GEOTECHNICAL INVESTIGATION REPORT

FOR

PROPOSED

INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA

UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P)

SUBMITTED TO

M/s TATA CONSULTING ENGINEERS LIMITED
GREEN BOULEVARD, GROUND FLOOR, TOWER B&C,
PLOT NO. – B9A, SECTOR – 62,
NOIDA – 201301 (U.P)

PROJECT NO- 1503

MARCH- 2015

BY

SAI GEOTECHNICAL ENGINEERS PVT. LTD.
(AN ISO 9001-2008 CERTIFED COMPANY)
22, INDRAPRASTH APPTT, 826 SHALIMAR GARDEN EXT-1
SAHIBABAD, GHAZIABAD- 201005 (UP)
PHONE: 0120-2649279, 9811522331
e-mail address: saigeotech@gmail.com
website : www.saigeotechnical.com

REPORT ON
GEOTECHNICAL INVESTIGATION
FOR
PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P)

CONTENTS

REPORT ON
GEOTECHNICAL INVESTIGATION
FOR
PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P)

1.0 INTRODUCTION:

1.1 This report presented herein deals with the field and laboratory investigations carried out by us to access the nature of sub-strata and to evaluate the soil parameters required for design of foundations proposed to be constructed for Integrated Industrial Township Project area under Gautam Buddha Nagar district, (U.P) of **M/s Tata Consulting Engineers Limited.**

1.2 Client's help is gratefully acknowledged in providing borehole locations, close supervision and checking during boring, sampling, various testing operations and cooperation and guidance during preparation of report.

1.3 The work of Geotechnical Investigation was awarded to **M/s Sai Geotechnical Engineers Pvt. Ltd.**, 22, Indraprastha Apartment, 826, Shalimar Garden Ext-1, Sahibabad, Ghaziabad (U.P.) by **M/s Tata Consulting Engineers Limited.**

1.4 This report is based upon the results of field and laboratory tests conducted on selected soil samples collected from fourteen bore holes.

2.0 DETAILS OF SITE :

2.1 The details of the site & various test locations for the proposed project are shown in the figure. The proposed Project site is located at Gautam Buddha Nagar district.

3.0 SCOPE OF WORK:

The scope of work provided to us for this project was limited to the following:-

3.1 Mobilizing necessary plant, equipments and personnel to the project site, setting up the equipment, shifting of the equipment from one test location to another location, carrying out the field investigations on land and demobilization on completion of work.

3.2 Making 150 mm nominal diameter bore holes at various locations in all types of soil using suitable approved method of boring at the specified locations to be given at site by the Engineer-in-Charge up to 30.00m/20.00m depth or refusal whichever occurs earlier. Refusal shall mean when SPT field 'N' value reaches 100 for 30 cm or less penetration of SPT sampler.

3.2.1 Conducting standard penetration tests in the bore holes at 1.50 m interval in depth & at every change of strata, whichever is earlier as per specifications / instructions of Engineer-in-Charge.

3.2.2 Collecting undisturbed soil samples from bore holes at 3.00 m interval in depth or at every change of strata, whichever is earlier as per specifications.

3.2.3 Collecting disturbed soil samples from bore holes at regular interval and at every identifiable change of strata to supplement the boring records.

3.2.4 Recording the depth of ground water table in all the bore holes if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

3.2.5 Conducting three Field CBR (California Bearing ratio) test at 0.20m depth as per specifications / instructions of Engineer-in-Charge.

3.2.6 Conducting three Earth Resistivity test as per specifications / instructions of Engineer-in-Charge.

3.2.7 Conducting Permeability test in the bore hole as per specifications.

3.3 Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from various bore holes / test locations :-

(a) Liquid & Plastic limit.
(b) Sieve analysis
(c) Hydrometer analysis.
(d) Tri-axial shear test (UUT).
(e) Direct shear test.
(f) Consolidation test.
(g) Bulk and Dry density.
(h) Natural moisture content.
(i) Specific gravity.
(j) Permeability test.

3.3 Preparation and submission of report in three copies.

4.0 FIELD INVESTIGATIONS:

4.1 Necessary plant, equipment and personnel for conducting the requisite field work were mobilized to the site. These were shifted from one test location to another location during execution of the field work and demobilized on satisfactory completion of the entire field work.

4.2 Fourteen bore holes carried out were first marked on the ground surface as per the layout given to us by the Engineer-in-Charge.

4.3 All bore holes were bored at this site using shell and auger method as per IS: 1892-1979. Casing as required was used to retain the bore holes.

Sl. No.	Test Type / Number	Test conducted at / up to a depth (m) from existing ground level
(1)	6 boreholes 8 boreholes	30.00 m 20.00 m
(2)	Standard penetrations-n tests in bore holes	1.50 m interval & at every change of strata whichever is earlier
(3)	Undisturbed soil sampling in bore holes	3.00 m interval & at every change of strata whichever is earlier

4.3.1 Standard penetration tests were conducted in the above bore holes at every 1.50 m interval & at change of strata as per specifications / instructions of Engineer-in-Charge. The bores were cleaned up to the desired depths. Standard split spoon sampler attached to lower end of 'A' drill rods was driven in the bore holes by means of standard hammer of 63.5 Kg. falling freely from a height of 75 cm. The sampler was driven 45 cm as per specifications & the numbers of blows required for each 15 cm penetration were recorded. The numbers of blows for the first 15 cm penetration were not taken into account. This was considered as seating drive. The numbers of blows for next 30 cm penetration were designated as SPT 'N' value. Wherever the total penetration was less than 45 cm, the number of blows & the depth penetrated is incorporated in respective bore logs. Disturbed soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags of suitable size. These samples were properly sealed, labelled, recorded and carefully transported to the laboratory for testing.

4.3.2 Undisturbed soil samples were collected from the bore holes at every 3.00 m interval in depth & at change of strata as per sampling specifications, in thin walled sampling tubes of 100 mm dia and 450 mm length fitted to an adopter with ball and socket arrangement. These sampling tubes after retrieval from the bore holes were properly waxed and sealed at both ends. These were carefully labeled and transported to the laboratory for testing. Undisturbed soil samples wherever slipped during lifting, were duly marked in the field bore logs as well as in the soil profile.

4.3.3 Disturbed soil samples were also collected from the bore holes at suitable depths/intervals to supplement the boring records. These samples were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded & carefully transported to the laboratory for testing.

4.3.4 The ground water table was encountered in bore holes during the boring activity.

4.3.5 **Summary of bore holes:**

Borehole No	Easting	Northing	Depth of Soil (m)	Water table (m)
BH – B1	752857.50	3152167.36	30.45	5.55
BH – B2	753147.91	3152584.30	30.45	5.05
BH – B5	753436.94	3152307.39	30.45	4.75
BH – B6	753367.57	3152265.55	30.45	4.70
BH – B9	753744.68	3151907.71	20.45	3.80
BH – B10	753836.15	3152004.83	20.45	4.35
BH – B11	753856.09	3151961.82	30.45	4.30
BH – B12	753937.14	3151902.97	20.45	4.35
BH – B13	753899.96	3151873.04	20.45	4.40
BH – B14	753788.72	3151602.17	20.45	4.55
BH – B15	752574.56	3153569.03	20.45	4.55
BH – B16	752661.29	3153607.34	30.45	4.60
BH – B17	752714.74	3153643.65	20.45	4.60
BH – B20	754669.84	3150211.29	20.45	4.60

5.0 LABORATORY INVESTIGATIONS:

5.1 The following laboratory tests were conducted on selected soil samples recovered from various bore hole / test locations: -

(a) Liquid & Plastic limit.

(b) Sieve analysis

(c) Hydrometer analysis.

(d) Tri-axial shear test (UUT).

(e) Direct shear test.

(f) Consolidation test.

(g) Bulk and Dry density.

(h) Natural moisture content.

(i) Specific gravity.

(j) Permeability test.

All the above laboratory tests were carried out as per relevant Indian Standards. All the soil samples were identified and classified as per IS: 1498-1970.

6.0 FINDING OF GEOTECHNICAL INVESTIGATION:

The study of bore logs/results of laboratory and other field tests as above from ground level reveal that:-

6.1 At the locations of BH-1

The sub-soil strata: -

From existing ground surface to 1.50m depth consist of light brown sandy silt of low plasticity (ML-CL).

From 1.50m to 9.00m depth consist of light gray clayey silt of low plasticity (CL), SPT field 'N' values ranges from 15 to 29 showing very stiff consistency of the strata.

From 9.00m to 15.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 23 to 34 showing very stiff to hard consistency of the strata.

From 15.00m to 19.50m depth consist of light gray sandy silt (ML), SPT field 'N' values ranges from 39 to 46 showing dense compactness of the strata.

From 19.50m to 21.00m depth consist of light gray silty sand (SM), SPT field 'N' value is 44 showing dense compactness of the strata.

From 21.00m to 22.50m depth consist of light gray fine sand (SP-SM), SPT field 'N' value is 58 showing very dense compactness of the strata.

From 22.50m to 30.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 59 to 68 very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.2 At the locations of BH-2

The sub-soil strata: -

From existing ground surface to 5.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 13 to 20 showing stiff to very stiff consistency of the strata.

From 5.50m to 7.50m depth consist of light gray silty sand (SM), SPT field 'N' value is 23 showing medium dense compactness of the strata.

From 7.50m to 14.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 14 to 30 showing stiff to very stiff consistency of the strata.

From 14.50m to 19.50m depth consist of light gray clayey silt of low plasticity (CL), SPT field 'N' values ranges from 28 to 38 showing very stiff to hard consistency of the strata.

From 19.50m to 21.00m depth consist of light gray sandy silt (ML), SPT field 'N' value is 51 showing very dense compactness of the strata.

From 21.00m to 30.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 61 to 72 very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.3 At the locations of BH-5

The sub-soil strata: -

From existing ground surface to 3.00m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 12 showing stiff consistency of the strata.

From 3.00m to 6.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 16 to 19 showing medium dense compactness of the strata.

From 6.00m to 7.50m depth consist of light gray fine sand (SP-SM), SPT field 'N' value is 29 showing medium dense compactness of the strata.

From 7.50m to 13.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 18 to 31 showing very stiff to hard consistency of the strata.

From 13.50m to 15.00m depth consist of light gray clayey silt of low plasticity (CL), SPT field 'N' value is 35 showing hard consistency of the strata.

From 15.00m to 19.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 38 to 52 showing hard consistency of the strata.

From 19.50m to 30.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 54 to 69 very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.4 At the locations of BH-6

The sub-soil strata: -

From existing ground surface to 1.50m depth consist of light brown sandy silt of low plasticity (ML-CL).

From 1.50m to 3.00m depth consist of light brown clayey silt of low plasticity (CL), SPT field 'N' value is 16 showing very stiff consistency of the strata.

From 3.00m to 6.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 18 to 21 showing medium dense compactness of the strata.

From 6.00m to 9.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 18 to 31 showing very stiff to hard consistency of the strata.

From 9.00m to 12.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 33 to 38 showing dense compactness of the strata.

From 12.00m to 16.50m depth consist of light gray sandy silt (ML), SPT field 'N' values ranges from 39 to 48 showing dense compactness of the strata.

From 16.50m to 24.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 42 to 59 showing dense to very dense compactness of the strata.

From 24.00m to 30.45m depth consist of light gray fine sand (SP-SM), SPT field 'N' values ranges from 62 to 71 very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.5 At the locations of BH-9

The sub-soil strata: -

From existing ground surface to 3.00m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 14 showing stiff consistency of the strata.

From 3.00m to 6.00m depth consist of light brown Sandy silt (ML), SPT field 'N' values ranges from 16 to 22 showing medium dense compactness of the strata.

From 6.00m to 12.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 20 to 32 showing very stiff to hard consistency of the strata.

From 12.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 36 to 53 showing dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.6 At the locations of BH-10

The sub-soil strata: -

From existing ground surface to 2.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 14 showing stiff consistency of the strata.

From 2.50m to 7.50m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 16 to 22 showing medium dense compactness of the strata.

From 7.50m to 16.50m depth consist of light gray clayey silt of low plasticity (CL), SPT field 'N' values ranges from 25 to 44 showing very stiff to hard consistency of the strata.

From 16.50m to 20.45m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 46 to 53 showing hard consistency of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.7 At the locations of BH-11

The sub-soil strata: -

From existing ground surface to 2.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 14 showing stiff consistency of the strata.

From 2.50m to 7.50m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 17 to 29 showing medium dense compactness of the strata.

From 7.50m to 16.50m depth consist of light gray clayey silt of low plasticity (CL), SPT field 'N' values ranges from 26 to 48 showing very stiff to hard consistency of the strata.

From 16.50m to 21.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 44 to 56 showing hard consistency of the strata.

From 21.00m to 30.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 58 to 70 very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.8 At the locations of BH-12

The sub-soil strata: -

From existing ground surface to 3.00m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 11 showing stiff consistency of the strata.

From 3.00m to 10.50m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 15 to 39 showing medium dense to dense compactness of the strata.

From 10.50m to 12.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' value is 36 showing hard consistency of the strata.

From 12.00m to 15.00m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' values ranges from 31 to 34 showing hard consistency of the strata.

From 15.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 36 to 49 showing dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.9 At the locations of BH-13

The sub-soil strata: -

From existing ground surface to 3.00m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 12 showing stiff consistency of the strata.

From 3.00m to 10.50m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 13 to 39 showing medium dense to dense compactness of the strata.

From 10.50m to 12.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' value is 28 showing very stiff consistency of the strata.

From 12.00m to 15.00m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' values ranges from 32 to 34 showing hard consistency of the strata.

From 15.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 43 to 53 showing dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.10 At the locations of BH-14

The sub-soil strata: -

From existing ground surface to 3.00m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 10 showing stiff consistency of the strata.

From 3.00m to 6.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 15 to 17 showing medium dense compactness of the strata.

From 6.00m to 11.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 24 to 31 showing very stiff to hard consistency of the strata.

From 11.50m to 15.00m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' values ranges from 28 to 31 showing very stiff to hard consistency of the strata.

From 15.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 44 to 49 showing dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.11 At the locations of BH-15

The sub-soil strata: -

From existing ground surface to 4.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' values rages from 10 to 14 showing stiff consistency of the strata.

From 4.50m to 9.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 18 to 28 showing medium dense compactness of the strata.

From 9.00m to 13.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 24 to 34 showing very stiff to hard consistency of the strata.

From 13.50m to 15.00m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' value is 31 showing hard consistency of the strata.

From 15.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 44 to 53 showing dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.12 At the locations of BH-16

The sub-soil strata: -

From existing ground surface to 4.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' values rages from 11 to 13 showing stiff consistency of the strata.

From 4.50m to 8.50m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 16 to 22 showing medium dense compactness of the strata.

From 8.50m to 13.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 27 to 30 showing very stiff consistency of the strata.

From 13.50m to 16.50m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' values rages from 25 to 28 showing very stiff consistency of the strata.

From 16.50m to 30.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 44 to 68 showing dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.13 At the locations of BH-17

The sub-soil strata: -

From existing ground surface to 4.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' values rages from 11 to 13 showing stiff consistency of the strata.

From 4.50m to 9.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 17 to 22 showing medium dense compactness of the strata.

From 9.00m to 13.50m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 21 to 28 showing very stiff consistency of the strata.

From 13.50m to 15.00m depth consist of light gray sandy silt of medium plasticity (CI), SPT field 'N' value is 23 showing very stiff consistency of the strata.

From 15.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 43 to 50 showing dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.14 At the locations of BH-20

The sub-soil strata: -

From existing ground surface to 2.50m depth consist of light brown sandy silt of low plasticity (ML-CL), SPT field 'N' value is 8 showing firm consistency of the strata.

From 2.50m to 6.00m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 14 to 17 showing medium dense compactness of the strata.

From 6.00m to 7.50m depth consist of light gray clayey silt of medium plasticity (CI), SPT field 'N' value is 20 showing very stiff consistency of the strata.

From 7.50m to 12.00m depth consist of light gray sandy silt of low plasticity (ML-CL), SPT field 'N' values ranges from 25 to 30 showing very stiff consistency of the strata.

From 12.00m to 20.45m depth consist of light gray silty sand (SM), SPT field 'N' values ranges from 38 to 53 dense to very dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

7.0 TYPE AND DEPTH OF FOUNDATIONS:

Based upon the results of field investigations, laboratory test results & considering the structure going to construct, the following type of foundations have been analyzed herein below : -

1. Bored Cast in situ RCC Pile
2. Open Shallow Foundation

❖ **PILE FOUNDATION:**

Pile foundation is a fissible foundation scheme that may be designed where the loadings are heavy/medium, upper strata are loose/soft or filled up, and depth of water

table is less. The pile load bearing capacity is calculated in accordance with IS: 2911(Part-III).

Piles in cohesion less soil

The ultimate bearing capacity of pile in homogeneous sand may be represented by the following formula:

$$Q_u = A_P (0.5 D_\gamma N_\gamma + P_D N_q) + \sum_{i=1}^{D} K P_{Di} \tan A_{si}$$

Where
A_P = Cross sectional area of pile toe in sq cm
D = stem diameter in cm
γ = effective unit weight of soil at pile toe in kg/sq cm
P_D = effective overburden pressure at pile toe in kg/sq cm
$N\gamma$ & Nq = Bearing capacity factors
A_{si} = Surface area of pile stem in sq cm
K = Coefficient of Earth pressure
d = Angle of wall friction between pile and soil

Piles in cohesive soil

The ultimate bearing capacity of pile in homogeneous sand may be represented by the following formula:

$$Q_u = A_P \times N_c \times C_p + \alpha \times c \times A_s$$

Where,
A_P = Cross Sectional Area of Pile Toe
N_c = Bearing Capacity factor usually Taken as 9.0
C_p = Average Undrained Cohesion at Pile Tip
α = Reduction factor = 0.5 for Bored Piles in stiff Clay
c = Average undrained cohesion along embedded length of pile
A_s = Surface area of pile Shaft.

❖ **<u>OPEN SHALLOW FOUNDATIONS</u>**:

The allowable bearing capacity of sub-soil strata for Open foundation has been computed from shear and settlement failure considerations.

Allowable Bearing Capacity

The net intensity of loading which the foundation will carry without undergoing settlement in excess of the permissible value for the structure under consideration but not exceeding net safe bearing capacity.

Net Safe Bearing Capacity from Shear consideration

For Clayey Soil ($\phi = 0$)

The values are computed from unconfined compressive strength UCS, using the following equation;

qd = C Nc Sc dc - Refer IS:6403, Clause 5.3

where

qd = Net Ultimate bearing capacity

A factor of safety of 2.5 is used.

Considering $\phi = 0$, Nc = 5.14

Thus the equation is simplified as

$q_{(Net\ safe)}$ = 1 / 2.5 x C x 5.14 Sc dc

= 2.056 C Sc dc

For C - ϕ Soils

Refer IS:6403 – 1981, Clause 5.1

General Shear Failure

$q_d = C N_c Sc\ dc + \gamma D (N_q - 1) S_q d_q + 0.5 \gamma B N\gamma S\gamma d\gamma W'$

Local Shear Failure

$q_{d'} = 2/3C N'_c Sc\ dc + \gamma D (N'_q - 1) S_q d_q + 0.5 \gamma B N\gamma' S\gamma d\gamma W'$

where

qd and qd' are net ultimate bearing capacity for general and local shear failure

Net safe bearing capacity = 1 / 2.5 x Net ultimate bearing capacity

Bearing capacity factor shall be determined for ϕ for general shear failure and $\phi' = \tan^{-1}(0.67 \tan\phi)$ for local shear failure.

Shape and depth factors shall be determined as per IS: 6403-1981.

For cohesion less soil with e_o value less than 0.55, values are computed for General shear failure, for e_o values between 0. 55 to 0.75 the values are computed by linear interpolation between local and general shear failure, and for eo value greater than 0.75 the values are computed for local shear failure.

For footing resting on multilayer deposit, Bowls recommends that the ultimate bearing capacity of footing be determined using average values of cohesion, C_{av} and angle of shearing resistance, ϕ_{av}. The average values are computed over a depth H below the base of footing,

where
H = 0.5 B tan (45 + ϕ/2)

Safe Bearing pressure from settlement Consideration.

For normal consolidated clay

Sf = Sc + Si
Sc = λ Soed
Si = $pB(1-\mu^2)$ I /E; will be negligible
μ = poission's ratio,
Soed = $\Sigma(h_I C_c /(1 + e_0)) \log_{10} ((\Delta p' + p_0') / p_0'))$
(Reference: clause 9.2.2.2 IS 8009 (Part I))

where;
h_I = thickness of soil layer (m)
C_c = Compression index
e_0 = Initial void ratio
p_0' = effective overburden pressure (t/sq.m)
$\Delta p'$ = net increase in pressure at centre of cohesive soil layer

For precompressed clays

S_1 = Sc (for fully saturated clays)
Sc = λ Soed; λ is taken from table – 1, IS: 8009 (Part – 1), 0.7
Soed = $\Sigma m_v h_I \Delta p$
(Reference: clause 9.2.2.3 IS 8009 (Part I))

where;
h_I = thickness of soil layer (m)
m_v = Coefficient of volume compression
Δp = net increase in pressure at center of cohesive soil layer

If clays are lightly over consolidated, then the above method may be adopted but if the clay is heavily over consolidated, it may not be necessary to compute the settlement.

If the soil deposits consist of several regular soil layers in the influence zone, the settlement of each layer below the foundation shall be computed and summed to obtain the total settlement.

The settlement contribution by non cohesive / partially cohesive soil layer shall be estimated by the methods in clause 9.1, IS: 8009 (Part I); De Beer Marten method shall be used.

De Beer and Martens' Procedure

S_2 = $(2.303 / C_i) \log_{10} ((\Delta p + p_0') / p_0'))h_i$
h_I = thickness of soil layer (m)
C_i = a constant of compressibility = $3/2 (C_{kd} / p_0')$
C_{kd} = average static cone resistance
p_0' = effective overburden pressure (t/sq.m)
Δp = net increase in pressure at centre of non cohesive/ partially cohesive soil layer
Total settlement = $S_1 + S_2$

For purly noncohesive soils

Settlement shall be determined for unit pressure for a specified width of footing based on Corrected SPT values between the level of base of footing and the depth equal to 1.5 to 2.0 times the width of footing. Corrections shall be applied as applicable. Refer; IS: 8009 (Part-1).

Recommended Foundations

Considering the field up, nature of soil, type of proposed structures, expected loads, following type of foundations can be recommended;

a) Pile Foundation

Type of foundation	Diameter of Pile, mm	Cut off level, m	Effective Depth, m
Bored Cast in situ RCC Pile	1000 & 1200	1.50 – 1.80	15.0 – 25.0

b) Open Foundation:

Type of foundation (s)	Depth of Foundation,(m)	Size of Footing(m)
Raft Footing	2.00m to 3.00m	6.0 x 9.0 8.0 x 12.0
Circular Raft footing	2.00m to 4.00m	6.0 & 8.0

Isolated Square	2.00m to 3.00m	2.0 x 2.0 3.0 x 3.0

8.0 RECOMMENDATIONS

Location: BH – B1 & B2

Type of Foundation: Bored Cast in situ RCC Pile

Depending on the field and laboratory observations of subsoil strata, test results and the type of structures proposed at site, the most feasible soil-foundation system is recommended as normal bored cast in situ R.C.C. piles foundations of 1.0m & 1.2m diameter at different depths with cut-off level of 1.50m to 1.80m depth below existing Ground level.

The safe load carrying capacities of these piles are given in following table.

Dia of piles, (mm)	Cut-off level below EGL, (m)	Length of piles below cut-off, (m)	Safe load carrying capacity, (T)		
			In comp.	In uplift	In lateral
1000	1.50	15	131	81	25
		17	142	89	25
		19	263	105	25
		22	293	130	25
		25	323	155	25
1200	1.80	15	168	98	40
		17	186	113	40
		19	376	133	40
		22	416	166	40
		25	455	199	40

1. For design purpose, effective overburden pressure at pile tip should correspond to pile length equal to 15 times the diameter.

2. Permissible lateral deflection equal to 1% of pile diameter.

3. The above values should be confirmed through pile load tests in the field before adopting these values for design purposes.

Depending on the field and laboratory observations of subsoil strata, test results and the type of structures proposed at site, the types of foundations, depths and net safe

bearing capacities recommended for design purposes are given in the following table. The net SBC/API in the following table are the lower of the values obtained from shear failure criterion as per IS: 6403 and settlement failure criterion as per IS: 8009, Part-I.

Location: BH – B1

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	6.0 x 9.0	15.70	24.90	15.00
	8.0 x 12.0	17.00	17.70	15.00
3.00	6.0 x 9.0	18.00	24.50	16.00
	8.0 x 12.0	18.00	17.20	16.00
4.00	6.0 x 9.0	20.60	24.00	18.00
	8.0 x 12.0	22.90	17.10	16.00

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	2.0 x 2.0	18.30	48.20	16.00
	3.0 x 3.0	17.30	32.10	15.00
3.00	2.0 x 2.0	20.10	48.20	18.00
	3.0 x 3.0	18.60	32.10	17.00

Location: BH – B2

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended

2.00	6.0 x 9.0	17.40	24.60	16.00
	8.0 x 12.0	19.30	19.00	18.00
3.00	6.0 x 9.0	20.90	26.20	18.00
	8.0 x 12.0	22.20	19.70	19.00
4.00	6.0 x 9.0	24.90	28.90	20.00
	8.0 x 12.0	25.30	20.70	20.00

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	2.0 x 2.0	19.80	45.20	18.00
	3.0 x 3.0	18.70	24.70	17.00
3.00	2.0 x 2.0	21.70	36.30	19.00
	3.0 x 3.0	20.20	21.70	18.00

Location: BH – B5

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	17.20	31.40	15.00
	8.0 x 12.0	20.50	22.40	18.00
2.00	6.0 x 9.0	20.50	33.20	18.00
	8.0 x 12.0	23.00	23.50	20.00

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	17.90	39.10	15.00
	3.0 x 3.0	18.00	30.10	16.00
2.00	2.0 x 2.0	20.40	40.00	20.00
	3.0 x 3.0	20.50	32.70	20.00

Location: BH – B6

Type of Foundation: Circular Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	6.0	19.40	34.40	18.00
	8.0	30.20	33.80	25.00
3.00	6.0	23.00	48.90	20.00
	8.0	31.00	48.30	25.00
4.00	6.0	33.40	49.90	25.00
	8.0	32.50	47.70	25.00

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	2.0 x 2.0	13.70	30.90	13.00
	3.0 x 3.0	17.10	21.70	15.00
3.00	2.0 x 2.0	25.30	25.10	20.00
	3.0 x 3.0	25.00	23.40	20.00

Location: BH – B9

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	17.50	34.00	15.00
	3.0 x 3.0	17.60	25.90	15.00
2.00	2.0 x 2.0	19.80	33.90	17.00
	3.0 x 3.0	19.60	26.10	17.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	19.00	29.40	17.00
	8.0 x 12.0	21.40	23.00	18.00

2.00	6.0 x 9.0	22.10	30.40	20.00
	8.0 x 12.0	23.60	24.40	20.00

Location: BH – B10

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	17.90	45.50	15.00
	3.0 x 3.0	17.00	36.50	15.00
2.00	2.0 x 2.0	19.20	47.50	16.00
	3.0 x 3.0	18.00	41.10	16.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	15.40	39.40	14.00
	8.0 x 12.0	19.70	28.20	16.00
2.00	6.0 x 9.0	18.90	42.90	16.00
	8.0 x 12.0	22.60	30.20	18.00

Location: BH – B11

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	18.40	46.90	16.00
	3.0 x 3.0	18.00	37.80	16.00
2.00	2.0 x 2.0	20.40	50.20	18.00
	3.0 x 3.0	19.60	43.60	18.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	16.90	41.30	15.00
	8.0 x 12.0	21.50	29.60	17.00
2.00	6.0 x 9.0	21.10	45.60	17.00
	8.0 x 12.0	24.50	32.10	20.00

Location: BH – B12

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	16.80	38.30	15.00
	3.0 x 3.0	17.10	30.80	15.00

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	2.0 x 2.0	19.30	40.70	17.00
	3.0 x 3.0	19.30	35.30	17.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	16.50	35.10	15.00
	8.0 x 12.0	18.10	25.90	16.00
2.00	6.0 x 9.0	19.10	39.10	17.00
	8.0 x 12.0	20.70	28.30	18.00

Location: BH – B13

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	17.50	38.00	15.00
	3.0 x 3.0	17.90	29.00	15.00
2.00	2.0 x 2.0	20.20	37.80	18.00
	3.0 x 3.0	20.60	30.70	18.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	17.80	40.40	15.00
	8.0 x 12.0	19.60	30.00	16.00
2.00	6.0 x 9.0	20.70	44.50	18.00
	8.0 x 12.0	22.50	32.60	18.00

Location: BH – B14

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	16.80	34.20	15.00
	3.0 x 3.0	16.40	26.30	15.00
2.00	2.0 x 2.0	18.60	34.80	16.00
	3.0 x 3.0	18.00	27.20	16.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	18.20	25.90	16.00
	8.0 x 12.0	21.10	19.50	16.00

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	6.0 x 9.0	21.40	27.40	18.00
	8.0 x 12.0	23.40	20.50	18.00

Location: BH – B15

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	16.40	33.20	14.00
	3.0 x 3.0	15.80	22.50	14.00
2.00	2.0 x 2.0	17.40	32.60	15.00
	3.0 x 3.0	16.50	22.80	15.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	15.00	25.10	14.00
	8.0 x 12.0	16.10	19.00	14.00
2.00	6.0 x 9.0	16.70	25.70	15.00
	8.0 x 12.0	18.80	19.60	15.00

Location: BH – B16

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	17.70	34.70	15.00
	3.0 x 3.0	17.0	26.50	15.00
2.00	2.0 x 2.0	18.80	33.80	16.00
	3.0 x 3.0	17.90	25.80	16.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	16.00	24.90	14.00
	8.0 x 12.0	17.40	18.60	14.00
2.00	6.0 x 9.0	17.70	25.40	15.00
	8.0 x 12.0	19.70	19.10	15.00

Location: BH – B17

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	14.60	34.70	12.00
	3.0 x 3.0	14.10	23.20	12.00

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	2.0 x 2.0	15.60	33.70	13.00
	3.0 x 3.0	14.80	23.20	13.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	13.10	25.20	11.00
	8.0 x 12.0	14.00	18.70	12.00
2.00	6.0 x 9.0	14.60	25.60	12.00
	8.0 x 12.0	16.40	19.10	13.00

Location: BH – B20

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	2.0 x 2.0	14.80	32.20	12.00
	3.0 x 3.0	13.90	26.00	12.00
2.00	2.0 x 2.0	15.70	34.70	13.00
	3.0 x 3.0	14.80	28.60	13.00

Type of Foundation: Raft footing

For Permissible settlement = 75.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
1.50	6.0 x 9.0	16.50	26.00	14.00
	8.0 x 12.0	19.50	20.80	15.00
2.00	6.0 x 9.0	19.80	28.60	16.00
	8.0 x 12.0	22.00	23.30	17.00

- The ground water was encountered at a depth of 3.80m to 5.55m in the bore holes at the time of boring activities at site and for design purpose water table is considered at 2.0m depth from NGL.
- The Modulus of subgrade reaction may be taken 2.1 t/m^2/m.
- The results of chemical tests of soil and water samples of boreholes are within the permissible limit as per Indian Standards and are safe for construction purposes.
- ERT tests were conducted at one location using four electrodes driven into earth along a straight line at equal intervals. The current is passed through the two outer electrodes and voltage difference is observed between the two inner electrodes. The resistivity of the soil is proportional to the ratio of the voltage to current. The computed values of resistivity at this location for different depths are given in Sheet no – 117 to Sheet no – 140. The average resistivity values at test locations are:

  Test Location S1 : 86.0 Ohms.m

  Test Location S2 : 70.50 Ohms.m

  Test Location S3 : 67.0 Ohms.m

  The Polar curves are shown in enclosed sheets No 141 to 143.
- The Field CBR value for project area under consideration, the recommended value of California Bearing ratio may be for design purposes of roads & other paved areas are:

  1) Test Location C1 : Unsoaked CBR Value is 12%
  2) Test Location C2 : Unsoaked CBR Value is 18%
  3) Test Location C3 : Unsoaked CBR Value is 14%

The tests results are shown in enclosed sheets No 146 to 151.

- The top strata is cohesive soil in mostly locations, a slope of 1:1 (1H: 1V) may be adopted for exaction of foundation.

9.0 CLOSURE

We appreciate the opportunity given to us to submit this report. This presented report is based on observations and tests on samples collected from the boreholes as decided by the client. In case any difference is noticed in the field subsoil strata and reported subsoil strata during excavation please contact us before proceeding with further construction.

For SAI GEOTECHNICAL ENGINEERS PVT. LTD.

NAVIN BIHARI JOHARI
MANANING DIRECTOR

BOREHOLE NO. : 1
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 206.370 m

Location of Borehole : B1 **SHEET NO : 31**
DATE STARTED : 10/01/2015
DATE COMPLETED : 11/01/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTE D IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (kg/sqcm.)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
206.37	0.0	DS	0.00	1		0.00 - 0.45							Sandy Silt **(ML-CL)**		0.0	22.0	73.0	5.0	25	20				2.66				
205.37	1.0	SPT	1.50	1		1.50 - 1.95	15	30	15	21																		
204.37	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	9.0	78.0	13.0	33	22	1.76	1.54	14.30	2.67	0.55	9	0.139	0.734
203.37	3.0	SPT	3.00	2		3.00 - 3.45	17	30	17	24																		
202.37	4.0	SPT	4.50	3		4.50 - 4.95	20	30	20	27			Light Gray Clayey Silt of Low Plasticity **(CL)**															
201.37	5.0	UDS	5.50	2		5.50 - 5.95									0.0	8.0	80.0	12.0			1.92	1.59	20.90					
200.37	6.0	SPT	6.00	4		6.00 - 6.45	24	30	24	22																		
199.37	7.0	SPT	7.50	5		7.50 - 7.95	29	30	29	24																		
198.37	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	12.0	75.0	13.0	32	22	1.96	1.63	20.50		0.80	10		
197.37	9.0	SPT	9.00	6	5.55 m	9.00 - 9.45	27	30	27	22	150																	
196.37	10.0	SPT	10.50	7		10.50 - 10.95	23	30	23	19																		
195.37	11.0	UDS	11.50	4		11.50 - 11.95							Light Brownish Sandy Silt of low plasticity **(ML-CL)**		0.0	26.0	69.0	5.0	25	19	1.98	1.67	18.70	2.66			0.097	0.593
194.37	12.0	SPT	12.00	8		12.00 - 12.45	32	30	32	23																		
193.37	13.0	SPT	13.50	9		13.50 - 13.95	34	30	34	23																		
192.37	14.0	UDS	14.50	5		14.50 - 14.95								UUT	0.0	58.0	30.0	12.0	33	19	1.97	1.66	18.90	2.67	1.32	12		
191.37	15.0	SPT	15.00	10		15.00 - 15.45	43	30	43	27																		
190.37	16.0	SPT	16.50	11		16.50 - 16.95	46	30	46	27																		
189.37	17.0	UDS	17.50	6		17.50 - 17.95							Light Brownish Sandy Silt **(ML)**	DST+	4.0	38.0	55.0	3.0	N	P				2.65	0.00	34		
188.37	18.0	SPT	18.00	12		18.00 - 18.45	39	30	39	24																		
187.37	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

BOREHOLE NO. : 1
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 206.370 m

Location of Borehole : B1
DATE STARTED : 10/01/2015
DATE COMPLETED : 11/01/2015

SHEET NO : 32

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	SPT: NO. OF BLOWS	SPT: PENETRATION (CM)	SPT: N, VALUE (Recorded)	SPT: N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (t/sqm.)	Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	VOID RATIO e0
186.37	19.0												Sandy Silt **(ML)**																
186.37	20.0	SPT	19.50	13		19.50 - 19.95	44	30	44	25			Light Gray Silty Sand **(SM)**		0.0	67.0	33.0	0.0	N	P				2.63				
		UDS	20.50	7		20.50 - 20.95																						
185.37	21.0	SPT	21.00	14		21.00 - 21.45	58	30	58	30			**(SP-SM)**		0.0	90.0	10.0	0.0	N	P				2.62				
184.37	22.0	SPT	22.50	15		22.50 - 22.95	62	30	62	31																		
183.37	23.0	UDS	23.50	8		23.50 - 23.95									0.0	62.0	38.0	0.0	N	P								
182.37	24.0	SPT	24.00	16	5.55 m	24.00 - 24.45	59	30	59	29	150																	
181.37	25.0	SPT	25.50	17		25.50 - 25.95	65	30	65	30																		
180.37	26.0	UDS	26.50	9		26.50 - 26.95							Light Gray Silty Sand **(SM)**	DST+	0.0	61.0	39.0	0.0	N	P	2.02	1.72	17.20	2.63	0.0	36		
179.37	27.0	SPT	27.00	18		27.00 - 27.45	62	30	62	29																		
178.37	28.0	SPT	28.50	19		28.50 - 28.95	63	30	63	28																		
177.37	29.0	UDS	29.50	10		29.50 - 29.95									0.0	69.0	31.0	0.0	N	P				2.63				
176.37	30.0	SPT	30.00	20		30.00 - 30.45	68	30	68	29																		
175.92	30.5																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

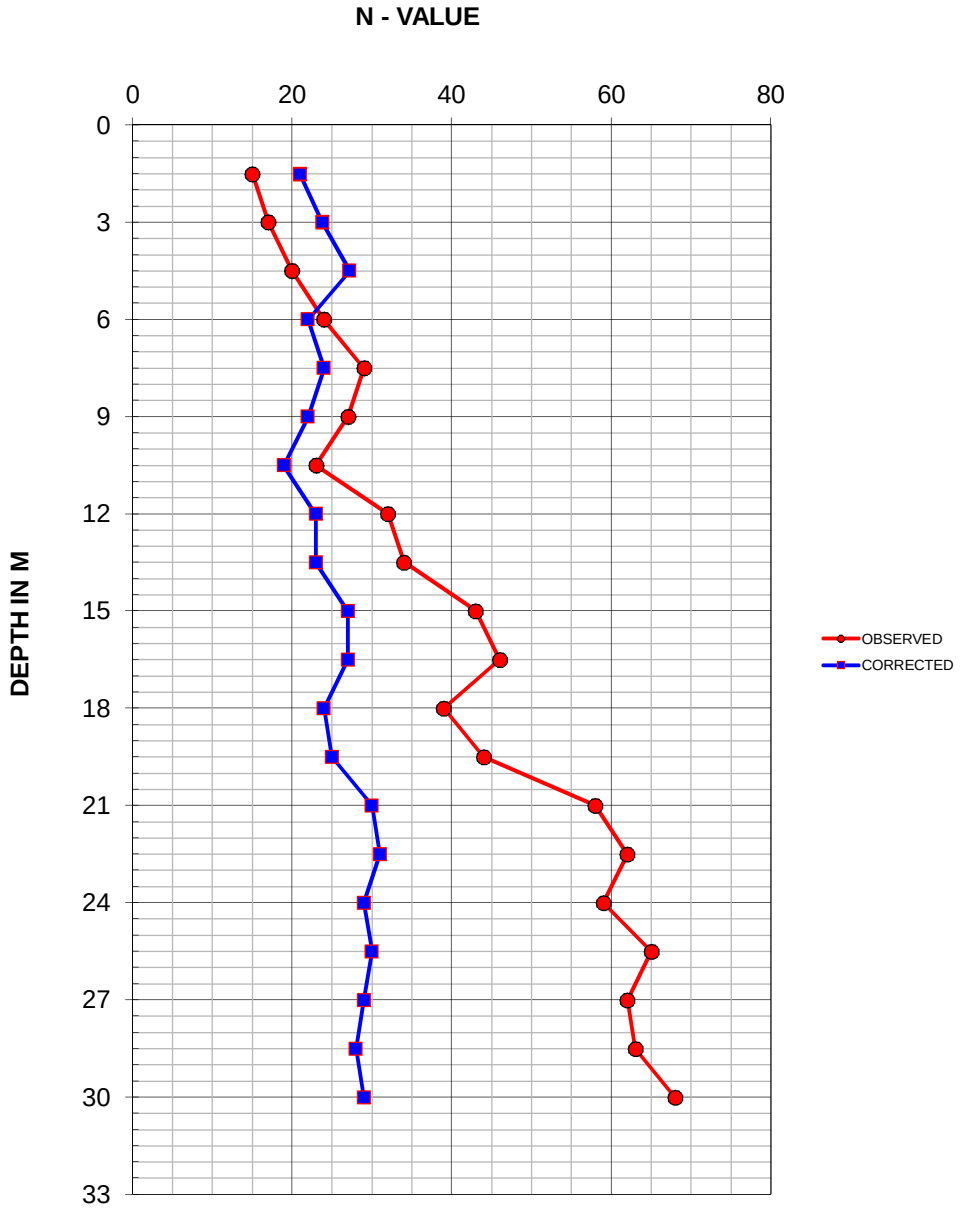
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 1



BOREHOLE NO. : 2
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.710 m

Location of Borehole : B2
DATE STARTED : 12/01/2015
DATE COMPLETED : 13/01/2015

SHEET NO : 34

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (t/sqm.)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.71	0.0	DS	0.00	1		0.00 - 0.45																						
204.71	1.0	SPT	1.50	1		1.50 - 1.95	13	30	13	18					0.0	19.0	75.0	6.0	25	19								
203.71	2.0	UDS	2.50	1		2.50 - 2.95							Light Brown Sandy Silt of low plasticity **(ML-CL)**	UUT							1.74	1.54	13.30	2.65	0.54	10	0.135	0.721
202.71	3.0	SPT	3.00	2		3.00 - 3.45	16	30	16	22					0.0	17.0	78.0	5.0	25	20								
201.71	4.0	SPT	4.50	3		4.50 - 4.95	20	30	20	27																		
200.71	5.0	UDS	5.50	2		5.50 - 5.95							Light Gray Silty Sand **(SM)**	DST+	0.0	63.0	37.0	0.0	N	P				2.64	0.00	31		
199.71	6.0	SPT	6.00	4		6.00 - 6.45	23	30	23	22																		
198.71	7.0	SPT	7.50	5		7.50 - 7.95	14	30	14	15																		
197.71	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	17.0	77.0	6.0	26	19	1.90	1.60	18.70	2.66	0.78	12		
196.71	9.0	SPT	9.00	6		9.00 - 9.45	19	30	19	18																		
195.71	10.0	SPT	10.50	7	5.05 m	10.50 - 10.95	26	30	26	21	150		Light Gray Sandy Silt of low plasticity **(ML-CL)**															
194.71	11.0	UDS	11.50	4		11.50 - 11.95									3.0	21.0	71.0	5.0	24	19	1.94	1.64	18.30	2.65				
193.71	12.0	SPT	12.00	8		12.00 - 12.45	30	30	30	22																		
192.71	13.0	SPT	13.50	9		13.50 - 13.95	24	30	24	19																		
191.71	14.0	UDS	14.50	5		14.50 - 14.95								UCS	0.0	9.0	79.0	12.0	33	22	1.99	1.65	20.60	2.67	1.24			
190.71	15.0	SPT	15.00	10		15.00 - 15.45	28	30	28	20																		
189.71	16.0	SPT	16.50	11		16.50 - 16.95	35	30	35	23			Light Gray Clayey Silt of low plasticity **(CL)**															
188.71	17.0	UDS	17.50	6		17.50 - 17.95									3.0	8.0	77.0	12.0	33	21	2.00	1.67	19.70	2.67			0.099	0.599
187.71	18.0	SPT	18.00	12		18.00 - 18.45	38	30	38	23																		
186.71	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BOREHOLE NO. : 2
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.710 m

Location of Borehole : B2
DATE STARTED : 12/01/2015
DATE COMPLETED : 13/01/2015

SHEET NO : 35

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	SPT: NO. OF BLOWS	SPT: PENETRATION (CM)	SPT: N, VALUE (Recorded)	SPT: N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	GRAIN SIZE ANALYSIS: SAND (%)	GRAIN SIZE ANALYSIS: SILT (%)	GRAIN SIZE ANALYSIS: CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (t/sqm.)	SHEAR STRENGTH CHARACTERISTICS: Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	CONSOLIDATION TEST PARAMETERS: VOID RATIO e0
185.71	19.0												**(CL)**																
185.71	20.0	SPT	19.50	13		19.50 - 19.95	51	30	51	28			Light gray Sandy Silt **(ML)**																
		UDS	20.50	7		20.50 - 20.95								DST+	6.0	33.0	58.0	3.0	N	P	1.99	1.70	17.20	2.64	0.0	33		
184.71	21.0	SPT	21.00	14		21.00 - 21.45	61	30	61	32																		
183.71	22.0	SPT	22.50	15		22.50 - 22.95	65	30	65	33					0.0	67.0	33.0	0.0	N	P				2.63				
182.71	23.0	UDS	23.50	8		23.50 - 23.95																						
181.71	24.0	SPT	24.00	16	5.05 m	24.00 - 24.45	67	30	67	32	150																	
180.71	25.0	SPT	25.50	17		25.50 - 25.95	69	30	69	32			Light Gray Silty Sand **(SM)**		0.0	62.0	38.0	0.0	N	P				2.63				
179.71	26.0	UDS	26.50	9		26.50 - 26.95																						
178.71	27.0	SPT	27.00	18		27.00 - 27.45	66	30	66	31																		
177.71	28.0	SPT	28.50	19		28.50 - 28.95	68	30	68	31																		
176.71	29.0	UDS	29.50	10		29.50 - 29.95									0.0	73.0	27.0	0.0	N	P				2.63				
175.71	30.0	SPT	30.00	20		30.00 - 30.45	72	30	72	31																		
175.26	30.5																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

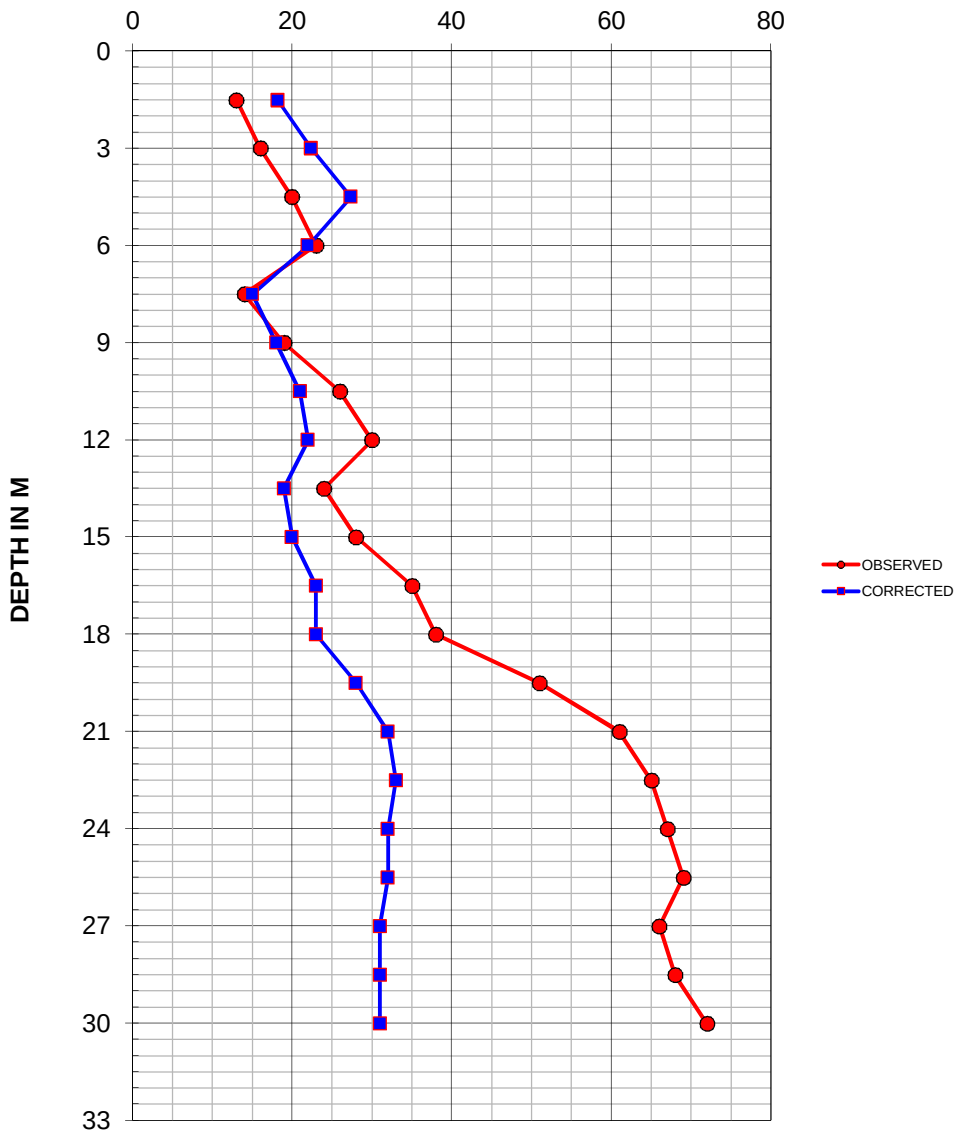
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 2



BOREHOLE NO. : 5 **Location of Borehole : B5** **SHEET NO : 37**

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP). **DATE STARTED** : 17/01/2015

REDUCED LEVEL OF B/HOLE : 205.490 m **DATE COMPLETED** : 18/01/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/Sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.49	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		0.0	28.0	67.0	5.0						2.66				
204.49	1.0	DS	1.50	1		1.50 - 1.95	12	30	12	17																		
203.49	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	34.0	60.0	6.0	24	19	1.75	1.55	13.20	2.65	0.50	10	0.132	0.710
202.49	3.0	SPT	3.00	2		3.00 - 3.45	16	30	16	22			Light Grayish Silty Sand **(SM)**															
201.49	4.0	SPT	4.50	3		4.50 - 4.95	19	30	19	22					0.0	66.0	34.0	0.0	N	P								
200.49	5.0	UDS	5.50	2		5.50 - 5.95								DST+										2.63	0.00	30		
199.49	6.0	SPT	6.00	4		6.00 - 6.45	29	30	29	23			Grayish Fine Sand **(SP-SM)**		0.0	91.0	9.0	0.0	N	P								
198.49	7.0	SPT	7.50	5		7.50 - 7.95	18	30	18	16																		
197.49	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	7.0	88.0	5.0	26	19	1.93	1.62	19.20	2.66	0.85	9		
196.49	9.0	SPT	9.00	6		9.00 - 9.45	20	30	20	17																		
195.49	10.0	SPT	10.50	7	4.75 m	10.50 - 10.95	28	30	28	20	150		light Brown Sandy Silt of low plasticity **(ML-CL)**															
194.49	11.0	UDS	11.50	4		11.50 - 11.95									4.0	13.0	78.0	5.0	25	19	1.96	1.65	18.90					
193.49	12.0	SPT	12.00	8		12.00 - 12.45	31	30	31	21																		
192.49	13.0	SPT	13.50	9		13.50 - 13.95	35	30	35	22			Light Gray Clayey Silt of Low Plasticity **(CL)**		0.0	6.0	82.0	12.0										
191.49	14.0	UDS	14.50	5		14.50 - 14.95								UCS					32	22	2.00	1.67	19.70	2.67	1.33			
190.49	15.0	SPT	15.00	10		15.00 - 15.45	38	30	38	23																		
189.49	16.0	SPT	16.50	11		16.50 - 16.95	46	30	46	26					4.0	17.0	72.0	7.0										
188.49	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Sandy Silt of low plasticity **(ML-CL)**	UUT					25	19	2.01	1.70	18.20	2.66	1.48	10		
187.49	18.0	SPT	18.00	12		18.00 - 18.45	52	30	52	28																		
186.49	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

BOREHOLE NO. : 5
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.490 m

Location of Borehole : B5
DATE STARTED : 17/01/2015
DATE COMPLETED : 16/12/2014

SHEET NO : 38

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	SPT: NO. OF BLOWS	SPT: PENETRATION (CM)	SPT: N, VALUE (Recorded)	SPT: N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	GRAIN SIZE ANALYSIS: SAND (%)	GRAIN SIZE ANALYSIS: SILT (%)	GRAIN SIZE ANALYSIS: CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (t/sqm.)	SHEAR STRENGTH CHARACTERISTICS: Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	CONSOLIDATION TEST PARAMETERS: VOID RATIO e0
185.49	19.0												**ML-CL**																
185.49	20.0	SPT	19.50	13		19.50 - 19.95	57	30	57	29																				
		UDS	20.50	7		20.50 - 20.95									0.0	76.0	24.0	0.0	N	P				2.63					
184.49	21.0	SPT	21.00	14		21.00 - 21.45	54	30	54	27																			
183.49	22.0	SPT	22.50	15		22.50 - 22.95	60	30	60	29																			
182.49	23.0	UDS	23.50	8		23.50 - 23.95								DST+	0.0	75.0	25.0	0.0	N	P	2.02	1.72	17.60	2.64	0.0	35		
181.49	24.0	SPT	24.00	16	4.75 m	24.00 - 24.45	65	30	65	30	150		Light Grayish Silty Fine Sand **(SM)**																
180.49	25.0	SPT	25.50	17		25.50 - 25.95	61	30	61	28																			
179.49	26.0	UDS	26.50	9		26.50 - 26.95									1.0	76.0	23.0	0.0	N	P				2.63					
178.49	27.0	SPT	27.00	18		27.00 - 27.45	66	30	66	29																			
177.49	28.0	SPT	28.50	19		28.50 - 28.95	62	30	62	27																			
176.49	29.0	UDS	29.50	10		29.50 - 29.95									0.0	80.0	20.0	0.0	N	P									
175.49	30.0	SPT	30.00	20		30.00 - 30.45	69	30	69	29																			
175.04	30.5																												

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

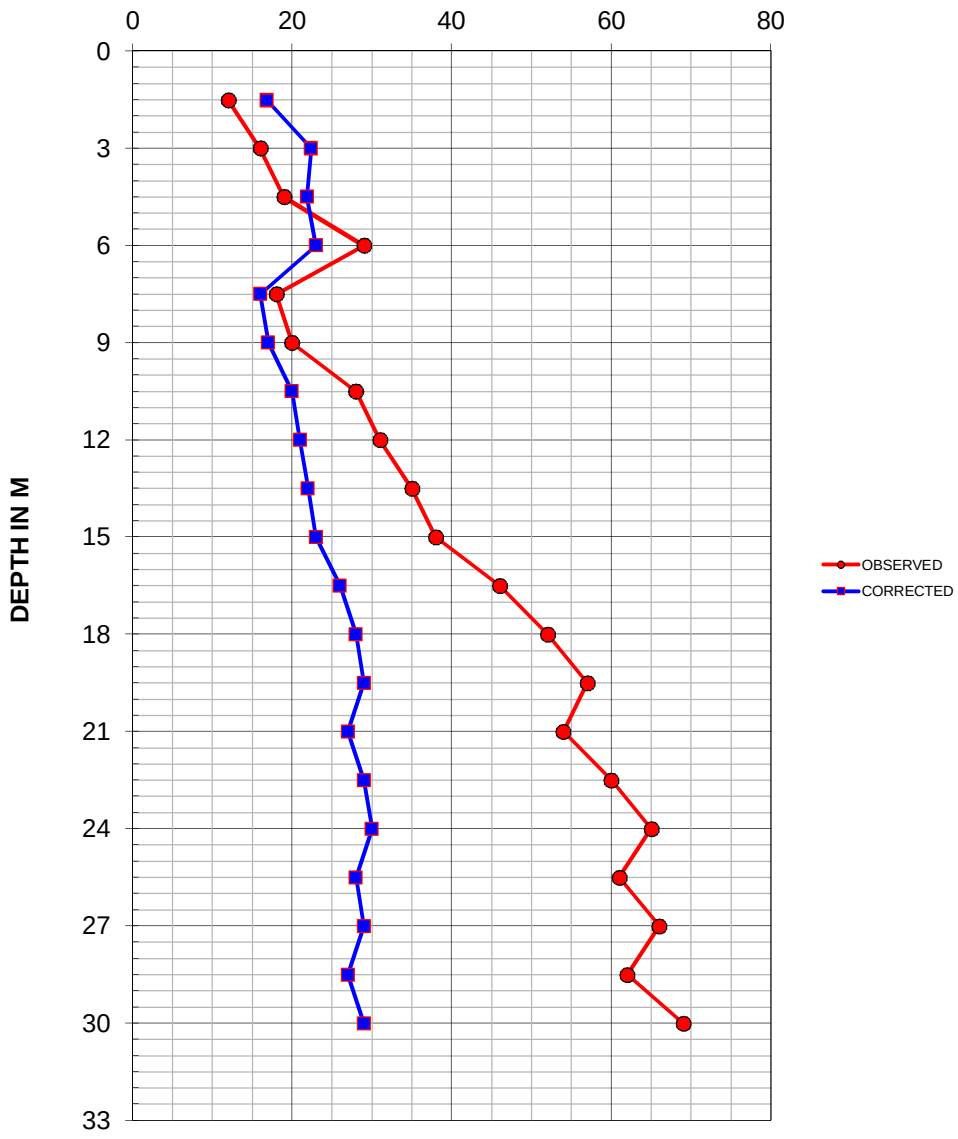
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 5



BOREHOLE NO. : 6
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.870 m

Location of Borehole : **B6**
DATE STARTED : 15/01/2015
DATE COMPLETED : 16/01/2015

SHEET NO : **40**

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (t/sq.m.)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.87	0.0	DS	0.00	1		0.00 - 0.45							Sandy Silt **(ML-CL)**		0.0	18.0	76.0	6.0	26	20				2.66				
204.87	1.0	SPT	1.50	1		1.50 - 1.95	16	30	16	22			Light Brown Clayey Silt of low Plasticity **(CL)**															
203.87	2.0	UDS	2.50	1		2.50 - 2.95								UCS	0.0	9.0	78.0	13.0	33	22	1.78	1.55	14.70	2.67	0.60		0.136	0.723
202.87	3.0	SPT	3.00	2		3.00 - 3.45	18	30	18	25			Light Grayish Silty Sand **(SM)**															
201.87	4.0	SPT	4.50	3		4.50 - 4.95	21	30	21	28																		
200.87	5.0	UDS	5.50	2		5.50 - 5.95								DST+	0.0	61.0	39.0	0.0	N	P				2.64	0.00	31		
199.87	6.0	SPT	6.00	4		6.00 - 6.45	28	30	28	25			light Brown Sandy Silt of low plasticity **(ML-CL)**															
198.87	7.0	SPT	7.50	5		7.50 - 7.95	30	30	30	25					6.0	21.0	68.0	5.0	25	20								
197.87	8.0	UDS	8.50	3		8.50 - 8.95								UUT							1.96	1.65	18.90	2.66	0.89	10		
196.87	9.0	SPT	9.00	6	4.70 m	9.00 - 9.45	33	30	33	25	150		Light Grayish Silty Sand **(SM)**															
195.87	10.0	SPT	10.50	7		10.50 - 10.95	38	30	38	27					0.0	68.0	32.0	0.0	N	P								
194.87	11.0	UDS	11.50	4		11.50 - 11.95																						
193.87	12.0	SPT	12.00	8		12.00 - 12.45	39	30	39	26			Light Brownish Sandy Silt **(ML)**		4.0	35.0	58.0	3.0	N	P				2.64				
192.87	13.0	SPT	13.50	9		13.50 - 13.95	44	30	44	28																		
191.87	14.0	UDS	14.50	5		14.50 - 14.95								DST	3.0	38.0	56.0	3.0	N	P	1.99	1.68	18.20		0.00	33		
190.87	15.0	SPT	15.00	10		15.00 - 15.45	48	30	48	29																		
189.87	16.0	SPT	16.50	11		16.50 - 16.95	52	30	52	30																		
188.87	17.0	UDS	17.50	6		17.50 - 17.95							Light Grayish Silty Sand **(SM)**		0.0	67.0	33.0	0.0	N	P				2.63				
187.87	18.0	SPT	18.00	12		18.00 - 18.45	47	30	47	27																		
186.87	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

BOREHOLE NO. : 6
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.870 m

Location of Borehole : B6
DATE STARTED : 15/01/2015
DATE COMPLETED : 16/12/2014

SHEET NO : 41

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	SPT: NO. OF BLOWS	SPT: PENETRATION (CM)	SPT: N, VALUE (Recorded)	SPT: N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	GRAIN SIZE ANALYSIS: SAND (%)	GRAIN SIZE ANALYSIS: SILT (%)	GRAIN SIZE ANALYSIS: CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (t/sqm.)	SHEAR STRENGTH CHARACTERISTICS: Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	CONSOLIDATION TEST PARAMETERS: VOID RATIO e0
185.87	19.0																												
185.87	20.0	SPT	19.50	13		19.50 - 19.95	42	30	42	24																			
		UDS	20.50	7		20.50 - 20.95							Light Grayish Silty Sand **(SM)**	DST+	0.0	63.0	37.0	0.0	N	P	1.98	1.69	17.30	2.64	0.0	34		
184.87	21.0	SPT	21.00	14		21.00 - 21.45	53	30	53	28																			
183.87	22.0	SPT	22.50	15		22.50 - 22.95	59	30	59	30					0.0	67.0	33.0	0.0	N	P				2.63					
182.87	23.0	UDS	23.50	8		23.50 - 23.95																							
181.87	24.0	SPT	24.00	16	4.70 m	24.00 - 24.45	63	30	63	30	150																		
180.87	25.0	SPT	25.50	17		25.50 - 25.95	66	30	66	31					0.0	89.0	11.0	0.0	N	P				2.62					
179.87	26.0	UDS	26.50	9		26.50 - 26.95																							
178.87	27.0	SPT	27.00	18		27.00 - 27.45	62	30	62	29			Grayish Fine Sand **(SP-SM)**		0.0	90.0	10.0	0.0											
177.87	28.0	SPT	28.50	19		28.50 - 28.95	68	30	68	30																			
176.87	29.0	UDS	29.50	10		29.50 - 29.95									0.0	90.0	10.0	0.0	N	P				2.62					
175.87	30.0	SPT	30.00	20		30.00 - 30.45	71	30	71	30																			
175.42	30.5																												

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

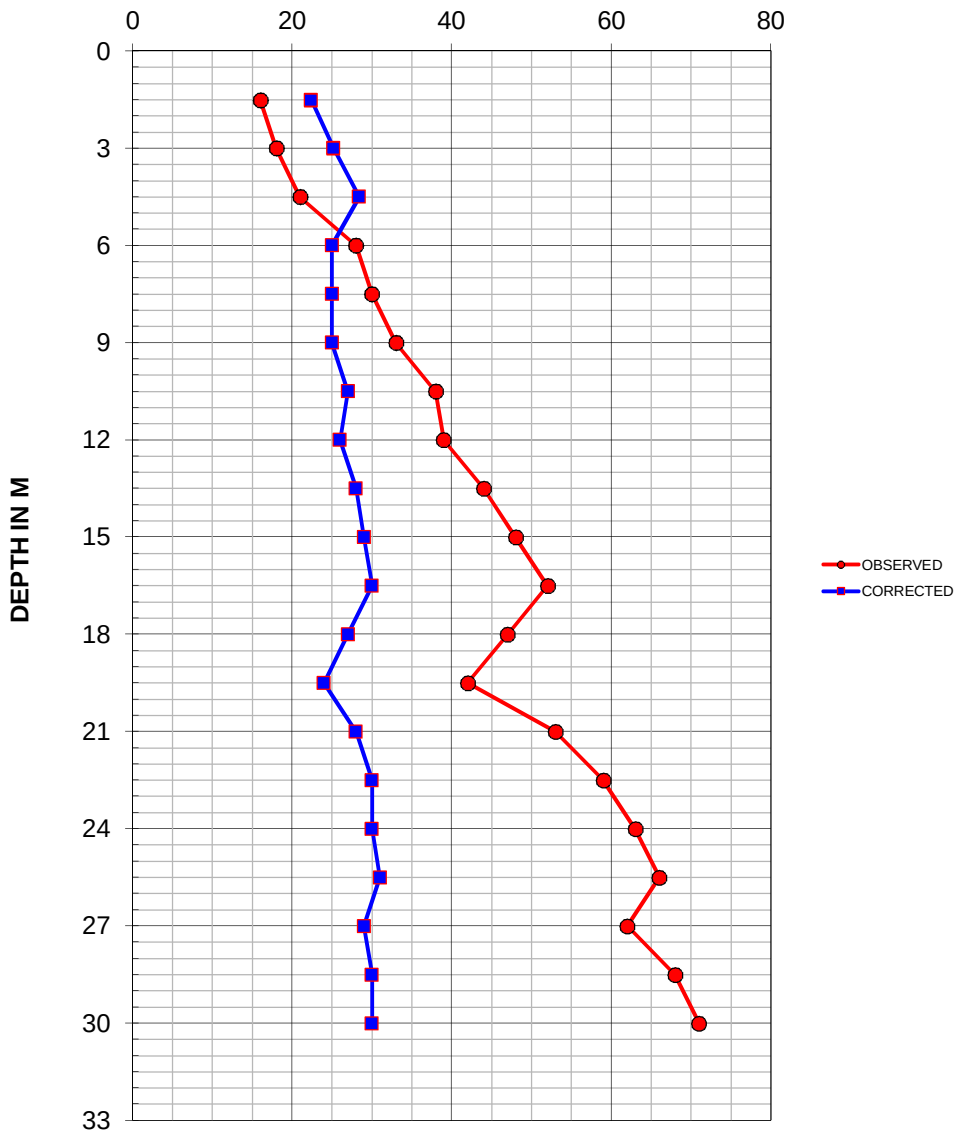
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 6



BOREHOLE NO. : 9
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.840 m

Location of Borehole : B09 **SHEET NO : 43**
DATE STARTED : 19/01/2015
DATE COMPLETED : 20/01/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTE D IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/Sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.84	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		0.0	18.0	77.0	5.0										
203.84	1.0	SPT	1.50	1		1.50 - 1.95	14	30	14	20																		
202.84	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	11.0	83.0	6.0	27	20	1.75	1.55	12.90	2.66	0.50	10	0.134	0.716
201.84	3.0	SPT	3.00	2		3.00 - 3.45	16	30	16	22			Light Brown Sandy Silt **(ML)**															
200.84	4.0	SPT	4.50	3		4.50 - 4.95	22	30	22	20																		
199.84	5.0	UDS	5.50	2		5.50 - 5.95								DST+	6.0	31.0	60.0	3.0	N	P				2.65	0.05	30		
198.84	6.0	SPT	6.00	4		6.00 - 6.45	20	30	20	18																		
197.84	7.0	SPT	7.50	5		7.50 - 7.95	25	30	25	20																		
196.84	8.0	UDS	8.50	3		8.50 - 8.95							Light Brown Sandy Silt of low Plasticity **(ML-CL)**	UUT	0.0	8.0	84.0	8.0	27	20	1.94	1.63	19.20	2.67	0.85	11		
195.84	9.0	SPT	9.00	6		9.00 - 9.45	29	30	29	22																		
194.84	10.0	SPT	10.50	7	3.80 m	10.50 - 10.95	32	30	32	22	150																	
193.84	11.0	UDS	11.50	4		11.50 - 11.95									0.0	13.0	80.0	7.0	26	19	1.98	1.66	19.30					
192.84	12.0	SPT	12.00	8		12.00 - 12.45	36	30	36	24																		
191.84	13.0	SPT	13.50	9		13.50 - 13.95	39	30	39	24																		
190.84	14.0	UDS	14.50	5		14.50 - 14.95								DST+	0.0	55.0	45.0	0.0	N	P				2.64	0.00	33		
189.84	15.0	SPT	15.00	10		15.00 - 15.45	44	30	44	26			Light Grayish Silty Sand **(SM)**															
188.84	16.0	SPT	16.50	11		16.50 - 16.95	46	30	46	26																		
187.84	17.0	UDS	17.50	6		17.50 - 17.95								DST+	0.0	58.0	42.0	0.0	N	P	1.97	1.68	17.40	2.63	0.00	34		
186.84	18.0	SPT	18.00	12		18.00 - 18.45	51	30	51	27																		
184.84	20.0	SPT	20.00	13		20.00 - 20.45	53	30	53	27																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

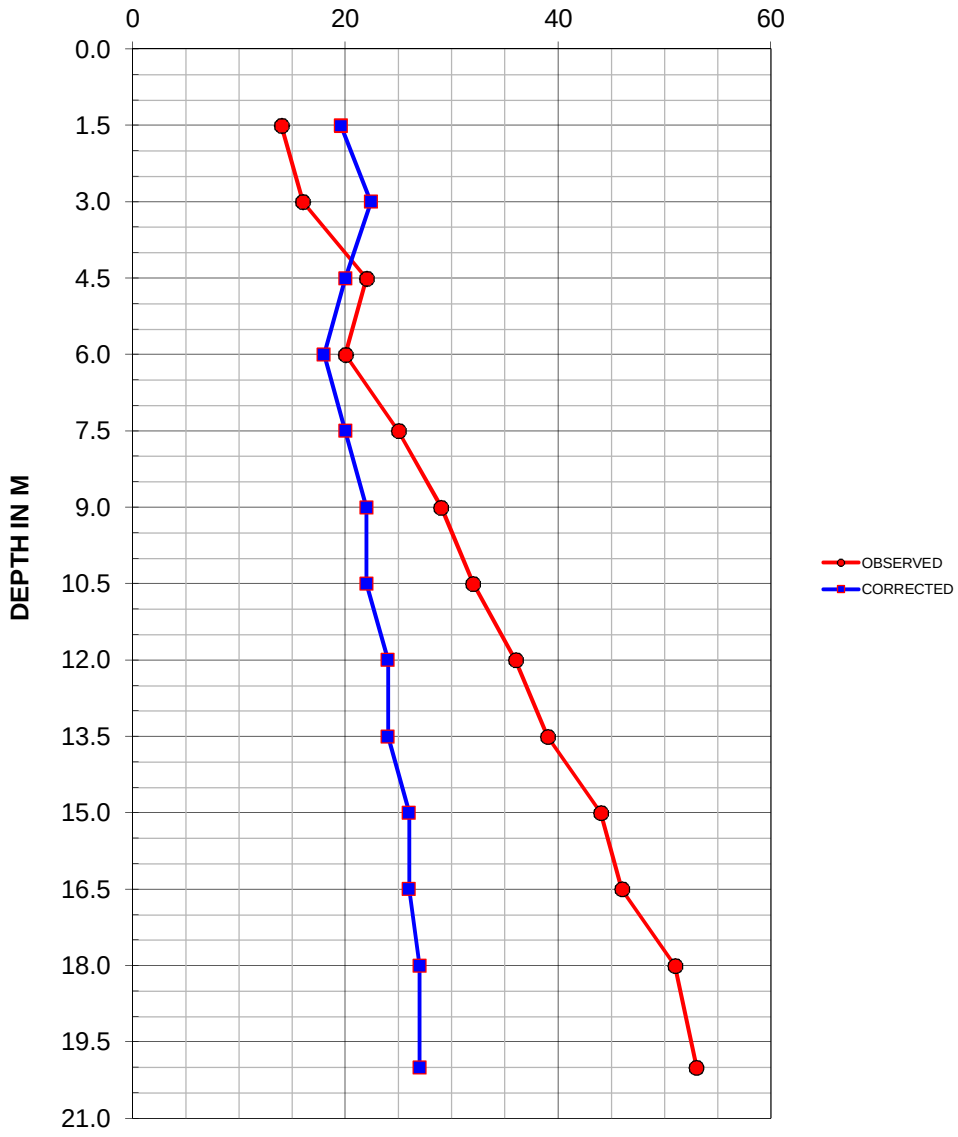
SGEPL

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 9



BOREHOLE NO. : 10
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.720 m

Location of Borehole : **B 10**
DATE STARTED : 30/01/2015
DATE COMPLETED : 31/01/2015

SHEET NO : **45**

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTE D IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.72	0.0	DS	0.00	1		0.00 - 0.45							Light Gray Sandy Silt of low Plasticity **(ML-CL)**		6.0	25.0	63.0	6.0	25	19				2.66				
203.72	1.0	SPT	1.50	1		1.50 - 1.95	14	30	14	20																		
202.72	2.0	UDS	2.50	1		2.50 - 2.95								DST+	0.0	52.0	45.0	3.0	N	P	1.76	1.55	13.70		0.00	29		
201.72	3.0	SPT	3.00	2		3.00 - 3.45	16	30	16	22																		
200.72	4.0	SPT	4.50	3		4.50 - 4.95	22	30	22	20			Light Gray Silty Sand **(SM)**															
199.72	5.0	UDS	5.50	2		5.50 - 5.95								DST+	0.0	76.0	24.0	0.0	N	P				2.64				
198.72	6.0	SPT	6.00	4		6.00 - 6.45	20	30	20	18																		
197.72	7.0	SPT	7.50	5		7.50 - 7.95	25	30	25	20																		
196.72	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	10.0	77.0	13.0	32	22	1.98	1.64	20.50	2.67	0.90	10	0.107	0.628
195.72	9.0	SPT	9.00	6		9.00 - 9.45	29	30	29	21																		
194.72	10.0	SPT	10.50	7	4.35 m	10.50 - 10.95	32	30	32	22	150																	
193.72	11.0	UDS	11.50	4		11.50 - 11.95							Light Gray Clayey Silt of low Plasticity **(CL)**		0.0	12.0	75.0	13.0	34	23	1.99	1.66	19.80					
192.72	12.0	SPT	12.00	8		12.00 - 12.45	36	30	36	23																		
191.72	13.0	SPT	13.50	9		13.50 - 13.95	39	30	39	24																		
190.72	14.0	UDS	14.50	5		14.50 - 14.95								UCS	8.0	8.0	67.0	17.0			2.00	1.67	19.90	2.68	1.36			
189.72	15.0	SPT	15.00	10		15.00 - 15.45	44	30	44	26																		
188.72	16.0	SPT	16.50	11		16.50 - 16.95	46	30	46	26																		
187.72	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Sandy Silt of low Plasticity **(ML-CL)**	UUT	0.0	21.0	73.0	6.0	25	19	2.01	1.70	18.20	2.66	1.44	10		
186.72	18.0	SPT	18.00	12		18.00 - 18.45	51	30	51	27																		
184.72	20.0	SPT	20.00	13		20.00 - 20.45	53	30	53	27																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

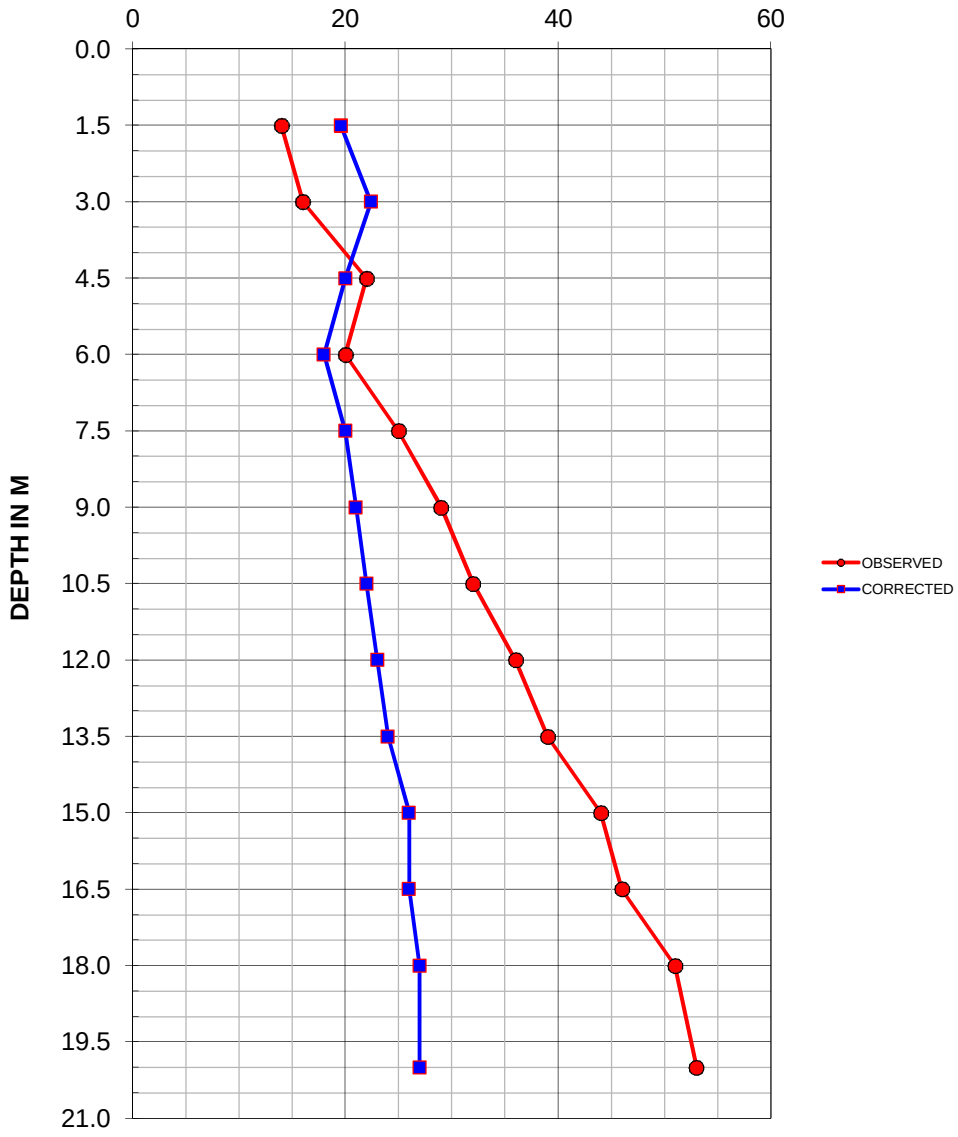
SGEPL

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 10



BOREHOLE NO. : 11
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.660 m

Location of Borehole : B11 **SHEET NO : 47**
DATE STARTED : 25/01/2015
DATE COMPLETED : 25/01/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTE D IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.66	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		4.0	22.0	69.0	5.0						2.66				
203.66	1.0	SPT	1.50	1		1.50 - 1.95	14	30	14	20																		
202.66	2.0	UDS	2.50	1		2.50 - 2.95								DST+	0.0	56.0	44.0	0.0	N	P	1.74	1.54	13.20	2.64	0.00	30		
201.66	3.0	SPT	3.00	2		3.00 - 3.45	17	30	17	24																		
200.66	4.0	SPT	4.50	3		4.50 - 4.95	21	30	21	24			Light Grayish Silty Sand **(SM)**															
199.66	5.0	UDS	5.50	2		5.50 - 5.95									0.0	72.0	28.0	0.0	N	P				2.63				
198.66	6.0	SPT	6.00	4		6.00 - 6.45	29	30	29	23																		
197.66	7.0	SPT	7.50	5		7.50 - 7.95	26	30	26	21																		
196.66	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	5.0	89.0	6.0	28	20	1.96	1.64	19.40	2.67	0.90	10		
195.66	9.0	SPT	9.00	6		9.00 - 9.45	33	30	33	24																		
194.66	10.0	SPT	10.50	7	4.30 m	10.50 - 10.95	36	30	36	24	150																	
193.66	11.0	UDS	11.50	4		11.50 - 11.95							Light Gray Clayey Silt of Low Plasticity **(CL)**		0.0	13.0	75.0	12.0	35	23	2.02	1.67	20.90					
192.66	12.0	SPT	12.00	8		12.00 - 12.45	43	30	43	27																		
191.66	13.0	SPT	13.50	9		13.50 - 13.95	41	30	41	25																		
190.66	14.0	UDS	14.50	5		14.50 - 14.95								UCS	0.0	4.0	80.0	16.0			2.05	1.70	20.70	2.68	1.36			
189.66	15.0	SPT	15.00	10		15.00 - 15.45	48	30	48	27																		
188.66	16.0	SPT	16.50	11		16.50 - 16.95	44	30	44	25																		
187.66	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Sandy Silt of low plasticity **(ML-CL)**	UUT	4.0	36.0	54.0	6.0	24	18	2.04	1.73	17.90	2.66				
186.66	18.0	SPT	18.00	12		18.00 - 18.45	51	30	51	27																		
185.66	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

BOREHOLE NO. : 11
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.660 m

Location of Borehole : B11
DATE STARTED : 25/01/2015
DATE COMPLETED : 16/12/2014

SHEET NO : 48

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N, VALUE (Recorded)	N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	VOID RATIO e0
184.66	19.0																												
184.66	20.0	SPT	19.50	13		19.50 - 19.95	56	30	56	29			Light Gray Sandy Silt of low plasticity **(ML-CL)**		5.0	29.0	61.0	5.0										
		UDS	20.50	7		20.50 - 20.95								UUT					25	19	2.05	1.75	17.30	2.66	1.40	12		
183.66	21.0	SPT	21.00	14		21.00 - 21.45	58	30	58	29																		
182.66	22.0	SPT	22.50	15		22.50 - 22.95	61	30	61	29																		
181.66	23.0	UDS	23.50	8		23.50 - 23.95								DST+	0.0	68.0	32.0	0.0	N	P				2.64	0.0	35		
180.66	24.0	SPT	24.00	16	4.30 m	24.00 - 24.45	68	30	68	31	150																	
179.66	25.0	SPT	25.50	17		25.50 - 25.95	64	30	64	29			Light Grayish Silty Fine Sand **(SM)**															
178.66	26.0	UDS	26.50	9		26.50 - 26.95									0.0	70.0	30.0	0.0	N	P				2.63				
177.66	27.0	SPT	27.00	18		27.00 - 27.45	65	30	65	29																		
176.66	28.0	SPT	28.50	19		28.50 - 28.95	68	30	68	29																		
175.66	29.0	UDS	29.50	10		29.50 - 29.95									0.0	72.0	28.0	0.0	N	P								
174.66	30.0	SPT	30.00	20		30.00 - 30.45	70	30	70	29																		
174.21	30.5																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

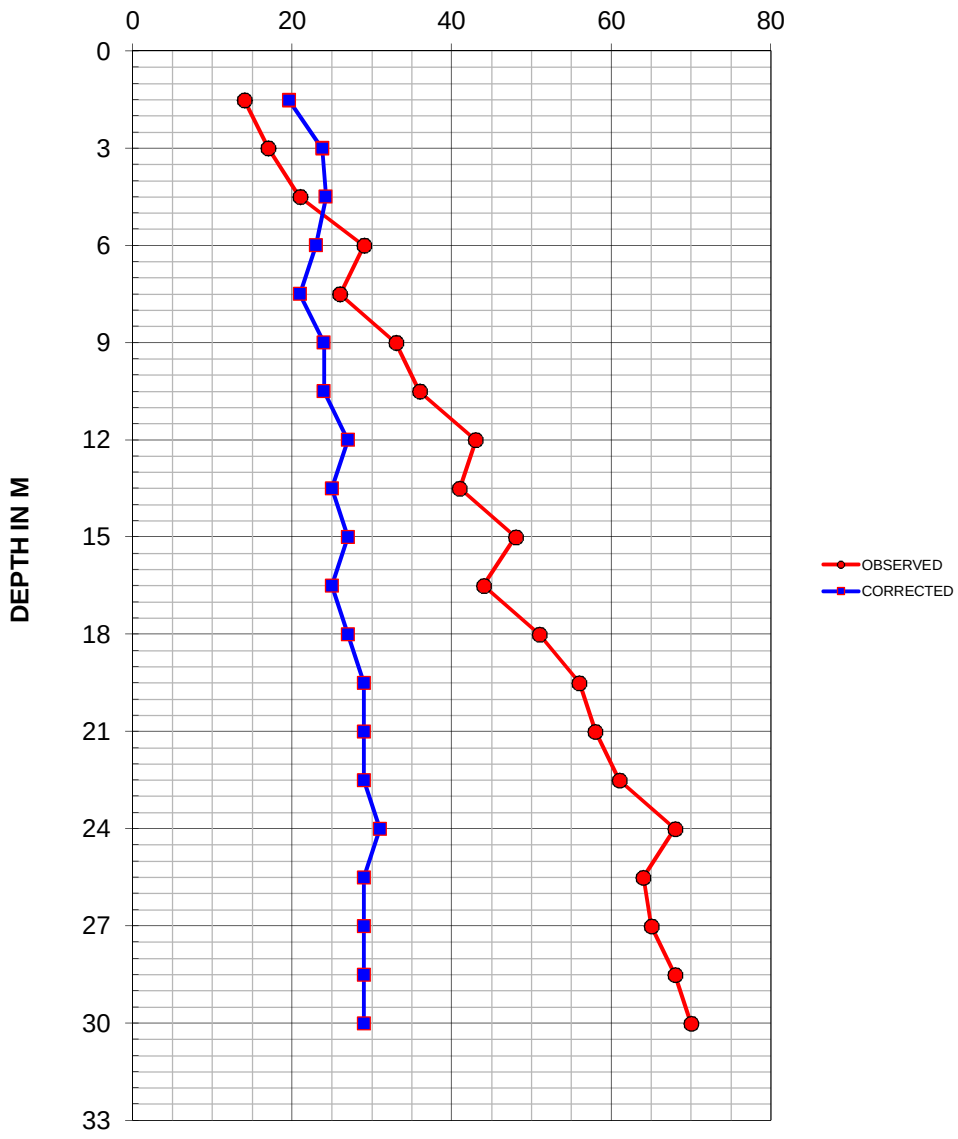
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 11



BOREHOLE NO. : 12
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.670 m

Location of Borehole : B 12 **SHEET NO : 50**
DATE STARTED : 01/02/2015
DATE COMPLETED : 02/02/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.67	0.0	DS	0.00	1		0.00 - 0.45									0.0	14.0	81.0	5.0	27	20				2.66				
203.67	1.0	SPT	1.50	1		1.50 - 1.95	11	30	11	15			Light Brown Sandy Silt of low Plasticity **(ML-CL)**															
202.67	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	11.0	84.0	5.0	26	20	1.75	1.54	13.50	2.66	0.50	10	0.137	0.727
201.67	3.0	SPT	3.00	2		3.00 - 3.45	15	30	15	21																		
200.67	4.0	SPT	4.50	3		4.50 - 4.95	16	30	16	16																		
199.67	5.0	UDS	5.50	2		5.50 - 5.95								DST+	0.0	52.0	46.0	2.0	N	P				2.64	0.00	31		
198.67	6.0	SPT	6.00	4		6.00 - 6.45	22	30	22	19			Light Gray Silty Sand **(SM)**															
197.67	7.0	SPT	7.50	5		7.50 - 7.95	29	30	29	22					0.0	66.0	34.0	0.0										
196.67	8.0	UDS	8.50	3		8.50 - 8.95								DST+					N	P	1.93	1.63	18.30	2.64	0.00	32		
195.67	9.0	SPT	9.00	6		9.00 - 9.45	39	30	39	27																		
194.67	10.0	SPT	10.50	7	4.35 m	10.50 - 10.95	36	30	36	24	150		Light Gray Sandy Silt of low Plasticity **(ML-CL)**		0.0	21.0	73.0	6.0										
193.67	11.0	UDS	11.50	4		11.50 - 11.95								UUT					25	19	1.98	1.66	19.20	2.66	1.24	10		
192.67	12.0	SPT	12.00	8		12.00 - 12.45	31	30	31	21																		
191.67	13.0	SPT	13.50	9		13.50 - 13.95	34	30	34	22			Light Gray Clayey Silt of medium Plasticity **(CI)**		0.0	2.0	72.0	26.0										
190.67	14.0	UDS	14.50	5		14.50 - 14.95								UCS					43	24	2.02	1.66	21.70	2.68	1.33			
189.67	15.0	SPT	15.00	10		15.00 - 15.45	44	30	44	26																		
188.67	16.0	SPT	16.50	11		16.50 - 16.95	49	30	49	27					0.0	52.0	45.0	3.0										
187.67	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Silty Sand **(SM)**	DST+					N	P				2.63	0.00	33		
186.67	18.0	SPT	18.00	12		18.00 - 18.45	36	30	36	21					0.0	53.0	45.0	2.0										
184.67	20.0	SPT	20.00	13		20.00 - 20.45	48	30	48	26																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

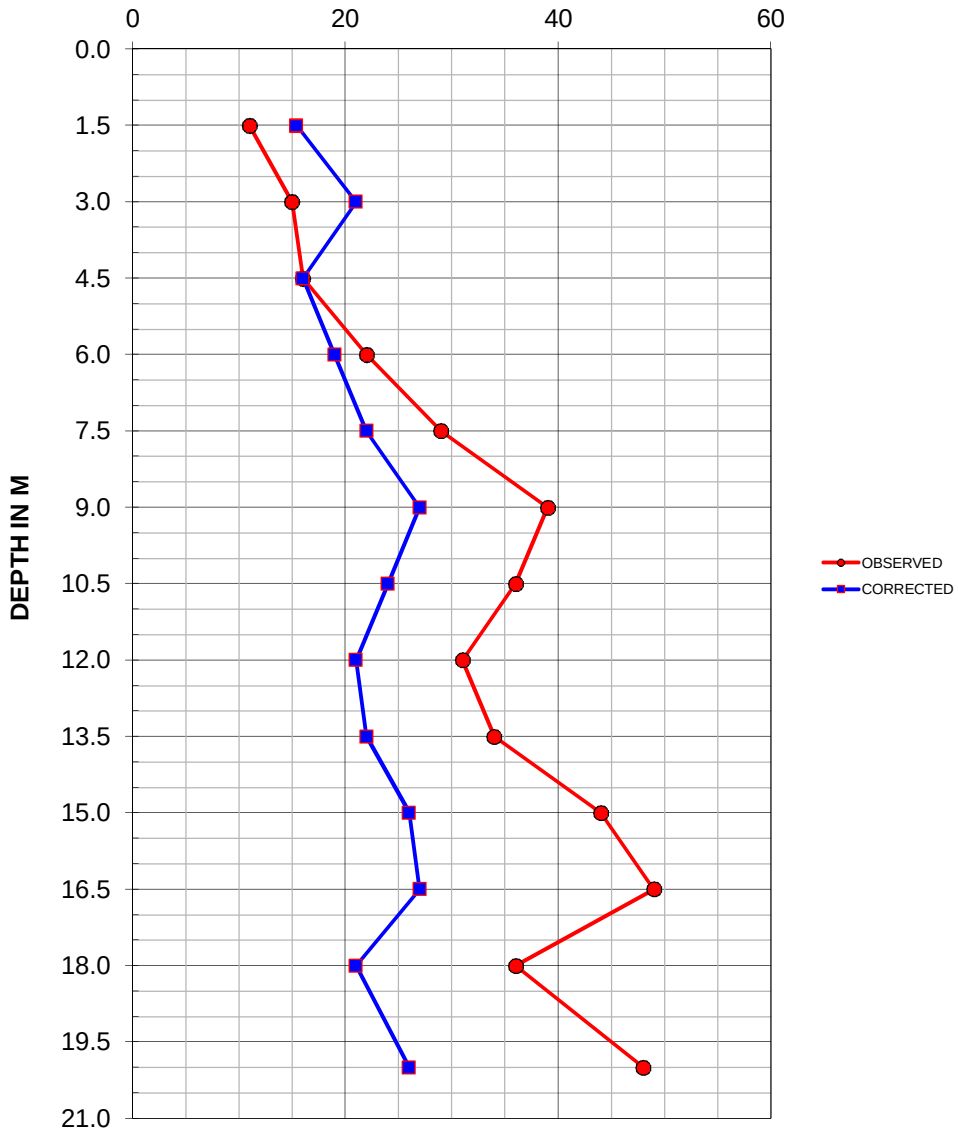
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 12



BOREHOLE NO. : 13
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.710 m

Location of Borehole : B 13 **SHEET NO : 52**
DATE STARTED : 02/02/2015
DATE COMPLETED : 03/02/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.71	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		6.0	16.0	73.0	5.0	26	20				2.66				
203.71	1.0	SPT	1.50	1		1.50 - 1.95	12	30	12	17																		
202.71	2.0	UDS	2.50	1		2.50 - 2.95								UUT	11.0	13.0	70.0	6.0			1.75	1.55	12.80	2.66	0.52	10	0.134	0.716
201.71	3.0	SPT	3.00	2		3.00 - 3.45	13	30	13	18																		
200.71	4.0	SPT	4.50	3		4.50 - 4.95	21	30	21	19																		
199.71	5.0	UDS	5.50	2		5.50 - 5.95								DST+	0.0	58.0	42.0	0.0	N	P	1.92	1.62	18.50	2.64	0.00	31		
198.71	6.0	SPT	6.00	4		6.00 - 6.45	24	30	24	20			Light Gray Silty Sand **(SM)**															
197.71	7.0	SPT	7.50	5		7.50 - 7.95	36	30	36	26																		
196.71	8.0	UDS	8.50	3		8.50 - 8.95									0.0	79.0	21.0	0.0	N	P	1.96	1.67	17.20					
195.71	9.0	SPT	9.00	6		9.00 - 9.45	39	30	39	27																		
194.71	10.0	SPT	10.50	7	4.40 m	10.50 - 10.95	28	30	28	20	150		Light Gray Sandy Silt of low Plasticity **(ML-CL)**															
193.71	11.0	UDS	11.50	4		11.50 - 11.95								UUT	0.0	12.0	82.0	6.0	27	20	1.97	1.65	19.50	2.66	1.10	9		
192.71	12.0	SPT	12.00	8		12.00 - 12.45	32	30	32	22			Light Gray Clayey Silt of medium Plasticity **(CI)**															
191.71	13.0	SPT	13.50	9		13.50 - 13.95	34	30	34	22																		
190.71	14.0	UDS	14.50	5		14.50 - 14.95								UCS	0.0	2.0	74.0	24.0	39	23	2.01	1.66	21.20	2.68	12.70			
189.71	15.0	SPT	15.00	10		15.00 - 15.45	43	30	43	25																		
188.71	16.0	SPT	16.50	11		16.50 - 16.95	46	30	46	26					0.0	67.0	33.0	0.0	N	P								
187.71	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Silty Sand **(SM)**	DST+							1.97	1.68	17.40	2.63	0.00	33		
186.71	18.0	SPT	18.00	12		18.00 - 18.45	48	30	48	26																		
184.71	20.0	SPT	20.00	13		20.00 - 20.45	53	30	53	27					0.0	69.0	31.0	0.0	N	P								

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

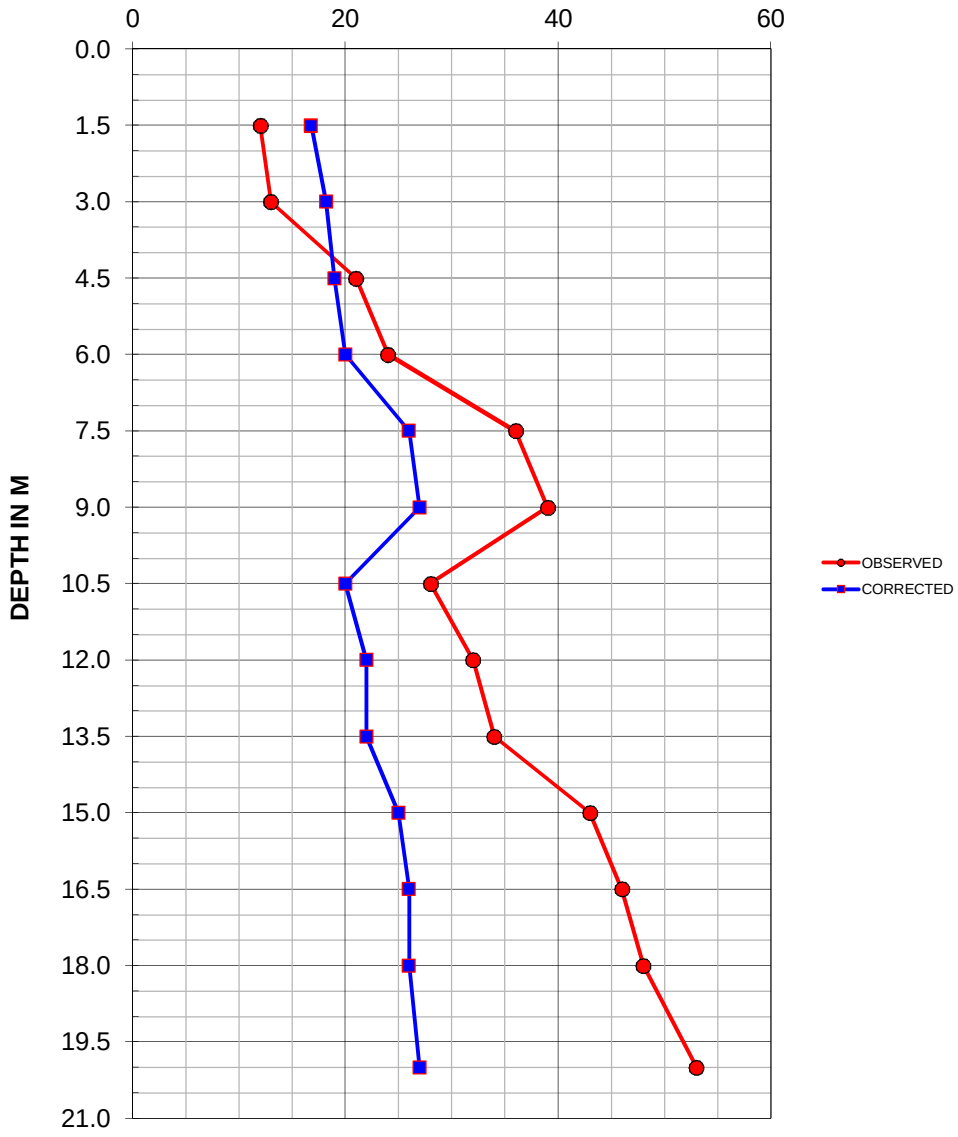
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 13



BOREHOLE NO. : 14 **Location of Borehole : B 14** **SHEET NO : 54**

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP). **DATE STARTED** : 03/02/2015

REDUCED LEVEL OF B/HOLE : **204.98** m **DATE COMPLETED** : 04/02/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.98	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		0.0	26.0	69.0	5.0						2.65				
203.98	1.0	SPT	1.50	1		1.50 - 1.95	10	30	10	14																		
202.98	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	31.0	63.0	6.0	24	19	1.73	1.53	13.20	2.65	0.48	11	0.139	0.732
201.98	3.0	SPT	3.00	2		3.00 - 3.45	15	30	15	21			Light Gray Silty Sand **(SM)**															
200.98	4.0	SPT	4.50	3		4.50 - 4.95	17	30	17	17																		
199.98	5.0	UDS	5.50	2		5.50 - 5.95								DST+	0.0	54.0	46.0	0.0	N	P				2.64	0.00	30		
198.98	6.0	SPT	6.00	4		6.00 - 6.45	24	30	24	20			Light Gray Sandy Silt of low Plasticity **(ML-CL)**															
197.98	7.0	SPT	7.50	5		7.50 - 7.95	26	30	26	21																		
196.98	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	18.0	77.0	5.0	26	20	1.97	1.65	19.20	2.66	0.95	11		
195.98	9.0	SPT	9.00	6	4.55 m	9.00 - 9.45	27	30	27	21	150																	
194.98	10.0	SPT	10.50	7		10.50 - 10.95	31	30	31	22																		
193.98	11.0	UDS	11.50	4		11.50 - 11.95							Light Gray Clayey Silt of medium Plasticity **(CI)**	UUT	0.0	6.0	72.0	22.0	39	23	2.00	1.66	20.60	2.69	1.28	9		
192.98	12.0	SPT	12.00	8		12.00 - 12.45	28	30	28	20																		
191.98	13.0	SPT	13.50	9		13.50 - 13.95	31	30	31	21																		
190.98	14.0	UDS	14.50	5		14.50 - 14.95									0.0	7.0	74.0	19.0	41	24	2.00	1.67	19.80					
189.98	15.0	SPT	15.00	10		15.00 - 15.45	44	30	44	26																		
188.98	16.0	SPT	16.50	11		16.50 - 16.95	47	30	47	26					0.0	69.0	31.0	0.0	N	P								
187.98	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Silty Sand **(SM)**	DST+										2.63	0.00	34		
186.98	18.0	SPT	18.00	12		18.00 - 18.45	45	30	45	25														.				
184.98	20.0	SPT	20.00	13		20.00 - 20.45	49	30	49	26					0.0	67.0	33.0	0.0	N	P								

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

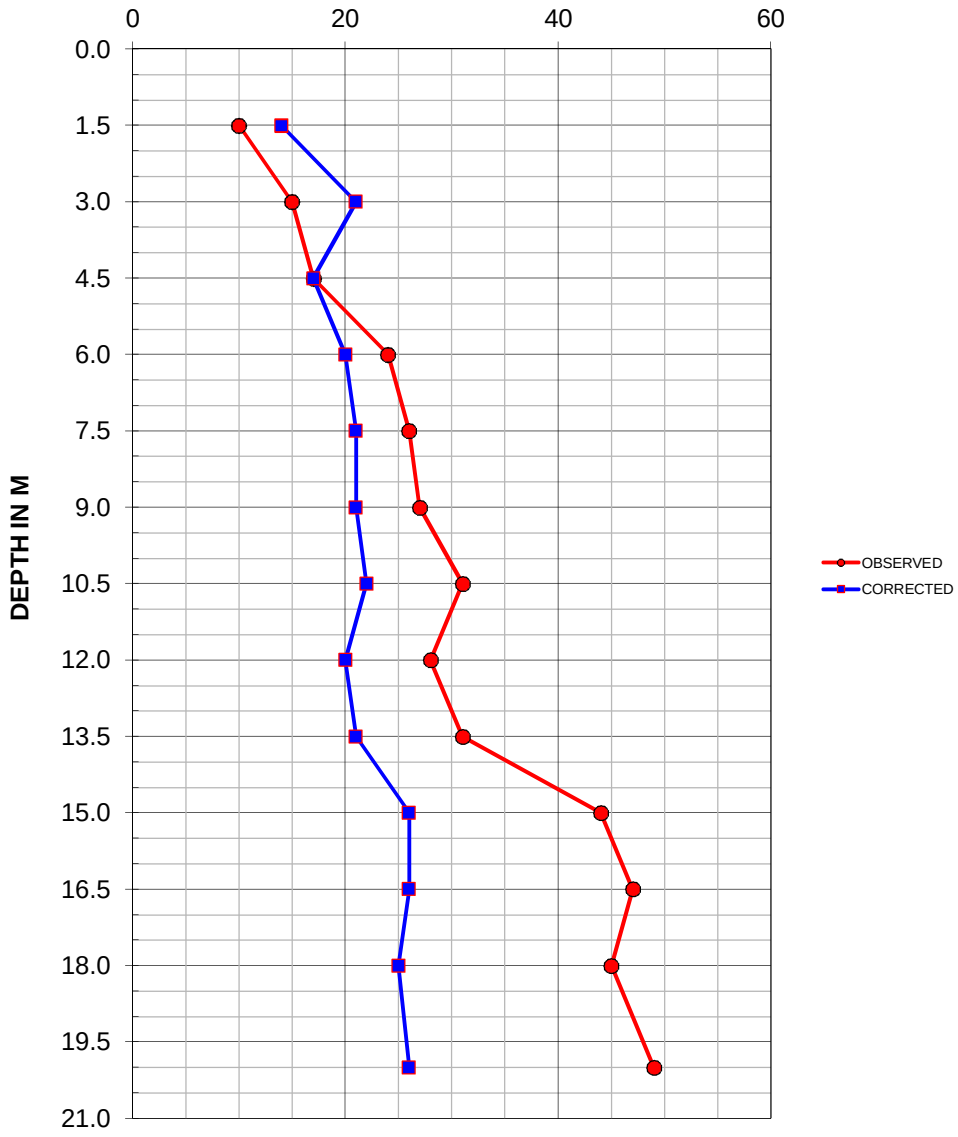
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 14



BOREHOLE NO. : 15
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.390 m

Location of Borehole : **B 15**
DATE STARTED : 06/02/2015
DATE COMPLETED : 06/02/2015

SHEET NO : **56**

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.39	0.0	DS	0.00	1		0.00 - 0.45									0.0	17.0	77.0	6.0						2.65				
204.39	1.0	SPT	1.50	1		1.50 - 1.95	10	30	10	14			Light Brown Sandy Silt of low Plasticity **(ML-CL)**															
203.39	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	18.0	77.0	5.0	26	20	1.76	1.54	14.20	2.65	0.50	9	0.135	0.721
202.39	3.0	SPT	3.00	2		3.00 - 3.45	14	30	14	20																		
201.39	4.0	SPT	4.50	3		4.50 - 4.95	18	30	18	17																		
200.39	5.0	UDS	5.50	2		5.50 - 5.95									0.0	62.0	38.0	0.0	N	P				2.64				
199.39	6.0	SPT	6.00	4		6.00 - 6.45	21	30	21	19			Light Gray Silty Sand **(SM)**															
198.39	7.0	SPT	7.50	5		7.50 - 7.95	28	30	28	22																		
197.39	8.0	UDS	8.50	3		8.50 - 8.95								DST+	0.0	67.0	33.0	0.0	N	P	1.92	1.63	17.50	2.64	0.00	32		
196.39	9.0	SPT	9.00	6		9.00 - 9.45	24	30	24	19																		
195.39	10.0	SPT	10.50	7	4.55 m	10.50 - 10.95	27	30	27	20	150		Light Gray Sandy Silt of low Plasticity **(ML-CL)**															
194.39	11.0	UDS	11.50	4		11.50 - 11.95								UUT	0.0	17.0	77.0	6.0	26	19	1.97	1.65	19.20	2.66	1.02	10		
193.39	12.0	SPT	12.00	8		12.00 - 12.45	34	30	34	23																		
192.39	13.0	SPT	13.50	9		13.50 - 13.95	31	30	31	21			Light Gray Clayey Silt of medium Plasticity **(CI)**															
191.39	14.0	UDS	14.50	5		14.50 - 14.95								UCS	0.0	4.0	73.0	23.0	40	23	2.02	1.66	21.70	2.69	1.38			
190.39	15.0	SPT	15.00	10		15.00 - 15.45	44	30	44	26																		
189.39	16.0	SPT	16.50	11		16.50 - 16.95	48	30	48	27																		
188.39	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Silty Sand **(SM)**	DST+	0.0	68.0	32.0	0.0	N	P	1.97	1.68	17.30	2.63	0.00	34		
187.39	18.0	SPT	18.00	12		18.00 - 18.45	50	30	50	27														.				
185.39	20.0	SPT	20.00	13		20.00 - 20.45	53	30	53	28																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

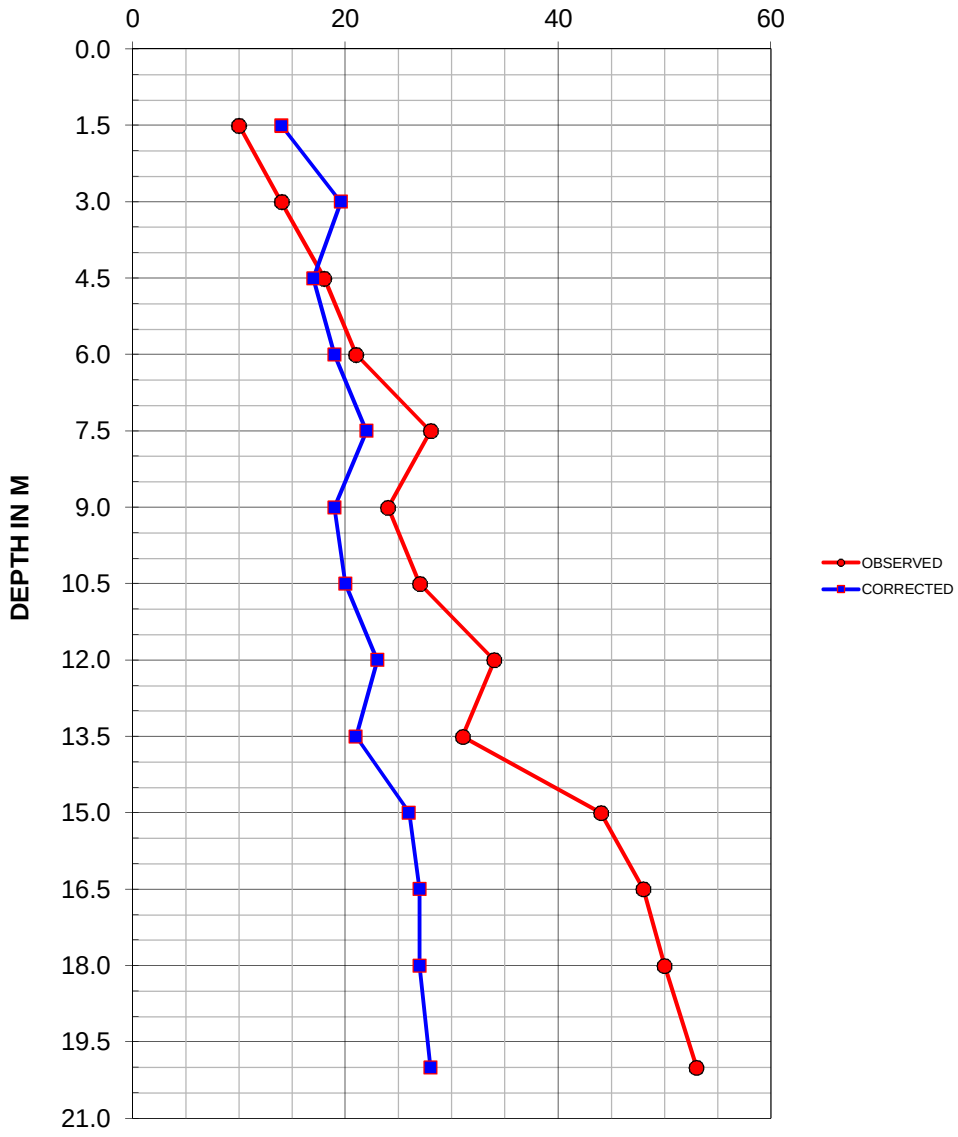
SGEPL

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 15



BOREHOLE NO. : 16
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.550 m

Location of Borehole : B16 **SHEET NO : 58**
DATE STARTED : 06/02/2015
DATE COMPLETED : 07/02/2015

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/Sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.55	0.0	DS	0.00	1		0.00 - 0.45									0.0	16.0	79.0	5.0										
204.55	1.0	SPT	1.50	1		1.50 - 1.95	11	30	11	15			Light Brown Sandy Silt of low Plasticity **(ML-CL)**															
203.55	2.0	UDS	2.50	1		2.50 - 2.95								UUT	3.0	14.0	77.0	6.0	26	20	1.76	1.55	13.70	2.66	0.51	10	0.135	0.718
202.55	3.0	SPT	3.00	2		3.00 - 3.45	13	30	13	18																		
201.55	4.0	SPT	4.50	3		4.50 - 4.95	16	30	16	18																		
200.55	5.0	UDS	5.50	2		5.50 - 5.95							Light Grayish Silty Sand **(SM)**	DST+	0.0	62.0	38.0	0.0	N	P				2.63	0.00	30		
199.55	6.0	SPT	6.00	4		6.00 - 6.45	20	30	20	18																		
198.55	7.0	SPT	7.50	5		7.50 - 7.95	22	30	22	19																		
197.55	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	17.0	77.0	6.0	26	20	1.95	1.63	19.90	2.67	0.90	9		
196.55	9.0	SPT	9.00	6		9.00 - 9.45	27	30	27	20																		
195.55	10.0	SPT	10.50	7	4.60 m	10.50 - 10.95	30	30	30	21	150		Light Gray Sandy Silt of low plasticity **(ML-CL)**															
194.55	11.0	UDS	11.50	4		11.50 - 11.95									0.0	18.0	76.0	6.0	25	19	1.99	1.66	19.70					
193.55	12.0	SPT	12.00	8		12.00 - 12.45	30	30	30	21																		
192.55	13.0	SPT	13.50	9		13.50 - 13.95	25	30	25	18			Light Gray Clayey Silt of Medium Plasticity **(CI)**															
191.55	14.0	UDS	14.50	5		14.50 - 14.95								UUT	0.0	3.0	76.0	21.0	40	24	2.01	1.65	21.90	2.69	1.25	9		
190.55	15.0	SPT	15.00	10		15.00 - 15.45	28	30	28	19																		
189.55	16.0	SPT	16.50	11		16.50 - 16.95	44	30	44	25																		
188.55	17.0	UDS	17.50	6		17.50 - 17.95							Light Grayish Silty Sand **(SM)**	DST+	0.0	54.0	46.0	0.0	N	P				2.63	0.00	33		
187.55	18.0	SPT	18.00	12		18.00 - 18.45	48	30	48	26																		
186.55	19.0																											

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

BORE LOG CHART AND DATA SHEET

BOREHOLE NO. : 16
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.550 m

Location of Borehole : B16
DATE STARTED : 06/02/2015
DATE COMPLETED : 16/12/2014

SHEET NO : 59

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS: DEPTH IN METERS	SPT: NO. OF BLOWS	SPT: PENETRATION (CM)	SPT: N, VALUE (Recorded)	SPT: N, VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS: GRAVEL (%)	GRAIN SIZE ANALYSIS: SAND (%)	GRAIN SIZE ANALYSIS: SILT (%)	GRAIN SIZE ANALYSIS: CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS: Cohesion, C, (Kg/sqcm)	SHEAR STRENGTH CHARACTERISTICS: Angle of friction (Degrees)	CONSOLIDATION TEST PARAMETERS: COMPRESSION INDEX Cc	CONSOLIDATION TEST PARAMETERS: VOID RATIO e0
185.55	19.0																												
185.55	20.0	SPT	19.50	13		19.50 - 19.95	50	30	50	26																			
		UDS	20.50	7		20.50 - 20.95									0.0	59.0	41.0	0.0	N	P								
184.55	21.0	SPT	21.00	14		21.00 - 21.45	56	30	56	28																			
183.55	22.0	SPT	22.50	15		22.50 - 22.95	51	30	51	25																			
182.55	23.0	UDS	23.50	8		23.50 - 23.95								DST+	0.0	68.0	32.0	0.0	N	P	1.98	1.69	17.20	2.64	0.0	34		
181.55	24.0	SPT	24.00	16	4.60 m	24.00 - 24.45	55	30	55	26	150		Light Grayish Silty Fine Sand **(SM)**																
180.55	25.0	SPT	25.50	17		25.50 - 25.95	58	30	58	27																			
179.55	26.0	UDS	26.50	9		26.50 - 26.95									0.0	77.0	23.0	0.0	N	P								
178.55	27.0	SPT	27.00	18		27.00 - 27.45	59	30	59	27																			
177.55	28.0	SPT	28.50	19		28.50 - 28.95	62	30	62	27																			
176.55	29.0	UDS	29.50	10		29.50 - 29.95									0.0	78.0	22.0	0.0	N	P				2.63				
175.55	30.0	SPT	30.00	20		30.00 - 30.45	68	30	68	28																			
175.10	30.5																												

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

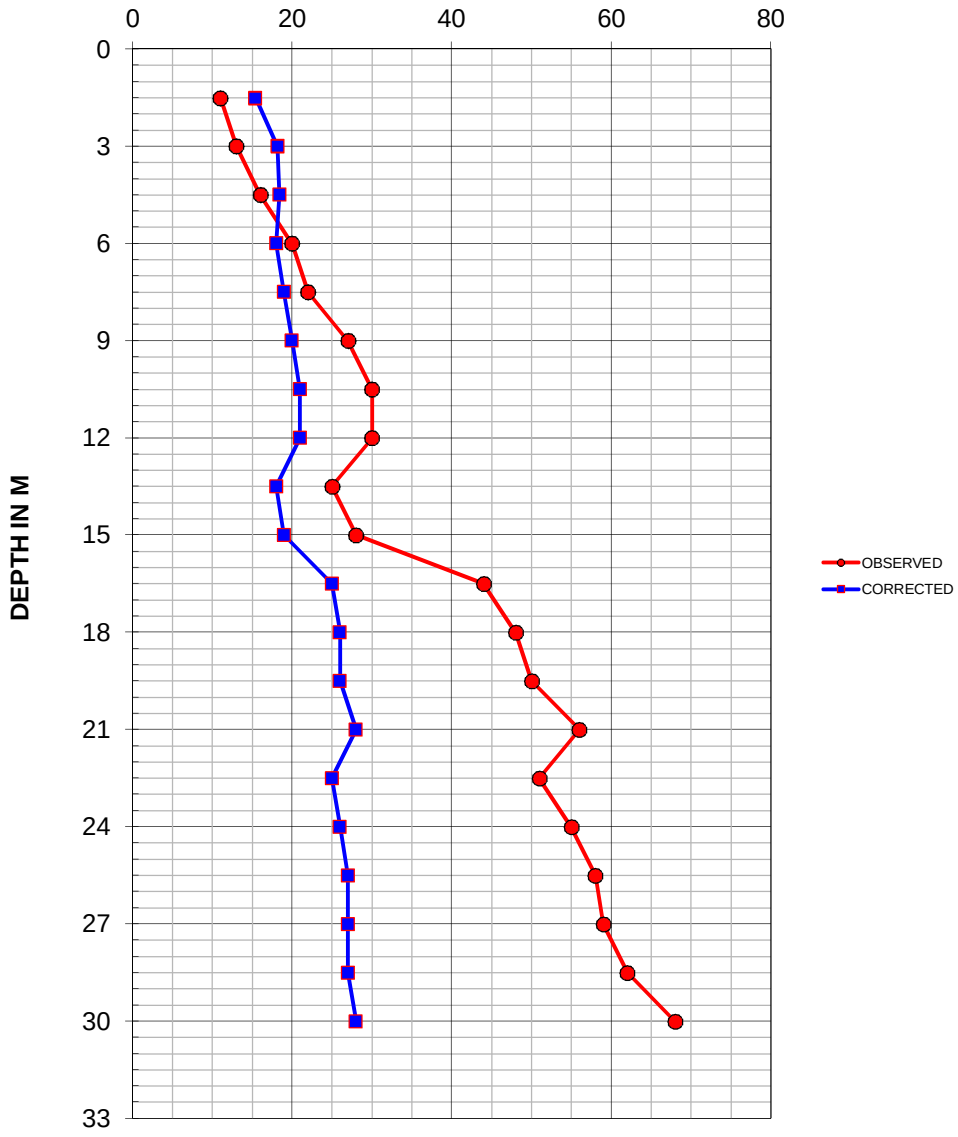
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 16



BOREHOLE NO. : 17
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 205.520 m

Location of Borehole : B 17
DATE STARTED : 08/02/2015
DATE COMPLETED : 08/02/2015

SHEET NO : 61

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
205.52	0.0	DS	0.00	1		0.00 - 0.45									0.0	17.0	77.0	6.0						2.65				
204.52	1.0	SPT	1.50	1		1.50 - 1.95	11	30	11	15			Light Brown Sandy Silt of low Plasticity **(ML-CL)**															
203.52	2.0	UDS	2.50	1		2.50 - 2.95								UUT	0.0	16.0	79.0	5.0	26	20	1.74	1.53	13.50	2.66	0.45	12	0.141	0.739
202.52	3.0	SPT	3.00	2		3.00 - 3.45	13	30	13	18																		
201.52	4.0	SPT	4.50	3		4.50 - 4.95	17	30	17	17																		
200.52	5.0	UDS	5.50	2		5.50 - 5.95									0.0	56.0	44.0	0.0	N	P				2.63				
199.52	6.0	SPT	6.00	4		6.00 - 6.45	19	30	19	17			Light Gray Silty Sand **(SM)**															
198.52	7.0	SPT	7.50	5		7.50 - 7.95	22	30	22	19																		
197.52	8.0	UDS	8.50	3		8.50 - 8.95								DST+	0.0	62.0	38.0	0.0	N	P	1.90	1.61	18.30		0.00	31		
196.52	9.0	SPT	9.00	6		9.00 - 9.45	21	30	21	18																		
195.52	10.0	SPT	10.50	7	4.60 m	10.50 - 10.95	25	30	25	19	150		Light Gray Sandy Silt of low Plasticity **(ML-CL)**															
194.52	11.0	UDS	11.50	4		11.50 - 11.95								UUT	0.0	14.0	81.0	5.0	26	19	1.96	1.64	19.60	2.66	0.98	10		
193.52	12.0	SPT	12.00	8		12.00 - 12.45	28	30	28	20																		
192.52	13.0	SPT	13.50	9		13.50 - 13.95	23	30	23	17			Light Gray Clayey Silt of medium Plasticity **(CI)**															
191.52	14.0	UDS	14.50	5		14.50 - 14.95								UCS	0.0	4.0	76.0	20.0	39	23	2.00	1.65	21.20	2.69	1.20			
190.52	15.0	SPT	15.00	10		15.00 - 15.45	45	30	45	26																		
189.52	16.0	SPT	16.50	11		16.50 - 16.95	48	30	48	27																		
188.52	17.0	UDS	17.50	6		17.50 - 17.95							Light Gray Silty Sand **(SM)**	DST+	0.0	64.0	36.0	0.0	N	P				2.63	0.00	33		
187.52	18.0	SPT	18.00	12		18.00 - 18.45	43	30	43	24														.				
185.52	20.0	SPT	20.00	13		20.00 - 20.45	50	30	50	27																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

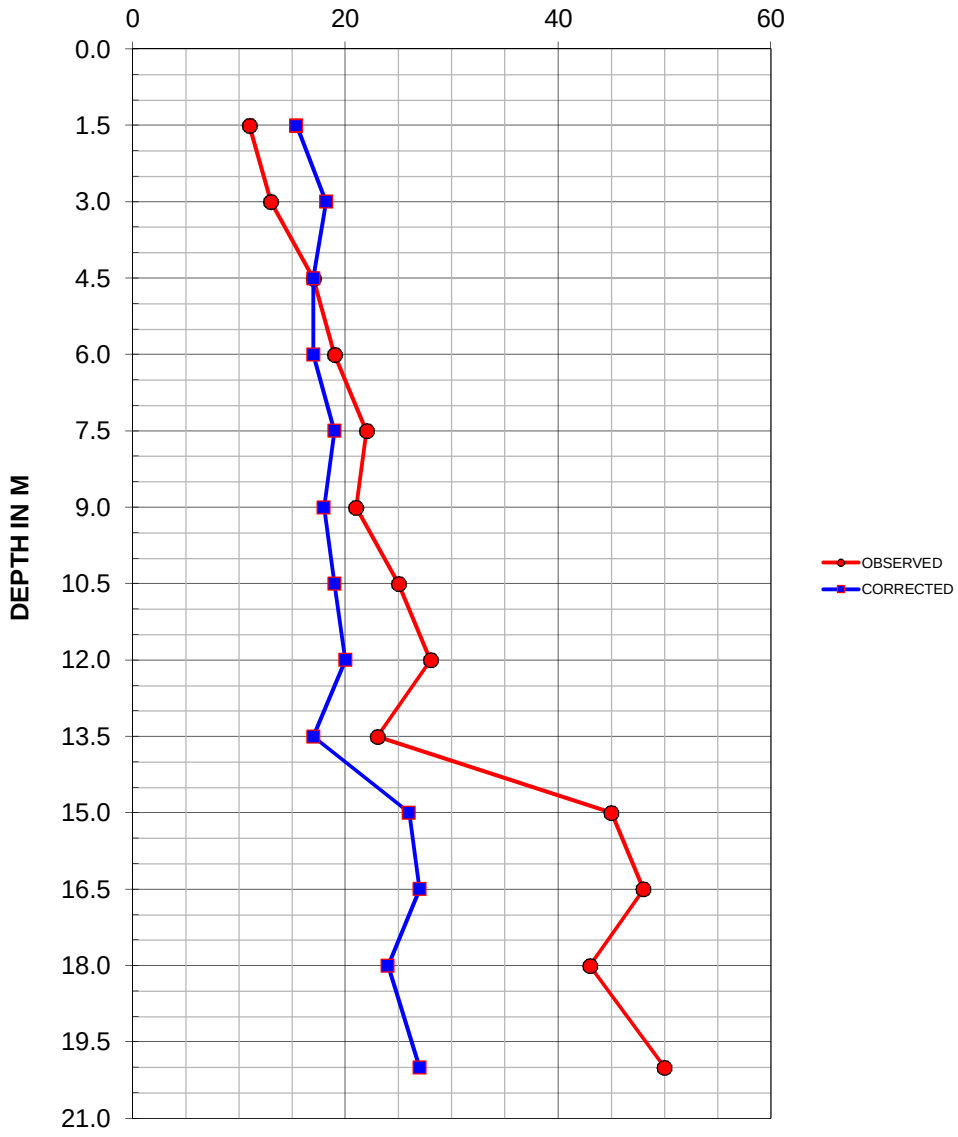
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 17



BOREHOLE NO. : 20
Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).
REDUCED LEVEL OF B/HOLE : 204.150 m

Location of Borehole : B 20
DATE STARTED : 05/02/2015
DATE COMPLETED : 05/02/2015

SHEET NO : 63

FIELD TEST RESULTS | LABORATORY TEST RESULTS

ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L	SPT TEST RESULTS					DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	TYPE OF TEST CONDUCTED IN THE LABORATORY	GRAIN SIZE ANALYSIS				LIQUID LIMIT (%)	PLASTIC LIMIT (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR STRENGTH CHARACTERISTICS		CONSOLIDATION TEST PARAMETERS	
						DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)					GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)							Cohesion, C, (Kg/Sqcm)	Angle of friction (Degrees)	COMPRESSION INDEX Cc	VOID RATIO e0
204.15	0.0	DS	0.00	1		0.00 - 0.45							Light Brown Sandy Silt of low Plasticity **(ML-CL)**		0.0	26.0	68.0	6.0	24	19				2.66				
203.15	1.0	SPT	1.50	1		1.50 - 1.95	8	30	8	11																		
202.15	2.0	UDS	2.50	1		2.50 - 2.95								DST+	0.0	54.0	46.0	0.0	N	P	1.71	1.53	11.50		0.00	29		
201.15	3.0	SPT	3.00	2		3.00 - 3.45	14	30	14	20			Light Gray Silty Sand **(SM)**															
200.15	4.0	SPT	4.50	3		4.50 - 4.95	17	30	17	17					0.0	61.0	39.0	0.0	N	P				2.63				
199.15	5.0	UDS	5.50	2		5.50 - 5.95																						
198.15	6.0	SPT	6.00	4		6.00 - 6.45	20	30	20	18			Grayish Clayey Silt **(CI)**		0.0	3.0	74.0	23.0	40	22				2.68				
197.15	7.0	SPT	7.50	5		7.50 - 7.95	25	30	25	20																		
196.15	8.0	UDS	8.50	3		8.50 - 8.95								UUT	0.0	21.0	74.0	5.0	25	19	1.96	1.65	18.70	2.66	0.90	12		
195.15	9.0	SPT	9.00	6		9.00 - 9.45	27	30	27	21			Light Gray Sandy Silt of low Plasticity **(ML-CL)**															
194.15	10.0	SPT	10.50	7	4.60 m	10.50 - 10.95	30	30	30	21	150																	
193.15	11.0	UDS	11.50	4		11.50 - 11.95									0.0	23.0	72.0	5.0	25	20	1.96	1.66	18.30					
192.15	12.0	SPT	12.00	8		12.00 - 12.45	38	30	38	25																		
191.15	13.0	SPT	13.50	9		13.50 - 13.95	41	30	41	25																		
190.15	14.0	UDS	14.50	5		14.50 - 14.95									0.0	66.0	34.0	0.0	N	P				2.64				
189.15	15.0	SPT	15.00	10		15.00 - 15.45	43	30	43	25			Light Gray Silty Sand **(SM)**															
188.15	16.0	SPT	16.50	11		16.50 - 16.95	44	30	44	25																		
187.15	17.0	UDS	17.50	6		17.50 - 17.95								DST+	0.0	73.0	27.0	0.0	N	P	1.96	1.68	16.80	2.63	0.00	33		
186.15	18.0	SPT	18.00	12		18.00 - 18.45	48	30	48	26														.				
184.15	20.0	SPT	20.00	13		20.00 - 20.45	53	30	53	27																		

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

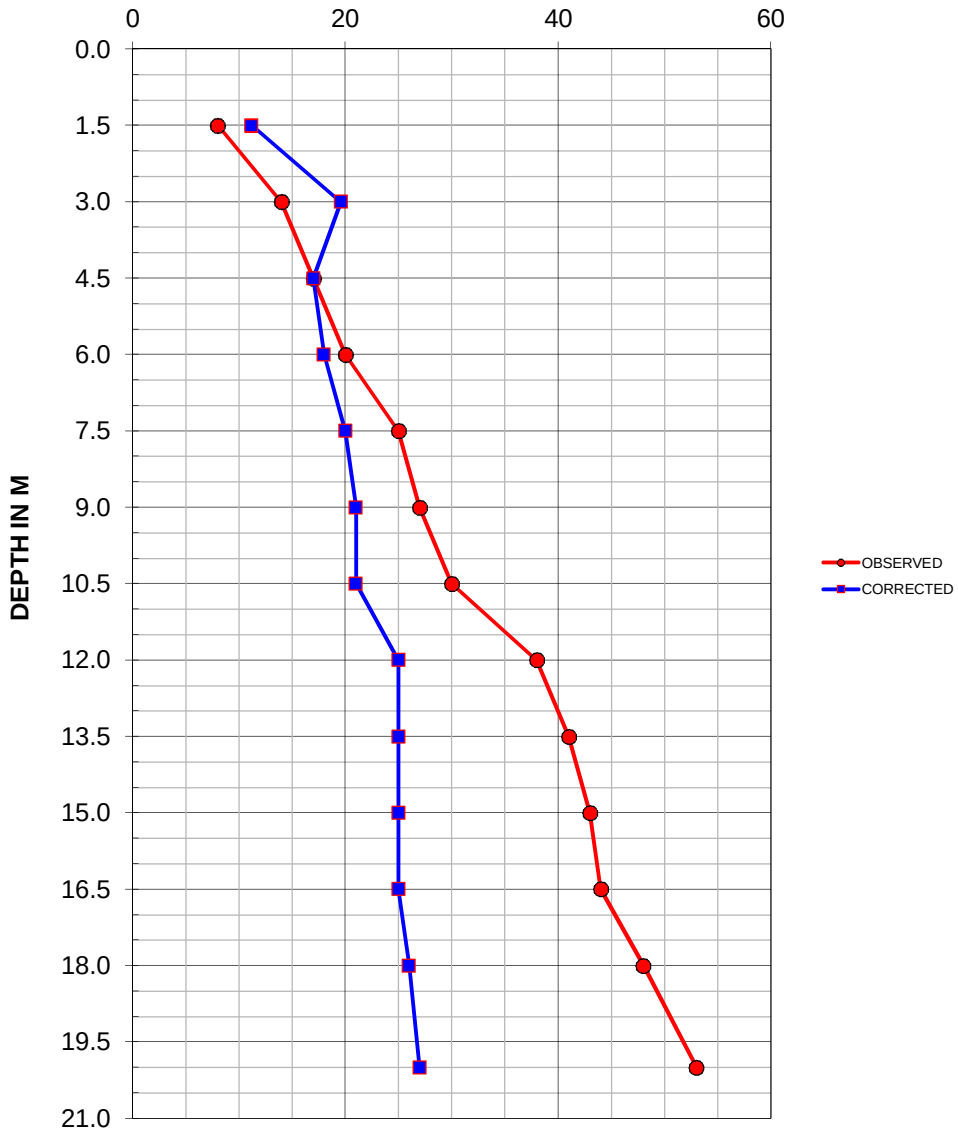
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 20

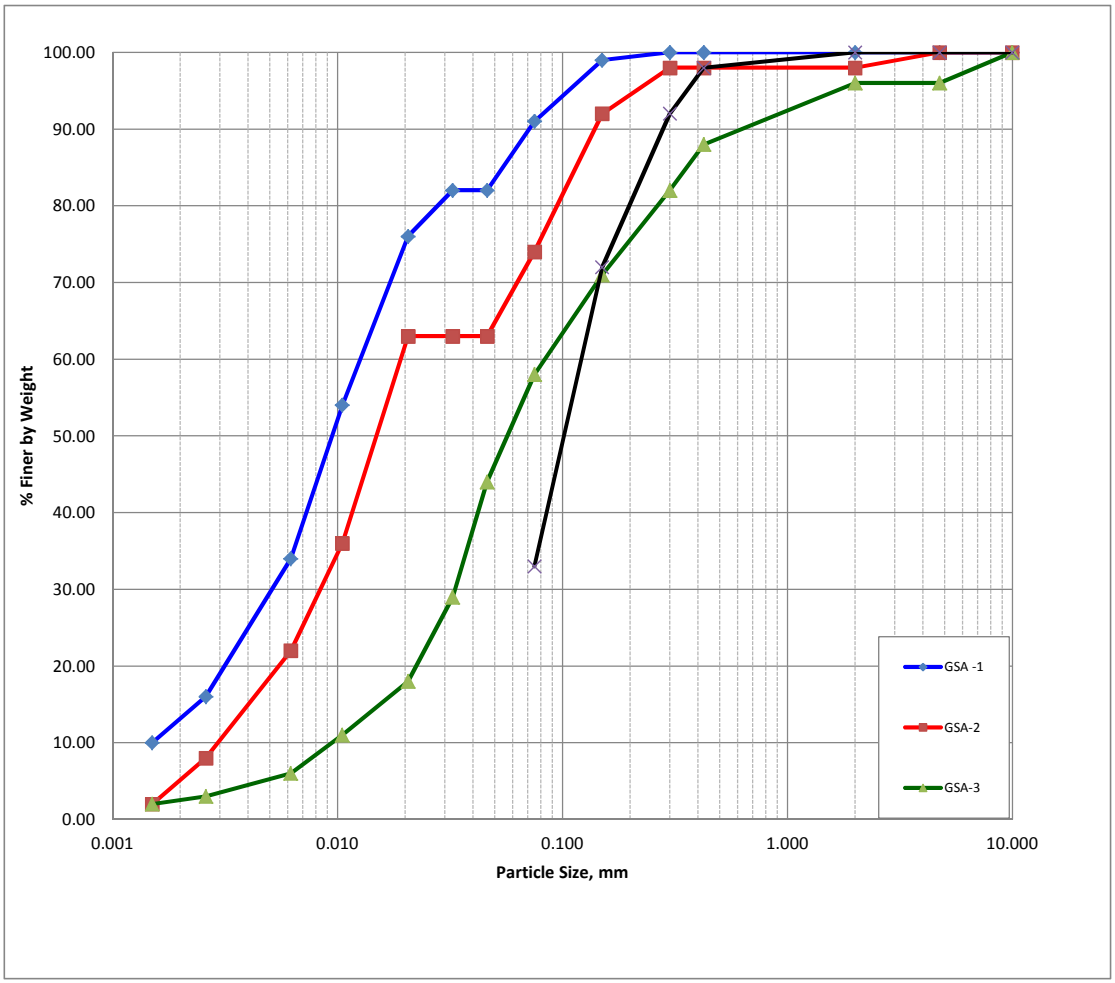


SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B1	2.50	CL	0.0	9.0	78.0	13.0	0.013	0.002	8.92	0.66
B1	11.50	ML-CL	0.0	26.0	69.0	5.0	0.029	0.002	12.09	0.82
B1	17.50	ML	4.0	38.0	55.0	3.0	0.083	0.008	9.86	1.59
B1	20.50	SM	0.0	67.0	33.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.045375	**0.375**
0.300	100.00	0.0	0.363	0.000		
0.150	99.00	1.0	0.225	0.225		
0.075	91.00	8.0	0.113	0.900		
PAN		91.0	0.038	3.413		
		100.0		4.538		

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **11.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **17.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **20.50 m**

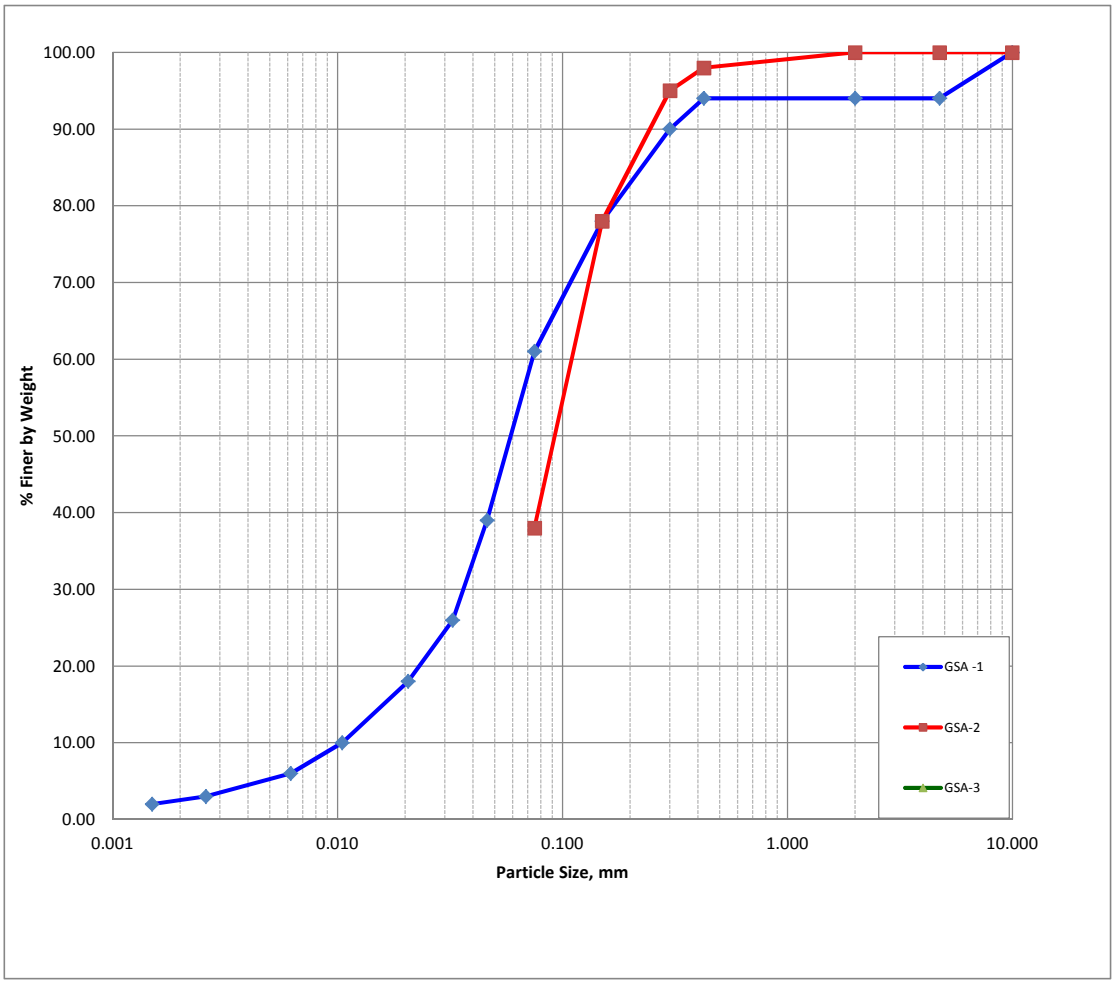
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B1	20.50	ML	6.0	33.0	58.0	3.0	0.073	0.011	6.97	1.66
B1	25.50	SM	0.0	62.0	38.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **20.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	94.00	6.0	7.375	44.250		
2.250	94.00	0.0	3.500	0.000		
0.425	94.00	0.0	1.338	0.000	0.526	**1.276**
0.300	90.00	4.0	0.363	1.450		
0.150	78.00	12.0	0.225	2.700		
0.075	61.00	17.0	0.113	1.913		
PAN		61.0	0.038	2.288		
		100.0		52.600		

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **25.50** m

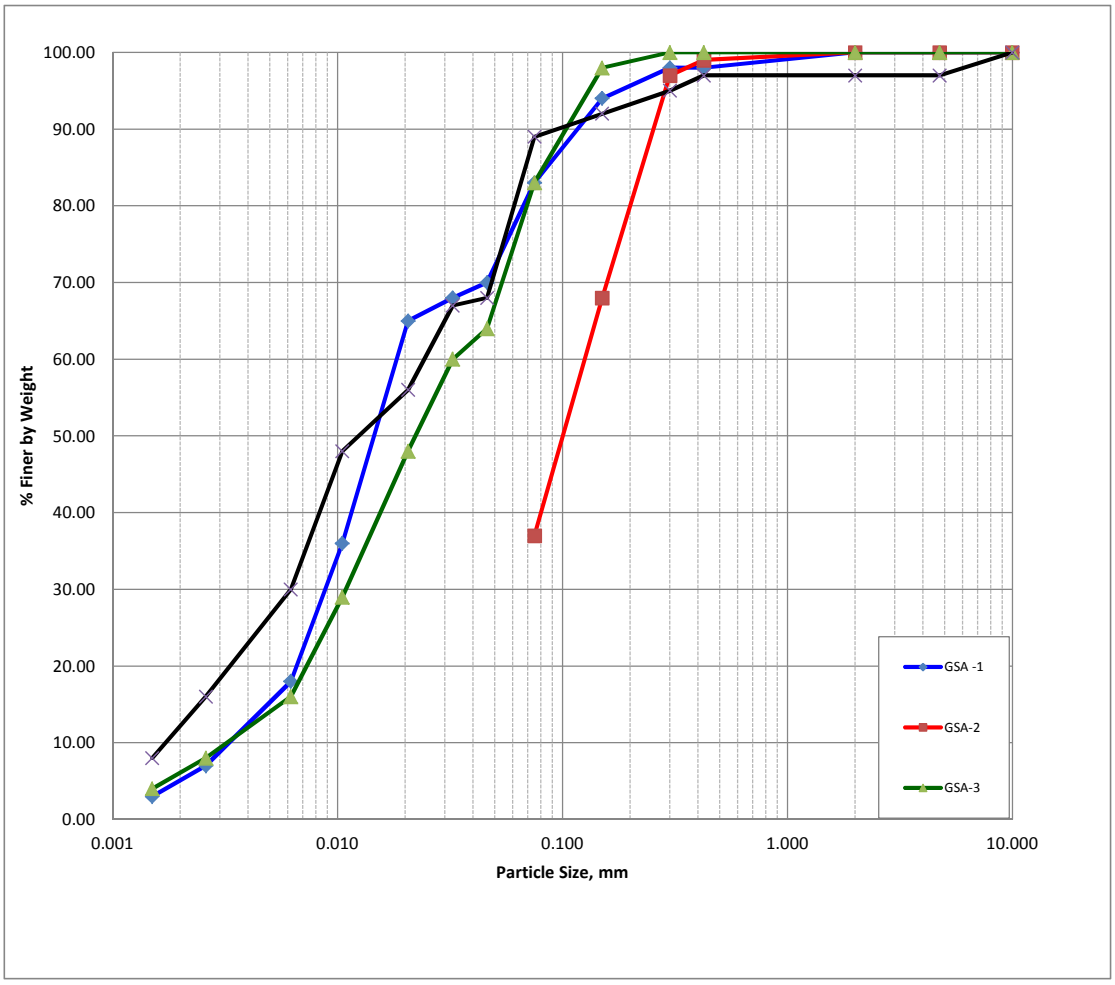
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B1	3.00	ML-CL	0.0	17.0	78.0	5.0	0.025	0.002	10.81	0.98
B1	5.50	SM	0.0	63.0	37.0	0.0	0.125	0.041	3.08	0.80
B1	8.50	ML-CL	0.0	17.0	77.0	6.0	0.033	0.002	13.58	1.52
B1	17.50	CL	3.0	8.0	77.0	12.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **3.00** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	98.00	2.0	1.338	2.675	0.07925	**0.495**
0.300	98.00	0.0	0.363	0.000		
0.150	94.00	4.0	0.225	0.900		
0.075	83.00	11.0	0.113	1.238		
PAN		83.0	0.038	3.113		
		100.0		7.925		

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **8.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B1**

DEPTH OF SAMPLE **17.50 m**

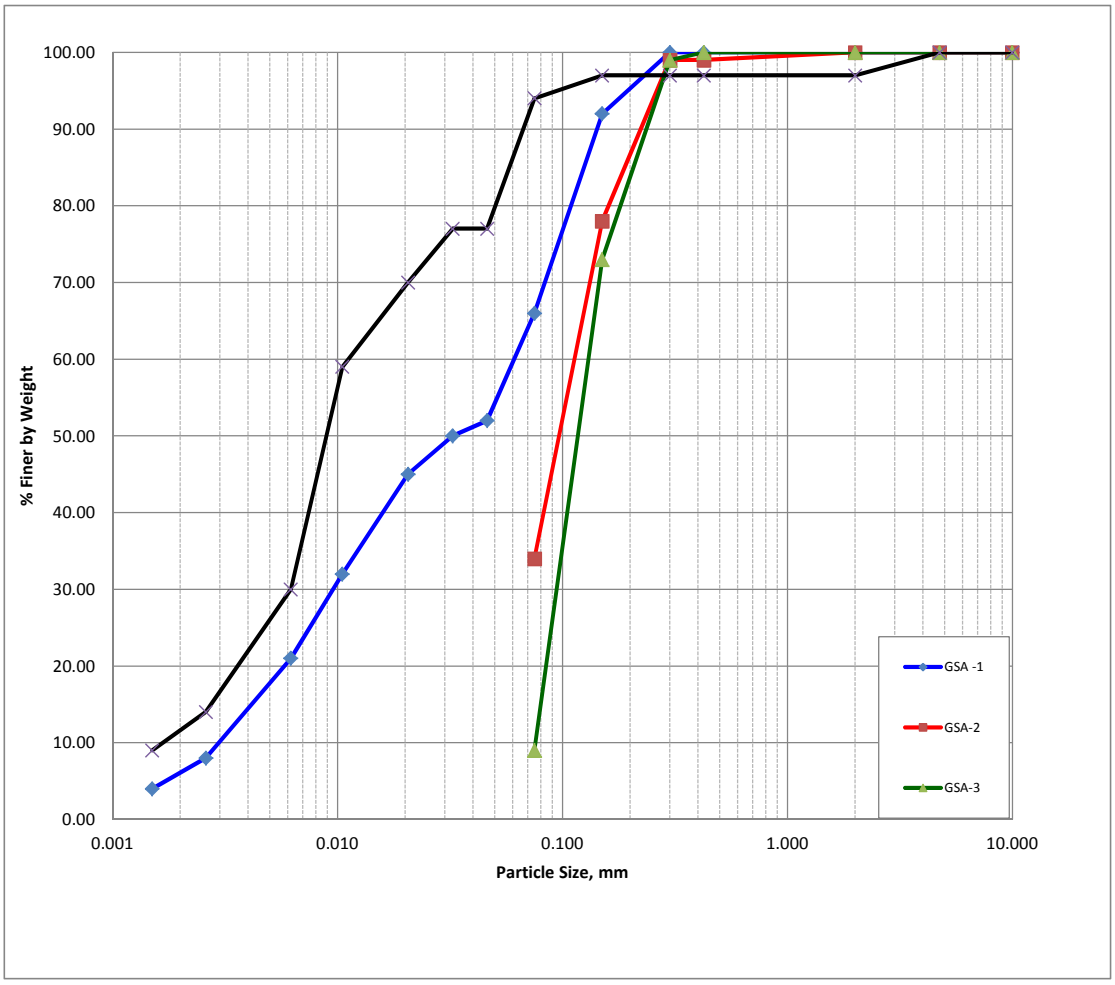
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B5	2.50	ML-CL	0.0	34.0	60.0	6.0	0.055	0.002	24.08	0.67
B5	4.50	SM	0.0	66.0	34.0	0.0				
B5	6.00	SP-SM	0.0	91.0	9.0	0.0				
B5	14.50	CL	0.0	6.0	82.0	12.0	0.011	0.002	7.17	0.66

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.072	**0.472**
0.300	100.00	0.0	0.363	0.000		
0.150	92.00	8.0	0.225	1.800		
0.075	66.00	26.0	0.113	2.925		
PAN		66.0	0.038	2.475		
		100.0		7.200		

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **4.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **6.00 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **14.50 m**

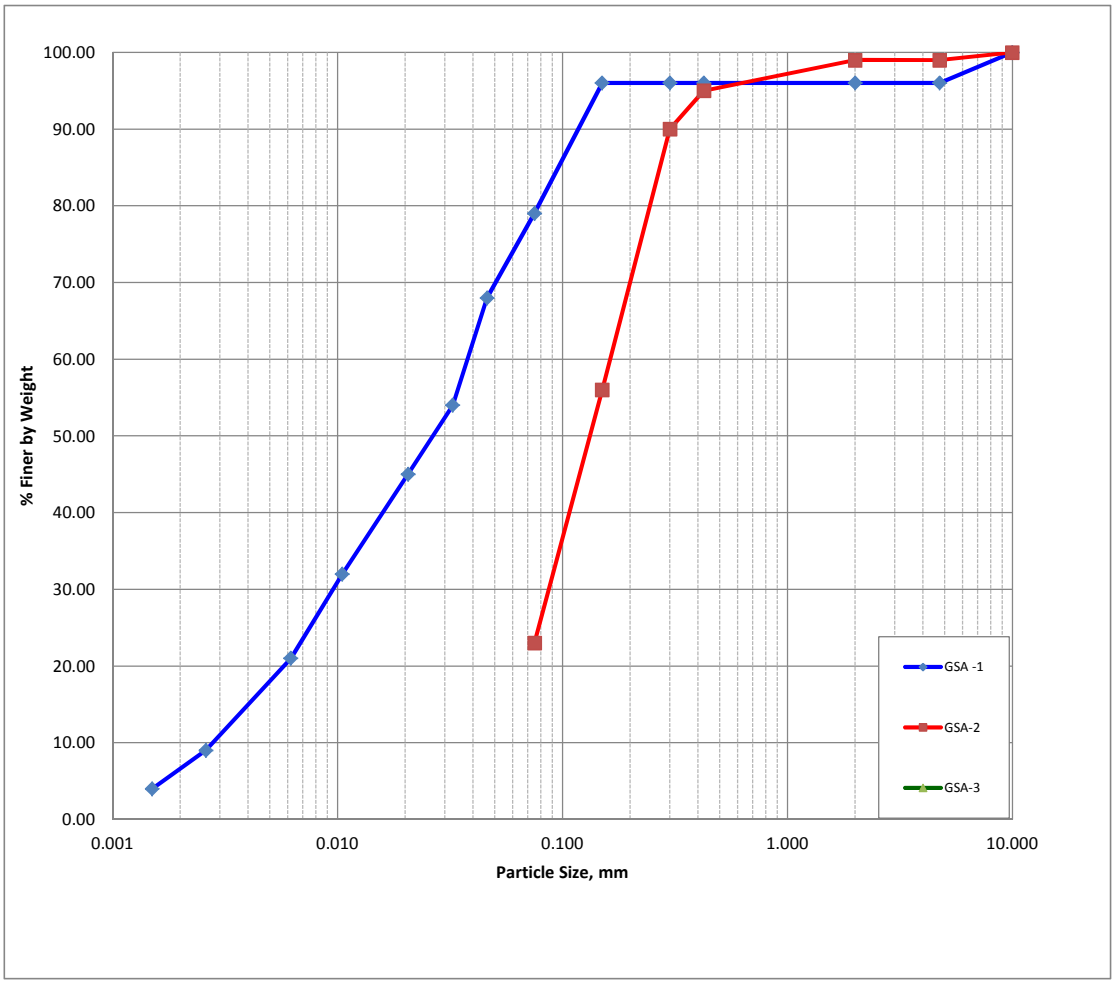
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B5	16.50	ML-CL	4.0	17.0	72.0	7.0	0.040	0.002	17.45	0.92
B5	26.50	SM	1.0	76.0	23.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **16.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	96.00	4.0	7.375	29.500		
2.250	96.00	0.0	3.500	0.000		
0.425	96.00	0.0	1.338	0.000	0.34375	**1.032**
0.300	96.00	0.0	0.363	0.000		
0.150	96.00	0.0	0.225	0.000		
0.075	79.00	17.0	0.113	1.913		
PAN		79.0	0.038	2.963		
		100.0		34.375		

BORE HOLE NO. **B5**

DEPTH OF SAMPLE **26.50** m

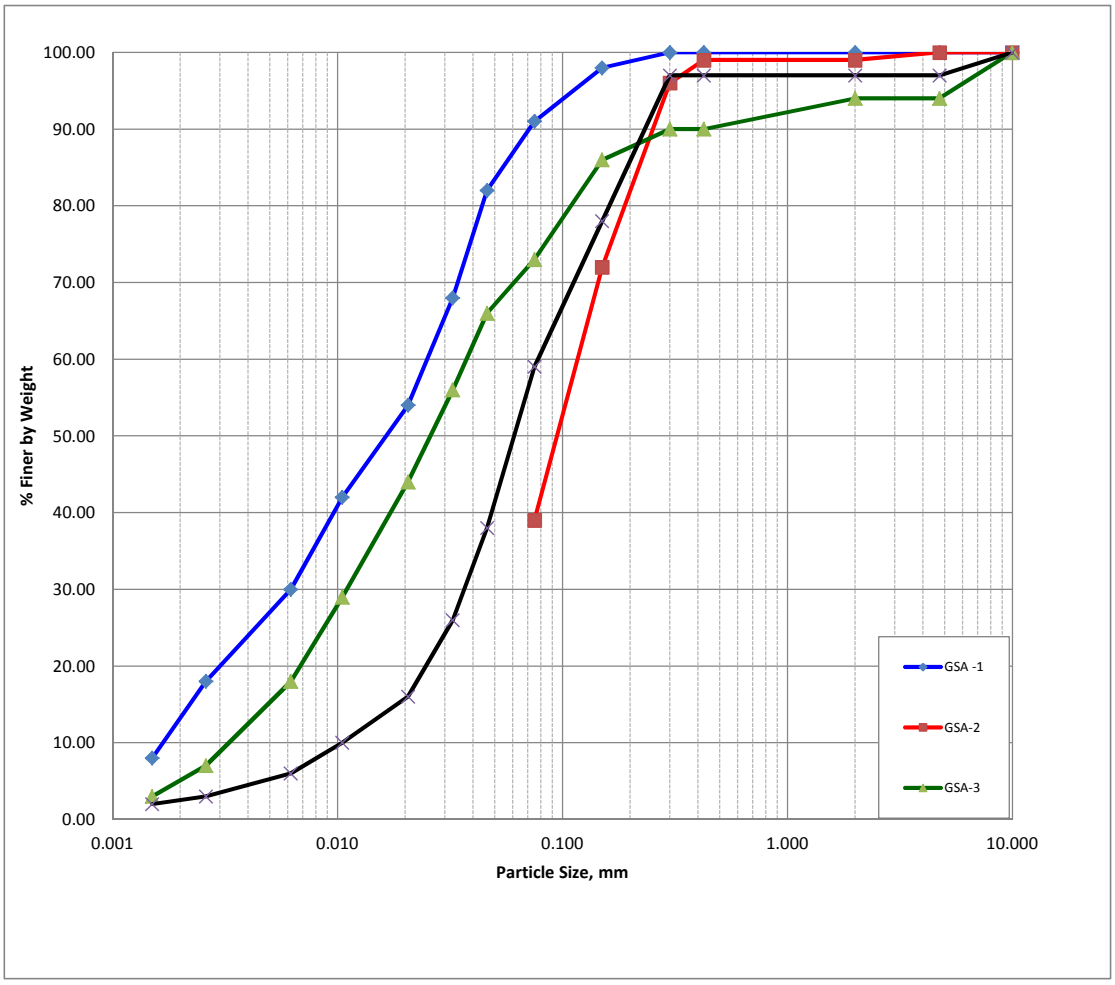
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B6	2.50	CL	0.0	9.0	78.0	13.0	0.023	0.002	13.65	0.72
B6	5.50	SM	0.0	61.0	39.0	0.0				
B6	7.50	ML-CL	6.0	21.0	68.0	5.0	0.040	0.003	15.62	1.20
B6	14.50	ML	3.0	38.0	56.0	3.0	0.078	0.011	7.41	1.58

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.0465	**0.380**
0.300	100.00	0.0	0.363	0.000		
0.150	98.00	2.0	0.225	0.450		
0.075	91.00	7.0	0.113	0.788		
PAN		91.0	0.038	3.413		
		100.0		4.650		

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **7.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **14.50 m**

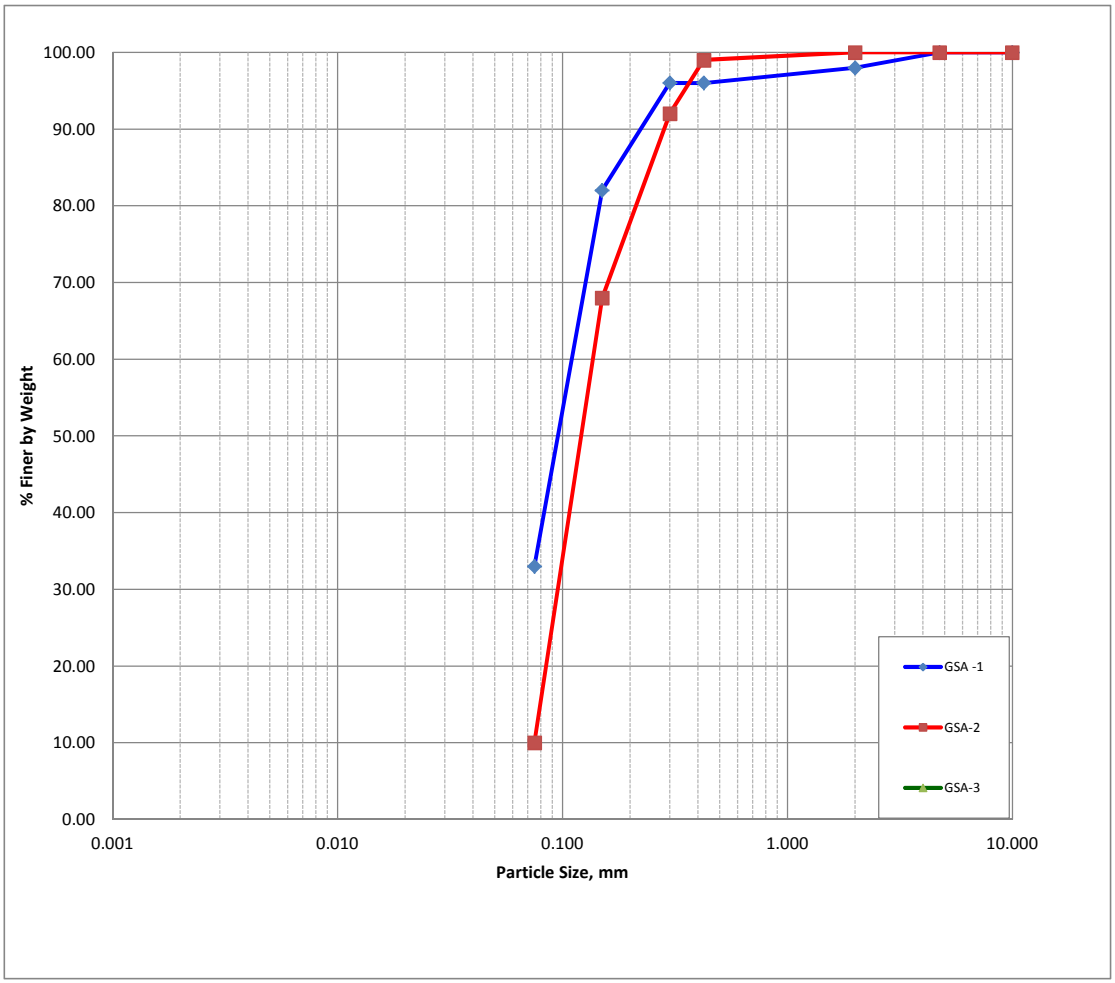
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B6	17.50	SM	0.0	67.0	33.0	0.0				
B6	27.00	SP-SM	0.0	90.0	10.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **17.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	98.00	2.0	3.500	7.000		
0.425	96.00	2.0	1.338	2.675	0.19575	**0.779**
0.300	96.00	0.0	0.363	0.000		
0.150	82.00	14.0	0.225	3.150		
0.075	33.00	49.0	0.113	5.513		
PAN		33.0	0.038	1.238		
		100.0		19.575		

BORE HOLE NO. **B6**

DEPTH OF SAMPLE **27.00** m

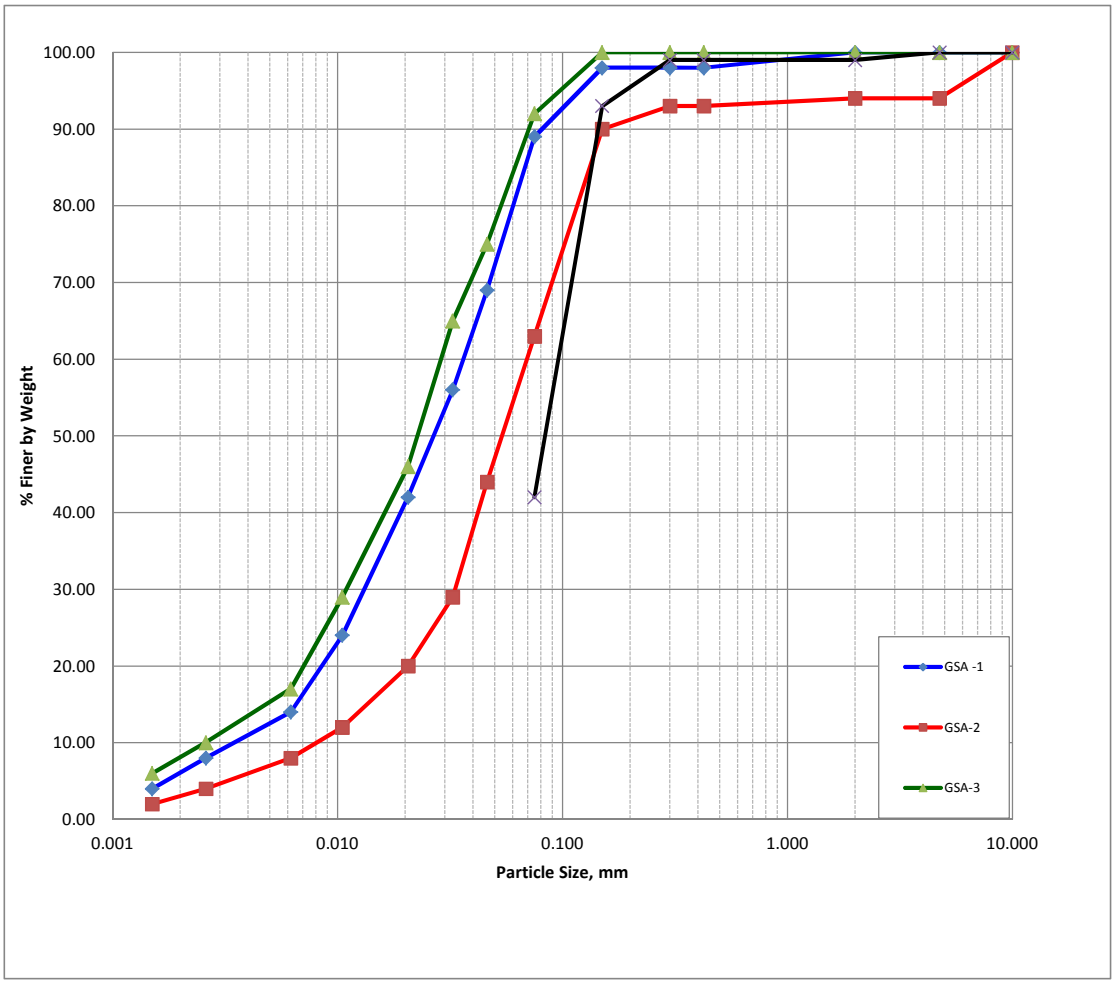
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B9	2.50	ML-CL	0.0	11.0	83.0	6.0	0.036	0.003	13.37	1.74
B9	5.50	ML	6.0	31.0	60.0	3.0	0.070	0.007	9.79	2.24
B9	8.50	ML-CL	0.0	8.0	84.0	8.0	0.028	0.002	13.20	2.01
B9	17.00	SM	0.0	58.0	42.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B9**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	98.00	2.0	1.338	2.675	0.07025	**0.466**
0.300	98.00	0.0	0.363	0.000		
0.150	98.00	0.0	0.225	0.000		
0.075	89.00	9.0	0.113	1.013		
PAN		89.0	0.038	3.338		
		100.0		7.025		

BORE HOLE NO. **B9**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B9**

DEPTH OF SAMPLE **8.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B9**

DEPTH OF SAMPLE **17.00 m**

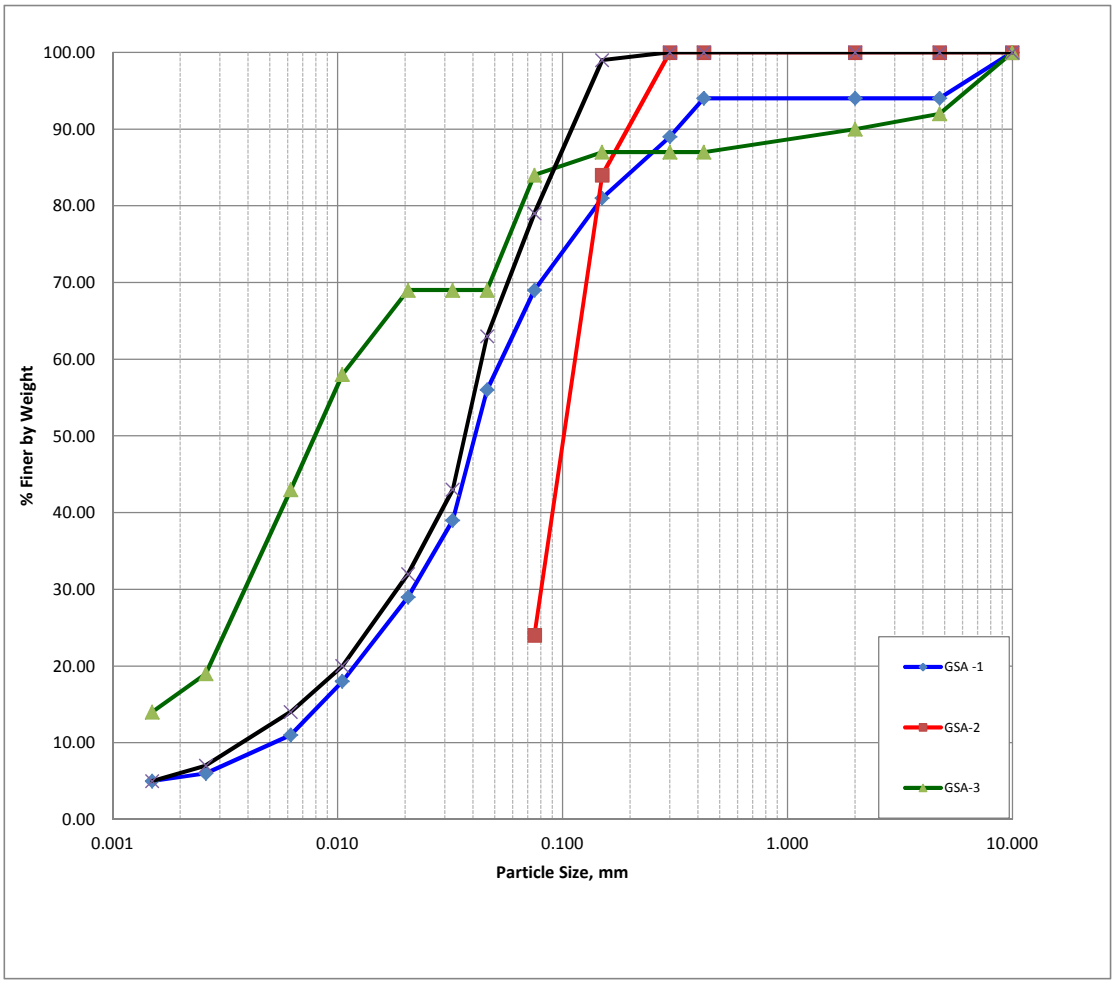
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B10	0.00	ML-CL	6.0	25.0	63.0	6.0	0.058	0.003	18.41	2.17
B10	5.50	SM	0.0	76.0	24.0	0.0				
B10	14.50	CL	8.0	8.0	67.0	17.0	0.013	-	-	-
B10	17.50	ML-CL	0.0	21.0	73.0	6.0	0.048	0.003	16.81	2.13

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B10**

DEPTH OF SAMPLE **0.00** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	94.00	6.0	7.375	44.250		
2.250	94.00	0.0	3.500	0.000		
0.425	94.00	0.0	1.338	0.000	0.518	**1.267**
0.300	89.00	5.0	0.363	1.813		
0.150	81.00	8.0	0.225	1.800		
0.075	69.00	12.0	0.113	1.350		
PAN		69.0	0.038	2.588		
		100.0		51.800		

BORE HOLE NO. **B10**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B10**

DEPTH OF SAMPLE **14.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B10**

DEPTH OF SAMPLE **17.50 m**

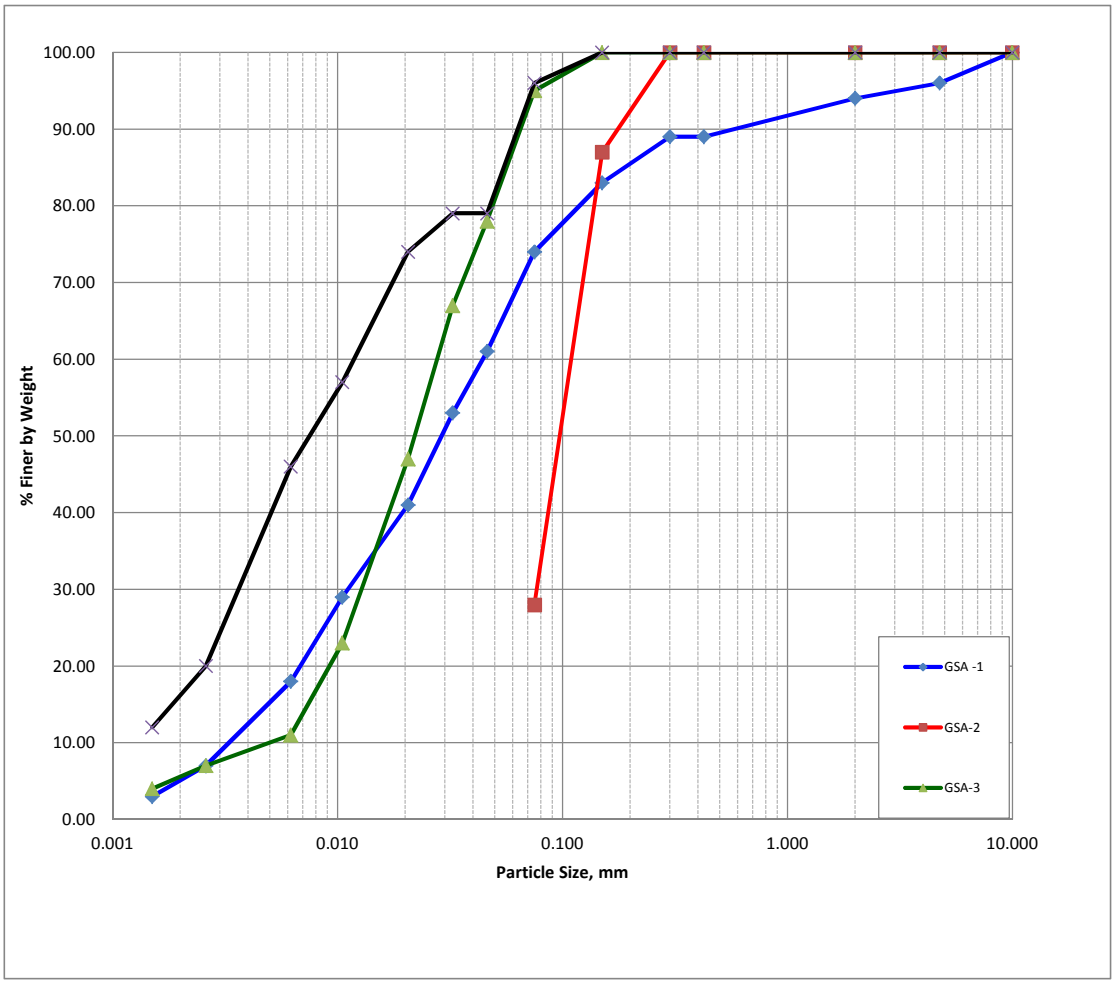
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B11	0.00	ML-CL	4.0	22.0	69.0	5.0	0.043	0.003	16.96	1.11
B11	5.50	SM	0.0	72.0	28.0	0.0				
B11	8.50	CL	0.0	5.0	89.0	6.0	0.027	0.003	9.79	2.10
B11	14.50	CL	0.0	4.0	80.0	16.0	0.012			

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **0.00** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	96.00	4.0	7.375	29.500		
2.250	94.00	2.0	3.500	7.000		
0.425	89.00	5.0	1.338	6.688	0.48325	**1.223**
0.300	89.00	0.0	0.363	0.000		
0.150	83.00	6.0	0.225	1.350		
0.075	74.00	9.0	0.113	1.013		
PAN		74.0	0.038	2.775		
		100.0		48.325		

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **8.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **14.50 m**

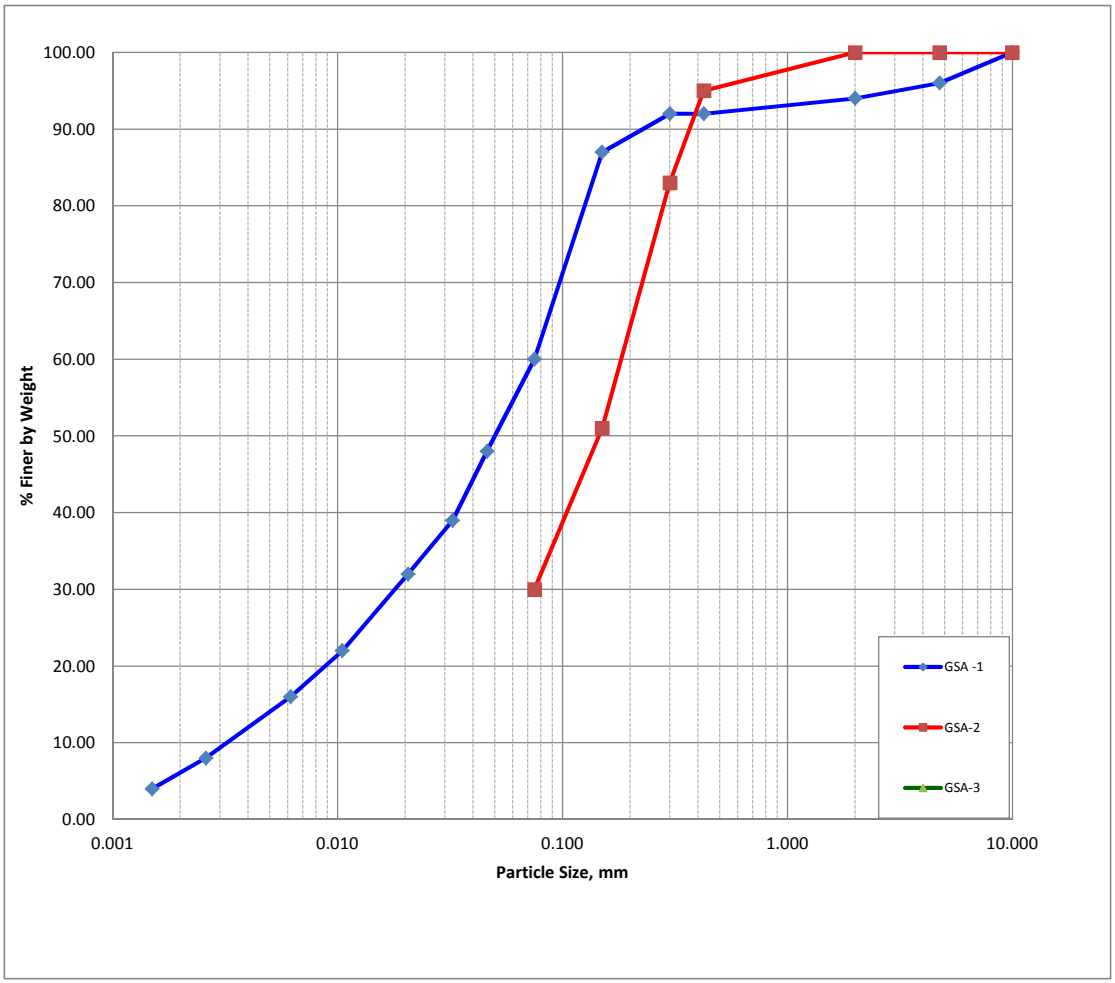
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B11	17.50	ML-CL	4.0	36.0	54.0	6.0	0.075	0.003	26.14	1.48
B11	26.50	SM	0.0	70.0	30.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **17.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	96.00	4.0	7.375	29.500		
2.250	94.00	2.0	3.500	7.000		
0.425	92.00	2.0	1.338	2.675	0.455875	**1.188**
0.300	92.00	0.0	0.363	0.000		
0.150	87.00	5.0	0.225	1.125		
0.075	60.00	27.0	0.113	3.038		
PAN		60.0	0.038	2.250		
		100.0		45.588		

BORE HOLE NO. **B11**

DEPTH OF SAMPLE **26.50** m

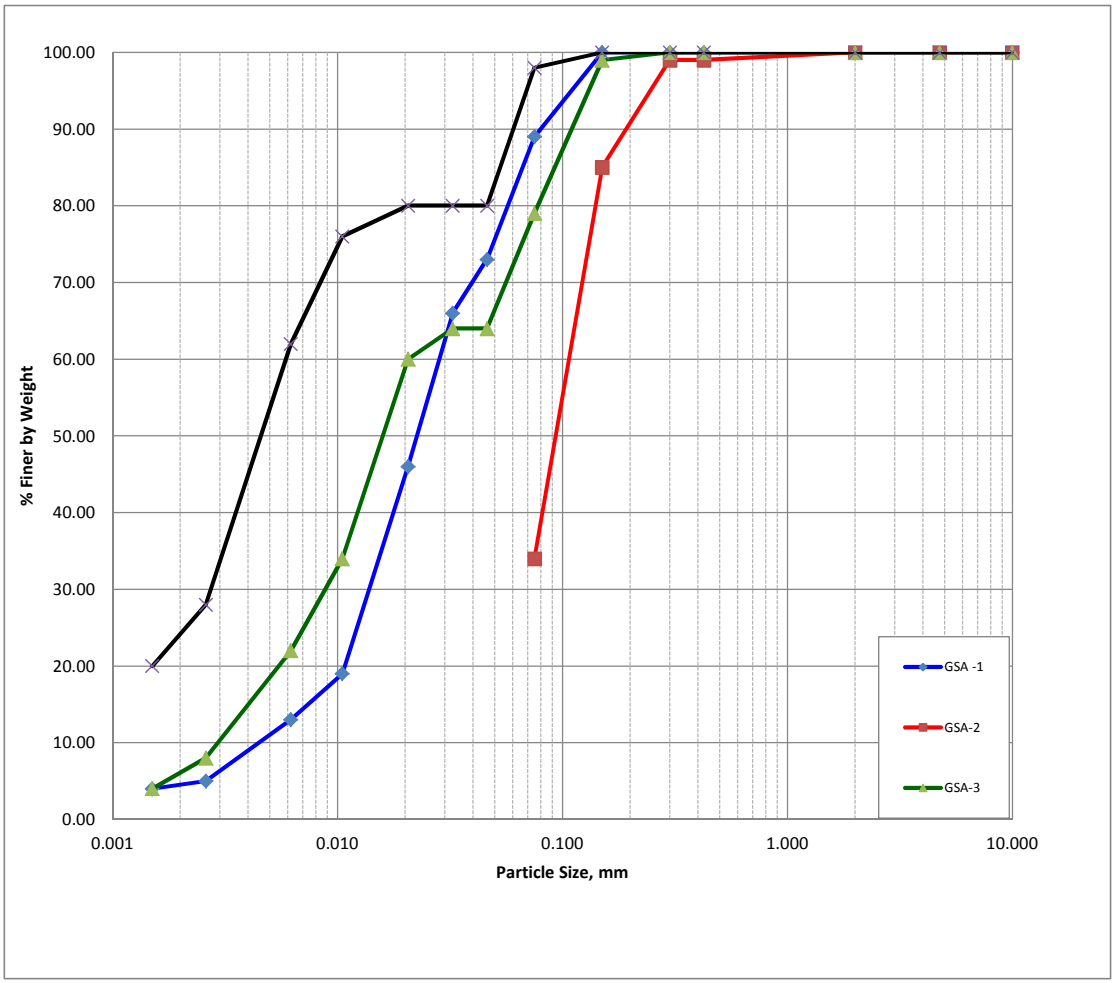
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B12	2.50	ML-CL	0.0	11.0	84.0	5.0	0.028	0.003	8.61	2.04
B12	7.50	SM	0.0	66.0	34.0	0.0				
B12	10.50	ML-CL	0.0	21.0	73.0	6.0	0.028	0.002	12.63	1.06
B12	13.50	CI	0.0	2.0	74.0	24.0	0.006	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B12**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.04575	**0.376**
0.300	100.00	0.0	0.363	0.000		
0.150	100.00	0.0	0.225	0.000		
0.075	89.00	11.0	0.113	1.238		
PAN		89.0	0.038	3.338		
		100.0		4.575		

BORE HOLE NO. **B12**

DEPTH OF SAMPLE **7.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B12**

DEPTH OF SAMPLE **10.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B12**

DEPTH OF SAMPLE **13.50 m**

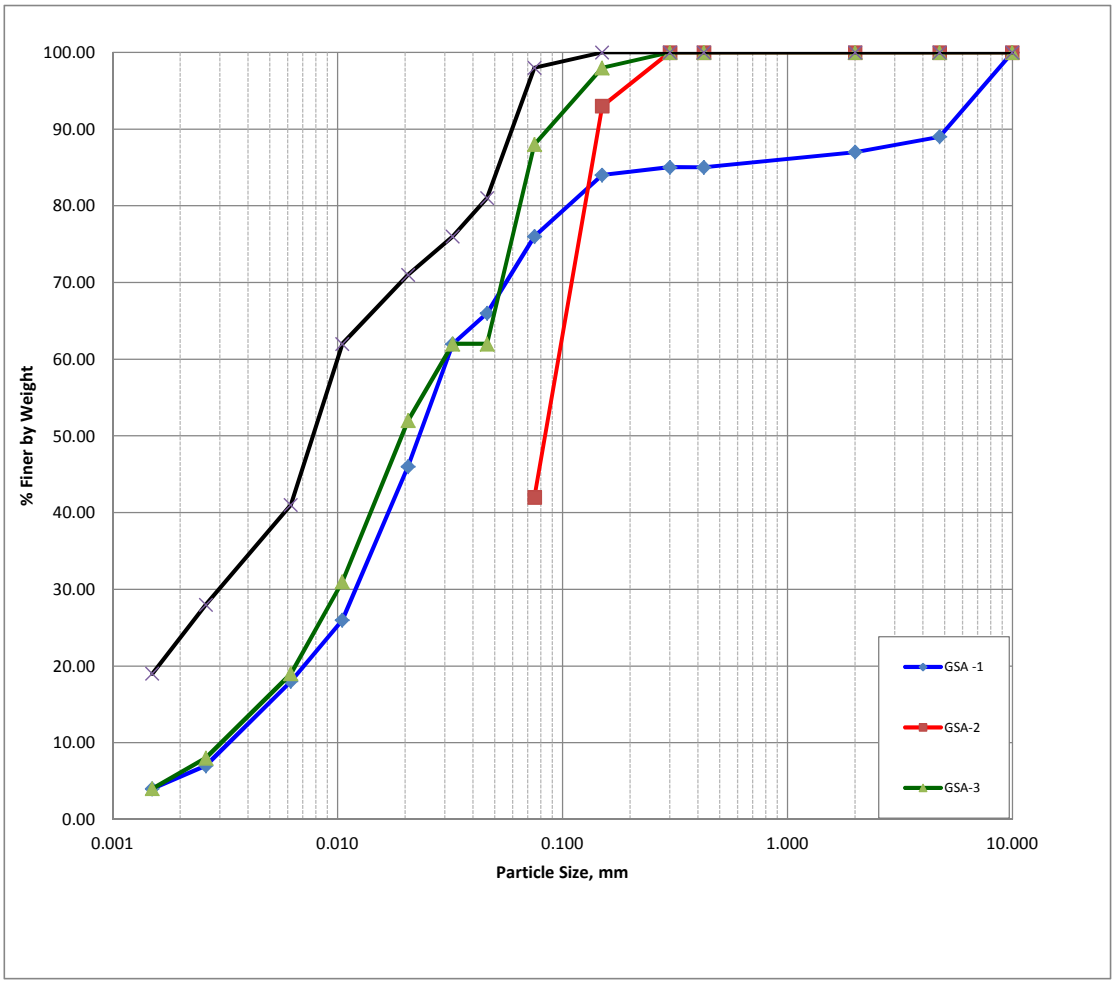
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B13	2.50	ML-CL	11.0	13.0	70.0	6.0	0.031	0.003	11.97	1.82
B13	5.50	SM	0.0	58.0	42.0	0.0				
B13	11.50	ML-CL	0.0	12.0	82.0	6.0	0.030	0.002	13.07	1.37
B13	14.50	CI	0.0	2.0	74.0	24.0	0.010	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B13**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	89.00	11.0	7.375	81.125		
2.250	87.00	2.0	3.500	7.000		
0.425	85.00	2.0	1.338	2.675	0.94775	**1.713**
0.300	85.00	0.0	0.363	0.000		
0.150	84.00	1.0	0.225	0.225		
0.075	76.00	8.0	0.113	0.900		
PAN		76.0	0.038	2.850		
		100.0		94.775		

BORE HOLE NO. **B13**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B13**

DEPTH OF SAMPLE **11.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B13**

DEPTH OF SAMPLE **14.50 m**

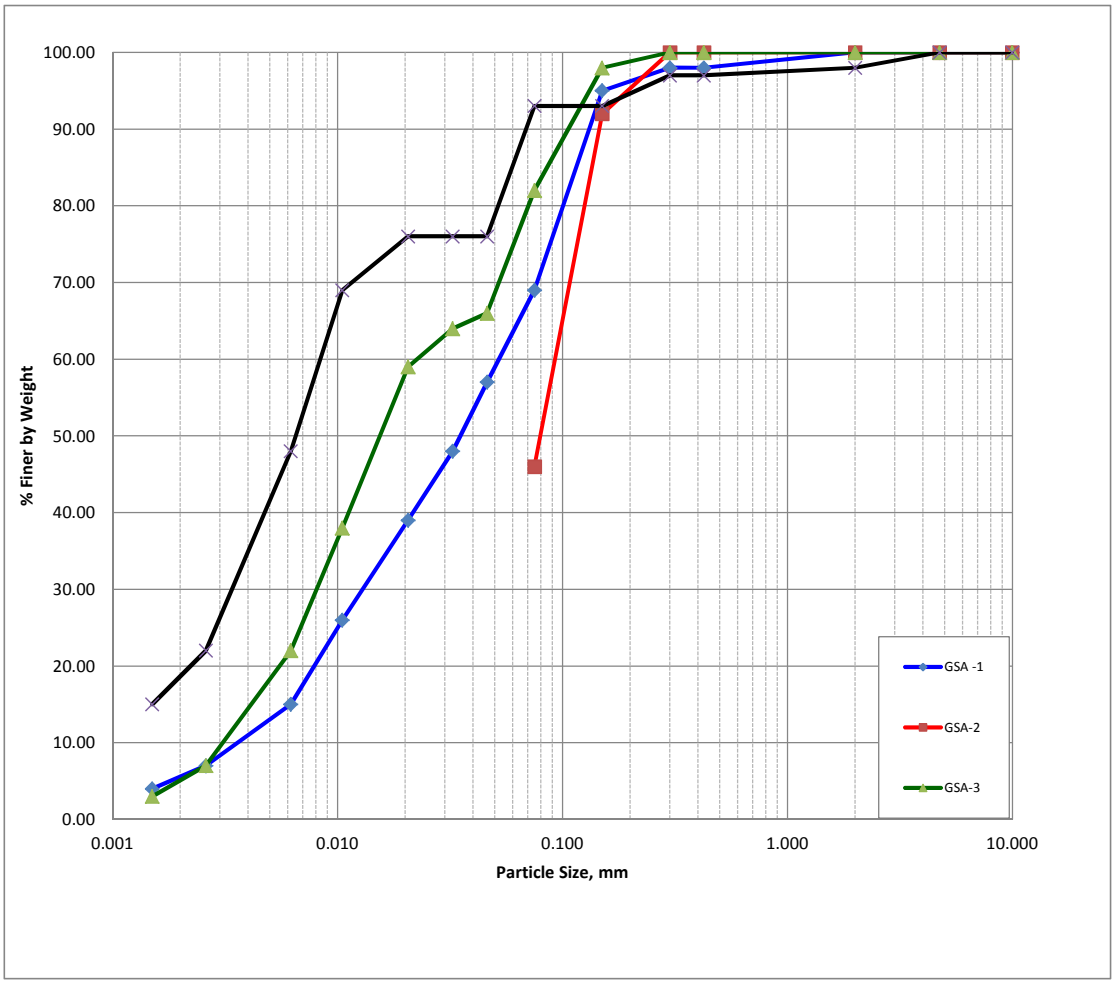
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B14	2.50	ML-CL	0.0	31.0	63.0	6.0	0.052	0.003	20.55	1.24
B14	5.50	SM	0.0	54.0	46.0	0.0				
B14	8.50	ML-CL	0.0	18.0	77.0	5.0	0.027	0.002	12.34	0.75
B14	14.50	CI	0.0	7.0	74.0	19.0	0.008	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B14**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	98.00	2.0	1.338	2.675	0.088625	**0.524**
0.300	98.00	0.0	0.363	0.000		
0.150	95.00	3.0	0.225	0.675		
0.075	69.00	26.0	0.113	2.925		
PAN		69.0	0.038	2.588		
		100.0		8.863		

BORE HOLE NO. **B14**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B14**

DEPTH OF SAMPLE **8.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B14**

DEPTH OF SAMPLE **14.50 m**

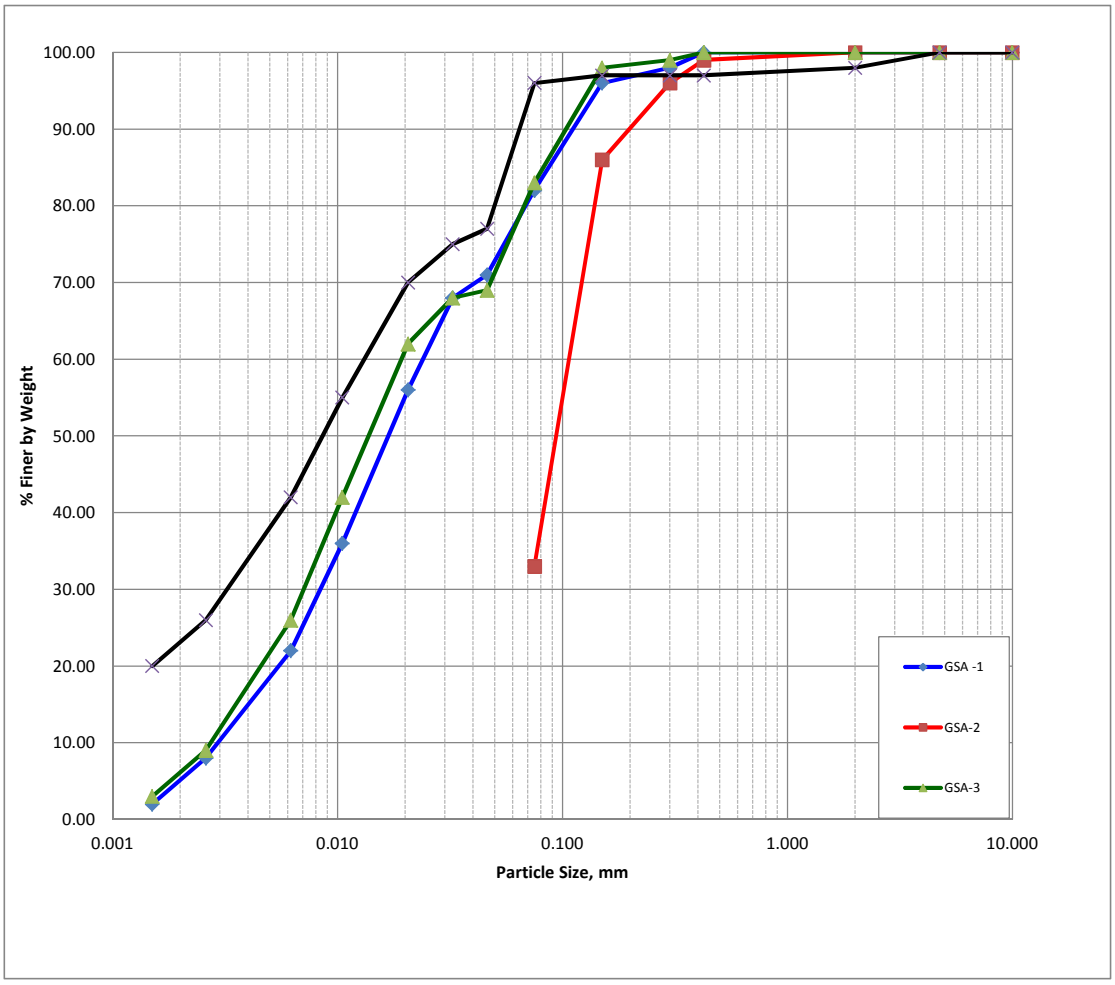
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B15	2.50	ML-CL	0.0	18.0	77.0	5.0	0.025	0.002	10.33	0.95
B15	8.50	SM	0.0	67.0	33.0	0.0				
B15	11.50	ML-CL	0.0	17.0	77.0	6.0	0.023	0.002	10.79	0.68
B15	14.50	CI	0.0	4.0	73.0	23.0	0.014	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B15**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.05825	**0.425**
0.300	98.00	2.0	0.363	0.725		
0.150	96.00	2.0	0.225	0.450		
0.075	82.00	14.0	0.113	1.575		
PAN		82.0	0.038	3.075		
		100.0		5.825		

BORE HOLE NO. **B15**

DEPTH OF SAMPLE **8.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B15**

DEPTH OF SAMPLE **11.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B15**

DEPTH OF SAMPLE **14.50 m**

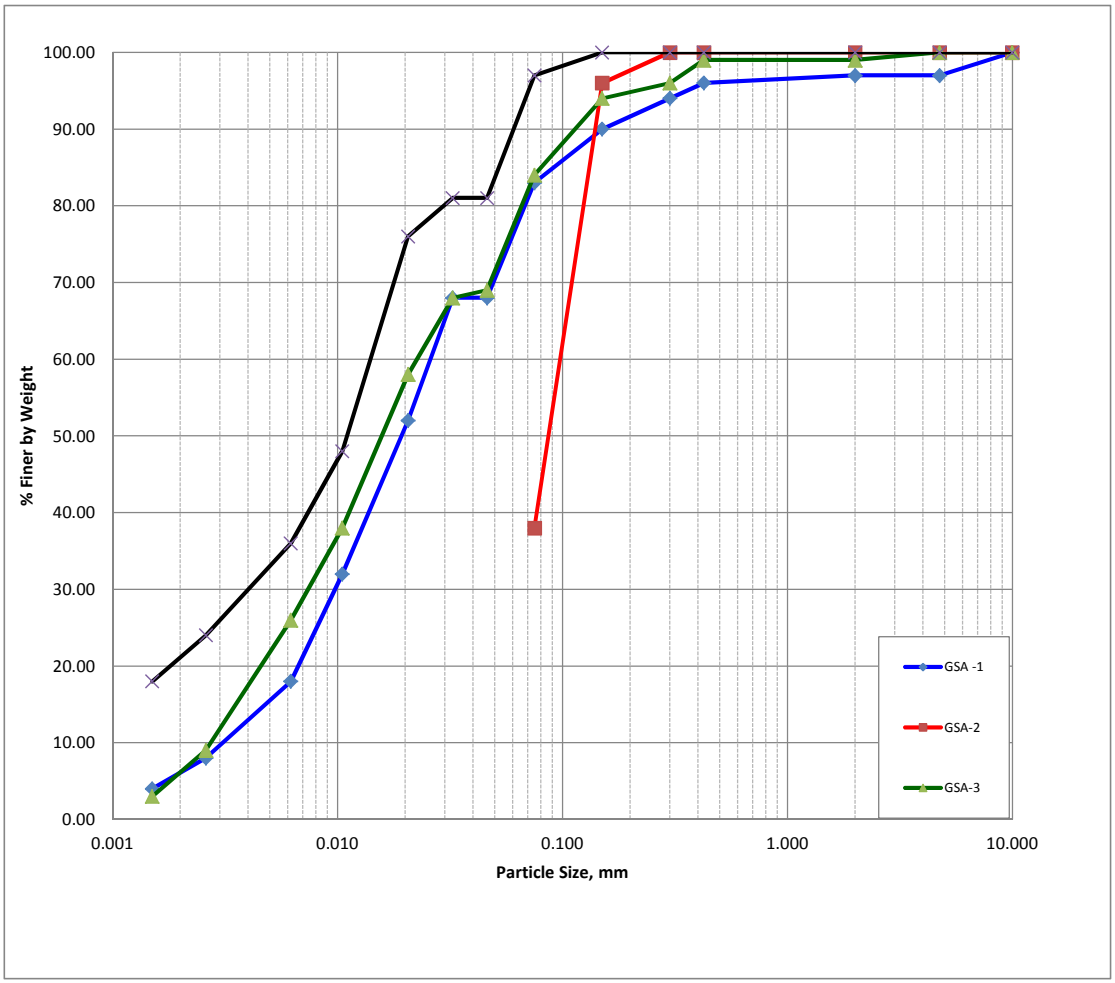
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B16	2.50	ML-CL	3.0	14.0	77.0	6.0	0.025	0.002	11.11	1.45
B16	5.50	SM	0.0	62.0	38.0	0.0				
B16	11.50	ML-CL	0.0	16.0	78.0	6.0	0.024	0.002	10.86	0.85
B16	14.50	CI	0.0	3.0	76.0	21.0	0.016	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	97.00	3.0	7.375	22.125		
2.250	97.00	0.0	3.500	0.000		
0.425	96.00	1.0	1.338	1.338	0.289875	**0.948**
0.300	94.00	2.0	0.363	0.725		
0.150	90.00	4.0	0.225	0.900		
0.075	83.00	7.0	0.113	0.788		
PAN		83.0	0.038	3.113		
		100.0		28.988		

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **11.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **14.50 m**

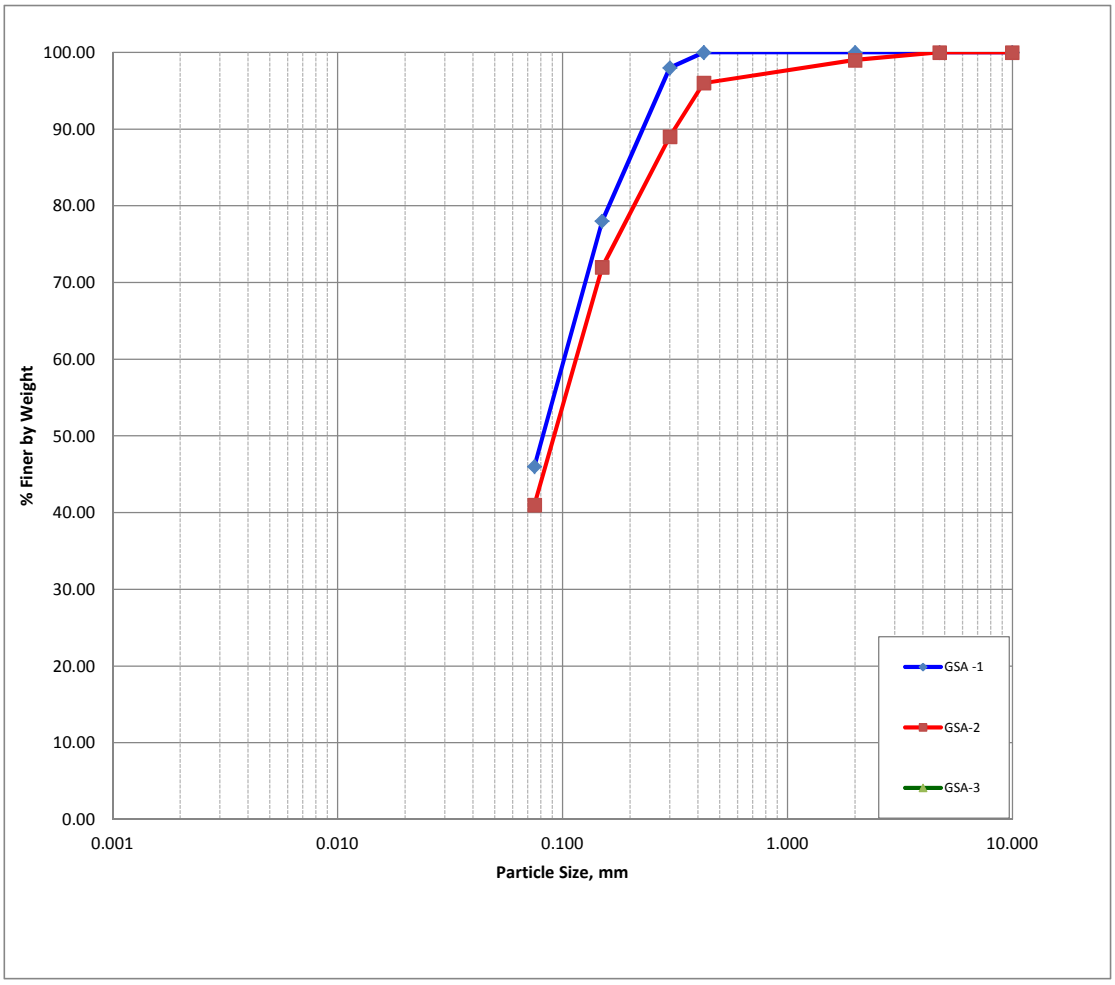
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B16	17.50	SM	0.0	54.0	46.0	0.0				
B16	20.50	SM	0.0	59.0	41.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **17.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.1055	**0.572**
0.300	98.00	2.0	0.363	0.725		
0.150	78.00	20.0	0.225	4.500		
0.075	46.00	32.0	0.113	3.600		
PAN		46.0	0.038	1.725		
		100.0		10.550		

BORE HOLE NO. **B16**

DEPTH OF SAMPLE **20.50** m

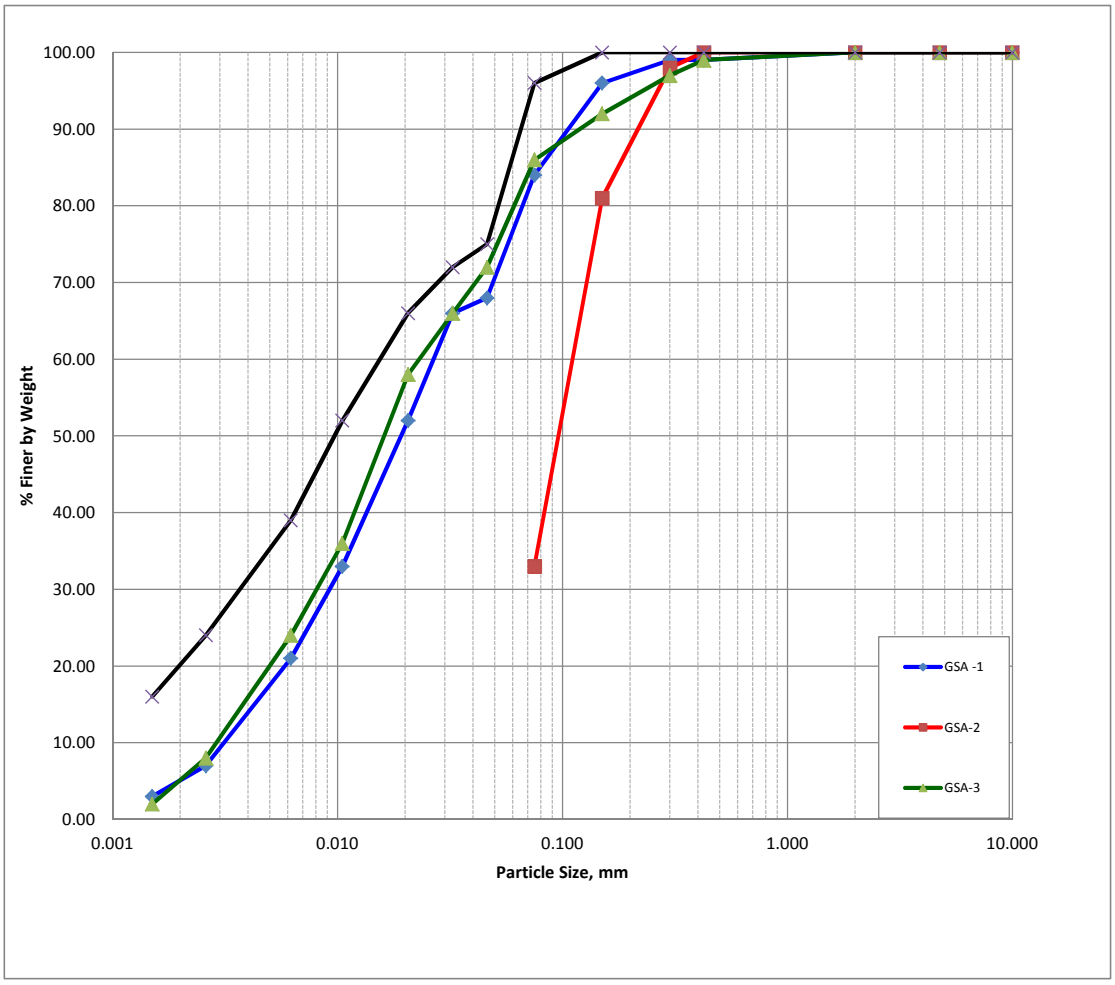
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B17	2.50	ML-CL	0.0	16.0	79.0	5.0	0.026	0.002	11.20	1.20
B17	5.50	SM	0.0	67.0	33.0	0.0				
B17	11.50	ML-CL	0.0	14.0	81.0	5.0	0.026	0.002	10.93	0.90
B17	14.50	CI	0.0	4.0	76.0	20.0	0.016	-	-	-

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B17**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	99.00	1.0	1.338	1.338	0.065125	**0.449**
0.300	99.00	0.0	0.363	0.000		
0.150	96.00	3.0	0.225	0.675		
0.075	84.00	12.0	0.113	1.350		
PAN		84.0	0.038	3.150		
		100.0		6.513		

BORE HOLE NO. **B17**

DEPTH OF SAMPLE **5.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B17**

DEPTH OF SAMPLE **11.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B17**

DEPTH OF SAMPLE **14.50 m**

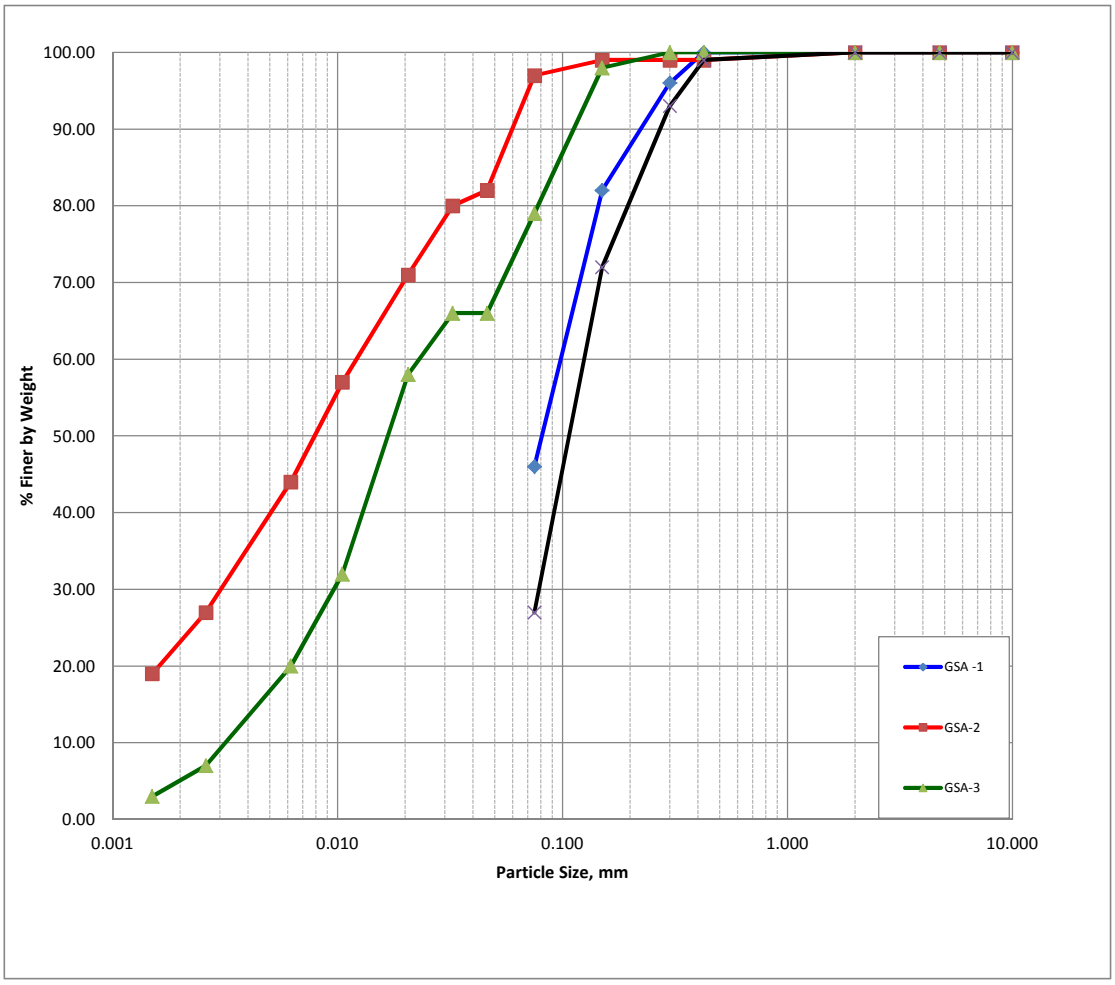
SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	100.00	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
B20	2.50	SM	0.0	54.0	46.0	0.0	0.098	0.039	2.52	0.82
B20	6.00	CI	0.0	3.0	74.0	23.0	0.012	-	-	-
B20	8.50	ML-CL	0.0	21.0	74.0	5.0	0.027	0.002	11.10	1.32
B20	17.50	SM	0.0	73.0	27.0	0.0				

GRAIN SIZE GRAPH



DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B20**

DEPTH OF SAMPLE **2.50** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100.00	0.0				
4.750	100.00	0.0	7.375	0.000		
2.250	100.00	0.0	3.500	0.000		
0.425	100.00	0.0	1.338	0.000	0.10375	**0.567**
0.300	96.00	4.0	0.363	1.450		
0.150	82.00	14.0	0.225	3.150		
0.075	46.00	36.0	0.113	4.050		
PAN		46.0	0.038	1.725		
		100.0		10.375		

BORE HOLE NO. **B20**

DEPTH OF SAMPLE **6.00** m

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	**2**	**3**	**4**	**5**	**5/100**	
10.000	100	0.0				
4.750	100.0	0.0	7.375	0.000		
2.250	99.0	1.0	3.500	3.500		
0.425	96.0	3.0	1.338	4.013	0.202	**0.791**
0.300	92.0	4.0	0.363	1.450		
0.150	82.0	10.0	0.225	2.250		
0.075	3.0	79.0	0.113	8.888		
PAN		3.0	0.038	0.113		
		100.0		20.213		

DETERMINATION OF SILT FACTOR

BORE HOLE NO. **B20**

DEPTH OF SAMPLE **8.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	95.00	5.0				
4.750	92.00	3.0	7.375	22.125		
2.250	92.00	0.0	3.500	0.000		
0.425	90.00	2.0	1.338	2.675	0.368	**1.068**
0.300	86.00	4.0	0.363	1.450		
0.150	76.00	10.0	0.225	2.250		
0.075	3.00	73.0	0.113	8.213		
PAN		3.0	0.038	0.113		
		100.0		36.825		

BORE HOLE NO. **B20**

DEPTH OF SAMPLE **17.50 m**

SIEVE SIZE (mm)	% Passing	PERCENTAGE RETAINED	AVERAGE SIZE OF SIEVE	3 X 4	MEAN DIAMETER (Dm), mm	SILT FACTOR, f
1	2	3	4	5	5/100	
10.000	91	0.0				
4.750	86.0	5.0	7.375	36.875		
2.250	86.0	0.0	3.500	0.000		
0.425	85.0	1.0	1.338	1.338	0.4888	**1.230**
0.300	83.0	2.0	0.363	0.725		
0.150	78.0	5.0	0.225	1.125		
0.075	4.0	74.0	0.113	8.325		
PAN		13.0	0.038	0.488		
		100.0		48.875		

Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 1 Along North-South Direction

Co-ordinates : **753633.6 E** **3151835.31 N**

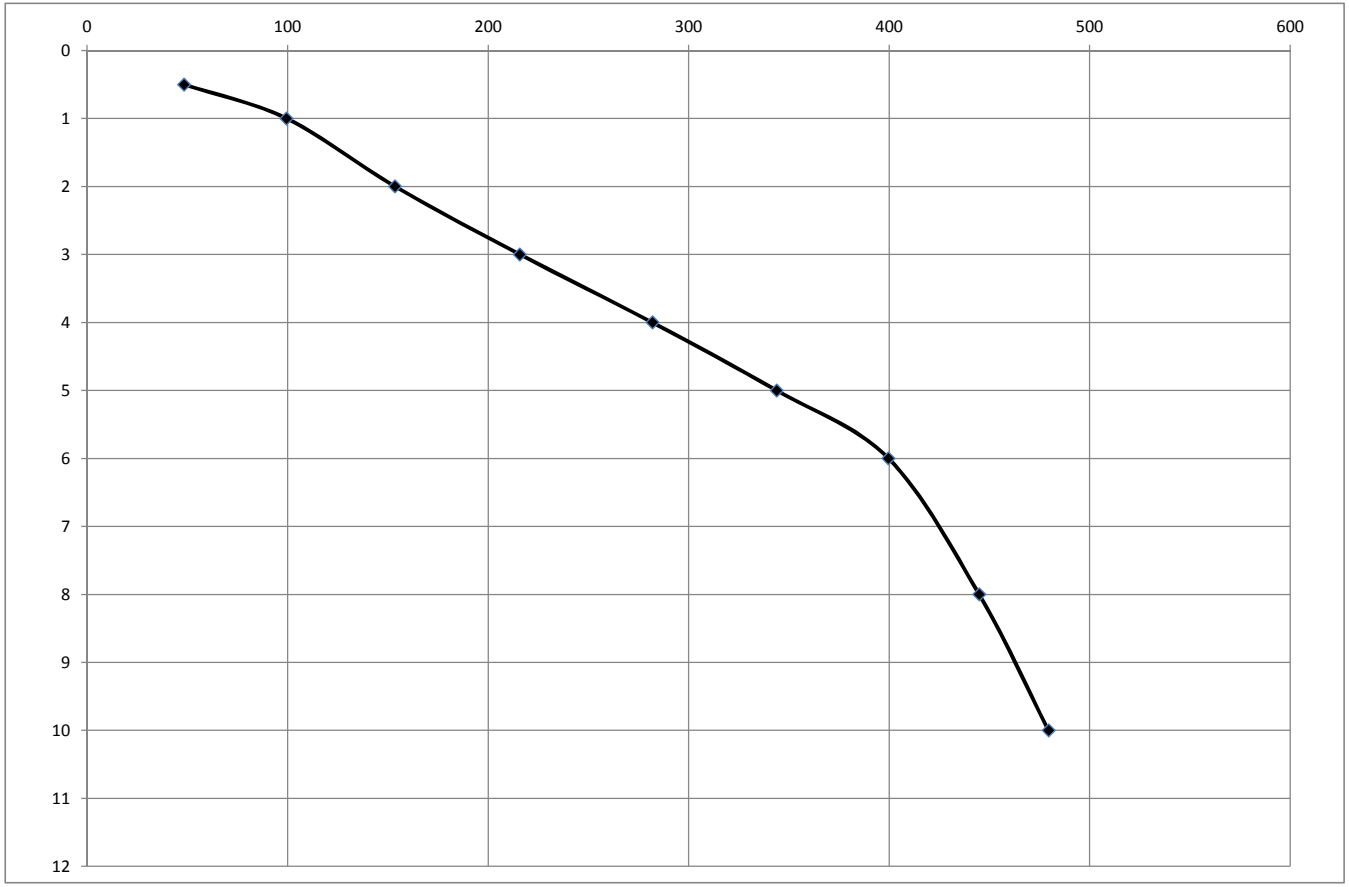
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 205.970 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	15.40	48.40	48.40
2	1	8.13	51.10	99.50
3	2	4.30	54.06	153.56
4	3	3.30	62.23	215.79
5	4	2.63	66.13	281.91
6	5	1.97	61.91	343.83
7	6	1.48	55.82	399.65
8	8	0.90	45.26	444.90
9	10	0.55	34.57	479.47

Sai Geotechnical Engineers Private Limited	SHEET NO. 118

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 1 **Along East-West Direction**

Co-ordinates : **753633.6 E** **3151835.31 N**

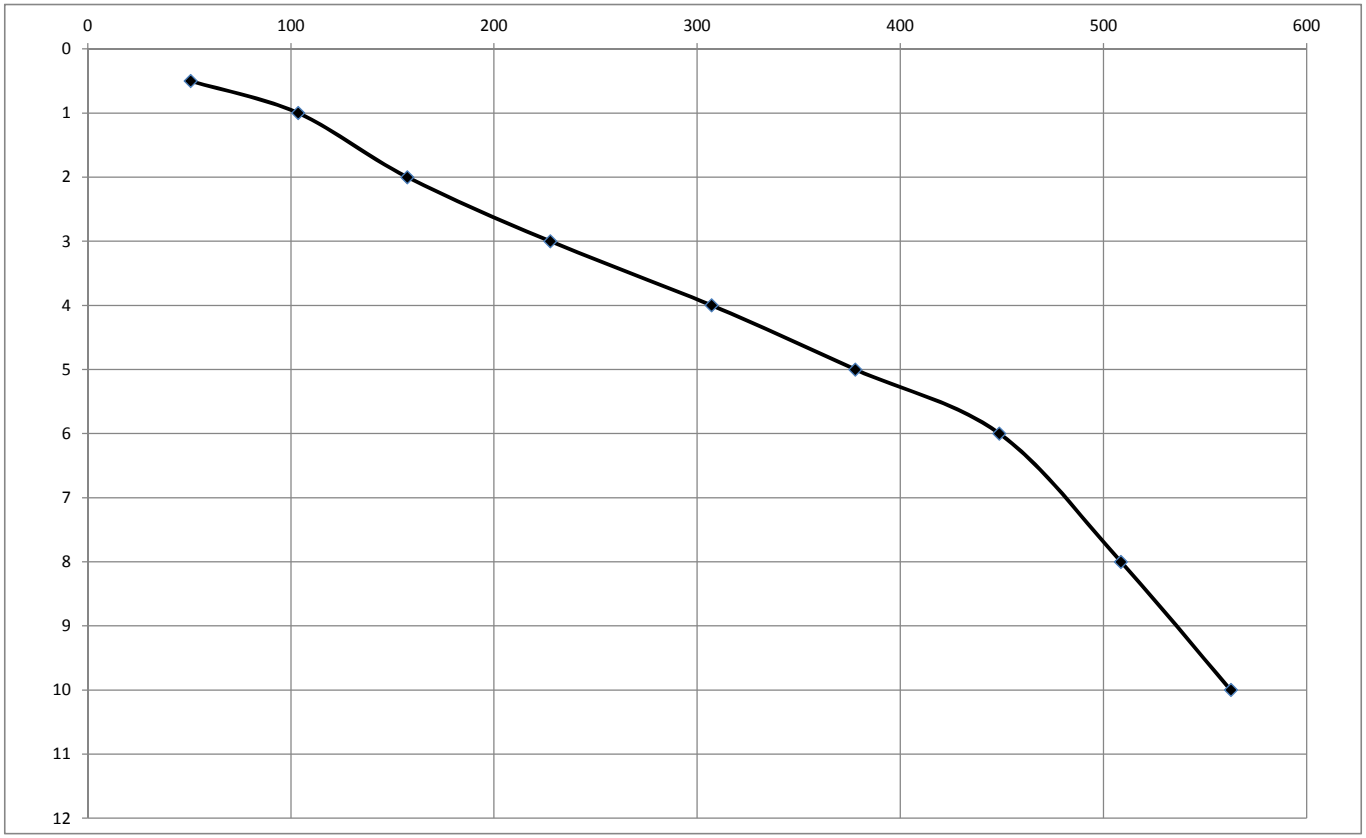
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 205.970 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	16.11	50.63	50.63
2	1	8.42	52.93	103.56
3	2	4.28	53.81	157.36
4	3	3.73	70.34	227.70
5	4	3.16	79.45	307.15
6	5	2.25	70.71	377.87
7	6	1.88	70.90	448.77
8	8	1.19	59.84	508.61
9	10	0.86	54.06	562.67

Sai Geotechnical Engineers Private Limited	SHEET NO. 120

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 1 **Along North East-South West Direction**

Co-ordinates : **753633.6 E** **3151835.31 N**

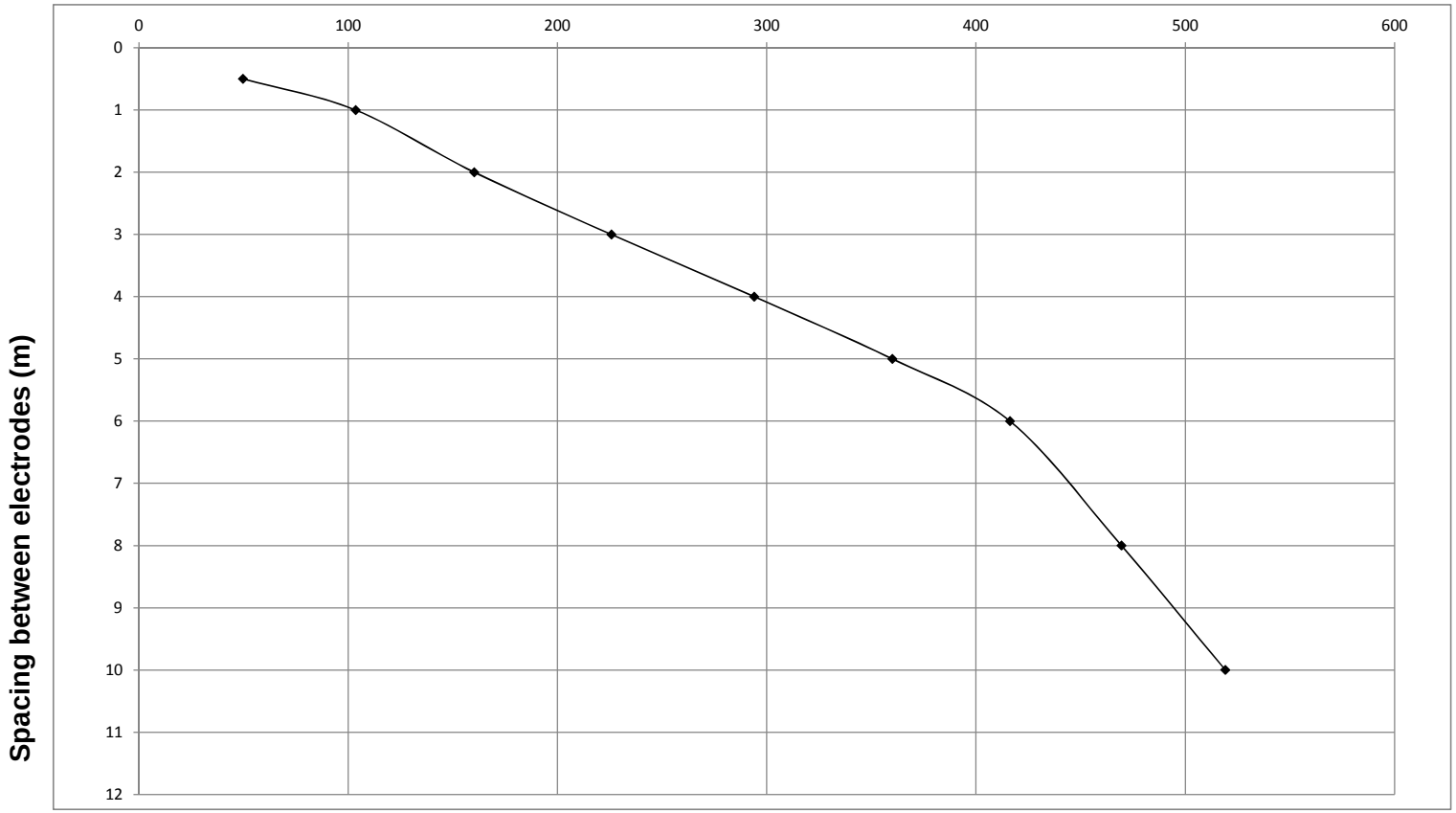
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 205.970 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	15.85	49.81	49.81
2	1	8.55	53.74	103.56
3	2	4.51	56.70	160.25
4	3	3.48	65.62	225.88
5	4	2.71	68.14	294.01
6	5	2.10	66.00	360.01
7	6	1.49	56.19	416.21
8	8	1.06	53.30	469.51
9	10	0.79	49.66	519.17

Sai Geotechnical Engineers Private Limited	SHEET NO. 122

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 1 **Along North West-South East Direction**

Co-ordinates : **753633.6 E** **3151835.31 N**

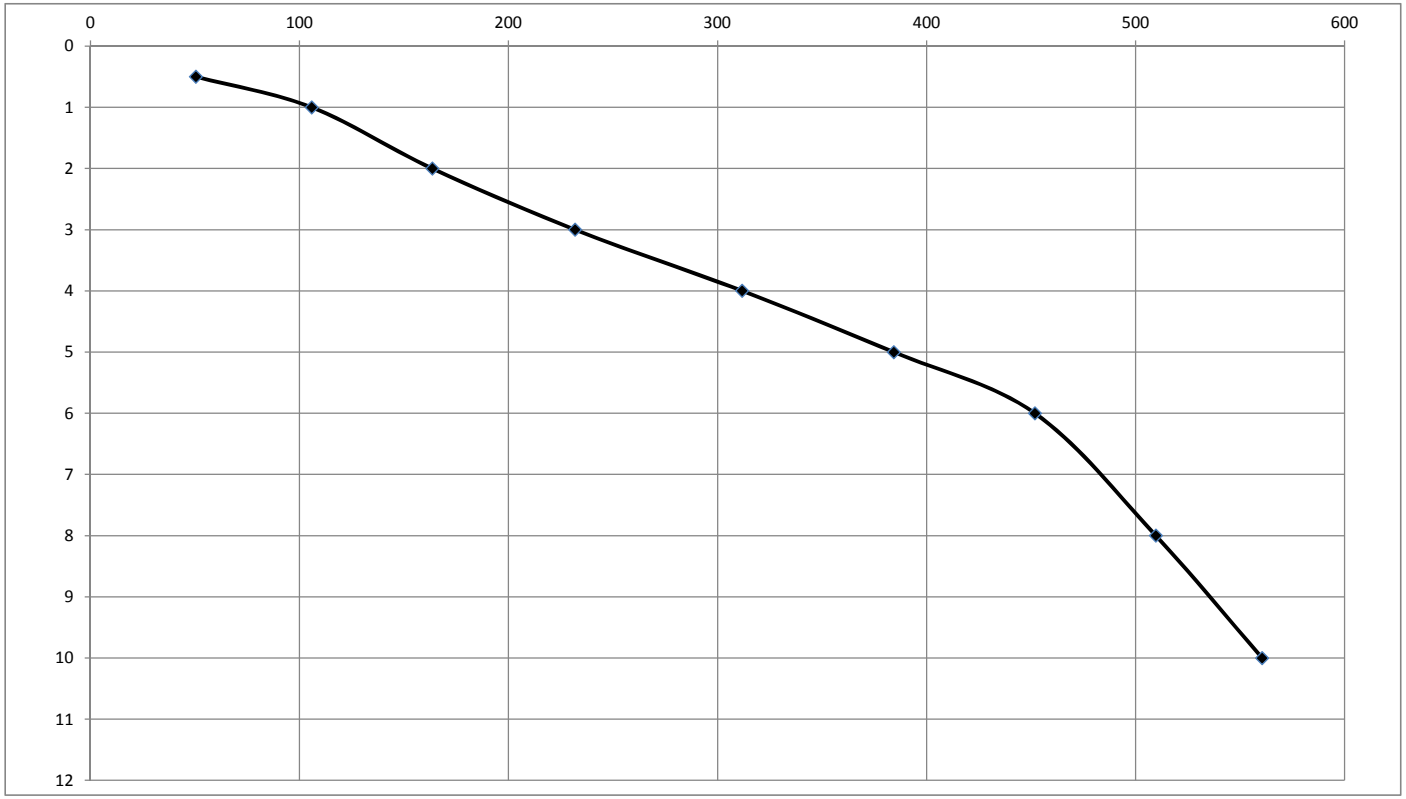
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 205.970 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	16.06	50.47	50.47
2	1	8.81	55.38	105.85
3	2	4.59	57.70	163.55
4	3	3.62	68.26	231.82
5	4	3.18	79.95	311.77
6	5	2.31	72.60	384.37
7	6	1.79	67.51	451.88
8	8	1.15	57.83	509.71
9	10	0.81	50.91	560.62

Sai Geotechnical Engineers Private Limited	SHEET NO 124

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 2 Along North-South Direction

Co-ordinates : **753580.68 E** **3151919.98 N**

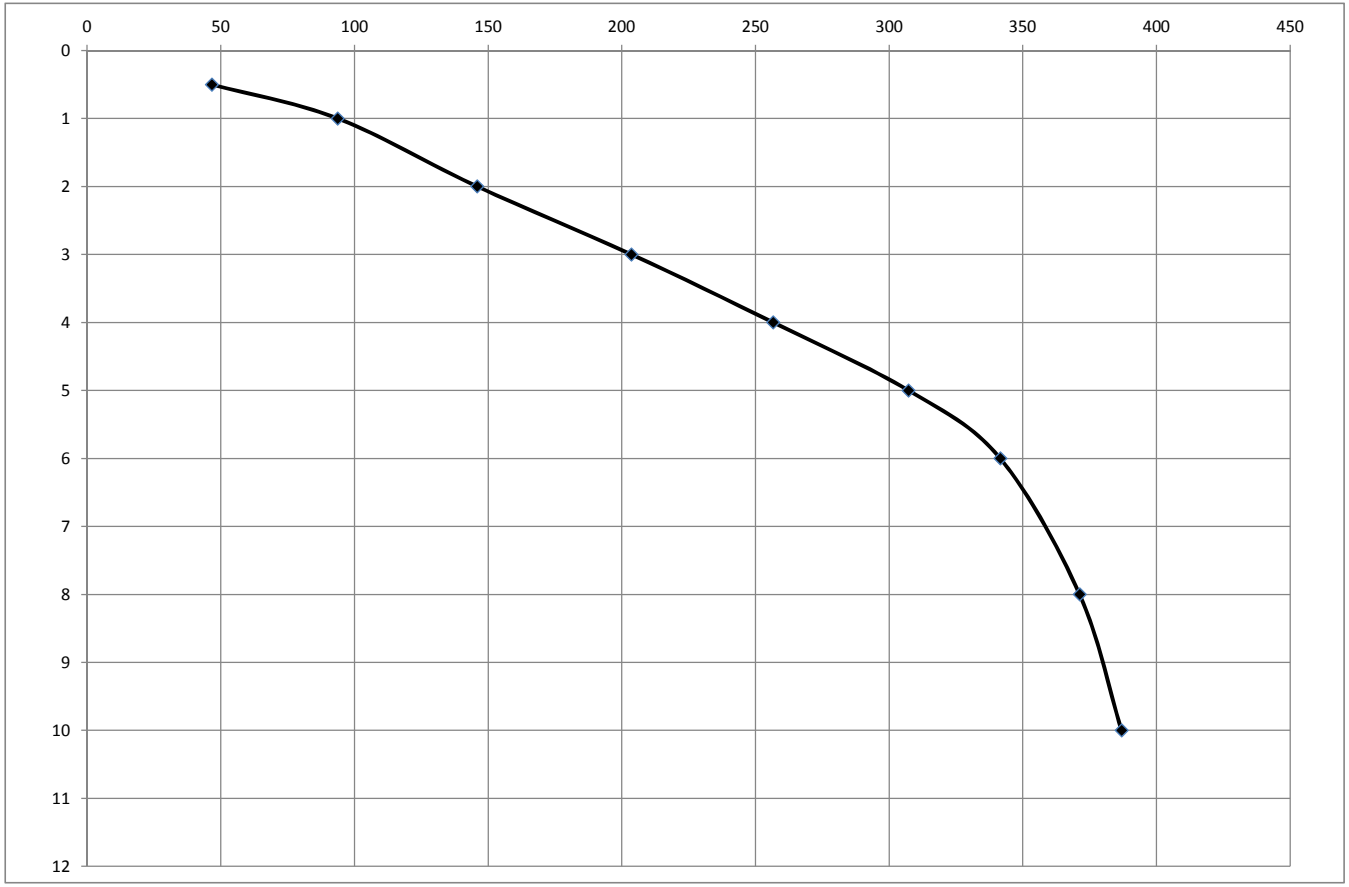
Date of Start : 18/01/2015 **Date of Finish :** 18/01/2015

Ground R.L. : 204.710 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.84	46.64	46.64
2	1	7.49	47.08	93.72
3	2	4.15	52.17	145.89
4	3	3.06	57.70	203.59
5	4	2.11	53.05	256.65
6	5	1.61	50.60	307.25
7	6	0.91	34.32	341.57
8	8	0.59	29.67	371.23
9	10	0.25	15.71	386.95

Sai Geotechnical Engineers Private Limited	SHEET NO. 126

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 2 **Along East-West Direction**

Co-ordinates : **753580.68 E** **3151919.98 N**

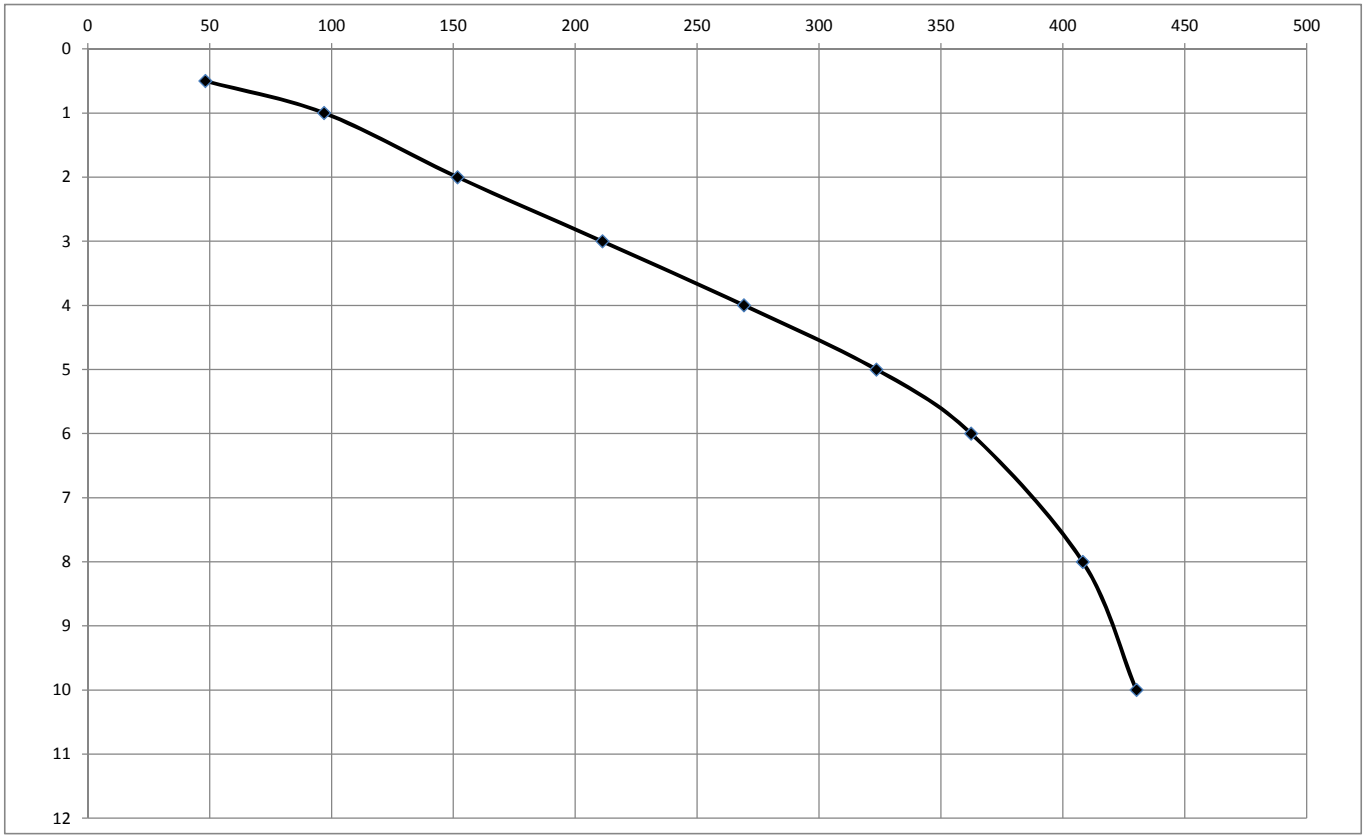
Date of Start : 18/01/2015 **Date of Finish :** 18/01/2015

Ground R.L. : 204.710 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	15.35	48.24	48.24
2	1	7.76	48.78	97.02
3	2	4.35	54.69	151.71
4	3	3.15	59.40	211.11
5	4	2.31	58.08	269.19
6	5	1.73	54.37	323.56
7	6	1.03	38.85	362.40
8	8	0.91	45.76	408.16
9	10	0.35	22.00	430.16

Sai Geotechnical Engineers Private Limited	SHEET NO. 128

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 2 **Along North East-South West Direction**

Co-ordinates : **753580.68 E** **3151919.98 N**

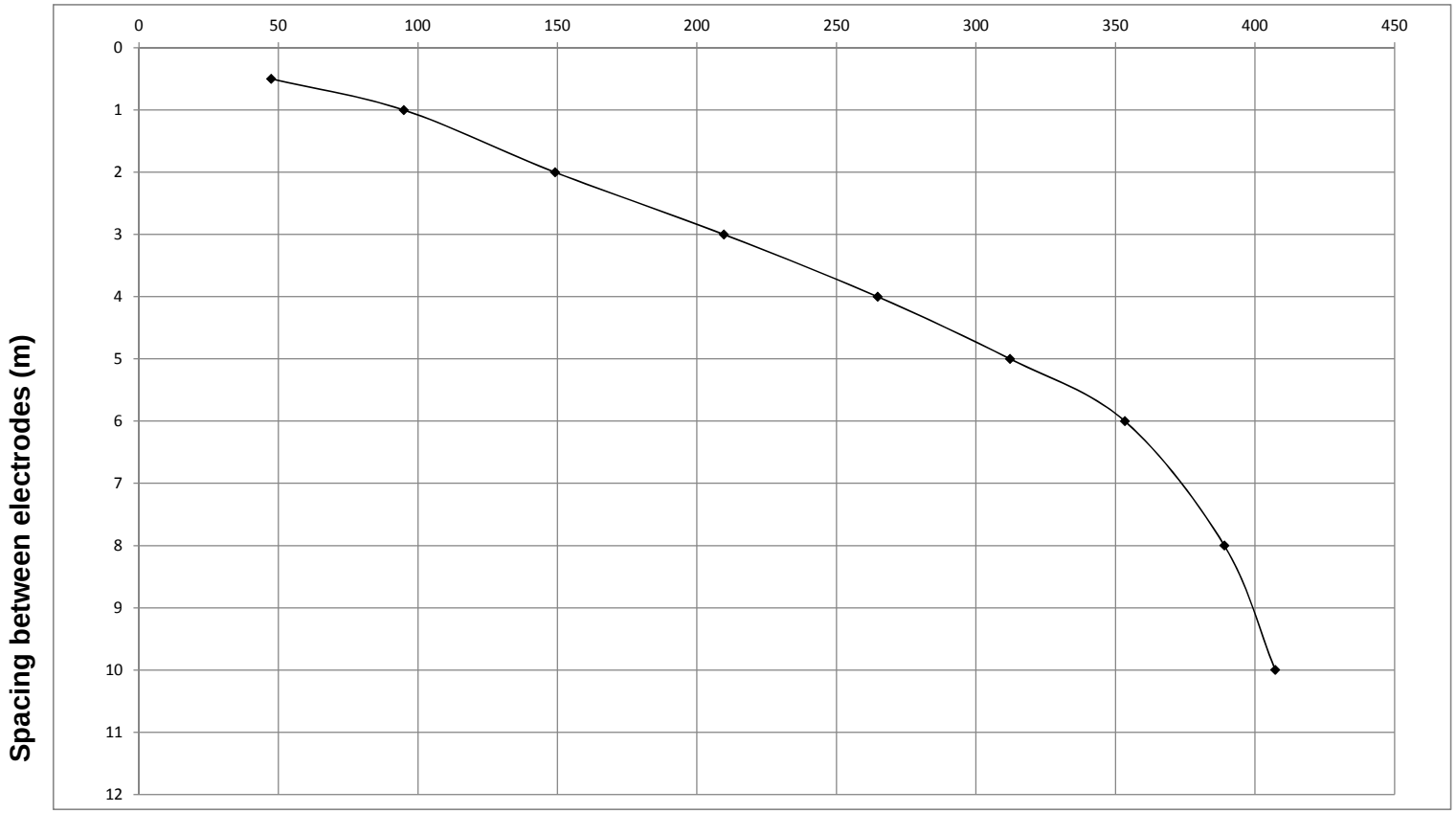
Date of Start : 18/01/2015 **Date of Finish :** 18/01/2015

Ground R.L. : 204.710 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	15.10	47.46	47.46
2	1	7.56	47.52	94.98
3	2	4.31	54.18	149.16
4	3	3.21	60.53	209.69
5	4	2.19	55.06	264.75
6	5	1.51	47.46	312.21
7	6	1.09	41.11	353.32
8	8	0.71	35.70	389.02
9	10	0.29	18.23	407.25

Sai Geotechnical Engineers Private Limited	SHEET NO. 130

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 2 **Along North West-South East Direction**

Co-ordinates : **753580.68 E** **3151919.98 N**

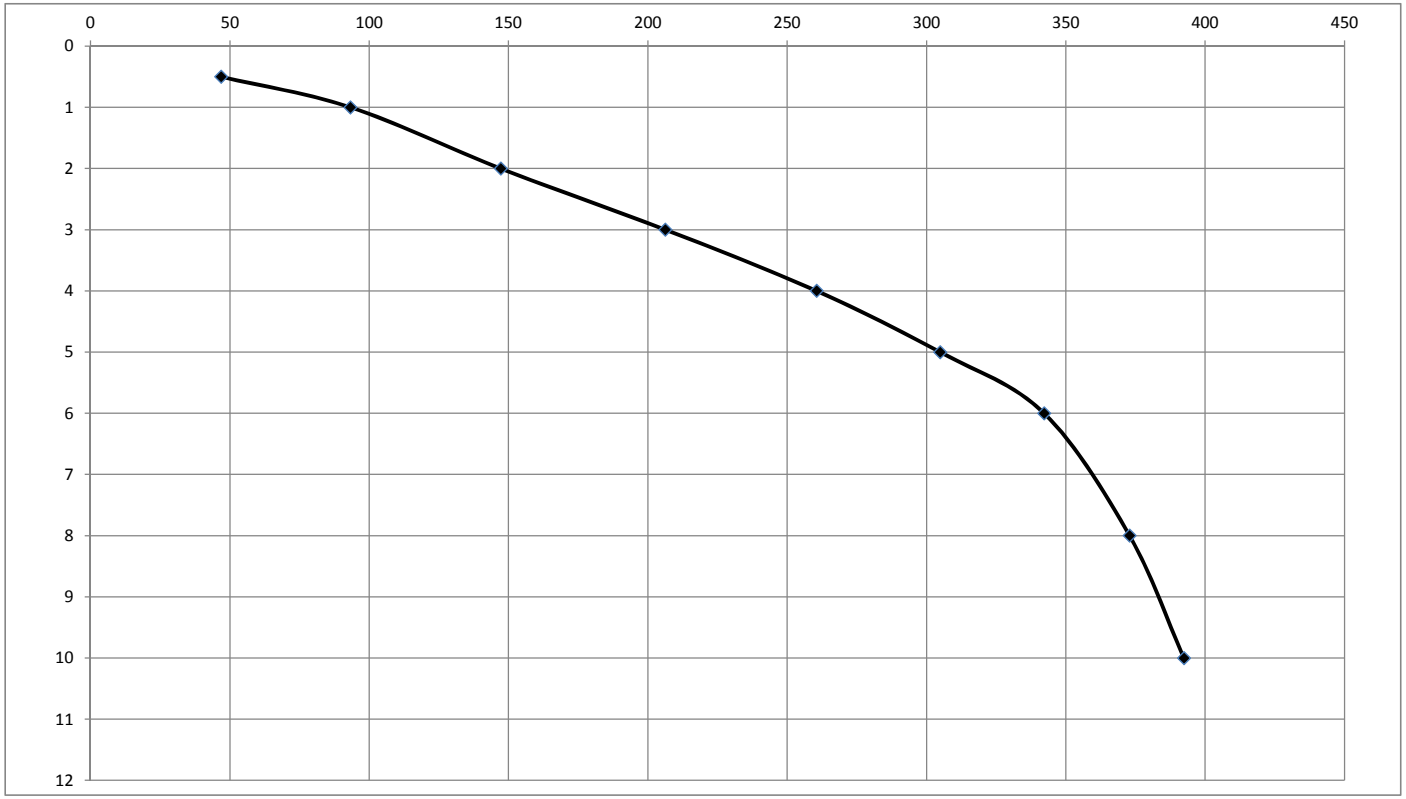
Date of Start : 18/01/2015 **Date of Finish :** 18/01/2015

Ground R.L. : 204.710 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.90	46.83	46.83
2	1	7.39	46.45	93.28
3	2	4.29	53.93	147.21
4	3	3.13	59.02	206.23
5	4	2.16	54.31	260.54
6	5	1.41	44.31	304.86
7	6	0.99	37.34	342.19
8	8	0.61	30.67	372.87
9	10	0.31	19.49	392.35

Sai Geotechnical Engineers Private Limited	SHEET NO 132

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 3 Along North-South Direction

Co-ordinates : **753703.97 E** **3151990.88 N**

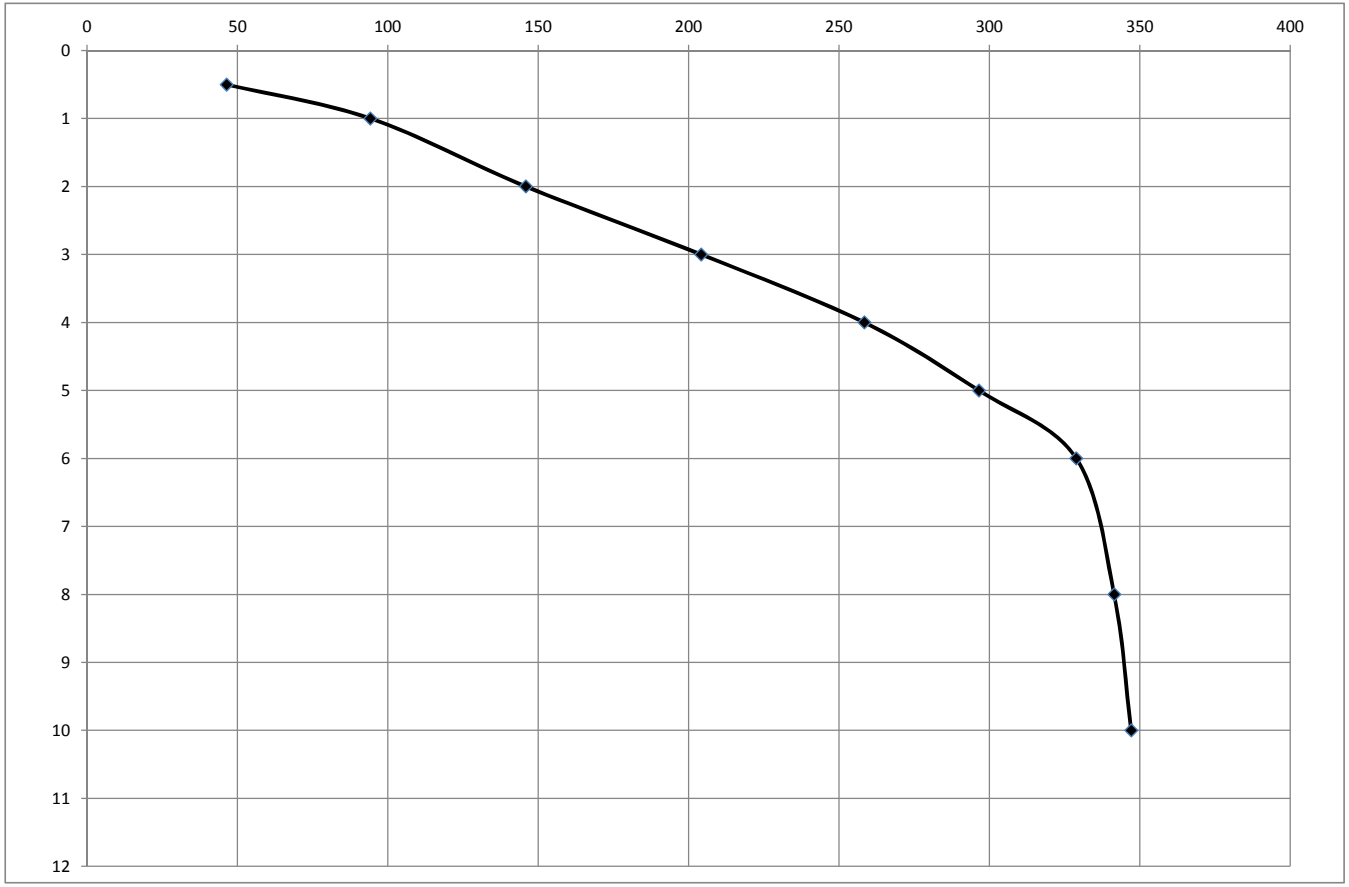
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 204.510 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.75	46.36	46.36
2	1	7.61	47.83	94.19
3	2	4.11	51.67	145.86
4	3	3.09	58.27	204.13
5	4	2.16	54.31	258.44
6	5	1.21	38.03	296.47
7	6	0.86	32.43	328.90
8	8	0.25	12.57	341.47
9	10	0.09	5.66	347.13

Sai Geotechnical Engineers Private Limited	SHEET NO. 134

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 3 **Along East-West Direction**

Co-ordinates : **753703.97 E** **3151990.88 N**

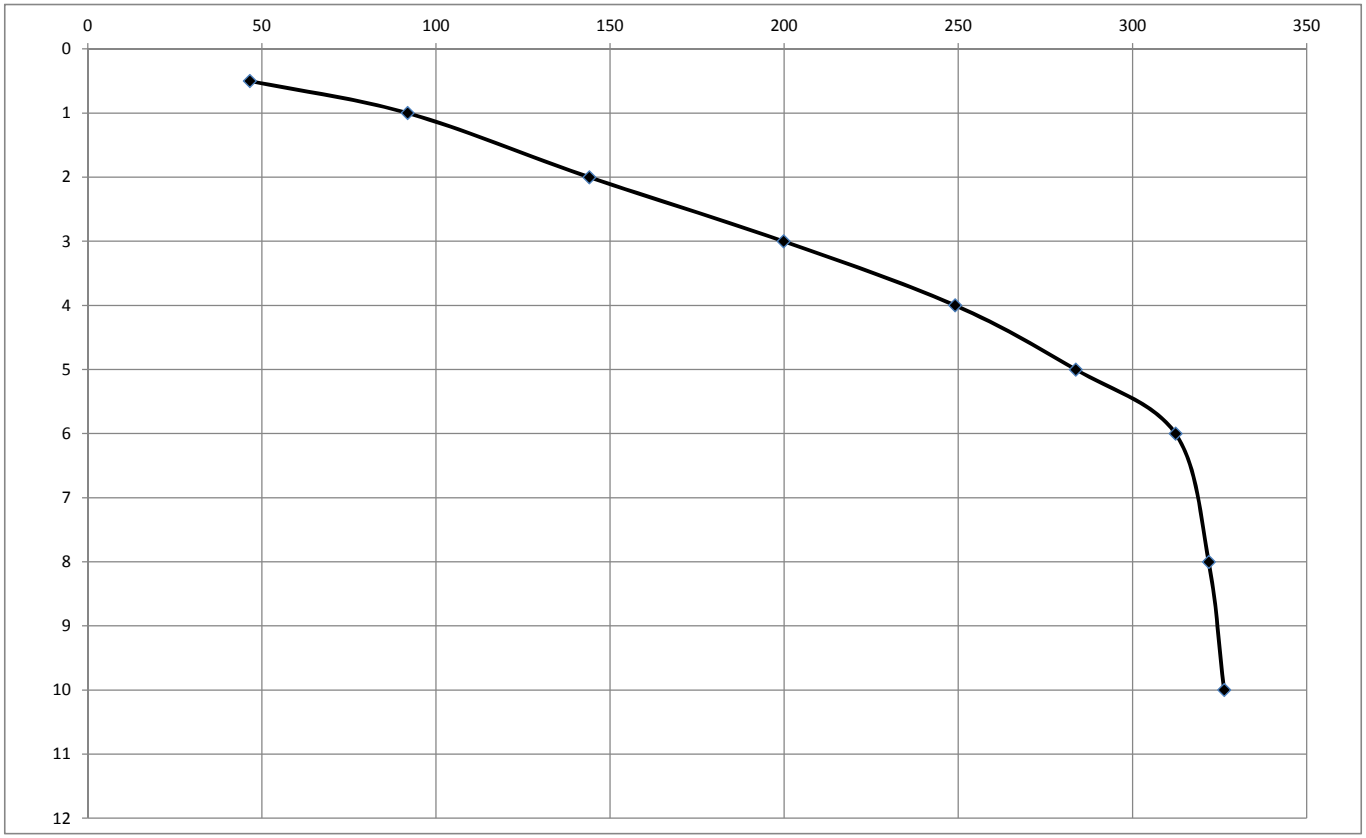
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 204.510 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.80	46.51	46.51
2	1	7.21	45.32	91.83
3	2	4.15	52.17	144.01
4	3	2.96	55.82	199.82
5	4	1.96	49.28	249.10
6	5	1.10	34.57	283.67
7	6	0.76	28.66	312.34
8	8	0.19	9.55	321.89
9	10	0.07	4.40	326.29

Sai Geotechnical Engineers Private Limited	SHEET NO. 136

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 3 **Along North East-South West Direction**

Co-ordinates : **753703.97 E** **3151990.88 N**

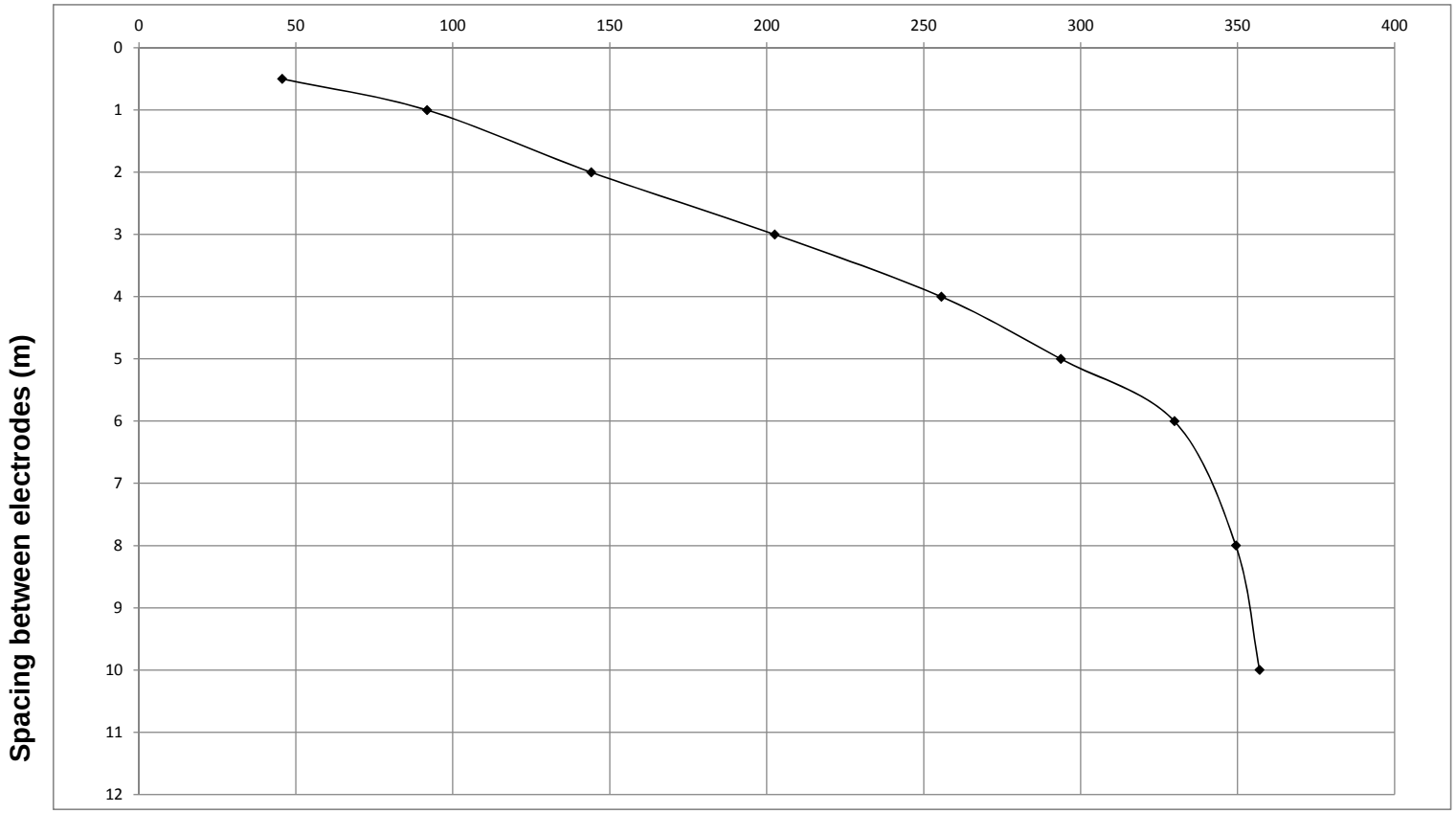
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 204.510 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.51	45.60	45.60
2	1	7.35	46.20	91.80
3	2	4.16	52.30	144.10
4	3	3.10	58.46	202.56
5	4	2.11	53.05	255.61
6	5	1.21	38.03	293.64
7	6	0.96	36.21	329.84
8	8	0.39	19.61	349.45
9	10	0.12	7.54	357.00

Sai Geotechnical Engineers Private Limited	SHEET NO. 138

Commulative Resistance (Ω)



Sai Geotechnical Engineers Private Limited

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

ERT No.: 3 **Along North West-South East Direction**

Co-ordinates : **753703.97 E** **3151990.88 N**

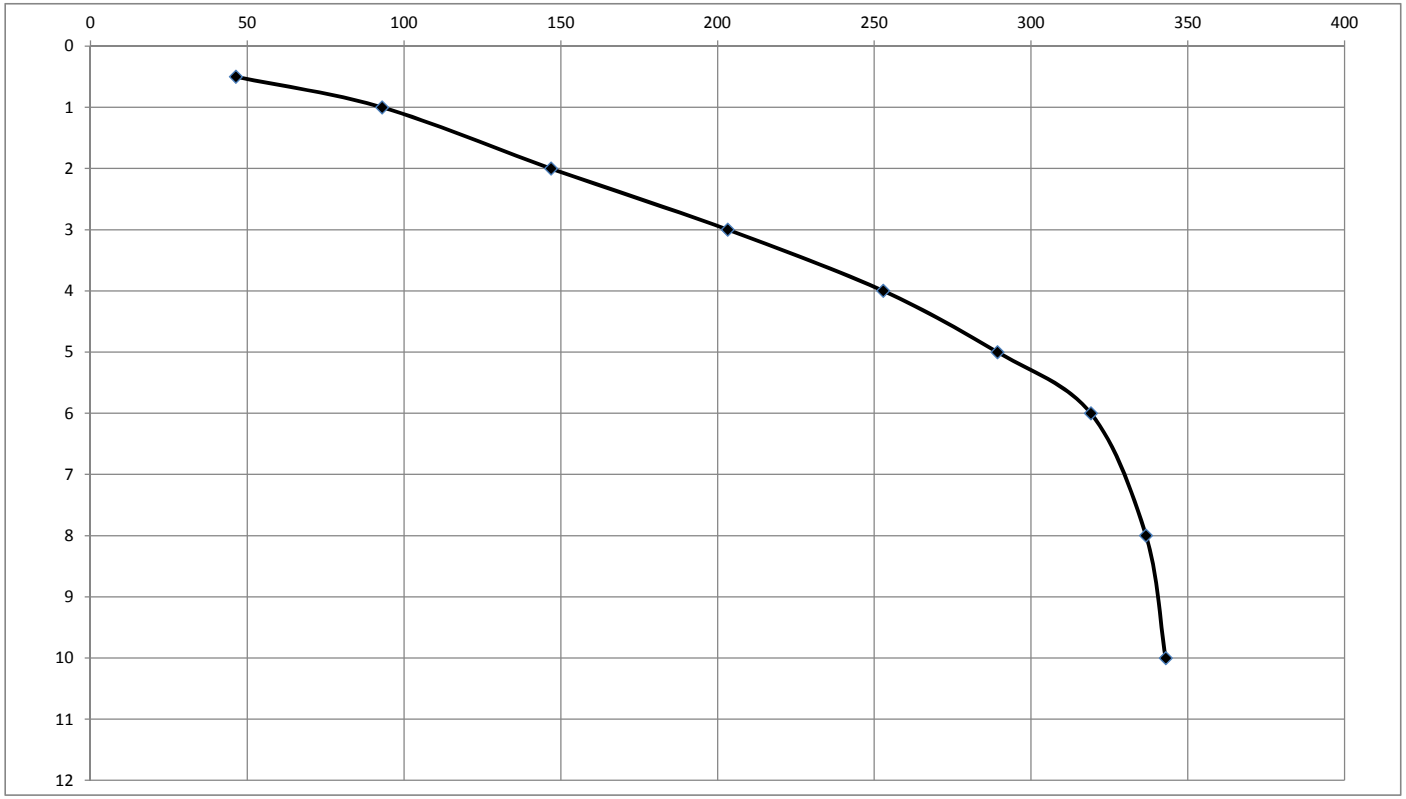
Date of Start : 28/01/2015 **Date of Finish :** 28/01/2015

Ground R.L. : 204.510 m

SL.NO.	SPACING OF ELECTRODES (a)	E.R METER READING (R) OHM	Resistivity (OHM M)	Cummulative Resistivity (OHM M)
1	0.5	14.76	46.39	46.39
2	1	7.41	46.58	92.97
3	2	4.29	53.93	146.90
4	3	2.99	56.38	203.28
5	4	1.97	49.53	252.81
6	5	1.16	36.46	289.27
7	6	0.79	29.79	319.06
8	8	0.35	17.60	336.66
9	10	0.10	6.29	342.95

Sai Geotechnical Engineers Private Limited	SHEET NO . 140

Commulative Resistance (Ω)

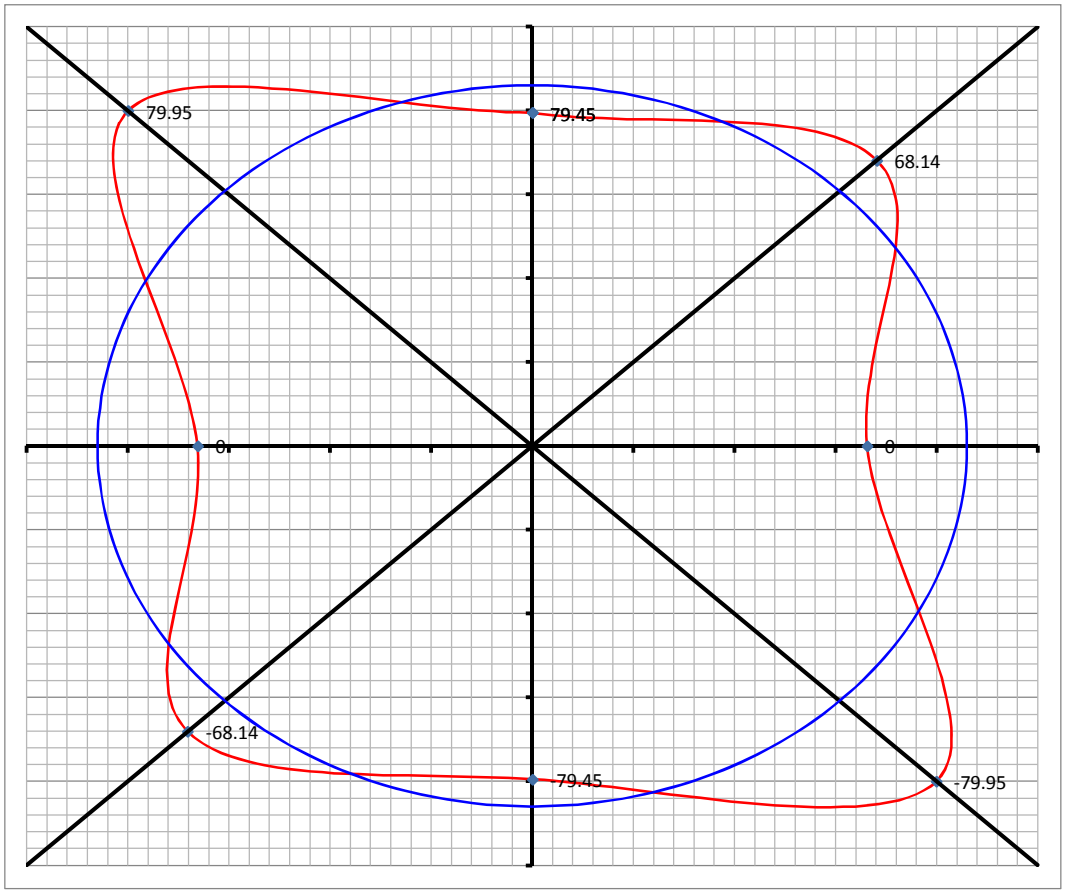


Sai Geotechnical Engineers Private Limited

Project Name: Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

Location:

POLAR CURVE



ERT NO - 1

Direction	Resistivity
East	79.45
East South	79.95
South	66.23
South West	68.14
West	79.45
North West	79.95
North	66.23
North East	68.14

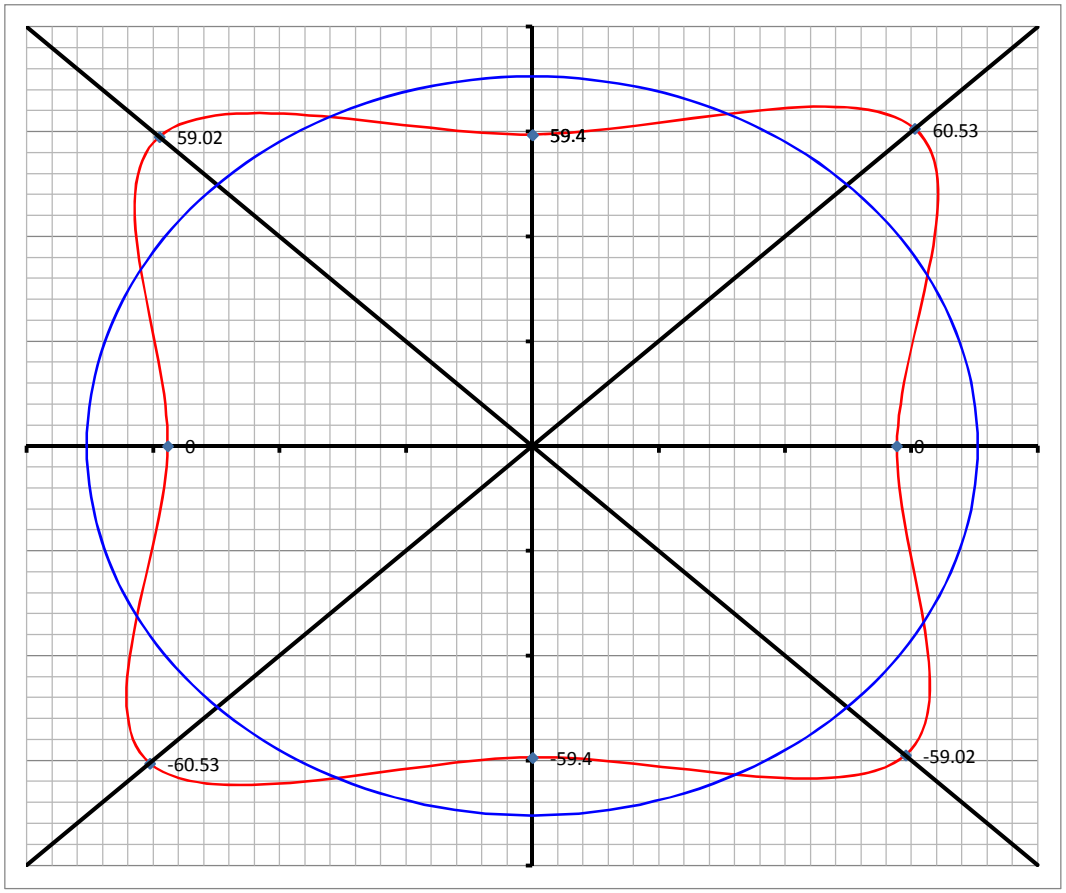
Average Resistivity	86.00 Ohm.m

Sai Geotechnical Engineers Private Limited

Project Name: Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

Location:

POLAR CURVE



ERT NO - 2

Direction	Resistivity
East	59.40
East South	59.02
South	57.70
South West	60.53
West	59.40
North West	59.02
North	57.70
North East	60.53

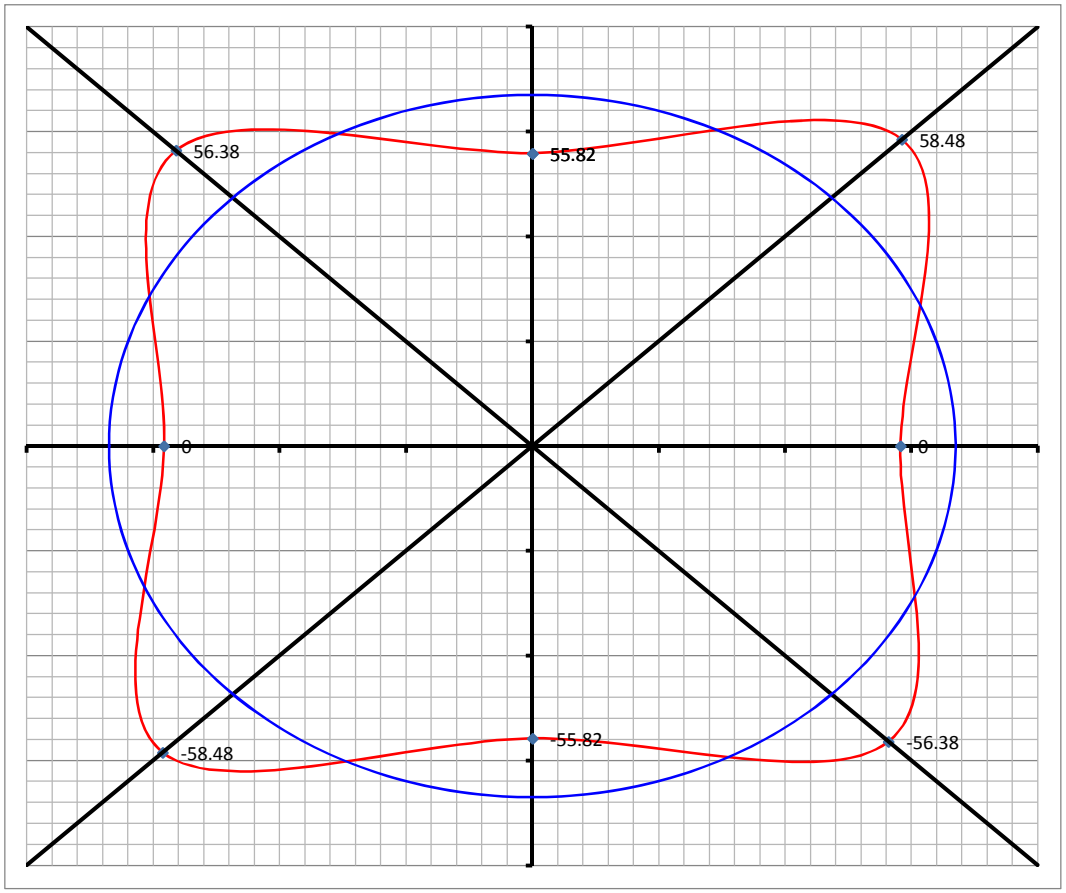
Average Resistivity	70.50 Ohm.m

Sai Geotechnical Engineers Private Limited

Project Name: Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

Location:

POLAR CURVE



ERT NO - 3

Direction	Resistivity
East	55.82
East South	56.38
South	58.27
South West	58.48
West	55.82
North West	56.38
North	58.27
North East	58.48

Average Resistivity	67.00 Ohm.m

CHEMICAL ANALYSIS ON SOIL SAMPLES

Sl. No.	Bore Hole	Sample	Depth	pH	Chloride (as Cl) in %	Sulphate (as SO_3) in %	Sulphate (as SO_4) in %	Organic Matters in %
1	1	UDS -1	2.50	8.50	0.017	0.009	0.008	0.027
2	6	SPT -1	1.50	9.00	0.008	0.009	0.008	0.034
3	16	SPT-2	3.00	8.80	0.014	0.009	0.008	0.042
Permissible Limit as per IS: 456-2000				> 6	0.25	0.20	0.20	

The results of chemical tests are within the permissible limit as per Indian Standard Code and are safe for construction purposes.

CHEMICAL ANALYSYS ON WATER SAMPLES

Sl. No.	Bore Hole	Water Table Depth, m	pH	Chloride (as Cl) in ppm	Sulphate (as SO_4) in ppm	Organic Matters in ppm
1	2	5.05	7.80	127.80	108.00	130.00
2	9	3.80	8.20	127.80	124.00	42.70
3	17	4.60	8.20	130.40	116.00	58.30
Permissible Limit as per IS: 456-2000			**> 6**	**500**	**400**	**200**

The results of chemical tests are within the permissible limit as per Indian Standard Code and are safe for construction purposes.

FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

As per IS: 2720(Part 31)-1990

TEST NO : **C1** DATED : 17.01.2015

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location: 752698.03 E 3153261.02 N
Depth of test point: 20.0 cm
Condition of Test: Soaked/unsoaked
Period of soaking, If any :
Surcharge weight :
Moisture content :
Density : t/m^3 (By Core Cutter method)

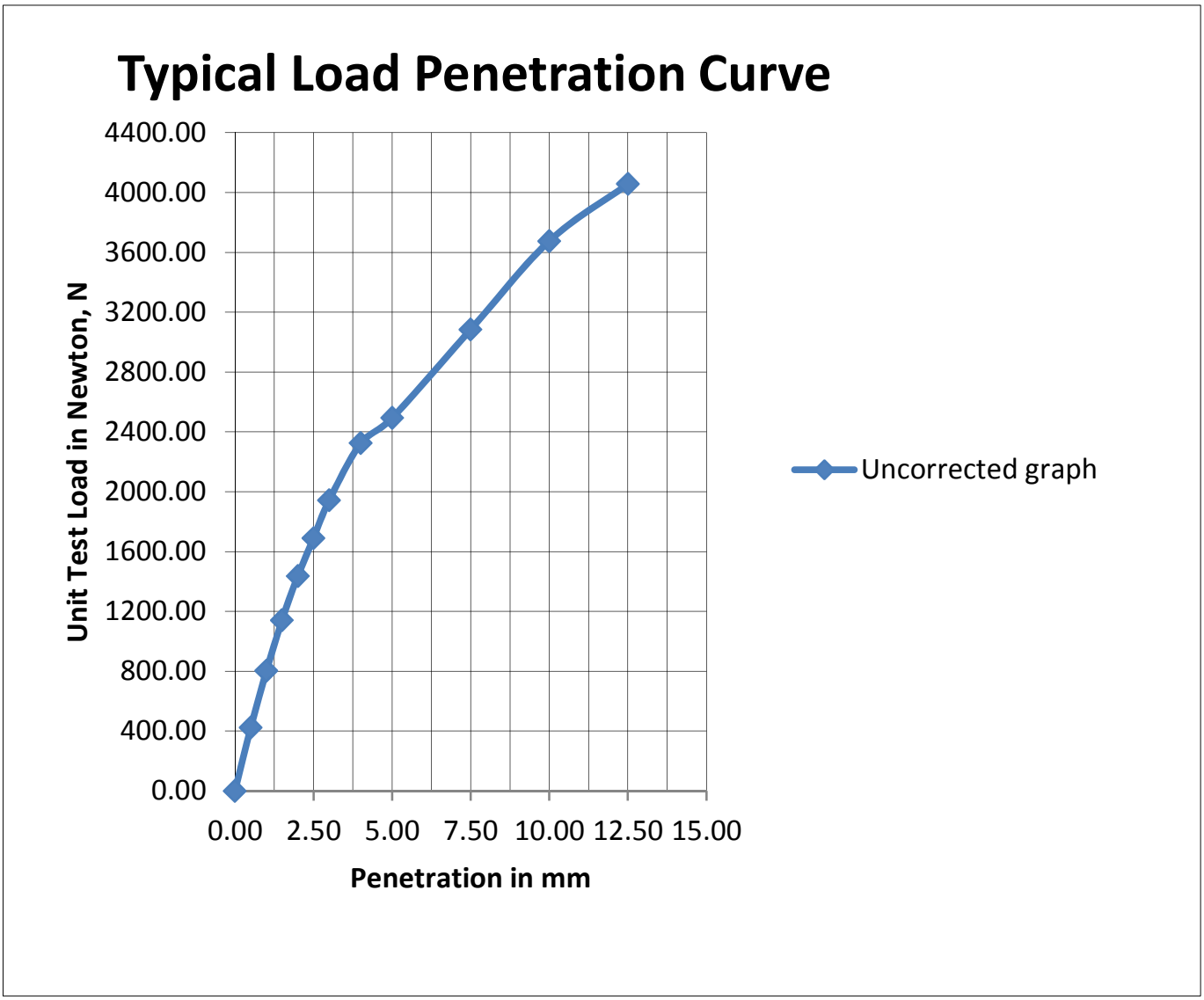
PENETRATION TEST

Penetration, mm	Proving Ring Dial Gauge Readings	Load, N	Corrected Load, N	Remarks
0.00	0.00	0.00	0.00	
0.50	10.00	422.54	422.54	
1.00	19.00	802.82	802.82	
1.50	27.00	1140.85	1140.85	
2.00	34.00	1436.62	1436.62	
2.50	40.00	1690.14	1690.14	
3.00	46.00	1943.66	1943.66	
4.00	55.00	2323.94	2323.94	
5.00	59.00	2492.96	2492.96	
7.50	73.00	3084.51	3084.51	
10.00	87.00	3676.06	3676.06	
12.50	96.00	4056.34	4056.34	

Bearing Ration at 2.50 mm Penetration = $\frac{1690.14}{13430.00}$ = 12.585 %

Bearing Ration at 5.00 mm Penetration = $\frac{2492.96}{20150.00}$ = 12.372 %

CBR value for this location = 12.58 %


Typical Load Penetration Curve
Unit Test Load in Newton, N
4400.00
4000.00
3600.00
3200.00
2800.00
2400.00
2000.00
1600.00
1200.00
800.00
400.00
0.00
0.00 2.50 5.00 7.50 10.00 12.50 15.00
Penetration in mm
Uncorrected graph

FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

As per IS: 2720(Part 31)-1990

TEST NO : **C2** DATED : 17.01.2015

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location: 753687.57 E 3151502.86 N
Depth of test point: 20.0 cm
Condition of Test: Soaked/unsoaked
Period of soaking, If any :
Surcharge weight :
Moisture content :
Density : t/m^3 (By Core Cutter method)

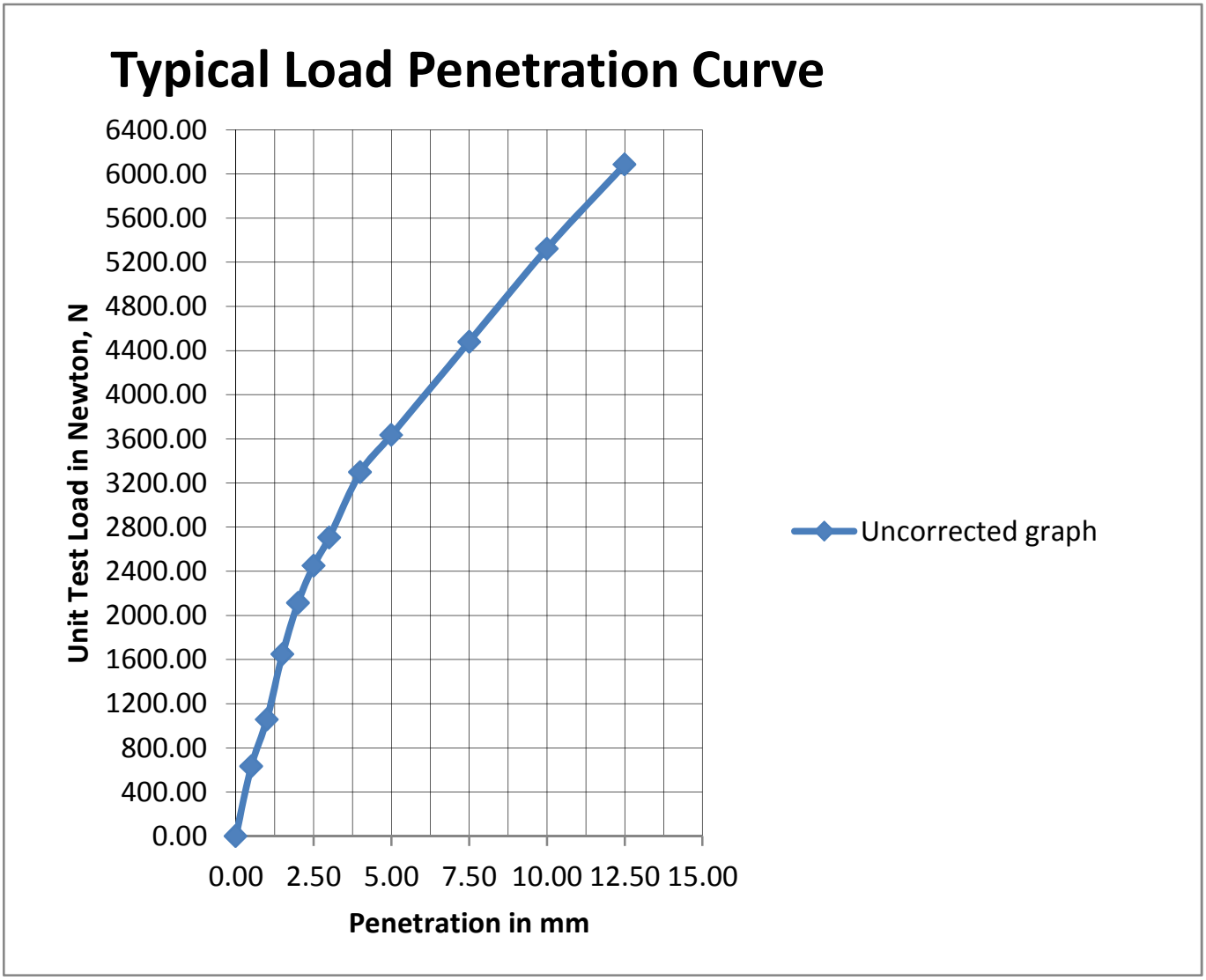
PENETRATION TEST

Penetration, mm	Proving Ring Dial Gauge Readings	Load, N	Corrected Load, N	Remarks
0.00	0.00	0.00	0.00	
0.50	15.00	633.80	633.80	
1.00	25.00	1056.34	1056.34	
1.50	39.00	1647.89	1647.89	
2.00	50.00	2112.68	2112.68	
2.50	58.00	2450.70	2450.70	
3.00	64.00	2704.23	2704.23	
4.00	78.00	3295.77	3295.77	
5.00	86.00	3633.80	3633.80	
7.50	106.00	4478.87	4478.87	
10.00	126.00	5323.94	5323.94	
12.50	144.00	6084.51	6084.51	

Bearing Ration at 2.50 mm Penetration = $\frac{2450.70}{13430.00}$ = 18.248 %

Bearing Ration at 5.00 mm Penetration = $\frac{3633.80}{20150.00}$ = 18.034 %

CBR value for this location = **18.25 %**


Typical Load Penetration Curve
Unit Test Load in Newton, N
6400.00
6000.00
5600.00
5200.00
4800.00
4400.00
4000.00
3600.00
3200.00
2800.00
2400.00
2000.00
1600.00
1200.00
800.00
400.00
0.00
0.00 2.50 5.00 7.50 10.00 12.50 15.00
Penetration in mm
Uncorrected graph

FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

As per IS: 2720(Part 31)-1990

TEST NO : **C3** DATED : 17.01.2015

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location: 754046.08 E 3150690.59 N
Depth of test point: 15.0 cm
Condition of Test: Soaked/unsoaked
Period of soaking, If any :
Surcharge weight :
Moisture content :
Density : t/m^3 (By Core Cutter method)

PENETRATION TEST

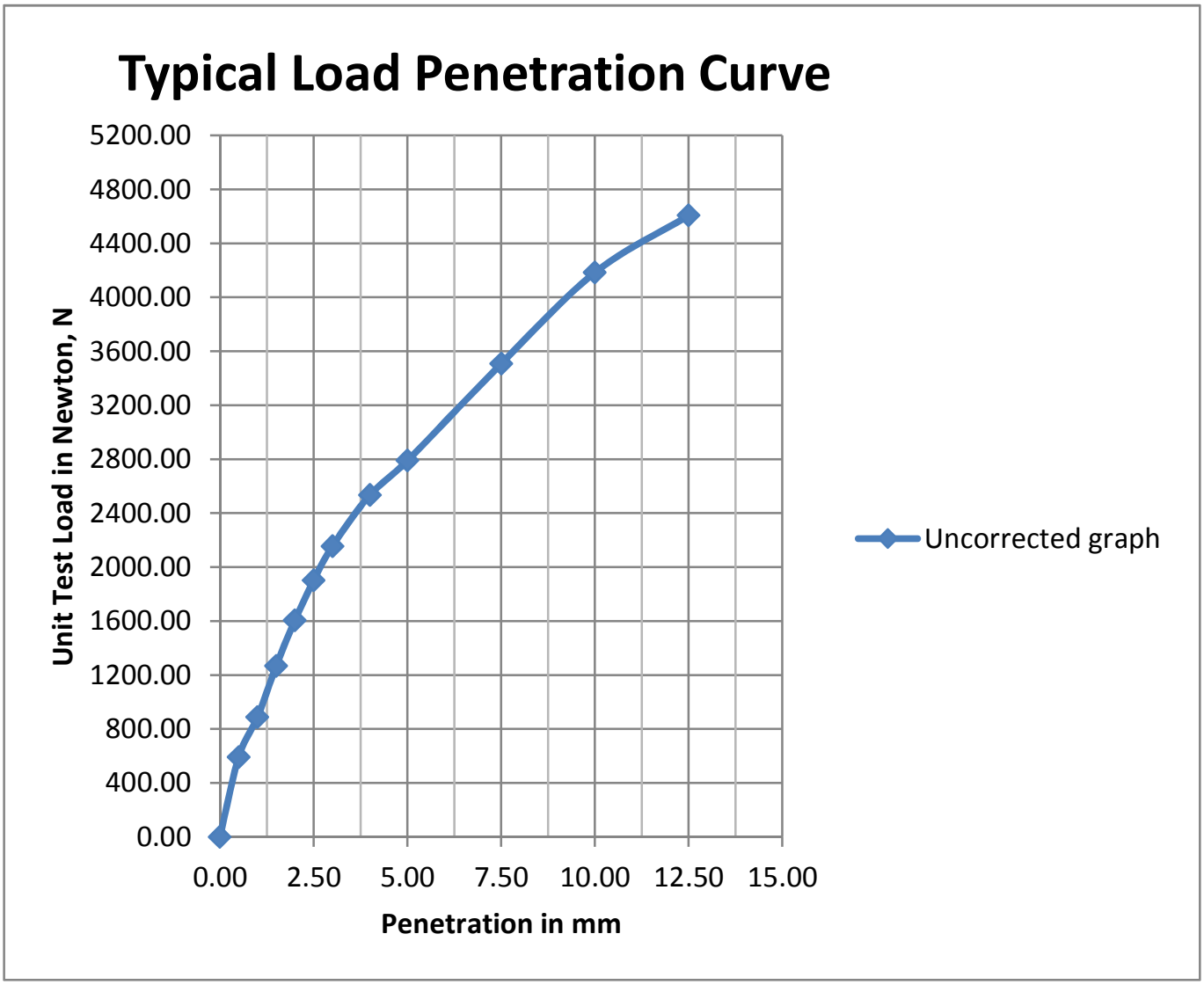
Surcharge weight used : 20.0 KG

Penetration, mm	Proving Ring Dial Gauge Readings	Load, N	Corrected Load, N	Remarks
0.00	0.00	0.00	0.00	
0.50	14.00	591.55	591.55	
1.00	21.00	887.32	887.32	
1.50	30.00	1267.61	1267.61	
2.00	38.00	1605.63	1605.63	
2.50	45.00	1901.41	1901.41	
3.00	51.00	2154.93	2154.93	
4.00	60.00	2535.21	2535.21	
5.00	66.00	2788.73	2788.73	
7.50	83.00	3507.04	3507.04	
10.00	99.00	4183.10	4183.10	
12.50	109.00	4605.63	4605.63	

Bearing Ration at 2.50 mm Penetration = $\frac{1901.41}{13430.00}$ = 14.158 %

Bearing Ration at 5.00 mm Penetration = $\frac{2788.73}{20150.00}$ = 13.840 %

CBR value for this location = 14.16 %


Typical Load Penetration Curve
Unit Test Load in Newton, N
5200.00
4800.00
4400.00
4000.00
3600.00
3200.00
2800.00
2400.00
2000.00
1600.00
1200.00
800.00
400.00
0.00
0.00
2.50
5.00
7.50
10.00
12.50
15.00
Penetration in mm
Uncorrected graph

SAI GEOTECHNICAL ENGINEERS PRIVATE LIMITED

Project Name : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

RESULT OF PERMEABILITY TEST

Sl No.	B/Hole No	Sample Type	Depth of test section (m)	Co-efficient of permeability (cm/sec)
1	1	UDS-1	2.50	6.24×10^{-6}
2	2	UDS-1	2.50	2.97×10^{-7}
3	5	UDS-1	2.50	8.68×10^{-5}
4	6	UDS-1	2.50	2.36×10^{-7}
5	9	UDS-1	2.50	5.97×10^{-6}
6	10	UDS-1	2.50	3.89×10^{-5}
7	11	UDS-1	2.50	4.06×10^{-4}
8	12	UDS-1	2.50	7.09×10^{-6}
9	13	UDS-1	2.50	4.92×10^{-6}
10	14	UDS-1	2.50	8.64×10^{-6}
11	15	UDS-1	2.50	6.75×10^{-6}
12	16	UDS-1	2.50	6.04×10^{-6}
13	17	UDS-1	2.50	6.94×10^{-6}
14	20	UDS-1	2.50	4.65×10^{-4}

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

Considering Borehole No : BH-1 & 2 **Dia of pile =** **1.00 m** **Cut-off Level =** 1.50 m

Dia of pile	Cut off level	Soil layers		Properties of layers									Pd	Nc	Nq	Ny	As	Ap	qs	Qp
		from	to	c	Ø	Øm	δ	k	α	γeff	ΔL	pd								
(m)	(m)	(m)	(m)	t/m^2	deg	deg	deg			t/m^3	m	t/m^2	t/m^2				m^2	m^2	t	t
1.00	1.50	0.00	1.50																	
1.00		1.50	5.50	5.40	10	10	10	1.0	0.70	0.74	4.0	1.48					3.142857		50.801	
1.00		5.50	7.50	0.00	31	31	31	1.0	0.65	0.90	2.0	3.86					3.142857		14.579	
1.00		7.50	14.50	7.80	12	12	12	1.0	0.60	0.94	7.0	8.05					3.142857		140.604	
1.00		14.50	16.50	12.40	0	0	0	1.0	0.50	0.94	2.0	12.28					3.142857		38.971	
1.00		16.50	19.50	12.40	0	0	0	1.0	0.40	1.00	3.0	12.28					3.142857		46.766	
1.00		19.50	23.50	0.00	33	33	33	1.0	0.30	1.00	4.0	12.28	12.28	9	34.00	35.19	3.142857	0.785714	100.254	341.9
								Length of pile			22.0									
																			392.0	341.9

Factor of Safety in Compression = 2.50 Factor of Safety in Uplift = 3.00

Qa,comp.= 293.5 Ton **Qa,uplift =** 130.7 Ton

Project : Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP).

Considering Borehole No : BH-1 & 2 **Dia of pile =** **1.20 m** **Cut-off Level =** 1.80 m

Dia of pile	Cut off level	Soil layers		Properties of layers									Pd	Nc	Nq	Ny	As	Ap	qs	Qp
		from	to	c	Ø	Øm	δ	k	α	γeff	ΔL	pd								
(m)	(m)	(m)	(m)	t/m^2	deg	deg	deg			t/m^3	m	t/m^2	t/m^2				m^2	m^2	t	t
1.20	1.80	0.00	1.80																	
1.20		1.80	5.50	5.40	10	10	10	1.0	0.70	0.74	3.7	1.37					3.771429		56.116	
1.20		5.50	7.50	0.00	31	31	31	1.0	0.65	0.90	2.0	3.64					3.771429		16.488	
1.20		7.50	14.50	7.80	12	12	12	1.0	0.60	0.94	7.0	7.83					3.771429		167.479	
1.20		14.50	19.50	12.40	0	0	0	1.0	0.50	0.94	5.0	13.47					3.771429		116.914	
1.20		19.50	19.50	12.40	0	0	0	1.0	0.40	1.00	0.0	13.47					3.771429		0.000	
1.20		19.50	23.80	0.00	33	33	33	1.0	0.30	1.00	4.3	13.47	13.47	9	34.00	35.19	3.771429	1.131429	141.839	542.0
								Length of pile			22.0									
																			498.8	542.0

Factor of Safety in Compression = 2.50 Factor of Safety in Uplift = 3.00

Qa,comp.= 416.3 Ton **Qa,uplift =** 166.3 Ton

LATERAL LOAD CAPACITY OF PILES

Pile Type : Cast-in Situ RCC Pile

Pile Cut-off-Level below GL 1.0 m

Pile Head : Fixed

Grade of Concrete : M 35

BH NO 1 and 2

Soil : Sandy Silt

Density Condition Stiff to very stiff

Saturation : Submerged

D, m	η_h, N/m^3	E, N/m^2	I, m^4	T = $(EI/\eta_h)^{0.20}$	Lf/T	$Z_{f,\ m}$	$L_{1\ (Free\ length),}$ m	Y, m	H, KN	H, Tons
For Fixed Head Condition										
BH NO 1										
1.00	1976000	29580398915	0.04909	3.74	2.23	8.35	0.00	0.010	299.59	29.96
1.20	1976000	29580398915	0.10179	4.33	2.23	9.66	0.00	0.012	481.28	48.13

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP)**

Location - **BH -1**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

q = overburden pressure

γ = Bulk density of soil below founding level

N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

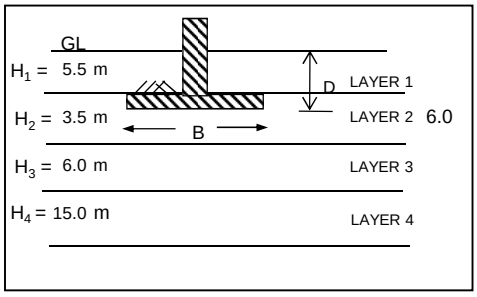
d_c, d_q, d_γ = Depth factors

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors

c_{equi} = equivalent cohesion intercept

B = Foundation width

FS = Factor of safety



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	5.5	5.5	9	1.76
2	5.5	9.0	8.0	10	1.96
3	9.0	15.0	13.2	12	1.98
4	15.0	30.0	0.0	34	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	6.0 m
Length of Foundation	L	=	9.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	96.00 m
Depth of foundation	D_f	=	4.00 m

Equivalent Shear Parameters

ϕ_{equi} = 9.70 ^{o}

c_{equi} = 7.14

DESIGN PARAMETERS

ϕ_{Design} = 9.7 ^{o}

c_{Design} = 7.1

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	6.0	m	
Length of Foundation	L	=	9.0	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	96.0	m	
Depth of foundation	D_f	=	4.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	4.56	t/m^2	
Cohesion	C	=	7.14	t/m^2	
Angle of internal friction	ϕ_{des}	=	9.7	deg	
Void Ratio		=	0.734		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	4.76	kPa
Mobilised angle of internal friction	ϕ'	=	6.50	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 6.98	Sc = 1.13	dc = 1.15	i_c = 1.00	dw = 2.00 m
Nq = 1.80	Sq = 1.13	dq = 1.00	i_q = 1.00	Df+B = 10.0 m
$N\gamma$ = 0.637	$S\gamma$ = 0.73	$d\gamma$ = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 48.6 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **19.42** kN/m^2

General Shear Failure

Mobilised cohesion	c'	=	7.14	kPa
Mobilised angle of internal friction	ϕ'	=	9.70	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 8.22	Sc = 1.13	dc = 1.16	i_c = 1.00	Df+B = 10.0 m
Nq = 2.40	Sq = 1.13	dq = 1.00	i_q = 1.00	dw = 2.00 m
Ng = 1.16	Sg = 0.73	dg = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 86 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **34.5** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **20.6** t/m^2

Settlement Failure Consideration

Location - **BH -1** Raft footing

Allowable Settlement Consideration	=	75.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	4.00 m
Width of Footing	=	6.0 m
Length of Footing	=	9.0 m
Depth of Influence zone below Foundation depth	=	9.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	4.0	9.0	5.0	5.0	Fine Grained	24
2	9.0	15.0	6.0	4.0	Fine Grained	22
3	15.0	30.0	15.0	0.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v = Coeffcient of volume compressibilty (cm^2/kg) = 0.0106 cm^2/kg

Δp = Effective Pressure (kg/cm^2) = 5.52 kg/cm^2

H = Thickness of Layer (cm) = 500 cm

Settlement = 29.24 mm

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v = Coeffcient of volume compressibilty (cm^2/kg) = 0.013 cm^2/kg

Δp = Effective Pressure (kg/cm^2) = 2.27 kg/cm^2

H = Thickness of Layer (cm) = 400 cm

Settlement = 9.77 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer = 0.0

Average SPT 'N' value = 27

Settlement under 10 t/m^2 : 10.91 mm From Figure 9 of IS:8009 Part -I

Hence total settlement = 10.91 mm

Water Correction Factor = 0.50

Rigidity Correction Factor = 0.80

Corrected settlement = 0.00 mm

Total settlement = 31.21 mm

Permissible settlement = 75.0 mm

Net allowable Bearing pressure for permissible settlement

= 24.03 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP)**

Location - **BH -B1**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

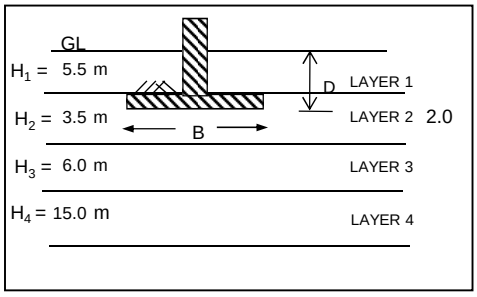
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	5.5	5.5	9	1.76
2	5.5	9.0	8.0	10	1.96
3	9.0	15.0	13.2	12	1.98
4	15.0	30.0	0.0	34	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	2.0 m
Length of Foundation	L	=	2.0 m
Type of Foundation		=	Square
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	98.00 m
Depth of foundation	D_f	=	2.00 m

Equivalent Shear Parameters

ϕ_{equi} = 9.00 ^{o}

c_{equi} = 5.50

DESIGN PARAMETERS

ϕ_{Design} = 9.0 ^{o}

c_{Design} = 5.5

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	2.0	m	
Length of Foundation	L	=	2.0	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	98.0	m	
Depth of foundation	D_f	=	2.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	3.28	t/m^2	
Cohesion	C	=	5.50	t/m^2	
Angle of internal friction	ϕ_{des}	=	9.0	deg	
Void Ratio		=	0.734		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	3.66667	kPa
Mobilised angle of internal friction	ϕ'	=	6.03	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 6.82	Sc = 1.30	dc = 1.22	i_c = 1.00	dw = 2.00 m
Nq = 1.72	Sq = 1.30	dq = 1.00	i_q = 1.00	Df+B = 4.0 m
Nγ = 0.574	Sγ = 0.80	dγ = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 43.2 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **17.28** kN/m^2

General Shear Failure

Mobilised cohesion	c'	=	5.5	kPa
Mobilised angle of internal friction	ϕ'	=	9.00	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 7.92	Sc = 1.30	dc = 1.23	i_c = 1.00	Df+B = 4.0 m
Nq = 2.25	Sq = 1.30	dq = 1.00	i_q = 1.00	dw = 2.00 m
Ng = 1.03	Sg = 0.80	dg = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 76 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **30.4** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **18.3** t/m^2

Settlement Failure Consideration

Location - **BH -B1** Isolated Square footing

Allowable Settlement Consideration	=	50.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	2.0 m
Width of Footing	=	2.0 m
Length of Footing	=	2.0 m
Depth of Influence zone below Foundation depth	=	3.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	2.0	9.0	7.0	3.0	Fine Grained	24
2	9.0	15.0	6.0	0.0	Fine Grained	22
3	15.0	30.0	15.0	0.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0106 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	3.27 kg/cm^2	
H =	Thickness of Layer (cm) =	300 cm	

Settlement = 10.37 mm

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.013 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.28 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0	
Average SPT 'N' value =	27	
Settlement under 10 t/ m^2 :	9.10 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	9.10 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	0.80	
Corrected settlement =	0.00 mm	

Total settlement = 10.37 mm

Permissible settlement = 50.0 mm

Net allowable Bearing pressure for permissible settlement
= 48.21 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP)**

Location - **BH -B2**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

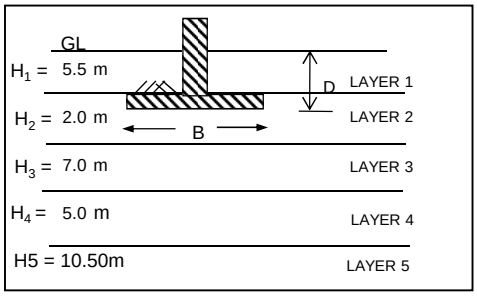
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	5.5	5.4	10	1.74
2	5.5	7.5	0.0	31	1.80
3	7.5	14.5	7.8	12	1.94
4	14.5	19.5	12.4	0	1.99
5	19.5	30.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	6.0 m
Length of Foundation	L	=	9.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	96.00 m
Depth of foundation	D_f	=	4.00 m

Equivalent Shear Parameters

ϕ_{equi} = 19.40 ^{o}

c_{equi} = 4.10

DESIGN PARAMETERS

ϕ_{Design} = 19.4 ^{o}

c_{Design} = 4.1

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	6.0	m	
Length of Foundation	L	=	9.0	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	96.0	m	
Depth of foundation	D_f	=	4.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	4.56	t/m^2	
Cohesion	C	=	4.10	t/m^2	
Angle of internal friction	ϕ_{des}	=	19.4	deg	
Void Ratio		=	0.721		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.73333	kPa
Mobilised angle of internal friction	ϕ'	=	13.21	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 9.92	Sc = 1.13	dc = 1.17	i_c = 1.00	dw = 2.00 m
Nq = 3.33	Sq = 1.13	dq = 1.09	i_q = 1.00	Df+B = 10.0 m
Nγ = 2.033	Sγ = 0.73	dγ = 1.09	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity	q_u	=	$C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$	
	q_u	=	53.1	t/m^2
Factor of safety	FOS	=	2.5	as per IS 1904-1986
Safe bearing capacity (q_u/FOS)	q_{slocal}	=	**21.24**	kN/m^2

General Shear Failure

Mobilised cohesion	c'	=	4.1	kPa
Mobilised angle of internal friction	ϕ'	=	19.40	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 14.29	Sc = 1.13	dc = 1.19	i_c = 1.00	Df+B = 10.0 m
Nq = 6.03	Sq = 1.13	dq = 1.09	i_q = 1.00	dw = 2.00 m
Ng = 4.95	Sg = 0.73	dg = 1.09	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity	q_u	=	$C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$	
	q_u	=	117	t/m^2
Factor of safety	FOS	=	2.5	as per IS 1904-1986
Safe bearing capacity (q_u/FOS)	$q_{sgenera}$	=	**46.8**	t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **25.0** t/m^2

Settlement Failure Consideration

Location - **BH -B2** (Raft footing)

Allowable Settlement Consideration	=	75.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	4.0 m
Width of Footing	=	6.0 m
Length of Footing	=	9.0 m
Depth of Influence zone below Foundation depth	=	9.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	4.0	5.5	1.5	1.5	Fine Grained	22
2	5.5	7.5	2.0	2.0	Coarse Grained	22
3	7.5	19.5	12.0	5.5	fine Grained	19
4	19.5	30	10.5		Coarse Grained	31

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0113 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	8.21 kg/cm^2	
H =	Thickness of Layer (cm) =	150 cm	

Settlement = 13.89 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	2.0	
Average SPT 'N' value =	22	
Settlement under 10 t/ m^2 :	13.79 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	13.79 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	0.80	
	4.90 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	1.88 kg/cm^2	
H =	Thickness of Layer (cm) =	550 cm	

Settlement = 12.37 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Total settlement = 25.91 mm

Permissible settlement = 75.0 mm

Net allowable Bearing pressure for permissible settlement
= 28.94 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **Soil Investigations for proposed Integrated Industrial Township Project Area under Gautam Buddha Nagar (UP)**

Location - **BH -2**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

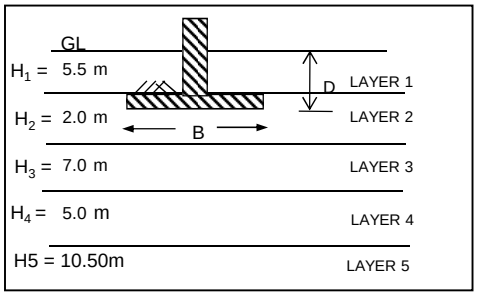
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	5.5	5.4	10	1.74
2	5.5	7.5	0.0	31	1.80
3	7.5	14.5	7.8	12	1.94
4	14.5	19.5	12.4	0	1.99
5	19.5	30.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	2.0 m
Length of Foundation	L	=	2.0 m
Type of Foundation		=	Square
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	97.00 m
Depth of foundation	D_f	=	3.00 m

Equivalent Shear Parameters

ϕ_{equi} = 10.00 ^{o}

c_{equi} = 5.40

DESIGN PARAMETERS

ϕ_{Design} = 10.0 ^{o}

c_{Design} = 5.4

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	2.0	m	
Length of Foundation	L	=	2.0	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	97.0	m	
Depth of foundation	D_f	=	3.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	3.92	t/m^2	
Cohesion	C	=	5.40	t/m^2	
Angle of internal friction	ϕ_{des}	=	10.0	deg	
Void Ratio		=	0.721		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	3.6	kPa
Mobilised angle of internal friction	ϕ'	=	6.70	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 7.05	Sc = 1.30	dc = 1.34	i_c = 1.00	dw = 2.00 m
Nq = 1.83	Sq = 1.30	dq = 1.00	i_q = 1.00	Df+B = 5.0 m
Nγ = 0.665	Sγ = 0.80	dγ = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 48.8 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **19.52** kN/m^2

General Shear Failure

Mobilised cohesion	c'	=	5.4	kPa
Mobilised angle of internal friction	ϕ'	=	10.00	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 8.34	Sc = 1.30	dc = 1.36	i_c = 1.00	Df+B = 5.0 m
Nq = 2.47	Sq = 1.30	dq = 1.00	i_q = 1.00	dw = 2.00 m
Ng = 1.22	Sg = 0.80	dg = 1.00	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 88 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **35.1** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **21.8** t/m^2

Settlement Failure Consideration

Location - **BH -2** Isolated Square footing

Allowable Settlement Consideration	=	50.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	3.0 m
Width of Footing	=	2.0 m
Length of Footing	=	2.0 m
Depth of Influence zone below Foundation depth	=	3.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	3.0	5.5	2.5	2.5	Fine Grained	22
2	5.5	7.5	2.0	0.5	Coarse Grained	22
3	7.5	19.5	12.0	0.0	fine Grained	19
4	19.5	30	10.5		Coarse Grained	31

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0113 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	3.79 kg/cm^2	
H =	Thickness of Layer (cm) =	250 cm	

Settlement = 10.69 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.5	
Average SPT 'N' value =	22	
Settlement under 10 t/m^2 :	11.49 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.49 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	0.80	
	3.06 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.26 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Total settlement = 13.75 mm

Permissible settlement = 50.0 mm

Net allowable Bearing pressure for permissible settlement

= 36.36 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B5**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

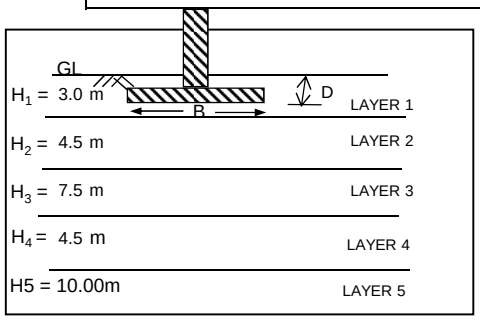
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	7.5	0.0	30	1.80
3	7.5	15.0	8.5	9	1.93
4	15.0	19.5	14.8	10	1.99
5	19.5	30.0	0.0	35	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	6.0 m
Length of Foundation	L	=	9.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	205.49 m
RL of proposed Foundation level		=	203.99 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 25.30 °

c_{equi} = 1.29 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 25.3 °

c_{Design} = 1.29 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	6.0	m
Length of Foundation	L	=	9.0	m
RL of existing ground level		=	205.49	m
RL of proposed Foundation level		=	203.99	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	1.3	t/m^2
Angle of internal friction	ϕ_{des}	=	25	deg
Void Ratio		=	0.710	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	0.86	t/m^2
Mobilised angle of internal friction	ϕ'	=	17.49	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 12.71	Sc = 1.13	dc = 1.07	i_c = 1.00	dw = 2.00 m
Nq = 5.00	Sq = 1.13	dq = 1.04	i_q = 1.00	Df+B = 7.5 m
Nγ = 3.784	Sγ = 0.73	dγ = 1.04	i_γ = 1.00	W' = 0.54

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 32.5 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **13.01** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	1.29	t/m^2
Mobilised angle of internal friction	ϕ'	=	25	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 21.17	Sc = 1.13	dc = 1.08	i_c = 1.00	Df+B = 7.5 m
Nq = 11.00	Sq = 1.13	dq = 1.04	i_q = 1.00	dw = 2.00 m
Ng = 11.35	Sg = 0.73	dg = 1.04	i_γ = 1.00	W' = 0.54

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 85 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **34.2** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **17.24** t/m^2

Settlement Failure Consideration

Location - **BH - B5** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	6.0	m
Length of Footing	=	6.0	m
Depth of Influence zone below Foundation depth	=	9.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	17
2	3.0	7.5	4.5	4.5	Coarse Grained	22
3	7.5	19.5	12.0	3.0	fine Grained	17
4	19.5	30	10.5	0.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0135 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.79	kg/cm^2
H =	Thickness of Layer (cm) =	150	cm

Settlement = 12.82 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	4.5	
Average SPT 'N' value =	22	
Effective Pressure =	3.79 t/m^2	
Settlement under 10 t/m^2 :	13.79 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	13.79 mm	
Water Correction Factor =	0.54	
Rigidity Correction Factor =	0.80	
	3.86 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.015 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.20	kg/cm^2
H =	Thickness of Layer (cm) =	300	cm

Settlement = 7.19 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	27		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	10.91	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	10.91	mm	
Water Correction Factor =	0.54		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	23.86	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 31.43 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B5**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

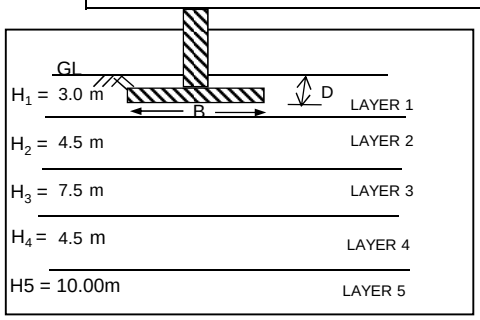
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	7.5	0.0	30	1.80
3	7.5	15.0	8.5	9	1.93
4	15.0	19.5	14.8	10	1.99
5	19.5	30.0	0.0	35	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	2.0 m
Length of Foundation	L	=	2.0 m
Type of Foundation		=	Square
RL of Borehole level		=	205.49 m
RL of proposed Foundation level		=	203.99 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 10.00 °

c_{equi} = 5.00 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 10.0 °

c_{Design} = 5.0 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	2.0	m
Length of Foundation	L	=	2.0	m
RL of existing ground level		=	205.49	m
RL of proposed Foundation level		=	203.99	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	5.0	t/m^2
Angle of internal friction	ϕ_{des}	=	10	deg
Void Ratio		=	0.710	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	3.33	t/m^2
Mobilised angle of internal friction	ϕ'	=	6.70	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 7.05	Sc = 1.30	dc = 1.17	i_c = 1.00	dw = 2.00 m
Nq = 1.83	Sq = 1.20	dq = 1.00	i_q = 1.00	Df+B = 3.5 m
Nγ = 0.665	Sγ = 0.80	dγ = 1.00	i_γ = 1.00	W' = 0.63

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 38.7 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **15.49** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	5	t/m^2
Mobilised angle of internal friction	ϕ'	=	10	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 8.34	Sc = 1.30	dc = 1.18	i_c = 1.00	Df+B = 3.5 m
Nq = 2.47	Sq = 1.30	dq = 1.00	i_q = 1.00	dw = 2.00 m
Ng = 1.22	Sg = 0.80	dg = 1.00	i_γ = 1.00	W' = 0.63

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 70 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **27.9** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **17.96** t/m^2

Settlement Failure Consideration

Location - **BH - B5** Isolated Square footing

Allowable Settlement Consideration	=	50.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	2.0	m
Length of Footing	=	2.0	m
Depth of Influence zone below Foundation depth	=	3.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	17
2	3.0	7.5	4.5	1.5	Coarse Grained	22
3	7.5	19.5	12.0	0.0	fine Grained	17
4	19.5	30	10.5	0.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0135 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.53 kg/cm^2	
H =	Thickness of Layer (cm) =	150 cm	

Settlement = 10.73 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	1.5	
Average SPT 'N' value =	22	
Effective Pressure =	2.21 t/m^2	
Settlement under 10 t/m^2 :	11.49 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.49 mm	
Water Correction Factor =	0.63	
Rigidity Correction Factor =	1.00	
	2.04 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.015 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.16 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	27		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	9.10	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	9.10	mm	
Water Correction Factor =	0.63		
Rigidity Correction Factor =	1.00		
Corrected settlement =	0.00	mm	

Total settlement =	12.76	mm
Permissible settlement =	50.0	mm

Net allowable Bearing pressure for permissible settlement

= 39.18 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH -B6**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

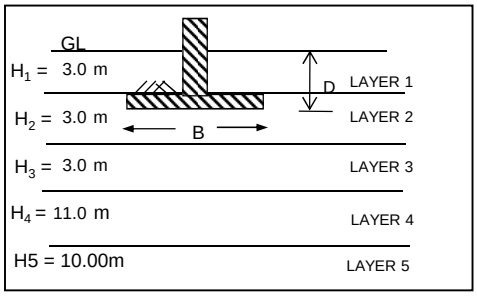
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	3.0	6.0	0	1.78
2	3.0	6.0	0.0	31	1.80
3	6.0	9.0	8.9	10	1.96
4	9.0	20.0	0.0	33	1.99
5	20.0	30.0	0.0	34	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	- m
Type of Foundation		=	Circle
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	96.00 m
Depth of foundation	D_f	=	4.00 m

Equivalent Shear Parameters

ϕ_{equi} = 19.10 ^{o}

c_{equi} = 5.33

DESIGN PARAMETERS

ϕ_{Design} = 19.1 ^{o}

c_{Design} = 5.3

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m	
Length of Foundation	L	=	-	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	96.0	m	
Depth of foundation	D_f	=	4.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	4.56	t/m^2	
Cohesion	C	=	5.33	t/m^2	
Angle of internal friction	ϕ_{des}	=	19.1	deg	
Void Ratio		=	0.721		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	3.55333	kPa
Mobilised angle of internal friction	ϕ'	=	13.00	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 9.81	Sc = 1.30	dc = 1.13	i_c = 1.00	dw = 2.00 m
Nq = 3.26	Sq = 1.30	dq = 1.07	i_q = 1.00	Df+B = 12.0 m
Nγ = 1.969	Sγ = 0.60	dγ = 1.07	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity	q_u	=	$C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$	
	q_u	=	69.5	t/m^2
Factor of safety	FOS	=	2.5	as per IS 1904-1986
Safe bearing capacity (q_u/FOS)	q_{slocal}	=	**27.80**	kN/m^2

General Shear Failure

Mobilised cohesion	c'	=	5.33	kPa
Mobilised angle of internal friction	ϕ'	=	19.10	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 14.02	Sc = 1.30	dc = 1.14	i_c = 1.00	Df+B = 12.0 m
Nq = 5.85	Sq = 1.30	dq = 1.07	i_q = 1.00	dw = 2.00 m
Ng = 4.75	Sg = 0.60	dg = 1.07	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity	q_u	=	$C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$	
	q_u	=	152	t/m^2
Factor of safety	FOS	=	2.5	as per IS 1904-1986
Safe bearing capacity (q_u/FOS)	$q_{sgenera}$	=	**60.6**	t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **32.6** t/m^2

Settlement Failure Consideration

Location - **BH -B6** (Circular Raft footing)

Allowable Settlement Consideration	=	75.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	4.0 m
Diameter of Footing	=	8.0 m
Depth of Influence zone below Foundation depth	=	12.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	4.0	4.0	0.0	0.0	Fine Grained	22
2	4.0	6.0	2.0	2.0	Coarse Grained	26
3	6.0	9.0	3.0	3.0	fine Grained	25
4	9.0	20	11.0	7.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0113 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	10.00 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	2.0	
Average SPT 'N' value =	26	
Settlement under 10 t/m^2 :	11.67 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.67 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	0.80	
	3.11 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.012 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	4.84 kg/cm^2	
H =	Thickness of Layer (cm) =	300 cm	

Settlement = 14.22 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	7.0		
Average SPT 'N' value =	27		
Settlement under 10 t/ m^2 :	11.18	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.18	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
Corrected settlement =	2.61	mm	

Settlement for Coarse grained soil

Thickness of Layer =	3.0		
Average SPT 'N' value =	25		
Settlement under 10 t/ m^2 :	12.20	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.20	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
	1.22	mm	

Total settlement = 15.70 mm

Permissible settlement = 75.0 mm

Net allowable Bearing pressure for permissible settlement
= 47.76 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH -6**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

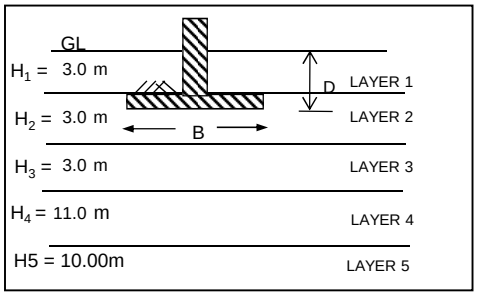
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m^2	ϕ deg.	γ t/m^3
1	0.0	3.0	6.0	0	1.78
2	3.0	6.0	0.0	31	1.80
3	6.0	9.0	8.9	10	1.96
4	9.0	20.0	0.0	33	1.99
5	20.0	30.0	0.0	34	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	2.0 m
Length of Foundation	L	=	2.0 m
Type of Foundation		=	Square
RL of Borehole level		=	100.00 m
RL of proposed Foundation level		=	97.00 m
Depth of foundation	D_f	=	3.00 m

Equivalent Shear Parameters

ϕ_{equi} = 31.00 ^{o}

c_{equi} = 0.00

DESIGN PARAMETERS

ϕ_{Design} = 31.0 ^{o}

c_{Design} = 0.0

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	2.0	m	
Length of Foundation	L	=	2.0	m	
RL of existing ground level		=	100.0	m	
RL of proposed Foundation level		=	97.0	m	
Depth of foundation	D_f	=	3.00	m	
Depth of GWT from ground level	d_w	=	2.00	m	
Inclination of the footing	α	=	0	deg.	
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3	
Unit weight of water	γ_w	=	1.0	t/m^3	
Effective overburden pressure	$\gamma'.D_f$	=	3.92	t/m^2	
Cohesion	C	=	0.00	t/m^2	
Angle of internal friction	ϕ_{des}	=	31.0	deg	
Void Ratio		=	0.721		From Soil Profile Sheet

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion c' = 0 kPa

Mobilised angle of internal friction ϕ' = 21.83 deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 16.69	Sc = 1.30	dc = 1.44	i_c = 1.00	dw = 2.00 m
Nq = 7.69	Sq = 1.30	dq = 1.27	i_q = 1.00	Df+B = 5.0 m
$N\gamma$ = 6.960	$S\gamma$ = 0.80	$d\gamma$ = 1.27	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity q_u = $C.N_c\, s_c d_c i_c + q(N_{q-1})s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 48.9 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **19.56** kN/m^2

General Shear Failure

Mobilised cohesion c' = 0 kPa

Mobilised angle of internal friction ϕ' = 31.00 deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 32.67	Sc = 1.30	dc = 1.53	i_c = 1.00	Df+B = 5.0 m
Nq = 20.63	Sq = 1.30	dq = 1.27	i_q = 1.00	dw = 2.00 m
Ng = 25.99	Sg = 0.80	dg = 1.27	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity q_u = $C.N_c\, s_c d_c i_c + q(N_{q-1})s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 148 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **59.3** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **25.3** t/m^2

Settlement Failure Consideration

Location - **BH -6** Isolated Square footing

Allowable Settlement Consideration	=	50.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	3.0 m
Diameter of Footing	=	2.0 m
Length of Footing	=	2.0 m
Depth of Influence zone below Foundation depth	=	3.0 m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	3.0	4.0	1.0	1.0	Fine Grained	22
2	4.0	6.0	2.0	2.0	Coarse Grained	26
3	6.0	9.0	3.0	0.0	fine Grained	25
4	9.0	20	11.0	0.0	Coarse Grained	27

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0113 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	6.40 kg/cm^2	
H =	Thickness of Layer (cm) =	100 cm	

Settlement = 7.22 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	2.0	
Average SPT 'N' value =	26	
Settlement under 10 t/m^2 :	9.49 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	9.49 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	1.00	
	12.66 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.012 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.95 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	27		
Settlement under 10 t/ m^2 :	9.10	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	9.10	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	1.00		
Corrected settlement =	0.00	mm	

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	25		
Settlement under 10 t/ m^2 :	9.93	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	9.93	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
	0.00	mm	

Total settlement = 19.88 mm

Permissible settlement = 50.0 mm

Net allowable Bearing pressure for permissible settlement
= 25.15 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B9**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

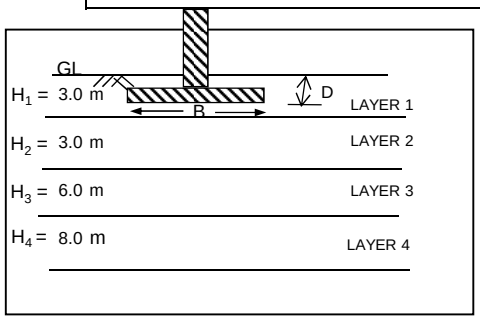
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	6.0	0.0	30	1.80
3	6.0	12.0	8.5	11	1.94
4	12.0	20.0	14.8	10	1.99

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	3.0 m
Length of Foundation	L	=	3.0 m
Type of Foundation		=	Square
RL of Borehole level		=	204.84 m
RL of proposed Foundation level		=	203.34 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 15.10 °

c_{equi} = 3.83 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 15.1 °

c_{Design} = 3.83 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	3.0	m
Length of Foundation	L	=	3.0	m
RL of existing ground level		=	204.84	m
RL of proposed Foundation level		=	203.34	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	3.8	t/m^2
Angle of internal friction	ϕ_{des}	=	15	deg
Void Ratio		=	0.716	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.55	t/m^2
Mobilised angle of internal friction	ϕ'	=	10.20	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 8.43	Sc = 1.30	dc = 1.12	i_c = 1.00	dw = 2.00 m
Nq = 2.52	Sq = 1.20	dq = 1.07	i_q = 1.00	Df+B = 4.5 m
Nγ = 1.265	Sγ = 0.80	dγ = 1.07	i_γ = 1.00	W' = 0.58

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 37.7 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **15.06** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	3.83	t/m^2
Mobilised angle of internal friction	ϕ'	=	15	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.04	Sc = 1.30	dc = 1.13	i_c = 1.00	Df+B = 4.5 m
Nq = 3.98	Sq = 1.20	dq = 1.07	i_q = 1.00	dw = 2.00 m
Ng = 2.69	Sg = 0.80	dg = 1.07	i_γ = 1.00	W' = 0.58

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 75 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **29.9** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **17.59** t/m^2

Settlement Failure Consideration

Location - **BH - B9** Isolated Square footing

Allowable Settlement Consideration	=	40.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	3.0	m
Length of Footing	=	3.0	m
Depth of Influence zone below Foundation depth	=	4.5	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	20
2	3.0	6.0	3.0	3.0	Coarse Grained	21
3	6.0	12.0	6.0	0.0	fine Grained	20
4	12.0	20	8.0	0.0	Coarse Grained	24

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =	0.0121	cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.64	kg/cm^2
H =	Thickness of Layer (cm) =	150	cm

Settlement = 11.60 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	3.0	
Average SPT 'N' value =	21	
Effective Pressure =	2.50 t/m^2	
Settlement under 10 t/m^2 :	13.26 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	13.26 mm	
Water Correction Factor =	0.58	
Rigidity Correction Factor =	1.00	
	3.79 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =	0.014	cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.16	kg/cm^2
H =	Thickness of Layer (cm) =	0	cm

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	24		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	11.37	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.37	mm	
Water Correction Factor =	0.58		
Rigidity Correction Factor =	1.00		
Corrected settlement =	0.00	mm	

Total settlement =	15.39	mm
Permissible settlement =	40.0	mm

Net allowable Bearing pressure for permissible settlement

= 25.99 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B9**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

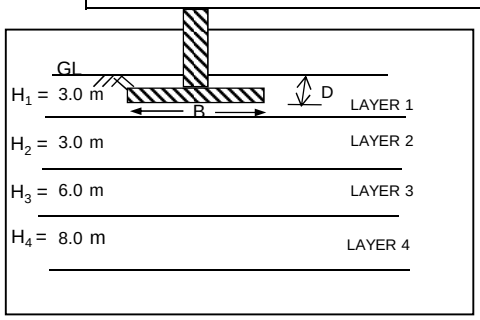
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	6.0	0.0	30	1.80
3	6.0	12.0	8.5	11	1.94
4	12.0	20.0	14.8	10	1.99

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.84 m
RL of proposed Foundation level		=	203.34 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 19.60 °

c_{equi} = 4.07 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 19.6 °

c_{Design} = 4.07 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	204.84	m
RL of proposed Foundation level		=	203.34	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	4.1	t/m^2
Angle of internal friction	ϕ_{des}	=	20	deg
Void Ratio		=	0.716	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.71	t/m^2
Mobilised angle of internal friction	ϕ'	=	13.35	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 10.00	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 3.37	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 2.077	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 44.5 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **17.78** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	4.07	t/m^2
Mobilised angle of internal friction	ϕ'	=	20	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 14.47	Sc = 1.13	dc = 1.05	i_c = 1.00	Df+B = 9.5 m
Nq = 6.15	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 5.09	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 98 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **39.3** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **21.45** t/m^2

Settlement Failure Consideration

Location - **BH - B9** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	20
2	3.0	6.0	3.0	3.0	Coarse Grained	21
3	6.0	12.0	6.0	6.0	fine Grained	20
4	12.0	20	8.0	1.5	Coarse Grained	24

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0121 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.84 kg/cm^2	
H =	Thickness of Layer (cm) =	150 cm	

Settlement = 12.12 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	3.0	
Average SPT 'N' value =	21	
Effective Pressure =	5.29 t/m^2	
Settlement under 10 t/m^2 :	14.91 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	14.91 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	2.97 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.27 kg/cm^2	
H =	Thickness of Layer (cm) =	600 cm	

Settlement = 17.33 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	1.5		
Average SPT 'N' value =	24		
Effective Pressure =	1.727104065	t/m^2	
Settlement under 10 t/m^2 :	12.78	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.78	mm	
Water Correction Factor =	0.53		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.12	mm	

Total settlement =	32.54	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 23.05 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B10**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

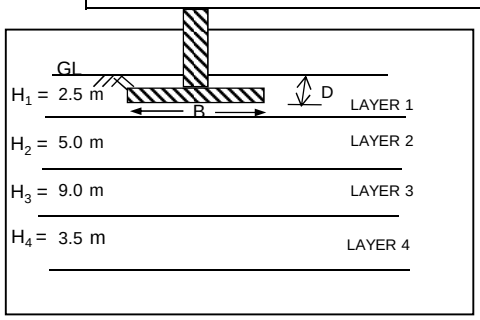
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	2.5	5.0	10	1.75
2	2.5	7.5	0.0	29	1.76
3	7.5	16.5	8.5	11	1.94
4	16.5	20.0	14.4	10	1.99

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.72 m
RL of proposed Foundation level		=	203.22 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 23.40 °

c_{equi} = 2.33 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 23.4 °

c_{Design} = 2.33 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	204.72	m
RL of proposed Foundation level		=	203.22	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	2.3	t/m^2
Angle of internal friction	ϕ_{des}	=	23	deg
Void Ratio		=	0.716	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	1.55	t/m^2
Mobilised angle of internal friction	ϕ'	=	16.09	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.69	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 4.37	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 3.101	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 39.4 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **15.77** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	2.33	t/m^2
Mobilised angle of internal friction	ϕ'	=	23	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 18.54	Sc = 1.13	dc = 1.06	i_c = 1.00	Df+B = 9.5 m
Nq = 9.03	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 8.68	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 98 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **39.0** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **19.73** t/m^2

Settlement Failure Consideration

Location - **BH - B10** Isolated Square footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	2.5	1.0	1.0	Fine Grained	20
2	2.5	7.5	5.0	5.0	Coarse Grained	21
3	7.5	16.5	9.0	6.0	Fine Grained	22
4	16.5	20	3.5	0.0	Fine Grained	26

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0121 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.89 kg/cm^2	
H =	Thickness of Layer (cm) =	100 cm	

Settlement = 8.56 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	5.0	
Average SPT 'N' value =	21	
Effective Pressure =	4.84 t/m^2	
Settlement under 10 t/m^2 :	14.91 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	14.91 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	4.53 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.013 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.22 kg/cm^2	
H =	Thickness of Layer (cm) =	600 cm	

Settlement = 13.46 mm

Total settlement = 26.55 mm

Permissible settlement = 75.0 mm

Net allowable Bearing pressure for permissible settlement
= 28.25 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B11**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

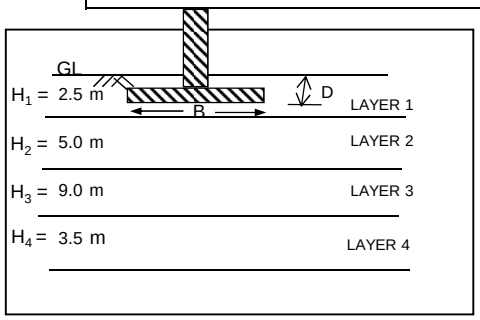
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	2.5	5.0	10	1.75
2	2.5	7.5	0.0	30	1.75
3	7.5	16.5	9.0	10	1.96
4	16.5	20.0	14.0	12	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.72 m
RL of proposed Foundation level		=	203.22 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 23.90 °

c_{equi} = 2.49 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 23.9 °

c_{Design} = 2.49 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	204.72	m
RL of proposed Foundation level		=	203.22	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	2.5	t/m^2
Angle of internal friction	ϕ_{des}	=	24	deg
Void Ratio		=	0.714	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	1.66	t/m^2
Mobilised angle of internal friction	ϕ'	=	16.46	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.95	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 4.53	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 3.267	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 42.3 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **16.93** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	2.49	t/m^2
Mobilised angle of internal friction	ϕ'	=	24	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 19.19	Sc = 1.13	dc = 1.06	i_c = 1.00	Df+B = 9.5 m
Nq = 9.50	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 9.31	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 106 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **42.5** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **21.52** t/m^2

Settlement Failure Consideration

Location - **BH - B11** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	2.5	1.0	1.0	Fine Grained	20
2	2.5	7.5	5.0	5.0	Coarse Grained	23
3	7.5	16.5	9.0	6.0	Fine Grained	24
4	16.5	20	3.5	0.0	Fine Grained	26

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0121 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.89 kg/cm^2	
H =	Thickness of Layer (cm) =	100 cm	

Settlement = 8.56 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	5.0	
Average SPT 'N' value =	23	
Effective Pressure =	4.84 t/m^2	
Settlement under 10 t/m^2 :	13.42 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	13.42 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	4.07 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.012 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.22 kg/cm^2	
H =	Thickness of Layer (cm) =	600 cm	

Settlement = 12.62 mm

Total settlement = 25.26 mm

Permissible settlement = 75.0 mm

Net allowable Bearing pressure for permissible settlement
= 29.69 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B12**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

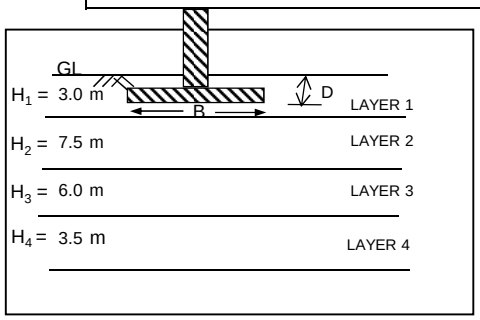
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	10.5	0.0	31	1.85
3	10.5	16.5	12.4	10	1.98
4	16.5	20.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	6.0 m
Length of Foundation	L	=	9.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.66 m
RL of proposed Foundation level		=	203.16 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 26.20 °

c_{equi} = 1.27 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 26.2 °

c_{Design} = 1.27 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	6.0	m
Length of Foundation	L	=	9.0	m
RL of existing ground level		=	204.66	m
RL of proposed Foundation level		=	203.16	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	1.3	t/m^2
Angle of internal friction	ϕ_{des}	=	26	deg
Void Ratio	e	=	0.727	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	0.85	t/m^2
Mobilised angle of internal friction	ϕ'	=	18.16	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 13.23	Sc = 1.13	dc = 1.07	i_c = 1.00	dw = 2.00 m
Nq = 5.34	Sq = 1.13	dq = 1.04	i_q = 1.00	Df+B = 7.5 m
Nγ = 4.160	Sγ = 0.73	dγ = 1.04	i_γ = 1.00	W' = 0.54

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 34.6 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **13.85** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	1.27	t/m^2
Mobilised angle of internal friction	ϕ'	=	26	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 22.58	Sc = 1.13	dc = 1.08	i_c = 1.00	Df+B = 7.5 m
Nq = 12.11	Sq = 1.13	dq = 1.04	i_q = 1.00	dw = 2.00 m
Ng = 12.90	Sg = 0.73	dg = 1.04	i_γ = 1.00	W' = 0.54

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 94 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **37.4** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **16.56** t/m^2

Settlement Failure Consideration

Location - **BH - B12** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	6.0	m
Length of Footing	=	6.0	m
Depth of Influence zone below Foundation depth	=	9.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	2.5	1.0	1.0	Fine Grained	15
2	2.5	7.5	5.0	5.0	Coarse Grained	19
3	7.5	16.5	9.0	3.0	Fine Grained	22
4	16.5	20	3.5	0.0	Coarse Grained	22

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0147 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.85 kg/cm^2	
H =	Thickness of Layer (cm) =	100 cm	

Settlement = 10.01 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	5.0	
Average SPT 'N' value =	19	
Effective Pressure =	3.99 t/m^2	
Settlement under 10 t/m^2 :	16.37 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	16.37 mm	
Water Correction Factor =	0.54	
Rigidity Correction Factor =	0.80	
	5.36 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.013 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.20 kg/cm^2	
H =	Thickness of Layer (cm) =	300 cm	

Settlement = 6.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	22		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	13.79	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	13.79	mm	
Water Correction Factor =	0.54		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	21.37	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 35.10 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B13**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

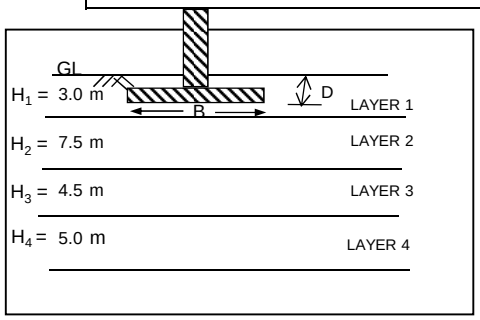
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	5.0	10	1.75
2	3.0	10.5	0.0	31	1.92
3	10.5	15.0	11.0	9	1.97
4	15.0	20.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	3.0 m
Length of Foundation	L	=	3.0 m
Type of Foundation		=	Square
RL of Borehole level		=	204.71 m
RL of proposed Foundation level			203.21 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 15.60 °

c_{equi} = 3.80 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 15.6 °

c_{Design} = 3.80 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	3.0	m
Length of Foundation	L	=	3.0	m
RL of existing ground level		=	204.71	m
RL of proposed Foundation level		=	203.21	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	3.8	t/m^2
Angle of internal friction	ϕ_{des}	=	16	deg
Void Ratio	e	=	0.716	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.53	t/m^2
Mobilised angle of internal friction	ϕ'	=	10.54	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 8.59	Sc = 1.30	dc = 1.12	i_c = 1.00	dw = 2.00 m
Nq = 2.60	Sq = 1.20	dq = 1.07	i_q = 1.00	Df+B = 4.5 m
Nγ = 1.340	Sγ = 0.80	dγ = 1.07	i_γ = 1.00	W' = 0.58

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 38.4 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **15.34** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	3.8	t/m^2
Mobilised angle of internal friction	ϕ'	=	16	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.36	Sc = 1.30	dc = 1.13	i_c = 1.00	Df+B = 4.5 m
Nq = 4.17	Sq = 1.20	dq = 1.07	i_q = 1.00	dw = 2.00 m
Ng = 2.89	Sg = 0.80	dg = 1.07	i_γ = 1.00	W' = 0.58

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 77 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **30.8** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **17.97** t/m^2

Settlement Failure Consideration

Location - **BH - B13** Isolated Square footing

Allowable Settlement Consideration	=	50.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	3.0	m
Length of Footing	=	3.0	m
Depth of Influence zone below Foundation depth	=	4.5	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	17
2	3.0	10.5	7.5	3.0	Coarse Grained	19
3	10.5	15.0	4.5	0.0	Fine Grained	22
4	15.0	20	5.0	0.0	Coarse Grained	25

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0135 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.64 kg/cm^2	
H =	Thickness of Layer (cm) =	150 cm	

Settlement = 12.98 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	3.0	
Average SPT 'N' value =	19	
Effective Pressure =	2.50 t/m^2	
Settlement under 10 t/m^2 :	14.92 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	14.92 mm	
Water Correction Factor =	0.58	
Rigidity Correction Factor =	1.00	
	4.26 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.013 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.16 kg/cm^2	
H =	Thickness of Layer (cm) =	0 cm	

Settlement = 0.00 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	25		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	10.85	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	10.85	mm	
Water Correction Factor =	0.58		
Rigidity Correction Factor =	1.00		
Corrected settlement =	0.00	mm	

Total settlement =	17.24	mm
Permissible settlement =	50.0	mm

Net allowable Bearing pressure for permissible settlement

= 29.00 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B14**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

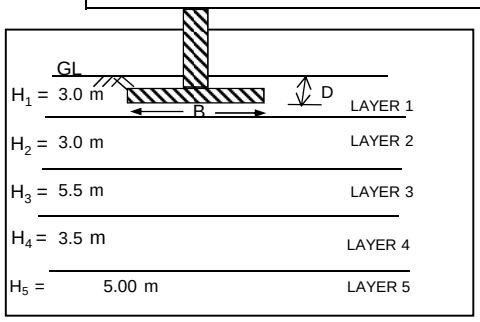
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	3.0	4.8	11	1.73
2	3.0	6.0	0.0	30	1.80
3	6.0	11.5	9.5	11	1.97
4	11.5	15.0	12.8	9	2.00
5	15.0	20.0	0.0	34	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.98 m
RL of proposed Foundation level			203.48 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 19.80 °

c_{equi} = 4.40 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 19.8 °

c_{Design} = 4.40 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	204.98	m
RL of proposed Foundation level		=	203.48	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	4.4	t/m^2
Angle of internal friction	ϕ_{des}	=	20	deg
Void Ratio	e	=	0.732	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.93	t/m^2
Mobilised angle of internal friction	ϕ'	=	13.50	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 10.08	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 3.42	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 2.122	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 47.6 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **19.04** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	4.4	t/m^2
Mobilised angle of internal friction	ϕ'	=	20	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 14.65	Sc = 1.13	dc = 1.05	i_c = 1.00	Df+B = 9.5 m
Nq = 6.27	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 5.24	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 106 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **42.3** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **21.14** t/m^2

Settlement Failure Consideration

Location - **BH - B14** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	3.0	1.5	1.5	Fine Grained	14
2	3.0	6.0	3.0	3.0	Coarse Grained	19
3	6.0	15.0	9.0	7.5	Fine Grained	20
4	15.0	20	5.0	0.0	Coarse Grained	25

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0153 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.84 kg/cm^2	
H =	Thickness of Layer (cm) =	150 cm	

Settlement = 15.39 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	3.0	
Average SPT 'N' value =	19	
Effective Pressure =	5.29 t/m^2	
Settlement under 10 t/m^2 :	16.77 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	16.77 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	3.34 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.24 kg/cm^2	
H =	Thickness of Layer (cm) =	750 cm	

Settlement = 19.71 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	25		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	12.20	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.20	mm	
Water Correction Factor =	0.53		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	38.44	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 19.51 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B15**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

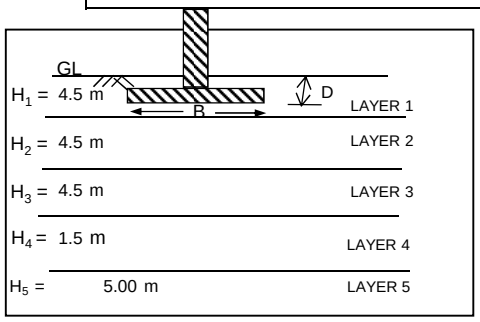
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	4.5	5.0	9	1.76
2	4.5	9.0	0.0	30	1.80
3	9.0	13.5	10.2	10	1.97
4	13.5	15.0	13.8		2.00
5	15.0	20.0	0.0	34	1.97

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	205.39 m
RL of proposed Foundation level			203.39 m
Depth of foundation	D_f	=	2.00 m

Equivalent Shear Parameters

ϕ_{equi} = 22.60 °

c_{equi} = 2.18 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 22.6 °

c_{Design} = 2.18 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	205.39	m
RL of proposed Foundation level		=	203.39	m
Depth of foundation	D_f	=	2.00	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	3.28	t/m^2
Cohesion	C	=	2.2	t/m^2
Angle of internal friction	ϕ_{des}	=	23	deg
Void Ratio	e	=	0.721	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	1.45	t/m^2
Mobilised angle of internal friction	ϕ'	=	15.51	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.30	Sc = 1.13	dc = 1.07	i_c = 1.00	dw = 2.00 m
Nq = 4.14	Sq = 1.13	dq = 1.04	i_q = 1.00	Df+B = 10.0 m
Nγ = 2.851	Sγ = 0.73	dγ = 1.04	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 39.1 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **15.62** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	2.18	t/m^2
Mobilised angle of internal friction	ϕ'	=	23	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 17.57	Sc = 1.13	dc = 1.07	i_c = 1.00	Df+B = 10.0 m
Nq = 8.31	Sq = 1.13	dq = 1.04	i_q = 1.00	dw = 2.00 m
Ng = 7.75	Sg = 0.73	dg = 1.04	i_γ = 1.00	W' = 0.5

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 94 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **37.7** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **18.82** t/m^2

Settlement Failure Consideration

Location - **BH - B15** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	2.0	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	2.0	4.5	2.5	2.5	Fine Grained	14
2	4.5	9.0	4.5	4.5	Coarse Grained	19
3	9.0	15.0	6.0	5.0	Fine Grained	20
4	15.0	20	5.0	0.0	Coarse Grained	26

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0153 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.75 kg/cm^2	
H =	Thickness of Layer (cm) =	250 cm	

Settlement = 22.95 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	4.5	
Average SPT 'N' value =	19	
Effective Pressure =	3.94 t/m^2	
Settlement under 10 t/m^2 :	16.77 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	16.77 mm	
Water Correction Factor =	0.50	
Rigidity Correction Factor =	0.80	
	3.96 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.21 kg/cm^2	
H =	Thickness of Layer (cm) =	500 cm	

Settlement = 11.33 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	26		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	11.67	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	11.67	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	38.24	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 19.61 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B16**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

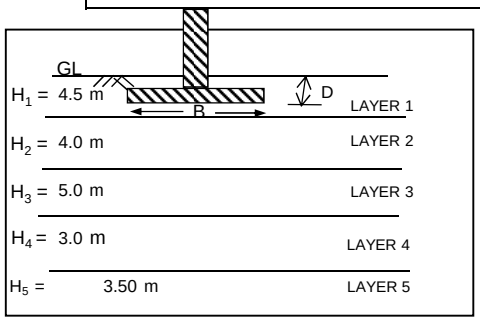
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	4.5	5.1	10	1.76
2	4.5	8.5	0.0	30	1.80
3	8.5	13.5	9.0	9	1.95
4	13.5	16.5	12.5	9	2.00
5	16.5	20.0	0.0	33	1.97

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	205.55 m
RL of proposed Foundation level			204.05 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 21.70 °

c_{equi} = 2.40 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 21.7 °

c_{Design} = 2.40 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	205.55	m
RL of proposed Foundation level		=	204.05	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	2.4	t/m^2
Angle of internal friction	ϕ_{des}	=	22	deg
Void Ratio	e	=	0.718	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	1.60	t/m^2
Mobilised angle of internal friction	ϕ'	=	14.86	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 10.89	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 3.89	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 2.594	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 35.8 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **14.32** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	2.4	t/m^2
Mobilised angle of internal friction	ϕ'	=	22	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 16.55	Sc = 1.13	dc = 1.06	i_c = 1.00	Df+B = 9.5 m
Nq = 7.59	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 6.83	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 84 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **33.7** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **17.42** t/m^2

Settlement Failure Consideration

Location - **BH - B16** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	4.5	3.0	3.0	Fine Grained	15
2	4.5	8.5	4.0	4.0	Coarse Grained	18
3	8.5	16.5	8.0	5.0	Fine Grained	19
4	16.5	20	3.5	0.0	Coarse Grained	25

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0147 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.71	kg/cm^2
H =	Thickness of Layer (cm) =	300	cm

Settlement = 24.98 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	4.0	
Average SPT 'N' value =	18	
Effective Pressure =	3.79 t/m^2	
Settlement under 10 t/m^2 :	17.89 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	17.89 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	3.40 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.014 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.21	kg/cm^2
H =	Thickness of Layer (cm) =	500	cm

Settlement = 11.75 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	25		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	12.20	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.20	mm	
Water Correction Factor =	0.53		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	40.13	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 18.69 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B17**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

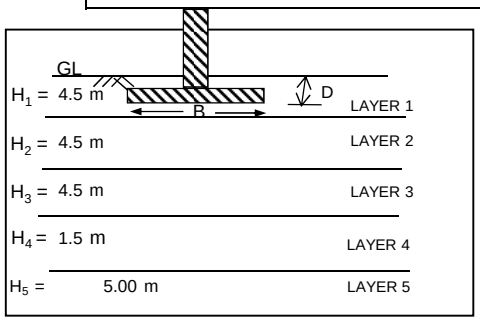
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	4.5	4.5	10	1.74
2	4.5	9.0	0.0	30	1.80
3	9.0	13.5	9.6	10	1.96
4	13.5	15.0	12.0	0	2.00
5	15.0	20.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\,B\tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1\tan\phi_1 + H_2\tan\phi_2 + H_3\tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	205.55 m
RL of proposed Foundation level			204.05 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 22.40 °

c_{equi} = 1.84 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 22.4 °

c_{Design} = 1.84 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	205.55	m
RL of proposed Foundation level		=	204.05	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	1.8	t/m^2
Angle of internal friction	ϕ_{des}	=	22	deg
Void Ratio	e	=	0.739	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	1.23	t/m^2
Mobilised angle of internal friction	ϕ'	=	15.36	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 11.21	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 4.08	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 2.792	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 32.5 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **13.01** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	1.84	t/m^2
Mobilised angle of internal friction	ϕ'	=	22	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 17.34	Sc = 1.13	dc = 1.06	i_c = 1.00	Df+B = 9.5 m
Nq = 8.15	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 7.54	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 78 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **31.4** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **14.02** t/m^2

Settlement Failure Consideration

Location - **BH - B17** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	4.5	3.0	3.0	Fine Grained	15
2	4.5	9.0	4.5	4.5	Coarse Grained	17
3	9.0	15.0	6.0	4.5	Fine Grained	17
4	15.0	20	5.0	0.0	Coarse Grained	24

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0147 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.71 kg/cm^2	
H =	Thickness of Layer (cm) =	300 cm	

Settlement = 24.98 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	4.5	
Average SPT 'N' value =	17	
Effective Pressure =	3.65 t/m^2	
Settlement under 10 t/m^2 :	19.16 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	19.16 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	3.95 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.015 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.20 kg/cm^2	
H =	Thickness of Layer (cm) =	450 cm	

Settlement = 11.09 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	0.0		
Average SPT 'N' value =	24		
Effective Pressure =	1.6	t/m^2	
Settlement under 10 t/m^2 :	12.78	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.78	mm	
Water Correction Factor =	0.53		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.00	mm	

Total settlement =	40.02	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 18.74 t/m^2

BEARING CAPACITY CALCULATION SHEETS

BEARING CAPACITY ANALYSIS FOR SHALLOW FOUNDATIONS

LAYERED SOILS Analysis as per IS 6403-1981

Project : **SOIL INVESTIGATION WORK FOR PROPOSED INTEGRATED INDUSTRIAL TOWNSHIP PROJECT AREA UNDER GAUTAM BUDDHA NAGAR DISTRICT, (U.P).**

Location - **BH - B20**

The bearing capacity equation is as follows :

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

where:

$q_{net\ safe}$ = safe net bearing capacity

c_{equi} = equivalent cohesion intercept

q = overburden pressure

B = Foundation width

γ = Bulk density of soil below founding level

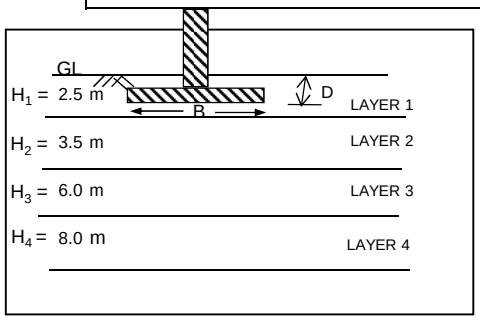
N_c, N_q, N_γ = bearing capacity factors, which are a function of $\phi_{equi,}$ equivalent ϕ

R_w = Water table correction factor

d_c, d_q, d_γ = Depth factors

FS = Factor of safety

$\zeta_c, \zeta_q, \zeta_\gamma$ = Shape factors



Layer No.	Depth, m From	Depth, m To	c t/m²	φ deg.	γ t/m³
1	0.0	2.5	4.5	10	1.74
2	2.5	6.0	0.0	29	1.80
3	6.0	12.0	9.0	12	1.96
4	12.0	20.0	0.0	33	2.00

Reference : Foundation Analysis and Design by J.E.Bowles, fifth edition (1995)

$$H_{equi} = 0.5\ B \tan(45 + \phi_{equi}/2) = H_1 + H_2 + H_3 + \ldots$$

$$\tan\phi_{equi} = \frac{H_1 \tan\phi_1 + H_2 \tan\phi_2 + H_3 \tan\phi_3 + \ldots}{H_{equi}}$$

$$c_{equi} = \frac{c_1 H_1 + c_2 H_2 + c_3 H_3 + \ldots}{H_{equi}}$$

where

H_{equi} = Effective Depth of influence of foundation of width B

ϕ_{equi} = Equivalent angle of internal friction

c_{equi} = Equivalent cohesion intercept

Width of Foundation	B	=	8.0 m
Length of Foundation	L	=	12.0 m
Type of Foundation		=	Rectangle
RL of Borehole level		=	204.15 m
RL of proposed Foundation level			202.65 m
Depth of foundation	D_f	=	1.50 m

Equivalent Shear Parameters

ϕ_{equi} = 20.60 °

c_{equi} = 3.91 t/m²

DESIGN PARAMETERS

ϕ_{Design} = 20.6 °

c_{Design} = 3.91 t/m²

Bearing capacity Calculation (Ref. IS 6403 : 1981)

Width of Foundation	B	=	8.0	m
Length of Foundation	L	=	12.0	m
RL of existing ground level		=	204.15	m
RL of proposed Foundation level		=	202.65	m
Depth of foundation	D_f	=	1.50	m
Depth of GWT from ground level	d_w	=	2.00	m
Inclination of the footing	α	=	0	deg.
Unit weight of soil	$\gamma_{\beta\upsilon\lambda\kappa}$	=	1.64	t/m^3
Unit weight of water	γ_w	=	1.0	t/m^3
Effective overburden pressure	$\gamma'.D_f$	=	2.46	t/m^2
Cohesion	C	=	3.9	t/m^2
Angle of internal friction	ϕ_{des}	=	21	deg
Void Ratio	e	=	0.739	

Failure Mode **INTERMEDIATE**

Bearing Capacity Calculations

Local Shear Failure

Mobilised cohesion	c'	=	2.61	t/m^2
Mobilised angle of internal friction	ϕ'	=	14.07	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 10.41	Sc = 1.13	dc = 1.05	i_c = 1.00	dw = 2.00 m
Nq = 3.61	Sq = 1.13	dq = 1.03	i_q = 1.00	Df+B = 9.5 m
Nγ = 2.310	Sγ = 0.73	dγ = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 45.8 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) q_{slocal} = **18.31** t/m^2

General Shear Failure

Mobilised cohesion	c'	=	3.91	t/m^2
Mobilised angle of internal friction	ϕ'	=	21	deg

Bearing Capacity Factors	*Shape Factors*	*Depth Factors*	*Inclination Factors*	*Water table correction*
Nc = 15.41	Sc = 1.13	dc = 1.05	i_c = 1.00	Df+B = 9.5 m
Nq = 6.79	Sq = 1.13	dq = 1.03	i_q = 1.00	dw = 2.00 m
Ng = 5.86	Sg = 0.73	dg = 1.03	i_γ = 1.00	W' = 0.53

dw = depth of water table

Ultimate bearing capacity $q_u = C.N_c\, s_c d_c i_c + q(N_{q-1}) s_q d_q i_q + 0.5\, \gamma_{sat}.B\, N_g\, s_\gamma\, d_\gamma\, i_\gamma\, W`$

q_u = 104 t/m^2

Factor of safety FOS = 2.5 as per IS 1904-1986

Safe bearing capacity (q_u/FOS) $q_{sgenera}$ = **41.6** t/m^2

c) Interpoplation

after interploating for the actual failure case from the above general and local failure modes,

q_s = **19.59** t/m^2

Settlement Failure Consideration

Location - **BH - B20** Raft footing

Allowable Settlement Consideration	=	75.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	1.5	m
Diameter of Footing	=	8.0	m
Length of Footing	=	8.0	m
Depth of Influence zone below Foundation depth	=	12.0	m

Layer No	Depth		Layer Thickness	Effective Layer Thickness	Type of strata	Corr. Av. SPT N Value
	From	to				
1	1.5	2.5	1.0	1.0	Fine Grained	11
2	2.5	6.0	3.5	3.5	Coarse Grained	17
3	6.0	12.0	6.0	6.0	Fine Grained	18
4	12.0	20	8.0	1.5	Coarse Grained	25

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.0177 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.89 kg/cm^2	
H =	Thickness of Layer (cm) =	100 cm	

Settlement = 12.56 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	3.5	
Average SPT 'N' value =	17	
Effective Pressure =	5.54 t/m^2	
Settlement under 10 t/m^2 :	19.16 mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	19.16 mm	
Water Correction Factor =	0.53	
Rigidity Correction Factor =	0.80	
	4.66 mm	

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v =	Coeffcient of volume compressibilty (cm^2/kg) =		0.015 cm^2/kg
Δp =	Effective Pressure (kg/cm^2) =	0.27 kg/cm^2	
H =	Thickness of Layer (cm) =	600 cm	

Settlement = 18.65 mm

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

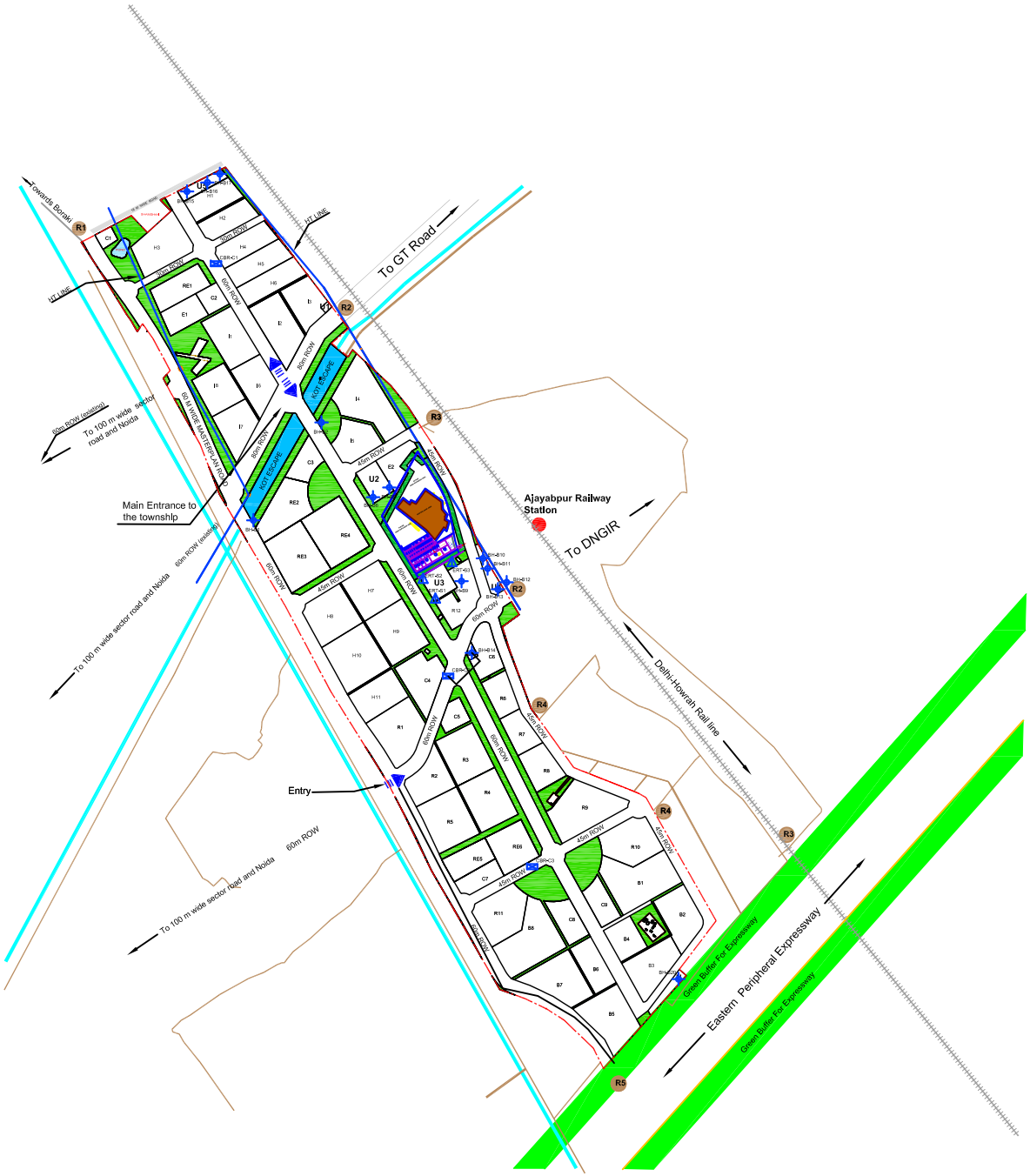
Settlement for Coarse grained soil

Thickness of Layer =	1.5		
Average SPT 'N' value =	25		
Effective Pressure =	1.727104065	t/m^2	
Settlement under 10 t/m^2 :	12.20	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	12.20	mm	
Water Correction Factor =	0.53		
Rigidity Correction Factor =	0.80		
Corrected settlement =	0.11	mm	

Total settlement =	35.99	mm
Permissible settlement =	75.0	mm

Net allowable Bearing pressure for permissible settlement

= 20.84 t/m^2



BORE HOLE/TEST LOCATION PLAN