DEP Report

SOIL EXPLORATION AND SITE INVESTIGATION REPORT

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1. Introduction

Soil exploration is the cornerstone of geotechnical engineering, providing critical data for safe and economical foundation design. IIT ROPAR, situated in the Rupnagar district of Punjab, lies in the Indo-Gangetic alluvial plains, characterized by heterogeneous soil deposits from the Sutlej River and Shivalik foothills. Understanding local soil properties is essential for infrastructure projects on campus, such as buildings, roads, and drainage systems.

Soil exploration involves the investigation of subsurface soil to determine their engineering properties. The primary objective of soil exploration is to gather comprehensive data on the subsurface conditions, including soil type, density, strength, and other relevant properties.

This information is essential for designing and constructing safe and stable structures, such as buildings, bridges, dams etc. Soil exploration typically involves a combination of field and laboratory tests, including drilling and sampling, in-situ testing, and laboratory analysis of soil samples.

This report summarizes the results of laboratory investigations carried out on soil samples collected from the project site. The focus is on understanding the nature and behavior of both sandy and silty soils in the area. The findings will assist in developing appropriate geotechnical recommendations for construction and site development.

2. Objectives

The objective of this project is to conduct a comprehensive **soil exploration and site investigation** to assess the subsurface conditions and determine the engineering properties of the soil. This investigation aims to:

Evaluate Soil Properties–Determine the physical and mechanical characteristics of the soil, such as grain size distribution, moisture content, shear strength, permeability, and bearing capacity.
Assess Site Suitability – Analyze the site conditions for construction suitability, identifying potential geotechnical challenges such as weak soil layers, groundwater conditions, or expansive soils.
Foundation Design Recommendations–Provide data-driven recommendations for the design and selection of suitable foundation types based on soil strength and stability.
Identify Geotechnical Hazards – Detect possible issues like soil settlement, liquefaction, slope instability,or erosion that may impact construction and long-term structural stability.
Determine Groundwater Conditions–Identify the depth and fluctuation of the water table, which influences foundation design, excavation, and drainage planning.

3. Methodology

The methodology for soil exploration and site investigation involves a systematic approach to assessing the subsurface conditions through field and laboratory investigations. The following steps outline the methodology:

1.Preliminary Study

Study of any past geotechnical reports.
Identification of potential geotechnical issues.

2.Site Reconnaissance (Walkover Survey)

Visual inspection of the site to assess surface conditions, vegetation, drainage patterns, and signs of soil instability.
Identification of accessibility for exploration equipment.

3.FieldInvestigation

Selection of appropriate exploration methods based on project requirements.

a) Sampling

Digging Land: Dig at predetermined locations to obtain soil samples.
Soil Sampling: Collection of soil samples of 1m and 2m depth for laboratory testing.
Standard Penetration Test (SPT): Conducted at different depths to assess soil resistance and bearing capacity.
Cone Penetration Test (CPT): Performed for continuous profiling of soil strength and stratification.

b) Laboratory Testing

Grain Size Analysis: Determines soil classification based on particle size distribution.
Atterberg Limits Test: Establishes plasticity characteristics of fine-grained soils.
Compaction Test (Proctor Test): Evaluates soil compaction and moisture-density relationship.

Unconfined Compression Test: Measures soil resistance to shear stress.

Sandy soil sample were compacted into cylindrical mold with known dimensions.

The specimens were subjected to axial compressive loads using a UCS testing machine.

The peak load at failure was recorded.

Permeability Test: Determines permeability of soil.

A falling head permeability test was conducted

The soil sample was placed in a permeability mold and saturated with water. Water was allowed to flow through the sample under a hydraulic head.

The volume of water collected over a specific time was measured and used to compute the coefficient of permeability.

For Silty Soil (2m depth):

Sieve Analysis:

The silty soil sample was air-dried and passed through a stack of IS sieves to separate coarser particles.

The mass retained on each sieve was measured.

A particle size distribution curve was plotted.

Hydrometer Test: Determines the particle size distribution of fine-grained soils.

The fine fraction of silty soil (passing through the 75-micron sieve) was used.

A suspension was prepared by mixing the soil with water and a dispersing agent.

A hydrometer was used to take readings at various time intervals to measure the relative density of the suspension.

These readings were corrected and used to calculate particle sizes using sedimentation principles and Stokes Law.

4.Work done

The following activities have been completed:

- Soil Sampling from Site: soil samples were collected from two different depths of the proposed construction site.
- Preparation: The soil samples were air-dried and prepared according to IS standards.
- Compressive Strength (UCS) Test on Sandy Soil

- Permeability Test on Sandy soil
- Sieve Analysis on Silty soil
- Hydrometer Analysis on Silty Soil
- Data Processing and Interpretation
- Results were analyzed to interpret the geotechnical behavior of the soils and to aid in site suitability assessment.

5.Findings/Results

UNCONFINED COMPRESSIVE STRENGTH(UCS):

Diameter of specimen (cm)	3.8
Height of specimen (cm), L	7.6
Area (Ao)(Cm2)	11.34114948
Volume (Cm3)	86.19273604
Dry density (g/cc)	1.8
Weight of soil required (g)	155
Optimum moisture content	12.5%
Weight of water required (g)	21.7
Bulk density (g/cc)	2.052

Proving ring constant= 0.006

Least count of dial gauge=0.01

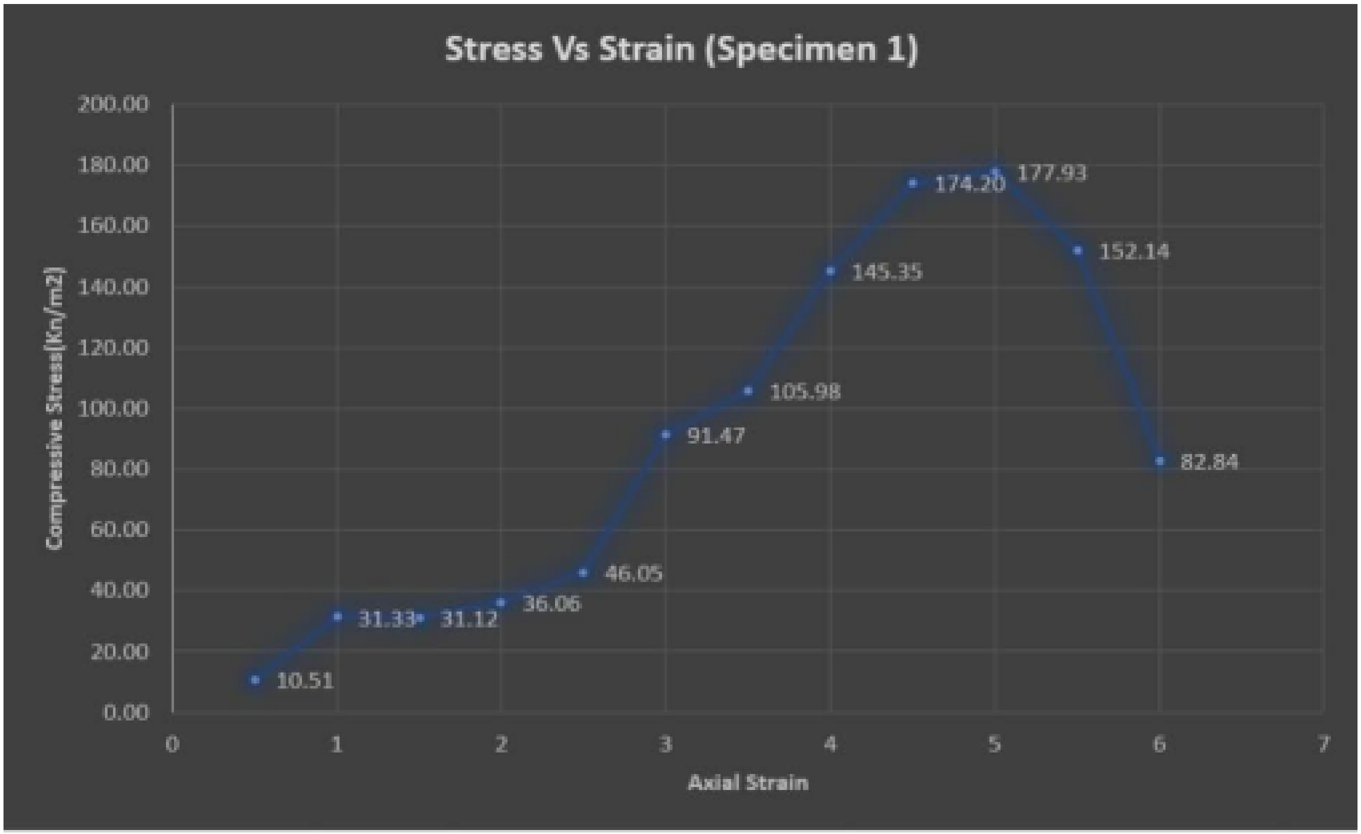
Using Delta L = Dial gauge reading*0.01

Load (KN)= Proving ring division * 0.006

Readings						
Dial Gauge readings (division)	**ΔL (mm) deformation**	**e= (ΔL/L)**	**Ac=(Ao/(1-e)), (m2)**	**Proving ring reading (division)**	**Load (KN)**	**σ= Load/Ac, (KN/m^2)**
50	**0.5**	**0.065789**	**0.001141626**	**2**	**0.012**	**10.51**
100	**1**	**0.131579**	**0.001149236**	**6**	**0.036**	**31.33**
150	**1.5**	**0.197368**	**0.001156949**	**6**	**0.036**	**31.12**
200	**2**	**0.263158**	**0.001164767**	**7**	**0.042**	**36.06**
250	**2.5**	**0.328947**	**0.00117269**	**9**	**0.054**	**46.05**
300	**3**	**0.394737**	**0.001180722**	**18**	**0.108**	**91.47**
350	**3.5**	**0.460526**	**0.001188865**	**21**	**0.126**	**105.98**
400	**4**	**0.526316**	**0.001197121**	**29**	**0.174**	**145.35**
450	**4.5**	**0.592105**	**0.001205493**	**35**	**0.21**	**174.20**
500	**5**	**0.657895**	**0.001213982**	**36**	**0.216**	**177.93**
550	**5.5**	**0.723684**	**0.001222592**	**31**	**0.186**	**152.14**
600	**6**	**0.789474**	**0.001231325**	**17**	**0.102**	**82.84**
Cohesion=σd max/2 (KN/m^2) =177.93/2=88.965						

Unconfined Compressive Strength= 177.93KN/m^2

Cohesion = 88.965 KN/m^2



- Suitable for moderate structures [under100-200]
- Decent strength and moderate bearing capacity (suitable for shallow foundation)

FALLING HEAD PERMEABILITY TEST

Internal Diameter of specimen(D) = 100mm

Height of specimen(H) = 128mm

Internal Diameter of stand pipe(d) = 20mm

Specific Gravity of soil = 2.65

Area of stand pipe(a) = pi d^2/4 = 3.14cm^2

Area of the specimen(A) = pi D^2/4 = 78.5 cm^2

Volume of the specimen(V) = A*H= 1004.8cm^3

Readings				
	Initial Time t1 (sec)	**Final Time t2 (sec)**	**Initial Head h1 (cm)**	**Final Head h2 (cm)**
Sample 1	0	5.3	154	150.5
Sample 2	0	5.3	154	150.4
Sample 3	0	5.25	154	150.7

Using k= 2.303 *log(h1/h2) *(aH/A(t2-t1)

k1 = 2.222*10^-3 cm/sec

k2= 2.285*10^-3cm/sec

k3= 2.112*10^-3cm/sec

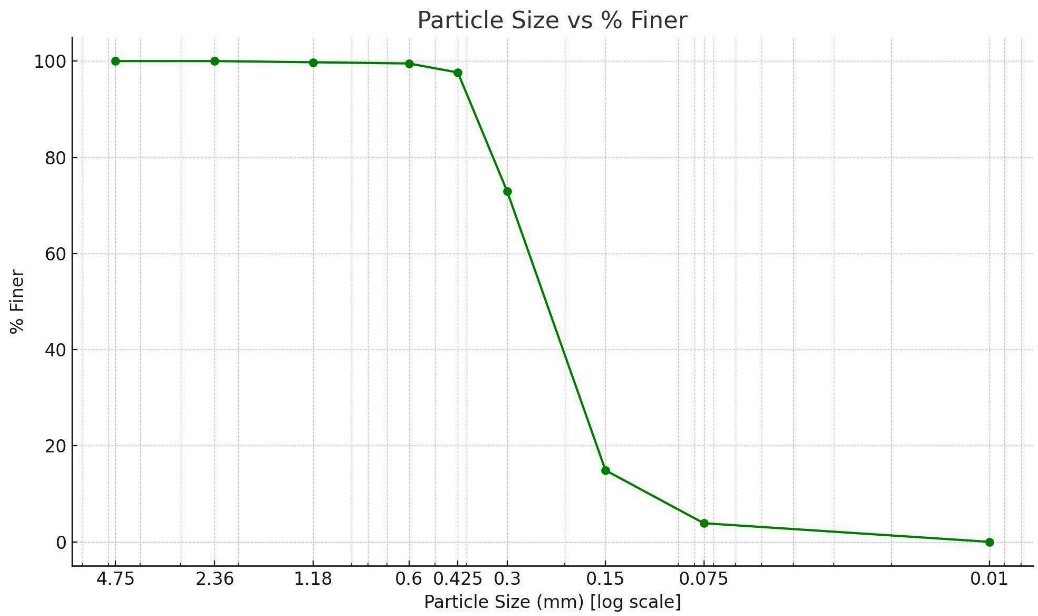
Average coefficient of permeability= 2.206*10^-3cm/sec

- This soil has medium permeability, indicating silty to fine sand — drains water moderately well.

For Deeper Soil(@2m)

SIEVE ANALYSIS

Sieve size(mm)	Weight of sieve(w1) (g)	Weight of sieve +soil(w2) (g)	Weight of soil retained (w3= w2-w1) (g)	% weight retained	%Cumulative Weight retained	
4.75	332	332	0	0	0	
2.36	320	320	0	0	0	
1.18	270	272	2	0.25	0.25	
0.6	310	312	2	0.25	0.5	
0.425	329	344	15	1.875	2.375	
0.3	371	569	198	24.75	27.125	
0.15	300	764	464	58	85.125	
0.075	245	333	88	11	96.125	
Pan	273	304	31	3.875	100	

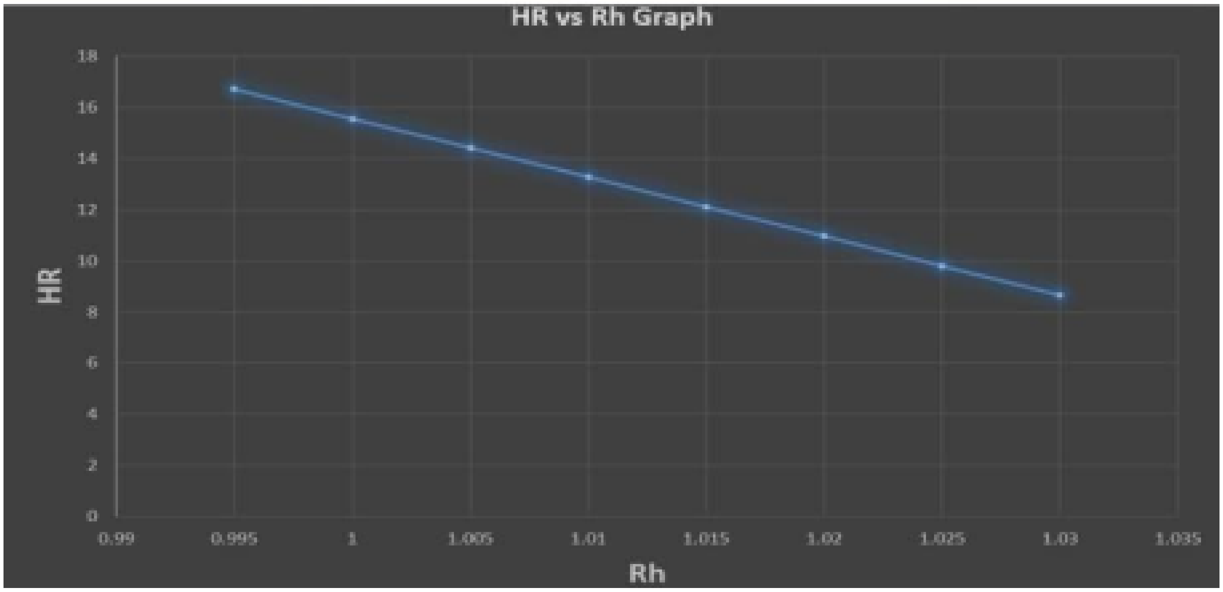

Particle Size vs % Finer
% Finer
100
80
60
40
20
0
4.75
2.36
1.18
0.6
0.425
0.3
0.15
0.075
0.01
Particle Size (mm) [log scale]

HYDROMETER

Dry weight of soil (g) = 50
Viscosity of fluid (poise) = 0.0086
Specific Gravity of soil (G) = 2.6
Meniscus Correction=Cm (cm) = 0.0005
Dispersing agent correction=Cd (cm) = 0.0035
Temperature correction = 0
Volume of hydrometer (cm3) = 60
Area of hydrometer (cm2) = 30.3
Length of bulb, h (cm) = 17.3

Time (min)	Rh’ (cm)	Rh (cm)	HR (cm)	(HR/time) ^0.5	D(mm)	%Finer
0.5	1.023	1.02	10.6	4.68	0.06	65
1	1.022	1.019	11.19	3.35	0.042	61.75
2	1.02	1.017	11.65	2.41	0.03	55.25
4	1.017	1.014	12.34	1.76	0.022	45.5
15	1.013	1.01	13.26	0.94	0.012	32.5
30	1.011	1.008	13.72	0.68	0.009	26
60	1.01	1.007	13.95	0.48	0.006	22.75
120	1.0085	1.0055	14.295	0.35	0.004	17.87

Rh	HR
1.03	8.6599
1.025	9.8099
1.02	10.96
1.015	12.11
1.01	13.26
1.005	14.41
1	15.56
0.995	16.71



All particle sizes fall in the silt range (0.002 mm – 0.075 mm).Therefore, the soil is classified as: Silt (likely ML)

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