
3.0	**3.0**	*Square*	**4.0**	0.60	1.30	1.20	0.80	1.18	1.09	1.09				48.1		**48.1**	50.8

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH-1,BH-6,BH 10

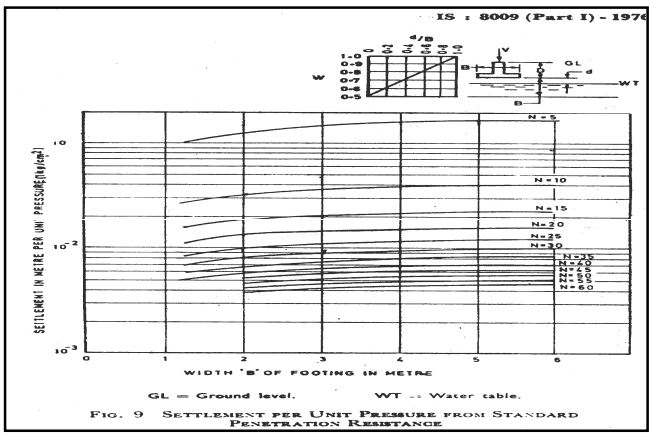


FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 1.5 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_r	Computed Settlement, mm
3.0	3.0	1.5	Square	20.0	**21.0**	14.0	0.60	1.00	1.0	49.1
6.0	6.0	1.5	Square	20.0	**21.0**	15.4	0.60	1.00	0.8	43.1
3.0	3.0	2.5	Square	21.0	**24.0**	13.3	0.60	0.91	1.0	48.3
6.0	6.0	2.5	Square	21.0	**24.0**	14.6	0.60	0.96	0.8	44.7

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH-6 Basement

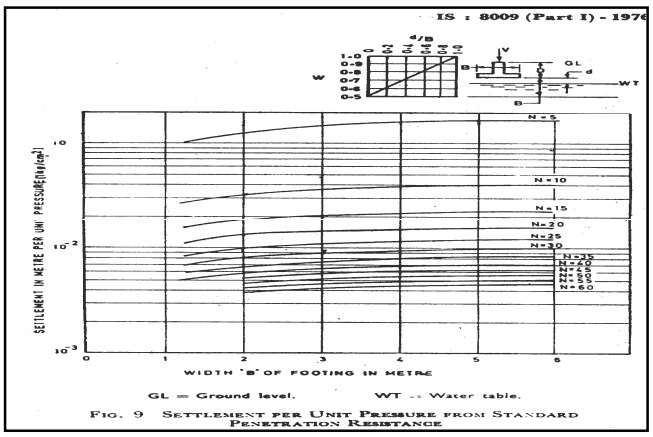


FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 2.5 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_r	Computed Settlement, mm
3.0	3.0	4.0	Square	25.0	**30.0**	10.8	0.60	0.85	1.0	46.1
6.0	6.0	4.0	Square	25.0	**30.0**	11.9	0.60	0.94	0.8	44.8

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-4 Basement

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cNc\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity
c = cohesion intercept
q = overburden pressure
B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor
FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 33.0 degrees GENERAL SHEAR FAILURE

c' = 0.00 T/m^2 ϕ'= 23.4 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 38.64 N_q = 26.09 N_γ = 35.19

Local Shear Failure : N_c' = 18.56 N_q' = 9.03 N_γ' = 8.69

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	2.0	
2.0	6.0	1.75
6.0	9.0	1.85
9.0	12.0	1.90

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET

R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60

Depth factor to be considered ? Y

For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 2.0 m

FAILURE CRITERIA : **GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
3.0	**3.0**	*Square*	**3.0**	0.60	1.30	1.20	0.80	1.12	1.06	1.06				41.2		**41.2**	42.9
6.0	**6.0**	*Square*	**3.0**	0.60	1.30	1.20	0.80	1.06	1.03	1.03				59.3		**59.3**	61.1

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH-4 Basement

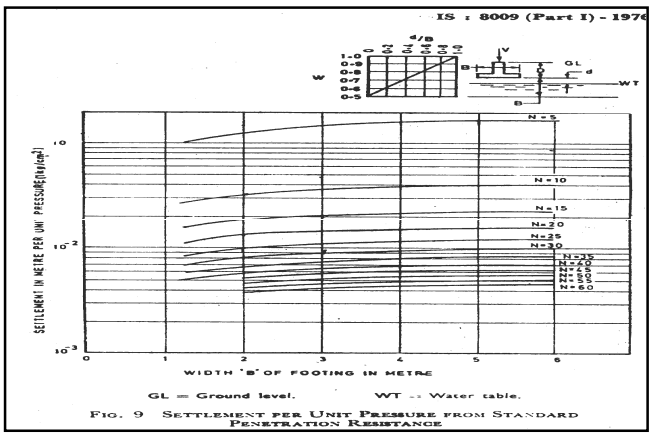


FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 2.0 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_f	Computed Settlement, mm
3.0	3.0	3.0	Square	50.0	**30.0**	5.1	0.60	0.91	1.0	23.1
6.0	6.0	3.0	Square	50.0	**30.0**	5.6	0.60	0.96	0.8	21.4

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-2,BH 3,BH 7and BH 8

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cN_c\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity — c = cohesion intercept
q = overburden pressure — B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor — FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 30.0 degrees GENERAL SHEAR FAILURE
c' = 0.00 T/m^2 ϕ'= 21.1 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 30.14 N_q = 18.40 N_γ = 22.40
Local Shear Failure : N_c' = 15.87 N_q' = 7.11 N_γ' = 6.24

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	3.0	1.70
3.0	6.0	1.80
6.0	9.0	1.90
9.0	12.0	2.00

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET
R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60
Depth factor to be considered ? Y
For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 1.5 m
FAILURE CRITERIA : **AVERAGE OF LOCAL & GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
2.0	**2.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00	1.00	1.00	1.00	28.7	9.5	**19.1**	21.7
3.0	**3.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00	1.00	1.00	1.00	32.6	10.6	**21.6**	24.2
2.0	**2.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.17	1.09	1.09	1.15	1.07	1.07	46.9	15.7	**31.3**	35.5
3.0	**3.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.12	1.06	1.06	1.10	1.05	1.05	49.7	16.4	**33.1**	37.3

CENGRS GEOTECHNICA PVT. LTD

NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH-2,BH-3,BH-7 and BH-8

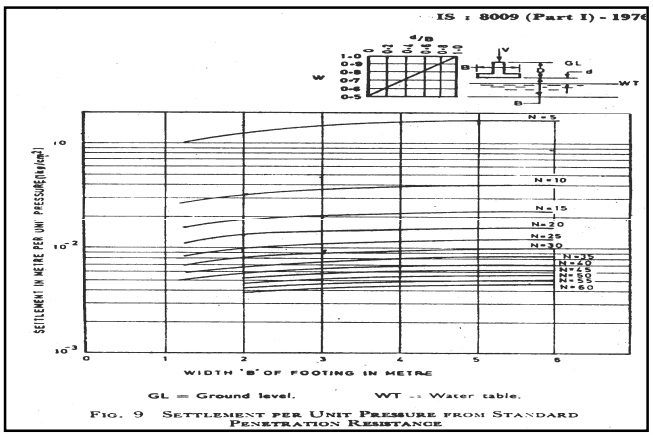


FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 1.5 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_r	Computed Settlement, mm
3.0	3.0	1.5	Square	14.0	**13.5**	21.7	0.60	1.00	1.0	48.8
6.0	6.0	1.5	Square	14.0	**13.5**	23.8	0.60	1.00	0.8	42.9
3.0	3.0	2.5	Square	15.0	**16.5**	19.9	0.60	0.91	1.0	49.8
6.0	6.0	2.5	Square	15.0	**16.5**	21.8	0.60	0.96	0.8	46.1

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NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-5and BH 9

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cNc\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity — c = cohesion intercept
q = overburden pressure — B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor — FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 30.0 degrees GENERAL SHEAR FAILURE
c' = 0.00 T/m^2 ϕ'= 21.1 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 30.14 N_q = 18.40 N_γ = 22.40
Local Shear Failure : N_c' = 15.87 N_q' = 7.11 N_γ' = 6.24

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	3.0	1.70
3.0	6.0	1.80
6.0	9.0	1.90
9.0	12.0	2.00

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET
R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60
Depth factor to be considered ? Y
For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 1.5 m
FAILURE CRITERIA : **GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
3.0	**3.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00				32.6		**32.6**	35.1
6.0	**6.0**	*Square*	**1.5**	0.60	1.30	1.20	0.80	1.00	1.00	1.00				44.5		**44.5**	47.1
2.0	**2.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.17	1.09	1.09				46.9		**46.9**	51.1
3.0	**3.0**	*Square*	**2.5**	0.60	1.30	1.20	0.80	1.12	1.06	1.06				49.7		**49.7**	54.0

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NEW DELHI

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

Analysis as per IS 6403-1981

Project : **Environmental Regulatory Training Institute at Nimli, Alwar, (Raj)**
BH-5 Basement

The bearing capacity equation is as follows :

$$q_{net\ safe} = (1/FS)\{cNc\zeta_c d_c + q(N_q-1)\zeta_q d_q + 0.5B\gamma N_\gamma \zeta_\gamma d_\gamma R_w\}$$

where:

$q_{net\ safe}$ = safe net bearing capacity — c = cohesion intercept
q = overburden pressure — B = Foundation width
γ = Bulk density of soil below founding level
R_w = Water table correction factor — FS = Factor of safety
N_c, N_q, N_γ = bearing capacity factors, which are a function of ϕ
d_c, d_q, d_γ = Depth factors
ζ_c, ζ_q, ζ_γ = Shape factors

Soil parameters :

c = 0.00 T/m^2 ϕ = 30.0 degrees GENERAL SHEAR FAILURE
c' = 0.00 T/m^2 ϕ'= 21.1 degrees LOCAL SHEAR FAILURE

General Shear Failure : N_c = 30.14 N_q = 18.40 N_γ = 22.40
Local Shear Failure : N_c' = 15.87 N_q' = 7.11 N_γ' = 6.24

Bulk Density Profile

Depth, m From	Depth, m To	γ T/m^3
0.0	2.0	
2.0	3.0	1.70
3.0	6.0	1.80
6.0	9.0	1.90
9.0	12.0	2.00

Factor of safety = 2.5 as per IS 1904-1986

Design Water Table depth = NOT MET

R_w factor: Constant value(**V**) for worst condition or calculate(**C**) based on WT Depth ? : V Rw = 0.60

Depth factor to be considered ? Y

For computation of Depth Factor, depth below GL to be ignored to account for loose soils,poorly compacted backfill above foundation, scour etc. = 2.0 m

FAILURE CRITERIA : **GENERAL SHEAR FAILURE**

Foundation Dimensions B, m	Foundation Dimensions L, m	FOUN-DATION SHAPE	Depth,m	R_w	Shape Factors ζ_c	Shape Factors ζ_q	Shape Factors ζ_γ	Depth factors (GSF) d_c	Depth factors (GSF) d_q	Depth factors (GSF) d_γ	Depth factors (LSF) d_c'	Depth factors (LSF) $d_{q'}$	Depth factors (LSF) d_γ'	$q_{net\ safe}$, T/m^2 GSF	$q_{net\ safe}$, T/m^2 LSF	Safe Net Bearing Capacity T/m^2	Gross Bearing Capacity (Safe) T/m^2
3.0	**3.0**	*Square*	**4.0**	0.60	1.30	1.20	0.80	1.23	1.12	1.12				45.8		**45.8**	49.3
6.0	**6.0**	*Square*	**4.0**	0.60	1.30	1.20	0.80	1.12	1.06	1.06				56.6		**56.6**	60.1

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NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH 5 and BH 9

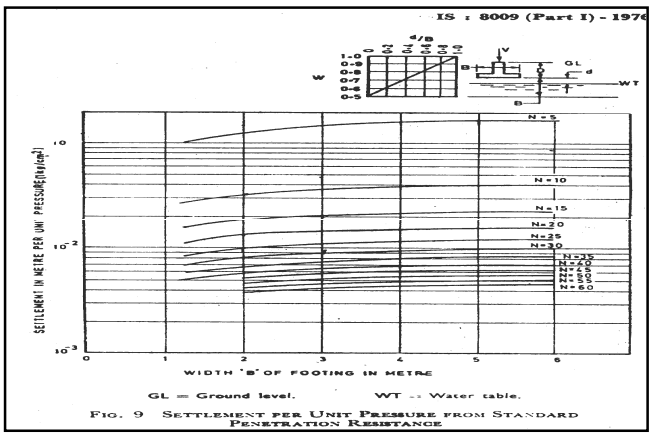

FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 1.5 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_r	Computed Settlement, mm
3.0	3.0	1.5	Square	20.0	**21.0**	14.0	0.60	1.00	1.0	49.1
6.0	6.0	1.5	Square	20.0	**21.0**	15.4	0.60	1.00	0.8	43.1
3.0	3.0	2.5	Square	22.0	**26.0**	12.6	0.60	0.91	1.0	49.5
6.0	6.0	2.5	Square	22.0	**26.0**	13.8	0.60	0.96	0.8	45.9

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NEW DELHI

SETTLEMEMT ANALYSIS FOR SHALLOW FOUNDATIONS BASED ON N - VALUES

Analysis as per IS:8009(Part 1)-1976 , Clause 9.1.4

Project : **Environmental Regulatory Training Institute at Nimli.Alwar.(Raj)**
BH 5 and BH 9

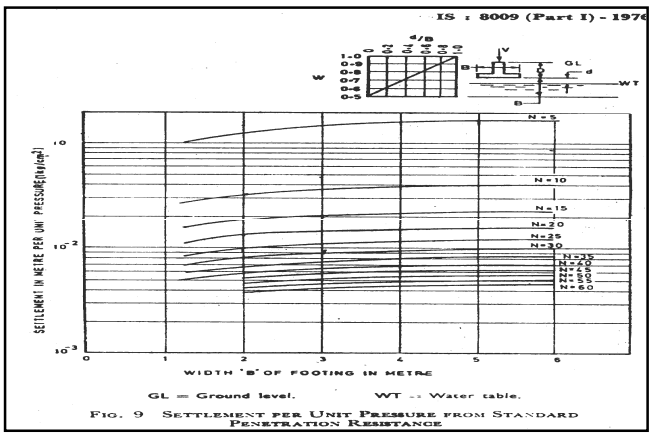

FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

Design Water Table Depth : Not Met

R_w factor : Calculate (**C**) based on water table depth or Fixed Value(**V**) for worst condition : V Rw factor for design : 0.6

Fox's Depth Factor to be considered ? Y

Depth to be ignored in Depth Factor Computation for loose soils, poorly compacted backfill, scour, etc. 2.5 m

Foundation Width,m	Foundation Length,m	Foundation Depth,m	Shape	Design N-Value	Design Net Bearing Pressure, T/m^2	Settlement @ $1kg/cm^2$ (as read off from graph), mm	R_w	Fox's Depth Factor, d_f	Rigidity Factor, d_r	Computed Settlement, mm
3.0	3.0	4.0	Square	24.0	**30.0**	11.4	0.60	0.85	1.0	48.3
6.0	6.0	4.0	Square	24.0	**30.0**	12.5	0.60	0.94	0.8	46.9