Plant	Client	Contract Code	Document ID	Contract No.
1.0 MTPA ALUMINA REFINERY STREAM-5	NALCO	NAL	6695-CVC-G00-EC-0001 F01	66-6695

thyssenkrupp

Civil – General Engineering Specifications (GES)

नालको NALCO
नेशनल एल्युमिनियम कम्पनी लिमिटेड
National Aluminium Company Ltd.

Rev	03	Page	1	of	3

tkIS India / Vendor

Category Codes (Submission Purpose)

- ☐ 1 For Approval
- ☐ 2 For Review / Comments
- ☐ 3 For Information
- ☐ 4 For Engineering
- ☐ 5 For Enquiry
- ☐ 6 For Order Placement
- ☐ 7 Final & Approved
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Acceptance Codes (Approval Codes)

- ☐ 1 Approved
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Remarks for AC2 : This marked-up drawings is hereby approved for fabrication / manufacturing and shall be re-sbumitted after revision. This drawing should be revised only to the extent of tkIS India / Owner / Client comments. Any other changes made by you will not be considered unless clearly highlighted in covering letter asking for approval.

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Date : ___/___/______ Name : ______________________

Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC
03		Soil investigation report details incorporated & issued for Engineering	19.12.19	ASJ	19.12.19	BHK	19.12.19	GLP	
02		Wind and Seismic Parameters Revised & Issued For Engineering	18.01.18	BHK	18.01.18	VBV	18.01.18	GLP	
01		Issued for Engineering	27.10.17	BHK	27.10.17	VBV	27.10.17	GLP	
00		Issued for NALCO Review	15.09.17	BHK	15.09.17	VBV	18.09.17	GLP / SJP	-

Based on : PIN-LES-CVC-0001 F01

Barcode

Category Code: -

Contents:

Enclosures :

1. ADDENDUM TO STANDARD GES PIN-LES-CVC-0001 F02 REV 00

This addendum is to be read in conjunction with GES Standard Doc. No PIN-LES-CVC-0001 F02 REV 00 1

The changes are as follows:

Superseded Clause no. In Standard Doc. No PIN-LES-CVC-0001 F02 REV 00	**Revised Text as per change required**	**Reason for Change**
4.1.1	Office rooms and Control Rooms shall have clear height of 3300mm. All other areas / buildings, minimum ceiling height shall be as specified in the original clause.	Client recommendation
4.1.2	Single Door Access: 1000 x 2100mm Toilet & Shower Door: 750 x 2100mm Equipment Door: 2100 x 2400mm	Client recommendation
ADD Clause 7.0	Waterproofing of Buildings: Waterproofing of buildings shall be carried out using APP (Atactic Polypropylene) membrane.	Client recommendation
ADD Clause 8.0	PAINTING OF BUILDINGS AND STEEL STRUCTURES	
ADD Clause 8.1	Painting of Buildings: External Painting of Buildings shall be carried out with weather-proof paint of approved manufacturer over suitable primer coat. The weather-proof paint shall be suitable for the local climate and shall have a comprehensive 7 (seven) years performance warranty.	Client recommendation
ADD Clause 8.2	Painting of steel structures: Painting of steel structures shall be as per 6695-EQS-G00-EC-0007_GES for Painting.	

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MIGRATED FROM CI-UCH-003-02-STANDARD

00		REVISED WITH STANDARD TKIS FORMAT	24.05.15	KMG	24.05.15	NKR	24.05.15	RSD	-
Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC

Based on : PIN-LES-CVC-0001 F02

Barcode

Category Code: -

Contents:

1 Scope

This Engineering Specification (ES) applies to the design and construction of industrial and chemical plants. It contains requirements for the design of steel structures and concrete foundations and structures, e.g. equipment supporting structures, pipe racks, platforms and as well as process and non-process building structures.

2 Units, Abbreviations

2.1 Units

Table 1. Units

General	SI-units
Dimensions	mm
Temperature	°C
Elevations	mm
Force	kN
Mass	t
Moment	kNm
Stress	N/mm²
Pressure	kPa

For simplification purposes, one 1 kg weight may be taken as equal to 10 N (0.010 kN).

2.2 Abbreviations

UDL = Uniformly Distribution Load

3 Structural design standards

3.1 General

The design shall be based on the codes and standards as stipulated in B.3.1

3.2 Loading components

The design shall be checked against the various combinations indicated in section 3.5 of this specification, with the following components:

a) = Weight of structure, including flooring (dead load). (see section 3.3.1)
b) = Weight of equipment category I, piping (diameter smaller 300 mm) and cabling (see section 3.3.2, 3.3.3 and 3.3.4)
c) = Empty weight (see section 3.3.5)
d) = Operating weight (see section 3.3.5)
e) = Hydrostatic test load (see section 3.3.5)
Equipment category II, piping(diameter≥ 300 mm), etc.
f) = Exchanger bundle pull force. (see section 3.3.6)
g) = Thermal loads. (see section 3.3.7)
h) = Moving loads (see section 3.3.8)
i) = Live loads and Laydown loads (see section 3.3.9)
j) = Wind loads (see section 3.3.10)
k) = Snow loads (see section 3.3.11)
l) = Earthquake loads (see section 3.3.12)
m) = Other loads (see section 3.3.13 and 3.3.14)

3.3 Design loads for structures

3.3.1 Civil structures

The weight of civil structures shall be derived by the weight of all materials forming the permanent civil part of the building structure.

3.3.2 Equipment category I

The weight of equipment category I, such as pumps, compressors, motors, etc., shall be derived as far as possible from manufacturer's data and shall include controls, auxiliary machinery, piping, etc. Equipment category I loads shall be assumed to be permanent loads.

3.3.3 Piping, diameter smaller 300 mm and light single pipes, diameter greater than or equal to 300 mm

This subsection covers the pipe loads (Piping, diameter smaller 300 mm and light single pipes, diameter greater than or equal to 300 mm with single loads equivalent to uniform distributed average pipe load without heavy hydrostatic test loads) on operating and service platforms as well as on pipe racks between and within buildings.

For design, a basic uniform distributed average (in operating condition) pipe load (kN/m²) per each operating and service platform and per each layer of a pipe rack shall be determined. Weight of pipe insulation and fire proofing shall be taken into account. For assumptions see Table **2**.

Table 2. Assumptions for the weight of Piping, diameter smaller than 300 mm and light single pipes, diameter greater than or equal to 300 mm

	Pipe diameter	Pipe load– Empty weight (60 %)	Pipe load– Contents (40 %)
Light pipe load	Ø 50 to 150 mm	0.90 kN/m²	0.60 kN/m²
Medium pipe load	Ø 100 to 200 mm	1.20 kN/m²	0.80 kN/m²
Heavy pipe load	Ø 150 to 300 mm	1.80 kN/m²	1.20 kN/m²

The loads quoted above shall be assumed to be permanent loads and shall be treated as dead load for seismic load calculations. During empty condition, only pipe empty weight shall be considered. Entire floor need not have one single value of pipe loads as above. The values may vary in different areas of each floor. It is expected that above values will be indicated on unit plot plans.

All beams (main, secondary, tertiary / grating supporting) shall be able to withstand a concentrated load of 15 kN at the most unfavorable location across the span in lieu of piping load as UDL as defined above.

3.3.4 Cabling

This subsection covers the cable loads within building structures as well as on pipe racks between and within buildings.
The weight of bundled cabling shall be determined by the number of cable trays fully nested with power cables. Assumptions according Table 3 can be made:

Table 3.Assumptions for the weight of cable trays

Width of cable tray mm	Height of cable tray mm	Weight kN/m
200	80	0.4
300		0.6
400		0.8
600		1.2

A single load of 0.75 kN shall be considered on the top layer of a cable tray.

The weight of one layer cable trays fastened to operating and services platforms can be assumed as being included in the uniform distributed average pipe load as indicated in section 3.3.3.

3.3.5 Equipment category II and heavy single pipes diameter greater than or equal to 300 mm

This category consists of vessels, columns, heat exchangers, condensers, settlers, filters and the like, complete with their piping as well as single heavy pipes (Ø ≥ 300 mm with single load ≥ 1 kN/m).
The following weights / loads shall be considered in the calculations:

- Empty weight:
  This is the dead weight of vessels, columns, single heavy pipes, etc., completely installed (including platforms and ladders, piping, insulation and fireproofing) and ready for operation, however, without liquid filling.
- Operating load:
  This is the empty weight plus the weight of the maximum contents of vessels, columns, single heavy pipes, etc., which will apply during operation of the plant.
- Hydrostatic test load:
  When hydrostatic pressure testing of equipment and single heavy pipes is required at site, the empty weight of this equipment and single heavy pipes and the weight of the test medium, shall be considered in the design of the supporting structure. Only one process system is assumed to be tested at the same time.
- Exchanger loadings:
  When exchangers are located on structures, the supports shall be designed for vertical and horizontal forces (bundle pulling forces or friction forces, see section 3.3.6 and 3.3.7). Weight distribution over two saddles of an exchanger shall be according to Table **4**:

Table 4.Weight distribution over two saddles of an exchanger

Exchanger type	Channel side	Shell side
Floating head type	60 %	40 %
Fixed tube sheet type	50 %	50 %
Kettle type	45 %	55 %
U-tube and other types	67 %	33 %

For each exchanger, both saddles shall be supported on identical beams.

3.3.6 Exchanger bundle pull force

When tube bundles of exchangers are removable (by means of mobile equipment or deadmen), the beams and / or frames used to support the fixed end of the exchanger shall be designed for a horizontal bundle pull force equal to ___Table **5**.

Table 5. Exchanger bundle pull force

Bundle weight BW	**Horizontal bundle pull force H**
BW ≤ 50 kN	BW
50 kN ≤ BW ≤ 100 kN	50 kN
BW ≥ 100 kN	0.5 BW

If several exchangers are stacked, only one bundle will be assumed to be pulled at a time.
Bundle pulling force is not applicable when bundles are pulled by means of a mechanical device, which acts on the principle of equilibrium of forces (no forces on the support structure).

3.3.7 Thermal loads (during operation conditions)

If thermal loads (such as produced by temperature changes in piping, equipment and structures) results in friction between equipment and supports (exchangers) or piping and supports, the friction force shall be taken as the operating load on the support multiplied by the applicable friction coefficient μ given in Table 6:

Table 6.Friction coefficient

Surfaces	**Friction coefficient μ**
Rolling supports	0.05
PTFE (Teflon) to PTFE (Teflon)	0.08 1)
Stainless steel to PTFE (Teflon)	0.10
Graphite to graphite	0.15
Steel to steel	0.30
1) At a minimum compressive stress of 3.5 N/mm²	

If the friction coefficient is unknown, a friction coefficient of 0.30 shall be considered.

Table 7.Transfer factor

Structural element	**Transfer factor of longitudinal friction forces based on uniform distributed pipe load**	**Transfer factor of longitudinal friction forces based on single heavy pipe load**	**Transfer factor of transversal friction forces based on single heavy pipe load**
Affected main girder of platforms	0.5	1	1
Affected intermediate girder of platforms		0	0
Global structure of building with affected platforms	0 1)	0 1)	0 1)
Affected transversal main girder of pipe racks	0.5	1	1
Affected transversal intermediate girder of racks		0	0
Affected longitudinal girder of pipe racks			
Global structure of pipe rack with 1 layer		1	1
Global structure of pipe rack with 2 layers	0.4	0.8	0.8
Global structure of pipe rack with > 2 layer	0.3	0.6	0.6
1) It can be assumed that all friction loads related to pipe loads will be balanced within a building			

As friction forces related to pipe loads on operating and service platforms as well as on pipe racks between and within buildings are partly or completely balanced, the final friction force of piping shall be taken as the operating load on the support or structure multiplied by the applicable friction coefficient μ (see above) multiplied by an reduction factor given in Table **7**:

After completion of a detailed piping stress analysis, all assumption have to be verified accordingly.

Horizontal loads due to anchors / guides / stops / valves etc. shall be treated like equipment loads and shall be obtained accordingly. These loads shall be considered for local / global design of members / structure as appropriate.

3.3.8 Impact allowances of moving loads

The design load for structures handling moving loads shall be in accordance with applicable standards stipulated in Annex B and derived from manufacturer's data, with a minimum impact allowance, in percents of moving loads, as given in Table Table **8**:

Table 8.Minimum impact allowance, in percents of moving loads

<table>
<tr><th colspan="2">Item (Including connections)</th><th>Vertical</th><th>Lateral</th><th>Longitudinal</th></tr>
<tr><td rowspan="2">Gantry girder for overhead cranes</td><td>Power operated</td><td>25</td><td>10</td><td rowspan="4">5</td></tr>
<tr><td>Manually operated</td><td>10</td><td>5</td></tr>
<tr><td rowspan="2">Monorails</td><td>Power operated</td><td>25</td><td rowspan="2"></td></tr>
<tr><td>Manually operated</td><td>15</td></tr>
</table>

3.3.9 Live loads and Laydown loads

Live loads shall be defined as the weight of all movable loads, including personnel, tools, miscellaneous equipment and temporarily stored material. Laydown loads shall be defined as the weight of parts of dismantled equipment temporarily kept on the floor. The live load shall be uniformly distributed over the horizontal projection of the specified areas and shall have the minimum values as given in Table 9.

Table 9.Minimum values of live loads

<table>
<tr><th>Area</th><th>Live load</th><th>Laydown load</th></tr>
<tr><td>Ground slab</td><td>15 kN/m^2 3)</td><td>0</td></tr>
<tr><td>Compressor / generator platforms</td><td>3 kN/m^2 4)</td><td>4.5 kN/m^2 4)</td></tr>
<tr><td>Operating / service platforms</td><td rowspan="4">3 kN/m^2 4) or
3 kN concentrated point load1)</td><td>2 kN/m^2 4)</td></tr>
<tr><td>Equipment / tower platforms</td><td>0</td></tr>
<tr><td>Access platforms / walkways</td><td>0</td></tr>
<tr><td>Stairs / landings</td><td>1 kN/m^2</td></tr>
<tr><td>Flat roof areas</td><td>1.5 kN/m^2 or 3 kN concentrated point load or snow load1)</td><td>0</td></tr>
<tr><td>Sloping roof areas</td><td>0.75 kN/m^2 or 3 kN concentrated point load or snow load1)</td><td>0</td></tr>
<tr><td>Storage areas2)</td><td>15 kN/m^2</td><td>0</td></tr>
<tr><td>Switch, motor control center / battery rooms</td><td>10 kN/m^2 (including weight of panels / batteries)</td><td>0</td></tr>
<tr><td>False floors in switch / motor control center rooms</td><td>3 kN/m^2 (as equipment / panels are not supported from False floor)</td><td>0</td></tr>
<tr><td>Instrumentation /control rooms</td><td>5 kN/m^2 (including weight of cables / instruments)</td><td>0</td></tr>
<tr><td>Offices and auxiliary rooms</td><td>3 kN/m^2</td><td>0</td></tr>
<tr><td>Laboratories /public stairs</td><td>3.5 kN/m^2 (including weight of equipment / platform)</td><td>0</td></tr>
<tr><td>Hand railing, horizontal</td><td>0.5 kN/m</td><td>0</td></tr>
<tr><td>Ladders</td><td>2.5 kN moving concentrated load</td><td>0</td></tr>
<tr><td colspan="3">1) Whichever is more unfavorable
2) Areas with forklift (up to 70 kN total load) and truck traffic shall be calculated with 20 kN/m^2.Refer 3.3.13
3) Pipe support load up to 15 kN load is deemed to be considered in this load.
4) Pipe load as appropriate shall be considered in addition to these loads.</td></tr>
</table>

For global design of structure, only live load shall be considered along with pipe empty and pipe contents load.

For local design of floor, both Live load and Laydown load shall be considered along with pipe empty load.

3.3.10 Wind loads on building structures

The method of wind load calculation shall be in accordance with codes and standards stipulated in Annex B

The wind can blow in any direction and the most unfavorable case shall be considered.

Wind loads on major equipment shall be calculated and applied locally to the supporting beams. For global structure wind loads on equipment shall be evaluated with shielding effects, and added to the wind load of structure. Alternatively effective wind load on structure including equipment, handrails, pipes, cable trays and so forth considering shielding effects, can be assumed as a wind band of 50 % of the enclosed area of the structure.

The basic wind speed shall be determined either as 3 second gust or as hourly mean value, as required by the applicable standards stipulated in Annex B

3.3.11 Snow loads

The method of snow load calculation shall be in accordance with applicable standards stipulated in Annex B . Snow loads shall not be considered for platforms, stairs and walkways covered with grating.

3.3.12 Seismic loads

All plant structures and foundations shall be designed for earthquake in accordance with applicable codes and standards stipulated in Annex B

Seismic loads on major equipment shall be calculated and applied locally to the supporting beams. For global structure, seismic loads on equipment shall be evaluated considering it as mass and added to the mass of the structure. Laydown loads shall not be considered during seismic condition.

3.3.13 Traffic loads

In storage areas forklifts with a minimum total weight of 7.0 t and in areas only affected by forklift loads in case of repair purposes a minimum total weight of 3.5 t shall be considered.

Table 10.Traffic loads

	In storage areas
Permissible total weight	70 kN
Nominal pay load	25 kN
Static load per axle	65 kN
Track width	1.0 m
Overall width	1.2 m
Overall length	3.4 m
Bearing area per wheel	0.2 m × 0.2 m
Uniformly distributed equivalent load	20 kN/m²

Horizontal impacts on load-bearing columns and walls of storage facilities and buildings which are exposed to the danger of collision with road vehicles:

- Impact by a truck: Horizontal loads shall be 100 kN at a height of 1.2 m above ground.
- Impact by a fork-lift truck: Horizontal loads shall be 5 times the permissible total weight at a height of 0.75 m above ground.

The impact load need not be taken into consideration for the calculation of the foundations.

3.3.14 Other loads

Following loads shall also be considered in the design:

- Thermal loads, such as produced by temperature changes in piping, equipment and structures, acting as anchor loads.
- Pressure loads, such as resulting from the use of expansion joints in piping.
- Dynamic loads, such as resulting from rotating equipment and from surging fluids in piping and equipment. Data for performing dynamic calculations shall be obtained from equipment vendor. Allowances to be made for dynamic effects, in accordance with section 3.8.
- Blast loads, for buildings located within the proximity of a potential blast hazard (see section 3.9).

3.3.15 Miscellaneous loads

Following possible additional loads shall also be considered in the design:

- Loads related to reaction- and resistance forces of compensators
- Loads related to nozzle forces from piping on vessels and equipment
- Loads resulting from non-uniform foundation settlement
- Loads related to soil pressure
- Loads related to collected leaked out liquids
- Buoyancy due to ground-water or leaked out liquids
- Reserves for future extensions
- Loads related to creeping and shrinkage

3.4 Pipe rack design

3.4.1 General

Pipe racks consist of rigid main frames in transverse direction and connected with longitudinal beams, which will transfer horizontal loads to braced anchor bays. In longitudinal direction, pipe rack shall be divided into approximately 40 m long sections, each consisting of 6 to 8 bays from which one is an anchor bay. The sections are connected by means of sliding joints (at one end of the section only) at longitudinal beams to each others. Alternatively, the sections may be separated by keeping a distance of 3m over which pipes may span without support.

Pipe racks shall be designed in relation to actual piping arrangement and line sizes and for all piping loading conditions and for any additional equipment supported on same (e.g. air coolers, etc.), all as described below.

For design, a basic uniform distributed average pipe load "P (kN/m²)" per level shall be determined (P minimum is the weight of the empty pipe and P maximum is the pipe weight in operating condition). Weight of pipe insulation shall be taken into account.

Based on above, pipe loads as defined in section 3.3.3 and 3.3.5 shall be adopted.

Extreme pipe loads (e.g. for large diameter pipe) shall be taken into account separately as defined in section 3.3.3 and 3.3.5.

Weight of fireproofing shall be taken into account.

Electrical / instrument requirements (overhead cable and tray loads) shall be considered.

3.4.2 Transverse direction

Transverse beams of pipe rack main frames shall be designed for a uniform distributed load:

$q\ (kN/m) = p \times L$

where: p = uniform distributed load, refer to section 3.3.3 and 3.4.1

L = Distance [m] between main frames in longitudinal direction.

When intermediate support beams are introduced, these beams shall be designed for a uniform distributed load intensity equal to ⅓ q. At the same time, the uniform distributed load on the main transverse beams will be reduced to ⅔ q.

For vertical loads, the transverse beams are considered laterally restrained by the supported piping.

Pipe rack and supports shall be designed to resist the friction and anchor forces induced by the piping. Assume a resultant longitudinal friction force equal to 15 % of the total pipe weight tributary to that pipe support (beam). These friction forces will not be transferred to the foundations. Instead friction forces and anchor forces are transferred to the anchor frames by the longitudinal beams of the pipe rack. For beams subjected to above-mentioned horizontal friction or anchor forces, use 50 % of the minor axis section modules.
For pipe racks, a concentrated load of 10 kN at mid span shall be applied to all lowest main beams and an axial load of 10 kN has to be applied to each pipe rack stanchion (contingency loads). Above loads shall not be transferred to the foundations.

For wind on overhead pipe racks, the projected height of pipes (HWP) per layer for wind in cross direction shall be:
HWP = DP + W tan 10°
where: DP = Largest pipe diameter + insulation,
W = Corresponding width of pipe layer,
shape factor to be used for pipe layer: C = 0.8.
HWP need not to be more than the distance between the pipe layers.

In addition to lateral wind load on pipe layers, the wind load on longitudinal pipe rack frames shall be taken into account. The shape factor to be used for the longitudinal pipe rack frame is C = 1.7 in case of structural steel and C = 1.3 incase of concrete sections.
The projected height of stacked cable trays (HWC) for wind in cross direction shall be:
HWC = 0.5 × H
Where: H = Total height of stacked cable trays,
shape factor to be used for stacked cable trays: C = 1.3.
HWC need not to be more than the distance between the pipe layers.

3.4.3 Longitudinal direction

Longitudinal beams shall be designed for maximum of an uniform distributed load
q = 0.25 × p × B
where: p = uniform distributed load, refer to section 3.3.3 and 3.4.1
B = greater value of span between beams in transverse direction (say width of pipe rack)
or
q = a 10 kN concentrated load at mid span
In case of intermediate beams, the longitudinal beams shall be designed for the additional loads (including wind load) of the intermediate beams.
Horizontal forces per pipe layer in longitudinal direction braced anchor bays shall be determined as follows:
HTOT = the greatest value of HS or HWL or HE + Ha (longitudinal direction).
where: HS = Stability force
= 1½ % of the weight of the structure and operating loads of the pipes.
HWL = Longitudinal wind force due to wind drag
= 0.3 × (DP + HB) × Pw × L
DP = largest pipe diameter + insulation,
HB = depth of longitudinal beam,
Pw = wind pressure,
L = spacing between braced bays.
HE = Earthquake loading
Ha = Anchor force (pipe thrust) or 10 % of the operating pipe weight, whichever is higher.
In addition to above loads, the longitudinal wind load on transverse pipe rack frames between the braced bays shall be taken into account.

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3.5 Load combinations

Structures and members of structures as well as their supports shall be designed for the combinations of loading components tabulated in Annex A as a minimum requirement.

For loading conditions applied to two or more items of equipment supported by a common structure, variable effects such as weight of contents, wind load (when considering shielding) and thermal reactions of piping shall be based on compatible conditions.

When hydrostatic pressure testing of equipment is required at site and more than one vessel, etc. is supported by one structure, the structure shall be designed on the basis that only one vessel will be tested at any one time, and that the others will be empty.

Maintenance loads shall be considered in design, but shall be limited to reasonable combination of operations, i.e.:

- In designing a structure with more than one maintenance load, consideration shall be limited to one crane or trolley load.
- In designing skeleton frame-type structures, maintenance loads shall be combined with reduced wind effects, i.e. 50 % wind.

3.6 Allowable deflections and displacement (in serviceability limit state)

Following are recommended deflection limits based on provisions of IS codes and industrial practices where such provisions do not exist in IS codes. The deflections shall be checked using a load factor of 1.0

a) Maximum allowable Vertical deflection for Structural steel members

Sr. no	Member	Load	Maximum deflection
1.0	**Purlin , Girt , Roof Rafter**		
i)	Steel Purlins, Girts supporting Elastic cladding like profiled metal sheeting	Live load / Wind load	Span / 150
ii)	Steel Purlins, Girts supporting Brittle cladding like Fibre cement sheeting	Live load / Wind load	Span / 180
iii)	Roof Rafter Steel beam supporting Elastic cladding like profiled metal sheeting	Live load / Wind load	Span / 180
iv)	Roof Rafter Steel beam supporting Brittle cladding like Fibre cement sheeting,	Live load / Wind load	Span / 240

2.0	**Floor, Roof beams**		
i)	Simply supported steel beams for Floor / platform / stair/ piperack and Roof not supporting elements susceptible to cracking, without fireproofing	Live load	Span / 300
ii)	Cantilever steel beams for Floor / platform / stair/ piperack and Roof not supporting elements susceptible to cracking, without fireproofing	Live load	Span / 150
iii)	Simply supported steel beams for Floor / platform / stair/ piperack and Roof supporting elements susceptible to cracking such as cementitious fireproofing , floor finish, masonry wall etc.	Live load	Span / 360
iv)	Cantilever steel beams for Floor / platform / stair/ piperack and Roof supporting elements susceptible to cracking such as cementitious fireproofing , floor finish, masonry wall etc.	Live load	Span / 180
v)	Steel beam supporting equipment	Live load + Equipment load	Span / 400
3.0	**Gantry , Crane Girder, Monorail supporting beams**		
i)	Steel Gantry / Beams supporting Manually operated crane, Monorail	Lifting load + Selfweight of Hoist	Span / 500
ii)	Steel Gantry / Beams supporting Electrically operated crane, Monorail upto 500KN capacity	Lifting load + Selfweight of Hoist	Span / 750
iii)	Steel Gantry / Beams supporting Electrically operated crane, Monorail more than 500KN capacity	Lifting load + Selfweight of Hoist	Span / 1000
4.0	**Grating floor, Chequered plate**	Total load	Span / 200 but not more than 4mm

b) **Maximum allowable Horizontal deflection for Structural steel members**

Sr. No.	Member	Load	Maximum deflection
1.0	**Columns**		
i)	Columns in Steel Structure without crane and with Elastic cladding	Wind / Seismic load	Height / 150
ii)	Columns in Steel Structure without crane and with Masonry / Brittle cladding	Wind / Seismic load	Height / 240
iii)	Columns in Steel Structure with pendent operated crane and / or with Elastic cladding	Crane + Wind	Height / 200
iv)	Columns in Steel Structure with Cab operated crane and / or with Brittle cladding	Crane + Wind	Height / 400
v)	Piperacks, Open multistoried structures and Closed multistoried structures with Elastic cladding	Wind / Thermal load	Height / 300 and Storey height / 300
		Earthquke (Interstorey drift)	Storey height / 250
vi)	Closed multistoried structures with Brittle cladding	Wind	Height / 500 and Storey height / 300
		Earthquke (Interstorey drift)	Storey height / 250
2.0	**Gantry , Crane Girder – Relative displacement between crane supporting rail**	Crane + Wind	10mm

c) **Maximum allowable Vertical deflection for Concrete members (Clause 23.2 of IS456:2000)**

Sr. no	Member	Load	Maximum deflection
1.0	**Beams, Slabs**	Total vertical load **without** partitions / Finishes	Span / 250
		Total vertical load **with** partitions / Finishes	Span / 350 or 20mm whichever less

d) **Lateral sway for Concrete structure (Clause 20.5 of IS456:2000)**

Sr. no	Member	Load	Maximum deflection
1.0	Building / Structure / Frame	Wind Load	Height / 500
		Earthquke (Interstorey drift)	Storey height / 250

e) **Separation Between adjacent units**

Two adjacent buildings or two adjacent units of the same building with separation joint in between shall be separated by a distance equal to the amount *R* times the sum of the calculated storey displacements for each of them, to avoid damaging contact when the two units deflect towards each other. When floor levels of two similar adjacent units or buildings are at the same elevation levels, factor *R* in this requirement may be replaced by R/2. (R = Response Reduction factor)

3.7 Allowable settlement (in serviceability limit state)

Allowable settlements, due to permanent loads are shown in Table 11.

Table 11. Allowable settlements

Foundation type	Maximum total settlement	Maximum differential settlement
Towers and vertical equipment	25 mm	$^1/_{1000}$ not more than 15 mm Deviations from vertical line due to differential settlement shall not exceed 0,1 % but not more than 20 mm
Equipment structures Horizontal equipment	25 mm	$^1/_{500}$ not more than 15 mm
Rotating equipment	15 mm	$^1/_{2000}$ not more than 5 mm
Buildings	40 mm	$^1/_{500}$ not more than 20 mm
Storage tanks	25 mm after hydtotest However, a higher value of 75 mm may be permitted during hydrotest.	$^1/_{500}$ not more than 15 mm

Maximum differential settlement between two adjacent equipment shall not exceed 15 mm.
Special care shall be taken for heavy permanent loads (equipments with heavy storage tanks and storage buildings) with regard to long term settlements and to rigid connections between single units or equipments.

3.8 Foundation design for reciprocating or rotary machinery

3.8.1 Definition

Heavy machinery in this context is any equipment having reciprocating or rotary masses as major moving parts (such as rotary compressors, pumps, fans, engines and turbines), with a total rotating weight in excess of 1350 kg.

Dynamic analysis can be omitted

- for smaller rotating machines up to 1000 kg weight,
- if the rotating mass is less than 1/100 of the total weight including foundation, and
- if the weight of foundation is greater 5 times the weight of the machine.

The basic principles of design involve:

- The determination of the natural frequencies of the system (machinery plus foundation), to ensure that these frequencies are outside the range of 0.8 to 1.2 times the operating frequencies of the machinery. In case this is impossible, resonance shall be considered. An estimate for damping will then be required.
- Limitation of vibration amplitudes
- The provision of sufficient strength and rigidity to maintain equipment alignment and to prevent failures due to fatigue or overstressing, caused by imposed piping forces and thermal distortions.
- The provisions for adequate foundation bearing capacity and settlement.

The vibration amplitudes shall be governed by following values:

- The maximum allowable values stated by manufacturer of the equipment, or if this data will not be supplied, the amplitude (single amplitude) which causes the effective velocity of vibration to exceed:
  - 2 mm/s at the location of the machine bearing housings.
  - 2.5 mm/s at any location of the structure.
- The dynamic amplitudes of any part of the foundation including any reciprocating compressor shall be less than 8×10^{-5} m single amplitude.
- In case, if the governing criteria as above can not be adhered to, then the relaxation in above values may be taken in consultation with manufacturer of the equipment.

Note:
In the case of a purely sinusoidal function, the effective velocity is 0.71 times the peak value of the velocity.

3.8.2 Dynamic force

Dynamic design for either type foundation shall be as follows **(if this data will not be supplied by manufacturer of the equipment):**

- Amplitudes shall be determined using dynamic forces from each rotor, calculated as follows: Dynamic Force: (0.08 (rotor weight) × (rotor speed, R_n min)) / (50 × 60)
- When there is more than one rotor, amplitudes shall be computed with the rotor forces assumed in phase and 180° out-of-phase to obtain, respectively, the maximum translational and torsional amplitudes.

3.8.3 Foundation design

Foundation design shall be as per IS2974. The foundation structure shall be isolated from the main building and also from other structures in the plant to avoid the transfer of vibrations to the adjoining structures.

3.8.4 Minimum reinforcement

Minimum reinforcement shall be as per IS2974 Part1 as follows:

Minimum Reinforcement for Block Foundations FOR RECIPROCATING TYPE MACHINES

Minimum reinforcement in block shall be not less than 25 kg/m3. For machines requiring special design considerations of foundations, like machines pumping explosive gases the reinforcement shall be not less than 40 kg/m3.

The minimum reinforcement in the block shall usually consist of 12 mm bars spaced at 200/250 mm centre to centre extending both vertically and horizontally near all the faces of the foundation block.

3.8.5 Pile loads or soil bearing pressures

Under static loading, the net bearing pressure on soil or the load pile shall not exceed 80 percent of the net allowable bearing pressure or the safe load capacity of piles respectively.

3.9 Blast resistant design

Following specifications shall be used for Blast resistant design.

a) Design loads
The design loads resulting from a hazardous event shall be taken from the expert's report which is to be done in case of a potential of blast event, see Annex C.

b) Stresses and load combinations
Blast loads are not to be combined with wind, snow and earthquake loads. Limit state design method shall be used. For Load combinations involving blast load , the Load factor shall be considered as 1.0

c) Structural design criteria
The structure shall be designed as a shear wall structure, with the roof acting as a horizontal diaphragm that transfers the transverse loads to the side shear walls.

The walls and the roof shall be made from cast-in-situ reinforced concrete of load-bearing type, designed to resist bending and transmit horizontal shear. Precast concrete panels may be used but shall be either mechanically bonded to cast-in-situ reinforced concrete columns or provided with built-in, load transmitting steel plates or angles so that the panels can be welded in place.

Walls shall be anchored to foundations and concrete roof slabs with steel reinforcing bars to provide full moment connections. Roof framing with bearing and good anchorage to the supporting walls has to be provided. Loads on walls and roof shall be distributed in two directions. Stress reversals of 20 % shall be provided at each member.

To allow for stress reversal, provide reinforcing steel in both concrete faces; shear reinforcement shall be perpendicular, not inclined. Provide local strengthening of concrete at openings by applying additional diagonal reinforcement.

d) Openings
Openings in the building enclosure shall be minimized and located away from the blast source. Windows shall be limited in size to maximum 0.25 m² per window. The total glazed area shall not exceed 7 % of the wall area. Windows shall be provided with special glazing.
Select external doors, louvers and similar items, together with their frames, capable of withstanding the pressures given in Annex C. Do not use glass panels in these doors. Provide at least two personnel access doors, located away from each other and not in opposite walls. Size equipment doors for maneuvering factory fabricated items like control panels into or out of the building.
All openings like doors, windows or cable inlets have to be designed for resisting the same blast loads as the wall in which they are located.
Especially cable inlets shall be located away from the blast source.

3.10 Soil data

For every project a soil investigation report shall be prepared or already be available.
This report shall contain as a minimum requirement the following information about:

- recommendations for the type of foundations
- allowable bearing pressure as a function of the shape and the depth of the foundation
- expected settlement as a function of the allowable bearing pressure
- the ground-water level
- chemical properties of the soil and ground-water
- weight and angle of internal friction of the soil
- dynamic properties of soil
-

4 General design standards

4.1 Minimum dimensions

4.1.1 Minimum clear ceiling height

The minimum clear ceiling height shall be as follows:

- Offices, toilets, wash and locker rooms, guard room, mechanical and electrical rooms 2500 mm
- Control room, rack room, computer room, laboratory, analyser room 3000 mm (may further be increased depending on height of equipment and handling space required)
- Substation switchgear and motor control center room 3000 mm (may further be increased depending on height of equipment and handling space required)
- Corridors / staircases 2400 mm

All clear heights are from finished floor to underside of suspended ceilings, roof slabs or beams, whichever is the lowest.

4.1.2 Minimum clear door dimensions

The minimum clear door dimensions shall be as given in Table **12**.

Table 12.Minimum clear door dimensions

Door type	Width × Height
Single door – access	900 × 2100 mm
Double door – access	1400 × 2100 mm
Toilet and shower door	600 × 2100 mm
Equipment door	1800 × 2400 mm[1)]
Roll-up / overhead	2900 × 3400 mm[1)]
Sliding door	2400 × 3000 mm[1)]
1) may further be increased depending on size of equipment to be brought in and out of the building	

5 Design standards structural steel

5.1 Stairways

All stairs shall be in accordance with codes and standards stipulated in Annex B

Stairways shall be constructed of standard channel stringers with open grating treads (see section 5.4).

5.2 Ladders

All ladders shall be as per standard drawing **PIN-LEP-CVS-1020**

5.3 Hand railing

Hand railing shall be as per standard drawing **PIN-LEP-CVS-1023**

5.4 Flooring

All Grating floors shall be as per standard drawing **PIN-LEP-CVS-1014**

All chequered plate floor shall be as per standard drawing **PIN-LEP-CVS-1016** for 6/7 mm thick plate or **PIN-LEP-CVS-1017** for 8/9 mm thick plate

5.5 Trolley beams and crane ways

Trolley beams and crane ways shall be in accordance with codes and standards stipulated in Annex B

6 Design standards concrete

6.1 Elevation of foundations

All elevations shall refer to plant level (possibly equal to high point paving). Reference to true elevation will be made on key layout drawings (Overall plot plan).

6.2 Anchor bolts

All anchor bolts Embedded in concrete shall be as per standard drawing **PIN-LEP-CVS-1004 / 0005 / 0006 / 0007**

All anchor bolts for Equipment located on steel structure shall be as per standard drawing **PIN-LEP-CVS-1013**

6.3 Grouting of structures and equipment

Grout shall be used under all base plates of equipment and structures, where a uniform bearing surface is required for the transfer of loads into the foundation.

Standard grout thickness shall be 50 mm. In case of the sliding plates for horizontal vessels and exchangers the grouting thickness of 50 mm includes the thickness of the sliding plate.

6.4 Foundation design

Refer Annex B.1.4.3

Annexure to Civil - General Engineering Specifications (GES)

Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC
03		Soil investigation report details incorporated & issued for Engineering	19.12.19	ASJ	19.12.19	BHK	19.12.19	GLP	
02		Wind and Seismic Parameters Revised & Issued For Engineering	18.01.18	BHK	18.01.18	VBV	18.01.18	GLP	
01		Issued For Engineering	27.10.17	BHK	27.10.17	VBV	27.10.17	GLP	
00		Issued for NALCO Review	15.09.17	BHK	15.09.17	VBV	18.09.17	GLP	-

Based on : PIN-LES-CVC-0001 F03

Barcode

Category Code: -

Contents:

Annexure A Load combinations

The following table for load combinations applies for both the calculation of the bearing capacity and the calculation of the serviceability limit stage. The serviceability need only be checked for the load combinations in the case of operating.

The safety factors shall be in accordance with codes and standards stipulated in Annexure B .

Table A1. Load combinations[1)]

	Loading Component	Type	Load combinations Empty	Operating	Test	Erection
a.	Weight of structure	P	X	X	X	X
b.	Weight of equipment category I, piping (Ø < 300 mm) and cabling	P	X	X	X	X
c.	Empty weight of equipment category II and empty piping (Ø ≥ 300 mm)	P	X	X[2)]		X[3)]
d.	Operating weight of equipment category II and empty piping (Ø ≥ 300 mm)	P		X[2)]		
e.	Hydrostatic test load of equipment category II and empty piping (Ø ≥ 300 mm)	P			X	
f.	Exchanger bundle pull force	V	X			
g.	Thermal loads	V		X		
h.	Moving loads	V	X	X	X	
i.	Live loads	V		X[4)]	X[4)]	
j.	Wind loads	V	X[6)8)]	X[6)8)]	X[5)6)7)]	X[5)7)]
k.	Snow loads	V	X[9)]	X[9)]		
l.	Rainwater loads	V	X	X		
m.	Earthquake loads	V	X[6)]	X[6)]		
n.	Other loads	V	X[6)]	X[6)]	X[6)]	

P = Permanent load
V = Variable load
1) The load combinations given below cover the minimum requirements. In case of conflict with applicable standards the most stringent requirements shall govern.
2) The most unfavorable load combination shall be taken into account.
3) The weight of the equipment as shipped, excluding the weight of all parts that are field installed after erection. For field assembled equipment, it shall be the minimum weight of the complete shells, excluding the weight of all internal and external parts, fireproofing, etc.
4) Live load shall be taken into account only when this is an unfavorable case.
5) The effect of wind forces acting on scaffolding shall be considered. The actual projected area of the scaffold members together with the correct shape factor and drag coefficient should be used. As an approximation, the overall width of the scaffolding may be taken as 1.5 m on each side of the vessel or column, with 50 % closed surface and shape factor 1.
6) Structures should not be designed for earthquake - blast - design load and wind load occurring simultaneously.
7) Only 50 % wind load shall be taken into account.
8) Wind load on equipment shall include an allowance for piping and platforms. Values for wind taken from datasheets prepared by the department responsible for designing the static equipment.
9) In countries with relatively low snow loads, snow may be included in live load.

Annexure B Additional terms and conditions

B.1 Related engineering specifications

B.1.1 Engineering Specification - Preparation of civil documents
6695-CVC-G00-EC-0003

B.1.2 Engineering specification – Concrete

B.1.2.1 Cement for RCC :

Ordinary Portland Cement of Grade 33 as per IS269 or Grade 43 as per IS8112 or Grade 53 as per IS12269 *(subject to recommendations in Soil Investigation Report)*

B.1.2.2 Reinforcement :

HYSD rebars of Grade **Fe500** conforming to requirements of IS1786 (As ductile detailing is not required)

B.1.2.3 Chemical resistant lining: As per duty conditions & temperature

B.1.2.4 As per IS 456:2000,Table 3, the exposure conditions for concrete during working life shall be **SEVERE.** Based on the above environmental exposure condition, the following shall be adopted, UNO.

B.1.2.5 **Minimum grade of concrete shall be as follows:** (CL.8.2.2, Table 5 of IS456:2000)

a) Environmental exposure condition for all concrete	**Severe**	**Remarks**
i) Grade of plain concrete used as Blinding Concrete, Lean Concrete, Mudmat,	M15	As per Licensor Specification
ii) Grade of plain concrete used as structural concrete	M20	
iii) Grade of reinforced concrete - Footing	M30	
- Piles, Columns	M30	As per Licensor Specification
- Beams, Floor slabs, walls	M30	As per Licensor Specification
b) Grade of concrete for RCC flooring at plinth / paving / grade slab	M30	

B.1.2.6 **Minimum Nominal cover to all reinforcement including links shall be as follows:** (CL.8.2.2 , Table 16 of IS456:2000)

Environmental exposure condition	Severe	Remarks
i) Footings (on all sides) and Pilecap – Top & sides	50 mm	As per IS Code
Pilecap – Bottom	150mm	
Ii) Beams - on all sides for beams below **Ground (Sub structure)**	45mm	As per IS Code
Beams - on all sides for beams above **Ground (Super structure)**	45mm	As per IS Code
iii) Slabs - on all sides	45mm	As per IS Code
iv) Columns - on all sides above **Ground (Super structure)**	45mm	As per IS Code
Columns - on all sides below **Ground (Sub structure)**	45mm	As per IS Code
iv) Walls - on all sides above **Ground (Super structure)**	45mm	As per IS Code
Walls - on all sides below **Ground (Sub structure)**	45mm	As per IS Code
iv) Slabs, Walls, Beams, Columns – Exposed to Process Fluids - on all sides above **Ground (Super structure)**	65mm	As per Licensor Specification
Slabs, Walls, Beams, Columns – Exposed to Process Fluids - on all sides below **Ground (Sub structure)**	65mm	As per Licensor Specification

B.1.2.7 **Minimum grade of concrete <u>for Liquid retaining structures</u> shall be as follows:** (CL.8.2.2 , Table 5 of IS456:2000 and CL.6.1 of IS3370 (Part1):2009

a) Environmental exposure condition for all concrete	**Severe**
i) Grade of plain concrete used as Blinding Concrete, Lean Concrete, Mudmat,	M10
ii) Grade of plain concrete used as structural concrete	M20
iii) Grade of reinforced concrete	M30

B.1.2.8 **Minimum Nominal cover to all reinforcement including links <u>for Liquid retaining structures</u> shall be as follows:** (CL.8.2.2, Table 16 of IS456:2000 and CL.6.2 of IS3370 (Part 1):2009

Environmental exposure condition	**Severe**	**Remarks**
i) Base slab (on all sides) and Pilecap – Top & sides	50mm	
Pilecap – Bottom	150mm	
Ii) Beams - on all sides	45mm	65mm for Process Fluid
iii) Slabs - on all sides	45mm	65mm for Process Fluid
iv) Columns - on all sides	45mm	65mm for Process Fluid
iv) Walls - on all sides	45mm	65mm for Process Fluid

B.1.2.9 **Grout**

Non-shrink cementitious grout (minimum compressive strength = 65 MPa) shall be provided under base plates and in anchor bolt pockets for all structures and equipment foundation.

Non-shrink epoxy grout (minimum compressive strength = 80 MPa) shall be used for all rotating equipments like pumps and compressors, if recommended by the Manufacturer.

B.1.3 Engineering specification – Steel

Anchor Bolts	:	Class 4.6 Grade E250(Fe410W) Quality A as per IS2062
Structural steel	:	E250(Fe410W) Quality A as per IS2062
		OR
		British Universal Beams, Columns and Plates – Grade 275JR/JO and S355JO to BS EN 10025 (as per availability).
Connection bolts	:	Turned and Fitted bolts Class 8.8 Grade B as per IS3640
		And nuts as per IS1367
		All connection bolts shall be galvanised
Cladding / sheeting	:	Pre-coated GI Sheets with 0.5mm TCT sheet and accessories
Grating	:	Electroforged MS- Galvanized- 25/30mm thk. As per tkIS standard Drg. PIN-LEP-CVS-1014; FRP gratings for Caustic environments.
Chequered plates	:	As per tkIS standard Drg. PIN-LEP-CVS-1016/1017
Handrail	:	As per tkIS standard Drg. PIN-LEP-CVS-1023

B.1.4 Engineering specification – Buildings / Structures

B.1.4.1 Wind data (As per IS 875 (Part-3): 2015

Wind load on plant buildings / structures (Damanjodi) shall be calculated in accordance with IS875 - Part-3 - 2015 based on following parameters:-

DESCRIPTION / ITEM	APPLICABLE	REMARK
Basic wind speed V_b	44 m/s	CL. 6.2 of IS:875 Part-3 – 2015
Risk coefficient K1	1 (for All Buildings & Structures)	As per Table 1 of IS:875 Part-3 - 2015
Terrain roughness and height factor K2		As per Table 2 of IS:875 Part-3 - 2015
Category (Terrain)	**2**	
Topography factor,K3	1	Cl. 6.3.3 of IS875 Part 3 - 2015
Importance Factor for Cyclonic Region k4	1 (NA for areas beyond 60km range from coast)	Cl. 6.3.4 of IS875 Part 3 - 2015

Design wind speed, $V_Z = V_b * K1 * K2 * K3 * K4$

Wind pressure, $Pz = 0.6 * V_Z^{2}$

Based on above K1, K2, K3 and K4 factors, the wind pressure for different heights shall not be less than following:

Height z (m) above FGL	k2 for Terrain Category-2	Vz (m/s)	Pz (kPa)
Up to 10	1.00	44	1.16
15	1.05	46.2	1.28
20	1.07	47.08	1.33
25	1.095	48.18	1.39
30	1.12	49.28	1.46
35	1.1325	49.83	1.49
40	1.145	50.38	1.52
50	1.17	51.48	1.59
100	1.24	54.56	1.78

Note :-

1) Linear interpolation shall be followed for intermediate heights.
2) Wind pressures may be reduced by 20% for structures with height less than 10 meters.

Wind load on plant buildings / structures (Vishakhapatnam Port) shall be calculated in accordance with IS875 - Part-3 based on following parameters:-

DESCRIPTION / ITEM	**APPLICABLE**	**REMARK**
Basic wind speed V_b	50 m/s	CL. 6.2 of IS:875 Part-3 – 2015
Risk coefficient K1	1 (for All Buildings & Structures)	As per Table 1 of IS:875 Part-3 - 2015
Terrain roughness and height factor K2		As per Table 2 of IS:875 Part-3 - 2015
Category (Terrain)	**2**	
Topography factor,K3	1	Cl. 6.3.3 of IS875 Part 3 - 2015
Importance Factor for Cyclonic Region k4	1.15 (Industrial Structures)	Cl. 6.3.4 of IS875 Part 3 - 2015

Design wind speed, $V_Z = V_b * K1 * K2 * K3 * K4$

Wind pressure, $Pz = 0.6 * V_Z^{2}$

Based on above K1, K2, K3 and K4 factors, the wind pressure for different heights shall not be less than following:

Height z (m) above FGL	k2 for Terrain Category-2	Vz (m/s)	Pz (kPa)
Up to 10	1.00	57.5	1.98
15	1.05	60.375	2.19
20	1.07	61.525	2.27
25	1.095	62.96	2.38
30	1.12	64.4	2.49
35	1.1325	65.12	2.54
40	1.145	65.84	2.60
50	1.17	67.275	2.715
100	1.24	71.3	3.05

Note :-

1) Linear interpolation shall be followed for intermediate heights.
2) Wind pressures may be reduced by 20% for structures with height less than 10 meters.

Additionally for Vishakhapatnam Port area, reference shall be made to IS 15498 for guidelines for improving the cyclonic resistance of the structures.

Design Wind Pressure:

The Design Wind Pressure shall be calculated, in accordance with IS 875 Part 3:2015, as

Pd = Kd * Ka * Kc * Pz; where

Kd = Wind directionality factor

Ka = Area averaging factor

Kc = Combination factor

However, the value of Pd shall not be taken as less than 0.70 times Pz.

B.1.4.2 Earthquake data as per IS 1983 (Part IV): 2015 for Industrial structures

DESCRIPTION / ITEM	APPLICABLE	REMARK
Seismic Zone	II	For both Damanjodi and Vishakhapatnam Port
Zone Factor, Z	0.10	As per Annexure A of IS1893-Part 4:2015

Ductile detailing **is not necessary**, as per the provisions of IS1893 & IS13920.

The Spectral acceleration coefficient for rock and soil sites, Sa/g, is considered as per Annexure B of IS1893-Part 4:2015 for

Name of structure	Category As per Table 6 of IS1893-Part 4:2015	Importance Factor, I As per Table 3 of IS1893-Part 4:2015	Reduction Factor, R As per Table-4 of IS1893-Part 4:2015 and IS800:2007 for steel structures	Type of Analysis as per Cl 10.2 of IS1893-Part 4:2005
Process Structures	2	1.5	3	Simplified Analysis
Pipe-rack	2	1.5	3	Simplified Analysis
Compressor House	2	1.5	3	Simplified Analysis
Substations and Control Room	2	1.5	3	Simplified Analysis

NOTE: In case of braced steel structures Response reduction factor, R = 4.

Damping ratio coefficient shall be as per Table 5 of IS1893-Part 4:2015 as follows:

Structural Steel – 2%

RCC – 5%

As per Cl 8.3.2.1 of IS1893-Part 4: 2015:

Where the plan wise distribution of mass and stiffness of the structural system is not symmetrical about X & Y directions, the response due to each component may be combined using the assumption that when the maximum response from one component occurs, the response from other two components are 30 percent of corresponding maximum.

As an alternative to this procedure, the response due to combined effect of three components can be obtained on the basis of square root of sum of squares (SRSS).

Where the plan wise distribution of mass and stiffness of the structural system is symmetrical about two lateral directions X & Y, the structure shall be designed for the effects due to full design earthquake load in one horizontal direction at a time.

3

B.1.4.3 SUB-SOIL DATA FOR FOUNDATIONS

For Main Plant Site at Damanjodi:

Subsoil data is based on the soil investigation report by Foundation conultants M/s C. E. Testing Company Pvt. Limited, Dt. September– 2019 Revised on 15th October, 2019 (Volume 2) and Volume 1 (April 2018)

a) Net safe bearing capacity of soil :

Refer tables below for recommended safe bearing capacities

Area	Borelog	FGL EL+ (m)	Depth of foundation below FGL (m)	Size of foundation (mxm)	SBC (T/sqm) (for settlement upto 25mm)
Indirect bauxite slurry heating	BH-9	930.000	0.6	ALL	165
	BH-11	930.000	0.6	ALL	200
Digestion	BH-12	930.000	2	2X2	30
				3X3	30
				4X4	30
			3	2X2	35
				3X3	35
				4X4	35
	BH-13	930.000	2	2X2	30
				3X3	30
				4X4	30
			3	2X2	30
				3X3	35
				4X4	35
Acid cleaning preparation	BH-8	928.000	2	2X2	30
				3X3	30
				4X4	30
			3	2X2	30
				3X3	35
				4X4	35
Precipitation	BH-45	930.000	2	2X2	40
				3X3	40
				4X4	40
			4	2X2	45
				3X3	50
				4X4	50
	BH-48	927.150	2	2X2	20
				3X3	20
				4X4	25
			3	2X2	25
				3X3	25
				4X4	25
	BH-50	925.891	0.6	ALL	85
	BH-52	922.000	2	2X2	20

				3X3	20
				4X4	25
			3	2X2	25
				3X3	25
				4X4	25
Product hydration filteration stage 1	BH-49	910.000	2	2X2	15
				3X3	15
				4X4	15
			3	2X2	20
				3X3	20
				4X4	20
	BH-51	919.000	0.6	ALL	145
Caustic soda receipt and storage	BH-74	921.108	2.1	2X2	40
				3X3	40
				4X4	45
			3.1	2X2	45
				3X3	45
				4X4	45
Piperack-HID	BH-42	927.451	1.5	2X2	55
				3X3	55
				4X4	60
			2.5	2X2	65
				3X3	65
				4X4	75
Piperack-CISF colony	BH-56	910.400	1.5	2X2	20
				3X3	23
				4X4	25
			2.5	2X2	30
				3X3	30
				4X4	30
	BH-57	907.067	1.5	2X2	15
				3X3	15
				4X4	15
			2.5	2X2	20
				3X3	20
				4X4	20
	BH-58	908.833	1.5	2X2	20
				3X3	20
				4X4	20
			2.5	2X2	25
				3X3	25
				4X4	25
	BH-59	913.592	1.5	2X2	20
				3X3	20

				4X4	20
			2.5	2X2	25
				3X3	25
				4X4	25
	BH-60	921.400	1.9	2X2	35
				3X3	35
				4X4	35
			2.9	2X2	40
				3X3	45
				4X4	45
Substation	BH-66	915	0.6	ALL	75
Substation	BH-34	935.150	0.6	ALL	200
Fuel oil unloading and storage	BH-75	919.815	2	2X2	25
				3X3	25
				4X4	30
			3	2X2	30
				3X3	30
				4X4	30
	BH-76	921.816	2	2X2	35
				3X3	35
				4X4	40
			3	2X2	40
				3X3	45
				4X4	45

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Effluent Treatment Plant	BH-01 (FGL = 914.000M)	1.00	1<B≤3	1.0	45.72	--	40	40
				1.5	39.85	--	36	38
				2.0	38.66	--	34	38
			3 <B ≤6	1.0	44.30	--	28	40
				1.5	38.60	--	26	38
				2.0	37.46	--	25	36
			B> 6	1.0	43.73	--	22	35
				1.5	38.11	--	20	32
				2.0	36.97	--	20	32
		2.00	1<B≤3	1.0	48.65	--	40	40
				1.5	42.38	--	40	40
				2.0	41.12	--	40	40
			3 <B ≤6	1.0	45.80	--	32	40
				1.5	39.90	--	28	38
				2.0	38.70	--	26	38
			B> 6	1.0	44.66	--	24	38
				1.5	38.90	--	23	36
				2.0	37.74	--	22	35
		3.00	1<B≤3	1.0	51.58	--	40	40
				1.5	44.92	--	40	40
				2.0	43.57	--	40	40
			3 <B ≤6	1.0	47.30	--	35	40
				1.5	41.19	--	32	40
				2.0	39.94	--	30	38
			B> 6	1.0	45.58	--	28	40
				1.5	39.70	--	26	38
				2.0	38.50	--	25	38
Evaporation	BH-19 (FGL = 930.000M)	1.00	1<B≤3	1.0	35.74	--	28	35
				1.5	31.14	--	24	30
				2.0	30.21	--	22	30
			3 <B ≤6	1.0	34.62	--	18	28
				1.5	30.17	--	16	25
				2.0	29.27	--	15	24
			B> 6	1.0	34.18	--	13	20
				1.5	29.78	--	12	18
				2.0	28.89	--	11	18
		2.00	1<B≤3	1.0	38.04	--	32	38
				1.5	33.13	--	26	32
				2.0	32.14	--	24	32
			3 <B ≤6	1.0	35.81	--	18	30
				1.5	31.19	--	16	25
				2.0	30.25	--	15	24
			B> 6	1.0	34.92	--	14	22
				1.5	30.41	--	12	18
				2.0	29.50	--	12	18
		3.00	1<B≤3	1.0	40.34	--	35	40
				1.5	35.12	--	30	35
				2.0	34.06	--	26	34
			3 <B ≤6	1.0	37.00	--	22	35
				1.5	32.21	--	19	30
				2.0	31.23	--	18	28
			B> 6	1.0	35.66	--	15	24
				1.5	31.04	--	14	22
				2.0	30.10	--	14	22
Cooling Tower Evaporation	BH-20 & 22 (FGL = 930.000M)	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	40	40
				2.0	43.15	--	36	40

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Cooling Tower Evaporation	BH-20 & 22 (FGL = 930.000M)	4.00	3 <B ≤6	1.0	45.76	--	26	40
				1.5	39.84	--	22	35
				2.0	38.62	--	20	32
			B> 6	1.0	43.62	--	15	24
				1.5	37.97	--	13	20
				2.0	36.81	--	12	18
Sub-Station 05	BH-21 (FGL = 930.000M)	1.00	1<B≤3	1.0	42.87	--	38	40
				1.5	37.36	--	32	36
				2.0	36.25	--	30	36
			3 <B ≤6	1.0	41.53	--	22	35
				1.5	36.19	--	20	32
				2.0	35.12	--	18	28
			B> 6	1.0	41.00	--	14	22
				1.5	35.73	--	12	18
				2.0	34.67	--	11	18
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	36	38
				2.0	38.55	--	32	38
			3 <B ≤6	1.0	42.94	--	22	35
				1.5	37.41	--	20	32
				2.0	36.29	--	18	28
			B> 6	1.0	41.87	--	14	22
				1.5	36.48	--	13	20
				2.0	35.38	--	12	18
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	35	40
			3 <B ≤6	1.0	44.35	--	24	38
				1.5	38.62	--	21	34
				2.0	37.45	--	19	30
			B> 6	1.0	42.75	--	15	24
				1.5	37.22	--	13	20
				2.0	36.10	--	12	18
Causticisation	BH-30 (FGL = 933.000M)	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	30.46	--	22	30
				1.5	26.53	--	19	26
				2.0	25.72	--	17	25
			3<B≤6	1.0	28.68	--	16	25
				1.5	24.97	--	15	24
				2.0	24.22	--	14	22
			B> 6	1.0	27.96	--	13	20
				1.5	24.35	--	12	18
				2.0	23.61	--	12	18
		3.00	1<B≤3	1.0	32.32	--	26	32
				1.5	28.13	--	23	28
				2.0	27.27	--	21	26
			3 <B ≤6	1.0	29.64	--	20	28
				1.5	25.80	--	18	26
				2.0	25.01	--	17	25
			B> 6	1.0	28.57	--	16	25
				1.5	24.86	--	15	24
				2.0	24.10	--	14	22
HD Acid Area	BH-37 (FGL = 935.000M)	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--

CCR & Plant Office	BH-44 (FGL = 935.000M)	1.00 - 5.50	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		6.50	1<B≤3	1.0	46.48	--	40	40
				1.5	40.43	--	40	40
				2.0	39.17	--	40	38
			3<B≤6	1.0	39.52	--	38	38
				1.5	34.36	--	34	34
				2.0	33.28	--	32	32
			B> 6	1.0	36.74	--	36	36
				1.5	31.94	--	30	30
				2.0	30.93	--	30	30
		9.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Pipe Rack CISF Colony	BH-53 (FGL = EGL)	1.00	1≤ B <3	1.0	31.46	--	30	30
				1.5	27.41	--	26	26
				2.0	26.59	--	26	26
			3≤ B <6	1.0	30.48	--	21	30
				1.5	26.55	--	20	26
				2.0	25.76	--	20	25
			B ≥ 6	1.0	30.08	--	22	30
				1.5	26.21	--	22	26
				2.0	25.43	--	20	25
		2.00	1≤ B <3	1.0	33.49	--	32	32
				1.5	29.17	--	28	28
				2.0	28.29	--	28	28
			3≤ B <6	1.0	31.53	--	30	30
				1.5	27.46	--	26	26
				2.0	26.63	--	26	26
			B ≥ 6	1.0	30.75	--	30	30
				1.5	26.77	--	26	26
				2.0	25.97	--	25	25
		3.00	1≤ B <3	1.0	64.84	--	40	40
				1.5	60.73	--	40	40
				2.0	60.70	--	40	40
			3≤ B <6	1.0	67.36	--	40	40
				1.5	62.94	--	40	40
				2.0	63.52	--	40	40
			B ≥ 6	1.0	82.38	--	40	40
				1.5	76.60	--	40	40
				2.0	78.85	--	40	40
Effluent Treatment Plant CISF Colony	BH-54 & 55 (FGL = 908.000M)	1.00	1<B≤3	1.0	42.87	--	28	40
				1.5	37.36	--	24	36
				2.0	36.25	--	22	35
			3 <B ≤6	1.0	41.53	--	20	32
				1.5	36.19	--	18	28
				2.0	35.12	--	16	26
			B> 6	1.0	41.00	--	16	26
				1.5	35.73	--	15	24
				2.0	34.67	--	14	22
		2.00	1<B≤3	1.0	45.62	--	32	40
				1.5	39.74	--	26	38
				2.0	38.55	--	24	38

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Effluent Treatment Plant CISF Colony	BH-54 & 55 (FGL = 908.000M)	2.00	3 <B ≤6	1.0	42.94	--	22	35
				1.5	37.41	--	20	32
				2.0	36.29	--	20	32
			B> 6	1.0	41.87	--	18	28
				1.5	36.48	--	16	26
				2.0	35.38	--	16	26
		3.00	1<B≤3	1.0	48.37	--	36	40
				1.5	42.12	--	32	40
				2.0	40.85	--	30	40
			3 <B ≤6	1.0	44.35	--	28	40
				1.5	38.62	--	25	38
				2.0	37.45	--	24	36
			B> 6	1.0	42.75	--	21	34
				1.5	37.22	--	20	32
				2.0	36.10	--	19	30
Product Filtration Stage	BH-61 (FGL = 914.000M)	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Calciner	BH-62 (FGL = 910.000M)	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Cooling Tower Calciner	BH-63 & 64 (FGL = 910.000M)	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Calciner	BH-65 (FGL = 910.000M)	1.00	1≤ B <3	1.0	22.45	--	22	22
				1.5	20.98	--	20	20
				2.0	21.17	--	20	20
			3≤ B <6	1.0	33.29	--	32	32
				1.5	30.87	--	30	30
				2.0	32.15	--	32	32
			B ≥ 6	1.0	51.63	--	40	40
				1.5	47.67	--	40	40
				2.0	50.52	--	40	40
		2.00	1≤ B <3	1.0	43.63	--	40	40
				1.5	40.93	--	40	40
				2.0	40.66	--	40	40

Alumina Storage	BH-67 & 68 (FGL = EGL)	1.00	1<B≤3	1.0	32.88	--	28	32
				1.5	28.65	--	24	28
				2.0	27.80	--	22	26
			3<B≤6	1.0	31.86	--	17	27
				1.5	27.76	--	15	24
				2.0	26.93	--	14	22
			B> 6	1.0	31.45	--	12	20
				1.5	27.40	--	11	18
				2.0	26.59	--	11	18
		2.00	1<B≤3	1.0	35.01	--	32	35
				1.5	30.49	--	28	30
				2.0	29.57	--	25	28
			3<B≤6	1.0	32.96	--	18	28
				1.5	28.70	--	16	25
				2.0	27.84	--	15	24
			B> 6	1.0	32.14	--	14	22
				1.5	27.99	--	12	20
				2.0	27.14	--	12	20
		3.00	1<B≤3	1.0	37.13	--	36	36
				1.5	32.33	--	32	32
				2.0	31.34	--	28	30
			3 <B ≤6	1.0	34.05	--	22	34
				1.5	29.64	--	18	28
				2.0	28.74	--	17	27
			B> 6	1.0	32.82	--	15	24
				1.5	28.57	--	14	22
				2.0	27.70	--	13	21

Filtered Water Reservoir	BH-69 (FGL = EGL)	1.00	1<B≤3	1.0	28.60	--	17	26
				1.5	24.92	--	15	24
				2.0	24.18	--	14	22
			3<B≤6	1.0	27.71	--	12	18
				1.5	24.15	--	11	17
				2.0	23.42	--	10	16
			B> 6	1.0	27.36	--	10	16
				1.5	23.83	--	9	14
				2.0	23.12	--	9	14
		2.00	1<B≤3	1.0	30.46	--	20	30
				1.5	26.53	--	18	26
				2.0	25.72	--	16	25
			3<B≤6	1.0	28.68	--	15	24
				1.5	24.97	--	13	21
				2.0	24.22	--	13	21
			B> 6	1.0	27.96	--	12	19
				1.5	24.35	--	11	18
				2.0	23.61	--	10	16
		3.00	1<B≤3	1.0	32.32	--	25	32
				1.5	28.13	--	22	28
				2.0	27.27	--	20	26

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Filtered Water Reservoir	BH-69 (FGL = EGL)	3.00	3 <B ≤6	1.0	29.64	--	18	28
				1.5	25.80	--	16	25
				2.0	25.01	--	16	25
			B> 6	1.0	28.57	--	14	22
				1.5	24.86	--	13	21
				2.0	24.10	--	13	21
Raw Water Reservoir	BH-70 & 71 (FGL = EGL)	1.00	1<B≤3	1.0	31.46	--	30	30
				1.5	27.41	--	26	26
				2.0	26.59	--	25	26
			3<B≤6	1.0	30.48	--	25	30
				1.5	26.55	--	22	26
				2.0	25.76	--	22	25
			B> 6	1.0	30.08	--	21	30
				1.5	26.21	--	20	26
				2.0	25.43	--	19	25
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	38	38
				2.0	38.55	--	35	38
			3<B≤6	1.0	42.94	--	36	40
				1.5	37.41	--	32	36
				2.0	36.29	--	30	36
			B> 6	1.0	41.87	--	28	40
				1.5	36.48	--	28	36
				2.0	35.38	--	26	35
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	40	40
			3 <B ≤6	1.0	44.35	--	40	40
				1.5	38.62	--	38	38
				2.0	37.45	--	36	36
			B> 6	1.0	42.75	--	36	40
				1.5	37.22	--	35	36
				2.0	36.10	--	34	36

Drinking Water Unit	BH-72 & 73 (FGL = EGL)	1.00	1<B≤3	1.0	42.87	--	35	40
				1.5	37.36	--	30	36
				2.0	36.25	--	28	36
			3<B≤6	1.0	41.53	--	26	40
				1.5	36.19	--	24	36
				2.0	35.12	--	22	35
			B> 6	1.0	41.00	--	20	32
				1.5	35.73	--	18	28
				2.0	34.67	--	18	28
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	35	38
				2.0	38.55	--	30	38
			3<B≤6	1.0	42.94	--	30	40
				1.5	37.41	--	26	36
				2.0	36.29	--	26	36
			B> 6	1.0	41.87	--	22	35
				1.5	36.48	--	22	35
				2.0	35.38	--	20	35
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	38	40
			3 <B ≤6	1.0	44.35	--	36	40
				1.5	38.62	--	32	38
				2.0	37.45	--	30	36
			B> 6	1.0	42.75	--	28	40
				1.5	37.22	--	26	36
				2.0	36.10	--	25	36
Caustic Soda Storage	BH-74 (FGL = EGL)	1.00	1<B≤3	1.0	57.14	--	40	40
				1.5	49.80	--	40	40
				2.0	48.32	--	40	40
			3<B≤6	1.0	55.35	--	40	40
				1.5	48.24	--	40	40
				2.0	46.81	--	40	40

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Caustic Soda Storage	BH-74 (FGL = EGL)	1.00	B> 6	1.0	54.64	--	40	40
				1.5	47.62	--	40	40
				2.0	46.21	--	40	40
		2.00	1<B≤3	1.0	60.78	--	40	40
				1.5	52.95	--	40	40
				2.0	51.38	--	40	40
			3<B≤6	1.0	57.21	--	40	40
				1.5	49.84	--	40	40
				2.0	48.36	--	40	40
			B> 6	1.0	55.78	--	40	40
				1.5	48.60	--	40	40
				2.0	47.15	--	40	40
		3.00	1 - 6	1.00 - 2.00	66.32	50	--	--
			≥ 6	1.00 - 2.00	66.32	50	--	--

Lime Preparation	BH-92	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
	(FGL = EGL)	4.00	1<B≤3	1.0	34.17	--	34	34
				1.5	29.73	--	28	28
				2.0	28.82	--	28	28
			3<B≤6	1.0	30.61	--	28	30
				1.5	26.62	--	25	26
				2.0	25.80	--	24	25
			B> 6	1.0	29.18	--	22	28
				1.5	25.38	--	20	25
				2.0	24.59	--	18	24
		5.00	1<B≤3	1.0	36.03	--	36	36
				1.5	31.34	--	30	30
				2.0	30.36	--	30	30
			3<B≤6	1.0	31.57	--	30	30
				1.5	27.45	--	26	26
				2.0	26.59	--	26	26

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Lime Preparation	BH-92	5.00	B> 6	1.0	29.79	--	28	28
	(FGL = EGL)			1.5	25.89	--	25	25
				2.0	25.08	--	25	25
		6.00	1<B≤3	1.0	56.61	--	40	40
				1.5	49.26	--	40	40
				2.0	47.75	--	40	40
			3<B≤6	1.0	48.58	--	40	40
				1.5	42.27	--	40	40
				2.0	40.96	--	40	40
			B> 6	1.0	45.37	--	40	40
				1.5	39.47	--	38	38
				2.0	38.24	--	38	38
[illegible]		[illegible]		[illegible]	[illegible]		[illegible]	[illegible]

Power plant	BH-93 & 94 (FGL = EGL)	1.00	1<B≤3	1.0	28.60	--	23	28
				1.5	24.92	--	20	24
				2.0	24.18	--	19	24
			3<B≤6	1.0	27.71	--	15	24
				1.5	24.15	--	13	22
				2.0	23.42	--	12	20
			B> 6	1.0	27.36	--	11	18
				1.5	23.83	--	10	16
				2.0	23.12	--	10	16
		2.00	1<B≤3	1.0	30.46	--	28	30
				1.5	26.53	--	24	26
				2.0	25.72	--	22	25
			3<B≤6	1.0	28.68	--	17	28
				1.5	24.97	--	15	24
				2.0	24.22	--	14	22
			B> 6	1.0	27.96	--	13	20
				1.5	24.35	--	11	18
				2.0	23.61	--	11	18
		3.00	1<B≤3	1.0	32.32	--	32	32
				1.5	28.13	--	28	28
				2.0	27.27	--	26	26
			3 <B ≤6	1.0	29.64	--	21	28
				1.5	25.80	--	18	25
				2.0	25.01	--	16	25
			B> 6	1.0	28.57	--	14	22
				1.5	24.86	--	13	21
				2.0	24.10	--	12	20
	BH-96 & 97 (FGL = EGL)	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	33.49	--	32	32
				1.5	29.17	--	28	28
				2.0	28.29	--	26	28
			3<B≤6	1.0	31.53	--	22	30
				1.5	27.46	--	20	26
				2.0	26.63	--	18	26
			B> 6	1.0	30.75	--	22	30
				1.5	26.77	--	20	26
				2.0	25.97	--	20	26
		3.00	1<B≤3	1.0	35.53	--	35	35
				1.5	30.93	--	30	30
				2.0	29.99	--	28	28
			3 <B ≤6	1.0	32.58	--	32	32
				1.5	28.36	--	28	28
				2.0	27.50	--	26	26
			B> 6	1.0	31.41	--	30	30
				1.5	27.34	--	26	26
				2.0	26.50	--	26	26

Substation Extension Building	BH-98 (FGL = EGL)	1.00	1<B≤3	1.0	18.62	--	8	12
				1.5	16.22	--	6	9
				2.0	15.73	--	6	9
			3<B≤6	1.0	18.04	--	4	7
				1.5	15.71	--	4	6
				2.0	15.24	--	3	5
			B> 6	1.0	17.81	--	3	5
				1.5	15.51	--	3	5
				2.0	15.04	--	3	5

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Substation Extension Building	BH-98 (FGL = EGL)	2.00	1<B≤3	1.0	19.85	--	9	14
				1.5	17.28	--	7	11
				2.0	16.75	--	6	9
			3<B≤6	1.0	18.69	--	4	7
				1.5	16.27	--	4	7
				2.0	15.77	--	3	6
			B> 6	1.0	18.23	--	4	6
				1.5	15.86	--	3	5
				2.0	15.37	--	3	5
		3.00	1<B≤3	1.0	21.08	--	10	16
				1.5	18.33	--	8	12
				2.0	17.76	--	7	11
			3 <B ≤6	1.0	19.34	--	5	8
				1.5	16.82	--	4	7
				2.0	16.29	--	4	6
			B> 6	1.0	18.65	--	4	7
				1.5	16.21	--	4	6
				2.0	15.70	--	3	6

Switch Yard	BH-99 (FGL = EGL)	1.00	1<B≤3	1.0	22.90	--	12	18
				1.5	19.95	--	10	16
				2.0	19.35	--	9	14
			3<B≤6	1.0	22.18	--	8	13
				1.5	19.33	--	7	11
				2.0	18.75	--	7	11
			B> 6	1.0	21.90	--	5	9
				1.5	19.08	--	5	8
				2.0	18.51	--	5	8
		2.00	1<B≤3	1.0	24.40	--	14	22
				1.5	21.24	--	11	18
				2.0	20.59	--	10	16
			3<B≤6	1.0	22.97	--	9	14
				1.5	20.00	--	8	13
				2.0	19.39	--	7	11
			B> 6	1.0	22.40	--	6	10
				1.5	19.50	--	5	8
				2.0	18.90	--	5	8
		3.00	1<B≤3	1.0	25.90	--	16	25
				1.5	22.53	--	13	21
				2.0	21.84	--	12	19
			3 <B ≤6	1.0	23.76	--	10	16
				1.5	20.67	--	9	14
				2.0	20.03	--	8	13
			B> 6	1.0	22.90	--	7	11
				1.5	19.92	--	6	10
				2.0	19.30	--	6	9
Sewage Treatment Plant	BH-100 (FGL = EGL)	1.00	1<B≤3	1.0	22.90	--	16	22
				1.5	19.95	--	14	18
				2.0	19.35	--	13	18
			3<B≤6	1.0	22.18	--	12	19
				1.5	19.33	--	11	18
				2.0	18.75	--	10	16
			B> 6	1.0	21.90	--	8	13
				1.5	19.08	--	8	12
				2.0	18.51	--	7	11
		2.00	1<B≤3	1.0	24.40	--	22	24
				1.5	21.24	--	20	21
				2.0	20.59	--	19	20
			3<B≤6	1.0	22.97	--	13	21
				1.5	20.00	--	11	18
				2.0	19.39	--	11	17
			B> 6	1.0	22.40	--	8	13
				1.5	19.50	--	7	11
				2.0	18.90	--	7	11

Structure Name	Foundation Location	Depth of Foundation below FGL / EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Sewage Treatment Plant	BH-100 (FGL = EGL)	3.00	1<B≤3	1.0	25.90	--	25	25
				1.5	22.53	--	22	22
				2.0	21.84	--	21	21
			3 <B ≤6	1.0	23.76	--	20	23
				1.5	20.67	--	17	20
				2.0	20.03	--	15	20
			B> 6	1.0	22.90	--	11	18
				1.5	19.92	--	10	16
				2.0	19.30	--	9	14

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
CHP	BH-MND01	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	33.49		26	32
				1.5	29.17	--	22	28
				2.0	28.29	--	20	28
			3 <B ≤6	1.0	31.53	--	16	25
				1.5	27.46	--	14	22
				2.0	26.63	--	12	18
			B> 6	1.0	30.75	--	12	18
				1.5	26.77	--	10	16
				2.0	25.97	--	10	16
		3.00	1<B≤3	1.0	35.53	--	30	35
				1.5	30.93	--	28	30
				2.0	29.99	--	25	28
			3 <B ≤6	1.0	32.58	--	18	28
				1.5	28.36	--	16	25
				2.0	27.50	--	15	24
			B> 6	1.0	31.41	--	13	21
				1.5	27.34	--	11	17
				2.0	26.50	--	11	17
CHP	BH-MND-02	1.00	1<B≤3	1.0	15.77	--	8	12
				1.5	13.73	--	7	11
				2.0	13.31	--	6	9
			3 <B ≤6	1.0	15.27	--	5	8
				1.5	13.30	--	5	8
				2.0	12.90	--	4	6
			B> 6	1.0	15.08	--	4	6
				1.5	13.13	--	3	5
				2.0	12.73	--	3	5
		2.00	1<B≤3	1.0	16.82	--	10	16
				1.5	14.63	--	8	12
				2.0	14.18	--	7	11
			3 <B ≤6	1.0	15.84	--	6	9
				1.5	13.78	--	5	8
				2.0	13.35	--	5	8
			B> 6	1.0	15.45	--	4	6
				1.5	13.44	--	4	6
				2.0	13.02	--	4	6
		3.00	1<B≤3	1.0	17.87	--	12	18
				1.5	15.54	--	10	16
				2.0	15.05	--	9	14
			3 <B ≤6	1.0	16.40	--	7	11
				1.5	14.25	--	6	9
				2.0	13.80	--	6	9
			B> 6	1.0	15.81	--	5	8
				1.5	13.74	--	5	8
				2.0	13.31	--	4	6

Cooling Tower		1.00 - 12.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		13.00	1<B≤3	1.0	48.38	--	25	40
				1.5	41.98	--	22	35
				2.0	40.61	--	20	32
			3 <B ≤6	1.0	37.37	--	18	28
				1.5	32.38	--	16	25
				2.0	31.29	--	14	22
			B> 6	1.0	32.96	--	12	18
				1.5	28.54	--	10	16
				2.0	27.57	--	9	14
CHP	BH-MND04	1.00 - 2.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		3.00	1<B≤3	2.0	48.37		40	40
				1.5	42.12	--	35	40
				2.0	40.85	--	32	40
			3 <B ≤6	1.0	44.35	--	24	38
				1.5	38.62	--	20	32
				2.0	37.45	--	18	28

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
CHP	BH-MND04	3.00	B> 6	1.0	42.75	--	16	25
				1.5	37.22	--	14	22
			B> 6	2.0	36.10	--	14	22
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	38	40
				2.0	43.15	--	34	40
			3 <B ≤6	1.0	45.76	--	26	40
				1.5	39.84	--	22	35
				2.0	38.62	--	20	32
			B> 6	1.0	43.62	--	17	26
				1.5	37.97	--	16	25
				2.0	36.81	--	15	24
CHP	BH-MND05	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	36	40
				2.0	43.15	--	32	40
			3<B≤6	1.0	45.76	--	24	38
				1.5	39.84	--	20	32
				2.0	38.62	--	18	28
			B> 6	1.0	43.62	--	16	25
				1.5	37.97	--	14	22
				2.0	36.81	--	12	18
		5.00	1<B≤3	1.0	53.86	--	40	40
				1.5	46.88	--	40	40
				2.0	45.45	--	34	40
			3<B≤6	1.0	47.17	--	26	40
				1.5	41.05	--	22	35
				2.0	39.79	--	20	32
			B> 6	1.0	44.5	--	18	28
				1.5	38.72	--	16	25
				2.0	37.53	--	14	22

SPP	BH-MND-06	1.00	1≤ B <3	1.0	28.60	--	13	20
				1.5	24.92	--	11	18
				2.0	24.18	--	10	16
			3≤ B <6	1.0	27.71	--	9	14
				1.5	24.15	--	8	13
				2.0	23.42	--	8	12
			B ≥ 6	1.0	27.36	--	7	11
				1.5	23.83	--	7	11
				2.0	23.12	--	6	10
		2.00	1≤ B <3	1.0	30.46	--	16	25
				1.5	26.53	--	14	22
				2.0	25.72	--	13	20
			3≤ B <6	1.0	28.68	--	11	18
				1.5	24.97	--	10	16
				2.0	24.22	--	9	14
			B ≥ 6	1.0	27.96	--	9	14
				1.5	24.35	--	8	12
				2.0	23.61	--	8	12
		3.00	1≤ B <3	1.0	32.32	--	20	32
				1.5	28.13	--	18	28
				2.0	27.27	--	16	25
			3≤ B <6	1.0	29.64	--	14	22
				1.5	25.8	--	13	20
				2.0	25.01	--	12	18
			B ≥ 6	1.0	28.57	--	11	18
				1.5	24.86	--	10	16
				2.0	24.10	--	9	14
SPP	BH-MND10	1.00	1<B≤3	1.0	27.18	--	15	24
				1.5	23.68	--	13	20
				2.0	22.97	--	12	18

SPP	BH-MND10	1.00	3<B≤6	1.0	26.33	--	9	14
				1.5	22.94	--	8	12
				2.0	22.26	--	7	11
			B> 6	1.0	25.99	--	6	9
				1.5	22.65	--	6	9
				2.0	21.97	--	6	9
		2.00	1<B≤3	1.0	28.94	--	17	27
				1.5	25.20	--	14	22
				2.0	24.44	--	13	20
			3<B≤6	1.0	27.25	--	10	16
				1.5	23.73	--	9	14
				2.0	23.01	--	8	12
			B> 6	1.0	26.57	--	7	11
				1.5	23.14	--	6	10
				2.0	22.44	--	6	9
		3.00	1<B≤3	1.0	30.71	--	19	30
				1.5	26.73	--	16	25
				2.0	25.91	--	14	22
			3<B≤6	1.0	28.17	--	11	18
				1.5	24.51	--	10	16
				2.0	23.76	--	9	14
			B> 6	1.0	27.15	--	8	12
				1.5	23.63	--	7	11
				2.0	22.90	--	7	11
SPP	BH-MND12	1.00	1<B≤3	1.0	30.03	--	21	30
				1.5	26.17	--	19	26
				2.0	25.39	--	17	25
			3<B≤6	1.0	29.09	--	14	22
				1.5	25.35	--	13	20
				2.0	24.59	--	12	18
			B> 6	1.0	28.72	--	11	18
				1.5	25.02	--	10	16
				2.0	24.28	--	10	16
		2.00	1<B≤3	1.0	31.98	--	26	30
				1.5	27.85	--	22	26
				2.0	27.01	--	20	26
			3<B≤6	1.0	30.10	--	16	25
				1.5	26.21	--	15	24
				2.0	25.42	--	14	22
			B> 6	1.0	29.35	--	12	19
				1.5	25.56	--	11	18
				2.0	24.79	--	11	18
		3.00	1<B≤3	1.0	33.92	--	32	32
				1.5	29.53	--	26	28
				2.0	28.63	--	25	28
			3<B≤6	1.0	31.11	--	20	30
				1.5	27.08	--	18	26
				2.0	26.25	--	16	26
			B> 6	1.0	29.99	--	15	24
				1.5	26.10	--	13	21
				2.0	25.30	--	13	21

DM Plant	BH-MND13	1.00	1≤ B <3	1.0	25.75	--	13	20
				1.5	22.44	--	11	18
				2.0	21.76	--	10	16
			3≤ B <6	1.0	24.95	--	9	14
				1.5	21.74	--	8	13
				2.0	21.09	--	8	13
			B ≥ 6	1.0	24.63	--	7	11
				1.5	21.46	--	6	10
				2.0	20.81	--	6	9
		2.00	1≤ B <3	1.0	27.43	--	16	25
				1.5	23.88	--	14	22
				2.0	23.16	--	13	21

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
DM Plant	BH-MND13	2.00	3≤ B <6	1.0	25.82	--	11	18
				1.5	22.48	--	10	16
				2.0	21.80	--	9	14
			B ≥ 6	1.0	25.18	--	8	13
				1.5	21.92	--	7	11
				2.0	21.26	--	7	11
		3.00	1≤ B <3	1.0	29.11	--	20	28
				1.5	25.33	--	18	25
				2.0	24.55	--	16	24
			3≤ B <6	1.0	26.70	--	14	22
				1.5	23.23	--	12	18
				2.0	22.52	--	12	18
			B ≥ 6	1.0	25.74	--	10	16
				1.5	22.39	--	9	14
				2.0	21.70	--	8	13

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Secondary Crushing	BH-02 (FGL = 920.000M)	1.00	1<B ≤3	1.00 - 2.00	29.01	--	22	28
			3 <B ≤6	1.00 - 2.00	28.28	--	13	20
			B≥ 6	1.00 - 2.00	28.10	--	18	28
		2.00	1<B ≤3	1.00 - 2.00	30.85	--	25	30
			3 <B ≤6	1.00 - 2.00	29.41	--	14	22
			B≥ 6	1.00 - 2.00	29.04	--	19	28
		3.00	1<B ≤3	1.00 - 2.00	32.70	--	27	30
			3 <B ≤6	1.00 - 2.00	30.53	--	15	24
			B≥ 6	1.00 - 2.00	29.99	--	20	29
Substation-07	BH-03 (FGL = 920.000M)	0.00 - 3.25	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.50	1<B ≤3	1.00 - 2.00	77.12	--	30	30
			3 <B ≤6	1.00 - 2.00	82.12	--	25	30
			B≥ 6	1.00 - 2.00	85.90	--	25	30
		5.50	1<B ≤3	1.00 - 2.00	94.37	--	30	30
			3 <B ≤6	1.00 - 2.00	96.83	--	30	30
			B≥ 6	1.00 - 2.00	99.98	--	30	30
Substation-01	BH-04 (FGL = 928.000M)	0.00 - 4.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		5.00	1<B ≤3	1.00 - 2.00	40.43	--	30	30
			3 <B ≤6	1.00 - 2.00	36.41	--	24	30
			B≥ 6	1.00 - 2.00	35.44	--	24	30
		6.00	1 <B ≤6	1.00 - 2.00	37.92	--	30	30
			B≥ 6	1.00 - 2.00	36.74	--	30	30
Bauxite Grinding	BH-05 (FGL = 928.000M)	0.00 - 2.20	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1 <B ≤6	1.00 - 2.00	79.14	--	30	30
			B≥ 6	1.00 - 2.00	79.10	--	30	30
		5.00 - 7.00	1 <B ≤6	1.00 - 2.00	141.01	30	--	--
			B≥ 6	1.00 - 2.00	122.82	30	--	--
	BH-07 (FGL = 928.000M)	1.50 - 3.00	1 <B ≤6	1.00 - 2.00	33.00	30	--	--
			B≥ 6	1.00 - 2.00	63.68	30	--	--
		4.00 - 5.00	1 <B ≤6	1.00 - 2.00	236.10	100	--	--
			B≥ 6	1.00 - 2.00	236.10	100	--	--
	BH-10 (FGL = 930.000M)	1.00 - 3.00	1 <B ≤6	1.00 - 2.00	258.05	100	--	--
			B≥ 6	1.00 - 2.00	258.05	100	--	--
Pipe Rack	BH-06 (FGL = EGL)	1.50 - 3.00	1 <B ≤6	1.00 - 2.00	56.95	30	--	--
			B≥ 6	1.00 - 2.00	63.68	30	--	--

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Pipe Rack	BH-15 (FGL = EGL)	1.00	1<B ≤3	1.00 - 2.00	29.01	–	22	28
			3 <B ≤6	1.00 - 2.00	28.28	–	13	20
			B≥ 6	1.00 - 2.00	28.10	–	18	28
		2.00	1<B ≤3	1.00 - 2.00	30.85	–	25	30
			3 <B ≤6	1.00 - 2.00	29.41	–	14	22
			B≥ 6	1.00 - 2.00	29.04	–	19	28
		3.00	1<B ≤3	1.00 - 2.00	32.70	–	27	30
			3 <B ≤6	1.00 - 2.00	30.53	–	15	24
			B≥ 6	1.00 - 2.00	29.99	–	20	29
Evaporation	BH-16 (FGL = 930.000M)	1.00 - 5.00	1 <B ≤6	1.00 - 2.00	49.24	30	–	–
			B≥ 6	1.00 - 2.00	56.07	30	–	–
		6.50	1 <B ≤6	1.00 - 2.00	98.36	50	–	–
			B≥ 6	1.00 - 2.00	98.36	50	–	–
		8.00	1 <B ≤6	1.00 - 2.00	258.05	100	–	–
			B≥ 6	1.00 - 2.00	258.05	100	–	–

Settling, Washing	BH-23 (FGL = 933.00)	3.50	1<B≤3	1.0	30.71	–	30	30
				1.5	28.93	–	28	28
				2.0	28.04	–	26	28
			3 <B ≤6	1.0	28.40	–	20	28
				1.5	26.75	–	16	25
				2.0	25.93	–	15	25
			B≥ 6	1.0	27.83	–	16	26
				1.5	26.21	–	14	22
				2.0	25.40	–	13	20
		4.50	1<B≤3	1.0	32.43	–	30	30
				1.5	30.53	–	30	30
				2.0	29.59	–	28	28
			3 <B ≤6	1.0	29.46	–	23	29
				1.5	27.74	–	20	27
				2.0	26.87	–	18	26
			B≥ 6	1.0	28.72	–	19	28
				1.5	27.04	–	16	26
				2.0	26.19	–	15	24
		5.50	1<B≤3	1.0	34.14	–	30	30
				1.5	32.14	–	30	30
				2.0	31.13	–	30	30
			3 <B ≤6	1.0	30.52	–	28	30
				1.5	28.72	–	25	28
				2.0	27.81	–	24	27
			B≥ 6	1.0	29.62	–	24	28
				1.5	27.86	–	20	27
				2.0	26.98	–	18	26
		6.50	1<B≤3	1.0	53.56	–	30	30
				1.5	50.45	–	30	30
				2.0	48.90	–	30	30
			3 <B ≤6	1.0	47.14	–	30	30
				1.5	44.39	–	25	30
				2.0	43.01	–	23	30
			B≥ 6	1.0	45.53	–	26	30
				1.5	42.87	–	21	30
				2.0	41.54	–	19	30

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Settling, Washing	BH-24 (FGL = 933.00)	1.50	1<B≤3	1.0	27.27	--	27	27
				1.5	25.72	--	25	25
				2.0	24.95	--	22	24
			3 <B ≤6	1.0	26.28	--	22	26
				1.5	24.79	--	18	24
				2.0	24.05	--	16	22
			B≥ 6	1.0	26.03	--	18	26
				1.5	24.56	--	15	22
				2.0	23.82	--	13	20
		2.50	1<B≤3	1.0	28.99	--	28	28
				1.5	27.33	--	26	26
				2.0	26.50	--	24	24
			3 <B ≤6	1.0	27.34	--	25	27
				1.5	25.77	--	21	25
				2.0	24.99	--	19	24
			B≥ 6	1.0	26.93	--	20	26
				1.5	25.38	--	18	24
				2.0	24.61	--	16	22
		3.50	1<B≤3	1.0	30.71	--	30	30
				1.5	28.93	--	28	28
				2.0	28.04	--	26	28
			3 <B ≤6	1.0	28.40	--	26	28
				1.5	26.75	--	23	26
				2.0	25.93	--	21	25
			B≥ 6	1.0	27.83	--	23	27
				1.5	26.21	--	19	25
				2.0	25.40	--	18	23
		4.50	1<B≤3	1.0	48.47	--	30	30
				1.5	45.69	--	30	30
				2.0	44.30	--	30	30
			3 <B ≤6	1.0	44.03	--	30	30
				1.5	41.49	--	26	30
				2.0	40.23	--	24	30
			B≥ 6	1.0	42.92	--	28	30
				1.5	40.44	--	22	30
				2.0	39.21	--	20	30
Settling, Washing	BH-25 (FGL = 933.00)	1.00	1<B≤3	1.0	27.74	--	27	27
				1.5	25.73	--	25	25
				2.0	26.74	--	25	25
			3 <B ≤6	1.0	37.60	--	30	30
				1.5	34.76	--	30	30
				2.0	36.62	--	30	30
			B≥ 6	1.0	42.59	--	30	30
				1.5	39.34	--	30	30
				2.0	41.62	--	30	30
		2.00	1<B≤3	1.0	47.87	--	30	30
				1.5	44.62	--	30	30
				2.0	45.48	--	30	30
			3 <B ≤6	1.0	58.42	--	30	30
				1.5	54.25	--	30	30
				2.0	56.14	--	30	30
			B≥ 6	1.0	64.01	--	30	30
				1.5	59.37	--	30	30
				2.0	61.76	--	30	30
		3.00	1<B≤3	1.0	65.33	--	30	30
				1.5	61.05	--	30	30
				2.0	61.55	--	30	30
			3 <B ≤6	1.0	74.28	--	30	30
				1.5	69.18	--	30	30
				2.0	70.74	--	30	30
			B≥ 6	1.0	79.48	--	30	30
				1.5	73.92	--	30	30
				2.0	76.00	--	30	30

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Settling, Washing	BH-26 (FGL = 933.00)	2.00	1<B≤3	1.0	28.13	--	28	28
				1.5	26.53	--	26	26
				2.0	25.72	--	24	25
			3 <B ≤6	1.0	26.81	--	24	26
				1.5	25.28	--	20	25
				2.0	24.52	--	18	24
			B≥ 6	1.0	26.48	--	20	26
				1.5	24.97	--	18	24
				2.0	24.22	--	16	22
		3.00	1<B≤3	1.0	29.85	--	28	29
				1.5	28.13	--	26	28
				2.0	27.27	--	24	27
			3 <B ≤6	1.0	27.87	--	26	27
				1.5	26.26	--	22	26
				2.0	25.46	--	20	25
			B≥ 6	1.0	27.38	--	24	27
				1.5	25.80	--	20	25
				2.0	25.01	--	18	24
		4.00	1<B≤3	1.0	31.57	--	30	30
				1.5	29.73	--	29	29
				2.0	28.82	--	28	28
			3 <B ≤6	1.0	28.93	--	28	28
				1.5	27.24	--	25	27
				2.0	26.40	--	23	26
			B≥ 6	1.0	28.27	--	26	28
				1.5	26.62	--	23	26
				2.0	25.80	--	21	25
		5.00	1<B≤3	1.0	91.73	--	30	30
				1.5	85.98	--	30	30
				2.0	85.59	--	30	30
			3 <B ≤6	1.0	94.94	--	30	30
				1.5	88.73	--	30	30
				2.0	89.38	--	30	30
			B≥ 6	1.0	98.28	--	30	30
				1.5	91.74	--	30	30
				2.0	92.86	--	30	30
Settling, Washing	BH-27 (FGL = 933.00)	6.50	1<B≤3	1.0	38.81	--	30	30
				1.5	33.74	--	30	30
				2.0	32.68	--	30	30
			3 <B ≤6	1.0	34.17	--	30	30
				1.5	29.70	--	28	29
				2.0	28.76	--	26	28
			B≥ 6	1.0	33.02	--	28	30
				1.5	28.69	--	25	28
				2.0	27.77	--	23	27
		7.50	1<B≤3	1.0	40.67	--	30	30
				1.5	35.34	--	30	30
				2.0	34.22	--	30	30
			3 <B ≤6	1.0	35.32	--	30	30
				1.5	30.68	--	30	30
				2.0	29.70	--	29	29
			B≥ 6	1.0	33.98	--	30	30
				1.5	29.51	--	29	29
				2.0	28.57	--	28	28
		9.00	1<B≤3	1.0	177.86	--	30	30
				1.5	167.14	--	30	30
				2.0	164.73	--	30	30
			3 <B ≤6	1.0	165.57	--	30	30
				1.5	155.26	--	30	30
				2.0	154.31	--	30	30
			B≥ 6	1.0	165.03	--	30	30
				1.5	154.61	--	30	30
				2.0	154.24	--	30	30

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Flocculation	BH-29 (FGL = 933.00)	7.00	1<B≤3	1.0	43.66	--	30	30
				1.5	37.96	--	30	30
				2.0	36.77	--	30	30
			3 <B ≤6	1.0	38.17	--	22	30
				1.5	33.17	--	18	28
				2.0	32.12	--	16	25
			B≥ 6	1.0	36.80	--	17	27
				1.5	31.98	--	14	22
				2.0	30.96	--	13	20
		8.00	1<B≤3	1.0	45.70	--	30	30
				1.5	39.72	--	30	30
				2.0	38.47	--	30	30
			3 <B ≤6	1.0	39.42	--	22	30
				1.5	34.25	--	18	28
				2.0	33.16	--	16	25
			B≥ 6	1.0	37.85	--	22	30
				1.5	32.88	--	18	28
				2.0	31.83	--	16	25
HCSD Pumps	BH-33 (FGL = 935.150M)	1.00 - 3.00	1<B ≤6	1.00 - 2.00	280.00	100	--	--
			B≥ 6	1.00 - 2.00	280.00	100	--	--
Pipe Rack	BH-31 (FGL = EGL)	1.00	1<B ≤3	1.00 - 2.00	29.01	--	22	28
			3 <B ≤6	1.00 - 2.00	28.28	--	13	20
			B≥ 6	1.00 - 2.00	28.10	--	18	28
		2.00	1<B ≤3	1.00 - 2.00	30.85	--	25	30
			3 <B ≤6	1.00 - 2.00	29.41	--	14	22
			B≥ 6	1.00 - 2.00	29.04	--	19	28
		3.00	1<B ≤3	1.00 - 2.00	32.70	--	27	30
			3 <B ≤6	1.00 - 2.00	30.53	--	15	24
			B≥ 6	1.00 - 2.00	29.99	--	20	29
Substation-02	BH-32 (FGL = 934.000M))	0.00 - 9.50	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
Assembly Area	BH-35 (FGL = 935.000M)	1.00 - 3.00	1<B ≤6	1.00 - 2.00	258.05	100	--	--
			B≥ 6	1.00 - 2.00	258.05	100	--	--
Canteen	BH-36 (FGL = 935.000M)	1.00 - 3.00	1<B ≤6	1.00 - 2.00	258.05	100	--	--
			B≥ 6	1.00 - 2.00	258.05	100	--	--
Hydrate Filtration	BH-38 (FGL = 935.000M)	1.00	1 <B ≤6	1.00 - 2.00	98.36	50	--	--
			B≥ 6	1.00 - 2.00	98.36	50	--	--
		2.00 - 3.00	1 <B ≤6	1.00 - 2.00	280.00	100	--	--
			B≥ 6	1.00 - 2.00	280.00	100	--	--
Cooling Towers & Cooling Water Distribution	BH-39 (FGL = 935.000M)	1.00 - 3.00	1 <B ≤6	1.00 - 2.00	98.36	50	--	--
			B≥ 6	1.00 - 2.00	98.36	50	--	--
		4.00 - 5.00	1 <B ≤6	1.00 - 2.00	258.05	100	--	--
			B≥ 6	1.00 - 2.00	258.05	100	--	--
Pipe Rack	BH-41 & 42 (FGL = EGL)	1.00 - 3.00	1 <B ≤6	1.00 - 2.00	98.36	50	--	--
			B≥ 6	1.00 - 2.00	98.36	50	--	--
Substation-04	BH-43 (FGL = 935.000M))	0.00 - 15.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					

Bauxite Handling Conveyor	BH-126 (FGL = EGL)	1.50	1<B≤3	1.0	27.27	--	27	27
				1.5	25.72	--	25	25
				2.0	24.95	--	22	24
			3 <B ≤6	1.0	26.28	--	22	26
				1.5	24.79	--	18	24
				2.0	24.05	--	16	22
			B≥ 6	1.0	26.03	--	18	26
				1.5	24.56	--	15	22
				2.0	23.82	--	13	20
		2.50	1<B≤3	1.0	28.99	--	28	28
				1.5	27.33	--	26	26
				2.0	26.50	--	24	24
			3 <B ≤6	1.0	27.34	--	25	27
				1.5	25.77	--	21	25
				2.0	24.99	--	19	24
			B≥ 6	1.0	26.93	--	20	26
				1.5	25.38	--	18	24
				2.0	24.61	--	16	22
		3.50	1<B≤3	1.0	30.71	--	30	30
				1.5	28.93	--	28	28
				2.0	28.04	--	26	28
			3 <B ≤6	1.0	28.40	--	26	28
				1.5	26.75	--	23	26
				2.0	25.93	--	21	25
			B≥ 6	1.0	27.83	--	23	27
				1.5	26.21	--	19	25
				2.0	25.40	--	18	23
		4.50	1<B≤3	1.0	48.47	--	30	30
				1.5	45.69	--	30	30
				2.0	44.30	--	30	30
			3 <B ≤6	1.0	44.03	--	30	30
				1.5	41.49	--	26	30
				2.0	40.23	--	24	30
			B≥ 6	1.0	42.92	--	28	30
				1.5	40.44	--	22	30
				2.0	39.21	--	20	30

b) Depth ground water table : Varies from 0.4 to 4.3 m below existing ground level.

However, for design of all foundations, underground tanks, pits , basins etc. water level shall be assumed upto Finished Ground level (FGL)

c) Type of foundation : Open foundations / / Raft foundation / / Pile foundations

d) Bulk unit weight of Soil, γb : ...19....... KN/cu.m

Saturated unit weight of Soil, γsat : ....20...... KN/cu.m

Submerged unit weight of Soil, γsub : (γsat-10) KN/cu.m

e) Type of Pile : Bored cast in citu -End Bearing on Rock

Pile capacities:

Refer tables below for recommended pile capacities

Area	Borelog	FGL EL+ (m)	Pile dia (D) (mm)	Socket depth	Vertical Pile capacity (T)		Lateral Pile capacity (T)	
					Compression	Uplift	Free head	Fixed head
Precipitataion	BH-46	930.000	450	1D	60	12	1.4	3.7
				2D	73	25		
			600	1D	107	22	2.2	5.8
				2D	130	45		
			700	1D	146	30	2.8	7.5
				2D	177	61		
	BH-48	927.150	450	1D	60	12	2.4	6.4
				2D	73	25		
			600	1D	107	22	3.8	10
				2D	130	45		
			700	1D	146	30	4.9	13
				2D	177	61		
	BH-52	922.000	450	1D	52	12	2.4	6.4
				2D	65	25		
			600	1D	93	22	3.8	10
				2D	115	45		
			700	1D	126	30	4.9	13
				2D	157	61		
Product hydration filteration stage 1	BH-49	910.000	450	1D	60	12	6.5	14.7
				2D	73	25		
			600	1D	107	22	8.7	19.6
				2D	130	45		
			700	1D	146	30	10.2	22.8
				2D	177	61		
Condensate tank farm	BH-14	933.500	450	1D	52	12	1.4	3.7
				2D	65	25		
			600	1D	93	22	2.2	5.8
				2D	115	45		
			700	1D	126	30	2.8	7.5
				2D	157	61		
Evaporation/ SFL tank farm (piles socketed in weathered rock)	BH-17	930.000	450	1D	52	12	6.5	14.7
				2D	65	25		
			600	1D	93	22	8.7	19.6
				2D	115	45		
			700	1D	126	30	10.2	22.8
				2D	157	61		
Evaporation/ SFL tank farm Alt-I (piles socketed in completely weathered rock with SPT N>50)	BH-18	930.000	450	2D	133	30	6.5	14.7
				3D	152	45		
			600	2D	237	54	8.7	19.6
				3D	271	81		
			700	2D	323	73	10.2	22.8
				3D	369	100		
Evaporation/ SFL tank farm Alt-II (piles socketed in weathered rock)	BH-18	930.000	450	1D	52	12	6.5	14.7
				2D	65	25		
			600	1D	93	22	8.7	19.6
				2D	115	45		
			700	1D	126	30	10.2	22.8
				2D	157	61		

Foundation Location	Embedment Inside Weathered rock (m)	Length of pile below cut-off (m)	Pile Diameter (mm)	Recommended Pile Capacity (T)		Lateral Pile Capacity (T)			
				Vertical	Uplift	Free Head Cond.		Fixed Head Cond.	
						5mm	10mm	5mm	10mm
BH-02 (FGL = 920.000M)	1.50	10.50	600	150	130	6.5	13	14.5	29.5
	1.50	10.50	750	250	200	8.0	16.5	18.5	37
	2.00	11.00	1000	500	375	11.0	22	24.5	49
BH-03 (FGL = 920.000M)	1.50	9.25	600	150	130	2.5	5.5	9	18
	1.50	9.25	750	250	200	4.5	9	13.5	27.5
	2.00	9.75	1000	500	375	7.5	15	23	46

BH-23, 24, 26 (FGL = 933.000M)	1.50	15.00	600	150	130	5.5	11	12.5	25	4.32
	1.50	15.00	750	250	200	7.0	14	16.0	32	5.40
	2.00	15.50	1000	500	375	9.5	19	21.5	43	7.20
BH-25 (FGL = 933.000M)	1.50	4.25	600	150	130	6.5	13	17.5	35	3.89
	1.50	4.25	750	250	200	9.5	19	25	50	4.66
	2.00	4.75	1000	500	375	6	12	35	51	--
BH-27 & 29 (FGL = 933.000M)	1.50	21.25	600	150	130	1.0	2.5	4.0	8.0	3.72
	1.50	21.25	750	250	200	2.0	4.0	6.5	13.0	4.74
	2.00	21.75	1000	500	375	3.5	7.5	10.5	21.0	6.49
BH-32 (FGL = 934.000M)	1.50	20.50	600	150	130	0.25	0.50	1.00	2.00	3.19
	1.50	20.50	750	250	200	0.50	1.00	1.50	3.50	4.04
	2.00	21.00	1000	500	375	1.15	2.30	4.00	8.00	5.58
BH-43 (FGL = 935.000M)	1.50	15.00	600	150	130	0.08	0.16	0.30	0.60	--
	1.50	15.00	750	250	200	0.15	0.30	0.65	1.30	--
	2.00	15.50	1000	500	375	0.45	0.90	1.65	3.30	--

Foundation Location	Bottom depth of pile below FGL (M)	Pile Dia. (mm)	Recommended Pile Capacity	
			Vertical (T)	Uplift (T)
BH-87 to 91 (FGL = 904.000M)	31	450	55	42
		500	65	48
		750	105	74
BH-82, 85 & 86 (FGL = 904.000M)	30	450	55	25
		500	70	28
		750	190	50
BH-81 .(FGL = 904.000M)	22	450	55	25
		500	70	28
		750	190	50
BH-MND03 (FGL = EGL)	30	450	70	38
		500	90	45
		750	210	74

Minimum c/c distance between two piles,s :

(Clause 6.6 - IS 2911 Part 1 /Sec 1 to 4 : 2010)

s = 2.0 * dp for End Bearing on Rock

s = 2.5 * dp for End Bearing on Hard Stratum

s = 3.0 * dp for Friction pile

Allowable increase in SBC / Pile capacities in event of

- Wind : 25%
- Earthquake : As per Table 1 of IS1893 (Part 4):2015

For Facilities at Vishakhapatnam Port:

Subsoil data is based on the Soil investigation report (Port area) by Foundation conultants M/s C. E. Testing Company Pvt. Limited,Dt. July-2018

a) Net safe bearing capacity of soil : Due to presence of very soft to soft silty clay layer upto about 23.00m or more, shallow foundations are not recommended.

b) Depth ground water table : Varies from 0.5 to 1.3 m below existing ground level.

However, for design of all foundations, underground tanks, pits , basins etc. water level shall be assumed upto Finished Ground level (FGL)

c) Type of foundation : Pile foundations

d) Bulk unit weight of Soil, γb : ...19....... KN/cu.m

Saturated unit weight of Soil, γsat : ....20...... KN/cu.m

Submerged unit weight of Soil, γsub : (γsat-10) KN/cu.m

e) Type of Pile : Bored cast in citu- End Bearing on Rock / Hard Stratum

Pile capacities as per soil investigation report Summary & Recommendations :

Borelog	Pile dia (mm)	Recommended Pile capacity		
		Compression (T)	Uplift (T)	Lateral (T)
BH-01&02	450	40	26	3.00
	500	50	30	3.50
	750	110	48	5.50
BH-04&05 ABH-06&07	450	40	30	1.10
	500	45	34	1.35
	750	90	55	2.50

Minimum c/c distance between two piles,s :

(Clause 6.6 - IS 2911 Part 1 /Sec 1 to 4 : 2010)

s = 2.0 * dp for End Bearing on Rock

s = 2.5 * dp for End Bearing on Hard Stratum

s = 3.0 * dp for Friction pile

Allowable increase in SBC / Pile capacities in event of

- Wind : 25%
- Earthquake : As per Table 1 of IS1893 (Part 4):2015

f) **Factor of safety against**

Sliding – (Refer Cl.17.1.1 of IS1904)

The factor of safety against sliding of structures which resist lateral forces (such as retaining walls) shall be not less than 1.5 when dead load, live load and earth pressures are considered together with wind load or seismic forces. When dead load, live load and earth pressure only are considered, the factor of safety shall be not less than 1.75.

Overturning – (Refer Cl.17.2 of IS1904)

The factor of safety for shallow foundation against overturning shall be not less than 1.5 when dead load, live load and earth pressures are considered together with wind load or seismic forces. When dead load, live load and earth pressures only are considered, the factor of safety shall be not less than 2.

Uplift / buoyancy –Factor of safety against uplift / buoyancy shall be 1.2.

g) The following friction coefficient shall be considered in calculating the sliding friction forces:

In absence of data given in Geotechnical investigation report, Friction coefficient between soil and concrete shall be limited to 0.5

h) Modulus of Subgrade reaction (Ks) shall be considered as follows:

In absence of data given in Geotechnical investigation report, following values can be adopted

Sr.no	Soil	Ks in KN/m3
1	Loose sand	4800 - 16000
2	Medium dense sand	9600 - 80000
3	Dense sand	64000 - 128000
4	Clayey medium dense sand	32000 - 80000
5	Silty medium dense sand	24000 - 48000
6	Clayey soil	
	(i) qa ≤ 200 KN/Sq.m (kPa)	12000 - 24000
	(ii) 200 < qa ≤ 400 KN/Sq.m (kPa)	24000 - 48000
	(iii) qa > 800 KN/Sq.m (kPa)	> 48000

Where qa = Allowable bearing Capacity

i) Coefficients for Earth pressures

Active earth pressure coefficient Ka = (1 – sin(Φ)) / (1 + sin(Φ))

Passive earth pressure coefficient Kp = (1 + sin(Φ)) / (1 - sin(Φ))

Earth pressure at rest = K_0 = 1 − Sin Φ

Where Φ is Angle of internal friction

B.1.4.4 DESIGN CRITERIA FOR STORM WATER DRAINAGE SYSTEM

Maximum Design discharge shall be calculated considering

a) Maximum Design hourly rainfall : 80 mm /hr. at Damanjodi

100 mm /hr. at Vizag Port

RUN OFF COEFFICIENT

- For building roof : 1.0
- For paved areas : 1.0
- For roads and drains : 1.0
- For gravelled areas : 0.8
- For undeveloped areas / Lightly cultivated areas : 0.3
- For exposed areas covered with equipment (Tank roofs etc.) : 1.0

B.1.4.5 DESIGN CRITERIA FOR LIQUID RETAINING STRUCTURES

(IS:3370 (Part 1 & 2) – 2009 & IS:456 -2000)

- Check for buoyancy effect when empty tank is totally submerged in saturated soil upto ground level. Factor of safety against uplift / buoyancy shall be 1.2. (CL.7.2 b of IS3370 (Part1):2009)
- All liquid retaining/storage/conveying structures shall be designed assuming liquid up to full height of wall irrespective of provision of any over flow arrangement.
- The design shall be Limit state design as per Cl.4.4 of IS3370 (Part2):2009
- Calculation of Crackwidth due to Temperaturenand moisture shall be done as per Annex A of IS3370 (Part 2):2009
- Calculation of Crackwidth in mature concrete shall be done as per Annex B of IS3370 (Part2):2009
- For particularly aggressive environment, such as the ‘severe’ category, the assessed surface width of cracks should not in general, exceed 0.1 mm. (CL.35.3.2 of IS456:2000)

B.1.4.5 DESIGN CRITERIA FOR TEMPERATURE

Temperature analysis is not required to be carried out.

B.2 Regulatory requirements

The work covered in this specification shall comply with all relevant planning and building permissions, governmental and local laws, regulations and standards applicable for the relevant project.

B.2.1 Important Applicable governmental requirements (not limited to)

Not applicable

B.2.2 Conflict between regulatory requirements and specification

Stringent of both

B.2.3 Subjects not covered by regulatory requirements (**Specification by Licenser – RTAIL, DOCUMENT # Z02-000-1-DC-003) –**

Stringent of both.

B.3 Applicable codes and standards

The following codes (including applicable addenda) and standards shall constitute the minimum requirements for this specification. The latest edition of codes, standards, etc., shall be used, valid as per date, when the contract between CLIENT and tkIS is concluded.

B.3.1 International codes and standards

Not applicable

B.3.1.1 Indian codes and standards

The list of applicable codes includes but is not limited to the following:

List of applicable Indian Codes / Eurocodes

		RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
1. BRICK BLOCK, MORTAR			
IS-4860 (1968)	- Acid Resistant Bricks	RA2016	-
IS-1077 (1992)	- Common burnt clay building bricks.	RA2011	1
IS-2185	- Concrete masonry units	-	
Part-1 (2005)		RA2010	-
Part-2 (1983)		RA2010	-
Part-3 (1984)		RA2010	1
IS-4457 (2007)	- Ceramic unglazed vitreous acid resisting tiles.	RA 2012	-
IS-4832	- Chemical resistant mortar		
Part-1(1969)		RA2016	1
Part-2 (1969)		RA2016	1
Part-3 (1968)		RA2016	1
IS-4443 (1980)	- Resin type chemical Resistant mortar.	RA2016	1
IS-9510 (1980)	- Bitumen Mastic - A.R. Grade	RA2016	
IS-1580 (1991)	- Bituminous Compounds	RA2010	-
IS-4995 Part-II (1974)	- Chemical resistant mortar	RA2008	1
IS-12894 (2002)	- Pulverized Fuel Ash-lime Bricks	RA2002	
2. CEMENT			
IS-269 (2015)	- Ordinary Portland Cement (OPC)		
IS-455 (2015)	- Portland Slag Cement(BFS)		
IS-1489	- Specification for Portland Pozzolana Cement (PPC) Part I : 2015 Part II : 2015		
IS-8112 (2013)	- Ordinary Portland Cement,43 Grade.		
IS-12269 (2013)	- Specification for OPC 53 Grade		
IS-12330 (1988)	- Sulphate Resisting Portland	RA2009	1,2,3,4,5,6
IS-3812 (2013)	- Pulverized Fuel Ash – For use as Pozzolana in Cement, Cement mortar and Concrete	RA2013	

		RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
3. CONCRETE			
IS-456 (2000)	**- Code of Practice for Plain & Reinforced Concrete.**	RA2016	1,2,3,4
IS-516 (1959)	- Method of test for strength Of concrete.	RA2008	1,2
IS-3370	**- Design of Liquid Retaining Structures.**		
Part-I (2009)			
Part-II (2009)			
Part-III (1967)		RA2008	1
Part-IV (1967)		RA2008	1,2
IS-4991 (1968)	- Blast proof design of structures.	RA2008	-
4 STRUCTURAL STEEL			
IS-800 (2007)	**- General construction in steel Code of practice**		1
IS-806 (1968)	- Code of Practice of Steel tubes in general construction	RA2013	1
IS-808(1989)	**- Dimensions for Hot Rolled Steel beam, column, channel And angle sections.**	RA2009	1,2
IS-816 (1969)	- Metal arc welding for general conditions in mild steel.	RA2008	1 -
IS-813(1986)	- Scheme of symbols for Welding.	RA2008	-
IS-9595 (1996)	- Metal arc welding of carbon & carbon manganese steel.	RA 2007	
IS-2062 (2011)	**- Steel for general structural purpose.**	-	1
IS-3502 (2009)	- Steel chequered plates	RA 2015	
IS-1363 Part 1,2 (2002) Part 3 (2002)	- Hexagon head bolts, screws, nuts of product grade C (Size range M5 to M64)	- RA 2007 RA 2007	

	RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
IS-1364 - Hexagon head bolts, screws, nuts of producte grades A & B Part 1 to 3 (2002) Part 4 (2003) Part 5 (2002)	RA 2007 RA2008 RA 2007	
IS-1367 (2002) - Technical Supply Conditions for Threaded Steel Fasteners (Part 1 & Part 2)	-	
IS-2062 (2011) - Steel for general structural purpose.	-	1
IS-3502 (2009) - Steel chequered plates	RA 2015	
IS-1161 (2014) - Steel tubes for structural purpose		
IS-801 (1975) - Code of Practice for use of Cold formed light gauge steel structural members in general building construction.	RA2010	1
IS-2629 (1985) - Recommended practice for hot dip galvanizing on iron & steel.	RA2010	1,2,3
IS-2633(1986) - Methods of testing uniformity of coating of zinc coated articles.	RA2016	-
IS-3640(1982) - Hexagon Fit Bolts (PGD 31: Bolts, nuts and fasteners accessories)	RA2011	
BS EN 10025 - Hot Rolled Products of Structural Steels	2004	
IS-6745(1972) - Method of determination of mass of zinc coating on zinc Coated iron & steel articles.	RA2016	1,2,3,4,5
5. DOORS & WINDOWS		
IS-1948 (1961) - Aluminium doors, windows and ventilators.	RA2011	1
IS-1949 (1961) - Aluminium windows for Industrial buildings.	RA2006	1
IS-1038 (1983) - Steel doors, windows and Ventilators.	RA2011	1,2,3

		RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
IS-1361 (1978)	- Steel windows for industrial Buildings	RA2011	1,2
IS-4043 (1969)	- Symbolic designation of direction of closing of doors etc.	RA2011	-
IS-4021 (1995)	- Timber doors, windows and ventilator frames.	RA2016	3
IS-1003	- Timber panelled door & in window shutters.		
Part-1 (2003)		RA2008	2
Part-2 (1994)		RA2006	3
IS-2191	- Wooden flush door shutters		
Part-1 & 2 (1983)		RA2011	1
IS-1081 (1960)	- Fixing & glazing of metal (steel & aluminium) doors, windows & ventilators.	RA2011	1
6. FOUNDATION ENGG.			
IS-8009	- Calculation of Settlement of foundation.		
Part-1 (1976)		RA2008	1,2,3
Part-2 (1980)		RA2010	1
IS-2974	**- Design and construction of machine foundations.**		-
Part-1 (1982)		RA2008	1
Part-2 (1980)		RA2008	1
Part-3 (1992)		RA2010	-
Part-4 (1979)		RA2010	1
Part-5 (1987)		RA2008	-
IS-2950 (Part I) (1981)	- Design and construction of Raft Foundation.	RA2008	1
IS-1892 (1979)	- Sub surface investigation for Foundations.	RA2011	-
IS-1904 (1986)	**- Design & construction of foundations in soils: General requirements.**	RA2010	-
IS-11089(1984)	-Design and construction of Ring foundation	RA2011	1

	RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
IS-2911 **- Design and construction of pile foundation.**		
Part-1		
Sec. 1,2,3,4 **Sect.1 (2010)**		
Sect.2 (2010)		
Sect.3 (2010)		
Sec. 4 (2010)		
Part-2 (1980)	RA2010	1
Part-3 (1980)	RA2010	1,2,3,4
Part-4 (2013)		
IS-1080 (1985) - Design and construction of Shallow foundation.	RA2011	-
IS-6403 (1981) - Determination of bearing capacity of shallow foundations.	RA2011	1
7. FUNCTIONAL DESIGN OF BUILDINGS		
IS-2440 (1975) - Code of Practice for daylighting of buildings	RA2008	-
IS-6060 (1971) - Code of Practice for daylighting of factory buildings.	RA2008	-
8. LOADING STANDARDS		
IS-875 (1987) **- Loading Standards**		
Part 1 :1987	RA2008	1
Part 2 :1987	RA2008	1
Part 3 :2015		1
Part 4 :1987	RA2008	-
Part 5 :1987	RA2008	1
IS-1893 **- Criteria for earthquake resistantdesign of Structures.**	-	-
Part 1 (2016)		-
Part 4 (2015)		
IS-4326 (2013) **- Criteria for earthquake Resistant design & construction of bldgs.**		1
IS-13920 (2016) -Ductile detailing of RC Structures subjected to Seismic forces.		
IS 15498: Guidelines for Improving the Cyclonic Resistance of Low Rise Houses and Other Buildings/Structures	RA2010	

	RE-AFFIRMED IN THE YEAR	APPLICABLE AMENDMENTS
9. REINFORCEMENT		
IS-432 - Mild Steel & medium tensile bars & wires for concrete		
Part 1 (1982)	RA2015	2
Part 2 (1982)	RA2009	2
IS-1786 (2008) - High strength deformed steel bars & wires for concrete reinforcement.		1,2,3
	-	-
IS-2502 (1963) - Bending and fixing bars for Concrete reinforcement.	RA2008	
		-
IS-5525 (1969) - Recommendation for detailing.	RA2008	
10 ANCHOR BOLTS	RA2004	-
IS-5624 (1993) - Foundation Bolts	RA2008	
11. WATER PROOFING AND DAMP PROOFING		-
IS-4365 (1967) - Application of bitumen mastic	RA2010	
IS-7198 (1974) - Damp proofing using bitumen felts.	RA2010	-
		-
IS-1346 (1991) - Waterproofing of roof using bitumen felts.	RA2010	
		-
IS-2645 (2003) - Integral cement water proofing Compounds.	RA2007	
	-	-
12. DESIGN AIDS		
SP-7 (2016) - National Building Code of India.		
SP-34 (1987) - Handbook on concrete reinforcement detailing.		1
SP-36 – Compendium of Indian standards on Soil Engg. Part 1(1987) Part 2 (1988)	-	-
SP-6(5) (1980) -Handbook on cold formed Light gauge steel sections.		1

B.3.1.2 Applicable Software with their version & limitations

1. StaadPro V8i (SELECT Series 6)
2. Autocad 2013 or Lower
3. MS Office 2010 or Lower

B.3.2 Client's regulations and standards

Not applicable

1 Annexure C Report on blast load design

Buildings / structures in this project are not required to be designed for Blast load.

CIVIL AND STRUCTURAL

GUIDELINES

PREPARED BY

RTAIL

A	25/08/2017	ISSUED FOR PACKAGE 2	QUINCIEUC	SANTALUCIAG	ELKADIB
Rev.	Date	Description	Written by	Verified by	Approved by

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TABLE OF CONTENTS

1. SCOPE AND APPLICATION

1.1. APPLICATION

This Guideline sets out the minimum requirements for civil and structural design and construction for a Bayer alumina plant project.

This Guideline also includes minimum requirements for the design of steel tanks for Bayer refinery service.

1.2. EXCLUSIONS

This guideline does not address construction, inspection and testing of structures, except as included in referenced standards.

Issues relating specifically to bins, silos and bunkers for bulk solid materials are excluded.

2. INFORMATION REQUIREMENTS

2.1. SITE ENVIRONMENTAL DATA

A comprehensive report shall be prepared addressing the following environmental factors, prior to the commencement of Detailed Engineering Phase. Where applicable this report shall be presented in terms of design values associated with different return periods.

- Temperature and humidity distributions
- Rainfall characteristics, flood return periods and intensities
- Snowfall characteristics
- Wind speed characteristics
- Earthquake characteristics
- Soil characteristics

2.1.1. Wind

A cautionary note:

The design methods provided in the wind design codes of various authorities are based on widely different concepts, ranging from a basic 3 second gust to the concept of the fastest mile wind speed. Local records may have to be interpreted for application to the approved design guide.

Wind loads shall be derived in accordance with an approved Design Standard or Code of Practice. The basic design event shall have a probability of occurrence which is commensurate with the choice of design method: for example, 5% probability of exceedance in 50 years for Ultimate design wind, and 5% in 1 year for Serviceability design wind. Working stress loads would be intermediate between these values. Design wind pressures shall account for:

- Expected future development or demolition in the vicinity
- Elevation of structure above ground level
- Topography
- Importance of the structure (post disaster functional requirement)
- Shielding by upwind structures.

Members potentially subject to dynamic excitation by wind force shall be designed for the resultant amplified forces.

Design wind pressures shall be derived for strength as well as serviceability factors such as deflection assessment and shut down operational wind speed. Special requirements, such as impact resistance in cyclonic (or hurricane) areas shall be addressed.

The most unfavourable direction of wind force shall be considered on all structures. Pipe racks shall be designed for the unshielded wind load on the four largest pipes at any given level of the rack.

2.1.2. Earthquake

Earthquake loads shall be derived in accordance with the approved Design Standard or Code of Practice. In the absence of an approved local standard, the appropriate sections of ISO 23469 (Bases for design of structures – Seismic actions for designing geotechnical works) or of ANSI/ASCE (American Society of Civil Engineers) 7-93, together with the relevant publications by the SEAOC (Structural Engineers Association of California) is considered an acceptable design standard. The basic design event shall have a probability of occurrence which is commensurate with the choice of design method, for example 10% probability of exceedance in 50 years for Ultimate design load, but a shorter return period for Serviceability loads. Working stress loads shall be intermediate between these values. Earthquake design loads shall account for:

- Location
- Structure importance (post disaster functional requirement)
- Soil profile
- Structure type (seismic response depends on the ductility and flexibility of the structure)

Seismic loads shall be applied in the most unfavourable direction. The design for earthquake loads shall consider the fact that different components are subject to greatly differing accelerations when exposed to earthquake loading.

2.1.3. Soil Properties

A detailed soils report shall be prepared prior to the commencement of any foundation or seismic design. This report shall be prepared by an approved suitably qualified and experienced geotechnical engineer. This report shall address the following parameters where appropriate:

- Geotechnical mapping of the area, showing major rock and soil strata and their classification, location and levels of boreholes and sampling points.
- Borehole logs and soil sampling reports.
- Soil density, internal angle of friction, cohesion, permeability.
- Rankine K factors, active, passive and at rest.
- Safe bearing pressures net of effective overburden pressure at unfactored loads (long and short term).
- Potential for differential settlement.
- Friction factor between concrete and soil.
- Effect of foundation shapes and sizes.
- Dynamic and settlement characteristics (factors such as Poissons Ratio, Young's Modulus and Shear Modulus).
- Reaction or aggression to buried concrete and steel.

- Water table levels, seasonal as well as permanent.
- Compaction and excavation characteristics and recommendations to achieve densities required. Compaction below different types of construction, backfill requirements.
- Pile design information: recommended types, construction methods, bearing and skin friction capacities.
- Seismic characteristics of each sub-area.
- Susceptibility to seismic liquefaction.
- Potential for environmental damage in the event of escape of process fluids.
- Recommendations on use of local materials for backfill and compaction.

2.2. PROCESS REQUIREMENTS

A detailed report shall be prepared defining all operational parameters pertinent to structural design, prior to starting structural design. The report would include but not be limited to, the following points:

- Maximum and minimum contents of tanks and vessels
- Fluid densities under all operating conditions
- Class of risk and weight Equipment, contents and scale loads
- Temperature ranges under all operational conditions
- Special requirements for corrosion resistance
- Special access, clearance and maintenance requirements
- Services requirements (cranage, washdown water, compressed air)
- Wear allowances
- Thermal insulation
- Spillage Loads

2.3. INCIDENTAL LOADS

2.3.1. Thermal Loads

Thermal expansion and contraction as a result of operational or ambient factors can result in restraint forces acting on the structure. These restraint forces are commonly due to the friction between the supporting structure and equipment and piping. The frictional restraint loading shall be assessed for the operational loads on the support, multiplied by an appropriate friction factor. Friction factors to be adopted for design purposes shall be as follows:

Uncorroded steel to steel	0.30
Steel to concrete	0.35
Teflon to Teflon	0.10

2.3.2. Spillage Loads

The design loading shall take account of potential spillage from conveyors and feeders where these are installed. The design shall allow for spillage loads of 5 kPa unless a higher value is required by the approved Design Standard. Walkways and platforms subject to spillage loads shall be designed for the live load or the spillage load, whichever is the greater.

2.3.3. Scale Loads

Surfaces of machinery, structures and vessels exposed to Bayer process fluids are prone to develop major growths of scale precipitated from the process. These deposits can create a major load component, which shall be estimated on the basis of an assumed thickness for all wetted areas, dependant on the specific process situation.

2.3.4. Live Loads

The following minimum loads provided may be adjusted for contributory area effects in accordance with approved Design Standards and Codes of Practice. Specific equipment loads in excess of these loads shall take precedence.

Minor access walkways and stairs used for inspection only	2.5 kPa
Stair cases, frames and treads	5 kPa
Principal walkways and all working platforms	5 kPa

(The last item includes for incidental machinery and equipment loads that are not major loads.)

Principal walkways (> 1.2 metres wide) and platforms subject to specific major equipment loads shall be designed for the specific loads plus 10 kPa in the unoccupied area around the equipment.

Roofs accessible for inspection and repair only, the larger of:

1) 1 kPa
2) 25% of roof self weight

All structural floor members shall be designed for a 10 kN point live load applied at mid span, in addition to uniform loading from attributed area as above.

3. ENGINEERING REQUIREMENTS

3.1. STANDARDS AND CODES OF PRACTICE

The design shall comply in full with the requirements of approved local standards. In the absence of approved local standards the Project Owner shall nominate which standards are to be applied.

The specified Standards and Codes of Practice shall form a coherent, compatible set of design guides. In particular, mixing of Standards and Codes from different sources shall not be permitted. Approved international standards shall include those of Australia, Great Britain, European and United States of America.

Where this standard and or other approved documents require that several criteria be satisfied, then the most stringent of the requirements shall apply.

Some relevant Standards and Codes are listed in Section 11.0.

3.2. DESIGN

3.2.1. Choice of Design Method

There is a worldwide trend away from working stress design in favour of limit state design. Most recent codes of practice are in limit states design. Some have abandoned working stress design completely.

The designer shall determine which method of design is most appropriate for the particular structure being considered, bearing in mind the specific requirements of the approved Design Standard. Many international standards use working stress design and will probably continue to do so, for example, codes for pressure vessels and tanks.

Where the code of practice does not define loads in working stress terms, acceptable working stress loads can generally be determined by dividing the ultimate limit state load component (for example, ultimate wind or ultimate seismic) by 1.5, or by some other factor acceptable to the Design Authority.

3.2.2. Loads

The structural design shall consider the following unfactored loads in the combinations provided in Table 3.4, Design Load Combinations. These are a minimum requirement. Specific considerations may lead to more onerous requirements in the design of the structures. Local Standards and Regulations which require higher design loads, or more conservative load combinations, shall take precedence over these requirements.

Structural design shall consider the potential for higher loading than initially required in order to provide capacity for additional equipment and pipework beyond that presently defined.

3.3. LOADINGS

3.3.1. Structure Selfweight

The selfweight of the structure and permanent dead loads shall be derived using accurate unit weights provided in the approved design standards.

3.3.2. Equipment Weight

The weight of equipment such as, vessels, tanks, pumps, piping, cable ducts, compressors, motors, cranes and monorails shall where possible be derived from vendors' data. A suitable allowance shall be adopted to adjust the weights used in order to allow for the quality of the source information. In particular cranes, monorails and their supporting structures shall be designed for a conservative assessment of the probable safe working load required.

These loads shall be provided in a format that permits the discrete identification of the following sub loads:

Vessel Empty weight	Dead only
Vessel Operating weight	Live component (for example, fluid or dry material contents and scale allowance).
Vessel Upset load	Live component (greater than normal operating live load).
Test loads (for example, hydro-static testing of gas-filled pipes and vessels)	Live Component

Table 3.3: Design Load Components

To allow for future expansion, pipe and cable racks only partially utilised shall be designed for larger loads based on complete occupancy of the structure, at the load intensity of the initial design.

3.3.3. Dynamic

Structures subject to dynamic excitation from compressors, screens, large motors, pumps and other mechanical devices shall be investigated for dynamic response. The structure shall be "tuned" to avoid the risk of resonance causing structural fatigue, discomfort to personnel, or other detrimental effects. Specific dynamic factors shall be sourced from vendor data. Isolation of structures subject to dynamic forces shall be considered during Detailed Engineering.

In general a machine and its foundation are suitably "tuned" when the ratio of "operating frequency" to "resonant frequency of the combined machine and footing" is either less than 0.67 or greater than 1.5. The range less than 0.67 is preferred, due to the lower vibration amplitudes experienced.

The structural design shall consider suitable load combinations. These are designed to ensure satisfactory performance under operational loads, as well as ultimate strength, stability and serviceability conditions. Structures shall be designed for the most onerous combinations of the component loads, combined in all realistic potential combinations.

Specific load factors applied to Limit State ultimate strength and serviceability and stability combinations shall be in accordance with approved Design Standards and Codes of Practise.

Assumptions regarding the contents of each tank or vessel to be combined with design wind for stability considerations shall be conservative. In the absence of specific operating knowledge, stability considerations against wind load shall be satisfied with the tank/vessel in the empty state. Stability calculations for earthquake loads shall be considered for both full and empty states.

The design of tanks and vessels with a free surface shall take account of the load amplification caused by "sloshing" of the fluid under seismic conditions, as per section 10.1 of this Guidelines.

3.3.4. *Vehicle Loads*

The design of slabs on grade and other structural elements shall consider the effects of vehicle loads. Slabs on grade accessible to heavy traffic such as large earthmoving machinery, shall as a minimum be designed for an axle load of 450 kN. Slabs on grade where access is limited from large machines shall be designed for an axle load of 100 kN. Construction loading shall be carefully considered and allowed for in terms of design load as well as in considerations of age (strength) of concrete subjected to these loads.

Bollards, fencing and other access limiting structures shall be installed for operational security, and control of construction access. Impact loads shall be assessed for specific risks and operational criteria. A commonly adopted design load of 25% of vehicle weight is recommended in the absence of other information.

3.3.5. *Soil and Water Pressures*

Soil pressure loads for design shall be derived from Rankine or other accepted theory. The design loads considered shall include compaction, impact and live loads.

Retaining walls shall be designed for all likely combinations of loading, including (if warranted) a seismic event under saturated conditions. Drainage to back face of walls should be considered, to relieve potential hydrostatic pressures.

3.4. DESIGN LOAD COMBINATIONS

Actual load factors for application to Working, Ultimate Strength, Stability and Serviceability loads respectively shall be in accordance with the approved Standards and Codes of Practice, and sound engineering judgement.

Design Standards are usually written for very general load situations only and will not offer combination information for the specific loads listed below. The designer shall assign appropriate load factors. These factors should be determined early in the project and listed in a structural design document.

3.5. ROBUSTNESS AND RIGIDITY

3.5.1. General Design Principles

Structural designs providing alternative load paths are preferred.

Steel sections, concrete reinforcement patterns and so on shall be reasonably rationalised. With standardised connections this contributes to overall economy and robustness.

A limit on the ratio of Effective Length to Radius of Gyration (l/k) of 180 shall be adopted for all members between points of lateral support.

The stiffness provided by the structural design shall be such as to avoid the risk of excitation due to applied dynamic loads.

Floor beams may be restrained against lateral movement, where necessary, by welding to floor plate or by shear connectors into supported concrete flooring.

3.6. DEFLECTION LIMITS

In absence of code or standard, the stiffness of structures and structural elements shall satisfy the following limits when subjected to actual unfactored operational loads and load combinations. The Serviceability wind load shall be applied for deflection assessments. Actual limits shall be derived from the most severe of the following considerations. Specific differential deflection limits are also governed by equipment and nozzle criteria.

Total deflections of beams shall not exceed Span / 250.

Cross-falls and deflections in roofing and flooring shall be designed to minimise the risk of ponding.

3.6.1. Pipe Racks

Sway due to wind shall not exceed the lesser of:

1) (Centre to centre frames) / 200

2) Height / 150

3.6.2. Process Buildings Clad or Unclad (without cranes)

Sway due to wind shall not exceed the lesser of:

1) (Building frame centre-to-centre of columns) / 250

2) Height / 200

Where framing is in contact with masonry or other rigid elements susceptible to movement the allowable deflections above shall be halved.

3.6.3. Buildings Housing Gantry Cranes

Buildings housing gantry cranes shall be designed for the specific deflection criteria required by the approved Design Standard. Satisfactory crane performance dictates the need for substantially greater stiffness than the criteria above.

Monorails and cranes shall satisfy strict vertical deflection criteria. Calculations which include effects of settling and rotation of adjacent spans and supports should demonstrate compliance with imposed criteria. Crane rail alignment shall be maintained under all operating conditions within tolerances specified by the supplier.

4. DOCUMENTATION REQUIREMENTS

4.1. UNITS

All design calculations shall be carried out in a consistent manner in full compliance with the ISO 80000 who defines the SI System of Units.

4.2. DESIGN CALCULATIONS

To achieve uniformity of approach between designers, all calculations shall be founded on a consistent set of design assumptions, loads and combinations as discussed in Sections 2 and 3 above. These criteria shall be set out in a controlled stand-alone document and made accessible to all relevant personnel. This document shall form the basis of all structural and civil calculations to be carried out for the project.

All calculations shall be in English and shall be catalogued and cross referenced in a logical methodical manner in order to facilitate checking and confirmation of compliance with referenced standards. All calculations shall be checked and shall carry the signatures of no less than two qualified people. Revisions after Issue for Construction shall be clearly indicated. Calculations shall be cross referenced to the drawings to which they apply. Calculations shall form part of the Project Archives.

4.3. COMPUTER PROGRAMS FOR DESIGN

Computer programs for design shall be written and validated by appropriately qualified organizations. They shall comply with the requirements of the approved Design Standard and, where possible, be accredited by the Standards Association of the host country.

Computer input files shall be indexed and stored on disk or tape for the duration of the project and shall form part of the Project Archives.

4.4. DRAWINGS

All drawings shall be prepared to an approved format with an approved numbering system. All notes, titles and information included on drawings shall be in English. Drawing sheet sizes shall be to SI standards, with scales for work and letter size to approved standards. The use of approved standard drawings and details is recommended.

Drawings should contain notes directly relevant to the work described in the drawings. There should be a preference for notes on drawings instead of including them in Specifications, which are less frequently read. Where possible, reference should be made to the relevant approved Design Standard rather than reproducing the standard in note form.

5. CONSTRUCTION MATERIALS - STEELWORK AND TANKAGE

It is critical to the final integrity of structural work that the structural design adequately defines the materials to be used, and that these materials are in fact used in the construction stage.

5.1. HOT-ROLLED STEEL

5.1.1. Structural Steel Plate and Sections

Hot-rolled structural steel plate and sections shall be nominated and supplied to a recognised ASTM material specification. Material supplied shall be certified by an accredited testing authority to comply with the minimum engineering and mechanical design values.

5.1.2. Flooring Materials

Floor plate shall possess an angular raised pattern to one surface. The pattern and layout shall facilitate free drainage and cleaning while retaining a non-slip surface. Minimum plate thickness shall be not less than 8 mm.

Mesh floor grating shall be nominated and supplied to a recognised material specification. This will typically have 32 mm x 5 mm load bars at 40 mm centres to span up to 1.2 metres with 10 kPa applied loading or 1.5 metres with 5 kPa applied loading.

5.2. OTHER MATERIALS

5.2.1. Cold Rolled Sections

Cold-rolled steel sections shall be nominated and supplied to a recognised ASTM material specification. Material supplied shall be certified by an accredited testing authority to comply with the minimum engineering and mechanical design values. Approved proprietary systems shall be used strictly in accordance with the vendor's recommendations.

5.2.2. Bolting

Bolting for structural steel, excepting minor items such as handrail, shall be standardised to "High Strength" 20 mm diameter and larger. The minimum strength grade of these bolts shall be in accordance with the approved Design Standard. Preferred specifications are ASTM A325 and ISO 898 Grade C. "Commercial" bolts shall be specified to ASTM A307 or ISO 898 Grade A.

All bolts and nuts shall be hot-dip galvanised. The coating mass shall be in accordance with the approved Design Standard and shall generally be between 300 and 375 grams per square metre. Threads of nuts for galvanised bolts shall be retapped after galvanising. Nuts and bolts shall be lubricated before assembly to prevent seizing. Tapered washers shall be specified where connections are made to tapered flanges.

Design shear capacities for all bolts shall be based on the threads being included in the shear planes to simplify on-site checking and reduce the variety of bolt lengths required.

5.2.3. Cladding

Cladding materials shall be nominated and supplied to a recognised ASTM material specification. Material supplied shall be certified by an accredited testing authority to comply with the minimum engineering and mechanical design values. Approved proprietary systems including fasteners and washers shall be used strictly in accordance with the vendor's recommendations.

Cladding shall be supplied with a coating on both outer sides and edges, which shall be resistant to caustic attack and other corrosion agents. The cladding system including fasteners shall be selected after due consideration of its corrosion potential, both as a stand alone system and in conjunction with attachments to support structures. Aluminium cladding shall not be used under any circumstances, due to its susceptibility to caustic attack.

6. CONSTRUCTION MATERIALS - REINFORCED CONCRETE

6.1. CONCRETE MATERIALS AND MANUFACTURE

The specification of concrete shall recognise the custom of the local industry with respect to testing, sampling and acceptance criteria. For remote sites with no extensive history of concrete manufacture and application, it may be necessary to determine long term properties of local aggregates in contact with cement and strong alkalies, by laboratory investigation. In particular, the possibility of alkali-aggregate reactions shall be investigated.

The testing of concrete components (cement, aggregates, sand, water and additives) and cast specimens shall generally be performed in compliance with ASTM specifications. In particular, concrete compression testing shall be performed in accordance with ASTM C39 and ASTM C918.

Testing shall also be carried out in compliance with ASTM standards to determine the susceptibility of the proposed concrete mix to the full range of Alkali-Aggregate Reactions (AAR). The tests shall include, but not be limited to ASTM C1293, C289 and C295. The mix design shall be modified to minimise the effects of AAR.

The specification of concrete shall recognise the custom of the local industry with respect to testing, sampling and acceptance criteria. In specifying concrete the following factors shall be taken into account:

- Availability
- Durability
- Abrasion resistance of both the aggregates and the concrete
- Strength criteria

Strength distribution about the mean may have to be investigated in order to specify an achievable and reliable characteristic compressive strength for concrete mix design. The mix design shall also take into consideration the following factors:

- Availability and quality of production and delivery facilities
- Qualities of aggregates, cement and water
- Site facilities for pouring, finishing and curing, and ambient temperature range
- Specific performance requirements such as strength and resistance to caustic attack

The use of additives in concrete shall be subject to the approval of the Engineer, who shall determine their adequacy and compliance with reputable international standards. Local additives that do not carry the certification of international testing authorities such as ASTM shall not be approved for inclusion in any concrete to be used. Additives containing Chlorides shall not be used under any circumstances.

6.1.1. Minimum Strength Properties

Concrete 28 day Characteristic Compressive Strengths shall be as listed below unless greater values are required by the approved Design Standard:

Blinding layers	15 MPa
Piles	40 MPa
Footings	25 MPa
Columns	40 MPa
Beams	32 MPa
Floor Slabs, Walls	32 MPa

6.2. ANCILLARY MATERIALS

6.2.1. Reinforcement

Reinforcement for inclusion in reinforced concrete shall be nominated and supplied to a recognised international material specification. Reinforcement generally complies with one of two groupings of world-recognised standards:

1) American Standards, principally:

ASTM A615 Grade 60	(Yield Strength 414 MPa)
ASTM A615 Grade 75	(Yield Strength 485 MPa)

2) European Standards, principally:

DIN 448	(Yield Strength 500 MPa)
BS 4449	(Yield Strength 460 Mpa)

The American steels tend to have lower ductility and lower weldability. The above list is not exhaustive.

Material supplied shall be certified by an accredited testing authority to comply with the minimum engineering and mechanical design values. The designer shall specify the ductility (cold bending and rebending) and weldability properties required of the reinforcement, and ensure that these properties are taken fully into consideration during design, fabrication and erection.

All bar reinforcement other than ligatures and spacers shall be of a deformed surface profile. Reinforcing mesh may have either a smooth or a deformed surface profile. Reinforcement shall possess the mechanical properties required by the approved Design Standard, including cold bending, rebending and weldability requirements.

6.2.2. Embedments

Embedments and cast-ins such as hold down bolts shall be hot dip galvanised to a coating mass of at least 375 grams per square metre

6.2.3. Proprietary Items

Proprietary items shall be from a source that is certified, by an international testing authority such as ASTM, to comply with the minimum engineering and mechanical design values claimed by the supplier. Approved proprietary systems shall be used strictly in accordance with the vendor's recommendations. The issue of compatibility between products shall be specifically addressed.

7. SPECIFIC TECHNICAL REQUIREMENTS - CIVIL

7.1. ROADWAYS

7.1.1. Layouts, Widths

The roadway system including kerbs, sub-base, road base and surface course shall be designed to provide a 15 year service life before major repairs are needed.

Roadways shall be designed in compliance with the approved Design Standard and any additional Statutory requirements. Road widths, vertical clearances and kerb radii shall be proportioned to accommodate the largest and longest vehicles (including their loads) likely to be present at any time during the life of the plant, including construction and refit periods. Turnarounds shall be designed to allow easy manoeuvring of laden trucks. Suitable speed limits shall be imposed and signposted.

The sealing adopted will depend on local custom. The road seal shall be designed to provide 15 year service life before major repairs are needed. Sealing shall be designed to withstand the tearing effect of manoeuvring heavy vehicles.

7.1.2. Design Loadings

As a minimum design criterion, the roadways, including bridges and culverts, shall be designed for loads imposed by a 150 tonne wheeled crane or large earthmoving machinery. The exact configuration of the wheel loads shall be in accordance with a pattern provided in the approved Design Standard.

A suggested loading pattern for a Cat 992C Wheel loader is as follows:

Operating Weight	-	90 tonnes
Wheelbase	-	4.83 m
Width over Tires	-	4.55 m
Weight distribution	-	Equal to both axles

7.1.3. Traffic Control, Guardrails and Kerbs

Traffic control devices shall comply with local statutory requirements.

Drive-over kerbs shall be provided only in locations where occasional access by wheeled vehicles is required. Where more frequent vehicular access is required, consideration shall be given to providing a permanent ramp. Conventional kerbs shall be used elsewhere.

Guardrails shall be provided for permanent structures having less than 900 mm horizontal clearance to the road edge.

7.1.4. Drainage

Drainage for process areas shall be made on bunded slabs in accordance with RT standard drawings, with runoff to process sumps. Outside of these areas, drainage shall be provided by grading design, and installation of surface drains and underground pipework for efficient collection and removal of stormwater.

Bayer refinery storm drains are frequently contaminated with caustic and other substances which make the flow unsuitable for direct release. The Process Engineer shall integrate storm water control with the plant water balance, and specify appropriate routing and treatment processes.

Stormwater drainage installations shall comply with the approved Design Standard and Statutory requirements. As a guide, stormwater drainage shall be designed for a rainfall event of the following average recurrence intervals, unless a more stringent value is required:

- Major access roads, average recurrence interval 100 years.
- Minor access roads, average recurrence interval 10 years.

Stormwater sewers shall be routed under footways or piperacks adjacent to roads to provide easy access and avoid damage from wheel loads. Inclusion of two sewers, one on each side of the roadway, avoids the need for cross-connections. Gullies shall, where possible, be located outside the roadway to avoid traffic loads. Paved footways shall drain towards the kerb wherever possible.

The designer shall design the onsite drainage system to accommodate a 20 year return period flood. Pipe diameters shall be standardised to reduce the variety of sizes. A minimum main diameter of 200 mm is recommended on the grounds of easy maintenance. Pipe gradients shall be established with regard to the typical ground gradients on the site, with an absolute minimum of 1:100.

7.2. CIVIL WORKS

7.2.1. Site Works, Bulk and Detail

Earthworks shall be carried out to suit the founding levels of concrete footings, slabs and sumps etc. Where unsatisfactory or contaminated soil is encountered it shall be removed and replaced with compacted competent backfill, or weak mix concrete. Earthworks shall be maintained to divert surface drainage around all excavations. Direct rainfall shall be promptly removed from excavations, by pumping if necessary.

7.2.2. Compaction and Backfill Requirements

Compaction below various structures shall comply with the approved design document and geotechnical report. The geotechnical report shall provide information regarding densities to be achieved and methods of achieving these densities using available materials.

7.2.3. Pipe Installation

Buried pipes shall be placed on approved bedding materials and backfilled in accordance with the approved design document. Precast concrete and steel pipe shall be laid and bedding materials shall be placed and compacted in accordance with the manufacturers written instructions. All process pipes crossing beneath roadways shall be installed through sleeves or culverts providing for monitoring and replacement.

7.2.4. Gratings and Silt Traps

All gratings and covers shall be rated to carry the appropriate loadings to suit the location, as indicated in the approved design document.

Silt traps shall be provided to prevent the discharge of silt and other suspended trash beyond plant boundaries, and to comply with other statutory requirements. Traps shall be sized to handle the design run-off, and be designed for cleanout by wheeled machinery.

8. SPECIFIC TECHNICAL REQUIREMENTS - CONCRETE

8.1. DESIGN AND SPECIFICATION

8.1.1. Tolerances

Construction tolerances for the fabrication and erection of the structures shall be in accordance with a single compatible source document. In particular the construction tolerances of the concrete work shall be checked for agreement with the fabrication tolerances specified for the structural steel work.

8.1.2. Standardisation

The design shall standardise the levels of baseplates, related pedestals and kerbs within each area. The design shall standardise levels and depths of concrete slabs and beams to simplify reinforcement.

8.1.3. Standard Specifications

Standard specifications should refer wherever possible to the approved Design Standards, instead of repeating information in those documents. Drawings are usually read more thoroughly (and more frequently) than specifications. Do not include information in specifications that should more properly be shown on drawings.

8.2. REINFORCEMENT

8.2.1. Reinforcement Minimum Cover

Cover to reinforcement of cast in situ concrete shall be as listed below unless a greater value is required by the approved Design Standard. Cover shall be measured from the outer surface of the outermost reinforcement bar (usually a ligature) in the particular face under consideration.

Cast against and permanently exposed to earth		75 mm
Exposed to earth or weather:	Slabs, walls	50 mm
	Beams, columns	50 mm
Exposed to Process Fluids:	Slabs, walls	65 mm
	Beams, columns	65 mm

8.2.2. Detailing of Reinforcement

Minimum bar sizes shall be 12 mm, with 10 mm as a minimum for ligatures.

Lap lengths to reinforcement shall be as computed under the approved Design Standard. Where bars of different diameter are lapped, the lap length shall refer to the smaller bar.

The design should consider the host country's common practices in reinforcement detailing. If staged construction is planned the designer should consider whether the reinforcement will be work-hardened by cold bending and rebending. The Detail Engineer shall ascertain local dependence on the designer for provision of reinforcement schedules, and if necessary, the preferred format.

8.3. FOUNDATIONS

Concrete foundations shall be designed to resist all combinations of loads. The design shall consider the mechanism of load transfer between foundation and subsoil, and requirement for routing of new or existing underground services (stormwater, electrical or other utilities).

For centrifugal pump foundations subject to vibrations up to 30 Hz due to out-of-balance forces the following guidelines shall be applied:

The total mass of concrete plinth and installed equipment shall be not less than 50 times the mass of the pump impeller. For integral plinths the concrete mass may include an apron around the plinth equal in width to the nominal slab thickness.

For pump sets and other rotating equipment with a total equipment weight exceeding 15 kN, and other static items with a total weight exceeding 50 kN, a separate isolated foundation shall normally be used.

8.4. SLABS ON GRADE

It is essential that process liquors be completely prevented from leaking into subsoil. Caustic soda reacts with subsoil, causing upward heaving, eventually rupturing and destroying concrete paving and foundations. Even slight movements destroy the integrity of slab joint sealing, and accelerate leakage into the ground. The caustic liquor is highly toxic to all life forms and must be strictly contained to prevent contamination of groundwater and natural drainage systems.

All concrete pavement slabs and jointing detail shall be designed as liquid-retaining structures. All joints between slabs shall be fully sealed using details acceptable to the Project Owner, to prevent leakage of process liquors into the ground.

8.4.1. Slab Design

Slabs on grade, shall be designed for shrinkage and expansion forces resulting from drying and thermal effects, in addition to live loads. Slabs shall be jointed as required to minimize the deleterious effects of these forces. The top layer of reinforcement shall be continuous over the whole area of the slab between joints. Reinforcement laps shall develop the full bar strength at the lap.

As a guide, the typical thickness of on-ground pavement slabs that are not subject to heavy traffic or earthmoving machinery would be greater than 150 mm. The slab would typically be reinforced with a top layer of mesh (8 mm diameter bar at 100 mm centres in both directions), with a lower layer of similar reinforcing mesh in areas subject to high heat loads (e.g. spillages of hot liquors).

Where slabs on grade will be subject to heavy vehicular wear, the designer shall specify materials with enhanced wear resistance, such as fibre-reinforced concrete or an "iron aggregate" topping layer. Where ramp gradients are sufficiently steep that traction may be limiting, the designer shall consider appropriate surface roughening treatments. Maximum grade shall generally be 1:10.

8.4.2. Joints

The extent of construction and expansion joints in slabs for alumina refinery areas shall be minimised by:

- Providing generous steel reinforcement of slabs to permit construction of larger monolithic areas.
- Constructing machinery plinths (where practicable) integral with floor slabs (thickened as necessary).

Wherever practical joints shall be located at the high points of slabs, and shall cross all valleys and gutters at right angles. Standard Alcan drawings show typical details of joints with the required integrity for containment of caustic liquor.

8.4.3. Drainage

All concrete slabs shall be designed with continuous falls to route storm water, process spillage and drainage to sumps with the required slopes dependant on the extent of solids to be drained. A guide to the maximum and minimum floor slopes considered as desirable are tabulated below:

	Absolute Min.	**Designed Min.**	**Max.**
Areas immediately adjacent to process floor sumps carrying liquors with high solids content	1:20	1:10	1:5
Floor areas with liquors with high solids content	1:30	1:20	1:6
Floor areas with liquors with low solids	1:60	1:30	1:6

Table 8.4 - Typical Floor Slopes

Floor slopes shall be arranged so that the liquor collects at a low point or "Vee" in the slab in the shortest possible distance from the discharge point so that wherever possible "sheet flow" is eliminated. By concentrating flows a higher velocity can be attained which will result in more efficient cleaning of the slabs.

Process sumps shall be formed in reinforced concrete cast around a fully welded steel liner. Connection of sump construction with adjacent paving shall be fully detailed, as per RT Drawing N° Z02-000-3-STD-005 or other arrangements providing equivalent integrity.

8.5. CONSTRUCTION ISSUES

8.5.1. Curing

All concrete shall be cured utilising an approved pigmented water-based curing compound applied strictly in accordance with the manufacturer's specification. Alternatively, curing may be accomplished by saturation with water. The curing method shall follow international best practice regarding method and duration.

8.5.2. Stripping Times

Forms shall not be stripped until at least 70% of the 28 day Characteristic Strength has been attained. The stripping time will usually be determined from compression tests on test specimens. Alternatively, the concrete should have gained sufficient strength to provide a factor of safety of 2.0 on the working stresses to be sustained.

8.5.3. Protection of Mass Pours

The designer shall specify all necessary steps to avoid cracking of large concrete pours. In particular:

- Use cement with a low heat of hydration to avoid excessive heat build-up
- Pour in stages and make provision for construction joints
- Provide adequate reinforcement
- Provide adequate curing after initial set
- Avoid pouring in hot weather

8.5.4. Special Concrete Mixes

Special mixes shall be designed where the normal design is inadequate for any one of a reason, including but not limited to:

- Need for high early strength
- Difficulty of access for pouring
- Large pours
- Need to minimise subsequent working

The special mix shall be proved using test specimens following the procedures set out in the approved Design Standard. The specification for special mixes shall describe the strength grade, slump, nominal aggregate size, method of placement and other relevant parameters.

8.5.5. Reinforcement Stools

Reinforcement shall be kept in place relative to formwork by using plastic coated stools or wired-in concrete spacers. Top reinforcement of slabs on grade shall be supported sufficiently to ensure the reinforcement is not forced out of position during placement of concrete.

8.5.6. Blinding and Damp Proof Membrane

Blinding is defined as a layer of concrete at least 50 mm thick which is laid on prepared ground and worked to a smooth finish, to provide a clean dry work surface for subsequent concreting operations. The blinding layer is normally constructed to the finished final shape of the finished concrete including all slopes, Vee-drain, etc. The blinding shall be sufficiently watertight that concrete laid over it will not suffer from water loss and impaired curing by percolation through it. The blinding layer shall generally be strong enough to provide anchorage for formwork and temporary embedded items. Blinding may be used as site preparation for major concrete pours. Unless otherwise specified, blinding concrete shall normally consist of 15 parts sand to 1 part cement with sufficient water added to give a material which has a very low slump.

Damp Proof Membrane (DPM) is defined as a thin plastic sheet which is laid on prepared ground, and taped at the seams to prevent leakage of water. Concrete slabs on grade may then be laid over it and the DPM retains water in the mix so that curing is not impaired. In construction for alumina refineries DPM also serves as a backup to concrete paving for containment of liquor, and shall be installed with corresponding integrity. The DPM shall be sealed to all bases, foundations, and other slab penetrations with bitumastic rubber compound.

DPM shall be used in preparation for pouring of slabs on grade. The DPM is normally laid over the blinding. Where stools are placed on top of DPM, the DPM shall be adequately protected from damage.

8.5.7. Hold Down Bolts

Hold Down (HD) bolts 16 mm diameter and smaller shall be proprietary anchors, drilled and embedded into concrete in accordance with the manufacturer's instructions. Epoxy bonded threaded rods are preferred to expansion type anchors.

HD bolts 24 mm diameter and larger shall be cast in place during pouring. 20 mm bolts may be cast-in or epoxy bonded anchors as appropriate to the application. HD bolts shall be installed so that 2-5 complete threads will be exposed after steelwork or machinery is installed and nuts are tightened up.

Cast-in hold down bolts shall comply with ASTM F1554 (Standard Specification for Anchor Bolts). The design of hold down bolts, including allowance for on-site adjustment, shall take into account the construction tolerances of the supported steel structure.

Where short slotted or oversize holes are provided in baseplates, hardened washers or plate washers shall be used. Where long slotted holes are provided in baseplates (that is, 2.5 diameters long), a special washer or cover plate at least 8 mm thick shall be installed to completely cover the hole.

8.5.8. Tolerances

Concrete shall be constructed to the tolerances required by the approved Design Standard, unless the Project Owner requires a more stringent tolerance.

8.5.9. Grouting of Base Plates

Foundations shall be designed to allow a nominal clearance (25-50 mm) between the top surface of the finished concrete plinth and underside of baseplate.

The space between underside of baseplate and top of plinth shall be filled with an approved non-shrink grout. Care shall be taken that all spaces under the baseplate are completely filled with grout. Large baseplates shall be provided with a central hole for feeding of flowable grout. Grouting shall be bevelled off at the baseplate edges.

8.5.10. Chamfers and Fillets

External corners (chamfers) and internal or re-entrant corners (fillets) on concrete shall be formed at 45 degrees to the formwork. Each leg length shall be 20 mm minimum. On internal corners of large structural concrete items, a larger fillet may be provided.

8.5.11. Formwork Finishes

The quality of concrete finish is dependent on the type of formwork, method of working and curing, and the mix design. The designer shall determine the quality of finish required in view of the Project Owners' requirements for corrosion protection, durability, tolerances and appearance. The finish obtained on site shall be monitored by visual comparison with sample photographs in the approved Design Standard or with actual samples cast on site and approved by the Project Owner.

9. SPECIFIC TECHNICAL REQUIREMENTS - STEELWORK

9.1. DESIGN

Steelwork shall be designed and detailed with ease of fabrication and erection and overall economy in mind. The following points shall be noted:

- The lowest weight of each nominal size of universal section is the most structurally efficient in bending.
- Use repetition wherever possible. Interchangeable parts speed erection.
- Fabricate in fewer large subassemblies to simplify fabrication, transport and erection, subject to physical constraints and lifting capacity.
- For connections directly into the web of a column or beam use fin-plate connections to facilitate assembly.
- Use simple shear-type connections instead of moment-bearing arrangements.
- Detail lifting points on major items.

9.1.1. Minimum Connections

All member end connections shall be designed for the most onerous load combinations, with a minimum (working load) of 20 kN.

The minimum permissible plate thickness for connection cleats fins and for general structural work shall be 10 mm.

Every bolted structural connection except minor items, shall include at least two High Strength bolts, 20 mm diameter or larger. Minor connections such as hand-railing, shall include at least two bolts, 12-16 mm diameter (Commercial bolts).

9.1.2. Corrosion Protection

All structural steelwork shall be adequately protected from atmospheric corrosion and from corrosion resulting from the process itself, in accordance with Design Standards and Codes of Practice. Corrosion protection shall take the form of an acceptable painting system, or hot dipped galvanising, or the use of an acceptable grade of steel with inherent resistance to corrosion. It is a design criterion that the corrosion protection shall provide 15 year service before requiring recoating.

- Paints containing Coal Tar, Chromates or Lead are not acceptable.
- Paints containing High Build Epoxies, Urethanes, and Zinc Silicate are acceptable.

All bolts, nuts and washers used for the erection of structural steelwork shall be hot-dipped galvanised.

9.1.3. *Ladders, Stairs and Platforms, Walkways, Handrails*

All structures for access shall be designed in accordance with the approved Design Standard and the Standards of the Project Owner. The minimum load requirements of the approved Design Standard shall be used in design, unless a higher value is required by the Project Owner.

Access ways with gradients between 45 degrees and 60 degrees to the horizontal shall not be used, for safety reasons.

A minimum clear width of 700 mm between handrails and between kick plates shall be provided on catwalks.

Floor grating shall be installed with 25 mm mesh beneath where there is a possibility of small objects falling through onto personnel working below. Kick plates shall be used on all walkways and platforms to prevent objects being kicked over the side, and loss of personnel footing.

9.1.4. *Monorails and Cranes*

Monorails and cranes shall be designed in compliance with the approved Design Standard. The designer shall conservatively assess the safe working load and the mass of the hoist mechanism, and allow for future upgrading of the hoist mechanism. Allowance shall be made for the transfer of all forces, including dynamic forces, to the support structure. Travel end stops shall be detailed on design drawings.

9.1.5. *Pipe Racks*

Longitudinally connected pipe racks shall be provided with movement and thermal expansion joints at intervals not exceeding 70 metres. Pipe rack bents shall typically be installed at 6 metre centres.

9.1.6. *Structural Gaps*

Where relative movement between structures (due to wind, seismic or thermal effects) could lead to damage, a gap shall be designed between the structures. The clearance shall be dimensioned to accommodate the two structures moving towards each other. Walkways between these structures shall include a sliding floor plate. In the absence of specific information, a typical gap width of 100 mm shall be allowed.

Where structural gaps occur between a walkway or platform and the wall of another structure, and where the walkway or platform is elevated above ground so that objects falling from the walkway would constitute a danger to personnel below, the walkway or platform shall be provided with a kick plate trimming the gap.

9.1.7. *Avoidance of Dirt Traps and Corrosion*

All structural steelwork shall be detailed to avoid creating dirt and water traps which may encourage corrosion. Pockets which may collect water or dirt shall be plated over with steel plate of minimum thickness 3 mm and sealed with a continuous weld in order to exclude dirt and water.

Where spillage of material is likely and dirt or water traps are unavoidable, shedder plates shall be designed to ensure that the bulk of spilled material is deflected away from the dirt trap.

9.2. FABRICATION AND ERECTION

Structures shall be fabricated and erected to the tolerances contained in the approved Design Standard.

9.2.1. Welding

Design of welds shall be in compliance with local standard (or AWS Standard D1.1 if not exists). All welding procedures, consumables, joint preparations and personnel shall be qualified for the work in compliance with this standard.

Qualified welding procedures shall be approved by the Project Owner prior to commencement of welding.

Testing and inspection of welds, including frequencies and procedures, shall be carried out in compliance with the approved Design Standard.

The drawings shall clearly distinguish between field welds and shop welds. Field welds shall be used only where essential.

Generally, minimum fillet weld size for structural purpose shall be 6 mm, measured across the gauge dimension, not the throat dimension. Smaller fillet welds shall be acceptable where it can be shown that 6 mm fillets are uneconomic and that a smaller weld is structurally adequate. Consideration must be given to the closer tolerance required and the difficulty of guaranteeing an effective weld as the weld size diminishes.

Seal welds shall be provided to all junctions that are subject to potential corrosive influences.

9.2.2. Erection

The designer shall consider the project locality's level of technology and adapt designs to preferred construction methods. In particular the availability of heavy lift cranes may dictate the maximum practicable weight or outside dimensions of individual items.

The designer shall consider the efficiency of erection in terms of on-site safety.

9.2.3. Bolting Procedures

Standard bolting procedure shall be "Snug" tightening. This is defined as "the tightness obtained by the full effort of a man using a standard podger spanner". It describes the level of tightening that has always been obtained in general bolting. Slippage of the plies is required (and expected) in order to mobilise the bearing resistance of the plies and shear strength of the bolt. They should therefore not be used in rigid joints, which are joints where slippage cannot be tolerated.

"**Fully Tensioned**" bolts shall only be specified where required, and where permitted by the approved Design Standard. Bolts shall be fully tensioned in all structures subject to vibration. Tensioning shall be applied by either the part-turn-of-nut method or by using load indicating washers.

Fully tensioned bolted connections, if permitted, shall be designed as either bearing-type or friction-type. A bearing-type connection is expected to slip before transferring its design load and is therefore unsuitable in a rigid joint. Friction-type connections rely on an accurate assessment of the actual friction coefficient between mating surfaces and their use is therefore discouraged.

Standard "commercial" bolts shall be tightened using the "Snug" procedure.

Commercial bolts shall not be used in structural situations: their use shall be limited to handrails, stairways and similar locations. Commercial bolts shall be used only in 12 mm and 16 mm diameters to avoid inadvertent use in place of high strength bolts.

9.2.4. Temporary Works

Temporary Works fall into two categories.

Erection Bracing

Required to support individual members during their erection. This is solely the erector's responsibility to design, supply and remove on completion.

Temporary Bracing

Required to maintain the structure vertical and in a safe condition after erection is completed, until permanent bracing is completed. Design requires knowledge of the building sequence and other factors. It should be designed by the Engineer. Temporary Bracing and its connections shall be designed in accordance with the approved Design Standard.

9.2.5. Shop Detail Drawings

At appropriate times, the Fabricator shall submit shop drawings to the designer for comment.

It shall be made clear in the Contract documents that submission of shop detail drawings to the designer in no way absolves the Fabricator from his responsibilities.

10. SPECIFIC TECHNICAL REQUIREMENTS - TANKAGE

10.1. APPROVED DESIGN PROCEDURES

Tanks for Bayer refinery service shall be designed, constructed and tested in accordance with the latest version of American Petroleum Institute Standards below:

- API 650, for cylindrical flat-bottomed tanks.
- API 620, for conical bottom and other forms.

Flat bottomed tanks up to 10 cubic metres capacity require no analysis or engineering design beyond specification of approved materials and minimum plate thicknesses. For flat bottomed tanks from 10 to 100 cubic metres, calculations shall be prepared for lowest strake thickness, hold-down against wind load, and size of top rim angle. Flat bottom tanks above 100 cubic metres, and all cone bottom tanks, shall be subject to full engineering analysis to the approved codes.

10.1.1. Seismic Loads for Tanks

The seismic coefficients presented in the API codes are calibrated for the United States of America, and are unsuitable for use elsewhere. The base acceleration factor C1 for a site outside of the United States shall be determined (in m/s^2) from the seismic response spectra for the project site. The design horizontal seismic force (in Newtons) will then be

C1 x (Structure Mass in kg) , with the Zone Coefficient set to 1.0.

10.1.2. Maximum Stresses

The Product Design Stress applied in designs to API 650 shall be limited to the lesser of:

1) 175 Mpa

2) Value in API 650 Table 3-2

This limitation is imposed to avoid problems with caustic embrittlement of welds and applies to material at any level in the tank wall or base. It does not apply to tank roofs.

10.1.3. Minimum Thickness of Material

Each tank shall undergo individual engineering assessment, however, in general, the minimum thickness of material shall be as follows. All thickness quoted are inclusive of corrosion/erosion allowance where applicable:

All tank walls	6 mm
All process tank roofs	6 mm
All process tank floors	8 mm

(Note: The above ruling for roof and floor thickness may not necessarily apply to large bulk storage tanks. The API 650 code will still apply as a minimum)

In general where tank wall thickness exceeds 6mm, API 650 will determine the tank wall and floor thickness and the applicable erosion/corrosion allowance will be applied. In addition the tank designer shall take into consideration loads from scale, platforms and agitators as applicable.

Not withstanding the above, for Bayer process fluids with high solids concentration, the designer shall ensure that the following criteria are also met:

- Minimum floor and first strake wall thickness on tanks having a normal solids concentration greater than 550 g/l shall be 10mm
- Minimum floor and first strake wall thickness on tanks having a normal solids concentration greater than 800 g/l shall be 12mm.
- Where deemed necessary on tanks with high solids concentration, a finite element analysis shall be conducted.

Corrosion allowances for specific equipment and associated structures will be nominated on the equipment datasheets.

10.1.4. Tie Down Requirements

Tank hold-down bolts shall be designed to resist the most onerous load combinations. Attention shall be given to the tolerance on out-of-roundness of the column or skirt base plates and the location of cast-in HD Bolts.

10.1.5. Corrosion Protection

Corrosion protection involves many parameters, including the specific equipment design, the specific process, the specific environment and economic factors. The Refinery operator has a role to play in assessing the business risks associated with the chosen method and extent of corrosion protection.

The question of whether to paint or not is driven largely by the environment and where equipment is insulated, the effectiveness of insulation in preventing the ingress of moisture. Where appropriate, the refinery operator may chose to increase corrosion allowances for local economic or design reasons, or, if the risk of failure is high and there is uncertainty regarding the effectiveness of the cladding in the longer term then painting may be specified.

Corrosion protection is generally provided to the exterior of tankage in compliance with Section 9.1 of this specification. Where agreed with the Project Owner, tanks may be unpainted and shall have minimum corrosion allowances as follows:

- API 620 Tanks, 2 mm all over.
- API 650 Tanks, 2 mm on floor and shell, 1 mm on roof.

10.1.6. Thermal Insulation

Thermal insulation shall be provided for tanks and vessels where specified by the Process Engineer. As a guide, where the operating temperature of the tank or vessel is between 10 and 50°C, insulation is not generally required. For temperatures between 50 and 70°C, insulation is generally only necessary in areas for personnel protection. Where the operating temperature is above 70°C, insulation is normally required for energy conservation.

All insulation materials shall be asbestos-free. For process temperatures up to 110°C (atmospheric tanks and vessels) the insulation may be either sprayed polyurethane foam (PUF) or Mineral fibre/Fibreglass boards (Fibre) with a cladding of steel sheet or fibre-reinforced mastic. Above 110°C only Fibre insulation is suitable. Insulation shall be protected from personnel traffic by provision of walkways and platforms where access is required.

Fibre insulation shall be supported on stud-welded insulation stakes attached prior to stress-relief and painting. All insulated tanks and vessels shall be painted prior to insulation with a paint system rated for the operating process temperature.

Thermal insulation shall be terminated 100 mm above the bottom of the tank to eliminate absorption of rainwater and liquors causing subsequent corrosion. Insulation shall be fully sealed and flashed to prevent ingress of liquid from rainfall or spillage.

10.1.7. Specific Requirements

Loadings

The design shall take account of all special loads imposed on tanks, including:

- Scale loads
- Upset loads
- Buoyancy effects on immersed items
- Loads due to operating agitation, and maintenance machinery
- Full of settled solids for tanks in slurry service

Access Provisions

All tanks exceeding 10 m^3 shall include an access at least equivalent to a 600mm diameter manway at the lowest possible level to facilitate access and cleanout. Closed tanks shall also include at least one roof hatch of equivalent area, with mesh insert to prevent personnel falling through.

Where machinery is to be used for tank cleanout or maintenance suitable access ways shall be provided in roof or walls as appropriate. In either location reinforcement shall be designed at apertures to fully maintain the structural integrity of the vessel.

Agitated Tanks

In flat-bottomed tanks with mechanical agitators a transition plate shall be provided between walls and floor to facilitate agitation, and reduce scale build-up. The transition shall extend inwards from the wall at least 10% of the tank diameter. For tanks with (Height x Diameter) < 50 m^2, a 45º conical section is suitable.

Baffles shall be installed to designs and loadings specified by the agitator supplier.

10.2. CAUSTIC EMBRITTLEMENT

The design shall take all precautions against caustic embrittlement of welds. Carbon steel tanks to be used for storage of raw caustic or caustic cleaning liquor shall be subject to full post-weld stress relief, carried out in accordance with applicable API codes or as specified on the specific equipment datasheets.

10.3. BUNDING

10.3.1. Process Area Bunding

Containment of the largest tanks within each area is generally impractical, unsafe and expensive. Provision for bund overflow containment is incorporated in the inherent design of the refinery with the installation of an effluent drain system and catchments pond.

The philosophy adopted by the project for the containment and appropriate disposal of process spillage for each individual refinery area is as noted in the dot points below. Each area will still however require individual attention during the Detailed Engineering phase.

- The general philosophy adopted is to not fully contain area bunds according to tank volumes in that area, but rather to control the process excursion and direct it to the plant effluent drainage system for containment to the environmental requirements.
- In general, each area will contain its own process spillage in its sumps and return this back to the process via the sump pumps.
- Where there is excessive rainfall ending up in the sumps and the level of contamination is low, the sump pump discharge may be manually redirected to the effluent drain system. A 20 to 30 mm level of rainfall over the slab is generally considered sufficient to flush away contaminants; thereafter rainfall may be classified as ‘clean’. ‘Clean’ water may be re-directed to a clean water pond once it has been approved by the Environmental Officer.
- Where the sump pump is unable to cope with the influx of rainfall, the sump will fill and the rainwater will flood the bunded area.
- The bunded area will be sloped towards the sump(s). Depending on the specific area, the bund wall will be typically a maximum of 300mm high (at a single elevation all round) with an overflow weir on one side directed to the effluent drainage system.
- In areas such as Precipitation where there is considerable slope on the overall bund wall, individual attention is required. Typically, one side of

the bund will be positioned adjacent to the effluent drain and will contain a weir to direct overflow from the bund into the effluent drains.

- Preliminary sizing of this weir should be based on the maximum tank overflow that can be achieved from a tank within that particular area plus 25%. The final sizing of this weir will be conducted during Detailed Engineering.
- With regards to containment capacity, each specific area bund shall have a storage capacity to contain 15 minutes of the single largest flow from within that bund. The aim is to give the operators a short period of time in which to react before the bund will overflow.
- Where applicable, adjacent bunds and the operation of sump pumps in the bunded area can be considered to minimise containment volumes.

10.3.2. Bulk Storage Bunding

Bulk Acid, Fuel Oil and Fresh Caustic storage tanks not included in the refinery process areas will in general be bunded to comply with the applicable standard concerning the storage and handling of corrosive substances. In general, bulk storage shall be located within bunds for containment of spillage due to tank failure, or any other cause. The enclosed volume of the bund (allowing a minimum freeboard of 250 mm) shall not be less than the volume of the largest single vessel within the bund.

Bund walls may be constructed of earth or concrete, appropriately designed for potential hydrostatic loads. The need for impermeable lining shall be reviewed for each installation. Piping and other services shall not be routed through any earth bund wall. Specific provisions shall be made for adequate personnel access over the bunds. Earth bunds shall be adequately protected against erosion due to wind, rainfall or traffic.

Provision shall be made to capture spillage and rainfall in a sump within the bunded area for removal by pumping as necessary. Valved gravity drains shall not be used except for transfer into an approved disposal system.

10.4. OVERFLOWS

Every tank shall be provided with an emergency overflow arrangement to safely discharge excess liquid. The tank wall opening shall be calculated as a fully contracted weir with a capacity not less than 125% of the maximum simultaneous inflow (from flowsheets), at a minimum freeboard of 300mm to the tank rim.

Connected pipework shall be designed for the 125% flowrate above, with due allowance for velocity head and entry losses, and without reliance on siphon effects.

Overflow pipes shall be routed and discharged so as to prevent adverse effects on tank foundations, and minimise hazard to personnel. Where overflows are subject to scale formation (for example, most Bayer process tanks), ready access shall be provided for inspection and cleaning.

10.5. SPECIAL PROVISIONS – PRECIPITATORS

A group of precipitators applies heavier broad-area foundation loads than any other refinery equipment. Soil and foundation investigations must be particularly thorough, and extend to substantial depth, to ensure foundation integrity.

Tanks are subject to initial settlement, ongoing elastic movements between full and empty conditions and thermal movements between operating and cleaning cycles. Structural connections between tanks by platforms, launders and pipework shall be sufficiently flexible to absorb relative movements without distress.

Hydrate scale forms prolifically on all wetted surfaces. On draining the tank, loss of buoyancy from liquor substantially increases vertical loads to be supported by vertical tank walls, draft tubes etc. As a guide the inside of draft tubes, and immersed mechanical agitator components, shall have a scale allowance of 100 mm over their surface area at an SG of 2.4. All other wetted surfaces shall be assumed to carry a scale thickness of 2.5% of tank diameter. Discharge of settled solids from cone-bottom tanks creates a vertical drag component which must be considered in design of support structures for central (airlift) draft tubes.

In addition to API tank code design requirements, tank shells shall be specifically checked at all levels against buckling due to the total vertical loads from self-weight, scale, overhead platforms and equipment, and wind-induced moments. Hydrostatic pressure and buoyancy effects shall not be included.

When used, Air agitated tanks shall have an included cone angle not greater than 70°, and a draft tube diameter not less than 5% of tank diameter. For mechanically agitated tanks, requirements of section 4.2 above shall be applied, with the following specific adaptations:

- Arrangements for maintenance shall be completely established in Basic Engineering due to the major problems of access and cranage to be addressed.
- Drive reversal may not be a requirement for restarting settled tanks.
- Draft tube design (where applicable) shall be approved by the equipment vendor.
- Proven industry experience with large-scale alumina precipitators is an essential vendor qualification.

11. REFERENCES

11.1. API

ANSI/American Petroleum Institute

620-1992	Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks
650-1992	Welded Steel Tanks for Oil Storage

11.2. ASTM

ANSI/American Society for Testing of Materials

A307-94	Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
A325-94	Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength
A615(M)-94	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C39-94	Test Method for Compressive Strength of Cylindrical Concrete Test Specimens
C289-94	Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
C295-90	Guide for Petrographic Examination of Aggregates for Concrete
C918-93	Test Method for Measuring Early-Age Compressive Strength and Projecting Later-Age Strengths
C1293-95	Test Method for Concrete Aggregates by Determination of Length Change of Concrete due to Alkali-Silica Reaction

11.3. AWS

ANSI/American Welding Society

D1.1-96	Structural Welding Code - Steel

11.4. BS

British Standards Institute

BS 4449-1988	Specification for Carbon Steel Bars for Reinforcement of Concrete

11.5. DIN

Job No: 4095

REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
5th ALUMINA REFINERY AT DAMANJODI, ODISHA
AND PORT FACILITIES AT VISAKHAPATNAM

VOLUME 1
(*Main Report with Recommendations*)

Clients :

M/s. National Aluminium Company Limited
Nalco Bhawan, Nayapalli,
Bhubaneswar – 751 013

Foundation Consultants :

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001& OHSAS 18001 Certified Company
NABL Accredited Laboratory
124A, N.S.C. Bose Road : Kolkata - 700 092
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April – 2018
(Revised on 15-10-2018)

LIST OF CONTENTS

REPORT ON GEOTECHNICAL INVESTIGATION WORK FOR 5th ALUMINA REFINERY AT DAMANJODI, ODISHA AND PORT FACILITIES AT VISAKHAPATNAM

1. INTRODUCTION

M/s. National Aluminium Company Limited has proposed the construction of 5th Alumina Refinery at Damanjodi, Odisha and Port facilities at Visakhapatnam. For designing foundation structures coming under this project, it was necessary to conduct a detailed Geotechnical Investigation Work to obtain engineering properties of the underlying soil and **M/s. National Aluminium Company Limited,** in turn, appointed **M/s. C. E. Testing Company Pvt. Ltd., Kolkata** as their Geotechnical Consultant.

The scope of the work comprised of sinking 105 nos. bore holes. The scope also includes, TP (Trial Pit – 14 Nos.), CPLT (Cyclic Plate Load Tests – 6 Nos.), ERT (Electrical Resistivity Tests – 22 Nos.), BVT (Block Vibration Test – 6 Nos.) and Field CBR Tests – 10 Nos.

The boreholes of 150 mm diameter were advanced by Shell and Auger method in soil. In rock, rotary core drilling of "NX" size was adopted. The scope also included conducting Standard Penetration Tests, collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in the laboratory.

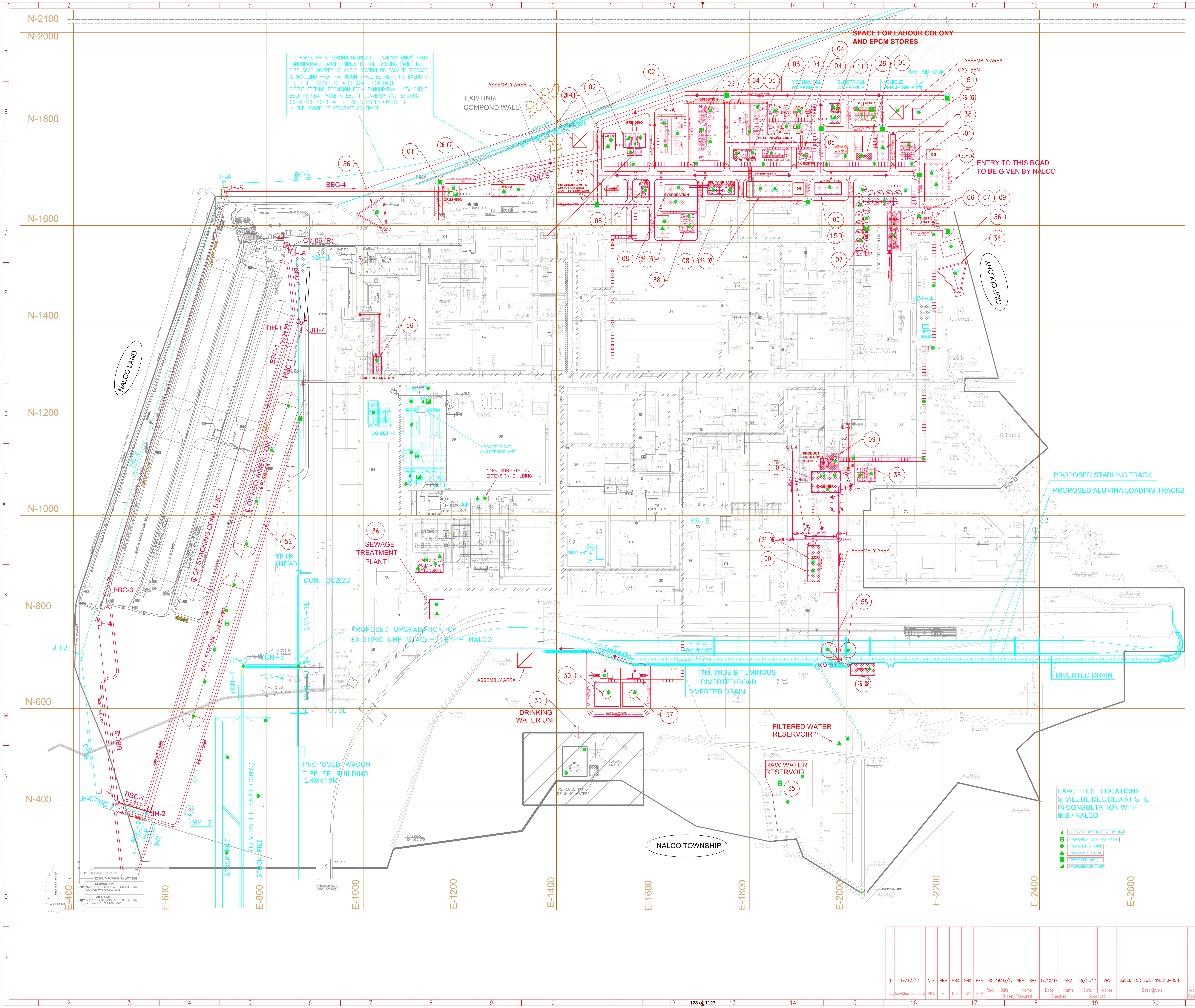
Based on the above, this report presents the Bore Logs, Soil Profile, laboratory and field Test Results.

The subsoil is characterised by filled up soil around some borehole locations followed by stiff to very stiff / hard silty clay. Below this dense to very dense silty sand with clay binder was observed. After that weathered rock layer was struck and that continued upto the terminating depth of all boreholes.

Considering the nature of the subsoil as revealed from field tests and laboratory tests shallow foundation is recommended. However, this is discussed in details later.

For easy handling, this part has been divide into two parts (volumes). The first part deals with subsoil condition and foundation recommendations, whereas the second part contains the borelog data sheets, Field and laboratory test results.

- **Volume – 1:– Main Report with Recommendations.**
- **Volume – 2:– Borelogs, Field & Laboratory Test results.**



GENERAL NOTES:-

1. ALL CO-ORDINATES, DIMENSIONS & ELEVATIONS IN METER UNLESS OTHERWISE STATED.
2. ALL LEVELS ARE ABSOLUTE LEVELS W.R.T MEAN SEA LEVEL.
3. THIS LAYOUT IS TO BE REFERRED ONLY FOR CONCEPTUAL LOCATION OF THE UNITS
4. THE LEVELS OF THE UNITS ARE PRESENTLY HOLD DUE TO NON-AVAILABILITY OF CONTOUR SURVEY. IT SHALL BE FINALIZED ONLY AFTER RECEIPT OF CONTOUR SURVEY.
5. THE UNIT SIZES AND CO-ORDINATES SHALL BE CONFIRMED AFTER RECEIPT OF UNIT PLOT PLANS FROM LICENSOR AND PRELIMINARY VENDOR DATA.
6. THE LOCATION OF NEW CAUSTIC AND FUEL OIL UNLOADING STATION IS UNDER HOLD. TO BE CONFIRMED DURING THE COURSE OF DETAILED ENGINEERING.
7. FEASIBILITY OF USAGE OF EXISTING PIPE RACKS FOR THE NEW PIPE LINES / CABLE TRAYS SHALL BE CONFIRMED ONLY AFTER SITE SURVEY. THE REQUIREMENT OF ADDITIONAL PIPE RACKS SHALL BE INDICATED BASED ON THE RESULTS OF THE SAME.
8. THE EXTENT OF RAW WATER RESERVOIR AND FILTERED WATER RESERVOIR IS UNDER HOLD. IT SHALL BE CONFIRMED DURING THE COURSE OF DETAILED ENGINEERING.
9. NO UNDERGROUND PIPING IS ENVISAGED IN THE NEW FACILITIES UNDER tkIS SCOPE.
10. PREVAILING WIND DIRECTION MOVING FROM SW DIRECTION CONSIDERED FROM WIND ROSE.
11. PASSIVE FIRE PROTECTION (i.e. FIRE-PROOFING) IS NOT APPLICABLE.

NEW UNITS / AREA SCHEDULE

NALCO AREA NO.	UNITS / AREA DESCRIPTION
52	BAUXITE STORAGE AND HANDLING *
01	SECONDARY CRUSHING. *
02	BAUXITE GRINDING *
02	INDIRECT BAUXITE SLURRY HEATING(IBSH) & PREDISILICATION
03	DIGESTION
08	ACID CLEANING PREPARATION
04	MUD SETTLING *
05	TRI CALCIUM ALUMINATE (TCA) PREPARATION *
04	MUD WASHING *
04	FLOCCULENT PREPARATION. *
05	SECURITY FILTRATION.
04	CAUSTICIZATION *
06	HEAT INTERCHANGE.
06	HYDRATE FILTRATION
07	PRECIPITATION
07	SEED GRINDING
07	CAUSTIC CLEANING PREPARATION (INCLUDED IN PRECIPITATION)
07	HYDRATE CLASSIFICATION
09	PRODUCT HYDRATE FILTRATION STAGE-1
09	PRODUCT HYDRATE FILTRATION STAGE-2 *
53	HYDRATE TRANSFER *
10	CALCINATION UNIT *
08	EVAPORATION *
08	CONDENSATE TANK FARM
56	LIME PREPARATION (SLAKING) *
11	RESIDUE PUMPING *
08	TANK FARM FOR EVAPORATION
55	ALUMINA STORAGE AND HANDLING *
57	CAUSTIC SODA RECEIPT & STORAGE
36	EFFLUENT TRETMENT PLANT
36	SEWAGE TRETMENT PLANT *
35	RAW WATER RESERVOIR *
35	DRINKING WATER UNIT *
38	COOLING TOWERS & COOLING WATER DISTRIBUTION *
28	PLANT AIR AND INSTRUMENT AIR SYSTEM
37	FIRE WATER STORAGE *
R01	MAIN PIPE RACK FOR MAIN PLANT
26-01 TO 08	SUBSTATION
00	CCR
30	FUEL OIL UNLOADING AND STORAGE

* LSTK PACKAGES

REFERENCE DRAWINGS

DRAWING Nos.	DESCRIPTION
11253-03-0001	PLAN GENERAL LAYOUT
Z02-000-1-GA-0001	PLOT PLAN PRELIMINARY
26328-03-02-ELE-0002	LAYOUT PLAN & SECTION FOR 220KV/132KV NALCO DAMANJODI SS(EXTN)
11253-B-02-0001	GENERAL LAYOUT NALCO DAMANJODI ALUMINA REFINERY.
	PLOT PLAN SUPERIMPOSED ON REVENUE MAP.

LEGEND:

COMPOUND WALL (EXISTING)
PIPERACK (EXISTING)
PIPERACK (EXISTING)
ROADS (EXISTING)
EXTENSION OF EXISTING PIPERACK
PIPE RACK (EXISTING)
NEW FACILITIES IN tkIS SCOPE.
NEW FACILITIES BY OTHER
NEW PIPE RACK ROUTING
NEW CONVEYOR
NEW FENCING

HOLD LIST

1. FUEL OIL UNLOADING STATION.
2. CAUSTIC SODA UNLOADING STATION.
3. FILTERED WATER RESERVOIR.
4. RAW WATER RESERVOIR.

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Category Codes (Submission purpose)

- [ ] 1 For Approval
- [ ] 2 For Review / Comments
- [ ] 3 For Information
- [ ] 4 For Engineering
- [ ] 5 For Enquiry
- [ ] 6 For Order Placement
- [ ] 7 Final & Approved
- [x] 8 Released for Construction

tkIS India / Owner/Client

Acceptance Codes (Approval Codes)

- [ ] 1 Approved
- [ ] 2 Approved for Manufacturing/ Fabrication With Comments as Marked
- [ ] 3 Not Approved/Resubmit
- [ ] 4 Retained for Information/Records
- [ ] 5 Reviewed
- [ ] 6 Reviewed as Noted/Resubmit

Date : __ /__ /____ Name : ____________

Contract No.	Document ID	Part	Rev.
66-6695-700	6695-CVC-G00-LA-0001		00

Store Location: Server/Share
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Store Location: Folder
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Store Name
6695-CVC-G00-LA-0001
BAR-Code

Pro. Unit	Con. Unit	TON	Group	Order No.	Type of Document	Sheet
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नालको NALCO
नेशनल एल्यूमिनियम कम्पनी लिमिटेड
National Aluminium Company Ltd.

1.0 MTPA ALUMINA REFINERY STREAM-5
DAMANJODI, ODISHA

thyssenkrupp

	Date	Name
Drawn		SRM
Prepared	19/12/2017	BHK
Checked	19/12/2017	VBV
Approved	19/12/2017	VBV

Scale	Cat. Code	Acc. Code	Status
1:2500			IFC

Description
SOIL INVESTIGATION –
BORE HOLE & TEST LOCATION PLAN
FOR DAMANJODI SITE

Rev.	Co-Checked Date	PRC	PI	ELT	INS.	PCM	Rev.	Date	Name Drawn/Prepared	Date	Name Checked	Date	Name Approved	Description	Acc. Code
0	19/12/17	VLK	PRM	MSD	SHD	PKM	00	19/12/17	SRM BHK	19/12/17	VBV	19/12/17	VBV	ISSUED FOR SOIL INVESTIGATION	

ISO A0

2. FIELD INVESTIGATIONS

2.1. GENERAL:

In an attempt for finalisation in the design of foundation for these proposed structures to be constructed at this site, Geotechnical Investigation was envisaged. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

I) Field works unfold the sub-surface deposit types and their characteristics and

II) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalisation of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the bore holes with the reduced level and standing water level are presented in a tabular form below.

Structure Name	BH No.	Co-ordinate (M)			Terminating Depth (M)	SWL (M)	Top of rock below EGL(M)
		E	N	R.L.			
Effluent Treatment Plant	BH-01	1028.394	1628.156	918.823	25.00	5.30	13.70
Crushing	BH-02	BH not yet conducted due to land related issues.					
Sub-Station 07	BH-03						
Sub-Station 01	BH-04						
Grinding	BH-05						
Pipe Rack Grinding	BH-06						
Grinding	BH-07						
Acid Plant	BH-08						
Pre-DS	BH-09						
Pre-DS	BH-10						
Pre-DS	BH-11						
Digestion	BH-12						
Digestion	BH-13						
Condensate	BH-14						
Pipe Rack Digestion	BH-15						
Evaporation	BH-16						
SFL Tank Farm	BH-17						
SFL Tank Farm	BH-18						
Evaporation	BH-19	1610.394	1650.850	931.047	23.00	5.20	14.00
Cooling Tower Evaporation	BH-20	1574.913	1615.011	927.752	21.00	Not Found	12.00
Sub-Station 05	BH-21	1623.453	1608.091	929.948	25.00	6.10	19.00
Cooling Tower Evaporation	BH-22	1674.670	1598.819	928.091	32.00	5.30	28.00
Settling Washing	BH-23	BH not yet conducted due to land related issues.					

Structure Name	BH No.	Co-ordinate (M)			Terminating Depth (M)	SWL (M)	Top of rock below EGL(M)
		E	N	R.L.			
Settling Washing	BH-24	BH not yet conducted due to land related issues.					
Settling Washing	BH-25						
Settling Washing	BH-26						
Settling Washing	BH-27						
Condensate	BH-28						
Flocculation	BH-29						
Causticisation	BH-30	1913.103	1744.541	931.375	20.70	6.30	5.70
Pipe Rack Flocculation	BH-31	BH not yet conducted due to land related issues.					
Sub-Station 02	BH-32						
HCSD Pumps	BH-33						
Air Comp	BH-34						
Assembly Area	BH-35						
Canteen	BH-36						
HID Acid Area	BH-37	1998.027	1744.020	941.150	19.10	9.70	1.10
HID Acid Area	BH-38	BH not yet conducted due to land related issues.					
Cooling Tower HID	BH-39						
Pipe Rack HID	BH-40	1959.075	1726.078	933.280	18.70	7.80	6.00
Pipe Rack HID	BH-41	BH not yet conducted due to land related issues.					
Pipe Rack HID	BH-42						
Sub-Station 04	BH-43						
CCR & Plant Office	BH-44	1965.713	1679.762	929.265	15.90	4.00	2.40
Precipitation	BH-45	BH not yet conducted due to land related issues.					
Precipitation	BH-46						
Precipitation	BH-47	2079.583	1650.307	927.274	9.00	6.50	1.10
Precipitation	BH-48	2028.806	1643.061	927.060	13.00	6.60	8.30
Hydrate Filtration	BH-49	2150.562	1619.967	916.757	12.50	5.30	7.30
Precipitation	BH-50	2042.373	1614.453	925.891	12.00	10.00	2.00
Hydrate Filtration	BH-51	2097.931	1579.081	923.579	11.00	9.50	3.00
Precipitation	BH-52	2028.806	1569.061	923.276	26.00	8.00	13.00
Pipe Rack CISF Colony	BH-53	2180.697	1581.658	911.782	9.50	3.10	4.10
Effluent Treatment Plant CISF Colony	BH-54	2216.941	1556.691	910.237	15.00	4.50	5.90
Effluent Treatment Plant CISF Colony	BH-55	2226.694	1500.494	908.800	16.00	4.00	9.90
Pipe Rack CISF Colony	BH-56	1475.767	2181.294	910.400	16.50	4.40	3.00
Pipe Rack CISF Colony	BH-57	2179.433	1346.843	907.067	16.50	6.30	8.00
Pipe Rack CISF Colony	BH-58	2160.319	1236.303	908.833	9.00	4.80	5.00
Pipe Rack CISF Colony	BH-59	2159.328	1117.064	913.592	11.00	4.20	5.00
Pipe Rack CISF Colony	BH-60	2014.777	1118.306	921.400	13.00	Not Found	0.00
Product Filtration Stage 2	BH-61	1977.133	1111.488	918.420	9.00	Not Found	0.00
Calciner	BH-62	1976.292	1082.838	918.790	12.50	Not Found	0.00

Structure Name	BH No.	Co-ordinate (M)			Terminating Depth (M)	SWL (M)	Top of rock below EGL(M)
		E	N	R.L.			
Cooling Tower Calciner	BH-63	2028.209	1082.909	923.170	17.00	Not Found	0.00
Cooling Tower Calciner	BH-64	2051.470	1086.474	920.240	16.50	Not Found	0.50
Calciner	BH-65	1958.170	1047.392	917.947	19.00	Not Found	11.00
Sub-Station 06	BH-66	1952.769	923.664	920.070	15.50	Not Found	3.10
Alumina Storage	BH-67	1961.774	722.426	907.020	13.00	8.50	8.30
Alumina Storage	BH-68	2003.705	720.664	906.844	18.00	10.00	13.50
Filtered Water Reservoir	BH-69	2003.306	537.241	898.601	18.00	3.30	11.00
Raw Water Reservoir	BH-70	1909.697	459.667	902.624	15.00	5.10	7.50
Raw Water Reservoir	BH-71	1878.984	406.758	906.105	12.60	3.90	4.60
Drinking Water Unit	BH-72	1420.073	466.705	959.753	19.10	Not Found	2.10
Drinking Water Unit	BH-73	1457.693	515.174	956.326	16.50	Not Found	7.50
Caustic Soda Storage	BH-74	1462.210	632.905	921.108	17.10	Not Found	2.10
Fuel Oil Unloading & Storage	BH-75	1498.876	668.828	919.815	19.60	Not Found	5.10
Fuel Oil Unloading & Storage	BH-76	1507.410	632.705	921.816	20.10	Not Found	1.10
Bauxite Handling	BH-81	648.006	548.563	893.442	20.00	4.30	8.00
Bauxite Handling	BH-82	671.754	655.301	891.785	25.00	3.90	16.00
Bauxite Handling	BH-85	691.854	721.597	892.139	32.00	12.10	18.00
Bauxite Handling	BH-86	716.627	803.306	895.717	34.00	4.30	21.50
Bauxite Handling	BH-87	732.704	856.333	902.260	40.00	9.80	38.00
Bauxite Handling	BH-88	758.290	940.723	905.049	40.00	9.40	35.10
Bauxite Handling	BH-89	778.576	1029.230	904.100	40.00	11.10	33.00
Bauxite Handling	BH-90	810.412	1134.878	904.180	40.00	11.70	35.30
Bauxite Handling	BH-91	845.002	1226.725	903.400	40.45	10.40	--
Lime Preparation	BH-92	1028.056	1321.374	902.436	21.00	Not Found	9.30
SPP	BH-93	1134.386	1263.133	902.396	30.00	4.10	16.50
SPP	BH-94	1098.918	1235.653	901.630	29.50	3.90	12.50
SPP	BH-96	1101.920	1175.304	900.581	23.50	5.30	6.50
SPP	BH-97	1099.187	1133.684	899.829	19.50	4.10	3.00
Substation BH-98 Extension Building		1251.836	1035.591	897.889	40.00	4.50	33.20
Switch Yard	BH-99	1149.224	899.710	892.349	28.00	3.20	21.20
Sewage Treatment Plant	BH-100	1151.054	815.773	893.111	40.00	1.70	35.00
CHP	BH-MND-01	752.175	325.876	893.568	19.00	6.80	1 4.70
CHP	BH-MND-02	751.600	687.500	891.530	21.00	9.40	15.00
CHP	BH-MND-03	865.575	1106.450	900.002	40.00	12.00	27.70
CHP	BH-MND-04	974.957	1124.599	898.603	36.00	8.70	12.90
CHP	BH-MND-05	972.075	1248.000	900.141	36.00	4.30	14.10
SPP	BH-MND-06	1050.985	1261.850	901.769	24.10	4.10	12.10
SPP	BH-MND-07	1103.042	1253.554	902.128	28.50	3.90	12.50
SPP	BH-MND-10	1103.245	1070.27	899.744	21.00	5.35	10.00

Structure Name	BH No.	Co-ordinate (M)			Terminating Depth (M)	SWL (M)	Top of rock below EGL(M)
		E	N	R.L.			
SPP	BH-MND-11	1087.882	1026.07	898.032	22.50	5.10	12.50
SPP	BH-MND-12	1087.697	948.727	895.298	30.50	6.20	13.50
DM Plant	BH-MND-13	1507.562	950.629	898.164	40.00	11.30	16.50

2.2. BORING:

Boring was carried out by Shell and Auger method to sink nominal 150mm diameter bore holes to depths envisaged by using a mechanical winch. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is earlier by open drive sampling method since it was intended to ascertain the sub-soil characteristics.

2.3. SAMPLING:

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 450 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far downs as was found practicable. As the soil is very stiff to hard and contains sand mixtures / calcareous nodules, cutting shoe was used with a area ratio < 20%. After withdrawal the ends of the tubes were sealed with wax and capped before onward transmission to the laboratory. At close intervals in depth disturbed samples were collected for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory.

2.4. STANDARD PENETRATION TESTS:

Standard Penetration Tests were conducted in the bore holes at intervals of 1.5M to 3.0M depth or at change of strata whichever is earlier using a split spoon sampler. The split spoon sampler used is of a Standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driven with a monkey weighing 63.5 kgs, falling freely through 75cms. A record of the number of blows required to penetrate every 15cms to a maximum depth of 45cms was made. The first 15cm of drive are considered to be seating drive and are neglected. The total blows required for second & third 15cm of penetration is counted and termed as penetration resistance "N". On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SP Tests were done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.5. MEASUREMENT OF WATER TABLE:

Standing water level after 24 hours of removal of casing was also noted and shown in the profile.

2.6. ROTARY CORE DRILLING:

This drilling technique is regarded as the most satisfactory method of assessing the character of rock formations, which lie at depth below the ground surface. Specimens of rock in the form of cylindrical cores are recovered from the drill holes by means of a core barrel. Double barrel technique is adopted according to field condition. The core barrel is provided at its lower end with a detachable shoe or core bit, which is of diamond. All rotary core bits were of NX (73mm) size.

2.7. TRIAL PITS:

14 nos. Trial Pits were excavated for physical verification of subsoil with depth. The co-ordinates of the Trial Pit locations are presented below.

Trial Pit No.	Co-ordinate (M)			Depth (M)	Standing Water Level(M)
	Easting	Northing	R.L.		
TP – 1	Not Yet conducted. Will be Incorporated Later				
TP – 2					
TP – 3					
TP – 4	2041.660	1594.187	924.910	1.60	Not found
TP – 5	1950.998	1081.527	918.233	0.80	Not found
TP – 6	1862.570	444.903	907.020	3.50	Not found
TP – 7	717.981	776.546	897.460	3.50	Not found
TP – 8	1129.369	907.525	892.280	3.50	Not found
TP-MND-01	750.013	107.771	891.289	3.50	Not found
TP-MND-02	1061.908	1176.219	900.078	3.50	Not found
TP-MND-03	1130.080	1261.109	902.600	3.50	Not found
TP-MND-04	1112.011	1181.943	900.735	3.50	Not found
TP-MND-05	1067.227	1072.026	897.331	3.50	Not found
TP-MND-06	1498.204	903.623	898.443	3.50	Not found

2.8. FIELD C.B.R. TEST:

The tests were carried out in accordance with IS 2720 (Part 31) : 1969 (and Amendment 1). Total 10 nos. Field C.B.R. Tests (soaked) were conducted. The co-ordinates of the test location are presented below.

FCBR No.	Co-ordinate (M)			Depth (M)
	E	N	R.L.	
CBR - 1	Not yet conducted. Will be Incorporated later			
CBR – 2	1483.948	1643.399	921.420	0.80
CBR – 3	Not yet conducted. Incorporated later			
CBR – 4	1921.028	1649.156	926.420	0.50
CBR – 5	Not yet conducted. Will be Incorporated later			
CBR – 6				
CBR – 7				
CBR – 8	2151.449	1704.949	923.066	0.50
CBR – 9	1587.995	2210.678	911.560	0.50
CBR - 10	869.240	1199.608	898.300	0.50

2.9. CYCLIC PLATE LOAD TESTS:

Total six (6) sets of Plate Load Tests (Cyclic type) were conducted **using a 450mm square plate.** Test is continued upto a maximum desired loading intensity or specified plate settlement which ever is earlier. The load is applied through a hydraulic jack. The reaction for applying the load on the plate is obtained by a loading platform with sandbags. After applying the load increments, settlement records are made at intervals of 1, 2.25, 4, 6.25, 9, 16, 25, 60, 90 & 120 minutes and thereafter at an interval of an hour. When the rate of plate settlement reduced to 0.02 mm per minute, the final reading of the dial gauges is recorded. The applied load is then released and the plate allowed to rebound. When no further rebound occurs or the rate of rebound becomes negligible, the readings of the dial gauges are again noted. The load then is increased gradually till its magnitude acquires a value equal to the proposed next higher stage of loading which is to be maintained constantly and the final dial gauge readings are noted as earlier. The entire load is then reduced to zero and final dial gauge readings recorded when the rate of rebound becomes negligible. The coordinate of test locations are given below.

PLT No.	Type of Tests	Plate size (mm x mm)	Co-ordinates (M)		R. L. (M)	Depth (M)
			E	N		
CPLT-01	Cyclic Type	450 x 450	Not yet conducted. Will be Incorporated later			
CPLT-02	Cyclic Type	450 x 450				
CPLT-03	Cyclic Type	450 x 450				
CPLT-04	Cyclic Type	450 x 450				

PLT No.	Type of Tests	Plate size (mm x mm)	Co-ordinates (M)		R. L. (M)	Depth (M)
			E	N		
CPLT-05	Cyclic Type	450 x 450	Not yet conducted. Will be Incorporated later			
CPLT-06	Cyclic Type	450 x 450				

2.10. ELECTRICAL RESISTIVITY TESTS:

Twenty two (22) nos. Electrical Resistivity Tests were carried out at the following locations. The test procedure and results are presented under Section-8.

ERT	Co-ordinate (M)		R.L. (M)
	E	N	
ERT-1	1291.008	1671.056	917.812
ERT-2	1506.561	1764.099	922.835
ERT-3	1619.433	1593.728	924.515
ERT-4	1852.263	1676.054	925.337
ERT-5	2062.506	1755.947	942.705
ERT-6	2186.045	1684.951	917.837
ERT-7	1931.618	884.742	920.136
ERT-8	1984.533	700.992	905.117
ERT-9	1985.515	527.878	898.887
ERT-10	1152.723	795.695	892.640
ERT-11	1113.529	890.739	892.584
ERT-12	1158.339	914.912	892.472
ERT-13	1236.499	1034.204	897.600
ERT-MND-01	772.751	658.617	891.600
ERT-MND-02	1017.218	1262.551	901.523
ERT-MND-03	1145.238	1262.902	900.912
ERT-MND-04	1059.191	1220.968	900.315
ERT-MND-05	1117.399	1108.098	899.920
ERT-MND-06	1087.081	1084.113	900.245
ERT-MND-07	1128.441	1067.682	899.821
ERT-MND-08	1093.592	937.014	892.846
ERT-MND-09	1513.269	927.554	898.833

2.11. BLOCK VIBRATION TESTS:

Six (6) nos. Block Vibration Tests were carried out to determine the dynamic properties of the layer for the construction of machine foundations at the following locations.

BVT No.	Co-ordinates		R. L. (M)
	Easting	Northing	
BVT-1	Not yet conducted. Will be Incorporated later		
BVT-2			
BVT-3			
BVT-4			
BVT-5			
BVT-6			

3. LABORATORY TESTING

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the following laboratory tests were conducted on the soil / rock samples collected from the exploratory bore holes:

On Soil Samples:

1. **Grain size analysis (Sieve as well as Hydrometer).**
2. **Determination of Liquid Limit, Plastic Limit and Shrinkage Limit.**
3. **Determination of Natural Moisture Content.**
4. **Determination of Specific Gravity.**
5. **Determination of Bulk & Dry Unit Weight.**
6. **Strength determination by Triaxial Unconsolidated Undrained Test (UU).**
7. **Strength determination by Triaxial Consolidated Drained Test (CD).**
8. **Strength Determination of Unconfined Compression Test on "UDS" (UNCONFD).**
9. **Strength Determination of Unconfined Compression Test on REMOULDED samples.**
10. **Strength determination by Direct Shear Test under Quick condition (CQ).**
11. **One-dimensional Consolidation Test for determining settlement potentiality.**
12. **Standard Proctor Compaction Test to determine OMC & MDD.**
13. **Determination of California Bearing Ratio (4 days soaked) compacted at 95% of MDD.**
14. **Determination of Permeability on samples compacted at MDD/OMC.**
15. **Determination of Free Swelling Index & Swelling Pressure.**
16. **Chemical tests on soil samples to determine pH value, Sulphate, Chloride & organic matter content etc.**

On Rock Samples:

1. **Determination of Bulk Density, Water Content, Specific Gravity & Porosity of Rock.**
2. **Determination of Unconfined Compressive Strength of Rock samples (Saturated & Dry State)**
3. **Determination of Point Load Strength Index.**

Laboratory test results are presented in a tabular form in Volume - 2. The results are self explanatory excepting that of consolidation tests. The compressibility for a pressure range has been separated into 2 components through the compression ratio. As a first step dial gauge reading is plotted against square root of time and by extrapolation dial reading at zero time, is obtained. The compression ratio is given as

$r = (d_i - d_s)/(d_i - d_f)$, where

d_i = Initial reading of dial before load application

d_s = Dial reading corresponding to theoretical zero time

d_f = Final dial reading after 24 hrs.

Now we write $m_{vc} = (1- r) \times m_v$

All the tests were conducted as per relevant Indian Standard Specifications.

4. SUBSOIL CONDITION, STRATIFICATION AND PROPERTIES

4.1. SUB-SOIL CONDITIONS:

The boring records showing the various soils met with are enclosed in Volume-2. These are prepared from field logs after proper modifications in the light of the laboratory test results and observation of disturbed and penetrometer soil samples. The results of the Standard Penetration Tests are given as 'N' values in these boring records. The sub-soil profiles (as obtained from field and Laboratory test results) across the bore holes are shown under Figs. 2.01 to 2.27 giving description, consistency and colour of each strata. The "N" values are shown in the profiles as well as presented in the borelogs in Volume-2. The laboratory test results and the back up sheets are also presented there.

4.2. SUB-SOIL STRATIFICATIONS:

The subsoil is characterised by filled up soil around some borehole locations followed by stiff to very stiff / hard silty clay. Below this dense to very dense silty sand with clay binder was observed. After that weathered rock layer was struck and that continued upto the terminating depth of all boreholes. The description of each layer is presented below.

4.2.1. FILL:

Filled up soil consists of reddish brown silty clay / clayey silt with moorum, boulder, tree roots, concrete pieces, brick bats, soda ash, construction garbage etc. The average properties of this layer are presented below, however these properties do not truly represents the properties of whole stratum.

Bulk Density, gms/cc	1.95	Specific gravity	2.75
Dry Density, gms/cc	1.59	Void Ratio	0.911
Natural Water Content %	22	Liquid limit %	44
TRSH-UU:		Plastic Limit %	24
Cohesion kg/sqcm	0.93	Shrinkage Limit %	20
Friction angle °	17°		
Unconfined cohesion, kg/sqcm	**0.82**		
Remoulded cohesion, kg/sqcm	**0.65**	**GRAIN SIZE**	
Sensitivity, S_t	**1.27**	Gravel %	01
DRSH-CU:		Sand %	42
Cohesion kg/sqcm	0.13	Silt %	39
Friction angle °	45°	Clay %	18

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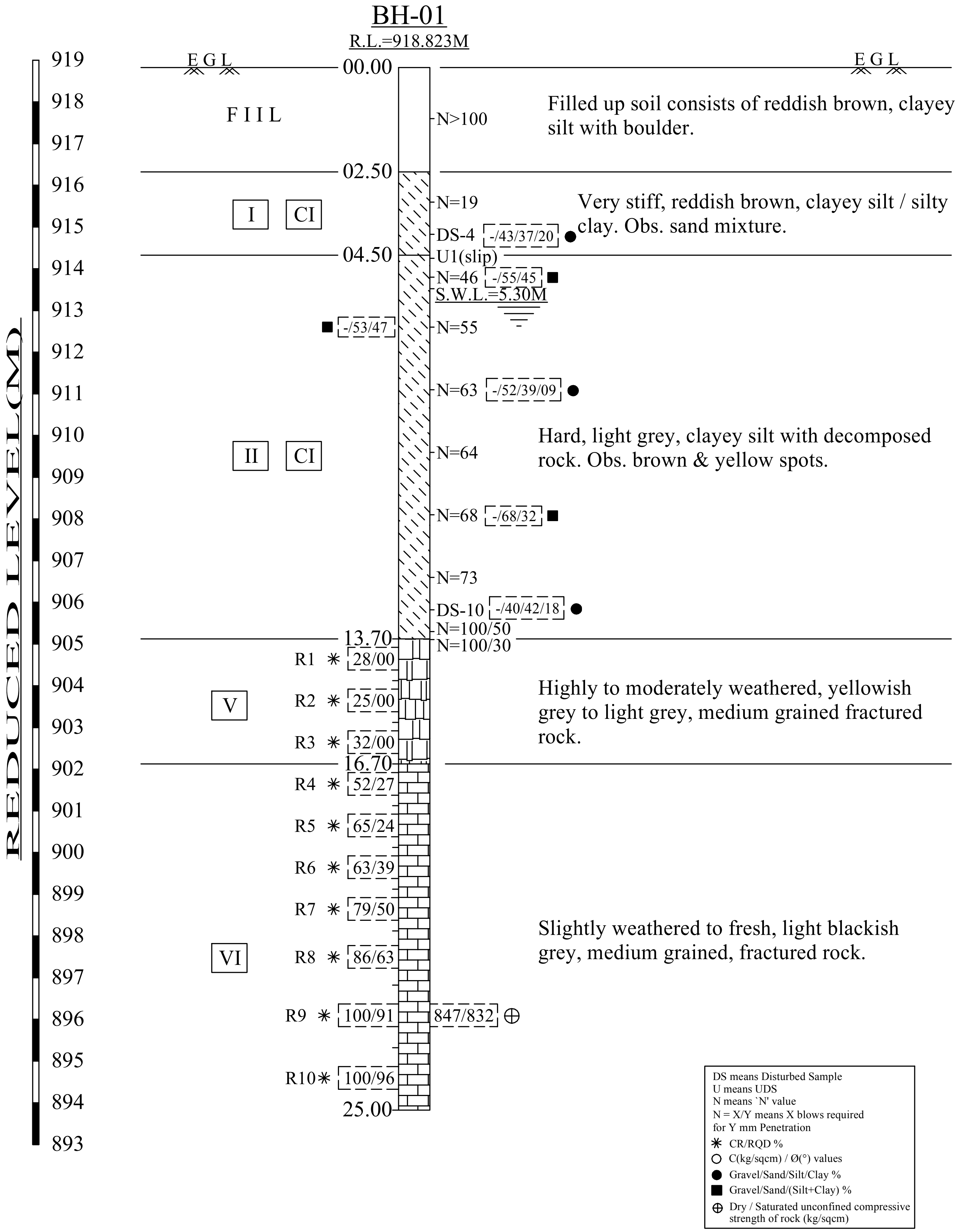
Job No : 4095	**Created by :** Chandrani	**Created on :** 03 / 03 / 2018	**Sheet No:**



(Effluent Treatment Plant)

FIG. 2.01 : GENERALISED SOIL PROFILE

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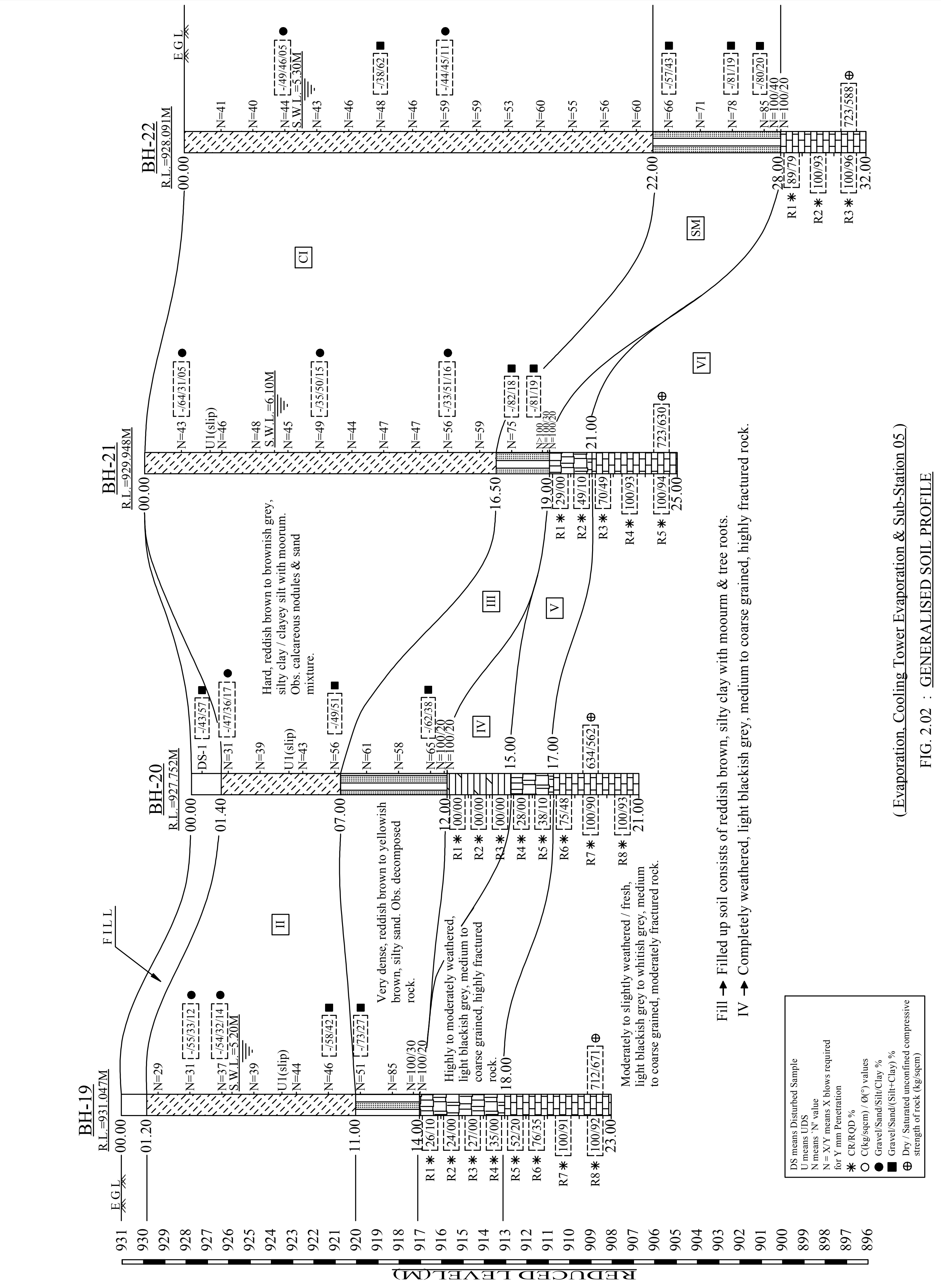

(Evaporation, Cooling Tower Evaporation & Sub-Station 05)

FIG. 2.02 : GENERALISED SOIL PROFILE

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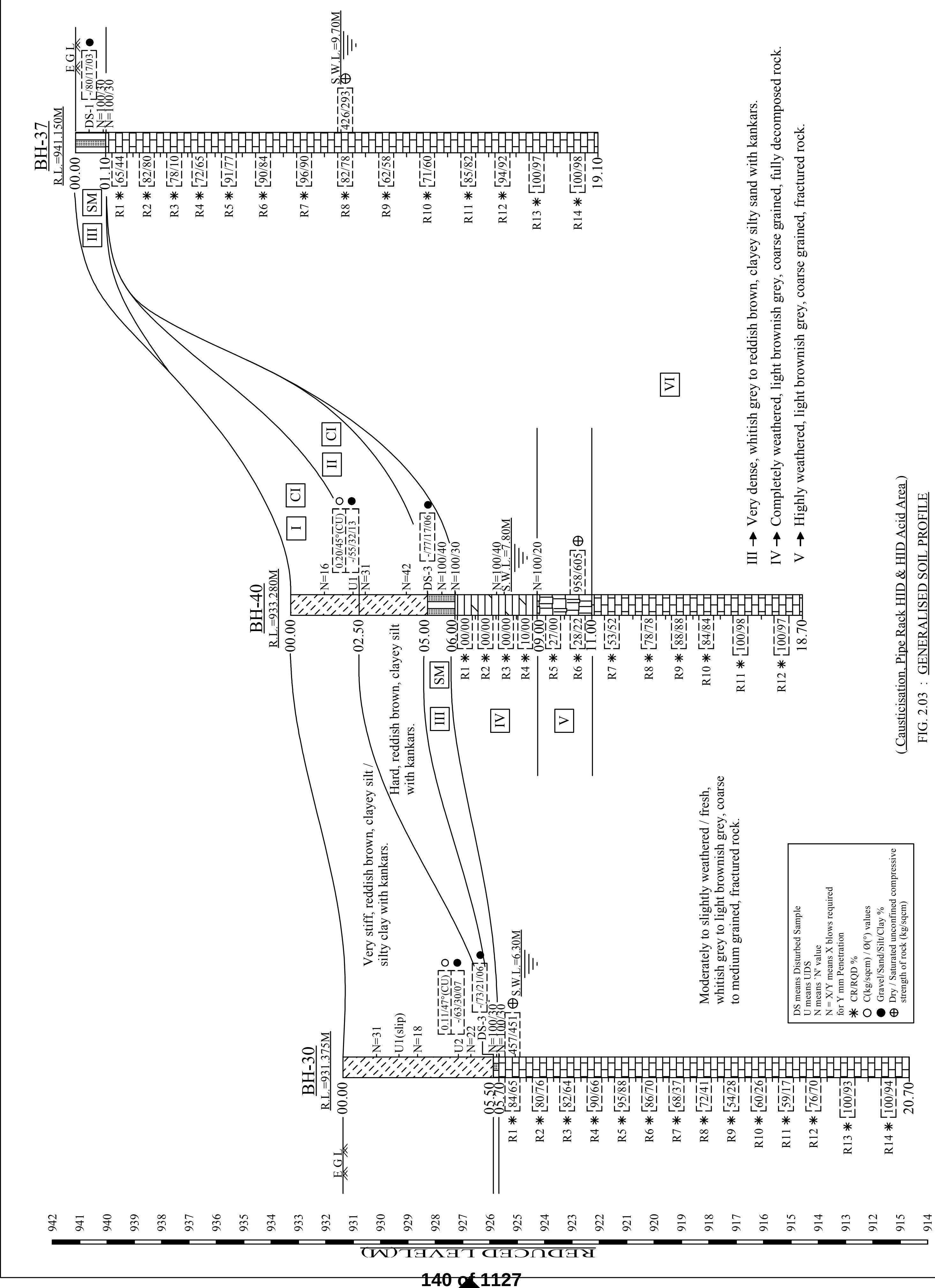

(Causticisation, Pipe Rack HID & HID Acid Area)

FIG. 2.03 : GENERALISED SOIL PROFILE

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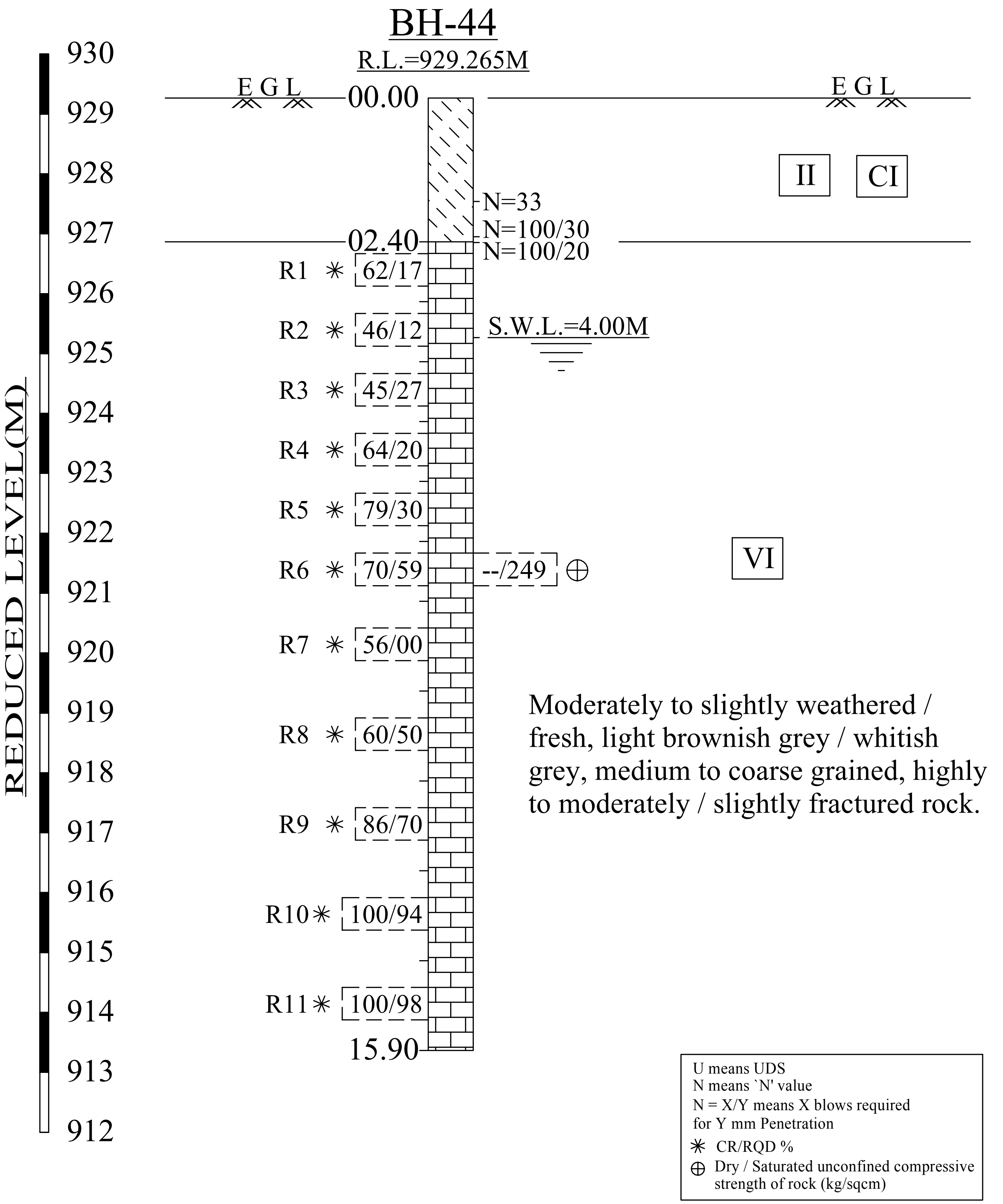


II → Hard, reddish brown, silty clay / clayey silt with moorum. Obs. decomposed rock.

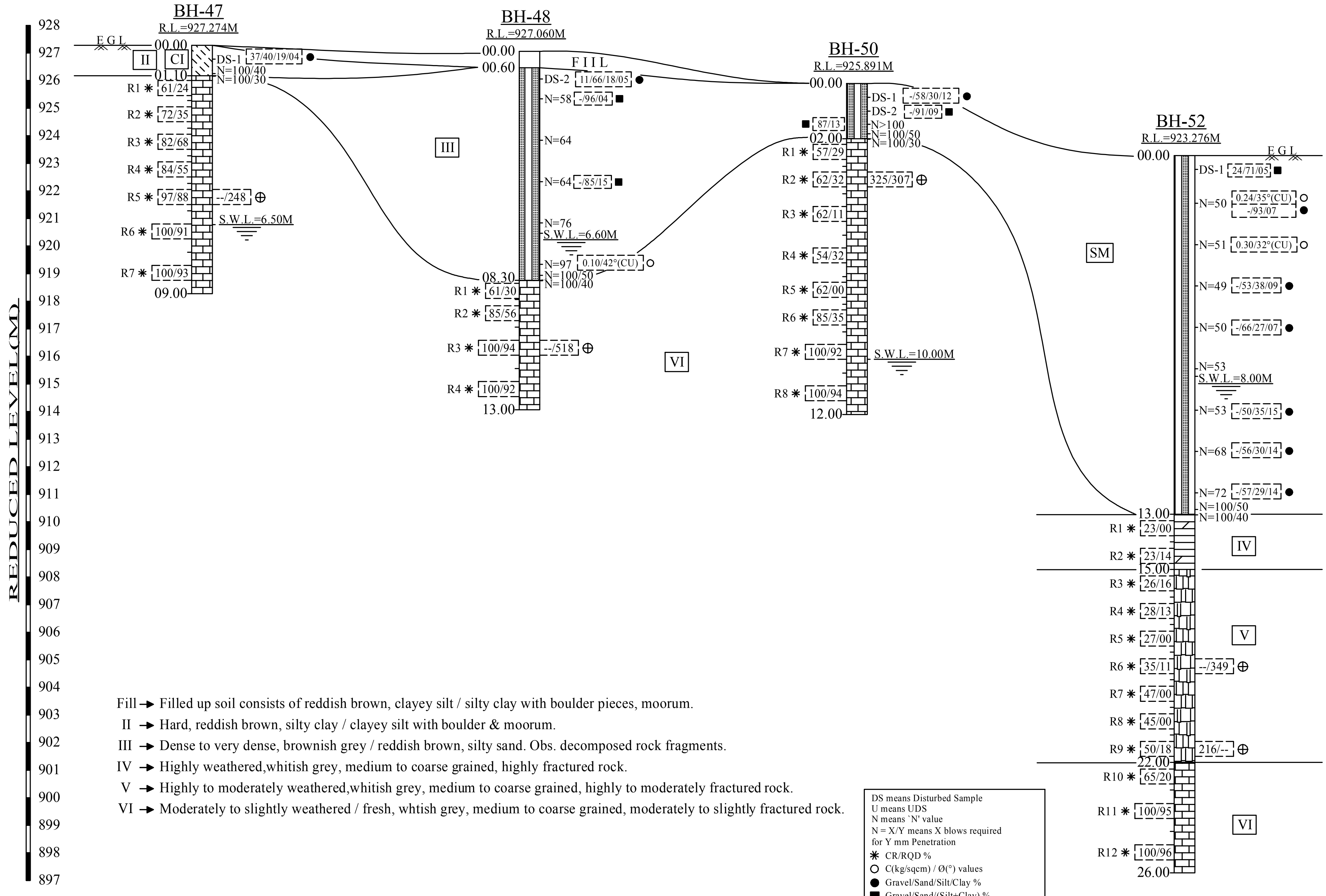
(Crushing)

FIG. 2.04 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.

CETEST

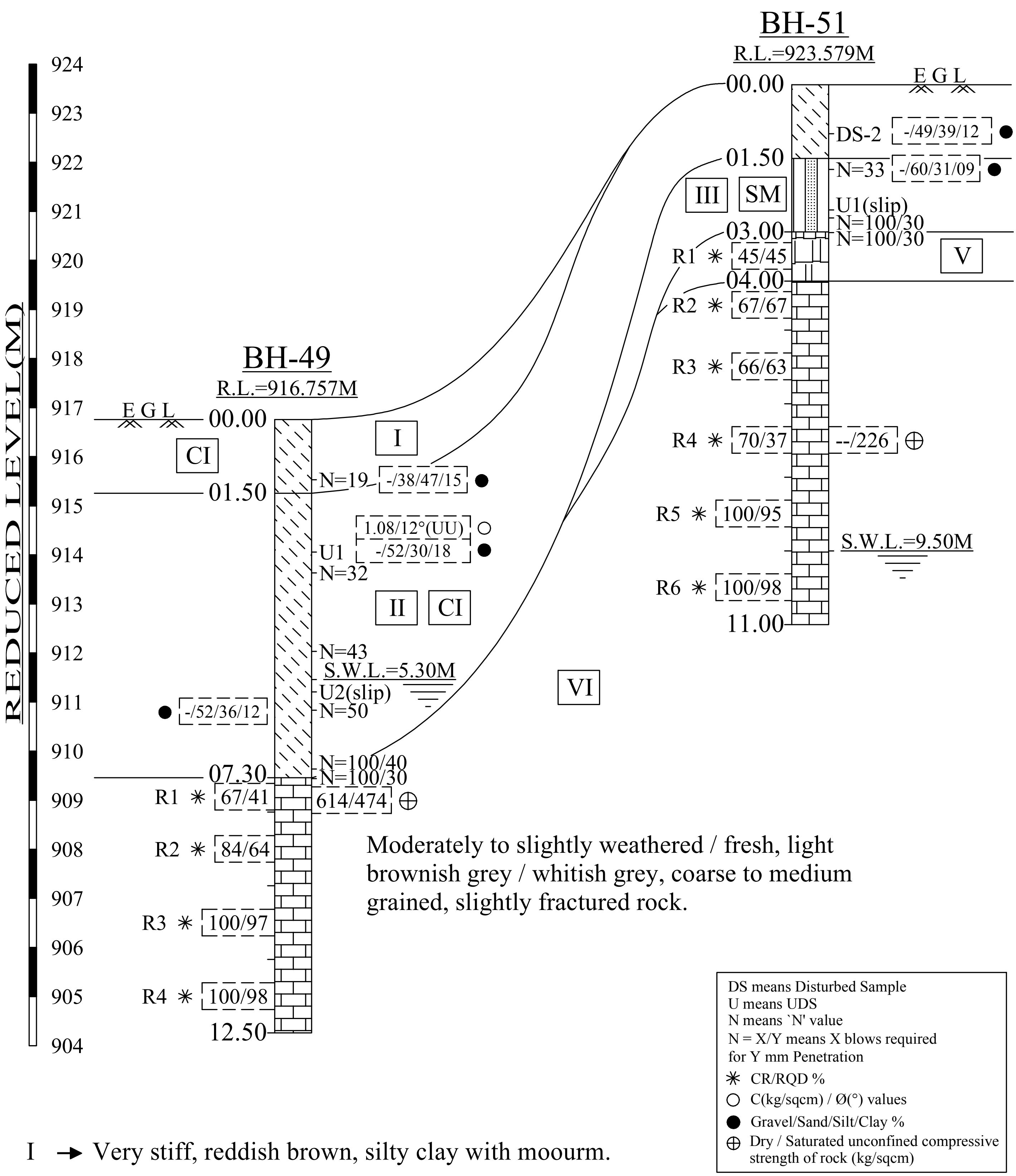
Job No : 4095 | Created by : Chandrani | Created on : 05 / 03 / 2018 | Sheet No:



(Precipitation)

FIG. 2.05 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 05 / 03 / 2018	Sheet No:



I → Very stiff, reddish brown, silty clay with moourm.

II → Hard, reddish brown, silty clay / clayey silt with kankars. Obs. moorum.

III → Dense, reddish brown, clayey silty sand with kankars. Obs. moourm.

V → Moderately weathered, light brownish grey / light whitish grey, coarse to medium grained, fractured rock.

(Hydrate Filtration)

FIG. 2.06 : GENERALISED SOIL PROFILE

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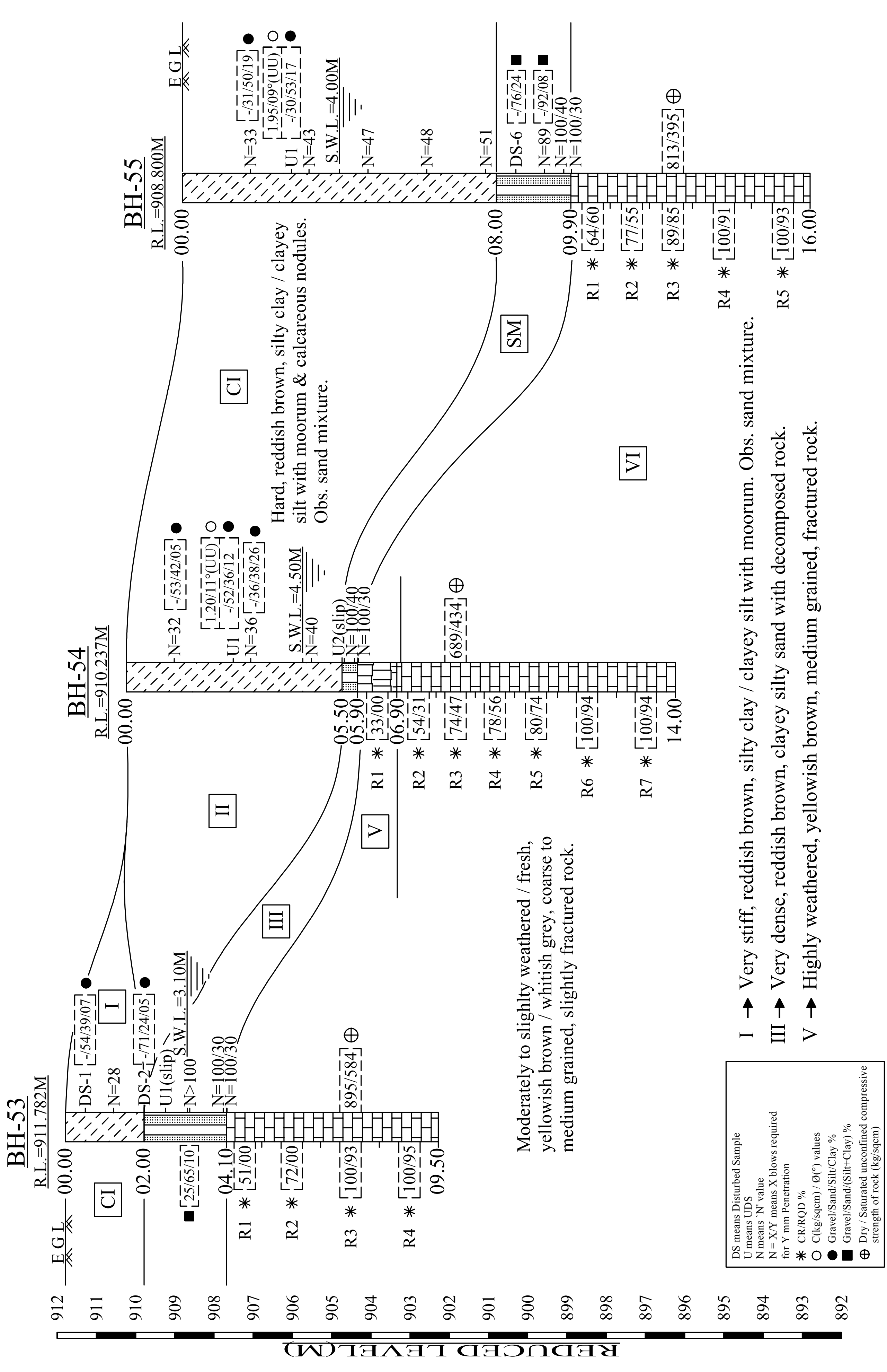

(Pipe Rack CISF Colony & Effluent Treatment Plant CISF Colony)

FIG. 2.07 : GENERALISED SOIL PROFILE

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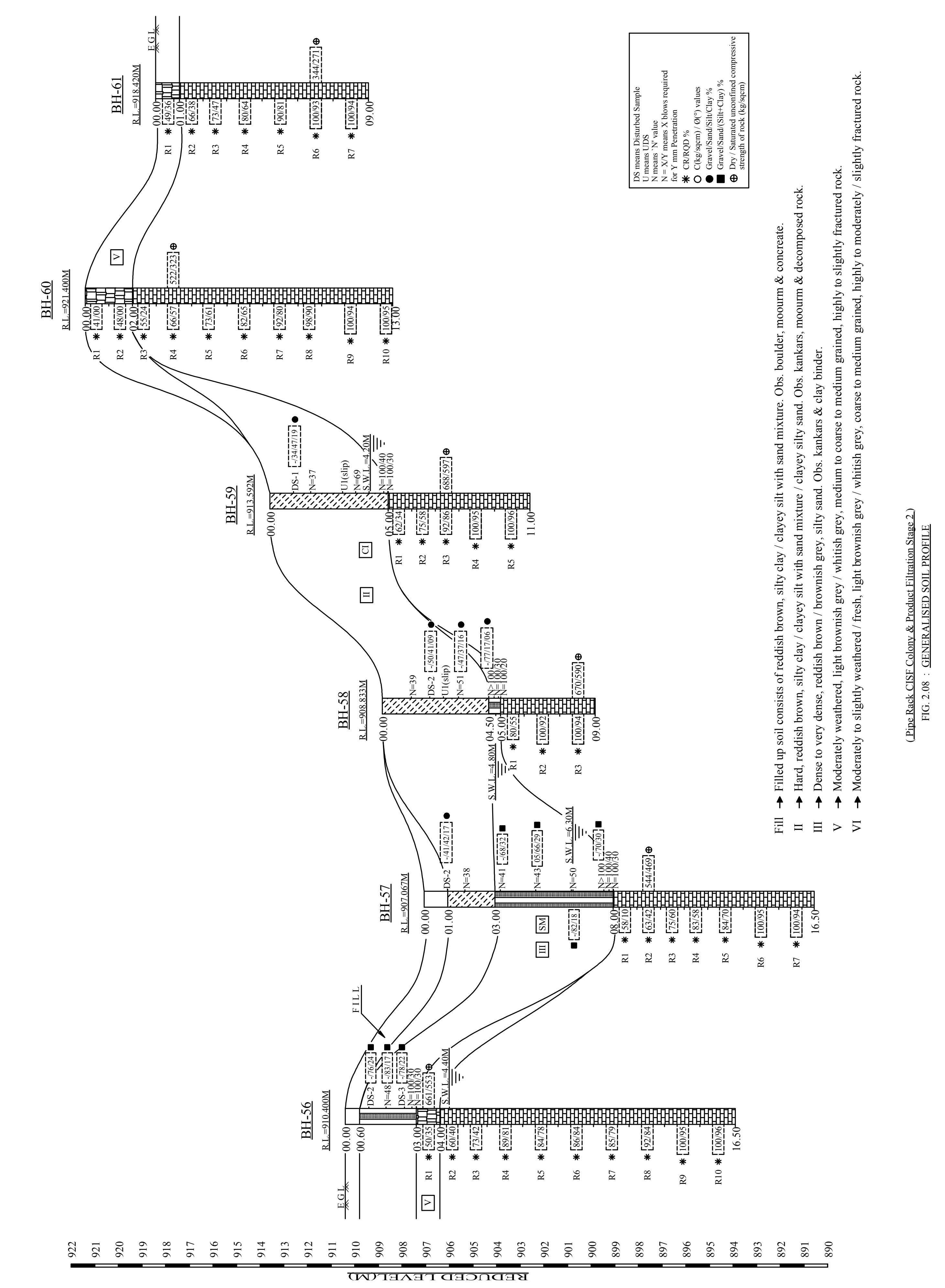

FIG. 2.08 : GENERALISED SOIL PROFILE
(Pipe Rack CISF Colony & Product Filtration Stage 2)

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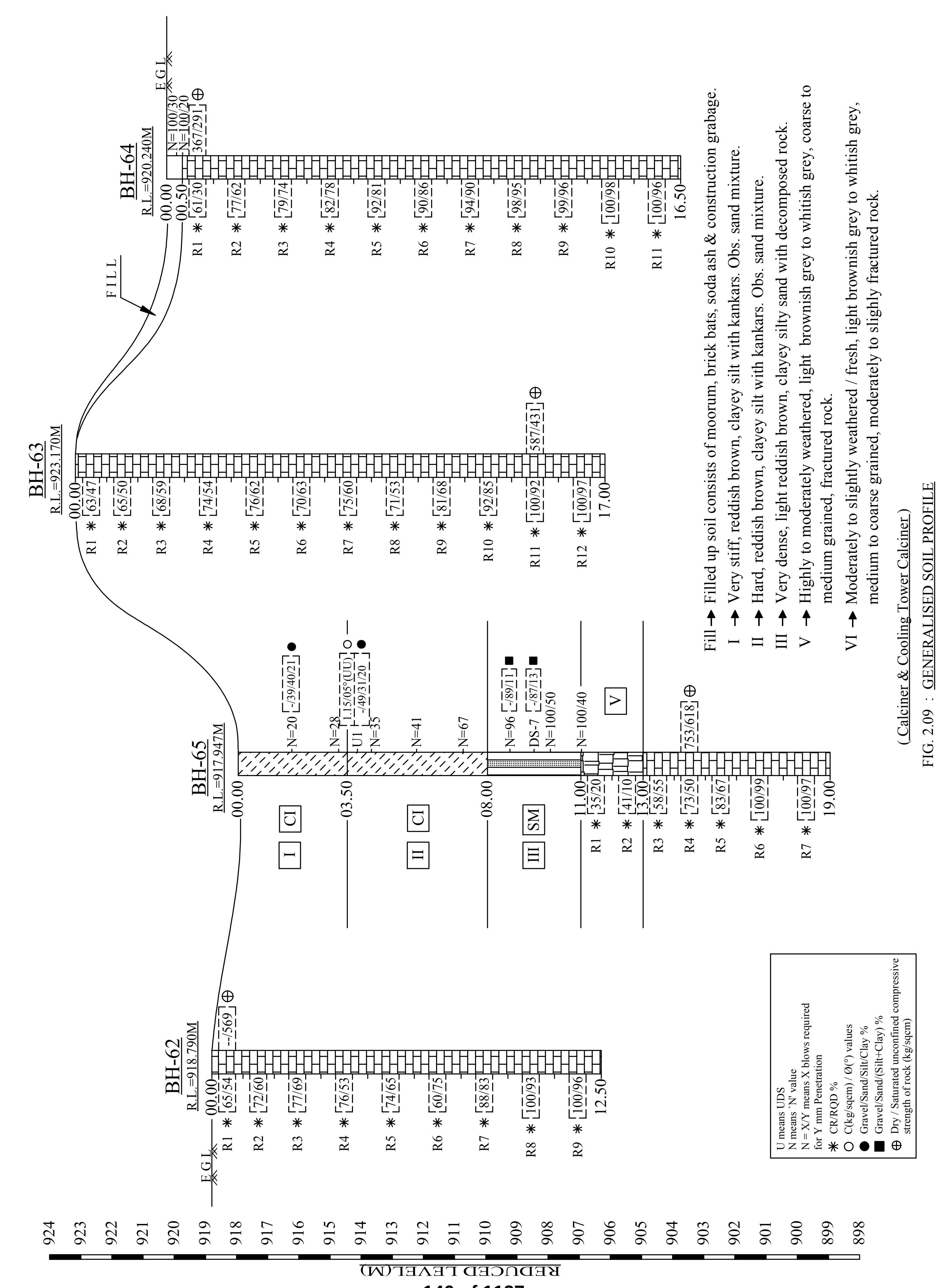

(Calciner & Cooling Tower Calciner)

FIG. 2.09 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
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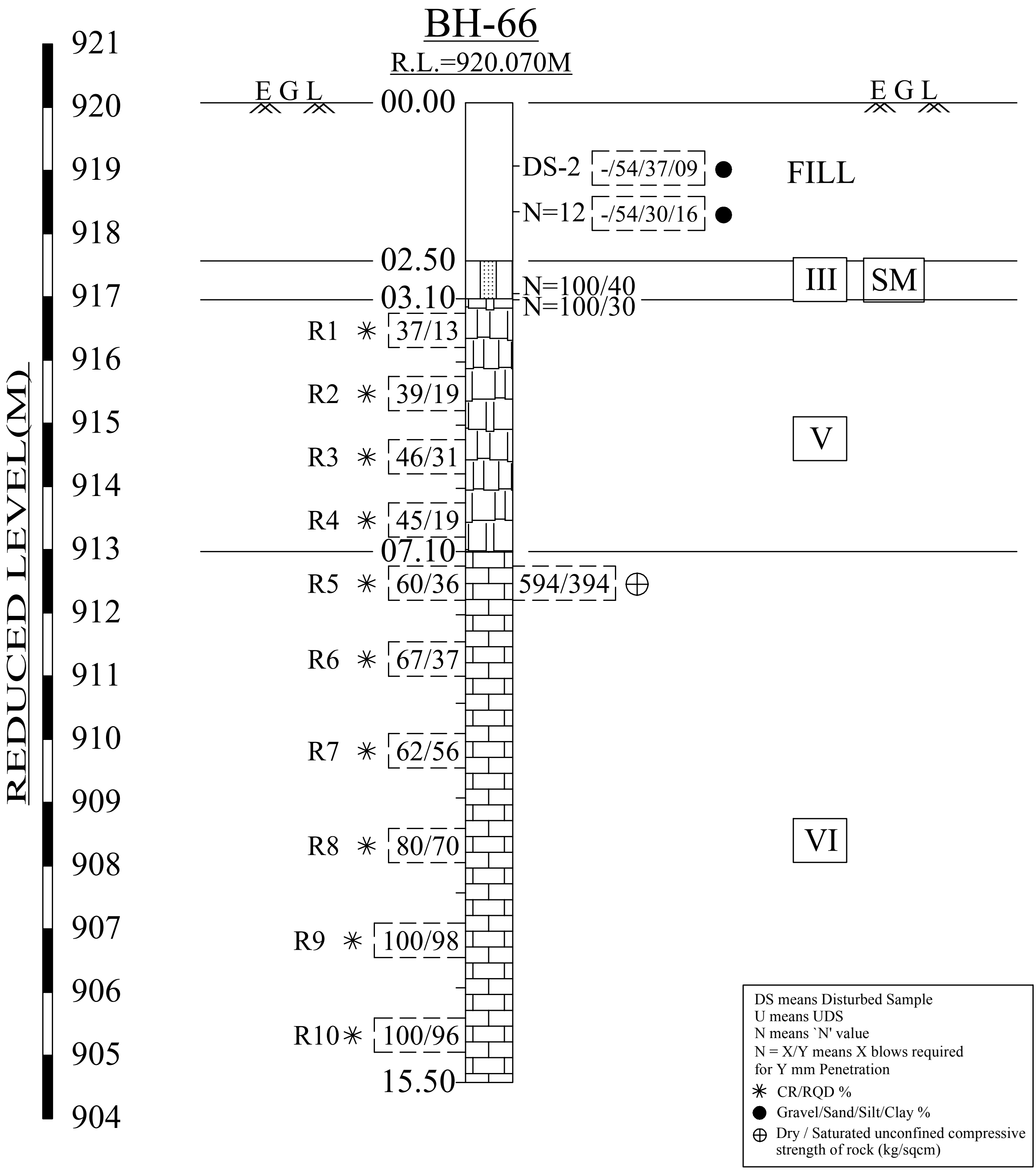


Fill → Filled up soil consists of boulder & moorum.

III → Very dense, reddish brown, clayey silty sand with decomposed rock.

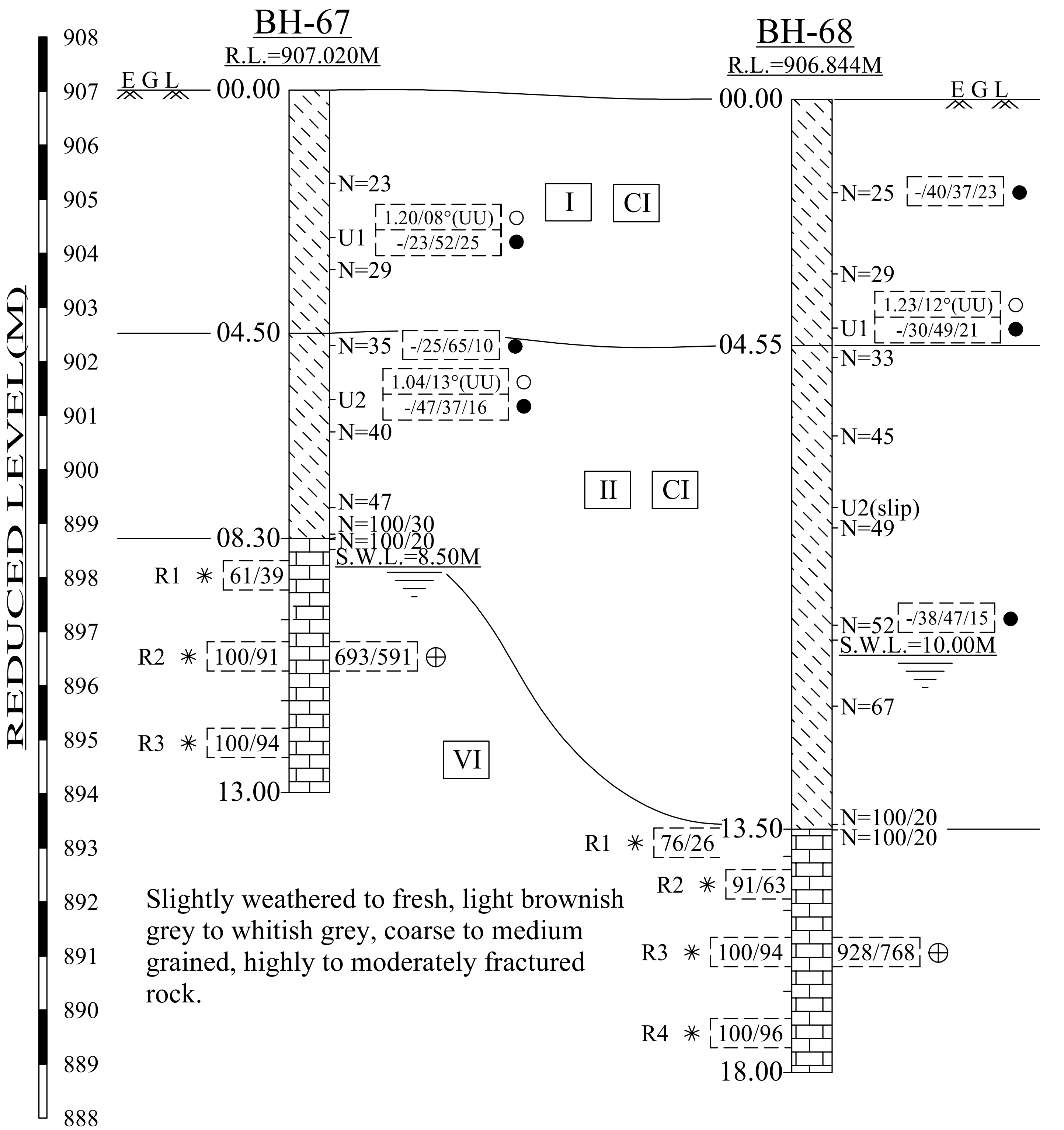
V → Highly to moderately weathered, whitish grey, medium grained, fractured rock.

VI → Slightly weathered to fresh, whitish grey, coarse grained, slightly fractured rock.

(Sub-Station 06)

FIG. 2.10 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:



I → Very stiff, reddish brown, silty clay / clayey silt with sand mixture. Obs. moorum.

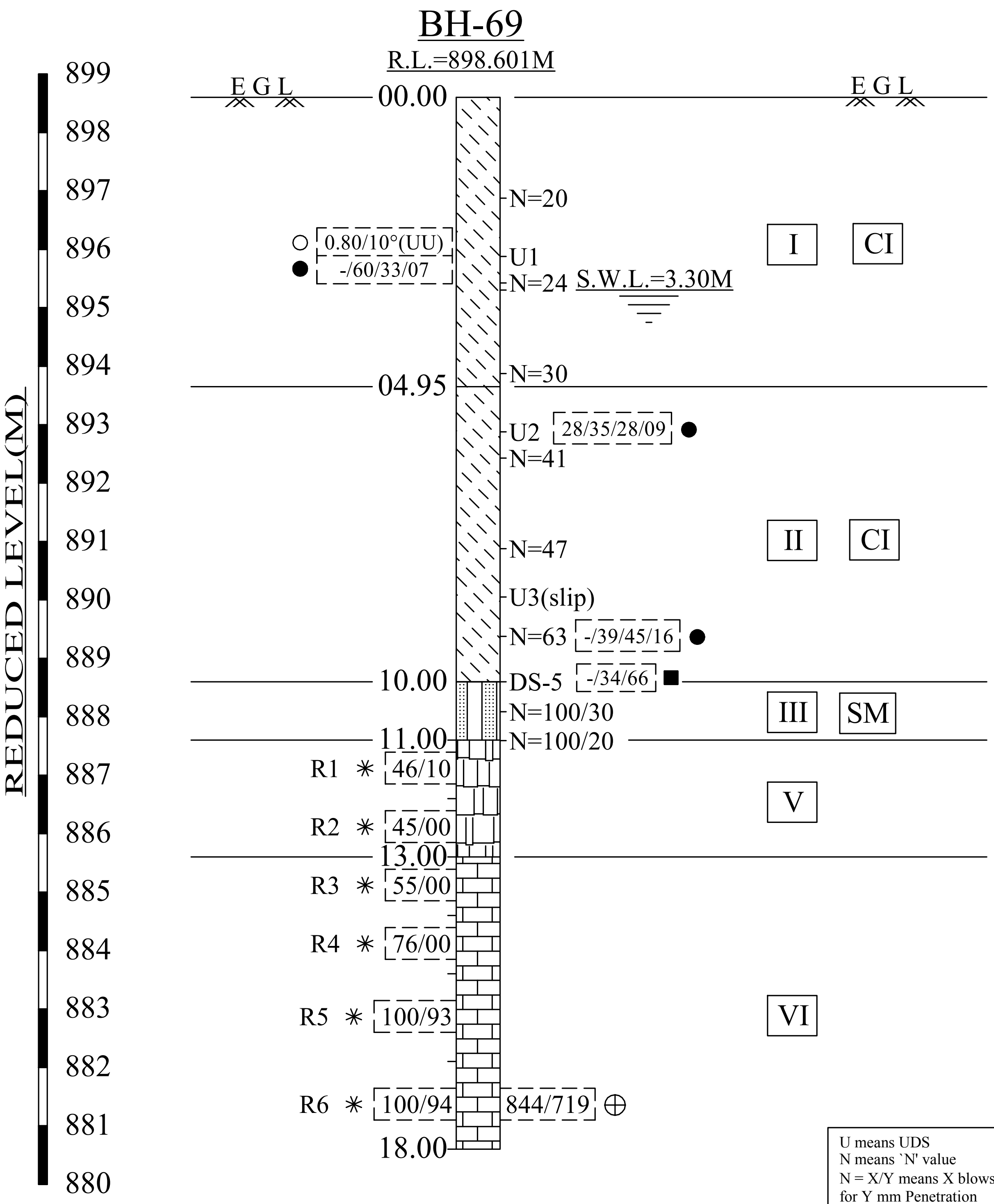
II → Hard, reddish to yellowish brown, silty clay / clayey silt with sand mixture & moorum. Obs. decomposed rock.

U means UDS
N means `N' value
N = X/Y means X blows required for Y mm Penetration
✳ CR/RQD %
○ C(kg/sqcm) / Ø(°) values
● Gravel/Sand/Silt/Clay %
⊕ Dry / Saturated unconfined compressive strength of rock (kg/sqcm)

(Alumina Storage)

FIG. 2.11 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03 / 03 / 2018	Sheet No:



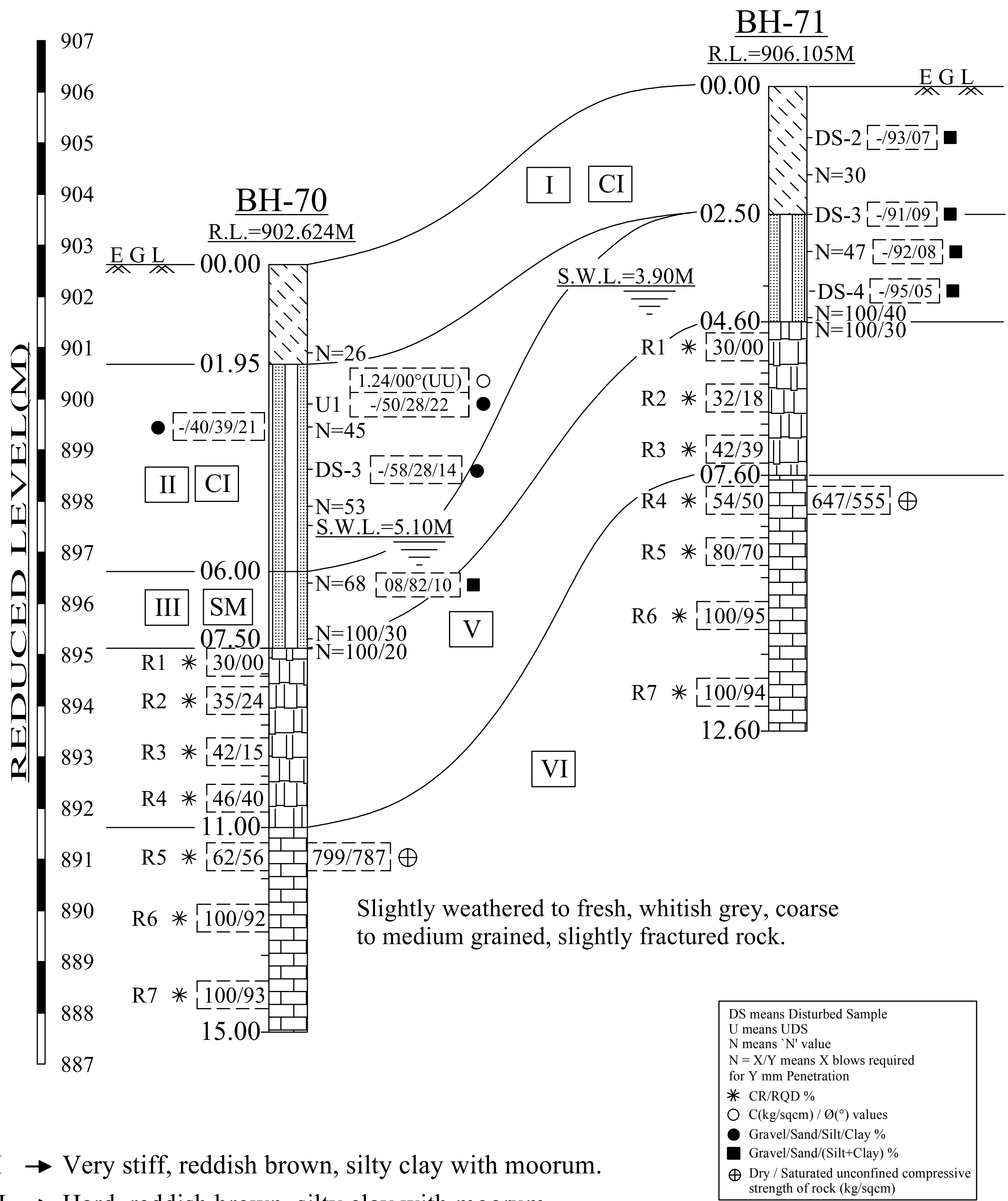
U means UDS
N means `N' value
N = X/Y means X blows required for Y mm Penetration
✳ CR/RQD %
○ C(kg/sqcm) / Ø(°) values
● Gravel/Sand/Silt/Clay %
■ Gravel/Sand/(Silt+Clay) %
⊕ Dry / Saturated unconfined compressive strength of rock (kg/sqcm)

I → Very stiff, reddish brown, silty clay with moourm.
II → Hard, reddish brown, silty clay with moourm.
III → Very dense, whitish grey, silty sand with decomposed rock.
V → Moderately weathered, whitish grey, medium grained, fractured rock.
VI → Moderately weathered to fresh, whitish grey, medium grained, slightly fractured rock.

(Filtered Water Reservoir)

FIG. 2.12 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 03 / 2018	**Sheet No:**



I → Very stiff, reddish brown, silty clay with moorum.

II → Hard, reddish brown, silty clay with moorum.

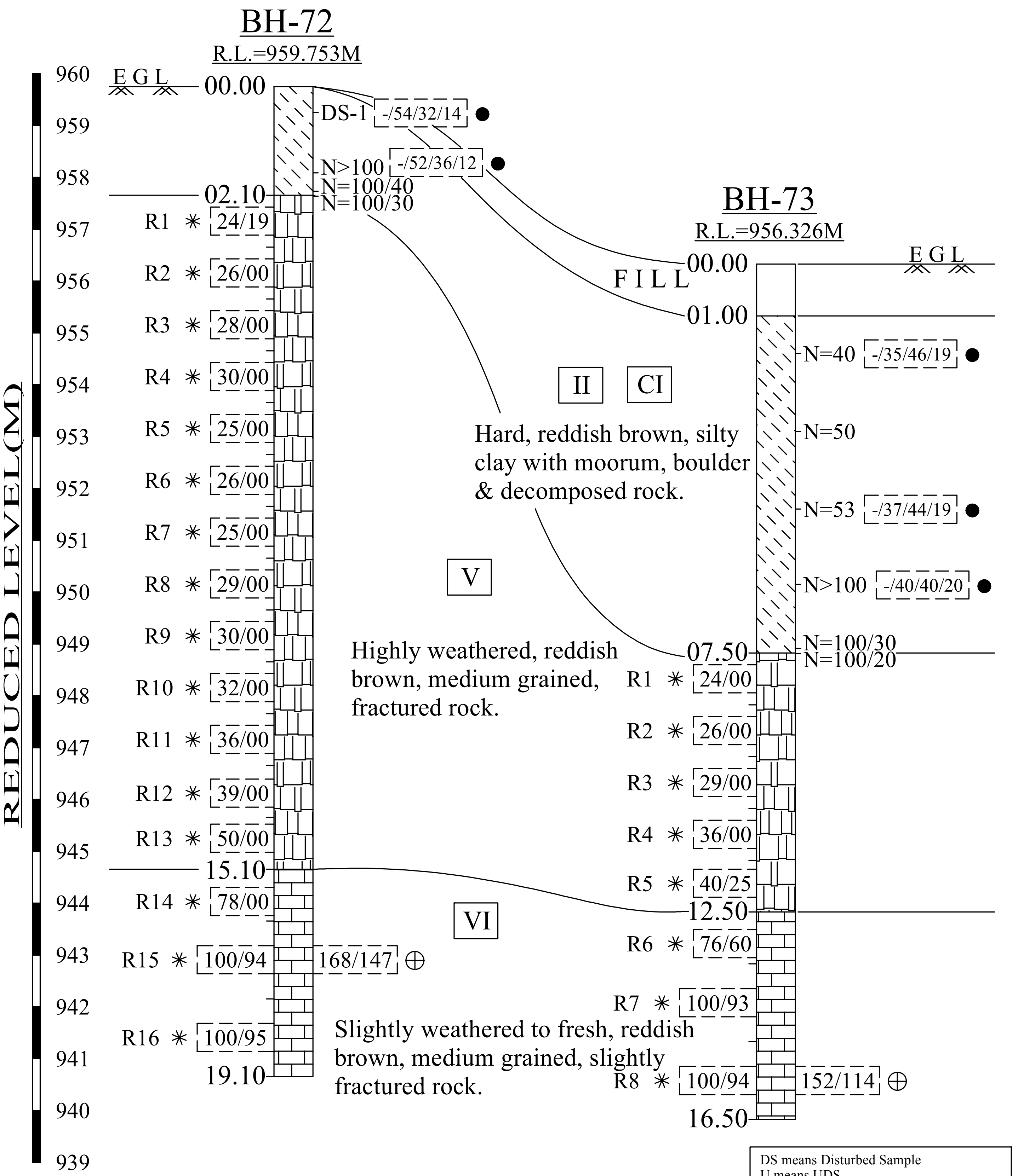
III → Dense to very dense, light grey to whitish grey, silty sand with decomposed rock & traces of mica.

V → Highly to moderately weathered, whitish grey, medium graiend, highly to moderately fractured rock.

(Raw Water Reservoir)

FIG. 2.13 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:



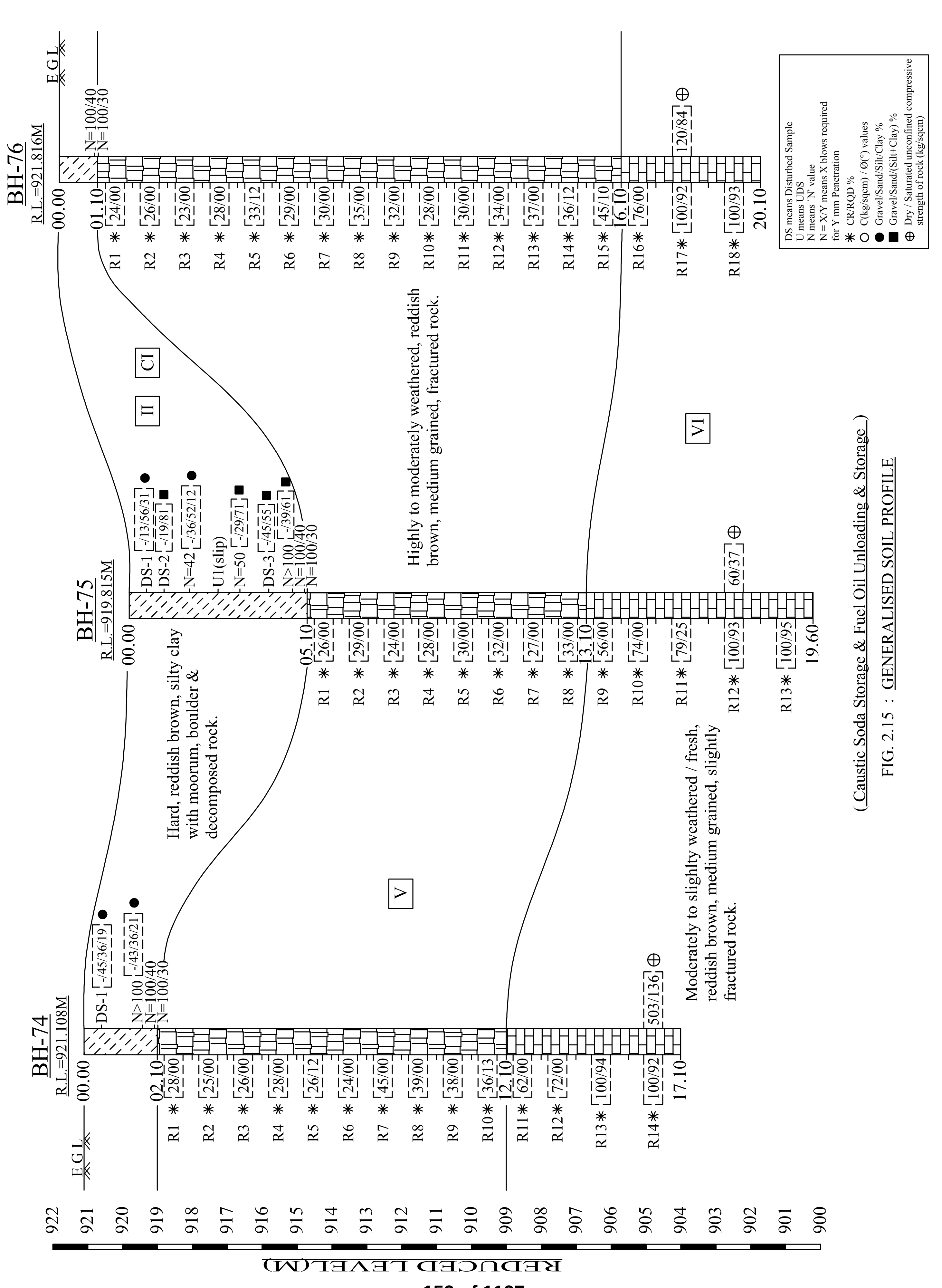
DS means Disturbed Sample
U means UDS
N means `N' value
N = X/Y means X blows required for Y mm Penetration
✳ CR/RQD %
○ C(kg/sqcm) / Ø(°) values
● Gravel/Sand/Silt/Clay %
⊕ Dry / Saturated unconfined compressive strength of rock (kg/sqcm)

Fill → Filled up soil consists of road materials with PCC.

(Drinking Water Unit)

FIG. 2.14 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 08 / 03 / 2018	Sheet No:



(Caustic Soda Storage & Fuel Oil Unloading & Storage)

FIG. 2.15 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 03 / 2018	**Sheet No:**

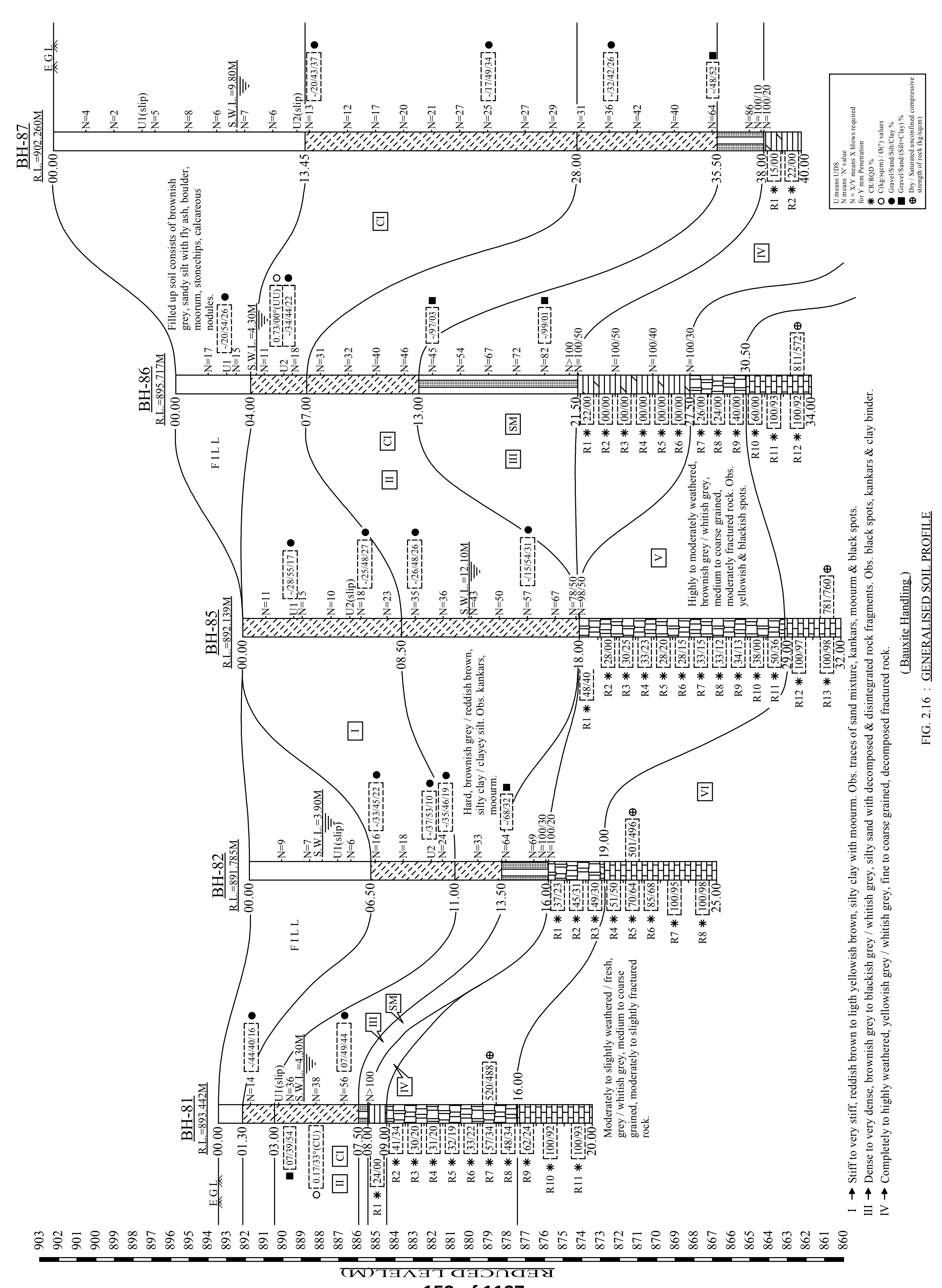


FIG. 2.16 : GENERALISED SOIL PROFILE

(Bauxite Handling)

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:

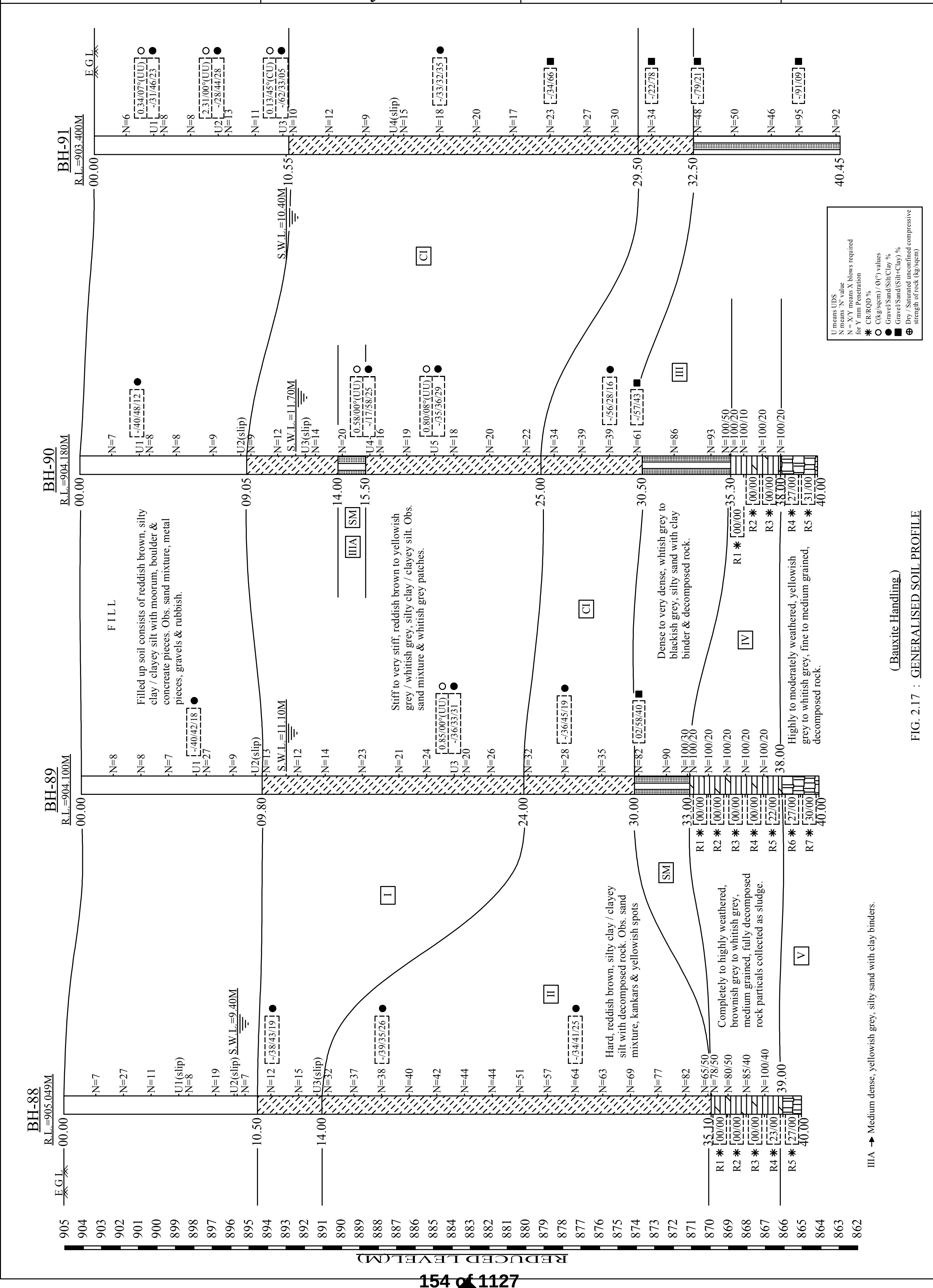
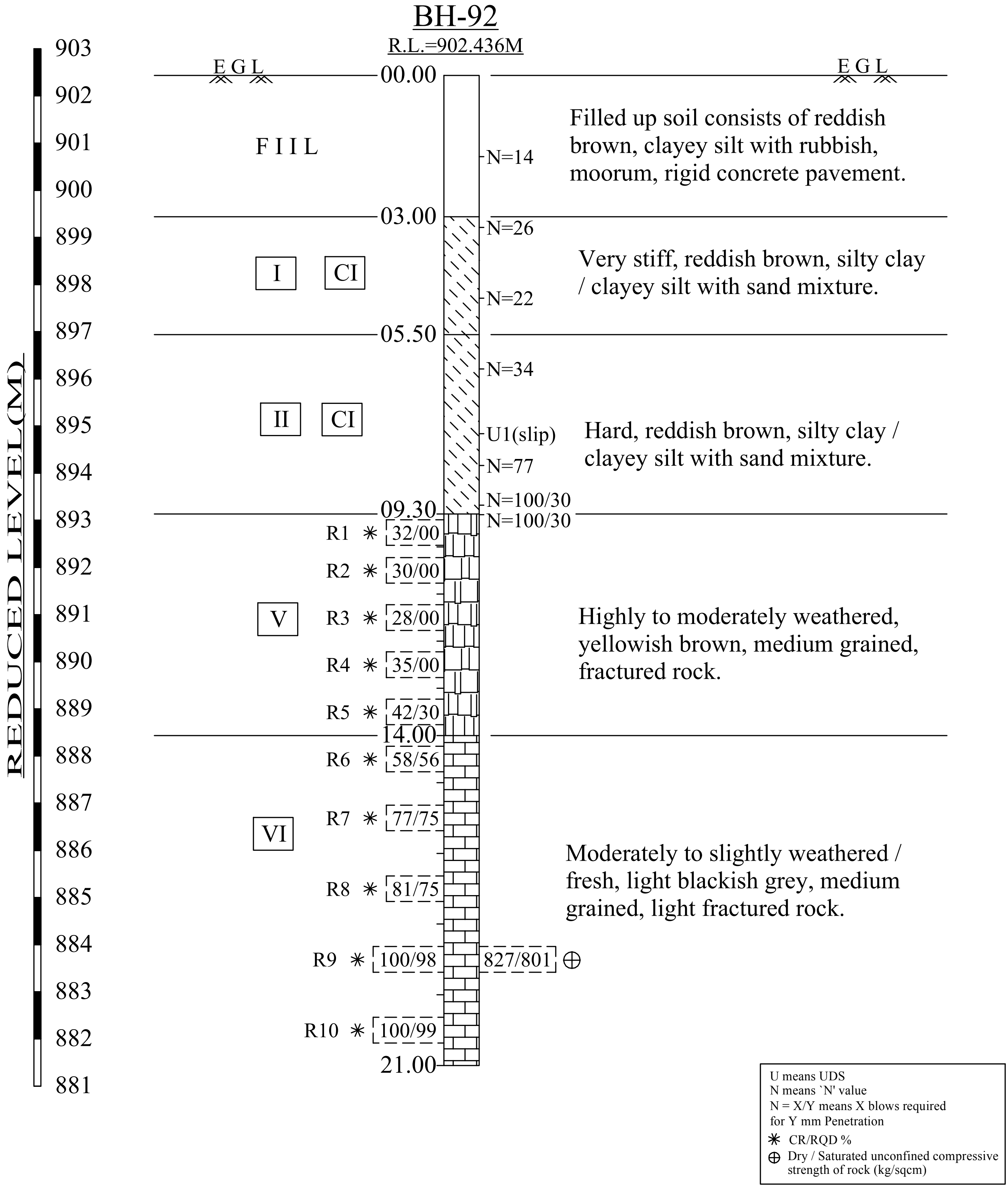


FIG. 2.17 : GENERALISED SOIL PROFILE
(Bauxite Handling)

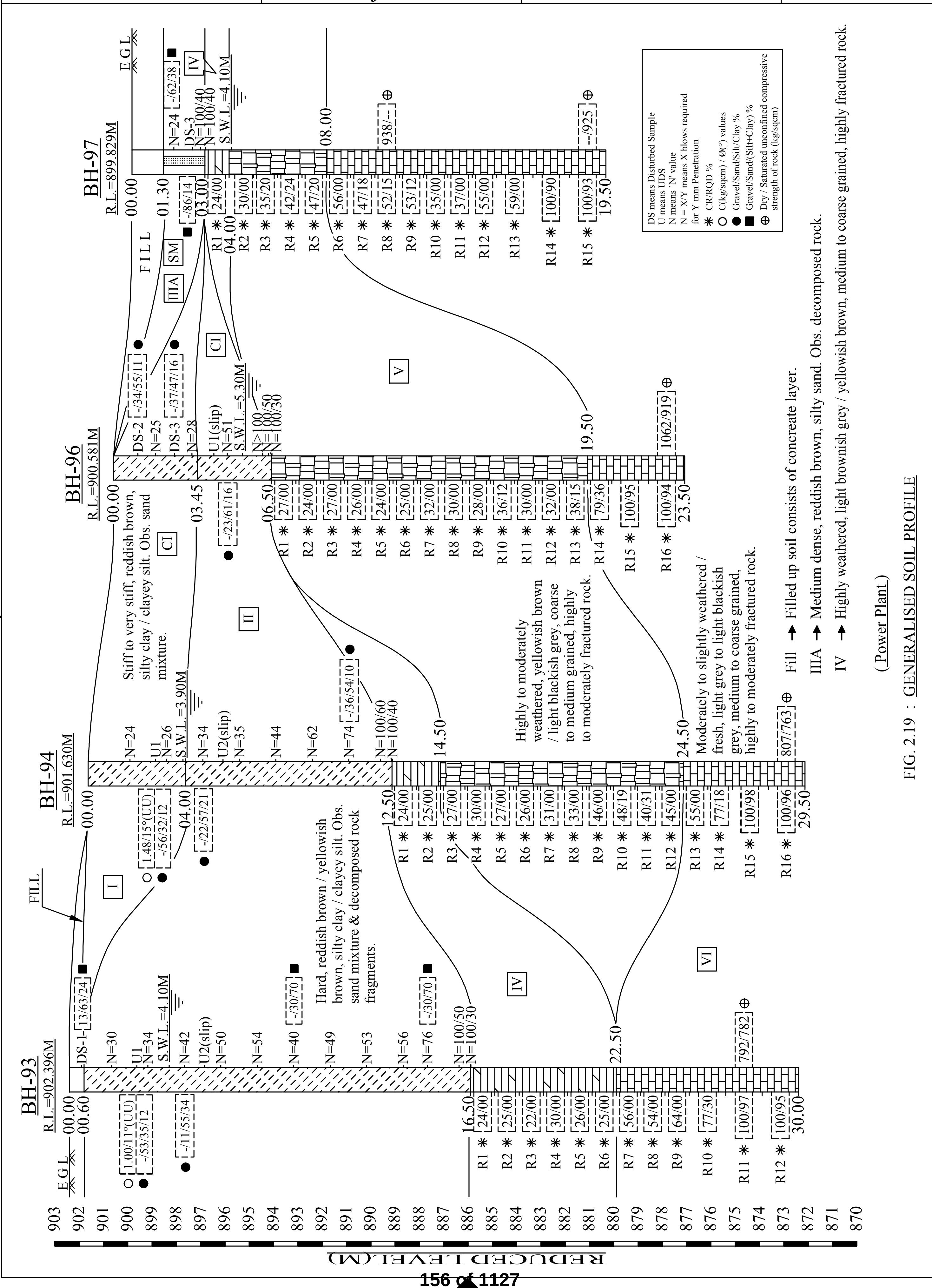
Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 03 / 03 / 2018	**Sheet No:**



(Lime Preparation)

FIG. 2.18 : GENERALISED SOIL PROFILE

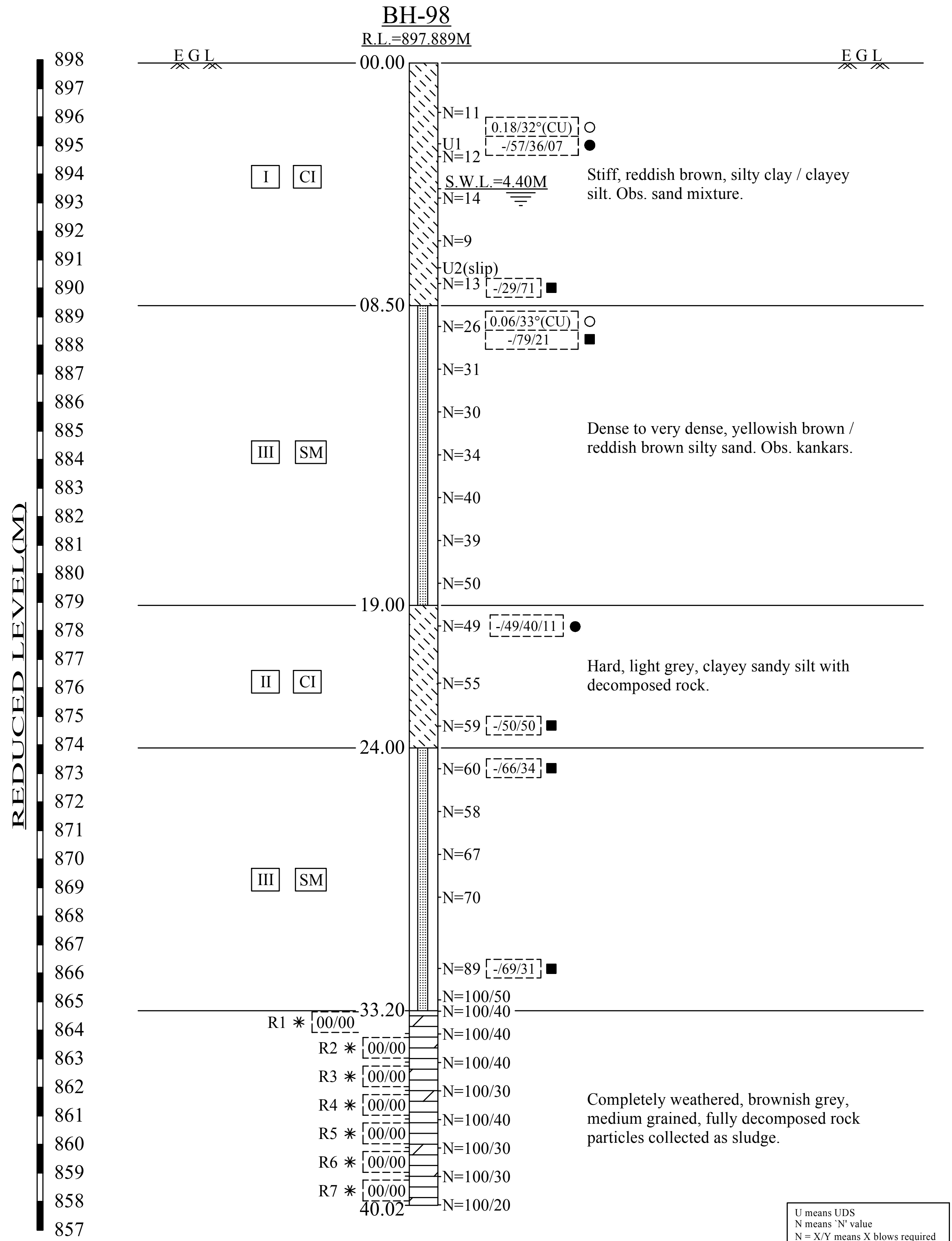
Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:



(Power Plant)

FIG. 2.19 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 03 / 03 / 2018	**Sheet No:**

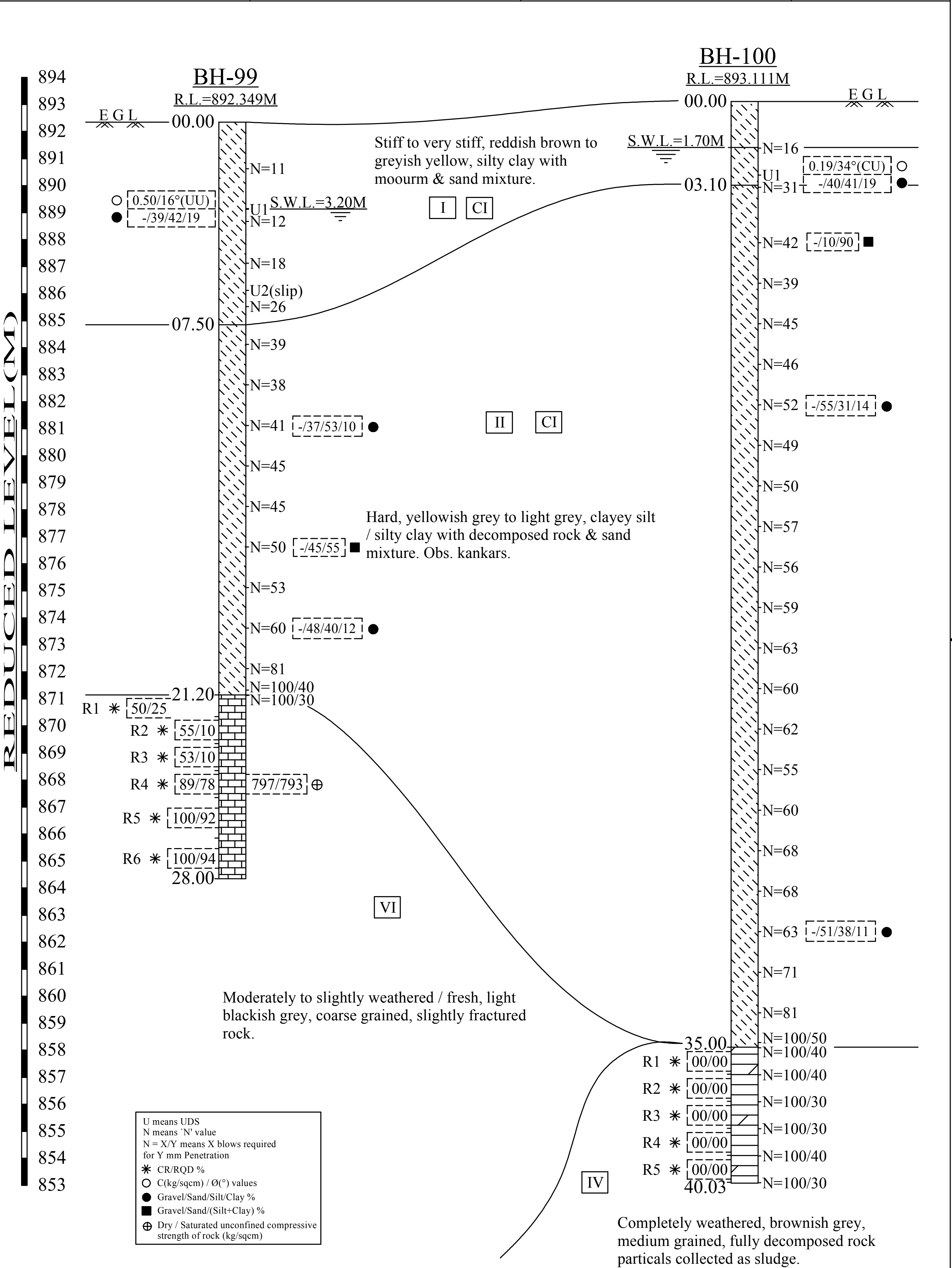


U means UDS
N means `N' value
N = X/Y means X blows required for Y mm Penetration
✳ CR/RQD %
○ C(kg/sqcm) / Ø(°) values
● Gravel/Sand/Silt/Clay %
■ Gravel/Sand/(Silt+Clay) %

(Substation Extension Building)

FIG. 2.20 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 03 / 2018	**Sheet No:**

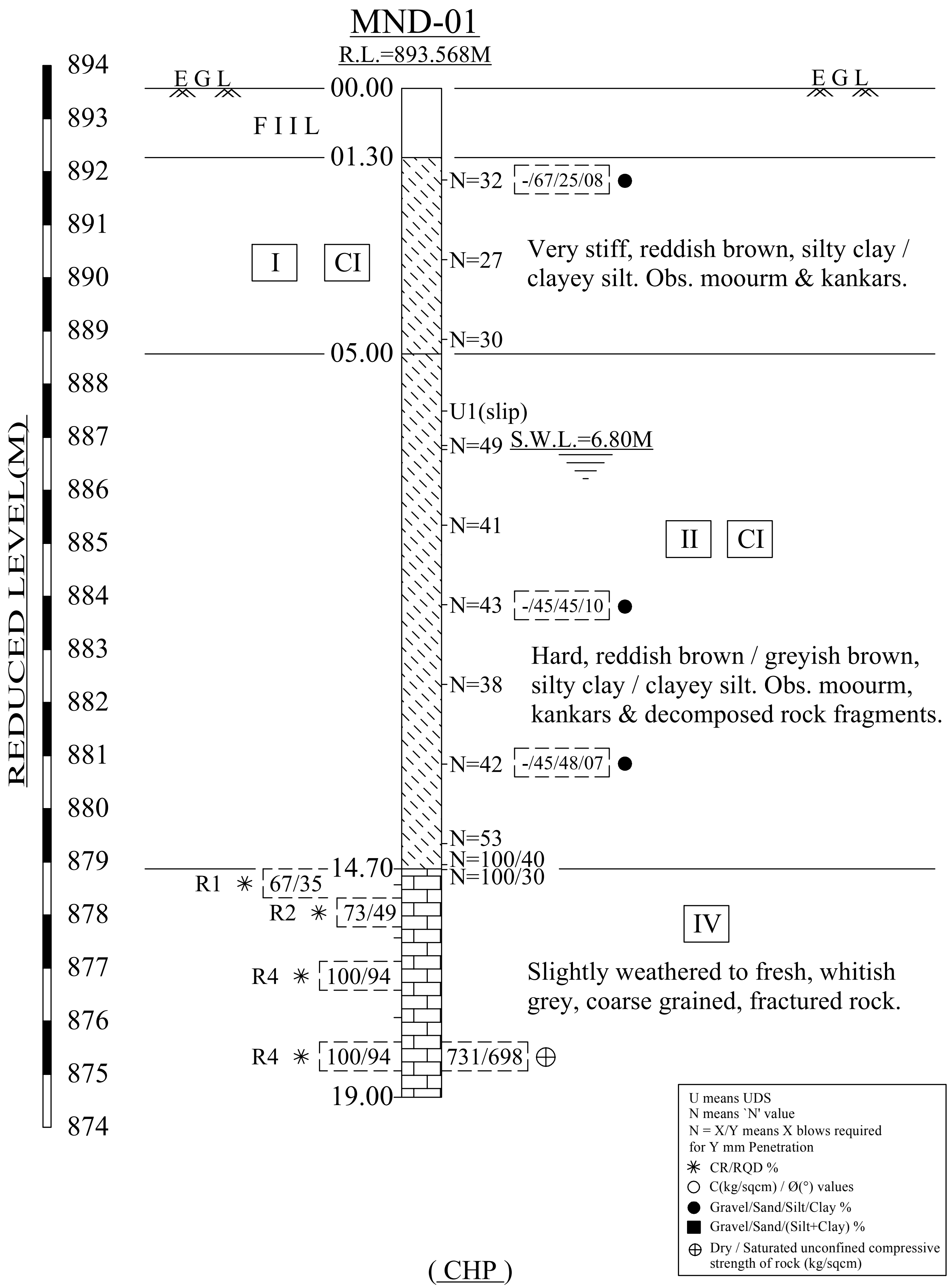


(Switch Yard & Sewage Treatment Plant)

FIG. 2.21 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

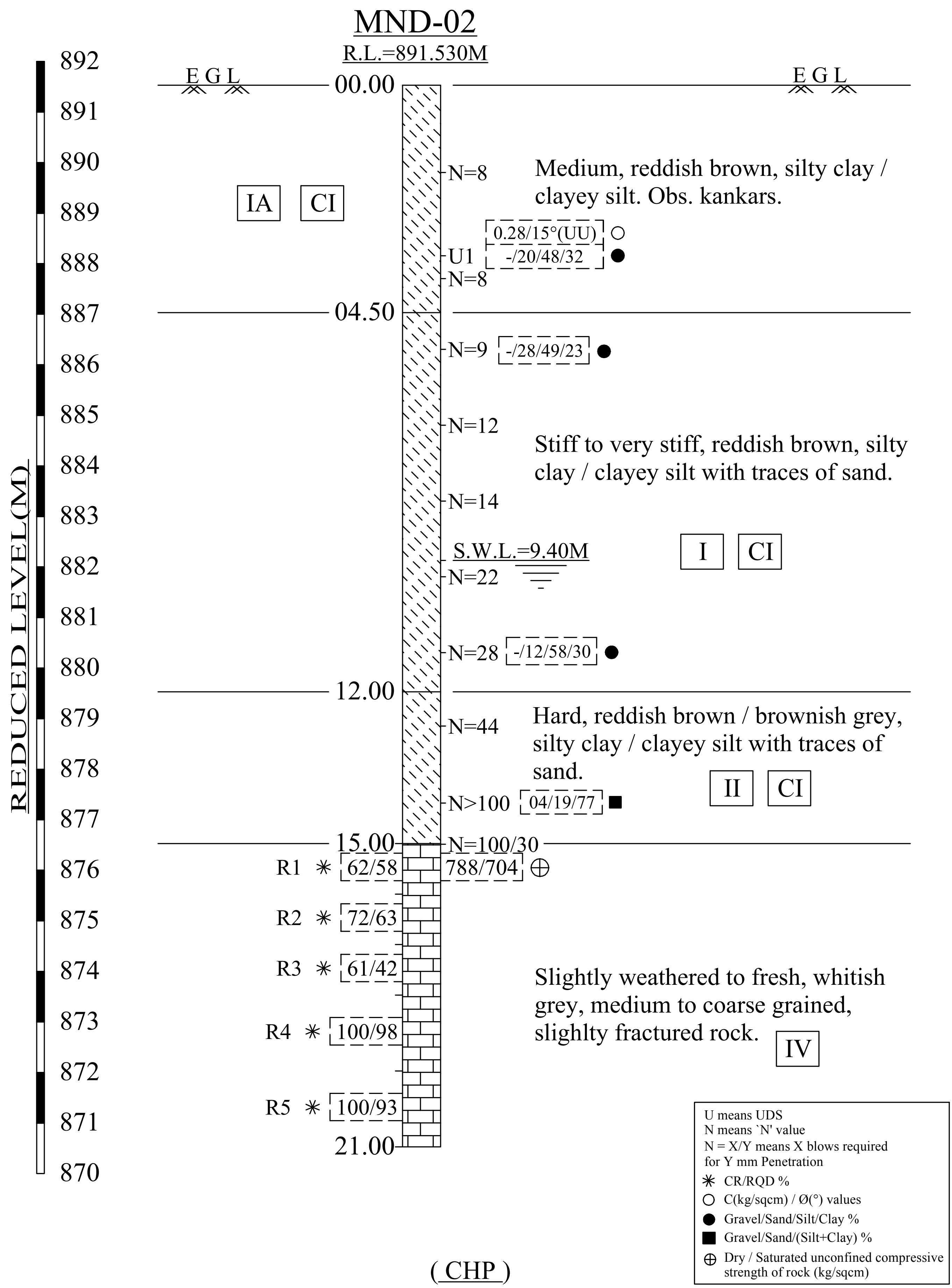
Job No : 4095	**Created by :** Chandrani	**Created on :** 22 / 03 / 2018	**Sheet No:**



(CHP)

FIG. 2.22 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 22 / 03 / 2018	**Sheet No:**

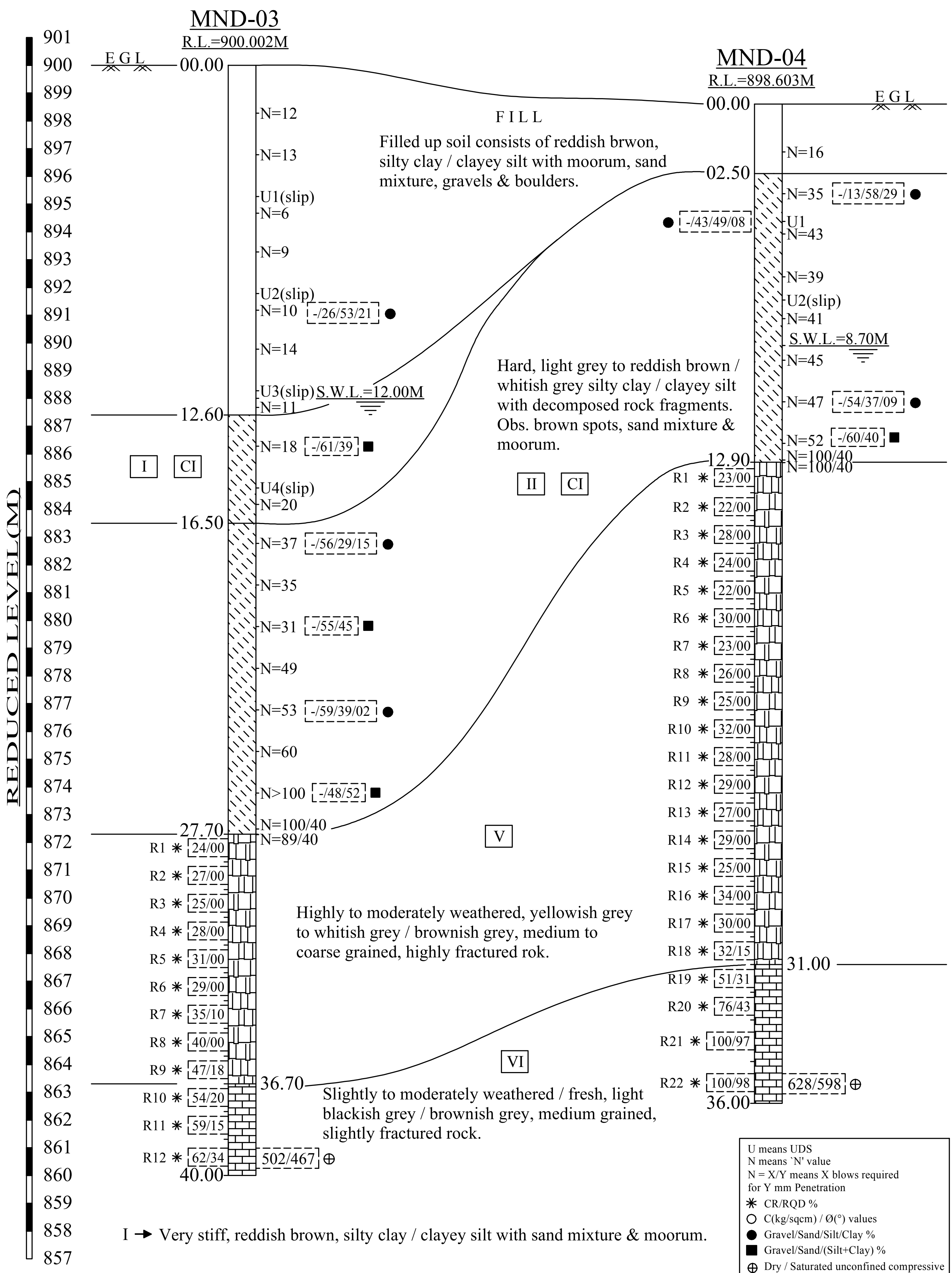


(CHP)

FIG. 2.23 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:



(CHP)

FIG. 2.24 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 03 / 2018	**Sheet No:**

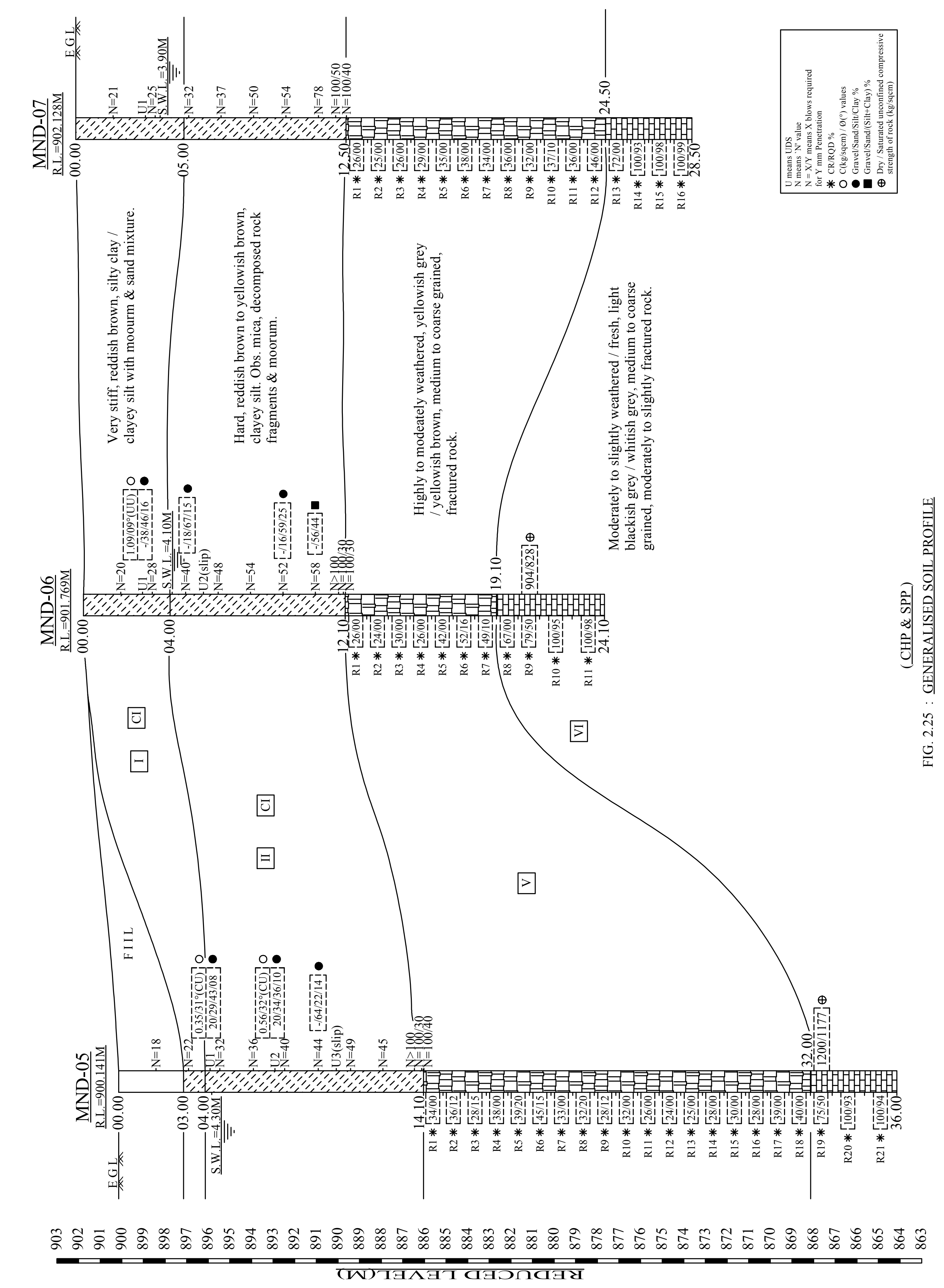


FIG. 2.25 : GENERALISED SOIL PROFILE (CHP & SPP)

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 06 / 03 / 2018	Sheet No:

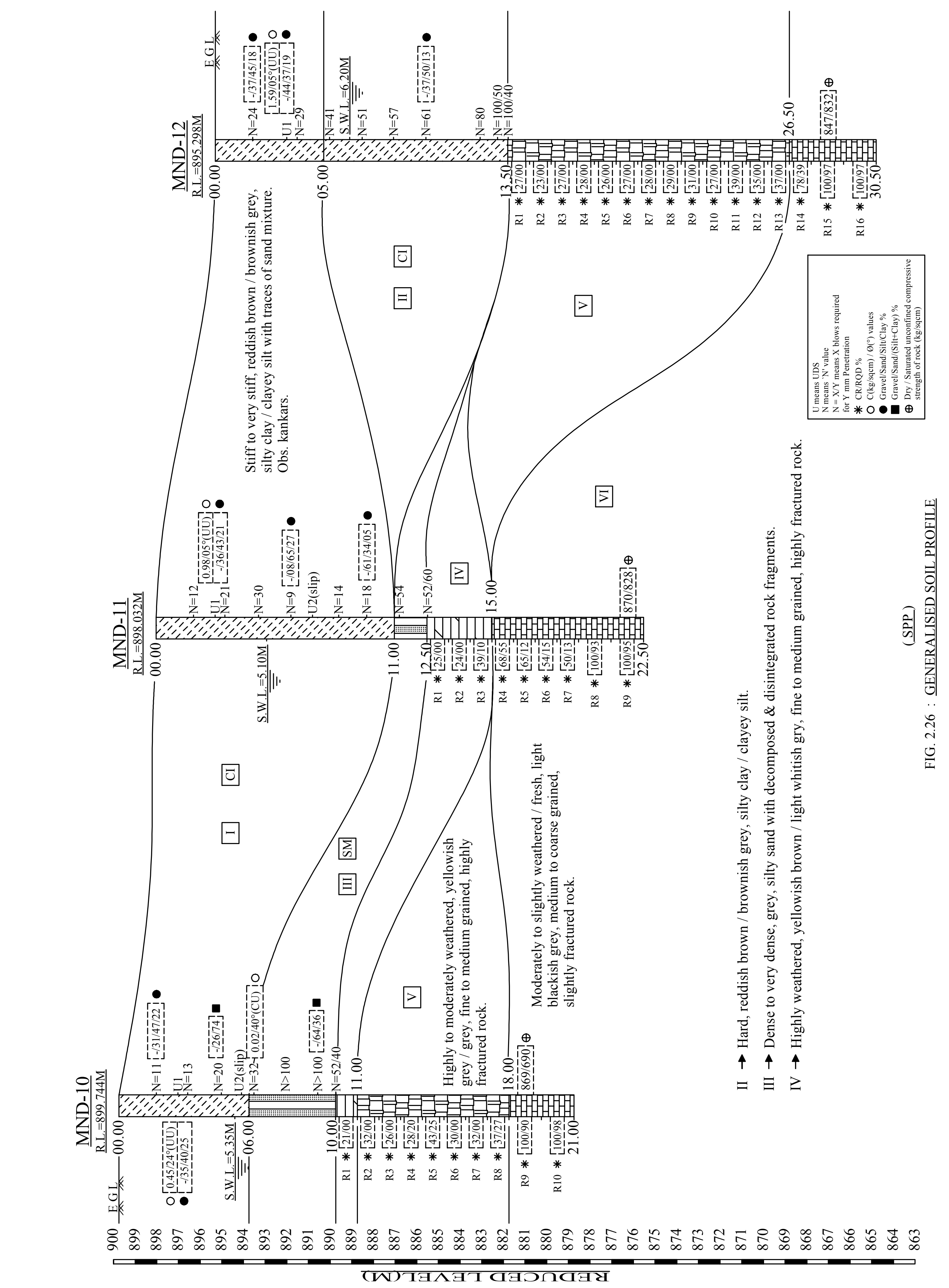
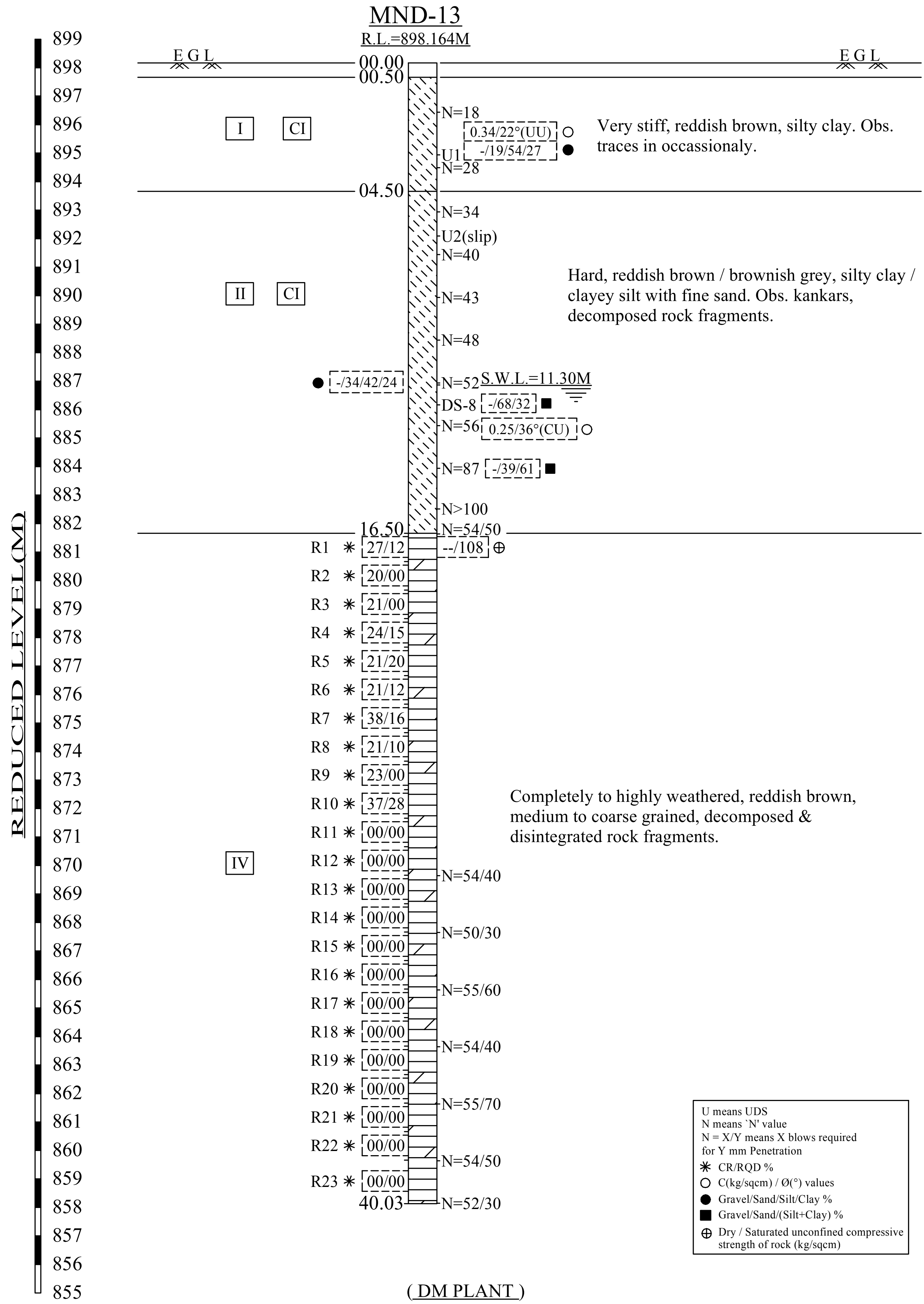


FIG. 2.26 : GENERALISED SOIL PROFILE (SPP)

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 03 / 03 / 2018	**Sheet No:**



(DM PLANT)

FIG. 2.27 : GENERALISED SOIL PROFILE

4.2.2. STRATUM - I:

The soil in this layer consists of stiff to very stiff, reddish brown / light yellowish brown, silty clay / clayey silt with sand mixture, kankar, moorum. Black spots & whitish grey spots have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.90	Natural Water Content %	22
Dry Density, gms/cc	1.55	Specific gravity	2.72
TRSH-UU:		Void Ratio	0.768
Cohesion kg/sqcm	0.89	Liquid limit %	46
Friction angle °	10°	Plastic Limit %	23
TRSH-CD:		Shrinkage Limit %	19
Cohesion kg/sqcm	0.00		
Friction angle °	34°	**GRAIN SIZE**	
Unconfined cohesion, kg/sqcm	**1.09**	Sand %	37
Remoulded cohesion, kg/sqcm	**0.89**	Silt %	44
SENSITIVITY, S_t	**1.22**	Clay %	19

4.2.3. STRATUM - II:

The soil in this layer consists of hard reddish brown to brownish grey / light grey, silty clay / clayey silt with sand mixture, kankar, boulder, moorum, decomposed rock fragments. Calcareous nodules, brown & yellow spots have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.88	Specific gravity	2.71
Dry Density, gms/cc	1.57	Void Ratio	0.735
Natural Water Content %	20	Liquid limit %	45
		Plastic Limit %	24
TRSH-UU:		Shrinkage Limit %	20
Cohesion kg/sqcm	1.24	**GRAIN SIZE**	
Friction angle °	9°	Gravel %	01
Unconfined cohesion, kg/sqcm	**1.14**	Sand %	41
Remoulded cohesion, kg/sqcm	**0.94**	Silt %	42
SENSITIVITY, S_t	**1.22**	Clay %	16

4.2.4. STRATUM - IIIA:

This layer is present around BH-90 & 97 locations and the soil in this layer consists of medium dense yellowish grey / reddish brown silty sand with clay binder & decomposed rock. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.80	Specific gravity	2.74
Dry Density, gms/cc	1.62		
Natural Water Content %	11	**GRAIN SIZE**	
DRSH-CU:		Gravel %	
Cohesion kg/sqcm	0.12	Sand %	74
Friction angle °	29°	(Silt + Clay) %	26

4.2.6. STRATUM - III:

The soil in this layer consists of dense to very dense yellowish brown / reddish brown silty sand with clay binder, kankar, moorum, decomposed rock fragments. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.80	Specific gravity	2.71
Dry Density, gms/cc	1.55		
Natural Water Content %	16	**GRAIN SIZE**	
DRSH-CU:		Gravel %	01
Cohesion kg/sqcm	0.10	Sand %	76
Friction angle °	37°	(Silt + Clay) %	23

4.2.7. STRATUM - IV:

This is rock layer and consists of completely to highly weathered, brownish grey to whitish grey / light blackish grey, medium to coarse grained, decomposed, highly fractured rock. Core recovery of this layer ranges from 0% to 25% and RQD varies from 0% to 14%.

The following tests were carried out on the rock samples viz.

1. Unconfined Compressive Strength determination of the rock samples after 24 hours full submergence and thereafter air drying before testing (i.e. saturated condition).
2. Determination of Point Load Strength Index.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.137	Porosity %	5.650
Dry Density, gms/cc	2.097		
Water Content %	1.882	UCS (saturated), kg/sqcm	108
Specific Gravity	2.537	Point Load Strength Index, kg/sqcm	11.90

4.2.8. STRATUM - V:

This is also rock layer and consists of highly to moderately weathered, light brownish grey to whitish grey / light yellowish brown, medium to coarse grained, highly to slightly fractured rock. Core recovery of this layer ranges from 26% to 50% and RQD varies from 0% to 45%.

The following tests were carried out on the rock samples viz.

1. Unconfined Compressive Strength determination of the rock samples as collected from the field (i.e. insitu condition).
2. Unconfined Compressive Strength determination of the rock samples after 24 hours full submergence and thereafter air drying before testing (i.e. saturated condition).
3. Determination of Point Load Strength Index.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.652	UCS (insitu), kg/sqcm	589
Dry Density, gms/cc	2.638	UCS (saturated), kg/sqcm	513
Water Content %	0.542	Co-efficient of Softening	0.87
Specific Gravity	2.680		
Porosity %	1.838	Point Load Strength Index, kg/sqcm	31.21

4.2.9. STRATUM - VI:

This is rock layer and consists of moderately to slightly weathered / fresh, whitish grey / light blackish grey, coarse to medium grained, highly to moderately / slightly fractured rock. Core recovery of this layer ranges from 53% to 100% and RQD varies from 0% to 99%.

The average properties of this layer as revealed from the routine laboratory test are as follows.

Bulk Density, gms/cc	2.837	UCS (insitu), kg/sqcm	666
Dry Density, gms/cc	2.830	UCS (saturated), kg/sqcm	552
Water Content %	0.219	Co-efficient of Softening	0.837
Specific Gravity	2.837		
Porosity %	1.505	Point Load Strength Index, kg/sqcm	48.88

4.3. GRAPHICAL PRESENTATION:

The detailed Laboratory Test Results in tabular form are given in Volume-2. The back up sheets are also presented there as given in below:

1. ***Strength envelopes from Triaxial Tests.***
2. ***Normal Stress vs. Shear Stress from Direct Shear Tests.***
3. ***Standard Proctor Compaction Curves.***
4. ***CBR Curves.***
5. ***e-log p curves from consolidation tests.***
6. ***Grain size distribution curves for sieve and hydrometer tests.***

The consolidation test results are analysed by numerical methods and only the final output in a tabular form is given. The m_{vc} indicates the time dependent component of m_v and c_v is the co-efficient of consolidation.

5. DISCUSSION

5.1. CYCLIC PLATE LOAD TEST:

Will be Incorporated Later

5.2. DETAILS OF STRUCTURES:

The subsoil quality, thickness of each layer varies widely within the zone of investigation. Again, the type of structures to be constructed is different with different requirement. Considering all these aspect, the entire area is subdivided in to the following.

Sl. No.	Structure Name	Bore Hole Points	Reference Figure No.
1	Effluent Treatment Plant	BH-01	2.01
2	Evaporation, Cooling Tower Evaporation & Sub-Station 05	BH-19, 20, 21 & 22	2.02
3	Causticisation, HID Acid Area & Pipe Rack HID	BH-30, 37 & 40	2.03
4	CCR & Plant Office	BH-44	2.04
5	Precipitation	BH-47, 48, 50 & 52	2.05
6	Hydrate Filtration	BH-49, 51	2.06
7	Pipe Rack CISF Colony & Effluent Treatment Plant CISF Colony	BH-53, 54 & 55	2.07
8	Pipe Rack CISF Colony & Product Filtration Stage 2	BH – 56 to 61	2.08
9	Calciner & Cooling Tower Calciner	BH-62 to 65	2.09
10	Sub-Station 06	BH-66	2.10
11	Alumina Storage	BH-67 & 68	2.11
12	Filtered Water Reservoir	BH-69	2.12
13	Raw Water Reservoir	BH-70 & 71	2.13
14	Drinking Water Unit	BH-72 & 73	2.14
15	Caustic Soda Storage & Fuel Oil Unloading & Storage	BH-74, 75 & 76	2.15
16	Bauxite Handling	BH-81, 82, 85, 86 & 87	2.16
17	Bauxite Handling	BH-88, 89, 90 & 91	2.17
18	Lime Preparation	BH-92	2.18
19	Power Plant	BH-93, 94, 96 & 97	2.19
20	Substation Extension Building	BH-98	2.20
21	Switch Yard & Sewage Treatment Plant	BH-99 & 100	2.21
22	CHP	BH-MND-01	2.22
23	CHP	BH-MND-02	2.23
24	CHP	BH-MND-03 & 04	2.24
25	CHP & SPP	BH-MND-05 to 07	2.25
26	SPP	BH-MND-10 to 12	2.26
27	DM Plant	BH-MND-13	2.27

5.3. CHOICE OF FOUNDATION AND FOUNDING LEVEL:

Considering the nature of the subsoil and the type of structures to be constructed at the present site, it is suggested to go for open foundation. Such foundation may be placed at a depth of 1.00m or more below EGL. The determination of bearing capacity is presented below.

5.4. BEARING CAPACITY AROUND HID ACID AREA:

5.4.1. DETERMINATION OF BEARING CAPACITY:

Let us consider BH-37.

Place the foundation at 2.00m below EGL.

Founding level falls inside weathered rock layer.

A) <u>Bearing Capacity Based on RMR Method:</u>

Calculated RMR = 48 as per IS: 13365(Part1)-1998, Annex B

a) Unconfined Compressive Strength is taken as 226 kg/sqcm, corresponding rating = 2.
b) Average RQD value = 55%, corresponding rating = 13.
c) Spacing of discontinuity taken as close (i.e. 0.06m), corresponding rating = 8.
d) Condition of discontinuity considered as Slightly rough and moderately to highly weathered wall rock surface, separation < 1mm, corresponding rating = 20.
e) Ground water condition taken as Wet, corresponding rating = 7.
f) Dip Angle Joint Orientation taken as favourable, corresponding rating = -2.

So, RMR = 2+13+8+20+7+(-)2 = 48

So, from Table-3 of IS: 12070: 1987 (Amendment No. 1, 2008), q_{ns} = 192.21 t/sqm

B) <u>Bearing Capacity Based on Uni-axial Compressive Strength Method:</u>

The safe bearing pressure, $q_s = q_c N_j$

Where, q_s = Safe bearing pressure

q_c = Average uniaxial compressive strength of rock core

N_j = Empirical co-efficient depending on spacing of discontinuities

For spacing of discontinuity, 0.06m i.e. 6cm, corresponding N_j = 0.10

q_c = 226 kg/sqcm (lowest value of layer V)

So, safe bearing pressure, q_s = 226 x 0.10 = 22.60 kg/sqcm = 226 t/sqm

A factor of 3/4 is taken considering rock with discontinuous joints with opening less than 1mm wide.

Hence, safe bearing pressure, = 226 x ¾ = 169.50 t/sqm

However, let us restrict the bearing capacity to 100t/sqm.

5.4.2. RECOMMENDATION:

With reference to the above and considering the subsoil condition around each bore hole, the following bearing capacity values may be used.

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Effluent Treatment Plant	BH-01 **(FGL = 914.000M)**	1.00	1<B≤3	1.0	45.72	--	40	40
				1.5	39.85	--	36	38
				2.0	38.66	--	34	38
			3 <B ≤6	1.0	44.30	--	28	40
				1.5	38.60	--	26	38
				2.0	37.46	--	25	36
			B> 6	1.0	43.73	--	22	35
				1.5	38.11	--	20	32
				2.0	36.97	--	20	32
		2.00	1<B≤3	1.0	48.65	--	40	40
				1.5	42.38	--	40	40
				2.0	41.12	--	40	40
			3 <B ≤6	1.0	45.80	--	32	40
				1.5	39.90	--	28	38
				2.0	38.70	--	26	38
			B> 6	1.0	44.66	--	24	38
				1.5	38.90	--	23	36
				2.0	37.74	--	22	35
		3.00	1<B≤3	1.0	51.58	--	40	40
				1.5	44.92	--	40	40
				2.0	43.57	--	40	40
			3 <B ≤6	1.0	47.30	--	35	40
				1.5	41.19	--	32	40
				2.0	39.94	--	30	38
			B> 6	1.0	45.58	--	28	40
				1.5	39.70	--	26	38
				2.0	38.50	--	25	38
Evaporation	BH-19 **(FGL = 930.000M)**	1.00	1<B≤3	1.0	35.74	--	28	35
				1.5	31.14	--	24	30
				2.0	30.21	--	22	30
			3 <B ≤6	1.0	34.62	--	18	28
				1.5	30.17	--	16	25
				2.0	29.27	--	15	24
			B> 6	1.0	34.18	--	13	20
				1.5	29.78	--	12	18
				2.0	28.89	--	11	18
		2.00	1<B≤3	1.0	38.04	--	32	38
				1.5	33.13	--	26	32
				2.0	32.14	--	24	32
			3 <B ≤6	1.0	35.81	--	18	30
				1.5	31.19	--	16	25
				2.0	30.25	--	15	24
			B> 6	1.0	34.92	--	14	22
				1.5	30.41	--	12	18
				2.0	29.50	--	12	18
		3.00	1<B≤3	1.0	40.34	--	35	40
				1.5	35.12	--	30	35
				2.0	34.06	--	26	34
			3 <B ≤6	1.0	37.00	--	22	35
				1.5	32.21	--	19	30
				2.0	31.23	--	18	28
			B> 6	1.0	35.66	--	15	24
				1.5	31.04	--	14	22
				2.0	30.10	--	14	22
Cooling Tower Evaporation	BH-20 & **22** **(FGL = 930.000M)**	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	40	40
				2.0	43.15	--	36	40

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Cooling Tower Evaporation	BH-20 & **22** **(FGL = 930.000M)**	4.00	3 <B ≤6	1.0	45.76	--	26	40
				1.5	39.84	--	22	35
				2.0	38.62	--	20	32
			B> 6	1.0	43.62	--	15	24
				1.5	37.97	--	13	20
				2.0	36.81	--	12	18
Sub-Station 05	BH-21 **(FGL = 930.000M)**	1.00	1<B≤3	1.0	42.87	--	38	40
				1.5	37.36	--	32	36
				2.0	36.25	--	30	36
			3 <B ≤6	1.0	41.53	--	22	35
				1.5	36.19	--	20	32
				2.0	35.12	--	18	28
			B> 6	1.0	41.00	--	14	22
				1.5	35.73	--	12	18
				2.0	34.67	--	11	18
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	36	38
				2.0	38.55	--	32	38
			3 <B ≤6	1.0	42.94	--	22	35
				1.5	37.41	--	20	32
				2.0	36.29	--	18	28
			B> 6	1.0	41.87	--	14	22
				1.5	36.48	--	13	20
				2.0	35.38	--	12	18
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	35	40
			3 <B ≤6	1.0	44.35	--	24	38
				1.5	38.62	--	21	34
				2.0	37.45	--	19	30
			B> 6	1.0	42.75	--	15	24
				1.5	37.22	--	13	20
				2.0	36.10	--	12	18
Causticisation	BH-30 **(FGL = 933.000M)**	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	30.46	--	22	30
				1.5	26.53	--	19	26
				2.0	25.72	--	17	25
			3<B≤6	1.0	28.68	--	16	25
				1.5	24.97	--	15	24
				2.0	24.22	--	14	22
			B> 6	1.0	27.96	--	13	20
				1.5	24.35	--	12	18
				2.0	23.61	--	12	18
		3.00	1<B≤3	1.0	32.32	--	26	32
				1.5	28.13	--	23	28
				2.0	27.27	--	21	26
			3 <B ≤6	1.0	29.64	--	20	28
				1.5	25.80	--	18	26
				2.0	25.01	--	17	25
			B> 6	1.0	28.57	--	16	25
				1.5	24.86	--	15	24
				2.0	24.10	--	14	22
HID Acid Area	BH-37 **(FGL = 935.000M)**	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Pipe Rack HID	BH-40 **(FGL = 935.000M)**	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.50	1<B≤3	1.0	26.71	--	18	26
				1.5	23.25	--	16	23
				2.0	22.54	--	15	22
			3<B≤6	1.0	24.81	--	15	24
				1.5	21.59	--	14	21
				2.0	20.93	--	13	20
			B> 6	1.0	24.05	--	12	19
				1.5	20.93	--	12	18
				2.0	20.29	--	11	18

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Pipe Rack HID	BH-40 **(FGL = 935.000M)**	3.50	1<B≤3	1.0	28.30	--	28	28
				1.5	24.62	--	24	24
				2.0	23.86	--	23	23
			3<B≤6	1.0	25.64	--	25	25
				1.5	22.30	--	22	22
				2.0	21.61	--	21	21
			B> 6	1.0	24.58	--	20	24
				1.5	21.38	--	18	21
				2.0	20.71	--	18	20
CCR & Plant Office	BH-44 **(FGL = 935.000M)**	1.00 - 5.50	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		6.50	1<B≤3	1.0	46.48	--	40	40
				1.5	40.43	--	40	40
				2.0	39.17	--	40	38
			3<B≤6	1.0	39.52	--	38	38
				1.5	34.36	--	34	34
				2.0	33.28	--	32	32
			B> 6	1.0	36.74	--	36	36
				1.5	31.94	--	30	30
				2.0	30.93	--	30	30
		9.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Precipitation	BH-47 **(FGL = 931.100M)**	6.00	1 - 6	1.00 - 2.00	155.63	100	--	
			≥ 6	1.00 - 2.00	155.63	100	--	
	BH-48 **(FGL = 920.00M)**	2.50	1 - 6	1.00 - 2.00	186.00	100	--	--
			≥ 6	1.00 - 2.00	186.00	100	--	--
	BH- 50 **(FGL = 920.00M)**	1.00	1 - 6	1.00 - 2.00	125.84	100	--	--
			≥ 6	1.00 - 2.00	125.84	100	--	--
	BH-52 **(FGL = 920.000M)**	13.00	1 - 6	1.00 - 2.00	80.05	80	--	--
			≥ 6	1.00 - 2.00	80.05	80	--	--
		20.00	1 - 6	1.00 - 2.00	125.84	100	--	--
			≥ 6	1.00 - 2.00	125.84	100	--	--
Hydrate Filtration	BH-49 **(FGL = 910.000M)**	1.50	1 - 6	1.00 - 2.00	206.84	100	--	--
			≥ 6	1.00 - 2.00	206.84	100	--	--
	BH-51 **(FGL = 912.000M)**	1.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Pipe Rack CISF Colony	BH-53 **(FGL = EGL)**	1.00	1≤ B <3	1.0	31.46	--	30	30
				1.5	27.41	--	26	26
				2.0	26.59	--	26	26
			3≤ B <6	1.0	30.48	--	21	30
				1.5	26.55	--	20	26
				2.0	25.76	--	20	25
			B ≥ 6	1.0	30.08	--	22	30
				1.5	26.21	--	22	26
				2.0	25.43	--	20	25
		2.00	1≤ B <3	1.0	33.49	--	32	32
				1.5	29.17	--	28	28
				2.0	28.29	--	28	28
			3≤ B <6	1.0	31.53	--	30	30
				1.5	27.46	--	26	26
				2.0	26.63	--	26	26
			B ≥ 6	1.0	30.75	--	30	30
				1.5	26.77	--	26	26
				2.0	25.97	--	25	25
		3.00	1≤ B <3	1.0	64.84	--	40	40
				1.5	60.73	--	40	40
				2.0	60.70	--	40	40
			3≤ B <6	1.0	67.36	--	40	40
				1.5	62.94	--	40	40
				2.0	63.52	--	40	40
			B ≥ 6	1.0	82.38	--	40	40
				1.5	76.60	--	40	40
				2.0	78.85	--	40	40

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Effluent Treatment Plant CISF Colony	BH-54 & **55 (FGL = 908.000M)**	1.00	1<B≤3	1.0	42.87	--	28	40
				1.5	37.36	--	24	36
				2.0	36.25	--	22	35
			3 <B ≤6	1.0	41.53	--	20	32
				1.5	36.19	--	18	28
				2.0	35.12	--	16	26
			B> 6	1.0	41.00	--	16	26
				1.5	35.73	--	15	24
				2.0	34.67	--	14	22
		2.00	1<B≤3	1.0	45.62	--	32	40
				1.5	39.74	--	26	38
				2.0	38.55	--	24	38
			3 <B ≤6	1.0	42.94	--	22	35
				1.5	37.41	--	20	32
				2.0	36.29	--	20	32
			B> 6	1.0	41.87	--	18	28
				1.5	36.48	--	16	26
				2.0	35.38	--	16	26
		3.00	1<B≤3	1.0	48.37	--	36	40
				1.5	42.12	--	32	40
				2.0	40.85	--	30	40
			3 <B ≤6	1.0	44.35	--	28	40
				1.5	38.62	--	25	38
				2.0	37.45	--	24	36
			B> 6	1.0	42.75	--	21	34
				1.5	37.22	--	20	32
				2.0	36.10	--	19	30
Pipe Rack CISF Colony	BH-56 to 59 **(FGL = EGL)**	1.00	1<B≤3	1.0	35.74	--	35	35
				1.5	31.14	--	30	30
				2.0	30.21	--	30	30
			3 <B ≤6	1.0	34.62	--	32	34
				1.5	30.17	--	30	30
				2.0	29.27	--	28	28
			B> 6	1.0	34.18	--	28	34
				1.5	29.78	--	26	28
				2.0	28.89	--	26	28
		2.00	1<B≤3	1.0	38.04	--	38	38
				1.5	33.13	--	32	32
				2.0	32.14	--	32	32
			3 <B ≤6	1.0	35.81	--	35	35
				1.5	31.19	--	30	30
				2.0	30.25	--	30	30
			B> 6	1.0	34.92	--	34	34
				1.5	30.41	--	30	30
				2.0	29.50	--	28	28
		3.00	1<B≤3	1.0	40.34	--	40	40
				1.5	35.12	--	35	35
				2.0	34.06	--	34	34
			3 <B ≤6	1.0	37.00	--	36	36
				1.5	32.21	--	32	32
				2.0	31.23	--	30	30
			B> 6	1.0	35.66	--	35	35
				1.5	31.04	--	30	30
				2.0	30.10	--	30	30
Pipe Rack CISF Colony	BH-60 **(FGL = EGL)**	1.00 - 2.00	1 - 6	1.00 - 2.00	66.32	50	--	--
			≥ 6	1.00 - 2.00	66.32	50	--	--
		3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Product Filtration Stage	BH-61 **(FGL = 914.000M)**	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Calciner	BH-62 **(FGL = 910.000M)**	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Cooling Tower Calciner	BH-63 & 64 **(FGL = 910.000M)**	1.00 - 3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Calciner	BH-65 **(FGL = 910.000M)**	1.00	1≤ B <3	1.0	22.45	--	22	22
				1.5	20.98	--	20	20
				2.0	21.17	--	20	20
			3≤ B <6	1.0	33.29	--	32	32
				1.5	30.87	--	30	30
				2.0	32.15	--	32	32
			B ≥ 6	1.0	51.63	--	40	40
				1.5	47.67	--	40	40
				2.0	50.52	--	40	40
		2.00	1≤ B <3	1.0	43.63	--	40	40
				1.5	40.93	--	40	40
				2.0	40.66	--	40	40
			3≤ B <6	1.0	49.50	--	40	40
				1.5	46.12	--	40	40
				2.0	47.08	--	40	40
			B ≥ 6	1.0	66.59	--	40	40
				1.5	61.74	--	40	40
				2.0	64.31	--	40	40
		3.00	1≤ B <3	1.0	64.84	--	40	40
				1.5	60.73	--	40	40
				2.0	60.70	--	40	40
			3≤ B <6	1.0	67.36	--	40	40
				1.5	62.94	--	40	40
				2.0	63.52	--	40	40
			B ≥ 6	1.0	82.38	--	40	40
				1.5	76.60	--	40	40
				2.0	78.85	--	40	40
Sub-Station 06	BH-66 **(FGL = 915.000M)**	1.00 - 2.00	1 - 6	1.00 - 2.00	66.32	50	--	--
			≥ 6	1.00 - 2.00	66.32	50	--	--
		3.00	1 - 6	1.00 - 2.00	169.50	100	--	--
			≥ 6	1.00 - 2.00	169.50	100	--	--
Alumina Storage	BH-67 & **68 (FGL = EGL)**	1.00	1<B≤3	1.0	32.88	--	28	32
				1.5	28.65	--	24	28
				2.0	27.80	--	22	26
			3<B≤6	1.0	31.86	--	17	27
				1.5	27.76	--	15	24
				2.0	26.93	--	14	22
			B> 6	1.0	31.45	--	12	20
				1.5	27.40	--	11	18
				2.0	26.59	--	11	18
		2.00	1<B≤3	1.0	35.01	--	32	35
				1.5	30.49	--	28	30
				2.0	29.57	--	25	28
			3<B≤6	1.0	32.96	--	18	28
				1.5	28.70	--	16	25
				2.0	27.84	--	15	24
			B> 6	1.0	32.14	--	14	22
				1.5	27.99	--	12	20
				2.0	27.14	--	12	20
		3.00	1<B≤3	1.0	37.13	--	36	36
				1.5	32.33	--	32	32
				2.0	31.34	--	28	30
			3 <B ≤6	1.0	34.05	--	22	34
				1.5	29.64	--	18	28
				2.0	28.74	--	17	27
			B> 6	1.0	32.82	--	15	24
				1.5	28.57	--	14	22
				2.0	27.70	--	13	21
Filtered Water Reservoir	BH-69 **(FGL = EGL)**	1.00	1<B≤3	1.0	28.60	--	17	26
				1.5	24.92	--	15	24
				2.0	24.18	--	14	22

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Filtered Water Reservoir	BH-69 **(FGL = EGL)**	1.00	3<B≤6	1.0	27.71	--	12	18
				1.5	24.15	--	11	17
				2.0	23.42	--	10	16
			B> 6	1.0	27.36	--	10	16
				1.5	23.83	--	9	14
				2.0	23.12	--	9	14
		2.00	1<B≤3	1.0	30.46	--	20	30
				1.5	26.53	--	18	26
				2.0	25.72	--	16	25
			3<B≤6	1.0	28.68	--	15	24
				1.5	24.97	--	13	21
				2.0	24.22	--	13	21
			B> 6	1.0	27.96	--	12	19
				1.5	24.35	--	11	18
				2.0	23.61	--	10	16
		3.00	1<B≤3	1.0	32.32	--	25	32
				1.5	28.13	--	22	28
				2.0	27.27	--	20	26
			3 <B ≤6	1.0	29.64	--	18	28
				1.5	25.80	--	16	25
				2.0	25.01	--	16	25
			B> 6	1.0	28.57	--	14	22
				1.5	24.86	--	13	21
				2.0	24.10	--	13	21
Raw Water Reservoir	BH-**70** & 71 **(FGL = EGL)**	1.00	1<B≤3	1.0	31.46	--	30	30
				1.5	27.41	--	26	26
				2.0	26.59	--	25	26
			3<B≤6	1.0	30.48	--	25	30
				1.5	26.55	--	22	26
				2.0	25.76	--	22	25
			B> 6	1.0	30.08	--	21	30
				1.5	26.21	--	20	26
				2.0	25.43	--	19	25
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	38	38
				2.0	38.55	--	35	38
			3<B≤6	1.0	42.94	--	36	40
				1.5	37.41	--	32	36
				2.0	36.29	--	30	36
			B> 6	1.0	41.87	--	28	40
				1.5	36.48	--	28	36
				2.0	35.38	--	26	35
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	40	40
			3 <B ≤6	1.0	44.35	--	40	40
				1.5	38.62	--	38	38
				2.0	37.45	--	36	36
			B> 6	1.0	42.75	--	36	40
				1.5	37.22	--	35	36
				2.0	36.10	--	34	36
Drinking Water Unit	BH-72 & **73** **(FGL = EGL)**	1.00	1<B≤3	1.0	42.87	--	35	40
				1.5	37.36	--	30	36
				2.0	36.25	--	28	36
			3<B≤6	1.0	41.53	--	26	40
				1.5	36.19	--	24	36
				2.0	35.12	--	22	35
			B> 6	1.0	41.00	--	20	32
				1.5	35.73	--	18	28
				2.0	34.67	--	18	28
		2.00	1<B≤3	1.0	45.62	--	40	40
				1.5	39.74	--	35	38
				2.0	38.55	--	30	38
			3<B≤6	1.0	42.94	--	30	40
				1.5	37.41	--	26	36
				2.0	36.29	--	26	36

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Drinking Water Unit	BH-72 & 73 (FGL = EGL)	2.00	B> 6	1.0	41.87	--	22	35
				1.5	36.48	--	22	35
				2.0	35.38	--	20	35
		3.00	1<B≤3	1.0	48.37	--	40	40
				1.5	42.12	--	40	40
				2.0	40.85	--	38	40
			3 <B ≤6	1.0	44.35	--	36	40
				1.5	38.62	--	32	38
				2.0	37.45	--	30	36
			B> 6	1.0	42.75	--	28	40
				1.5	37.22	--	26	36
				2.0	36.10	--	25	36
Caustic Soda Storage & Fuel Oil Unloading & Storage	BH-74, 75 & 76 (FGL = 900.000M)	1.00	1 - 6	1.00 - 2.00	125.84	100	--	--
			≥ 6	1.00 - 2.00	125.84	100	--	--
Lime Preparation	BH-92 (FGL = EGL)	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1<B≤3	1.0	34.17	--	34	34
				1.5	29.73	--	28	28
				2.0	28.82	--	28	28
			3<B≤6	1.0	30.61	--	28	30
				1.5	26.62	--	25	26
				2.0	25.80	--	24	25
			B> 6	1.0	29.18	--	22	28
				1.5	25.38	--	20	25
				2.0	24.59	--	18	24
		5.00	1<B≤3	1.0	36.03	--	36	36
				1.5	31.34	--	30	30
				2.0	30.36	--	30	30
			3<B≤6	1.0	31.57	--	30	30
				1.5	27.45	--	26	26
				2.0	26.59	--	26	26
			B> 6	1.0	29.79	--	28	28
				1.5	25.89	--	25	25
				2.0	25.08	--	25	25
		6.00	1<B≤3	1.0	56.61	--	40	40
				1.5	49.26	--	40	40
				2.0	47.75	--	40	40
			3<B≤6	1.0	48.58	--	40	40
				1.5	42.27	--	40	40
				2.0	40.96	--	40	40
			B> 6	1.0	45.37	--	40	40
				1.5	39.47	--	38	38
				2.0	38.24	--	38	38
Power Plant	BH-93 & 94 (FGL = EGL)	1.00	1<B≤3	1.0	28.60	--	23	28
				1.5	24.92	--	20	24
				2.0	24.18	--	19	24
			3<B≤6	1.0	27.71	--	15	24
				1.5	24.15	--	13	22
				2.0	23.42	--	12	20
			B> 6	1.0	27.36	--	11	18
				1.5	23.83	--	10	16
				2.0	23.12	--	10	16
		2.00	1<B≤3	1.0	30.46	--	28	30
				1.5	26.53	--	24	26
				2.0	25.72	--	22	25
			3<B≤6	1.0	28.68	--	17	28
				1.5	24.97	--	15	24
				2.0	24.22	--	14	22
			B> 6	1.0	27.96	--	13	20
				1.5	24.35	--	11	18
				2.0	23.61	--	11	18
		3.00	1<B≤3	1.0	32.32	--	32	32
				1.5	28.13	--	28	28
				2.0	27.27	--	26	26

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Power Plant	BH-93 & 94 (FGL = EGL)	3.00	3 <B ≤6	1.0	29.64	--	21	28
				1.5	25.80	--	18	25
				2.0	25.01	--	16	25
			B> 6	1.0	28.57	--	14	22
				1.5	24.86	--	13	21
				2.0	24.10	--	12	20
	BH-96 & 97 (FGL = EGL)	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	33.49	--	32	32
				1.5	29.17	--	28	28
				2.0	28.29	--	26	28
			3<B≤6	1.0	31.53	--	22	30
				1.5	27.46	--	20	26
				2.0	26.63	--	18	26
			B> 6	1.0	30.75	--	22	30
				1.5	26.77	--	20	26
				2.0	25.97	--	20	26
		3.00	1<B≤3	1.0	35.53	--	35	35
				1.5	30.93	--	30	30
				2.0	29.99	--	28	28
			3 <B ≤6	1.0	32.58	--	32	32
				1.5	28.36	--	28	28
				2.0	27.50	--	26	26
			B> 6	1.0	31.41	--	30	30
				1.5	27.34	--	26	26
				2.0	26.50	--	26	26
Substation Extension Building	BH-98 (FGL = EGL)	1.00	1<B≤3	1.0	18.62	--	8	12
				1.5	16.22	--	6	9
				2.0	15.73	--	6	9
			3<B≤6	1.0	18.04	--	4	7
				1.5	15.71	--	4	6
				2.0	15.24	--	3	5
			B> 6	1.0	17.81	--	3	5
				1.5	15.51	--	3	5
				2.0	15.04	--	3	5
		2.00	1<B≤3	1.0	19.85	--	9	14
				1.5	17.28	--	7	11
				2.0	16.75	--	6	9
			3<B≤6	1.0	18.69	--	4	7
				1.5	16.27	--	4	7
				2.0	15.77	--	3	6
			B> 6	1.0	18.23	--	4	6
				1.5	15.86	--	3	5
				2.0	15.37	--	3	5
		3.00	1<B≤3	1.0	21.08	--	10	16
				1.5	18.33	--	8	12
				2.0	17.76	--	7	11
			3 <B ≤6	1.0	19.34	--	5	8
				1.5	16.82	--	4	7
				2.0	16.29	--	4	6
			B> 6	1.0	18.65	--	4	7
				1.5	16.21	--	4	6
				2.0	15.70	--	3	6
Switch Yard	BH-99 (FGL = EGL)	1.00	1<B≤3	1.0	22.90	--	12	18
				1.5	19.95	--	10	16
				2.0	19.35	--	9	14
			3<B≤6	1.0	22.18	--	8	13
				1.5	19.33	--	7	11
				2.0	18.75	--	7	11
			B> 6	1.0	21.90	--	5	9
				1.5	19.08	--	5	8
				2.0	18.51	--	5	8
		2.00	1<B≤3	1.0	24.40	--	14	22
				1.5	21.24	--	11	18
				2.0	20.59	--	10	16

Structure Name	Foundation Location	Depth of Foundation below FGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
Switch Yard	BH-99 **(FGL = EGL)**	2.00	3<B≤6	1.0	22.97	--	9	14
				1.5	20.00	--	8	13
				2.0	19.39	--	7	11
			B> 6	1.0	22.40	--	6	10
				1.5	19.50	--	5	8
				2.0	18.90	--	5	8
		3.00	1<B≤3	1.0	25.90	--	16	25
				1.5	22.53	--	13	21
				2.0	21.84	--	12	19
			3 <B ≤6	1.0	23.76	--	10	16
				1.5	20.67	--	9	14
				2.0	20.03	--	8	13
			B> 6	1.0	22.90	--	7	11
				1.5	19.92	--	6	10
				2.0	19.30	--	6	9
Sewage Treatment Plant	BH-100 **(FGL = EGL)**	1.00	1<B≤3	1.0	22.90	--	16	22
				1.5	19.95	--	14	18
				2.0	19.35	--	13	18
			3<B≤6	1.0	22.18	--	12	19
				1.5	19.33	--	11	18
				2.0	18.75	--	10	16
			B> 6	1.0	21.90	--	8	13
				1.5	19.08	--	8	12
				2.0	18.51	--	7	11
		2.00	1<B≤3	1.0	24.40	--	22	24
				1.5	21.24	--	20	21
				2.0	20.59	--	19	20
			3<B≤6	1.0	22.97	--	13	21
				1.5	20.00	--	11	18
				2.0	19.39	--	11	17
			B> 6	1.0	22.40	--	8	13
				1.5	19.50	--	7	11
				2.0	18.90	--	7	11
		3.00	1<B≤3	1.0	25.90	--	25	25
				1.5	22.53	--	22	22
				2.0	21.84	--	21	21
			3 <B ≤6	1.0	23.76	--	20	23
				1.5	20.67	--	17	20
				2.0	20.03	--	15	20
			B> 6	1.0	22.90	--	11	18
				1.5	19.92	--	10	16
				2.0	19.30	--	9	14

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
CHP	BH-MND01	1.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		2.00	1<B≤3	1.0	33.49		26	32
				1.5	29.17	--	22	28
				2.0	28.29	--	20	28
			3 <B ≤6	1.0	31.53	--	16	25
				1.5	27.46	--	14	22
				2.0	26.63	--	12	18
			B> 6	1.0	30.75	--	12	18
				1.5	26.77	--	10	16
				2.0	25.97	--	10	16
		3.00	1<B≤3	1.0	35.53	--	30	35
				1.5	30.93	--	28	30
				2.0	29.99	--	25	28
			3 <B ≤6	1.0	32.58	--	18	28
				1.5	28.36	--	16	25
				2.0	27.50	--	15	24
			B> 6	1.0	31.41	--	13	21
				1.5	27.34	--	11	17
				2.0	26.50	--	11	17
CHP	BH-MND-02	1.00	1<B≤3	1.0	15.77	--	8	12
				1.5	13.73	--	7	11
				2.0	13.31	--	6	9
			3 <B ≤6	1.0	15.27	--	5	8
				1.5	13.30	--	5	8
				2.0	12.90	--	4	6
			B> 6	1.0	15.08	--	4	6
				1.5	13.13	--	3	5
				2.0	12.73	--	3	5
		2.00	1<B≤3	1.0	16.82	--	10	16
				1.5	14.63	--	8	12
				2.0	14.18	--	7	11
			3 <B ≤6	1.0	15.84	--	6	9
				1.5	13.78	--	5	8
				2.0	13.35	--	5	8
			B> 6	1.0	15.45	--	4	6
				1.5	13.44	--	4	6
				2.0	13.02	--	4	6
		3.00	1<B≤3	1.0	17.87	--	12	18
				1.5	15.54	--	10	16
				2.0	15.05	--	9	14
			3 <B ≤6	1.0	16.40	--	7	11
				1.5	14.25	--	6	9
				2.0	13.80	--	6	9
			B> 6	1.0	15.81	--	5	8
				1.5	13.74	--	5	8
				2.0	13.31	--	4	6
Cooling Tower		1.00 - 12.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		13.00	1<B≤3	1.0	48.38	--	25	40
				1.5	41.98	--	22	35
				2.0	40.61	--	20	32
			3 <B ≤6	1.0	37.37	--	18	28
				1.5	32.38	--	16	25
				2.0	31.29	--	14	22
			B> 6	1.0	32.96	--	12	18
				1.5	28.54	--	10	16
				2.0	27.57	--	9	14
CHP	BH-MND04	1.00 - 2.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		3.00	1<B≤3	2.0	48.37		40	40
				1.5	42.12	--	35	40
				2.0	40.85	--	32	40
			3 <B ≤6	1.0	44.35	--	24	38
				1.5	38.62	--	20	32
				2.0	37.45	--	18	28

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
CHP	BH-MND04	3.00	B> 6	1.0	42.75	--	16	25
				1.5	37.22	--	14	22
			B> 6	2.0	36.10	--	14	22
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	38	40
				2.0	43.15	--	34	40
			3 <B ≤6	1.0	45.76	--	26	40
				1.5	39.84	--	22	35
				2.0	38.62	--	20	32
			B> 6	1.0	43.62	--	17	26
				1.5	37.97	--	16	25
				2.0	36.81	--	15	24
CHP	BH-MND05	1.00 - 3.00	Filling soil. Use a net allowable bearing capacity of 5t/sqm.					
		4.00	1<B≤3	1.0	51.11	--	40	40
				1.5	44.50	--	36	40
				2.0	43.15	--	32	40
			3<B≤6	1.0	45.76	--	24	38
				1.5	39.84	--	20	32
				2.0	38.62	--	18	28
			B> 6	1.0	43.62	--	16	25
				1.5	37.97	--	14	22
				2.0	36.81	--	12	18
		5.00	1<B≤3	1.0	53.86	--	40	40
				1.5	46.88	--	40	40
				2.0	45.45	--	34	40
			3<B≤6	1.0	47.17	--	26	40
				1.5	41.05	--	22	35
				2.0	39.79	--	20	32
			B> 6	1.0	44.5	--	18	28
				1.5	38.72	--	16	25
				2.0	37.53	--	14	22
SPP	BH-MND-06	1.00	1≤ B <3	1.0	28.60	--	13	20
				1.5	24.92	--	11	18
				2.0	24.18	--	10	16
			3≤ B <6	1.0	27.71	--	9	14
				1.5	24.15	--	8	13
				2.0	23.42	--	8	12
			B ≥ 6	1.0	27.36	--	7	11
				1.5	23.83	--	7	11
				2.0	23.12	--	6	10
		2.00	1≤ B <3	1.0	30.46	--	16	25
				1.5	26.53	--	14	22
				2.0	25.72	--	13	20
			3≤ B <6	1.0	28.68	--	11	18
				1.5	24.97	--	10	16
				2.0	24.22	--	9	14
			B ≥ 6	1.0	27.96	--	9	14
				1.5	24.35	--	8	12
				2.0	23.61	--	8	12
		3.00	1≤ B <3	1.0	32.32	--	20	32
				1.5	28.13	--	18	28
				2.0	27.27	--	16	25
			3≤ B <6	1.0	29.64	--	14	22
				1.5	25.8	--	13	20
				2.0	25.01	--	12	18
			B ≥ 6	1.0	28.57	--	11	18
				1.5	24.86	--	10	16
				2.0	24.10	--	9	14
SPP	BH-MND10	1.00	1<B≤3	1.0	27.18	--	15	24
				1.5	23.68	--	13	20
				2.0	22.97	--	12	18

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
SPP	BH-MND10	1.00	3<B≤6	1.0	26.33	--	9	14
				1.5	22.94	--	8	12
				2.0	22.26	--	7	11
			B> 6	1.0	25.99	--	6	9
				1.5	22.65	--	6	9
				2.0	21.97	--	6	9
		2.00	1<B≤3	1.0	28.94	--	17	27
				1.5	25.20	--	14	22
				2.0	24.44	--	13	20
			3<B≤6	1.0	27.25	--	10	16
				1.5	23.73	--	9	14
				2.0	23.01	--	8	12
			B> 6	1.0	26.57	--	7	11
				1.5	23.14	--	6	10
				2.0	22.44	--	6	9
		3.00	1<B≤3	1.0	30.71	--	19	30
				1.5	26.73	--	16	25
				2.0	25.91	--	14	22
			3<B≤6	1.0	28.17	--	11	18
				1.5	24.51	--	10	16
				2.0	23.76	--	9	14
			B> 6	1.0	27.15	--	8	12
				1.5	23.63	--	7	11
				2.0	22.90	--	7	11
SPP	BH-MND12	1.00	1<B≤3	1.0	30.03	--	21	30
				1.5	26.17	--	19	26
				2.0	25.39	--	17	25
			3<B≤6	1.0	29.09	--	14	22
				1.5	25.35	--	13	20
				2.0	24.59	--	12	18
			B> 6	1.0	28.72	--	11	18
				1.5	25.02	--	10	16
				2.0	24.28	--	10	16
		2.00	1<B≤3	1.0	31.98	--	26	30
				1.5	27.85	--	22	26
				2.0	27.01	--	20	26
			3<B≤6	1.0	30.10	--	16	25
				1.5	26.21	--	15	24
				2.0	25.42	--	14	22
			B> 6	1.0	29.35	--	12	19
				1.5	25.56	--	11	18
				2.0	24.79	--	11	18
		3.00	1<B≤3	1.0	33.92	--	32	32
				1.5	29.53	--	26	28
				2.0	28.63	--	25	28
			3<B≤6	1.0	31.11	--	20	30
				1.5	27.08	--	18	26
				2.0	26.25	--	16	26
			B> 6	1.0	29.99	--	15	24
				1.5	26.10	--	13	21
				2.0	25.30	--	13	21
DM Plant	BH-MND13	1.00	1≤ B <3	1.0	25.75	--	13	20
				1.5	22.44	--	11	18
				2.0	21.76	--	10	16
			3≤ B <6	1.0	24.95	--	9	14
				1.5	21.74	--	8	13
				2.0	21.09	--	8	13
			B ≥ 6	1.0	24.63	--	7	11
				1.5	21.46	--	6	10
				2.0	20.81	--	6	9
		2.00	1≤ B <3	1.0	27.43	--	16	25
				1.5	23.88	--	14	22
				2.0	23.16	--	13	21

Structure Name	Foundation Location	Depth of Foundation below EGL (m)	Width of Foundation (m)	L/B Ratio	NSBC (t/sqm)	NABC (t/sqm)		
						S = 12mm	S = 25mm	S = 40mm
DM Plant	BH-MND13	2.00	3≤ B <6	1.0	25.82	--	11	18
				1.5	22.48	--	10	16
				2.0	21.80	--	9	14
			B ≥ 6	1.0	25.18	--	8	13
				1.5	21.92	--	7	11
				2.0	21.26	--	7	11
		3.00	1≤ B <3	1.0	29.11	--	20	28
				1.5	25.33	--	18	25
				2.0	24.55	--	16	24
			3≤ B <6	1.0	26.70	--	14	22
				1.5	23.23	--	12	18
				2.0	22.52	--	12	18
			B ≥ 6	1.0	25.74	--	10	16
				1.5	22.39	--	9	14
				2.0	21.70	--	8	13

Note:

1. NSBC = Net Safe Bearing Capacity, NABC = Net Allowable Bearing Capacity, EGL = Existing Ground Level
2. S = Limiting Settlement.
3. However for foundation placed inside rock, permissible settlement is considered as 12mm irrespective of type of foundation.
4. For Minor structures (which are not sensitive to settlement) foundation may be placed on the filled up soil. The minimum depth of foundation shall be 1m below EGL / FGL and use a net allowable bearing capacity of 5t/sqm.
5. In case any loose pocket is observed at the founding level, then the same should be excavated out and the same shall be filled up with PCC.

5.5. USE OF DEEP FOUNDATION:

Due to presence of thick fill layer deposits around few boreholes, (BH-81, 82, 85 to 91 & BH-MND-03), deep foundation in form of pile may be required. Bored cast in-situ piles are preferred due to availability of construction agencies and less noise pollution. The determination of pile capacity is given below.

At first, the design strength parameters are determined. Thereafter, the pile capacity values are calculated. While determining the pile capacity, the following considerations are made.

a) Cut off = 2.50 m
b) Diameter of pile used = 450, 500 and 750mm
c) Assumed Grade of Concrete = M30

5.5.1. PILE CAPACITY AROUND BAUXITE HANDLING & CHP AREA:

Around BH-87 to 91 locations:

Pile capacity is calculated using layer stratification of BH-91 location as this is worst case.

Layer – I:

Average N in this layer = 18, Use C = 0.90 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.500 [Refer IS: 2911 (Part 1/Sec 2): 2010 Annex B, Fig.2]

Layer – II:

Average N in this layer = 45, Use C = 1.50 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.297

Layer – III:

Average Corrected N = 27, corresponding ϕ = 36° (Refer IS: 6403: 1981, Fig. 1)

Use C = 0.00 kg/sqcm, Φ = 31° & K_0 = 1.05 [Refer IS: 2911 (Part 1/Sec 2): 2010 Annex B, Cl. B-1] (ϕ value is reduced considering fine content of this layer & loosening of soil due to boring operation)

Around BH-81, 82, 85 & 86 locations:

Layer – I:

Average N in this layer = 16, Use C = 0.80 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.567

Layer – II:

Average N in this layer = 42, Use C = 1.40 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.316

Determination of Vertical Pile Capacity:

Based on the above, pile capacity has been calculated for different depth and diameter of pile and the recommended pile capacity values are given below. A typical pile capacity calculation is enclosed at the end of the report. (Use cut-off = 2.50m, M30 grade of concrete)

Name of Structure	Foundation Location	Pile founding depth below FGL (M)	Pile Diameter (mm)	Recommended Vertical Pile Capacity (T)
Bauxite Handling	BH-87 to 91 (FGL = 904.000M)	31	450	55
			500	65
			750	105
	BH-82, 85 & 86 (FGL = 904.000M)	30	450	55
			500	70
			750	190
	BH-81 (FGL = 904.000M)	22	450	55
			500	70
			750	190
CHP	BH-MND03 (FGL = EGL)	30	450	70
			500	90
			750	210

Note: The piles are to be placed at 3D c/c

Determination of Uplift Pile Capacity:

Safe Uplift Capacity of Pile = 1/3rd of Shaft Resistance in Vertical Capacity + Self weight of pile (Buoyant)

(Refer IS: 2911 (Part 1/Sec 2): 2010, Cl. 6.3.2)

With reference to the above, the following uplift capacity values are recommended.

Name of Structure	Foundation Location	Bottom depth of pile below FGL (M)	Pile Diameter (mm)	Recommended Uplift Pile Capacity (T)
Bauxite Handling	BH-87 to 91 (FGL = 904.000M)	31	450	42
			500	48
			750	74
	BH-82, 85 & 86 (FGL = 904.000M)	30	450	25
			500	28
			750	50
	BH-81 . (FGL = 904.000M)	22	450	25
			500	28
			750	50
CHP	BH-MND03 (FGL = EGL)	30	450	38
			500	45
			750	74

5.5.2. PILE CAPACITY AROUND PRECIPITATION LOCATIONS:-

In precipitation area, FGL varies from 920.00M to 931.100M. Considering the borehole position, following FGL is considered as given below.

Name of Structure	BH	EGL (M)	FGL (M)
Precipitation	BH-47	927.274	931.100
	BH-48	927.060	920.000
	BH-50	925.891	920.000
	BH-52	923.276	920.000

Determination of Vertical Pile Capacity:

Bored cast in situ piles are preferred due to typical geological formation, ease of construction, availability of construction agencies and less sound pollution.

The pile capacities are evaluated based on following two approaches. As a sample calculation subsoil condition around BH-52 is used. It is suggested to place the pile at about 11.50m below FGL i.e. 1.50m inside weathered rock layer (Layer IV)

Approach A:

According to IS 2911 (Part 1/Sec 2): 2010, Annex B, Clause B-4.2

$Q_a = C_{u1}.N_c.\pi B^2/4F_s + \alpha C_{u2}.\pi BL/F_s$

Where,

C_{u1} = Shear Strength of rock below the base of the pile in KN/m^2 (see Fig. 3) = 200 t/m^2 = 2000 KN/m^2

N_c= Bearing capacity factor taken as 9

α = 0.9 (recommended value)

C_{u2} = Average shear strength of rock in the socketed length of pile in KN/m^2 (see Fig. 3) = 200 t/m^2 = 2000 KN/m^2

B = Minimum width of pile shaft (diameter in case of circular pile) in m = 750mm = 0.75m

L = Socket length of pile in m considered as 1.50m

D = Diameter of pile in m

F_s = Factor of Safety usually taken as 3

$Q_a = 200 \times 9 \times \pi \times (0.75)^2 / (4\times3) + 0.90 \times 200 \times \pi \times 0.75 \times 1.50 / 3 = 477.13$ T

Approach B:

As per IS 14593:1998, Safe load capacity of pile, $Q_s = q_c N_j N_d A_p + q_c \pi D l_s \alpha\beta$

Where,

Q_s = safe load capacity of pile, in ton

q_c = uni-axial compressive strength of rock, t/sqm

N_d = depth factor = $0.8 + 0.2l_s/D$, limited to 2

A_p = area of pile toe in m^2

D = diameter of pile in m

l_s = socket length into the rock in m

α = rock socket side resistance reduction factor (Fig.1 of IS 14593:1998)

β = rock socket correction factor (Fig.2 of IS 14593:1998)

N_j = values as per Fig. 2 of IS 12070 or Table 4 of IS 12070.

q_c = 307 kg/sqm = 3070 t/sqm

l_s = 2D

D = diameter of pile in m = 600mm = 0.60m

$N_d = 0.8 + 0.2l_s/D = 0.8 + 0.2\times 2D/D = 1.2$

$A_p = \pi D^2/4$
α = 0.03 (as per Fig.1 of IS 14593:1998)
Mass factor, j = 0.2 (for 0% to 25% RQD and fracture frequency 15nos./m) (As per M J Tomlinson, Sec.4.7.3 Pg-134)
Corresponding β = 0.57 (as per Fig.2 of IS 14593:1998)
N_j = 0.1 (as per Table 4 of IS 12070 for spacing of discontinuity 30-100 cm)
Therefore, $Q_s = q_c N_j N_d A_p + q_c \pi D l_s \alpha\beta$
$= (3070x0.1x1.2x\ 0.785D^2 + 3070x\pi xDx2Dx0.03x0.57)$ T
$= (289.194D^2 + 329.85D^2)T = 619.044D^2T$
So, for 750mm dia pile, Q_s = 348.29t

Considering the above two approaches and to be in the safer side, let us restrict the vertical pile capacity to 250T. The recommended uplift capacity = 175T

Determination of Lateral Pile Capacity:

Refer to IS : 2911 (Part I/Sec 2) - 2010, Appendix - C
Use average corrected N = 33 for determining lateral pile capacity.
Modulus of Subgrade Reaction, η_h = 0.45 kg/cucm corresponding to "N" value = 33 [Assuming Submerged Sand]
$T = [EI/\eta_h]^{1/5}$
Now, I = 1.55 x 10^6 cm^4 [for 750mm dia pile]
E = 5000 x $(f_{ck})^{0.5}$ = 5000 x $(30)^{0.5}$ = 27386 N/sqmm = 2.74 x 10^5 kg/sqcm
Hence, T = 248.30 cm
From Graph (Fig.4), L_f = 2.18 x T = 541.29 cm [Assuming Fixed Head Piles]
Pile Head deflection, Y = H x L_f^3 / 12EI = 0.3107mm for 1T load
So, for 5mm horizontal deflection at cut-off level horizontal force at pile head, H = 16.09T, say 16T
Now, Moment = [H x L_f/2] = [1 x 5.41/2] = 2.71t-m per T of thrust
The Reduction Factor for computation of Maximum Moment in Pile, m = 0.82
So, the corrected actual moment, M = 2.71 x 0.82 = 2.22t-m per T of thrust.

Under free head condition and for 5mm deflection, H = 5.5T

Foundation Location	Embedment Inside Weathered rock (m)	Pile Diameter (mm)	Recommended Pile Capacity (T)		Lateral Pile Capacity (T)			
			Vertical	Uplift	Free Head Cond.		Fixed Head Cond.	
					5mm	10mm	5mm	10mm
BH-47 (FGL = 931.100M)	1.50	600	150	110	4	5	14	14
	1.50	750	250	175	6	7	22	22
	2.00	1000	500	300	9	12	39	39
BH-48 & 50 (FGL = 920.000M)	1.50	600	150	110	1	1	4	4
	2.00	600	175	150	2	2	8	8
	1.50	750	250	175	3	3	7	7
	2.25	750	300	250	4	4	17	17
	2.00	1000	500	300	6.5	6.5	18	18
	3.00	1000	600	400	9	11	40	40
BH-52 (FGL = 920.000M)	1.50	600	150	110	4	8	11	22
	1.50	750	250	175	5.5	11	16	32
	2.00	1000	500	300	9	18	25	50

Note: The piles are to be placed at 2D c/c

5.5.3. PILE CAPACITY AROUND CCR & PLANT OFFICE AREA:

In CCR & Plant office area, due to high depth of filling, deep foundation in form of pile may be required. Bored cast in-situ piles are preferred due to availability of construction agencies and less noise pollution. The recommended pile capacity values are given below.

Foundation Location	Embedment Inside Weathered rock (m)	Pile Diameter (mm)	Recommended Pile Capacity (T)		Lateral Pile Capacity (T)			
			Vertical	Uplift	Free Head Cond.		Fixed Head Cond.	
					5mm	10mm	5mm	10mm
BH-44 (FGL = 935.000M)	1.50	600	150	110	4	5	14	14
	1.50	750	250	175	6	7	22	22
	2.00	1000	500	300	9	12	39	39

Note: The piles are to be placed at 2D c/c

5.5.4. PILE CAPACITY AROUND SUB-STATION EXTENSION BUILDING, SWITCH YARD & SEWAGE TREATMENT PLANT AREA:

Around BH-98 location:

Layer – I: (From 0.00m to 8.50m)

Average N in this layer = 11, Use C = 0.65 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.649

Layer – III: (From 8.50m to 19.00m)

Average Corrected N = 22, corresponding ϕ = 34°

Use C = 0.00 kg/sqcm, Φ = 30° & K_0 = 1.00

Layer – II: (From 19.00m to 24.00m)

Average N in this layer = 54, Use C = 1.50 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.297

Layer – III: (From 24.00m to 33.20m)

Average Corrected N = 29, corresponding ϕ = 37°

Use C = 0.00 kg/sqcm, Φ = 31° & K_0 = 1.05 (ϕ value is reduced considering fine content of this layer & loosening of soil due to boring operation)

Around BH-99 & 100 locations:

Pile capacity is calculated using design layer stratification.

Layer – I: (From 0.00m to 7.50m)

Average N in this layer = 16, Use C = 0.80 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.567

Layer – II: (From 7.50m to 35.00m)

Average N in this layer = 53, Use C = 1.50 kg/sqcm, Φ = 0° & Use Adhesion factor, α = 0.316

The recommended pile capacity values are given in tabular form below.

Name of Structure	Foundation Location	Bottom depth of pile below EGL (M)	Pile Diameter (mm)	Recommended Pile Capacity (T)		Lateral Pile Capacity (T)			
				Vertical	Uplift	Free Head Cond.		Fixed Head Cond.	
						5mm	10mm	5mm	10mm
Sub-Station Extension Building	BH-98	22	450	50	36	3	6	7	14
			500	60	44	3.5	7	7.5	15.5
			750	115	80	5	10.5	11.5	23
		26	450	60	46	3	6	7	14
			500	70	54	3.5	7	7.5	15.5
			750	150	100	5	10.5	11.5	23
Switch Yard & Sewage Treatment Plant	BH-99 & 100	20	450	50	38	3.5	7	8	16
			500	55	42	4	8	9	18
			750	90	65	6	12	13	27
		22	450	55	42	3.5	7	8	16
			500	60	46	4	8	9	18
			750	100	72	6	12	13	27

Note: The piles are to be placed at 2D c/c

5.6. SWELLING CHARACTERISTICS:

The swelling pressure and Free Swell Index tests were performed on few samples and the test results are presented in Volume 2. The average swelling pressure and free swell index are 0.18 kg/sqcm & 5.26% respectively. Thus, the subsoil has low swelling characteristics. So, no problem with respect to the swelling of the subsoil is anticipated.

5.7. CHEMICAL TESTS:

Chemical tests were performed on few soil samples for determining the pH value, Sulphate, Chloride content etc. The results are given in a tabular form below:

CHEMICAL TEST RESULTS ON SOIL SAMPLES:

BH/Sample No.	Depth (m)	pH value	Sulphate as SO_3 (%)	Chloride as Cl (%)	Organic matter (%)
BH01 / SPT01	1.50	8.96	BDL	0.0080	0.3253
BH19 / DS03	2.50	7.48	BDL	0.0070	0.1546
BH20 / DS02	1.00	6.48	BDL	0.0080	0.1238
BH21 / SPT04	6.50	5.05	BDL	0.0070	0.1252
BH22 / SPT02	3.00	5.53	BDL	0.0060	0.1122
BH30 / UDS02	4.00	5.46	BDL	0.0090	0.7645
BH37 / DS01	0.50	4.88	0.060	0.0140	1.2370
BH40 / UDS01	2.05	5.55	BDL	0.0100	1.1638
BH48 / DS03	2.50	7.45	BDL	0.0090	0.1760
BH52 / DS03	2.50	7.60	BDL	0.0080	0.2512
BH53 / DS03	3.50	7.68	0.060	0.0100	0.5616
BH54 / UDS01	2.50	7.26	BDL	0.0070	0.6185
BH55 / UDS01	2.55	5.87	BDL	0.0060	0.8448
BH56 / DS01	0.50	7.30	BDL	0.0060	0.4506
BH57 / DS03	2.50	6.84	BDL	0.0050	0.5027
BH58 / DS01	0.50	7.48	BDL	0.0070	0.6284
BH59 / DS02	1.00	7.35	BDL	0.0060	0.2532
BH67 / UDS01	2.50	5.07	BDL	0.0070	0.1859
BH68 / UDS01	4.00	5.11	BDL	0.0060	0.2479
BH69/ UDS01	2.50	5.94	BDL	0.0060	0.2106
BH70/ UDS01	2.50	6.43	BDL	0.0060	0.5397
BH73 / DS03	2.50	6.02	BDL	0.0060	2.0936
BH81 / DS04	4.50	7.41	BDL	0.0070	0.2462
BH85 / SPT01	1.00	7.72	BDL	0.0060	0.2950
BH86/ UDS01	2.50	7.90	BDL	0.0060	0.5577
BH87 / SPT02	3.00	8.8	BDL	0.0080	0.3409
BH88 / SPT03	4.50	7.16	BDL	0.0070	0.3105
BH89/ UDS03	20.00	6.54	BDL	0.0080	0.2779
BH90/ UDS04	15.50	6.25	BDL	0.0060	0.1861
BH91 / UDS01	3.00	6.95	BDL	0.0070	0.4638
BH93/ UDS01	2.55	6.49	BDL	0.0070	0.1238
BH94/ UDS01	2.55	7.10	BDL	0.0060	0.1362

BH/Sample No.	Depth (m)	pH value	Sulphate as SO_3 (%)	Chloride as Cl (%)	Organic matter (%)
BH96 / DS01	0.50	6.95	BDL	0.0060	0.1535
BH98 / UDS01	2.60	7.53	BDL	0.0050	1.8940
BH99 / UDS01	3.00	7.50	BDL	0.0070	0.3091
BH100 / UDS01	2.50	6.81	BDL	0.0050	0.4169
BH-MND-01/SPT02	3.00	6.64	BDL	0.0080	0.4628
BH-MND-02/UDS01	3.15	7.96	BDL	0.0050	0.6188
BH-MND-03/SPT01	1.50	8.26	BDL	0.0070	0.8399
BH-MND-04/UDS01	4.00	7.65	BDL	0.0060	0.8987
BH-MND-06/UDS01	2.50	8.05	BDL	0.0060	1.0949
BH-MND-07/UDS01	3.00	6.96	BDL	0.0080	1.7081
BH-MND-10/UDS01	2.50	7.13	BDL	0.0050	0.6772
BH-MND-11/UDS01	2.50	6.64	BDL	0.0070	0.3403
BH-MND-12/UDS01	3.05	7.26	BDL	0.0060	0.2619
BH-MND-13/UDS01	3.00	8.00	BDL	0.0070	0.6528

B.D.L: **B**elow **D**etection **L**imit (<0.05%).

It is seen that the values are on a safe side and so no precaution will be required for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

5.8. STANDARD PROCTOR COMPACTION, CBR & LABORATORY PERMEABILITY TEST:

Eight (8) nos. Standard Proctor Compaction tests were carried out. Thereafter, 5 nos. CBR (4 days soaked) tests were carried out on the samples prepared at 95% of MDD. Additionally, 5 nos. permeability were also conducted on samples compacted at MDD. The test results are presented below. The compaction & CBR graphs are presented in Volume 2.

SL No	Sample No	Depth (M)	Description	Standard Proctor Compaction Test		Soaked CBR Value at 95% of MDD (%)		Recommended Soaked CBR (%)	Permeability on samples compacted at MDD/OMC (cm/sec)
				OMC (%)	MDD (gm/cc)	2.50mm Penetration	5.00mm Penetration		
1	TP04/DS01	1.00	Reddish brown clayey silt with traces of sand mixture.	25.50	1.552	9.18	7.33	9	--
2	TP05/DS01	0.50	Reddish brown clayey silt with traces of decomposed rock fragments.	19.75	1.709	--	--	--	1.70×10^{-05}
3	TP07/DS02	2.00	Reddish brown clayey silt / silty clay with traces of sand mixture & kankar.	19.60	1.590	8.51	7.42	8	5.20×10^{-06}
4	TP08/DS03	3.00	Reddish brown clayey silt with traces of sand mixture & kankar.	30.05	1.437	--	--	--	1.78×10^{-06}
5	TP-MND-01/DS01	1.00	Reddish brown clayey silt / silty clay with traces of sand mixture & kankar.	24.90	1.604	8.16	6.48	8	8.23×10^{-07}
6	CBR-02/DS01	0.80	Greyish brown clayey silt.	30.10	1.421	3.63	3.22	3	--
7	CBR-09/DS01	0.50	Reddish brown clayey silt.	23.10	1.572	--	--	--	1.46×10^{-06}
8	CBR-10/DS01	0.50	Reddish brown clayey silt.	23.40	1.578	8.42	6.68	8	--

5.9. POSSIBILITY OF SUBSOIL LIQUEFACTION DUE TO EARTHQUAKE:

Seed et al. (1983) stated that based on both laboratory testing and field performance, the great majority of cohesive soils will not liquefy during earthquakes. Using criteria originally stated by Seed and Idriss (1982) and subsequently confirmed by Youd and Gilstrap (1999), in order for a cohesive soil to liquefy, it must meet all the following three criteria:

a) The soil must have less than 15 percent of the particles, based on dry weight, that are finer than 0.005 mm (i.e., percent finer at 0.005 mm < 15 percent).
b) The soil must have a liquid limit (LL) that is less than 35 (that is, LL < 35).
c) The water content w of the soil must be greater than 0.9 of the liquid limit [that is, w > 0.9 (LL)].

If the cohesive soil does not meet all three criteria, then it is generally considered to be not susceptible to liquefaction. In our present case, we have

a) The average clay % fraction of layer- I & II are 19% and 16% respectively i.e. more than the critical value of 15% ----- safe
b) The average Liquid Limit layer- I & II are 46% and 45% respectively i.e. more than the critical value of LL<35% ------- safe.

c) The average moisture content of layer- I & II are 22% and 20% respectively which is less than 90% of LL of a certain layer ----- safe.

From the above discussion, it can seen that all the three clause (a to c) are against the possibility of liquefaction of the subsoil.

At lower reaches, we have dense to very dense silty sand layer. Liquefaction of this layer is also not expected.

However around some borehole (BH-90 & 97) locations medium dense sand layer appears. So, the subsoil may have some possibility to liquefy under earthquake.

The liquefaction potential of subsoil is evaluated as per provision laid down in *"Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils"* by Dr. Gonzalo Castro et al. published in *"Journal of Geotechnical and Geoenvironmental Engineering"*, October' 2001.

The ratio of CRR/CSR ≤ 1.0 indicates that the soil is prone to liquefaction whereas CRR/CSR > 1.0 or corrected N_1 > 30 indicates the soil is non liquefiable.

Based on the SPT values in boreholes, the liquefaction resistance of all the boreholes were evaluated for zone – II as per IS:1893 Part I and presented in a separate sheet.

Bore Hole No.	Avg Depth	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	CN	CE	CB	CS	CR	(N1)	FC	α	β	Corr. (N1)	r_d	CSR	$CRR_{7.5}$	FOS
BH-90	14.23	20	27.36	13.13	0.87	1.00	1.05	1.10	1.00	20.2	26	4.39	1.12	27.0	0.79	0.11	0.34	***3.785***
BH-97	1.73	24	3.30	1.58	1.70	1.00	1.05	1.10	0.75	35.3	38	5.00	1.20	47.4	Non liquefiable			

1) C_N= Correction for Overburden pressure limited to 1.70

$$C_N = \sqrt{\frac{P_a}{\sigma}}$$

P_a = 1 Atmospheric pressure = 10t/sqm

σ = Vertical effective stress at the depth of SPT

2) C_E = Correction for Level of energy delivered by SPT hammer = 1.00.

3) C_B = Correction for Borehole Diameter = 1.05 for 150mm borehole dia.

4) C_S = Correction for SPT sampler use = 1.10 for sampler without liner.

5) C_R = Correction for short length of drill rod.

Rod length(m)	C_R	Rod length(m)	C_R
<3	0.75	6-<10	0.95
3-<4	0.80	10-30	1.00
4-<6	0.85		

$(N1) = N.C_NC_EC_BC_SC_R$

Fine content means particles smaller than 75 micron

For Fine Content<=5,α = 0 and β = 1

For(Fine Content>5 AND <35),α = EXP((1.76-(190/FC^2)) and β = (0.99+($FC^{1.5}$/1000))

For Fine Content>35,α = 5 and β = 1.20

Corrected (N1) = α+β*(N1)

r_d=(1-0.4113*$d^{0.5}$+0.04052*d+0.001753*$d^{1.5}$)/(1-0.4177*$d^{0.5}$+0.05729*d-0.006205*$d^{1.5}$+0.00121*d^2)

CSR = 0.65*(a_{max}/g)*(Total Overburden pressure)*r_d/(Effective Overburden pressure)

$CRR_{7.5}$=1/(34-Final$(N1)_{60}$)+Final$(N1)_{60}$/135+50/(10*Final$(N1)_{60}$+45)^2-1/200

FOS against Liquifaction = ($CRR_{7.5}$/CSR).MSF

For calculation of CSR & CRR, water level is considered at ground level.

5.10. SUITABILITY OF EXISTING SOIL FOR FILLING AND BACK-FILLING:

Recommendation for Filling At foundation locations & Backfilling Purposes: The subsoil at the site consists of silty clay (CI) with fine sand mixtures having low swelling properties. So, the soil can be used for filling and backfilling purposes with necessary compaction as required. The soil can be easily compacted and will easily attain an average dry density (by standard proctor) of 1.55 gm/cc and above.

5.11. SUITABILITY OF SOIL FOR CONSTRUCTION OF ROADS & PAVEMENT:

The subsoil at the site consists of silty clay / clayey silt with fine sand mixtures having low swelling properties. Thus the soil can be used for the construction of roads and pavement as a fill material.

Field CBR Tests: Both soaked and unsoaked field CBR test were conducted at site with average values of 8.12% and 13.79% respectively. These values correspond to field condition as available during site investigation.

Laboratory CBR Tests: From standard proctor tests, we have average maximum dry density is in the order 1.558 gm/cc with OMC of 24.55%. Thus the soil may be compacted at OMC and the Bulk density in that case will be around 1.939 gm/cc. 4 days soaked CBR tests were performed on remoulded soil samples (compacted at MDD). The CBR values are in the range of 8% to 9% (with a stray value of 3%) for soaked condition.

Conclusion: Considering the above, CBR value of 8% for soaked condition may be used for pavement subgrade design. In case of presence of swelling soil (if any) at the top, the same shall be replaced by granular material (like sand or moorum depending on availability at site) or other non-swelling soil available at site. If any loose soil is available at the top, the same can be compacted properly or replaced by material as stated above.

5.12. DEWATERING:

The standing water level was found from 1.70m to a maximum depth of 12.10m during the time of investigation. So, construction of open foundation, placed at a depth of 1.00m or more, may create a problem. The subsoil being predominantly clayey in nature, seepage is expected to be less. So, ordinary surface operated pump will be able to tackle the situation for dewatering. For excavation more than 4m proper shoring arrangement may be required to protect the side slope.

5.13. EXCAVATION:

For excavation in virgin soil, a slope of 1(H):2(V) may be used for layer I & II. For layer III, (cohesion less soil) a reduced slope of 2(H):1(V) may be used. For excavation in stratum-IV, V & VI (i.e. rock layer), vertical or almost vertical slope may be used. However, to be in the safer side, a nominal side slope of 0.5(H):1(V) for stratum-IV & V and 0.25(H):1(V) for stratum-VI should be provided.

It is also suggested to provide a Berm of at least 1m wide after each 3m to 4m of excavation. Excavation in stratum-I, II & III can be made with shovels and pick-axe. At lower reaches, pneumatic / jack hammer will be more efficient. Alternatively controlled blasting may be required.

5.14. DETERMINATION OF SUBGRADE MODULUS:

Refer to "Handbook of Machine Foundations" by P. Srinivasulu & C. V. Vaidyanathan, 2nd Reprint, 1978, pp-39

Co-efficient of uniform compression, $C_z = \frac{\alpha.E}{(1-\mu^2)}.\frac{1}{\sqrt{B.L}}$

Similarly, under static condition, Subgrade Modulus can be expressed, $K = \frac{\alpha.E}{(1-\mu^2)}.\frac{1}{\sqrt{B.L}}$

Where,

K = Subgrade Modulus, kg/cucm

α = Constant = 1.06, 1.07 & 1.09 for L/B = 1.00, 1.50 & 2.0 respectively.

E = Young's Modulus, kg/sqcm

μ = Poisson's Ratio

B, L = Width & Length of the foundation (cm)

Now, the Subgrade Modulus remains constant modulus for foundation area more than 10sqm.

Assume B.L = 10 sqm. Using L/B ratio as 2.00, α = 1.09

Using the above values and soil properties of each layer, the Subgrade Modulus is calculated for a foundation area of 10 sqm and is presented below.

Layer No.	Young's Modulus (Kg/sqcm)		Poisson's Ratio (m)	Subgrade Modulus (kg/cucm)	
	E_u	E_s		Short Term	Long Term
Layer – I	360	83.60	0.35	1.41	0.33
Layer – II	750	211.20	0.35	2.95	0.83
Layer – III	510	510	0.25	1.88	1.88
Layer – IV	2500	2500	0.25	9.19	9.19
Layer –V	5000	5000	0.25	18.38	18.38
Layer – VI	10000	10000	0.25	36.77	36.77

The above values of Subgrade Modulus can be used for different foundation sizes having area equal to 10sqm or more.

For lesser foundation area (say for 5sqm area), the following Subgrade Modulus values can be used.

Layer No.	Young's Modulus (Kg/sqcm)		Poisson's Ratio (m)	Subgrade Modulus (kg/cucm)	
	E_u	E_s		Short Term	Long Term
Layer – I	360	83.60	0.35	2.00	0.46
Layer – II	750	211.20	0.35	4.17	1.17
Layer – III	510	510	0.25	2.65	2.65
Layer – IV	2500	2500	0.25	13.00	13.00
Layer –V	5000	5000	0.25	26.00	26.00
Layer – VI	10000	10000	0.25	52.00	52.00

The above values of Subgrade Modulus can be used for different foundation sizes having area less than 10sqm. However, for more accurate result, the values may be recalculated using the formula as illustrated above.

Stratum I

Average N = 19, corresponding cohesion from N value = 0.95 kg/sqcm
From laboratory test results, average C = 0.89 kg/sqcm & ϕ = 10°
Use C = 0.90 kg/sqcm & ϕ = 0°
E_s = 4.4N = 83.60 kg/sqcm
E_u = 400 x 0.90 = 360 kg/sqcm

Stratum II

Average N = 48, corresponding cohesion from N value = 1.78 kg/sqcm
From laboratory test results, average C = 1.24 kg/sqcm & ϕ = 9°
Use C = 1.50 kg/sqcm & ϕ = 0°
E_s = 4.4N = 211.20 kg/sqcm
E_u = 500 x 1.50 = 750 kg/sqcm

Stratum III

Average corrected N = 36
Treating the sand to be normally consolidated sand, E_s = 5(N+15) = 255 kg/sqcm
Treating the sand to be over consolidated sand, E_s = 400 + 10.5N = 778 kg/sqcm
Thus average E_s = 517 kg/sqcm
Use E_s = 510 kg/sqcm

Stratum IV, V & VI

Use E_s for layer IV, V & VI = 2500 kg/sqcm, 5000 kg/sqcm & 10000 kg/sqcm respectively

6. SUMMARY & RECOMMENDATIONS

Based on the field and laboratory tests and the foregoing discussion the following are summarised.

1. The subsoil is characterised by filled up soil around some borehole locations followed by stiff to very stiff / hard silty clay. Below this dense to very dense silty sand with clay binder was observed. After that weathered rock layer was struck and that continued upto the terminating depth of all boreholes.
2. The standing water level was struck at an average depth of about 6.40m below existing ground level. So, construction of open foundation placed at a depth of 1.00m or more may not create any problem. However, if required ordinary surface operated pump will be able to tackle the situation for dewatering.
3. Considering the subsoil condition and the proposed structure to be constructed at the present site, it is suggested to go for open foundation. The foundation may be placed at 1.00m or more below FGL.
4. The recommended bearing capacity values with various depth of foundation are presented in Section 5.4.2.
5. Due to presence of thick fill layer deposits around few boreholes (BH-81, 82, 85 to 91 & BH-MND-03), deep foundation in form of pile may be required. Bored cast in-situ piles are preferred due to availability of construction agencies and less noise pollution as well as ease of construction.
6. The determination and recommendation of vertical, uplift and lateral capacity for different depth and diameter of pile are given in the previous section as detail below.
   - A) Bauxite Handling & CHP Area: Refer Section 5.5.1.
   - B) Precipitation Area: Refer Section 5.5.2.
   - C) CCR & Plant Office Area: Refer Section 5.5.3.
   - D) Sub-Station Extension Building, Switch Yard & Sewage Treatment Plant Area: Refer Section 5.5.4.
7. The discussion on swelling characteristics is given in Section 5.6.

8. Standard Proctor Compaction tests were carried out in the laboratory to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). Thereafter, CBR (soaked) tests were also carried out on the samples prepared at MDD. The summarised test results and the graphs are presented in Appendix.

9. Chemical tests were carried out on few soil samples so as to detect the **pH value, Sulphate, Chloride etc**. It is seen that the values are on a safe side. So, any cement can be used for foundation concrete. **Either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.**

10. The possibility of subsoil liquefaction due to earthquake is given in Section 5.9.

11. The suitability of existing soil for filling and back-filling is given in Section 5.10.

12. The suitability of soil for construction of roads & pavement is discussed in Section 5.11.

13. Dewatering Scheme is discussed in Section 5.12.

14. Excavation Scheme is discussed in Section 5.13.

15. Geological Logging for the zone of investigation is presented in Section -7.

16. 22 (Twenty Two) nos. ERT were performed at the site and the test results are discussed and presented in Section - 8.

For C. E. Testing Company Private Limited,

Prepared By	Checked By	Approved By
S. Sarkar	Sudip Nath	Mnayak
(S. SARKAR)	(S. NATH)	(DR. M. NAYAK)

7. GEOLOGICAL LOGGING

BH No. 01

(00.00 – 13.70)m: Overburden.

(13.70 – 25.00)m: **(13.70-16.72)m:**

Rock Description: Highly weathered, yellowish grey, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.

(16.72-25.00)m:

Rock Description: Moderately to slightly weathered (up to 22.00m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Moderately hard and moderately strong **to v**ery hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 20.70m) followed by medium spaced (5-8 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (30° dip at 16.70 – 17.70m; 50˚ dip at 18.70 – 19.70m; 50˚ dip at 20.70 – 22.00m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth, altered (up to 16.72m) and then slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough, slightly altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm along with pockets of <30mm (13.70 – 16.72m) and >300mm (20.70 – 25.00m).

Rock Mass Structure: The rock mass is very poor to poor (up to 20.70m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered to fresh and high to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result high to little amount of core loss occurred.

BH No. 19

(00.00 – 14.00)m: Overburden.

(14.00 – 23.00)m: **Rock Description**: Highly weathered (up to 18.00m) followed by moderately to slightly weathered (up to 20.00m) and then fresh, alternating dark and light bands with red spots, foliated (55°-60°), medium grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 20.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (60˚ dip at 15.00-16.00m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth, altered (up to 15.00m) and slightly altered to fresh. Open inclined fracture surface is planar, smooth and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm along with pockets of 100-300mm (20.00 – 23.00m).

Rock Mass Structure: The rock mass is very poor to poor (up to

20.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 20

(00.00 – 12.00)m: Overburden.

(12.00 – 15.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

(15.00 – 21.00)m: **Rock Description**: Highly weathered (up to 17.00m) followed by slightly weathered to fresh, alternating dark and light bands with red spots, foliated (50°-60°), medium grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 18.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (60˚ dip at 15.00-16.00m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth, slightly altered to fresh. Open inclined fracture surface is planar, smooth and altered.
Description of Core: Recovered core occurs as discontinuous framework up to 15.00m followed by continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm along with pockets of 100-300mm (18.00 – 21.00m).
Rock Mass Structure: The rock mass is very poor to poor (up to 18.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 21

(00.00 – 19.00)m: Overburden.

(19.00 – 25.00)m: **(19.00-20.25)m:**
Rock Description: Highly weathered, yellowish grey, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.
(20.25-25.00)m:
Rock Description: Highly to moderately weathered (up to 22.00m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong **to v**ery hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 21.00m) followed by closely spaced (15-8 nos./m, up to 22.00m) and

them widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (30° dip at 22.00-25.00m). Open horizontal fracture surfaces are planar, smooth, altered (up to 20.25m) followed by non-planar, rough, slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough, slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of 30-100mm.
Rock Mass Structure: The rock mass is very poor to poor (up to 22.00m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and high to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result high to little amount of core loss occurred.

BH No. 22

(00.00 – 28.00)m: Overburden.

(28.00 – 32.00)m: **Rock Description**: Slightly weathered to fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm (at 28.00-29.00m).
Rock Mass Structure: The rock mass is of excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered to fresh and little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result little amount of core loss occurred.

BH No. 30

(00.00 - 05.70)m: Overburden.

(05.70 - 20.70)m: **Rock Description**: Moderately to slightly weathered (up to 17.70m depth), followed by fresh, alternating dark and light bands with yellowish colouration and red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Medium spaced (8-5nos/m) to widely spaced (5-1 nos./m) fractures, along with very closely spaced fractures (>15nos/m) at 11-70-16.70m. Dominantly horizontal fractures. Open fracture surfaces are non-planar, rough and altered to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm,

with pockets of 30-100mm at 07.70-17.70m depth.
Rock Mass Structure: The rock mass is fair to good with pockets of very poor to poor quality at (11.70-16.70)m depth.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 37

(00.00 - 01.10)m: Overburden.

(01.10 - 19.10)m: **Rock Description**: Moderately to slightly weathered (up to 15.10m depth), followed by fresh, alternating dark and light bands with yellowish colouration and red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Dominantly medium spaced (8-5nos/m) to widely spaced (5-1 nos./m) fractures, along with very closely to closely spaced fractures (>15nos/m) at 1-10-2.10m, 3.10-4.10m. Dominantly horizontal fractures with locally inclined fracture (dip 60° at 3.10-4.10m). Open horizontal fracture surfaces are non-planar, rough and altered (up to 4.10m) to clean. Open inclined fracture surface is non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is fair to good with pockets of very poor to poor quality at (1.10-2.10m, 3.10-4.10m) depth.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 40

(00.00 - 06.00)m: Overburden.

(06.00 - 08.25)m: Completely weathered, decomposed and disintegrated, brownish grey, medium to coarse grained rock particles collected as sludge.

(08.25 - 18.70)m: **Rock Description**: Highly (up to 10.00m), followed by slightly weathered to fresh, alternating dark and light bands with yellowish colouration (up to 10.00m) and red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong (up to 10.00m) to very hard and strong rock.
Structural Condition: Very closely spaced (>15nos/m) up to 10.00m to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 10.00m) to clean.

Description of Core: Recovered core occurs as discontinuous framework (up to 8.25m) to continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at 8.25-10.00m.
Rock Mass Structure: The rock mass is very poor up to 10.00m, followed by good/ excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to slightly weathered and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 44
(00.00 - 02.40)m: Overburden.
(02.40 - 15.90)m: **Rock Description**: Moderately to slightly weathered (up to 12.90m depth), followed by fresh, alternating dark and light bands with yellowish colouration and red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely (>15 nos/m) to closely (15-8 nos/m) spaced up to 9.40m, followed by medium spaced (8-5nos/m) to widely spaced (5-1 nos./m) fractures, along with very closely to closely spaced fractures (>15nos/m) at 8.40-9.90m. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 8.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at 2.40-7.40m, 8.40-9.90m.
Rock Mass Structure: The rock mass is very poor to poor (up to 7.40m and 8.40-9.90m), followed by fair to good quality.

High (up to 4.40m) to partial drill water loss have been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 47
(00.00 - 01.10)m: Overburden.
(01.10 - 09.00)m: **Rock Description**: Moderately to slightly weathered (up to 05.00m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely (>15 nos/m) to closely (15-8 nos/m) spaced up to 5.00m, followed by widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 5.00m) to clean.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is very poor to poor (up to 5.00m), followed by good to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 48

(00.00 - 08.30)m: Overburden.

(08.30 - 13.00)m: **Rock Description**: Moderately to slightly weathered (up to 10.00m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely (15-8 nos/m) to medium (8-5 nos/m) spaced up to 10.00m, followed by widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 10.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is poor to fair (up to 10.00m), followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 49

(00.00 – 07.30)m: Overburden.

(07.30 – 12.50)m: **Rock Description**: Moderately to slightly weathered (up to 09.50m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely spaced (15-8 nos,/m, up to 08.00m) followed by medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar to planar, rough to smooth and slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is poor (up to 08.00m) followed

by fair to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 50

(00.00 - 02.00)m: Overburden.

(02.00 - 12.00)m: **Rock Description**: Moderately to slightly weathered (up to 9.00m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely (>15 nos/m) to closely (15-8 nos/m) spaced up to 9.00m, followed by widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 9.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is very poor to poor (up to 9.00m), followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 51

(00.00 - 03.00)m: Overburden.

(03.00 - 11.00)m: **Rock Description**: Highly (up to 4.00m), followed by moderately to slightly weathered (4.00-8.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong (up to 4.00m) to very hard and strong rock.
Structural Condition: Closely spaced (>15nos/m) up to 4.00m, followed by medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 4.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is poor up to 4.00m, followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 52

(00.00 - 13.00)m: Overburden.

(13.00 - 26.00)m: **Rock Description**: Highly (up to 18.10m and 21.00-23.00m), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Moderately hard and moderately strong (up to 18.10m) to very hard and strong rock.

Structural Condition: Very Closely spaced (>15nos/m) up to 23.00m, followed by widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 23.00m) to clean.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at 13.00-18.10m, 21.00-23.00m.

Rock Mass Structure: The rock mass is very poor to poor up to 23.00m, followed by excellent.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 53

(00.00 – 04.10)m: Overburden.

(04.10 – 08.00)m: **(04.10 – 05.00)m:**

Rock Description: Highly weathered brownish yellow with alternating dark and light bands and red spots, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.

(05.00 – 08.00)m:

Rock Description: Moderately weathered (up to 06.50m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Moderately hard and moderately strong **to v**ery hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 06.50m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar to planar, rough to smooth, altered (up to 05.00m) followed by slightly altered to fresh.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-300mm along with pockets of <30mm (04.10-05.00m) and >300mm (06.50-08.00m).

Rock Mass Structure: The rock mass is very poor to good.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and high to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result high to little amount of core loss occurred.

BH No. 54

(00.00 – 05.90)m: Overburden.

(05.90 – 14.00)m: **(05.90 – 06.90)m:**
Rock Description: Highly weathered, brownish yellow with alternating dark and light bands and red spots, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.
(06.90 – 14.00)m:
Rock Description: Moderately to slightly weathered (up to 11.00m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong **to v**ery hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 08.90m) followed by medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar to planar, rough to smooth, altered (up to 09.90m) followed by slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm along with pockets of 30-100mm (05.90-09.90m)
Rock Mass Structure: The rock mass is very poor to poor (up to 08.90m) and then fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and high to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result high to little amount of core loss occurred.

BH No. 55

(00.00 – 09.90)m: Overburden.

(09.90 – 16.00)m: **Rock Description**: Moderately to slightly weathered (up to 13.00m), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Medium spaced (8-5 nos./m, up to 11.90m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm.
Rock Mass Structure: The rock mass is fair (up to 11.90m) followed

by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 56

(00.00 – 03.00)m: Overburden.

(03.00 – 16.50)m: **Rock Description**: Highly weathered (up to 04.00m), followed by moderately to slightly weathered (up to 12.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°- 60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely spaced (15-8 nos./m, up to 06.00m) followed by medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered (up to 04.00m) followed by slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm, 100-300mm and >300mm with pockets of 30-100mm (03.00-06.00m).
Rock Mass Structure: The rock mass is poor (up to 06.00m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 57

(00.00 – 08.00)m: Overburden.

(08.00 – 16.50)m: **Rock Description**: Moderately to slightly weathered (up to 13.50m), followed by fresh, alternating dark and light bands with red spots, foliated (50°- 60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 09.00m) followed by closely spaced (15-8 nos./m) to medium spaced (8-5 nos./m, up to 13.50m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar to planar, rough to smooth, slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm along with pockets of 30-100mm.
Rock Mass Structure: The rock mass is very poor to fair (up to 13.50m) and then excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 58

(00.00 – 05.00)m: Overburden.

(05.00 – 09.00)m: **(05.00-07.30)m:**

Rock Description: Slightly weathered to fresh, alternating dark and light bands with yellowish colouration and red spots, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.

(07.30-09.00)m:

Rock Description: Fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Moderately hard and moderately strong to very hard and strong rock.

Structural Condition: Medium spaced (8-5 nos./m, up to 06.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with a pocket of inclined fracture (50° dip at 5.00-6.00m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 07.30m) followed by slightly altered to fresh. Open inclined fracture surface is non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm along with pocket of <30mm (5.00-5.20m).

Rock Mass Structure: The rock mass is fair (up to 06.00m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered to fresh and little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result little amount of core loss occurred.

BH No. 59

(00.00 – 05.00)m: Overburden.

(05.00 - 11.00)m: **Rock Description**: Moderately to slightly weathered (up to 07.00m), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Closely spaced (15-8 nos./m) to medium spaced (8-5 nos./m) up to 07.00m followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (50° dip at 07.00-08.00m). Open horizontal fracture surfaces are non-planar, rough and altered (up to 07.40m) followed by slightly altered to fresh. Open inclined fracture surface is planar, smooth and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm.

Rock Mass Structure: The rock mass is poor to fair (up to 07.00m), followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 60
(00.00 - 13.00)m: **Rock Description**: Highly (up to 2.00m) to moderately to slightly weathered (up to 7.50m), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong (up to 2.00m) to very hard and strong rock.
Structural Condition: Very Closely spaced (>15nos/m) up to 3.00m, followed by medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 1.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at 1.00-3.00m.
Rock Mass Structure: The rock mass is very poor to poor up to 3.00m, followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 61
(00.00 - 09.00)m: **Rock Description**: Moderately to slightly weathered (up to 4.50m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely (15-8 nos/m) spaced up to 3.00m, followed by medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 3.00m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is poor (up to 3.00m), followed by fair to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to

little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 62

(00.00 - 12.50)m: **Rock Description**: Moderately to slightly weathered (up to 9.50m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 9.00m) to clean.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.

Rock Mass Structure: The rock mass is good to excellent quality.

Partial drill water loss has been noticed for the entire depth.

The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 63

(00.00 - 17.00)m: **Rock Description**: Moderately to slightly weathered (up to 12.50m depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 12.50m) to clean.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.

Rock Mass Structure: The rock mass is fair to excellent quality.

Partial drill water loss has been noticed for the entire depth.

The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 64

(00.00 - 00.50)m: Overburden.

(00.50 - 16.50)m: **Rock Description**: Moderately to slightly weathered (up to 6.00m

depth), followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely (15-8 nos/m) up to 1.50m, followed by medium (8-5 nos/m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered (up to 12.50m) to clean.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm, with pockets of 30-100mm at places.
Rock Mass Structure: The rock mass is poor (up to 1.50m), followed by good to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 65

(00.00 – 11.00)m: Overburden.

(11.00 – 19.00)m: **Rock Description**: Highly weathered (up to 13.00m) followed by moderately to slightly weathered (up to 16.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to medium spaced (8-5 nos./m, up to 16.00m) followed by widely spaced (5-1 nos./m). Dominantly horizontal fractures along with a pocket of inclined fracture (60° dip at 14.00-15.00m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth and altered to fresh. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm, 100-300mm and >300mm along with pockets of <30mm (11.00-12.00m).
Rock Mass Structure: The rock mass is very poor to fair (up to 16.00m) and then excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 66

(00.00 – 03.10)m: Overburden.

(03.10 – 15.50)m: **Rock Description**: Highly weathered (up to 7.10m) followed by moderately to slightly weathered (up to 12.50m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°),

coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 9.50m) followed by medium (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (60° dip at 5.10-6.10m and 50° dip at 7.10-8.10m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 8.10m) and then slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of 30-100mm (3.10-9.60m) and >300mm (11.00-15.50m).
Rock Mass Structure: The rock mass is very poor to poor (up to 09.50m) and then fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 67

(00.00 – 08.30)m: Overburden.

(08.30 – 13.00)m: **Rock Description**: Moderately weathered (up to 09.80m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Closely spaced (15-8 nos./m, up to 09.80m) followed by widely spaced (5-1 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm along with pockets of 30-100mm (08.30-10.00m).
Rock Mass Structure: The rock mass is poor (up to 09.80m) and then excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 68

(00.00 –13.50)m: Overburden.

(13.50 – 18.00)m: **Rock Description**: Moderately weathered (up to 14.00m) followed by fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.

Structural Condition: Closely spaced (15-8 nos./m, up to 14.00m) followed by medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and slightly altered (up to 14.00m) and then fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm with few pieces 100-200mm (up to 15.00m) followed mostly by pieces of 100-300mm and >300mm.
Rock Mass Structure: The rock mass is poor (up to 09.80m) and then excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 69
(00.00 – 03.10)m: Overburden.
(03.10 – 15.50)m: **Rock Description**: Highly weathered (up to 07.10m) followed by moderately to slightly weathered (up to 12.50m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 09.50m) followed by medium spaced (8-5 nos./m, up to 12.50m) and then widely spaced (5-1 nos./m). Dominantly horizontal fractures along with pocket of inclined fracture (60° dip at 05.10 – 06.10m and 50° dip at 07.10 – 08.10m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 08.10m) and then slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm with pockets of 30-100mm (03.10 – 09.60m) and >300mm (11.00 – 15.50m).
Rock Mass Structure: The rock mass is very poor to poor (up to 09.50m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 70
(00.00 – 07.50)m: Overburden.
(07.50 – 15.00)m: **Rock Description**: Highly weathered (up to 11.00m) followed by moderately weathered (up to 12.00m) and then fresh, alternating dark

and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 10.00m) followed by closely spaced (15-8 nos./m) to medium spaced (8-5 nos./m, up to 12.00m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm, 100-300mm and 100-300mm with pockets of 30-100mm (07.50-10.00m).
Rock Mass Structure: The rock mass is very poor (up to 10.00m) followed by poor to fair quality (up to 12.00m) and then excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 71

(00.00 – 04.60)m: Overburden.

(04.60 – 12.60)m: **Rock Description**: Highly weathered (up to 07.60m) followed by moderately to slightly weathered (up to 09.60m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 08.60m) followed by medium spaced (8-5 nos./m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, slightly altered to fresh along with pockets of altered (07.60-08.60m).
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of 30-100mm (04.60 – 05.60m) and >300mm (11.10 – 12.60m).
Rock Mass Structure: The rock mass is very poor to poor (up to 08.60m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 72

(00.00 – 02.10)m: Overburden.

(02.10 – 19.10)m: **Rock Description**: Highly weathered (up to 15.10m) followed by slightly weathered to fresh, reddish brown to brownish grey, foliated

(50°-60°), coarse to medium grains are moderately compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 16.10m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal and randomly oriented fractures along with pocket of inclined fracture (30° dip at 15.10-16.10m). Open horizontal and randomly oriented fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm along with pockets of 100-200m and 100-300mm (16.10-19.10m).
Rock Mass Structure: The rock mass is very poor (up to 16.10m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 73

(00.00 – 07.50)m: Overburden.

(07.50 – 16.50)m: **Rock Description**: Highly weathered (up to 12.50m) followed by slightly weathered to fresh, reddish brown to brownish grey, foliated (50°-60°), coarse to medium grains are moderately compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 12.50m) followed by medium (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (50° dip at 10.50-11.50m). Open horizontal fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm along with pockets of 100-200m, 100-300mm and >300mm (13.50-16.50m).
Rock Mass Structure: The rock mass is very poor (up to 12.50m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 74

(00.00 – 02.10)m: Overburden.

(02.10 – 17.10)m: **Rock Description**: Highly weathered (up to 12.10m) followed by moderately to slightly weathered (up to 14.10m) and then fresh, reddish brown, foliated (50°-60°), coarse to medium grains are moderately compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 14.10m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal and randomly oriented fractures along with pockets of inclined fracture (60° dip at 3.10-4.10m; 80° dip at 14.10-15.60m and 60° dip at 15.60-17.10m) and vertical fracture (10.10-11.10m). Open horizontal and randomly oriented fracture surfaces are non-planar, rough and altered. Open vertical fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm along with pockets of 100-200m and 100-300mm (14.10-17.10m).
Rock Mass Structure: The rock mass is very poor (up to 14.10m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 75
(00.00 – 05.10)m: Overburden.
(05.10 – 19.60)m: **Rock Description**: Highly weathered (up to 13.10m) followed by moderately to slightly weathered (up to 16.60m) and then fresh, reddish brown, foliated (50°-60°), coarse to medium grains are moderately compacted **Khondalite**.
Rock Properties: Moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 16.60m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal and randomly oriented fractures (up to 13.10m) followed by horizontal fractures. Open horizontal and randomly oriented fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm along with pockets of 100-200m and 100-300mm (15.10-19.60m).
Rock Mass Structure: The rock mass is very poor (up to 16.60m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 76

(00.00 – 01.10)m: Overburden.

(01.10 – 20.10)m: **Rock Description**: Highly weathered (up to 16.10m) followed by slightly weathered to fresh, reddish brown, foliated (50°-60°), coarse to medium grains are moderately compacted **Khondalite**.

Rock Properties: Moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 17.10m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal and randomly oriented fractures along with pockets of inclined fracture (60° dip at 2.10-3.10m; 60° dip at 4.10-5.10m and 60° dip at 7.10-8.10m) and vertical fracture (7.10-8.10m). Open horizontal and randomly oriented fracture surfaces are non-planar, rough and altered. Open vertical fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm along with pockets of 100-200m and 100-300mm (17.10-20.10m).

Rock Mass Structure: The rock mass is very poor (up to 17.10m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 81

(00.00 – 08.00)m: Overburden.

(08.00 – 20.00)m: **(08.00-09.00)m:**

Rock Description: Highly weathered, brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.

(09.00-20.00)m:

Rock Description: Highly to moderately weathered (up to 17.00m) followed by fresh, alternating dark and light bands with red spots, indistinctly foliated, coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very soft and very weak to very hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 17.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (50° dip at 9.00-11.00m; 50˚ dip at 14.00-15.00m) and 60˚ dip at 16.00-18.50m). Open horizontal fracture surfaces are non-planar, rough, altered to slightly altered. Open inclined fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of <30mm (8.00-9.00m), >300mm (17.00-20.00m) and 30-100mm.

Rock Mass Structure: The rock mass is very poor to poor (up to

17.00m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is slightly weathered to fresh and little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result little amount of core loss occurred.

BH No. 82

(00.00 – 16.00)m: Overburden.

(16.00 – 25.00)m: **Rock Description**: Highly weathered (up to 19.00m) followed by moderately weathered (up to 22.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 20.00m) followed by medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (60° dip at 21.00-22.00m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 17.00m) and then slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm along with pockets of 30-100mm (up to 17.00m).
Rock Mass Structure: The rock mass is very poor to poor (up to 20.00m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 85

(00.00 – 18.00)m: Overburden.

(18.00 – 32.00)m: **(18.00-19.20)m:**
Rock Description: Highly weathered, yellowish/reddish brown, foliated (50˚-60˚), coarse grains are loosely compacted **Khondalite**.
(19.20-32.00)m:
Rock Description: Highly weathered (up to 29.00m) followed by fresh, alternating dark and light bands with red spots, foliated (50˚-60˚), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Soft and weak to very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 29.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (70° dip at 19.00-20.00m and 60° dip at 21.00-22.00m). Open horizontal fracture surfaces are non-planar, rough, altered to slightly altered. Open inclined fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths 100-200mm and 100-300mm with pockets of 30-100mm (18.00-28.00m) and >300mm (29.00-32.00m).
Rock Mass Structure: The rock mass is very poor to poor (up to 29.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 86
(00.00 – 21.50)m: Overburden.
(21.50 – 34.00)m: **(21.50-27.50)m:**
Rock Description: Highly weathered, yellowish brown, indistinctly foliated, coarse to medium grains are loosely compacted **Khondalite** along with pockets of completely weathered and completely disintegrated rock particles collected as sludge (22.50-27.50m).
(27.50-34.00)m:
Rock Description: Highly weathered (up to 30.00m) followed by moderately weathered to fresh, alternating dark and light bands with red spots, foliated (50˚-60˚), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very soft and very weak to very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 31.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered (up to 22.50m) followed by slightly altered to fresh.
Description of Core: Recovered core occurs as continuous framework along with pockets of discontinuity (22.50-27.50m). Cores are mostly in lengths <30mm and 30-100mm (up to 31.00m) followed by 100-300mm and >300mm.
Rock Mass Structure: The rock mass is very poor (up to 31.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 87
(00.00 – 38.00)m: Overburden.
(38.00 – 40.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
Rock Properties: Very soft and very weak rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH No. 88

(00.00 – 35.10)m: Overburden.

(35.10 – 38.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

(38.00 – 40.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
Rock Properties: Very soft and very weak rock.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered.
Description of Core: Recovered core occurs as discontinuous framework up to 38.00m followed by continuous core recovery. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH No. 89

(00.00 – 33.00)m: Overburden.

(33.00 – 37.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

(37.00 – 40.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
Rock Properties: Very soft and very weak rock.
Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered.
Description of Core: Recovered core occurs as discontinuous framework up to 37.00m followed by continuous core recovery. Cores are mostly in lengths of 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles

between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH No. 90

(00.00 – 35.30)m: Overburden.

(35.30 – 38.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

(38.00 – 40.00)m: **Rock Description**: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.

Rock Properties: Very soft and very weak rock.

Structural Condition: Very closely spaced (>15 nos./m). Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough, altered.

Description of Core: Recovered core occurs as discontinuous framework up to 38.00m followed by continuous core recovery. Cores are mostly in lengths of <30mm and 30-100mm.

Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

BH No. 91

(00.00 – 40.00)m: Overburden, no bedrock was found till the depth of investigation.

BH No. 92

(00.00 – 09.30)m: Overburden.

(09.30 – 21.00)m: **(09.30-13.10)m:**

Rock Description: Highly weathered, yellowish brown to yellowish grey, foliated (50°-60°), medium grains are tightly compacted **Khondalite**.

(13.10-21.00)m:

Rock Description: Highly weathered (up to 14.00m) followed by moderately to slightly weathered (up to 18.00m) and then fresh, alternating dark and light bands with red spots, medium grains are tightly compacted **Khondalite**.

Rock Properties: Very soft and very weak to very hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 14.00m) followed by medium spaced (5-8 nos./m) to widely spaced (5-1 nos./m). Dominantly horizontal fractures along pockets of inclined fracture (60° dip at 09.30-10.00m; 30° dip at 15.00-16.50m; 50° dip at 16.50-18.00m, 50° dip at 19.50-21.00m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 13.10m) followed by slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough, altered (up to 18.00m) and then planar, smooth and fresh.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm, 100-300mm and >300mm along with pockets of <30mm and 30-100mm (09.30-

13.10m).
Rock Mass Structure: The rock mass is very poor to poor (up to 14.00m) followed by fair to excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 93
(00.00 – 16.50)m: Overburden.
(16.50 – 30.00)m: **(16.50-23.50)m:**
Rock Description: Highly weathered (up to 22.50m) followed by moderately weathered, yellowish brown, medium grains are loosely compacted **Khondalite**.
(23.50-30.00)m:
Rock Description: Moderately to slightly weathered (up to 27.00m) and then fresh, blackish grey, medium grains are tightly compacted **Khondalite**.
Rock Properties: Soft and weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m, up to 27.00m) and then widely spaced (5-1 nos./m). Dominantly horizontal fractures along with pockets of vertical fracture (24.50-25.50m) and inclined fractures (50° dip at 24.50-27.00m and 20° dip at 27.00-28.50m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth, altered (up to 23.50m) followed by slightly altered to fresh. Open vertical fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar to planar, rough to smooth, altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 25.50m) and then 100-200mm, 100-300mm and >300mm lengths are dominant.
Rock Mass Structure: The rock mass is very poor to poor (up to 27.00m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 94
(00.00 – 12.50)m: Overburden.
(12.50 – 29.50)m: **(12.50-19.60)m:**
Rock Description: Highly weathered, yellowish brown, medium grains are loosely compacted **Khondalite**.
(19.60-29.50)m:

Rock Description: Highly weathered (up to 26.50m) and then fresh, blackish grey, medium grains are moderately compacted **Khondalite**.
Rock Properties: Soft and weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) along with pockets of closely spaced (15-8 nos./m, 22.50-23.50m) and widely spaced (5-1 nos./m, 26.50-29.50m). Dominantly horizontal fractures along with pockets of vertical fracture (19.50-20.50m and 22.50-26.50m) and inclined fracture (45° dip at 21.50-22.50m; 60° dip at 25.50-26.50m and 40° dip at 28.00-29.50m). Open horizontal fracture surfaces are planar to non-planar, rough to smooth, altered (up to 19.60m) and then slightly altered to fresh. Open vertical fracture surfaces are planar, smooth, altered. Open inclined fracture surfaces are planar, smooth and altered (up to 22.50m) and then slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths <30mm and 30-100mm along with pockets of 100-200mm and 100-300mm (21.50-23.50m, 25.50-26.50m) and >300mm (26.50-29.50m).
Rock Mass Structure: The rock mass is very poor along with pockets of poor (22.50-23.50m) and excellent quality (26.50-29.50m).

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 96

(00.00 – 06.50)m: Overburden.

(06.50 – 23.50)m: **(06.50-13.50)m:**
Rock Description: Highly weathered, yellowish brown, medium grains are loosely compacted **Khondalite**.
(13.50-23.50)m:
Rock Description: Highly weathered (up to 19.50m) followed by moderately weathered to fresh, blackish grey, medium grains are moderately compacted **Khondalite**.
Rock Properties: Soft and weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 19.50m) followed by closely spaced (15-8 nos./m, up to 20.50m) and then widely spaced (5-1 nos./m). Dominantly horizontal fractures along with pockets of vertical fractures (06.50-07.50m; 14.50-16.50m) and pockets of inclined fracture (60° dip at 07.50-08.00m; 60° dip at 13.50-14.50m; 30° dip at 20.50-22.00m and 30° dip at 22.00-23.50m). Open horizontal fracture surfaces are non-planar, rough, slightly altered to fresh. Open vertical fracture surfaces are planar to non-planar, rough to smooth, altered. Open inclined fracture surfaces are planar to non-planar, rough to smooth, altered to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up

to 18.50m) followed by 100-200mm and 100-300mm and pockets of >300mm (22.00-23.50m).
Rock Mass Structure: The rock mass is very poor to poor (up to 20.50m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 97

(00.00 – 03.00)m: Overburden.

(03.00 – 19.50)m: **(03.00 – 12.00)m:**

Rock Description: Highly weathered (up to 08.00m) followed by moderately weathered, greyish black, medium grains are tightly compacted **Khondalite**.

(12.00 – 16.50)m:

Rock Description: Highly weathered (up to 14.00m) followed by moderately weathered, yellowish brown, medium grains are moderately compacted **Khondalite**.

(16.50 – 19.50)m:

Rock Description: Fresh, greyish black, medium grains are tightly compacted

Rock Properties: Moderately hard and moderately strong to very hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 16.50m) and then widely spaced (5-1 nos./m) along with pockets of closely spaced (15-8 nos./m at 06.00-07.00m). Dominantly horizontal and vertical fractures along with a pocket of inclined fracture (50° dip at 09.00-10.00m). Open horizontal fracture surfaces are planar to non-planar, rough to smooth, slightly altered to fresh with pockets of altered (12.00-16.50m). Open vertical fracture surfaces are planar to non-planar, rough to smooth, slightly altered to fresh with pockets of altered (12.00-16.50m). Open inclined fracture surface is planar, smooth and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 30-100mm and 100-200mm with pockets of <30mm (12.00-16.50m), 100-300mm (05.00-06.00m, 07.00-08.00m, 10.00-11.00m, 16.50-19.50m) and >300mm (16.50-19.50m).

Rock Mass Structure: The rock mass is very poor (up to 16.50m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. 98

(00.00 – 33.20)m: Overburden.

(33.20 – 40.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

BH No. 99

(00.00 – 21.20)m: Overburden.

(21.20 – 28.00)m: **Rock Description**: Moderately weathered (up to 24.00m) followed by slightly weathered to fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 24.00m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pocket of inclined fracture (60° dip at 22.00-23.00m). Open horizontal fracture surfaces are non-planar to planar, rough to smooth, slightly altered to fresh. Open inclined fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of 30-100mm (21.20-24.20m) and >300mm (24.00-25.00m and 26.50-28.00m)

Rock Mass Structure: The rock mass is very poor (up to 24.00m) followed by excellent.

Partial drill water loss has been noticed for the entire depth.

The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. 100

(00.00 – 35.00)m: Overburden.

(35.00 – 40.00)m: Completely weathered and completely disintegrated rock particles collected as sludge.

BH No. MND-01

(00.00 – 14.70)m: Overburden.

(14.70 – 19.00)m: **Rock Description**: Moderately to slightly weathered (up to 16.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.

Rock Properties: Very hard and strong rock.

Structural Condition: Very closely spaced (15-8 nos./m) followed by widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures along with pocket of inclined fractures (60° dip at 15.00-16.00m). Open horizontal fracture surfaces non-planar, rough, altered to slightly altered. Open inclined fracture surface is non-planar, rough and fresh.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm.

Rock Mass Structure: The rock mass is of poor to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. MND-02

(00.00 – 15.00)m: Overburden.

(15.00 – 21.00)m: **Rock Description**: Moderately to slightly weathered (up to 18.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Medium spaced (8-5 nos./m) to widely spaced (5-1 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces non-planar, rough, altered to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-300mm and >300mm.
Rock Mass Structure: The rock mass is of fair to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is moderately weathered to fresh and modest to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result modest to little amount of core loss occurred.

BH No. MND-03

(00.00 – 27.70)m: Overburden.

(27.70 – 40.00)m: **Rock Description**: Highly to moderately weathered, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m) to closely spaced (15-8 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces non-planar, rough, altered to slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30 mm and 30-100mm along with pockets of 100-200mm (35.70-40.00m).
Rock Mass Structure: The rock mass is of very poor to poor quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly to moderately weathered and huge to modest amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to modest amount of core loss occurred.

BH No. MND-04

(00.00 – 12.90)m: Overburden.

(12.90 – 36.00)m: **(12.90-27.00)m:**
Rock Description: Highly weathered, brownish yellow to brownish grey, indistinctly foliated, coarse to medium grains are loosely compacted **Khondalite**.
(27.00-31.00)m:
Rock Description: Highly weathered, alternating dark and light bands with yellowish colouration and red spots, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.
(31.00-36.00)m:
Rock Description: Moderately to slightly weathered (up to 33.00m) and then fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very soft and very weak to very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 31.00m) followed by closely spaced (15-8 nos./m, up to 33.00m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal and randomly oriented fractures along with pockets of vertical fracture (31.00-32.00m) and inclined fracture (45° dip at 27.00-29.00m). Open horizontal and randomly oriented fracture surfaces are non-planar, rough, altered (up to 31.00m) and then slightly altered to fresh. Open inclined fracture surface is non-planar, rough and altered. Open vertical fracture surface is non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 30.00m) followed by 100-200mm, 100-300mm and >300mm.
Rock Mass Structure: The rock mass is very poor to poor (up to 33.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-05
(00.00 – 14.10)m: Overburden.
(14.10 – 36.00)m: **(14.10-30.00)m:**
Rock Description: Highly weathered, reddish brown to greyish brown, indistinctly foliated, coarse to medium grains are loosely compacted **Khondalite**.
(30.00-36.00)m:
Rock Description: Highly weathered (up to 32.00m) followed by slightly weathered to fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are tightly compacted **Khondalite**.
Rock Properties: Very soft and very weak to very hard and strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 32.00m) followed by closely spaced (15-8 nos./m, up to 33.00m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly

horizontal fractures along with pockets of inclined fracture (60° dip 31.00-32.00m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 30.00m) and then slightly altered to fresh. Open inclined fracture surface is non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 32.00m) followed by 100-200mm, 100-300mm and >300mm.
Rock Mass Structure: The rock mass is very poor to poor (up to 33.00m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-06
(00.00 – 12.10)m: Overburden.
(12.10 – 24.10)m: **(12.10-16.10)m:**
Rock Description: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
(16.10-24.10)m:
Rock Description: Highly to moderately weathered (up to 32.00m) followed by slightly weathered to fresh, alternating dark and light bands with red spots, foliated (50°-60°), coarse grains are moderately compacted **Khondalite**.
Rock Properties: Very soft and very weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 20.10m) followed by closely spaced (15-8 nos./m, up to 21.10m) and then widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (50° dip at 14.10-15.10m; 50° dip at 16.10-18.10m; 60° dip at 19.10-20.10m; 40° dip at 21.10-22.60m) and vertical fracture (17.10-19.10m, 20.10-21.10m and 22.60-24.10m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 16.10m) and then slightly altered to fresh. Open inclined fracture surfaces are planar to non-planar, smooth to rough and altered to fresh. Open vertical fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 17.10m) followed by 100-200mm, 100-300mm and >300mm.
Rock Mass Structure: The rock mass is very poor to poor (up to 20.10m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-07

(00.00 – 12.50)m: Overburden.

(12.50 – 28.50)m: **(12.50-22.40)m:**

Rock Description: Highly weathered, brownish yellow, indistinctly foliated, medium grains are loosely compacted **Khondalite**.

(22.40-28.50)m:

Rock Description: Highly weathered (up to 24.50m) followed by moderately weathered (up to 25.50m) and then fresh, blackish grey, foliated (50°-60°), medium grains are moderately compacted **Khondalite**.

Rock Properties: Soft and weak to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 25.50m) followed by widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (50° dip at 25.50-26.50m and 40° dip at 26.50-27.50m) and vertical fracture (16.50-17.50m and 19.50-23.50m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 25.50m) and then slightly altered to fresh. Open inclined fracture surface is non-planar to planar, rough to smooth and altered to slightly altered. Open vertical fracture surfaces are non-planar, rough and altered.

Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 25.50m) followed by 100-200mm, 100-300mm and >300mm.

Rock Mass Structure: The rock mass is very poor to poor (up to 25.50m) followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.

The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-10

(00.00 – 10.00)m: Overburden.

(10.00 – 21.00)m: **(10.00-13.00)m:**

Rock Description: Highly weathered, brownish yellow, indistinctly foliated, medium grains are loosely compacted **Khondalite**.

(13.00-21.00)m:

Rock Description: Highly weathered (up to 18.00m) followed by fresh, blackish grey, foliated (50°-60°), medium grains are moderately compacted **Khondalite**.

Rock Properties: Soft and weak to moderately hard and moderately strong rock.

Structural Condition: Very closely spaced (>15 nos./m, up to 17.00m) followed by closely spaced (15-8 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of inclined fracture (40° dip at 13.00-17.00m and 30° dip at 17.00-19.50m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 13.00m) and then slightly altered to fresh. Open

inclined fracture surface is non-planar, rough and slightly altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of <30mm and 30-100mm (10.00-13.00m and 15.00-17.00m) and >300mm (18.00-21.00m).
Rock Mass Structure: The rock mass is very poor (up to 17.00m) followed by poor to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-11

(00.00 – 12.50)m: Overburden.

(12.50 – 22.50)m: **(12.50-15.00)m:**
Rock Description: Highly weathered, brown to yellowish grey, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
(15.00-22.50)m:
Rock Description: Moderately to slightly weathered (up to 18.50m) followed by fresh, blackish grey, indistinctly foliated to massive, medium grains are moderately compacted **Khondalite**.
Rock Properties: Soft and weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m) along with pockets of medium spaced (8-5 nos./m, 15.50-16.50m) and widely spaced (5-1 nos./m, 19.50-22.50m) fractures. Dominantly horizontal along with pockets of inclined fracture (50° dip at 15.50-17.50m and 60° dip at 18.50-20.50m) and randomly oriented fractures (12.50-15.00m). Open horizontal fracture surfaces are non-planar, rough, altered to slightly altered. Open inclined fracture surfaces are non-planar, rough and altered. Open randomly oriented fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of 100-200mm and 100-300mm along with pockets of >30mm and 30-100mm (12.50-15.00m).
Rock Mass Structure: The rock mass is very poor to poor followed by excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-12

(00.00 – 13.50)m: Overburden.

(13.50 – 30.50)m: **(13.50-24.50)m:**
Rock Description: Highly weathered, yellowish brown, indistinctly

foliated, medium grains are loosely compacted **Khondalite**.
(24.50-30.50)m:
Rock Description: Highly weathered (up to 26.50m) followed by slightly weathered to fresh, blackish grey, foliated (50°-60°), medium grains are moderately compacted **Khondalite**.
Rock Properties: Very soft and very weak to moderately hard and moderately strong rock.
Structural Condition: Very closely spaced (>15 nos./m, up to 26.50m) followed by closely spaced (15-8 nos./m) to widely spaced (5-1 nos./m) fracture surfaces. Dominantly horizontal fractures along with pockets of randomly oriented fractures (22.50-26.50m), inclined fractures (40° dip at 26.00-29.00m and 65° dip at 29.00-30.50m) and vertical fractures (25.50-26.50m). Open horizontal fracture surfaces are non-planar, rough, altered (up to 24.50m) and then slightly altered to fresh. Open randomly oriented fracture surfaces are non-planar, rough and altered. Open inclined fracture surfaces are non-planar, rough and slightly altered. Open vertical fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework. Cores are mostly in lengths of <30mm and 30-100mm (up to 26.50m) followed by mostly in lengths of 100-200mm, 100-300mm and >300mm.
Rock Mass Structure: The rock mass is very poor (up to 26.50m) followed by poor to excellent quality.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered to fresh and huge to little amount of the rock mass is disintegrated. During drilling the disintegrated rock particles between fracture planes have been removed by drill water. As a result huge to little amount of core loss occurred.

BH No. MND-13

(00.00 – 16.50)m: Overburden.

(16.50 – 40.00)m: **(16.50-26.50)m:**
Rock Description: Highly weathered, yellowish brown, indistinctly foliated, medium grains are loosely compacted **Khondalite**.
(26.50-40.00)m:
Completely weathered and completely disintegrated rock particles collected as sludge.
Rock Properties: Very soft and very weak rock.
Structural Condition: Very closely spaced (>15 nos./m) fractures. Dominantly horizontal fractures. Open horizontal fracture surfaces are non-planar, rough and altered.
Description of Core: Recovered core occurs as continuous framework (up to 26.50m) followed by discontinuous framework. Cores are mostly in lengths of <30mm and 30-100mm.
Rock Mass Structure: The rock mass is very poor.

Partial drill water loss has been noticed for the entire depth.
The formation rock is highly weathered and huge amount of the rock mass is disintegrated. During drilling the disintegrated rock particles

between fracture planes have been removed by drill water. As a result huge amount of core loss occurred.

For C. E. Testing Company private Limited,

Devsankar Acharyya

(Mr. D. Acharyya, Geologist)

Sukha Paramanik

(Mr. S. Paramanik, Geologist)

For C. E. Testing Company Private Limited,

(Dr. A. Seth, Geologist)

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8. ELECTRICAL RESISTIVITY TEST

REPORT ON
ELECTRICAL RESISTIVITY TEST (ERT)
FOR 5th ALUMINA REFINERY AT DAMANJODI, ODISHA
AND PORT FACILITIES AT VISAKHAPATNAM

INTRODUCTION:

Electrical Resistivity Test was carried out for 5th Alumina Refinery at Damanjodi, Odisha and Port facilities at Visakhapatnam using resistivity meter (model DDR2 of IGIS) and following Indian standard Code: IS- 3043 at twenty two (22) locations.

METHODOLOGY:

The Soil Resistivity Survey is a method to find out the Electrical Resistivity (Specific Resistance) of a medium. It is the resistance offered by a unit cube of a particular medium (so called strata below the ground level) when a unit current passes perpendicular to the surface of a cross-sectional area A. The relation is given by Ohm's Law is –

$$\rho = R \frac{A}{l} \text{ ohm } \frac{m2}{m} = \text{ohm} - \text{m where}$$

ρ= Resistivity, R = resistance offered by the medium of length L and Cross-sectional area A.

In electrical resistivity survey a known current I (direct current or low frequency alternating current) is sent into the ground through a pair of current electrodes A & B and the potential difference (∆V) created in the medium is measured between another pair of electrodes M & N. The resistivity of the formation is then given

by $\rho = K \frac{\Delta V}{I}$ where ρ is the apparent resistivity, K is the geometric factor.

In the Earth Resistivity Test, the Wenner configuration was followed. In this configuration two potential electrodes M & N are placed in a line with the current electrodes A & B, all four being situated equidistance from one to another and disposed symmetrically with respect to a central point such that AM=MN=NB=a . The outer two electrodes A & B were used for sending current (I) and inner two M & N were used for measuring the potential differences (ΔV). The distance between each consecutive electrode (a) was kept constant and was progressively increased to reach the depth at which resistivity information are wanted. Suitable electrode spacing determines the conductivity of the top soil as well as the various subsurface layers occurring in the area under study. At each location, 4 sets of observations were taken for each of the electrode spacing (a) in eight directions (N-S,E-W,NE-SW and NW-SE) and in ten different electrode spacing viz,: a = 1.0m, 2.0m, 3.0m, 5.0m, 10.0m, 15.0m, 20.0m and 25.0m were used to know the nature of change of resistivity.

The apparent resistivity was determined by the formula –

$\rho = 6.28\, a \dfrac{\Delta V}{I}$ where 'a' is the distance between the two consecutive Electrodes and $\dfrac{\Delta V}{I}$ is R which is the observed resistance for measuring resistivity.

The mean value of the resistivity estimated was taken as the representative one.
The depth of investigation in an isotropic and homogeneous formation can be approximated to the distance between the consecutive two electrodes (a).

It may be indicated here that in case of highly resistive formations, current penetrates much deeper into the earth than when the subsurface formations are conducting. Further, in the present investigation only apparent resistivity is measured which may be taken (as a first approximation) as the weighted average of the true resistivity of the subsurface formations in which current lines flow

DISCUSSION:

Damonjodi is situated in the district of Koraput and located nearly 28.1km east of koraput town via NH26. Major parts of the Koraput district is underlain by hard rock of Pre-Cambrian age. The consolidated rocks of upper to middle Proterozoic age occupy a small portion of north-western part of the district. The Recent to sub Recent alluvium occurs as thin and discontinuous patches in limited scale along the prominent drainage channel. The Laterite occurs as their capping over the country rocks in isolated pockets.

This project area has been divided in two parts, namely inside and a outside of the plant. systematically electrical Resistivity test (ERT) has been carried out over both the area.

INSIDE THE PLANT:

The recorded minimum and maximum values 68.171 and 143.723 Ohm m located at ERT-1(MND) and ERT-6(MND) respectively. A low resistivity zone of the order of 80 Ohm m has been occupied the central part of the area where as north western and eastern parts are covered moderate resistivity of the order of 100 Ohm m. A comparatively high resistivity zone of the order 0f 140 Ohm m has been noticed as isolated pocked in the central part of the area.

OUT SIDE THE PLANT:

The total variation of apparent resistivity varies between 78.416 and 806.592 Ohm m. in this area and the maximum and minimum being observed at ERT-5 and ERT-10 respectively. Here resistivity is progressively increasing from west to east. Major part of the area, mainly central and south-east part of the area are covered by the resistivity varies between 150 to 400 Ohm m.

The apparent resistivity (from polar diagram) of the uniform soil for different ERT locations are as hereunder:–

Sl. No.	Location	ERT No	Easting	Northing	*Apparent Resistivity (Polar) in Ohm-m*
1.	Inside Plant	ERT-1(MND	772.751	685.617	68.171
2.		ERT-2(MND)	1017.218	1262.551	122.754
3.		ERT-3(MND)	1145.238	1262.902	89.22
4.		ERT-4(MND)	1059.191	1220.968	87.963
5.		ERT-5(MND)	1117.399	1108.098	63.851
6.		ERT-6(MND)	1087.081	1084.113	143.723
7.		ERT-7(MND)	1124.441	1067.682	93.459
8.		ERT-8(MND)	1093.592	937.014	95.242
9		ERT-9(MND)	1513.269	927.554	111.78
10	Outside Plant	ERT-1	1291008.7425	1671056.5050	89.848
11		ERT-2	1506561.6937	1764099.7619	323.16
12		ERT-3	1676054.5199	1593728.9250	270.169
13		ERT-4	1852263.1133	1676054.5199	153.963
14		ERT-5	1117.3990	91108.0980	806.592
15		ERT-6	2186045.7929	1684951.4157	686.824
16		ERT-7	1931618.4006	884742.3799	267.812
17		ERT-8	1984533.5767	700992.6192	232.082
18		ERT-9	1995515.6874	527878.1129	220.302
19		ERT-10	1152723.9190	795695.8518	78.416
20		ERT-11	1113529.6554	890739.4529	161.789
21		ERT-12	1158339.2670	914912.2579	82.856
22		ERT-13	1236499.8167	1034204.4768	222.796

APPARENT RESISTIVITY VALUES

ERT No. 01 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m) (N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	188.49	187.233	188.175	187.861	187.94
2	2.0	162.101	163.986	164.614	163.357	163.51
3	3.0	129.115	128.173	129.115	130.058	129.12
4	5.0	103.669	103.669	103.669	100.527	102.88
5	8.0	72.884	77.910	80.424	75.397	76.65
6	10.0	67.542	67.543	69.428	68.171	68.17
7	15.0	57.49	56.548	56.547	56.548	56.78
8	25.0	72.256	73.826	72.256	73.041	72.84

ERT No. 02 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m) (N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	123.460	123.146	123.774	123.146	123.38
2	2.0	92.988	92.360	94.873	92.359	93.15
3	3.0	121.575	122.518	124.403	122.518	122.75
4	5.0	113.093	109.952	113.094	111.523	111.92
5	8.0	108.069	113.096	--	110.582	110.58
6	10.0	109.953	103.670	--	109.953	107.86
7	15.0	--	122.521	--	136.657	129.59
8	25.0	--	180.640	--	188.494	184.57

ERT No. 03 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m) (N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	37.698	38.326	38.326	39.896	38.56
2	2.0	40.210	40.839	42.095	42.724	41.47
3	3.0	53.719	56.546	56.547	54.662	55.37
4	5.0	62.830	67.542	73.825	65.971	67.54
5	8.0	80.423	95.503	103.043	98.016	94.25
6	10.0	87.334	89.220	89.219	90.162	88.98
7	15.0	98.016	99.430	100.372	100.372	99.55
8	25.0	133.516	137.443	141.371	139.800	138.03

ERT No. 04 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	201.998	202.312	202.312	201.998	202.16
2	2.0	173.410	175.295	175.924	174.667	174.82
3	3.0	148.907	145.137	149.849	149.849	148.44
4	5.0	113.093	116.235	114.664	120.947	116.23
5	8.0	80.423	87.963	92.990	90.477	87.96
6	10.0	50.264	50.264	51.835	49.322	50.42
7	15.0	70.213	71.156	71.627	66.914	69.98
8	25.0	100.53	100.53	100.53	100.53	100.53

ERT No. 05 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	217.391	217.391	217.077	217.077	217.23
2	2.0	127.544	126.288	128.173	128.173	127.54
3	3.0	63.143	63.143	65.971	63.143	63.85
4	5.0	42.410	41.938	42.410	--	42.25
5	8.0	60.820	61.071	60.569	--	60.82
6	10.0	73.197	72.883	72.883	--	72.99
7	15.0	98.958	99.430	99.901	--	99.43
8	25.0	150.010	146.083	148.439	--	148.18

ERT No. 06 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	141.681	141.053	140.739	141.367	141.21
2	2.0	144.509	143.88	141.995	144.508	143.72
3	3.0	168.698	167.756	165.871	169.64	167.99
4	5.0	119.377	119.377	119.376	--	119.38
5	8.0	118.122	113.096	105.556	--	112.26
6	10.0	82.622	82.308	82.308	--	82.41
7	15.0	81.523	81.523	81.523	--	81.52
8	25.0	98.173	96.603	95.817	--	96.86

ERT No. 07 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	83.877	83.563	83.244	83.563	83.56
2	2.0	115.607	116.235	114.978	116.235	115.76
3	3.0	105.554	106.496	105.554	106.496	106.03
4	5.0	92.674	97.386	94.245	89.532	93.46
5	8.0	80.424	--	--	75.397	77.91
6	10.0	91.104	--	--	97.387	94.25
7	15.0	127.233	--	--	136.657	131.95
8	25.0	--	--	--	162.432	162.43

ERT No. 08 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	76.966	76.966	76.652	77.28	76.97
2	2.0	94.245	96.757	94.873	96.129	95.50
3	3.0	76.338	--	78.222	79.165	77.91
4	5.0	51.834	--	51.834	48.693	50.79
5	8.0	65.846	--	65.847	66.6	66.10
6	10.0	72.883	--	73.826	67.229	71.31
7	15.0	100.372	--	101.315	100.843	100.84
8	25.0	153.937	--	157.079	154.722	155.25

ERT No. 09 (MND)

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	97.700	97.072	97.386	98.014	97.54
2	2.0	91.731	94.245	94.244	92.988	93.30
3	3.0	107.439	114.036	113.093	112.151	111.68
4	5.0	119.377	119.377	116.235	114.664	117.41
5	8.0	125.662	128.175	149.102	140.662	135.90
6	10.0	103.670	131.945	119.378	116.24	117.81
7	15.0	170.587	172.00	172.471	170.115	171.29
8	25.0	206.558	206.558	208.129	206.558	206.95

ERT No. 01

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	212.993	213.622	212.993	213.622	213.31
2	2.0	138.226	139.482	140.739	138.854	139.33
3	3.0	77.28	75.395	74.453	75.395	75.63
4	5.0	69.112	72.254	73.825	73.825	72.25
5	8.0	80.423	85.45	95.503	98.016	89.85
6	10.0	94.246	94.246	84.821	87.963	90.32
7	15.0	141.37	141.37	146.082	150.794	144.90
8	25.0	259.18	274.888	282.742	259.18	269.00

ERT No. 02

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	232.785	233.099	233.413	234.041	233.33
2	2.0	156.446	158.331	158.331	157.703	157.70
3	3.0	165.871	163.043	161.158	165.871	163.99
4	5.0	216.763	218.334	223.046	219.904	219.51
5	8.0	268.917	271.431	295.391	268.917	276.16
6	10.0	320.438	329.862	314.155	329.862	323.58
7	15.0	386.412	386.412	372.275	372.275	379.34
8	25.0	565.484	581.192	581.192	565.484	573.34

ERT No. 03

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	285.248	284.305	284.305	285.248	284.78
2	2.0	251.948	251.32	251.32	251.948	251.63
3	3.0	261.058	262.001	257.288	258.231	259.64
4	5.0	271.739	273.31	270.169	265.456	270.17
5	8.0	281.483	276.457	276.457	271.43	276.46
6	10.0	292.163	282.739	282.739	279.597	284.31
7	15.0	301.59	311.015	296.877	282.741	298.06
8	25.0	306.304	361.281	--	322.011	329.87

ERT No. 04

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	361.586	362.214	362.529	360.958	361.82
2	2.0	240.01	240.01	238.753	238.754	239.38
3	3.0	197.914	199.799	199.799	198.856	199.09
4	5.0	155.504	160.216	166.499	174.353	164.14
5	8.0	155.821	158.334	148.281	153.308	153.94
6	10.0	182.209	182.209	182.209	179.068	181.42
7	15.0	230.904	249.754	249.754	268.603	249.75
8	25.0	306.304	329.865	337.719	353.427	331.83

ERT No. 05

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	327.344	327.972	325.145	326.401	326.72
2	2.0	439.81	439.81	441.066	440.438	440.28
3	3.0	530.599	533.426	533.426	532.483	532.48
4	5.0	655.002	647.149	648.719	651.861	650.68
5	8.0	698.683	711.249	716.276	708.736	708.74
6	10.0	794.811	810.519	816.802	804.236	806.59
7	15.0	980.168	984.881	984.88	975.456	981.35
8	25.0	1335.17	1319.46	1343.03	1358.73	1339.10

ERT No. 06

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	149.535	150.477	150.163	150.477	150.16
2	2.0	134.456	131.943	136.969	136.969	135.08
3	3.0	180.95	183.777	190.374	184.72	184.96
4	5.0	290.588	293.73	295.301	295.3	293.73
5	8.0	472.491	485.057	485.057	480.03	480.66
6	10.0	562.337	569.469	574.903	565.479	568.05
7	15.0	683.29	678.578	697.427	688.002	686.82
8	25.0	879.642	918.912	926.766	903.204	907.13

ERT No. 07

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	242.837	242.523	241.581	241.581	242.13
2	2.0	212.365	213.621	213.622	213.622	213.31
3	3.0	171.525	174.352	178.122	176.237	175.06
4	5.0	262.315	267.027	270.168	271.739	267.81
5	8.0	356.881	--	359.394	361.908	359.39
6	10.0	402.118	--	408.401	398.976	403.17
7	15.0	537.207	--	537.207	537.207	537.21
8	25.0	840.372	--	824.664	816.81	827.28

ERT No. 08

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	169.955	170.269	169.955	170.269	170.11
2	2.0	241.267	242.523	244.408	242.523	242.68
3	3.0	219.59	221.475	224.303	221.475	221.71
4	5.0	249.749	251.32	260.744	254.461	254.07
5	8.0	241.272	248.811	258.864	246.298	248.81
6	10.0	226.191	226.191	241.898	226.191	230.12
7	15.0	226.192	240.329	226.192	235.617	232.08
8	25.0	314.158	329.865	337.719	322.011	325.94

ERT No. 09

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	439.81	440.752	440.438	439.495	440.12
2	2.0	295.3	295.301	295.929	295.301	295.46
3	3.0	209.223	208.281	211.108	212.05	210.17
4	5.0	153.933	157.074	157.074	157.074	156.29
5	8.0	155.821	155.821	163.361	158.334	158.33
6	10.0	157.077	166.501	157.077	150.794	157.86
7	15.0	221.48	230.904	216.768	212.055	220.30
8	25.0	345.573	353.427	337.719	345.573	345.57

ERT No. 10

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	99.585	100.213	100.528	99.585	99.98
2	2.0	114.35	114.35	114.978	111.837	113.88
3	3.0	133.827	136.654	136.654	136.654	135.95
4	5.0	141.367	136.655	138.226	136.655	138.23
5	8.0	95.503	100.53	100.529	100.53	99.27
6	10.0	79.166	79.167	78.224	77.91	78.62
7	15.0	79.167	80.109	77.282	77.282	78.46
8	25.0	88.749	92.676	91.89	93.461	91.69

ERT No. 11

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	179.379	179.065	178.751	179.065	179.07
2	2.0	173.18	177.808	175.924	178.436	176.34
3	3.0	207.339	205.454	207.338	207.338	206.87
4	5.0	160.216	160.216	157.075	158.645	159.04
5	8.0	143.255	145.768	143.255	143.255	143.88
6	10.0	163.36	163.36	166.501	153.935	161.79
7	15.0	212.055	202.63	193.206	197.918	201.45
8	25.0	267.034	243.472	267.034	259.18	259.18

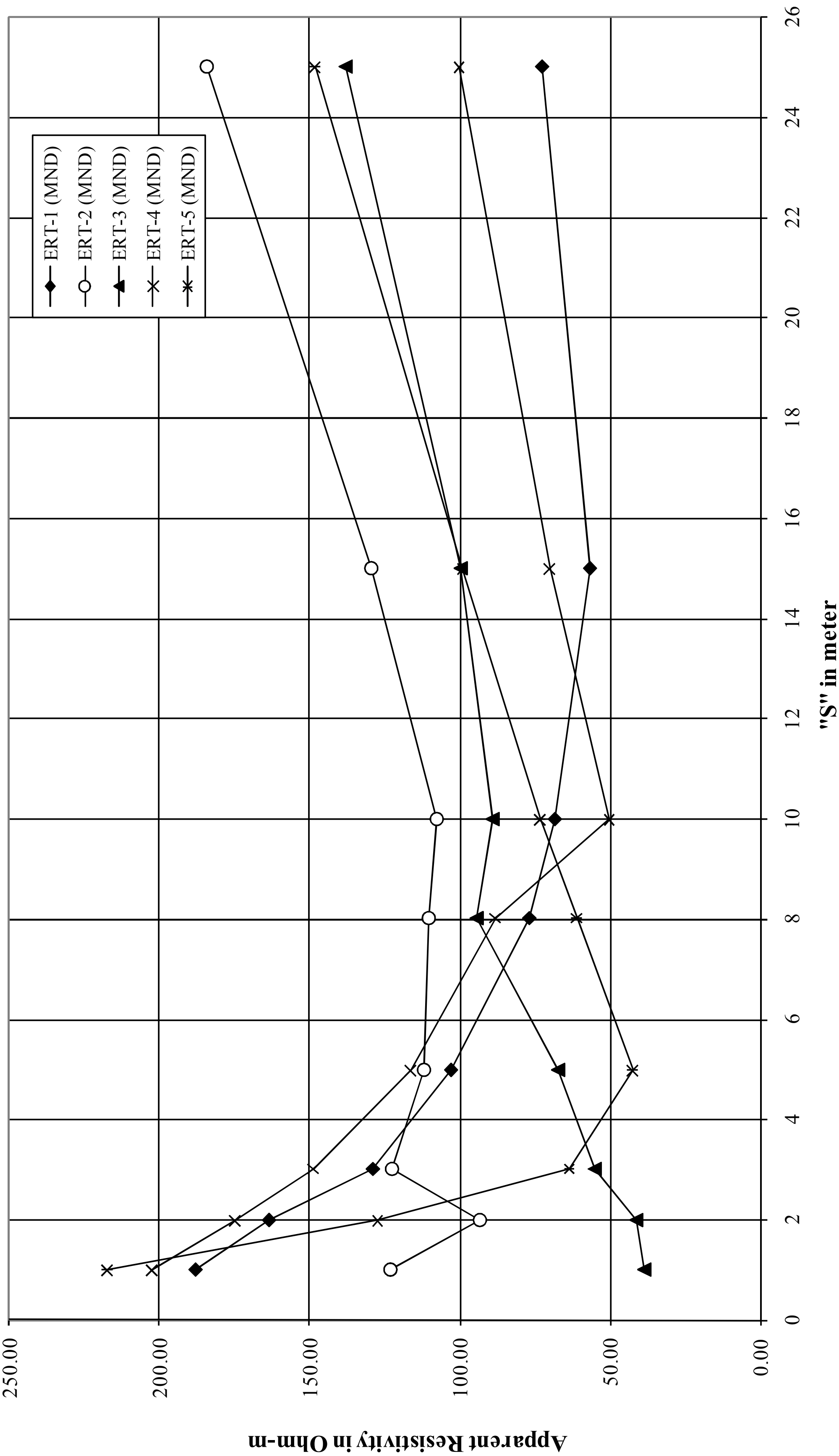
ERT No. 12

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	125.974	125.66	125.659	125.974	125.82
2	2.0	143.252	143.88	144.509	144.508	144.04
3	3.0	111.209	111.209	114.978	113.093	112.62
4	5.0	78.537	83.249	84.82	84.82	82.86
5	8.0	65.344	75.397	77.91	80.423	74.77
6	10.0	--	79.166	80.423	79.795	79.79
7	15.0	--	98.016	98.958	98.959	98.64
8	25.0	--	141.371	141.37	143.726	142.16

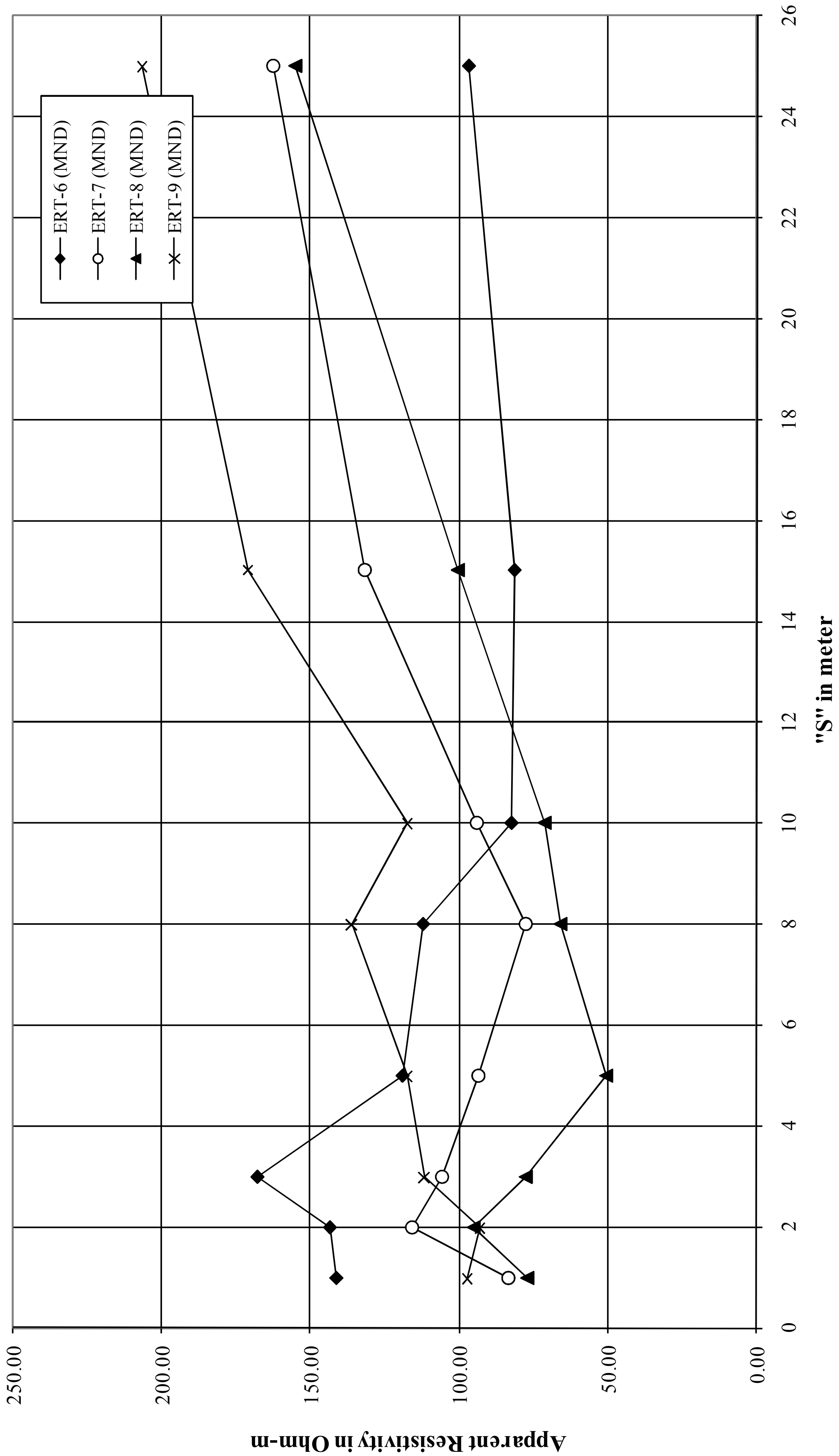
ERT No. 13

Sl No.	S (M)	Apparent Electrical Resistivity (Ohm-m)				
		(N - S)	(E - W)	(NE - SW)	(NW - SE)	Mean
1	1.0	214.25	214.25	213.622	214.25	214.09
2	2.0	248.806	251.948	250.063	251.319	250.53
3	3.0	199.799	199.799	202.626	199.799	200.51
4	5.0	216.763	224.617	226.187	224.617	223.05
5	8.0	--	246.298	--	251.324	248.81
6	10.0	--	--	--	--	--
7	15.0	--	--	--	--	--
8	25.0	--	--	--	--	--

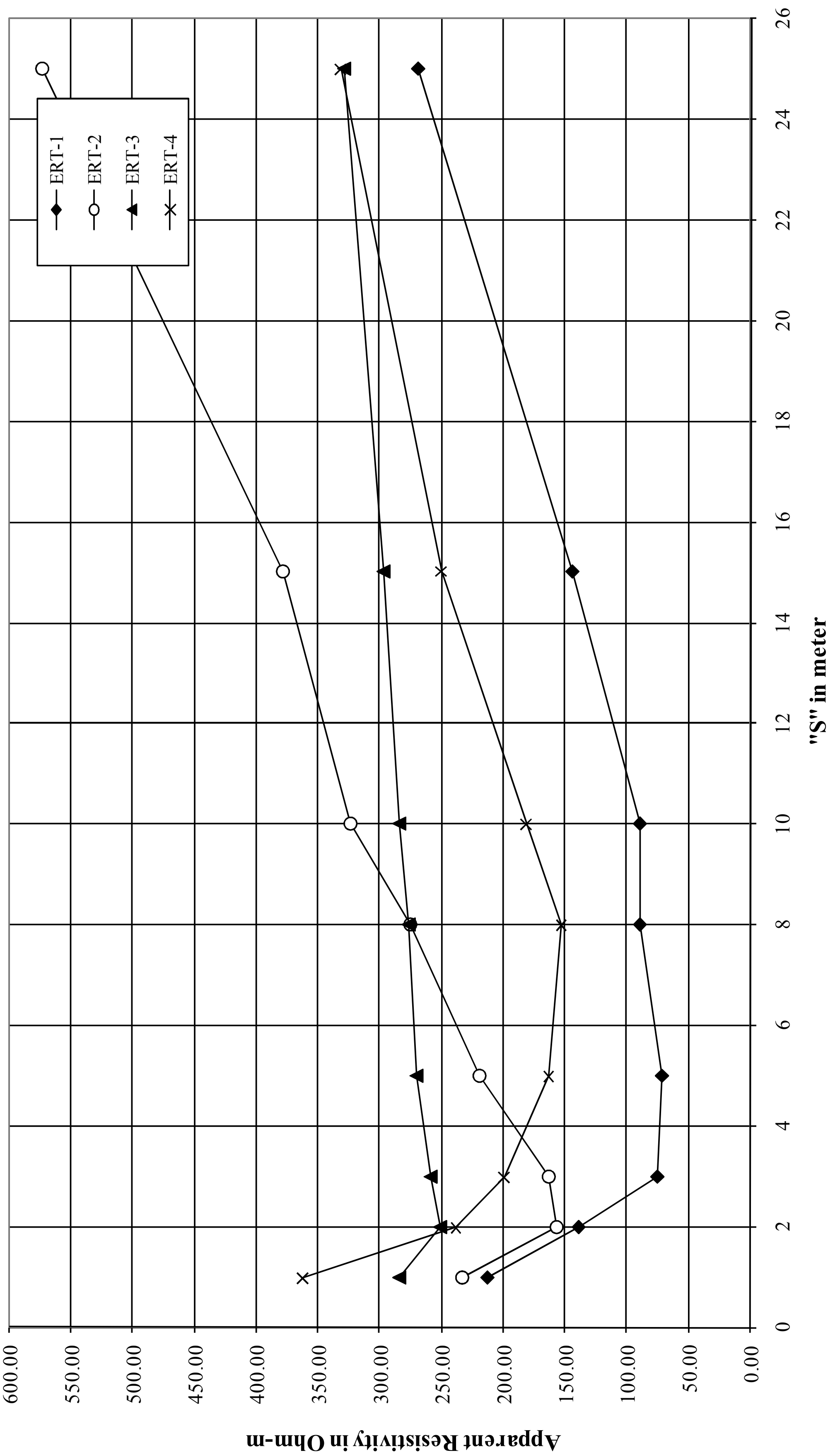
APPARENT RESISTIVITY CURVES



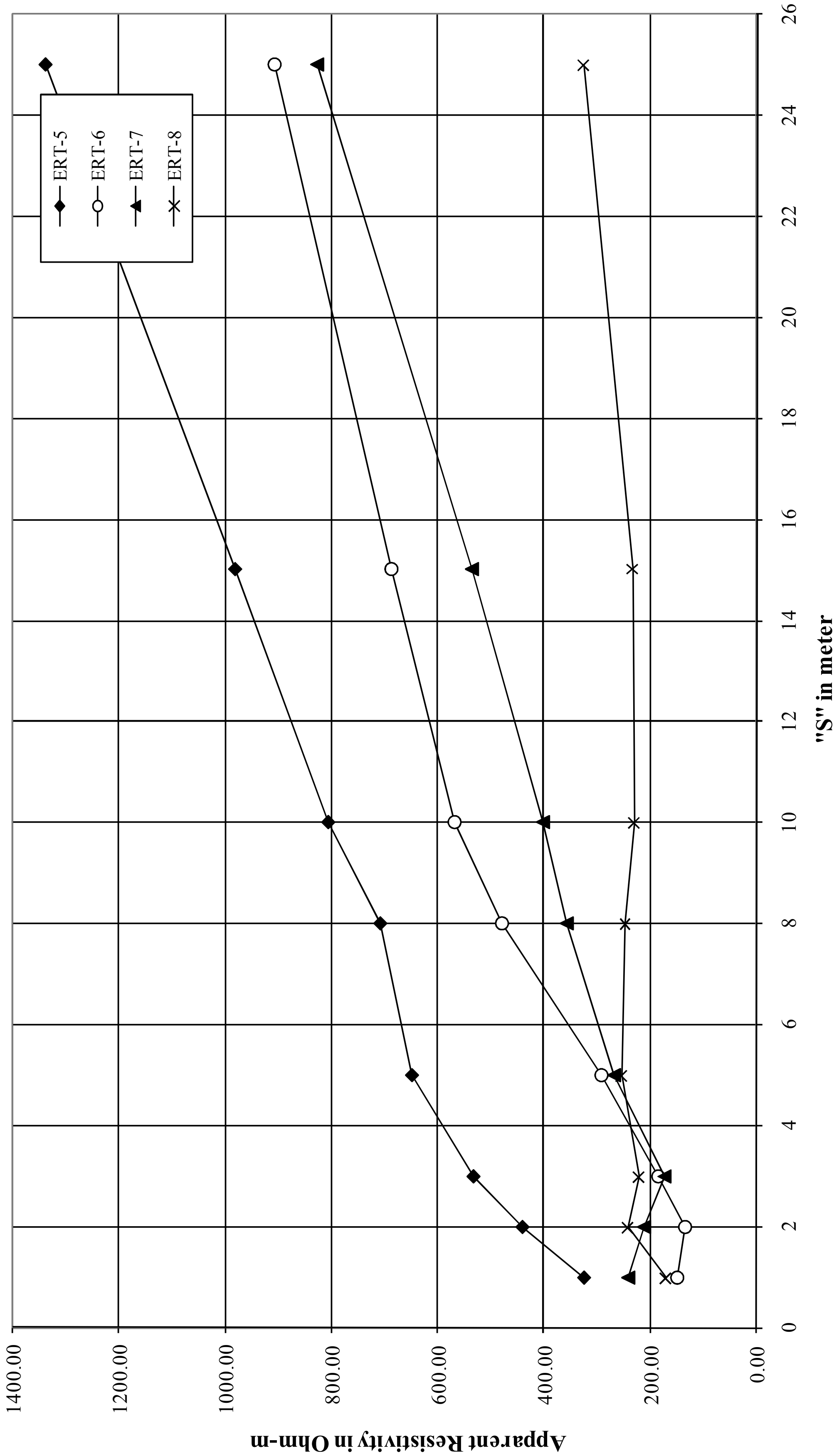
Apparent Resistivity Curves for ERT-1 (MND) to ERT-5 (MND)



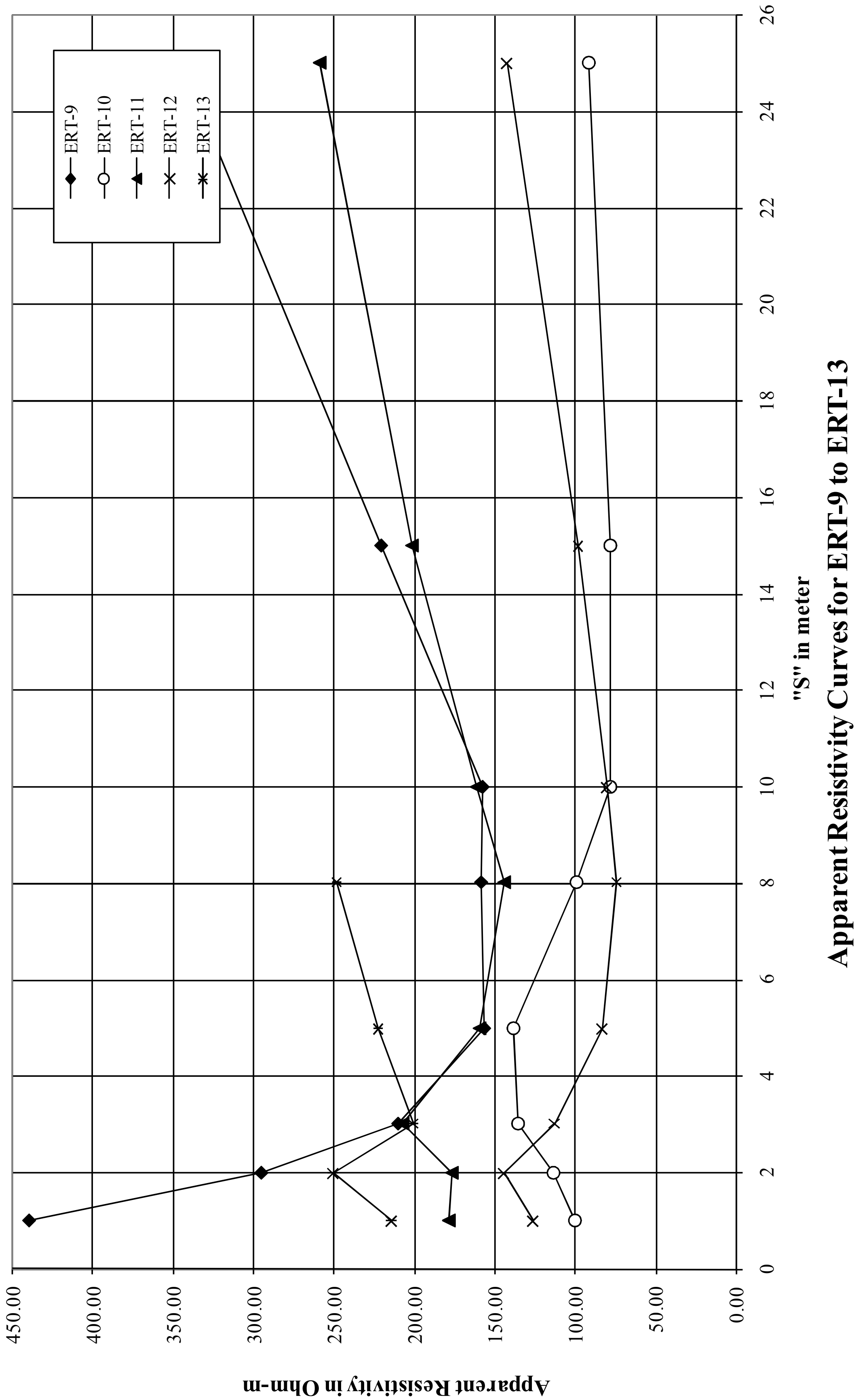
Apparent Resistivity Curves for ERT-6 (MND) to ERT-8 (MND)



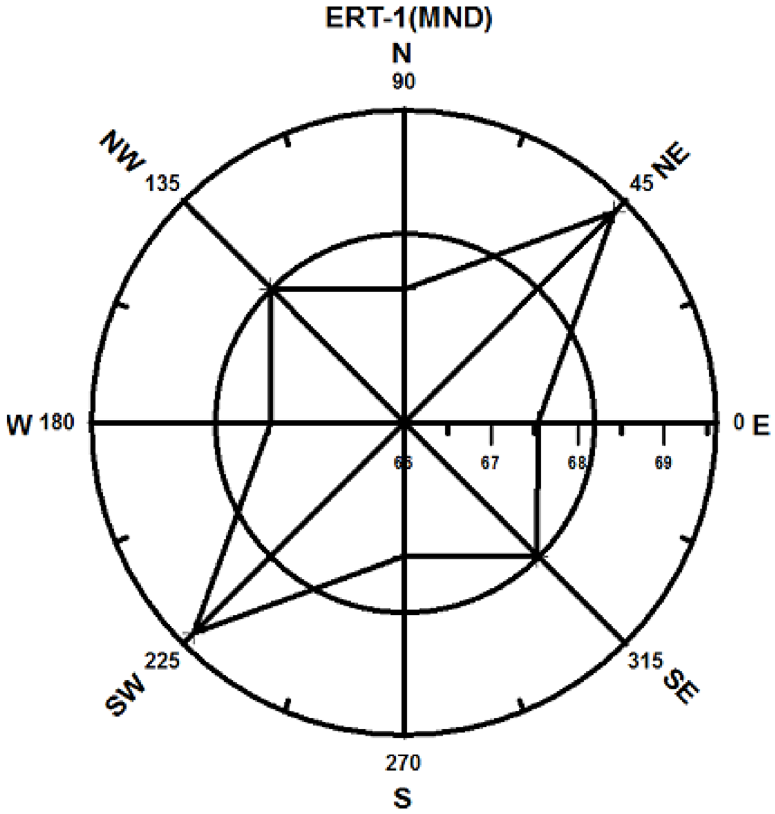
Apparent Resistivity Curves for ERT-1 to ERT-4



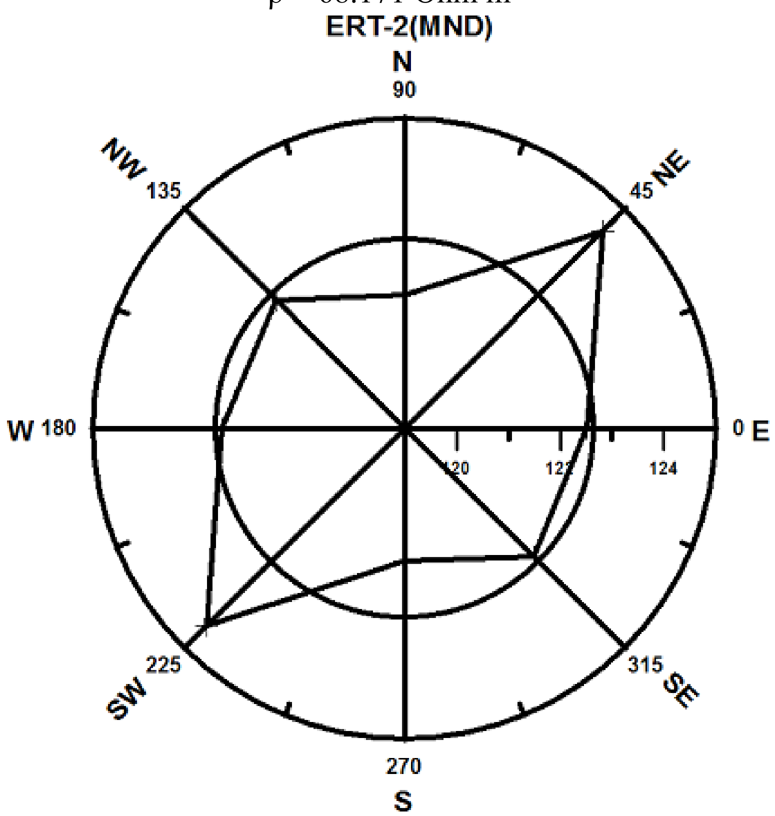
Apparent Resistivity Curves for ERT-5 to ERT-8


ERT-9
ERT-10
ERT-11
ERT-12
ERT-13
Apparent Resistivity in Ohm-m
"S" in meter
0
2
4
6
8
10
12
14
16
18
20
22
24
26
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Apparent Resistivity Curves for ERT-9 to ERT-13

POLAR CURVES

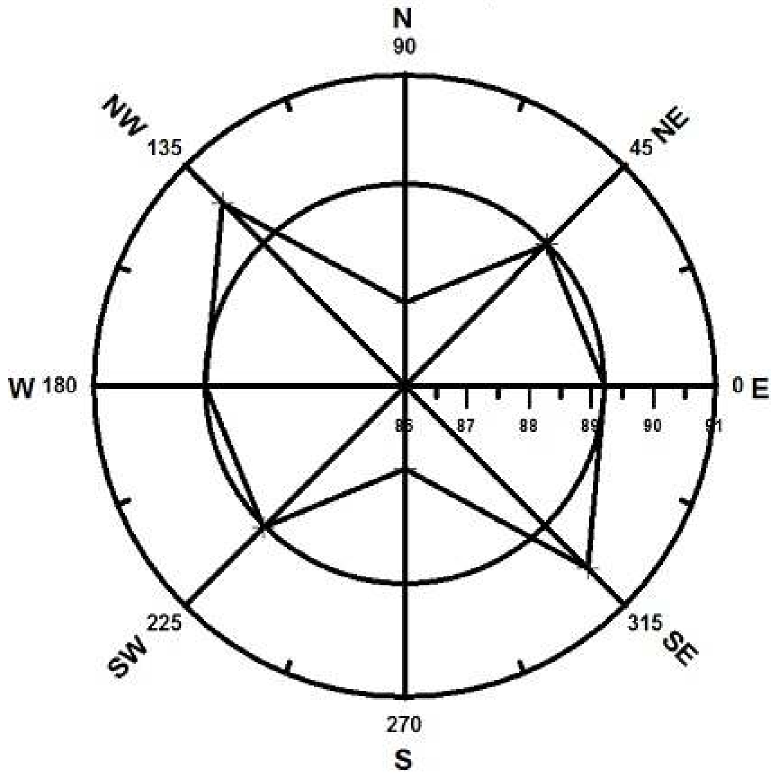


ρ = 68.171 Ohm m



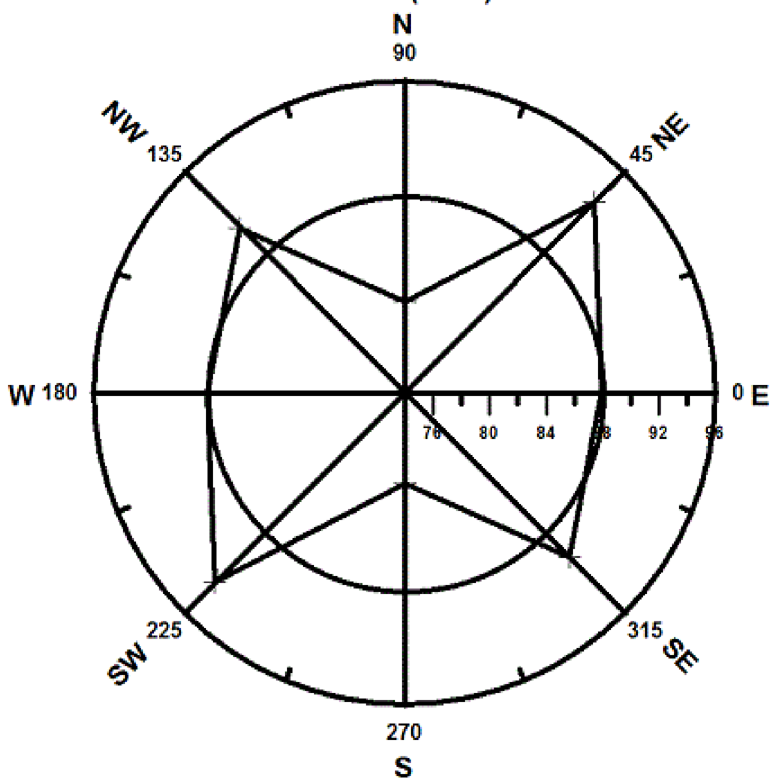
ρ = 122.754 Ohm m

ERT-3(MND)



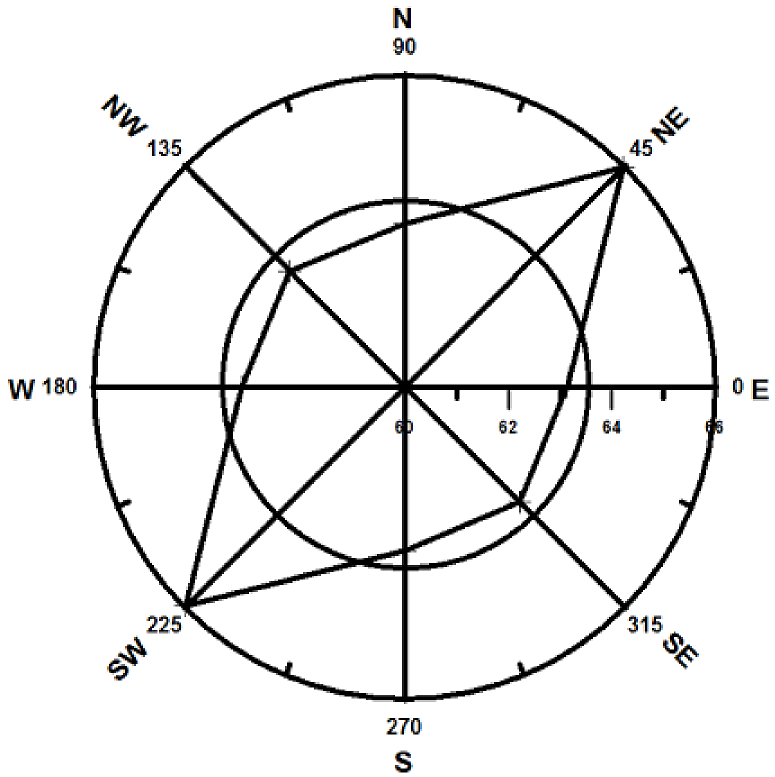
ρ = 89.220 Ohm m

ERT-4(MND)



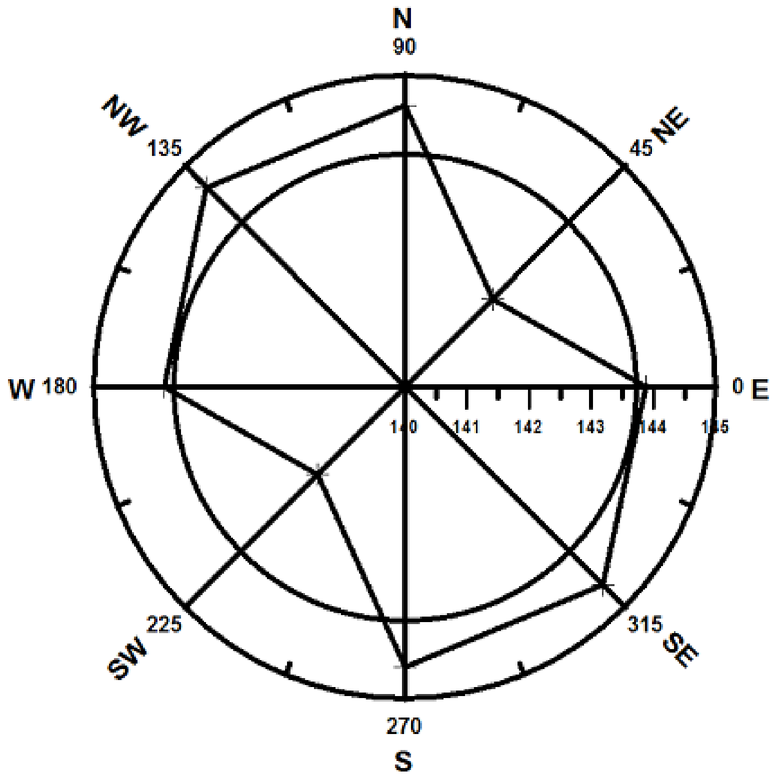
ρ = 87.963 Ohm m

ERT-5(MND)

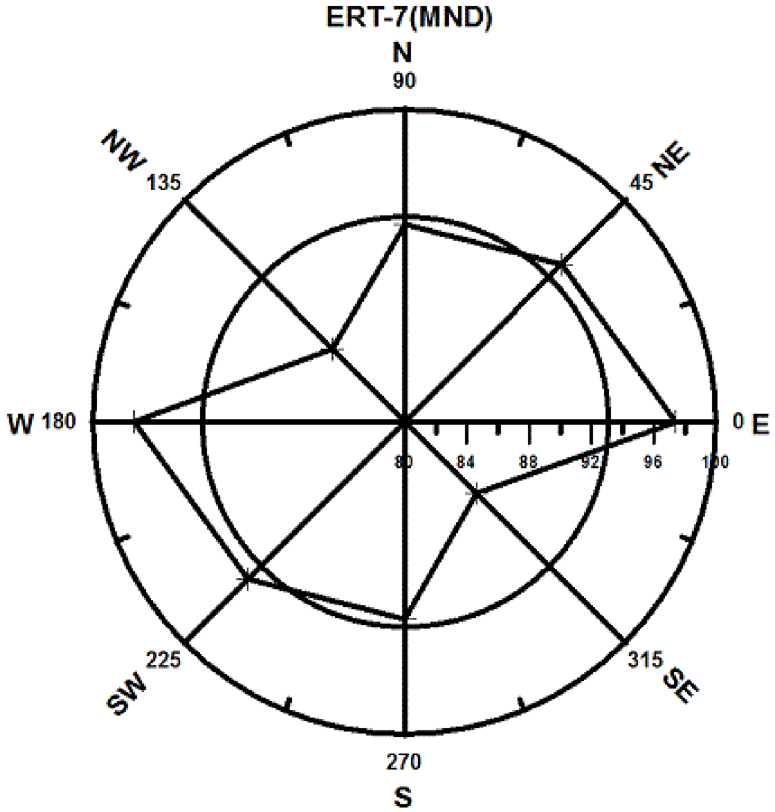


ρ =63.851 Ohm m

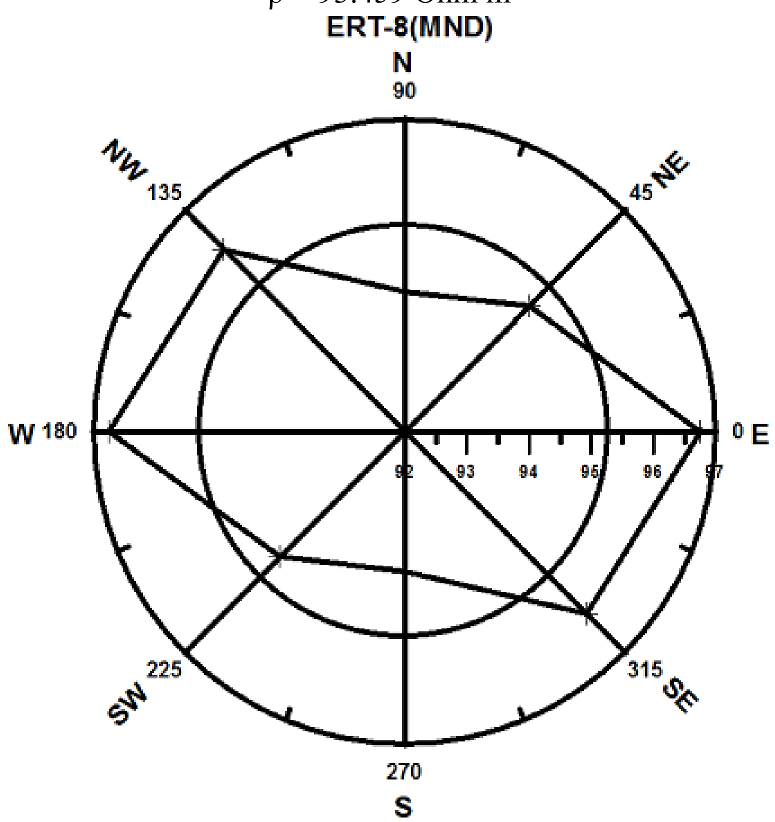
ERT-6(MND)



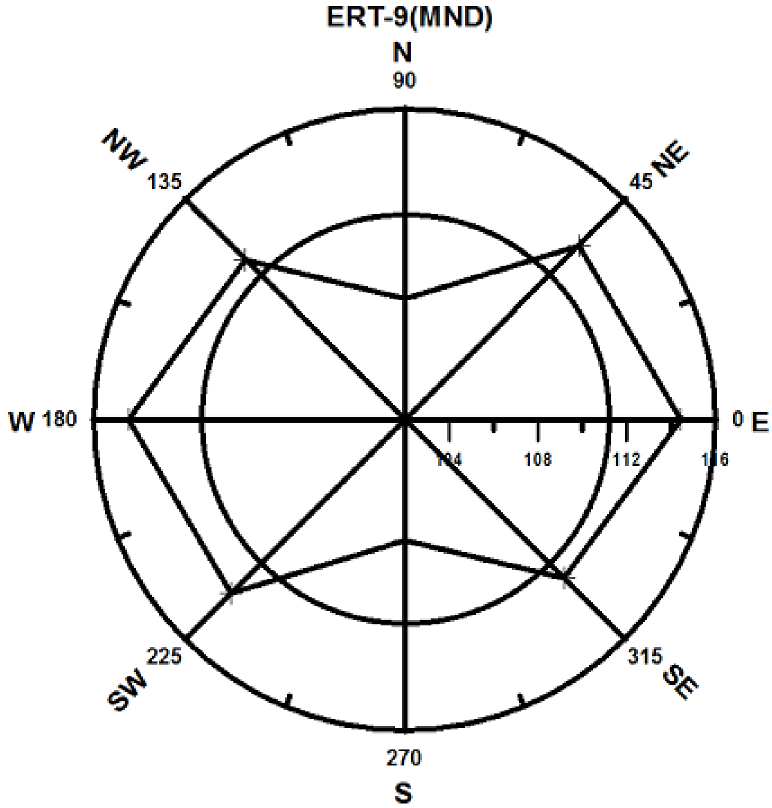
ρ = 143.723 Ohm m



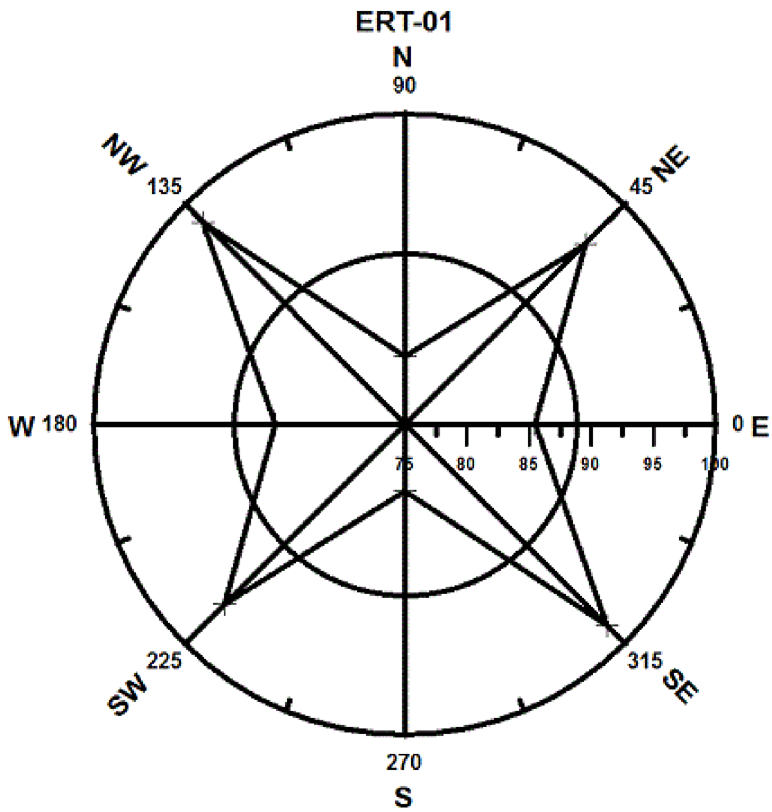
ρ = 93.459 Ohm m



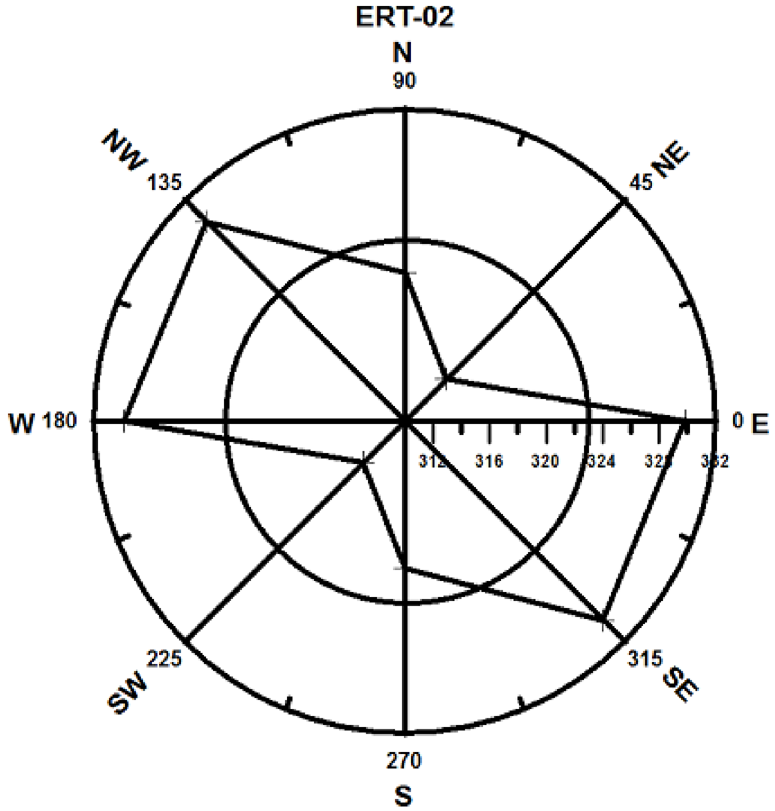
ρ = 95.242 Ohm m



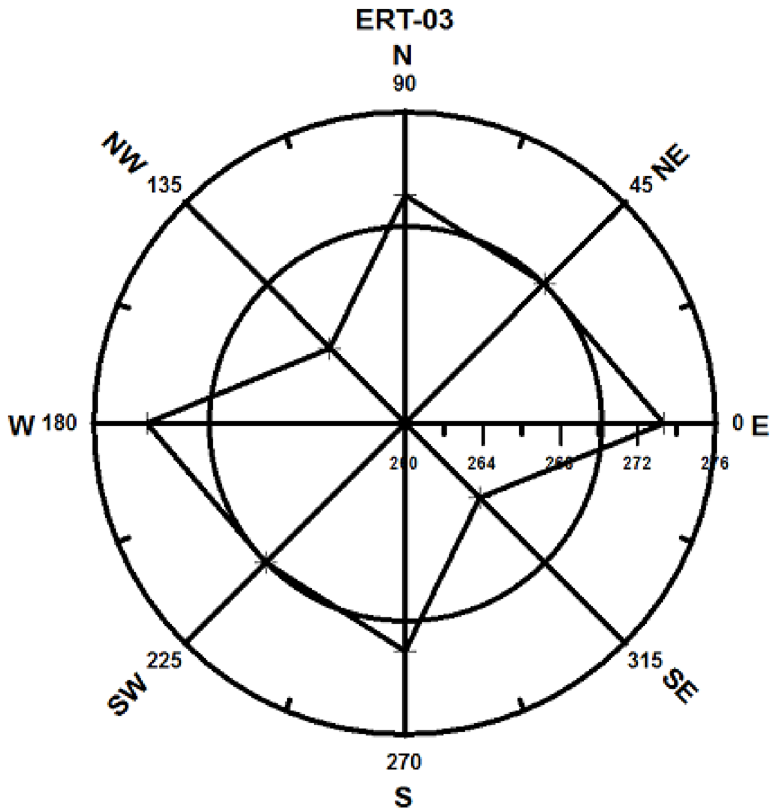
ρ = 111.780 Ohm m



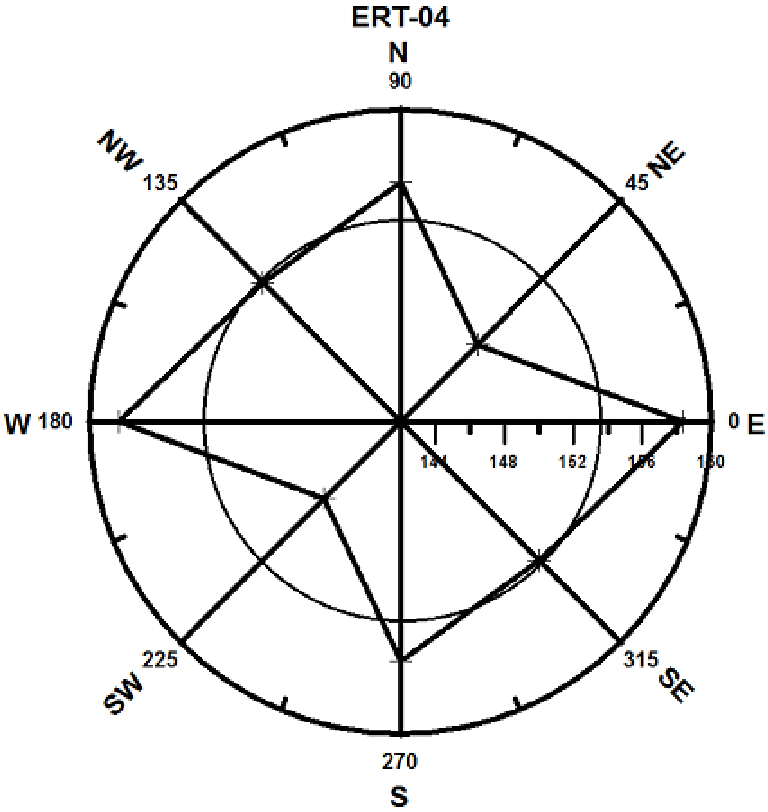
ρ = 89.848 Ohm m



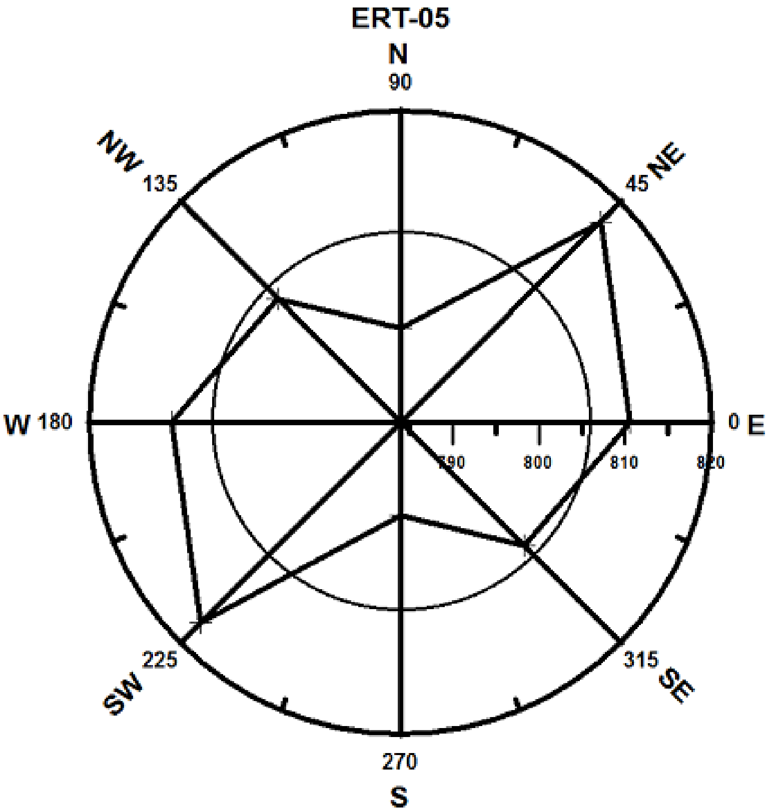
ρ = 323.580 Ohm m



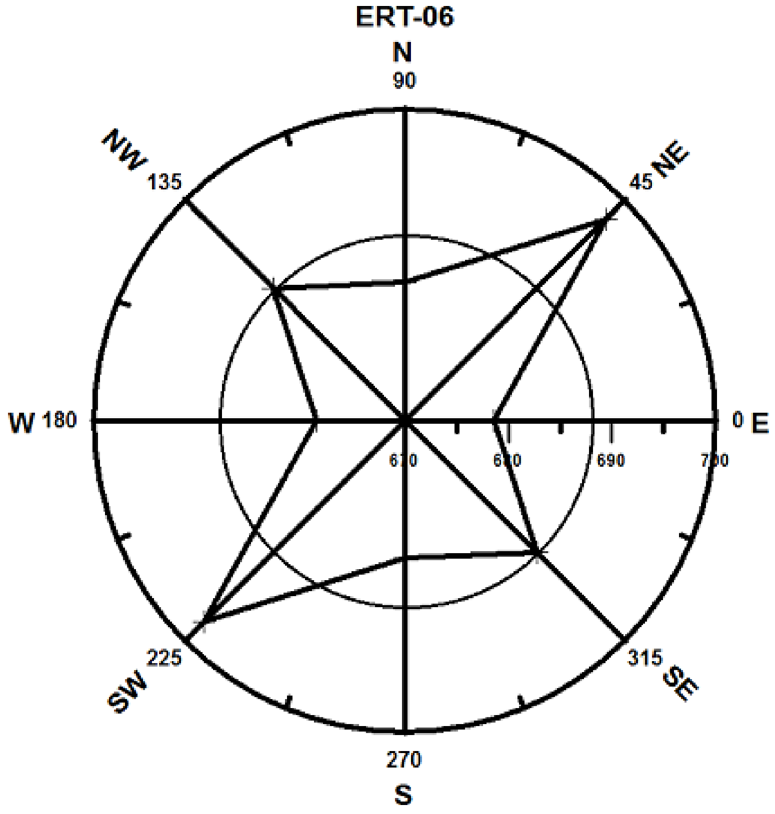
ρ = 270.169 Ohm m



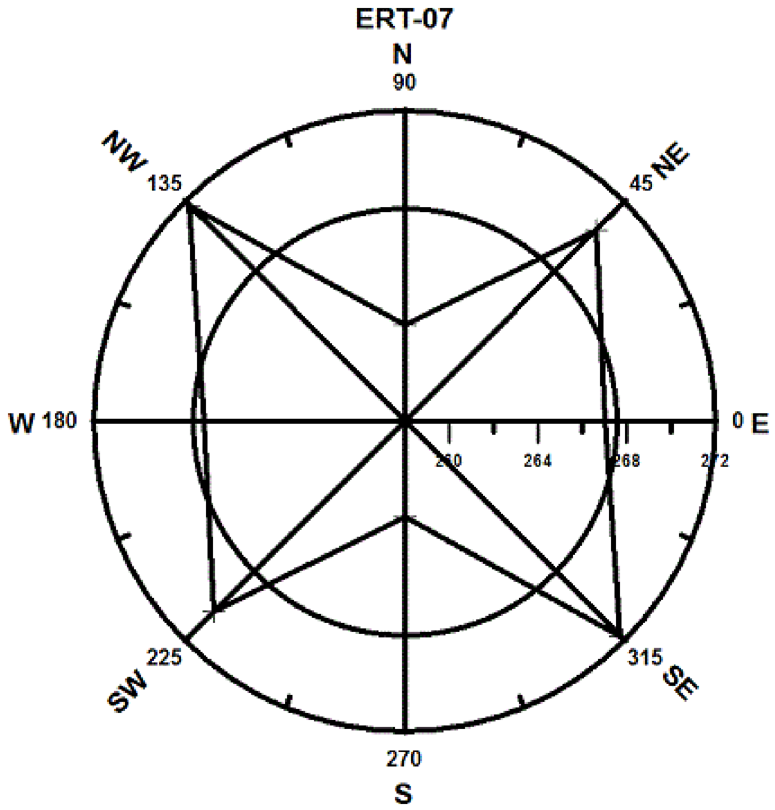
ρ = 153.963 Ohm m



ρ =806.592 Ohm m

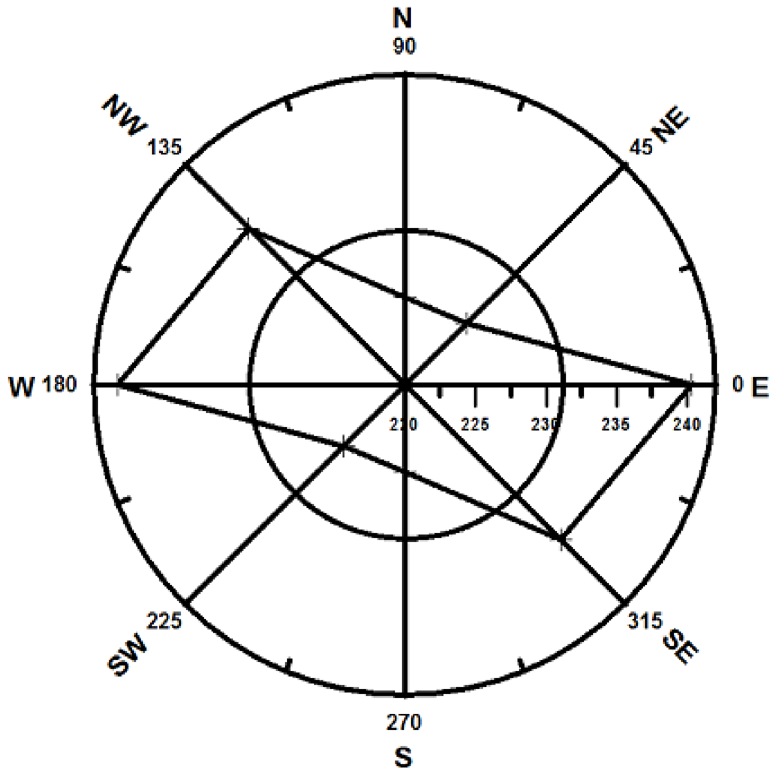


ρ = 686.824 Ohm m



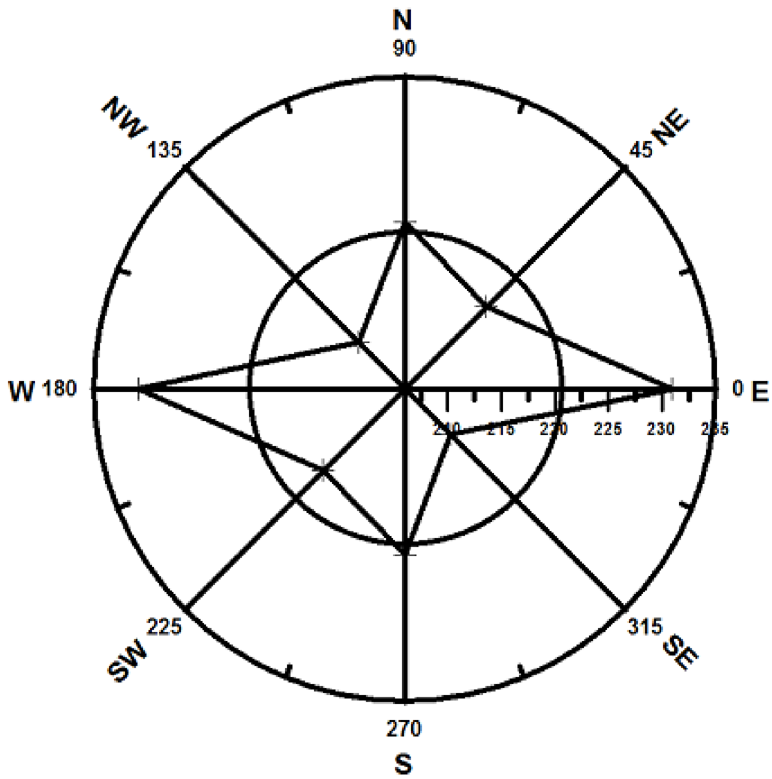
ρ = 267.812 Ohm m

ERT-08



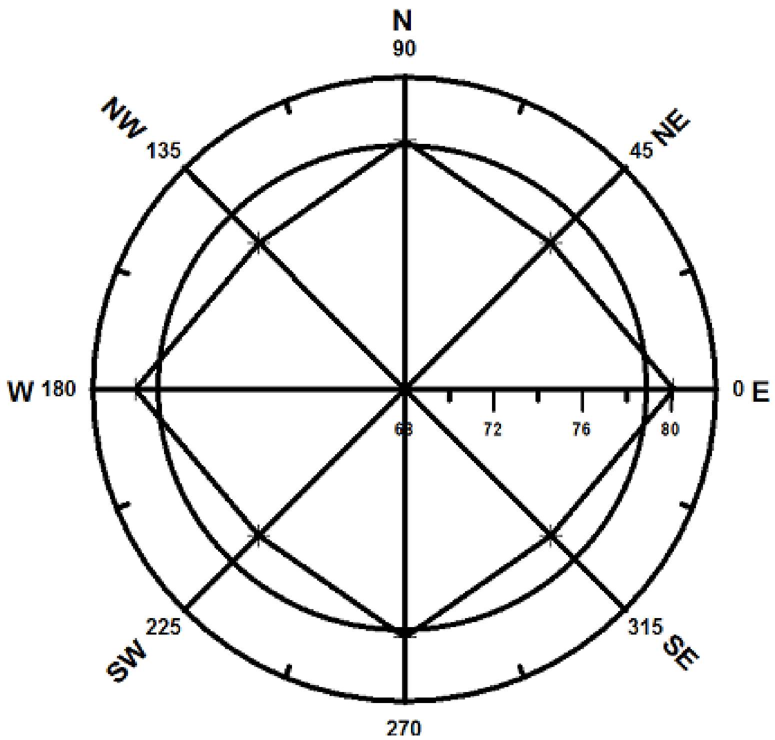
ρ = 232.082 Ohm m

ERT-09



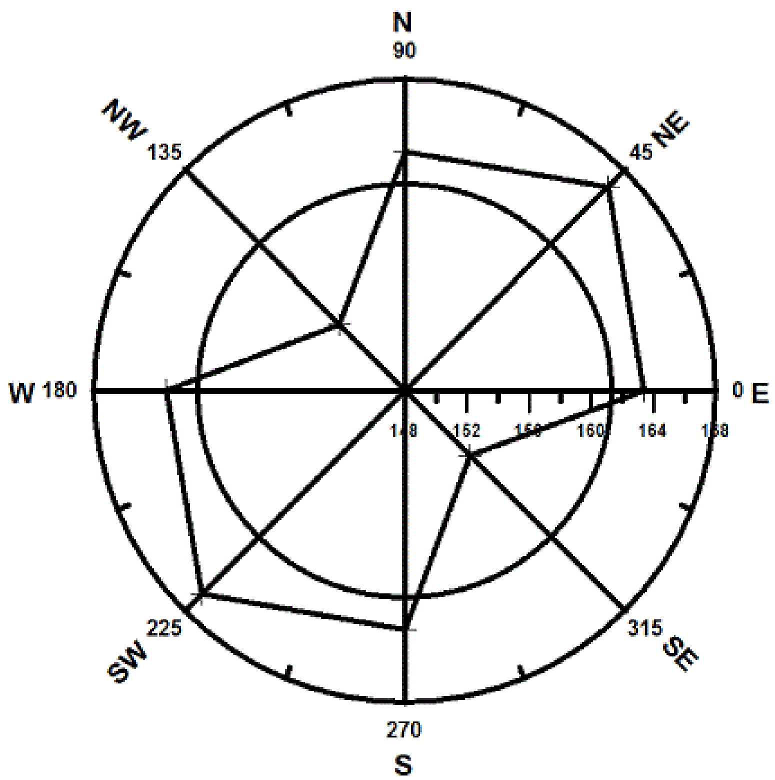
ρ = 220.302 Ohm m

ERT-10

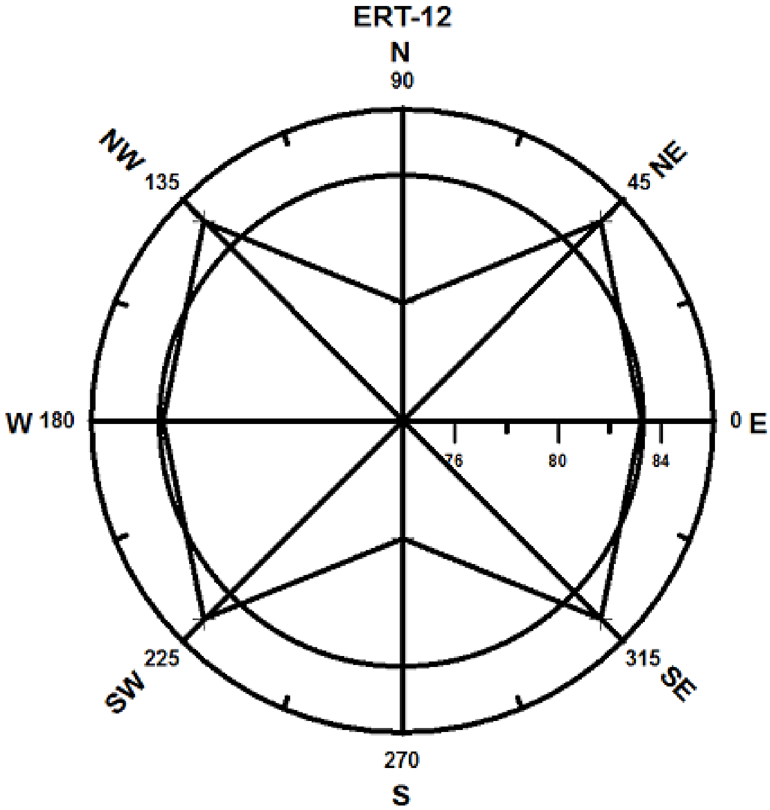


ρ = 78.416 Ohm m

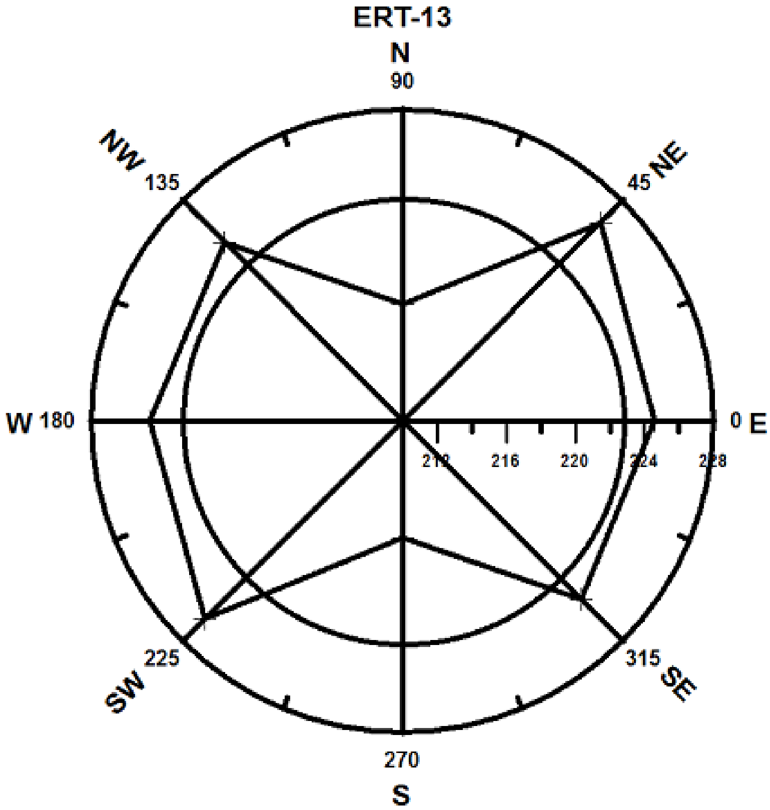
ERT-11



ρ = 161.789 Ohm m



ρ = 82.856 Ohm m



ρ = 222.796 Ohm m

Job No: 4095

REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
5th ALUMINA REFINERY AT DAMANJODI, ODISHA
AND PORT FACILITIES AT VISAKHAPATNAM

VOLUME 2
(*Borelogs, Field & Laboratory Test Results*)

Clients :

M/s. National Aluminium Company Limited
Nalco Bhawan, Nayapalli,
Bhubaneswar – 751 013

Foundation Consultants :

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001& OHSAS 18001 Certified Company
NABL Accredited Laboratory
124A, N.S.C. Bose Road : Kolkata - 700 092
Phones: 2428-6221/6222/6223 Fax: (033) 2428-6220
Email: cetest@cetestindia.com

April – 2018
(Revised on 15-10-2018)

LIST OF CONTENTS

SUBJECT	***SHEET NUMBER***

For C. E. Testing Company Private Limited,

Prepared By	**Checked By**	**Approved By**
S. Sarkar	Sudip Nath	
(S. SARKAR)	**(S. NATH)**	**(DR. M. NAYAK)**

PART I: ALL FIELD TESTS RESULTS

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.1

Co-ordinates E =1028.394 N=1628.156

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	10
		Water Sample (WS)	0

Commencement Date : 13/02/18
Completion Date : 16/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 918.823 M.
Water Struck At :
Standing Water Level : 5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	Ref. No	Depth (m)
	0.00m						
Filled up soil consists of reddish brown, clayey silt / silty clay with boulder.						DS-1	0.50
						DS-2	1.00
		26	45	63	≥100	SPT-1	1.50-1.95
	2.50m					DS-3	2.50
Very stiff, reddish brown, clayey silt / silty clay. Obs. sand mixture.		4	8	11	19	SPT-2	3.00-3.45
						DS-4	4.00
	4.50m					*UDS-1	4.50-4.65
Hard, light grey, clayey silt. Obs. brown & yellow spots.		11	19	27	46	SPT-3	4.80-5.25
						DS-5	5.50
		14	22	33	55	SPT-4	6.00-6.45
						DS-6	7.00
		17	25	38	63	SPT-5	7.50-7.95
	8.30m						
Hard, light grey, clayey silt with decomposed rock.						DS-7	8.50
		18	27	37	64	SPT-6	9.00-9.45
						DS-8	10.00
		17	29	39	68	SPT-7	10.50-10.95
						DS-9	11.50
		22	31	42	73	SPT-8	12.00-12.45
	13.00m					DS-10	13.00

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.1

Co-ordinates E =1028.394 N=1628.156

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	10
		Water Sample (WS)	0

Commencement Date : 13/02/18
Completion Date : 16/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 918.823 M.
Water Struck At :
Standing Water Level : 5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)	Remarks
Hard, light grey, clayey silt with decomposed rock.	13.00m – 13.70m	100 — 5.0 cm Pentn. Refusal	*SPT-9	13.50-13.55	
		100 — 3.0 cm Pentn. Refusal	*SPT-10	13.70-13.73	
Highly weathered, yellowish grey to light grey, medium grained, fractured rock.	13.70m – 16.70m	NX rotary drilling from 13.70m to 25.00m	R1	13.70-14.70	CR=28% RQD=NIL
			R2	14.70-15.70	CR=25% RQD=NIL
			R3	15.70-16.70	CR=32% RQD=NIL
Moderately to slightly weathered, yellowish grey to light grey, medium grained, fractured rock.	16.70m – 19.70m		R4	16.70-17.70	CR=52% RQD=27%
			R5	17.70-18.70	CR=65% RQD=24%
			R6	18.70-19.70	CR=63% RQD=39%
Slightly weathered to fresh, light blackish grey, medium to coarse grained, fractured rock.	19.70m – 25.00m		R7	19.70-20.70	CR=79% RQD=50%
			R8	20.70-22.00	CR=86% RQD=63%
			R9	22.00-23.50	CR=100% RQD=91%
			R10	23.50-25.00	CR=100% RQD=96%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.19

Co-ordinates E=1610.394 N=1650.850

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	10	Undisturbed (UDS)	1	Commencement Date :	18/02/18
Cone (Pc)		Penetrometer (SPT)	10	Completion Date :	21/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	931.047 M.
				Water Struck At :	
				Standing Water Level :	5.20 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.				SAMPLES Ref. No	Depth (m)
0.00m.							
Filled up soil consits of reddish brown, silty clay with moorum & tree roots.						DS-1	0.50
						DS-2	1.00
1.20m.							
Hard, reddish brown to brownish grey, silty clay / clayey silt with moorum. Obs. calcareous nodules & sand mixture		10	15	19	34	SPT-1	1.50-1.95
						DS-3	2.50
		11	14	17	31	SPT-2	3.00-3.45
						DS-4	4.00
		12	16	21	37	SPT-3	4.50-4.95
						DS-5	5.50
		11	15	24	39	SPT-4	6.00-6.45
						DS-6	7.00
						*UDS-1	7.50-7.59
		14	19	25	44	SPT-5	8.00-8.45
						DS-7	9.00
		13	20	26	46	SPT-6	9.50-9.95
						DS-8	10.50
11.00m.							
Very dense, reddish brown, silty sand. Obs. decomposed rock		16	22	29	51	SPT-7	11.00-11.45
12.00m.						DS-9	12.00

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.19	Co–ordinates E=1610.394 N=1650.850

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	10	Undisturbed (UDS)	1	Commencement Date :	18/02/18
Cone (Pc)		Penetrometer (SPT)	10	Completion Date :	21/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	931.047 M.
				Water Struck At :	
				Standing Water Level :	5.20 m.

DESCRIPTION	SYMBOL	N–VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
12.00m.				
Very dense, reddish brown, silty sand. Obs. decomposed rock		22 38 47 85	SPT–8	12.50–12.95
		100 Refusal 3.0 cm Pentn.	*SPT–9	13.70–13.73
14.00m.		100 Refusal 2.0 cm Pentn.	*SPT–10	14.00–14.02
Highly weathered, light blackish grey, medium to coarse grained, highly fractured rock.		NX rotary drilling from 14.00m to 23.00m	R1	14.00 CR=26% RQD=10% 15.00
			R2	CR=24% RQD=NIL 16.00
			R3	CR=27% RQD=NIL 17.00
			R4	CR=35% RQD=NIL 18.00
18.00m.				
Moderately to slightly weathered / fresh, light blackish grey, medium to coarse graiend, moderately fractured rock.			R5	CR=52% RQD=20% 19.00
			R6	CR=76% RQD=35% 20.00
			R7	CR=100% RQD=91% 21.50
			R8	CR=100% RQD=92% 23.00
23.00m.				

N.B. — '*' means sample could not be recovered.

BH–19/Sheet–2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			**CETEST**
Job No : 4095	**Created by : Chandrani**	**Created on : 03/03/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.20

Co-ordinates E=1574.913 N=1615.011

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	11
		Water Sample (WS)	0

Commencement Date : 22/02/18
Completion Date : 26/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 927.752 M.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	Depth
Filled up soil consists of reddish brown, silty clay with moourm.	0.00m – 1.40m
Hard, reddish brown, silty clay / clayey silt with moorum. Obs. calcareous nodules & sand mixture.	1.40m – 7.00m
Very dense, yellowish brown, silty sand with decomposed rock.	7.00m – 12.00m
Completely weathered, light blackish grey, medium to coarse graiend, highly fractured rock.	12.00m – 15.00m
Highly weathered, light blackish grey, medium to coarse graiend, highly fractured rock.	15.00m – 17.00m
Slightly weathered to fresh, light blackish grey, medium to fine grained, moderately fractured rock.	17.00m – 21.00m

N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
		DS-1	0.50
		DS-2	1.00
9 14 17	31	SPT-1	1.50-1.95
		DS-3	2.50
12 17 22	39	SPT-2	3.00-3.45
		DS-4	4.00
		*UDS-1	4.50-4.65
13 19 24	43	SPT-3	5.00-5.45
		DS-5	6.00
17 26 30	56	SPT-4	6.50-6.95
		DS-6	7.50
21 28 33	61	SPT-5	8.00-8.45
		DS-7	9.00
18 26 32	58	SPT-6	9.50-9.95
		DS-8	10.50
19 29 36	65	SPT-7	11.00-11.45
100 2.0 cm Pentn.	Refusal	*SPT-8	11.85-11.87
100 2.0 cm Pentn.	Refusal	*SPT-9	12.00-12.02
NX rotary drilling from 12.00m to 21.00m		R1	12.00-13.00 CR=NIL RQD=NIL
		DS-9	
		R2	13.00-14.00 CR=NIL RQD=NIL
		DS-10	
		R3	14.00-15.00 CR=NIL RQD=NIL
		DS-11	
		R4	15.00-16.00 CR=28% RQD=NIL
		R5	16.00-17.00 CR=38% RQD=10%
		R6	17.00-18.00 CR=75% RQD=48%
		R7	18.00-19.50 CR=100% RQD=90%
		R8	19.50-21.00 CR=100% RQD=93%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.				CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:	

BORE LOG DATA SHEET	BORE HOLE NO.21	Co-ordinates E=1623.453 N=1608.091

Field Test	Nos	Samples	Nos		
				Commencement Date :	02/02/18
				Completion Date :	05/02/18
Penetrometer (SPT)	14	Undisturbed (UDS)	1	Bore Hole Diameter :	150 mm. / N.X.
Cone (Pc)		Penetrometer (SPT)	14	Level Of Ground :	929.948 M.
		Disturbed (DS)	13	Water Struck At :	
Vane (V)		Water Sample (WS)	0	Standing Water Level :	6.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.				SAMPLES Ref. No	Depth (m)
0.00m.							
						DS-1	0.50
						DS-2	1.00
		12	19	24	43	SPT-1	1.50-1.95
						DS-3	2.50
						*UDS-1	3.00-3.15
		14	21	25	46	SPT-2	3.40-3.85
						DS-4	4.50
		12	22	26	48	SPT-3	5.00-5.45
						DS-5	6.00
Hard, reddish brown, clayey silt / silty clay. Obs. calcareous nodules & sand mi.ture.		13	20	25	45	SPT-4	6.50-6.95
						DS-6	7.50
		12	23	26	49	SPT-5	8.00-8.45
						DS-7	9.00
		15	19	25	44	SPT-6	9.50-9.95
						DS-8	10.50
		17	20	27	47	SPT-7	11.00-11.45
						DS-9	12.00
		17	19	28	47	SPT-8	12.50-12.95
13.00m.							

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.21	Co-ordinates E=1623.453 N=1608.091

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	14	Undisturbed (UDS)	1	Commencement Date :	02/02/18
Cone (Pc)		Penetrometer (SPT)	14	Completion Date :	05/02/18
Vane (V)		Disturbed (DS)	13	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	929.948 M.
				Water Struck At :	
				Standing Water Level :	6.10 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown, clayey silt / silty clay. Obs. calcareous nodules & sand mi.ture.	13.00m			DS-10	13.50
			19 23 33 — 56	SPT-9	14.00-14.45
				DS-11	15.00
			19 24 35 — 59	SPT-10	15.50-15.95
				DS-12	16.50
Very dense, brownish grey, silty sand. Obs. decomposed rock.	16.50m				
			24 36 39 — 75	SPT-11	17.00-17.45
				DS-13	18.00
			35 45 100 — >100 (5.0 cm Pentn.)	SPT-12	18.50-18.85
			100 — Refusal (3.0 cm Pentn.)	*SPT-13	18.90-18.93
			100 — Refusal (2.0 cm Pentn.)	*SPT-14	19.00-19.02
Highly to moderately weathered, yellowish grey, medium grained, fractured rock.	19.00m		NX rotary drilling from 19.00m to 25.00m	R1	19.00–20.00 CR=29% RQD=NIL
				R2	20.00–21.00 CR=49% RQD=10%
Slightly weathered to fresh, whitish grey, coarse grained, slightly fractured rock.	21.00m			R3	21.00–22.00 CR=70% RQD=49%
				R4	22.00–23.50 CR=100% RQD=93%
				R5	23.50–25.00 CR=100% RQD=94%
	25.00m				

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.22

Co-ordinates E=1674.670 N=1598.819

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	20	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	20
Vane (V)		Disturbed (DS)	19
		Water Sample (WS)	0

Commencement Date : 01/02/18
Completion Date : 04/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 928.091 M
Water Struck At :
Standing Water Level : 5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Depth (m)
Hard, reddish brown, clayey silt. Obs. calcareous nodules.	0.00m – 2.00m			DS-1	0.50
				DS-2	1.00
		9 18 23	41	SPT-1	1.50-1.95
Hard, yellowish grey to reddish brown, silty clay / clayey silt. Obs. calcareous nodules & sand mi.trure.	2.00m – 12.00m			DS-3	2.50
		9 16 24	40	SPT-2	3.00-3.45
				DS-4	4.00
		12 16 28	44	SPT-3	4.50-4.95
				DS-5	5.50
		10 15 28	43	SPT-4	6.00-6.45
				DS-6	7.00
		8 17 29	46	SPT-5	7.50-7.95
				DS-7	8.50
		11 19 29	48	SPT-6	9.00-9.45
				DS-8	10.00
		12 18 28	46	SPT-7	10.50-10.95
				DS-9	11.50
Hard, reddish brown, clayey silt / silty clay. Obs. calcareous nodules	12.00m – 17.00m	19 20 39	59	SPT-8	12.00-12.45
				DS-10	13.00
		12 21 38	59	SPT-9	13.50-13.95
				DS-11	14.50
		15 23 30	53	SPT-10	15.00-15.45
				DS-12	16.00
		17 28 32	60	SPT-11	16.50-16.95

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.22

Co-ordinates E=1674.670 N=1598.819

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	20	Undisturbed (UDS)	0	Commencement Date :	01/02/18
Cone (Pc)		Penetrometer (SPT)	20	Completion Date :	04/02/18
Vane (V)		Disturbed (DS)	19	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	928.091 M
				Water Struck At :	
				Standing Water Level :	5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
Hard, reddish brown, clayey silt / silty clay. Obs. calcareous nodules	17.00m. – 22.00m.			DS−13	17.50
		15 25 30	55	SPT−12	18.00−18.45
				DS−14	19.00
		16 25 31	56	SPT−13	19.50−19.95
				DS−15	20.50
		14 26 34	60	SPT−14	21.00−21.45
Very dense, light grey, silty sand with decomposed rock.	22.00m. – 28.00m.			DS−16	22.00
		20 27 39	66	SPT−15	22.50−22.95
				DS−17	23.50
		25 29 42	71	SPT−16	24.00−24.45
				DS−18	25.00
		24 28 50	78	SPT−17	25.50−25.95
				DS−19	26.50
		29 31 54	85	SPT−18	27.00−27.45
		100 4.0 cm Pentn.	Refusal	*SPT−19	27.80−27.84
		100 2.0 cm Pentn.	Refusal	*SPT−20	28.00−28.02
Fresh, whitish grey, coarse grained, slightly fractured rock.	28.00m. – 32.00m.	NX rotary drilling from 28.00m to 32.00m		R1	CR=89% RQD=79% (28.00–29.00)
				R2	CR=100% RQD=93% (29.00–30.50)
				R3	CR=100% RQD=96% (30.50–32.00)

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 25/01/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.30

Co-ordinates E=1913.103 N=1744.541

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date :	01/01/18
Completion Date :	05/01/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	931.375 M.
Water Struck At :	
Standing Water Level :	6.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Very stiff to hard, reddish brown, silty clay with moorum.	0.00m – 5.50m		DS-1	0.50
		10 14 17 — 31	SPT-1	1.00-1.45
			*UDS-1	2.00-2.10
		7 9 9 — 18	SPT-2	2.50-2.95
			DS-2	3.50
			UDS-2	4.00-4.45
		8 10 12 — 22	SPT-3	4.45-4.90
			DS-3	5.50
Very dense, whitish grey, silty sand with decomposed rock.	5.50m – 5.70m	100 — 3.0 cm Pentn. Refusal	*SPT-4	5.60-5.63
		100 — 3.0 cm Pentn. Refusal	*SPT-5	5.70-5.73
Fresh, whitish grey, medium grained, slightly fractured rock.	5.70m – 11.70m	NX rotary drilling from 5.70m to 20.70m	R1	CR=84% RQD=65% (5.70 – 6.70)
			R2	CR=80% RQD=76% (6.70 – 7.70)
			R3	CR=82% RQD=64% (7.70 – 8.70)
			R4	CR=90% RQD=66% (8.70 – 9.70)
			R5	CR=95% RQD=88% (9.70 – 10.70)
			R6	CR=86% RQD=70% (10.70 – 11.70)
Moderately to slightly weathered, whitish grey, medium grained, fractured rock.	11.70m – 16.70m		R7	CR=68% RQD=37% (11.70 – 12.70)
			R8	CR=72% RQD=41% (12.70 – 13.70)
			R9	CR=54% RQD=28% (13.70 – 14.70)
			R10	CR=60% RQD=26% (14.70 – 15.70)
			R11	CR=59% RQD=17% (15.70 – 16.70)
Slightly weathered / fresh, whitish grey, medium grained, slightly fractured rock.	16.70m – 20.70m		R12	CR=76% RQD=70% (16.70 – 17.70)
			R13	CR=100% RQD=93% (17.70 – 19.20)
			R14	CR=100% RQD=94% (19.20 – 20.70)

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.37

Co-ordinates E=1998.027 N=1744.020

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	2	Undisturbed (UDS)	0	Commencement Date :	05/01/18
Cone (Pc)		Penetrometer (SPT)	2	Completion Date :	09/01/18
Vane (V)		Disturbed (DS)	1	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	941.150 M.
				Water Struck At :	
				Standing Water Level :	9.70 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
	0.00m.				
Very dense, reddish brown, clayey silty sand with kankars.				DS-1	0.50
			100 3.0 cm Pentn. Refusal	*SPT-1	1.00-1.03
	1.10m.		100 3.0 cm Pentn. Refusal	*SPT-2	1.10-1.13
Slightly weathered, light brownish grey, light to moderately fractured rock.			NX rotary drilling from 1.10m to 19.10m	R1	1.10 - 2.10 CR=65% RQD=44%
				R2	2.10 - 3.10 CR=82% RQD=80%
				R3	3.10 - 4.10 CR=78% RQD=10%
				R4	4.10 - 5.10 CR=72% RQD=65%
	5.10m.				
Fresh, light whitish grey, coarse to medium grained, moderately to slightly fractured rock.				R5	5.10 - 6.10 CR=91% RQD=77%
				R6	6.10 - 7.60 CR=90% RQD=84%
				R7	7.60 - 9.10 CR=96% RQD=90%
				R8	9.10 - 10.60 CR=82% RQD=78%
	10.60m.				
Slightly weathered to fresh, light whitish grey, coarse to medium grained, fractured rock.				R9	10.60 - 12.10 CR=62% RQD=58%
				R10	12.10 - 13.60 CR=71% RQD=60%
				R11	13.60 - 15.10 CR=85% RQD=82%
				R12	15.10 - 16.10 CR=94% RQD=92%
				R13	16.10 - 17.60 CR=100% RQD=97%
				R14	17.60 - 19.10 CR=100% RQD=98%
	19.10m.				

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.40	Co-ordinates E=1959.075 N=1726.078

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	1	Commencement Date :	02/01/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	04/01/18
Vane (V)		Disturbed (DS)	4	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	933.280 M.
				Water Struck At :	
				Standing Water Level :	7.80 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)	CR / RQD
	0.00m		DS-1	0.50	
Very stiff, reddish brown, clayey silt with kankars.		4 7 9 — 16	SPT-1	1.00-1.45	
			UDS-1	2.05-2.50	
	2.50m	9 14 17 — 31	SPT-2	2.50-2.95	
Hard, reddish brown, clayey silt with kankars.			DS-2	3.50	
		11 18 24 — 42	SPT-3	4.00-4.45	
	5.00m		DS-3	5.00	
Yellowish grey, silty sand with clay binder & traces of kankars.		70 Refusal 4.0 cm Pentn.	*SPT-4	5.50-5.54	
	6.00m	83 Refusal 3.0 cm Pentn.	*SPT-5	6.00-6.03	6.00
Completely weathered, light brownish grey, coarse grained, fully decomposed rock.			DS-4/R1	6.00-6.75	CR=NIL RQD=NIL
			DS-5/R2	6.75-7.50	CR=NIL RQD=NIL
		75 Refusal 4.0 cm Pentn.	*SPT-6	7.50-7.54	7.50
			DS-6/R3	7.50-8.25	CR=NIL RQD=NIL
			R4	8.25-9.00	CR=10% RQD=NIL
	9.00m	80 Refusal 2.0 cm Pentn.	*SPT-7	9.00-9.02	9.00
Highly weathered, light brownish grey, coarese grained, fractured rock.			R5	9.00-10.00	CR=27% RQD=NIL
		NX rotary drilling from 6.00m to 18.70m	R6	10.00-11.00	CR=28% RQD=22%
	11.00m		R7	11.00-12.50	CR=53% RQD=52%
Modrately to slightly weathered / fresh, light brownish grey, coarse grained rock.			R8	12.50-13.70	CR=78% RQD=78%
			R9	13.70-14.70	CR=88% RQD=88%
			R10	14.70-15.70	CR=84% RQD=84%
			R11	15.70-17.20	CR=100% RQD=98%
			R12	17.20-18.70	CR=100% RQD=97%
	18.70m			18.70	

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.44

Co-ordinates E=1965.713 N=1679.762

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	3	Undisturbed (UDS)	0	Commencement Date :	05/01/18
Cone (Pc)		Penetrometer (SPT)	3	Completion Date :	09/01/18
Vane (V)		Disturbed (DS)	2	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	929.265 M.
				Water Struck At :	
				Standing Water Level :	4.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown, silty clay / clayey silt with moorum. Obs. decomposed rock.	0.00m.–2.40m.		DS-1	0.50
			DS-2	1.00
		12 15 18 (33)	SPT-1	1.50-1.95
		100 Refusal 3.0 cm Pentn.	*SPT-2	2.30-2.33
		100 Refusal 2.0 cm Pentn.	*SPT-3	2.40-2.42
Moderately to slightly weathered, light brownish grey, coarse graiend, highly to moderately fractured rock.	2.40m.–11.40m.	NX rotary drilling from 2.40m to 15.90m	R1	2.40–3.40 CR=62% RQD=17%
			R2	3.40–4.40 CR=46% RQD=12%
			R3	4.40–5.40 CR=45% RQD=27%
			R4	5.40–6.40 CR=64% RQD=20%
			R5	6.40–7.40 CR=79% RQD=30%
			R6	7.40–8.40 CR=70% RQD=59%
			R7	8.40–9.90 CR=56% RQD=NIL
			R8	9.90–11.40 CR=60% RQD=50%
Fresh, whitish grey, medium grained, slightly fractured rock.	11.40m.–15.90m.		R9	11.40–12.90 CR=86% RQD=70%
			R10	12.90–14.40 CR=100% RQD=94%
			R11	14.40–15.90 CR=100% RQD=98%

N.B. — '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.47	Co-ordinates E=2079.583 N=1650.307

Field Test	Nos	Samples	Nos	
Penetrometer (SPT)	2	Undisturbed (UDS)	0	Commencement Date : 13/01/18
Cone (Pc)		Penetrometer (SPT)	2	Completion Date : 16/01/18
Vane (V)		Disturbed (DS)	1	Bore Hole Diameter : 150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground : 927.274 M.
				Water Struck At :
				Standing Water Level : 6.50 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Hard, reddish brown, clayey silt / silty clay with boulder, moorum.			DS-1	0.50
		100 Refusal 4.0 cm Penth.	*SPT-1	1.00-1.04
1.10m		100 Refusal 3.0 cm Penth.	*SPT-2	1.10-1.13
Slightly weathered / fresh, whitish grey, medium to coarse grained, slightly fractured rock.		NX rotary drilling from 1.10m to 9.00m	R1	CR=61% RQD=24% (1.10–2.00)
			R2	CR=72% RQD=35% (2.00–3.00)
			R3	CR=82% RQD=68% (3.00–4.00)
			R4	CR=84% RQD=55% (4.00–5.00)
			R5	CR=97% RQD=88% (5.00–6.00)
			R6	CR=100% RQD=91% (6.00–7.50)
			R7	CR=100% RQD=93% (7.50–9.00)
9.00m				

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.		CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.48

Co-ordinates E=2028.806 N=1643.061

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	0	Commencement Date :	13/01/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	15/01/18
Vane (V)		Disturbed (DS)	6	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	927.060 M.
				Water Struck At :	
				Standing Water Level :	6.60 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)	Core run (m)
Reddish brown, clayey silt / silty clay with boulder pieces, moorum.	0.00m. – 0.60m.						DS-1	0.50	
Very dense, bronwish grey, silty sand. Obs. decomposed rock.	0.60m. – 8.30m.						DS-2	1.00	
			12	22	36	58	SPT-1	1.50-1.95	
							DS-3	2.50	
			19	29	35	64	SPT-2	3.00-3.45	
							DS-4	4.00	
			17	28	36	64	SPT-3	4.50-4.95	
							DS-5	5.50	
			22	31	45	76	SPT-4	6.00-6.45	
							DS-6	7.00	
			29	42	55	97	SPT-5	7.50-7.95	
			100	5.0 cm Pentn.		Refusal	*SPT-6	8.10-8.15	
			100	4.0 cm Pentn.		Refusal	*SPT-7	8.30-8.34	
Slightly weathered to fresh, whitish grey, medium to coarse grained, moderately fractured rock.	8.30m. – 13.00m.		NX rotary drilling from 8.30m to 13.00m				R1	CR=61% RQD=30%	8.30 – 9.00
							R2	CR=85% RQD=56%	9.00 – 10.00
							R3	CR=100% RQD=94%	10.00 – 11.50
							R4	CR=100% RQD=92%	11.50 – 13.00

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 29/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.49

Co-ordinates E=2150.562 N=1619.967

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 22/01/18
Completion Date : 24/01/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 916.757 M.
Water Struck At :
Standing Water Level : 5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	Ref. No	Depth (m)
Very stiff, reddish brown, silty clay with moorum.	0.00m – 1.50m					DS-1	0.50
		7	8	11	19	SPT-1	1.00-1.45
Hard, reddish brown, silty clay with moorum.	1.50m – 7.30m					DS-2	2.00
						UDS-1	2.50-2.90
		8	15	17	32	SPT-2	2.90-3.35
						DS-3	4.00
		7	19	24	43	SPT-3	4.50-4.95
						*UDS-2	5.50-5.60
		10	23	27	50	SPT-4	5.70-6.15
						DS-4	7.00
		100			Refusal 4.0 cm Pentn.	*SPT-5	7.10-7.14
Slightly weathered to fresh, whitish grey, medium grained, slightly fractured rock.	7.30m – 12.50m	100			Refusal 3.0 cm Pentn.	*SPT-6	7.30-7.33
		NX rotary drilling from 7.30m to 12.50m				R1	CR=67% RQD=41% (7.30 – 8.00)
						R2	CR=84% RQD=64% (8.00 – 9.50)
						R3	CR=100% RQD=97% (9.50 – 11.00)
						R4	CR=100% RQD=98% (11.00 – 12.50)

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.50

Co-ordinates E=2042.373 N=1614.453

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 17/01/18
Completion Date : 22/01/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 925.891 M.
Water Struck At :
Standing Water Level : 10.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Very dense, reddish brown, clayey silty sand with moorum. Obs. decomposed rock.	0.00m – 2.00m		DS-1	0.50
			DS-2	1.00
		21 42 100 5.0 cm Penth. ≥100	SPT-1	1.30-1.65
		100 5.0 cm Penth. Refusal	*SPT-2	1.80-1.85
		100 3.0 cm Penth. Refusal	*SPT-3	2.00-2.03
Moderately to slightly weathered, whitish grey, coarse grained, moderately fractured rock.	2.00m – 8.00m	NX rotary drilling from 2.00m to 12.00m	R1	2.00-3.00 CR=57% RQD=29%
			R2	3.00-4.00 CR=62% RQD=32%
			R3	4.00-5.50 CR=62% RQD=11%
			R4	5.50-7.00 CR=54% RQD=32%
			R5	7.00-8.00 CR=62% RQD=NIL
Fresh, whitish grey, coarse grained, slightly fractured rock.	8.00m – 12.00m		R6	8.00-9.00 CR=85% RQD=35%
			R7	9.00-10.50 CR=100% RQD=92%
			R8	10.50-12.00 CR=100% RQD=94%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.51

Co-ordinates E=2097.931 N=1579.081

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	3	Undisturbed (UDS)	1	Commencement Date :	19/01/18
Cone (Pc)		Penetrometer (SPT)	3	Completion Date :	22/01/18
Vane (V)		Disturbed (DS)	2	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	923.579 M.
				Water Struck At :	
				Standing Water Level :	9.50 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
	0.00m			
Reddish brown, silty clay / clayey silt with kankars. Obs. moorum & sand.			DS−1	0.50
			DS−2	1.00
	1.50m	8 15 18 (33)	SPT−1	1.50−1.95
Dense, reddish brown, clayey silty sand with kankars. Obs. moorum.			*UDS−1	2.50−2.60
		100 Refusal 3.0 cm Pentn.	*SPT−2	2.70−2.73
	3.00m	100 Refusal 3.0 cm Pentn.	*SPT−3	3.00−3.03
Moderately weathered, light brownish grey / light whitish grey, coarse to medium grained, fractured rock.		NX rotary drilling from 3.00m to 11.00m	R1	3.00–4.00 CR=45% RQD=45%
	4.00m		R2	4.00–5.00 CR=67% RQD=67%
Slightly weathered to fresh, light brownish grey / light whitish grey, coarse to medium grained, fractured rock.			R3	5.00–6.50 CR=66% RQD=63%
			R4	6.50–8.00 CR=70% RQD=37%
			R5	8.00–9.50 CR=100% RQD=95%
			R6	9.50–11.00 CR=100% RQD=98%
	11.00m			

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.52

Co-ordinates E=2028.806 N=1569.061

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	9
		Water Sample (WS)	0

Commencement Date : 16/01/18
Completion Date : 18/01/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 923.276 M.
Water Struck At :
Standing Water Level : 8.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
Dense to very dense, brownish grey, silty sand. Obs. kankars & decomposed rock fragments.	0.00m			DS−1	0.50
				DS−2	1.00
		14 22 28	50	SPT−1	1.50−1.95
				DS−3	2.50
		17 21 30	51	SPT−2	3.00−3.45
Dense to very dense, reddish brown, clayey silty sand / clayey sandy silt. Obs. moourm, decomposed rock fragments.	4.00m			DS−4	4.00
		12 20 29	49	SPT−3	4.50−4.95
				DS−5	5.50
		14 23 27	50	SPT−4	6.00−6.45
				DS−6	7.00
		15 24 29	53	SPT−5	7.50−7.95
				DS−7	8.50
		18 23 30	53	SPT−6	9.00−9.45
				DS−8	10.00
		22 29 39	68	SPT−7	10.50−10.95
				DS−9	11.50
		25 31 41	72	SPT−8	12.00−12.45
		100	Refusal 5.0 cm Penth.	*SPT−9	12.80−12.85
Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	13.00m	100	Refusal 4.0 cm Penth.	*SPT−10	13.00−13.04
	13.50m			R1	13.00 CR=23% RQD=NIL

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.52

Co-ordinates E=2028.806 N=1569.061

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	10	Undisturbed (UDS)	0	Commencement Date :	16/01/18
Cone (Pc)		Penetrometer (SPT)	10	Completion Date :	18/01/18
Vane (V)		Disturbed (DS)	10	Bore Hole Diameter :	150mm / N.X.
		Water Sample (WS)	0	Level Of Ground :	923.276 M.
				Water Struck At :	
				Standing Water Level :	8.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	13.50m – 15.00m	NX rotary drilling from 13.00m to 26.00m	R2	14.00 – 15.00 CR=23% RQD=14%
Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	15.00m – 19.00m		R3	15.00 – 16.00 CR=26% RQD=16%
			R4	16.00 – 17.00 CR=28% RQD=13%
			R5	17.00 – 18.00 CR=27% RQD=NIL
			R6	18.00 – 19.00 CR=35% RQD=11%
Moderately weathered, whitish grey, coarse grained, medium fractured rock.	19.00m – 22.00m		R7	19.00 – 20.00 CR=47% RQD=NIL
			R8	20.00 – 21.00 CR=45% RQD=NIL
			R9	21.00 – 22.00 CR=50% RQD=18%
Slightly weathered to fresh, whitish grey, coarse grained, medium fractured rock.	22.00m – 26.00m		R10	22.00 – 23.00 CR=65% RQD=20%
			R11	23.00 – 24.50 CR=100% RQD=95%
			R12	24.50 – 26.00 CR=100% RQD=96%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 29/01/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO.53

Co-ordinates E=2180.697 N=1581.658

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	4	Undisturbed (UDS)	1	Commencement Date :	22/01/18
Cone (Pc)		Penetrometer (SPT)	4	Completion Date :	24/01/18
Vane (V)		Disturbed (DS)	3	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	911.782 M.
				Water Struck At :	
				Standing Water Level :	3.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
	0.00m.			
Very stiff, reddish brown, silty clay / clayey silt with moorum. Obs. sand mi.ture.			DS-1	0.50
		8 10 18 — 28	SPT-1	1.00-1.45
	2.000m.		DS-2	2.00
Very dense, reddish brown, clayey silty sand with decomposed rock.			*UDS-1	2.50-2.60
		20 36 50 — ≥100 (3.0 cm Pentn.)	SPT-2	3.00-3.33
			DS-3	3.50
		50 — Refusal (3.0 cm Pentn.)	*SPT-3	4.00-4.03
	4.10m.	52 — Refusal (3.0 cm Pentn.)	*SPT-4	4.10-4.13
Moderately weathered to fresh, whitish grey, medium grained, slightly fractured rock.		NX rotary drilling from 4.10m to 9.50m	R1	CR=51% RQD=NIL (4.10-5.00)
			R2	CR=72% RQD=NIL (5.00-6.50)
			R3	CR=100% RQD=93% (6.50-8.00)
			R4	CR=100% RQD=95% (8.00-9.50)
	9.50m.			

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : SKD**	**Created on : 31/01/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.54

Co-ordinates E=2216.941 N=1556.691

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date :	24/01/2018
Completion Date :	30/01/2018
Bore Hole Diameter :	150mm / N.X.
Level Of Ground :	910.237 M.
Water Struck At :	
Standing Water Level :	4.50 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown, silty clay / clayey silt with moorum & calcareous nodules. Observed sand mi.ture.	0.00m. – 5.50m.		DS−1	0.50
		8 12 20 — 32	SPT−1	1.00−1.45
			DS−2	2.00
			UDS−1	2.50−2.95
		8 14 22 — 36	SPT−2	2.95−3.40
			DS−3	4.00
		10 16 24 — 40	SPT−3	4.50−4.95
Very dense, whitish grey, silty sand with decomposed rock.	5.50m. – 5.90m.		*UDS−2	5.50−5.62
		100 Refusal 4.0 cm Pentn.	*SPT−4	5.80−5.84
		92 Refusal 3.0 cm Pentn.	*SPT−5	5.90−5.93
Highly weathered, yellowish brown, medium grained, fractured rock.	5.90m. – 6.90m.	NX rotary drilling from 5.90m to 14.00m	R1	CR=33% RQD=Nil (5.90 – 6.90)
Moderately weathered, yellowish brown, medium grained, fractured rock.	6.90m. – 7.90m.		R2	CR=54% RQD=31% (6.90 – 7.90)
Slightly weathered to fresh, whitish grey, coarse grained, slightly fractured rock.	7.90m. – 14.00m.		R3	CR=74% RQD=47% (7.90 – 8.90)
			R4	CR=78% RQD=56% (8.90 – 9.90)
			R5	CR=80% RQD=74% (9.90 – 11.00)
			R6	CR=100% RQD=94% (11.00 – 12.50)
			R7	CR=100% RQD=94% (12.50 – 14.00)

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : SKD	Created on : 31/01/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.55	Co-ordinates E=2226.694 N=1500.494

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	8	Undisturbed (UDS)	1	Commencement Date :	24/01/2018
Cone (Pc)		Penetrometer (SPT)	8	Completion Date :	27/01/2018
Vane (V)		Disturbed (DS)	6	Bore Hole Diameter :	150mm / N.X.
		Water Sample (WS)	0	Level Of Ground :	908.800 M.
				Water Struck At :	
				Standing Water Level :	4.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown, silty clay / clayey silt with moorum. Observed calcareous nodules & sand mi.ture.	0.00m		DS-1	0.50
			DS-2	1.00
		12 14 19 — 33	SPT-1	1.50-1.95
			UDS-1	2.55-3.00
		16 16 27 — 43	SPT-2	3.00-3.45
			DS-3	4.00
		18 20 27 — 47	SPT-3	4.50-4.95
			DS-4	5.50
		17 19 29 — 48	SPT-4	6.00-6.45
			DS-5	7.00
		19 21 30 — 51	SPT-5	7.50-7.95
Very dense, brownish grey, silty sand. Observed decomposed rock.	8.00m		DS-6	8.50
		22 39 51 — 90	SPT-6	9.00-9.45
		100 4.0 cm Pentn. Refusal	*SPT-7	9.70-9.74
Slightly weathered to fresh, whitish grey, medium to coarse grained, slightly fractured rock.	9.90m	100 3.0 cm Pentn. Refusal	*SPT-8	9.90-9.93
		NX rotary drilling from 9.90m to 16.00m	R1	CR=64% RQD=60% (9.90 – 10.90)
			R2	CR=77% RQD=55% (10.90 – 11.90)
			R3	CR=89% RQD=85% (11.90 – 13.00)
			R4	CR=100% RQD=91% (13.00 – 14.50)
			R5	CR=100% RQD=93% (14.50 – 16.00)
N.B. — '*' means sample could not be recovered.	16.00m			

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : SKD	Created on : 31/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.56

Co-ordinates E=2181.294 N=1475.767

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date :	25/01/2018
Completion Date :	29/01/2018
Bore Hole Diameter :	150mm / N.X.
Level Of Ground :	910.400 M.
Water Struck At :	
Standing Water Level :	4.40 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Filled up with concrete.	0.00m – 0.60m		DS-1	0.50
Dense, reddish brown, silty sand.	0.60m – 3.00m		DS-2	1.00
		12 21 27 48	SPT-1	1.50-1.95
			DS-3	2.50
		100 Refusal 3.0 cm Pentn.	*SPT-2	2.80-2.83
Moderately weathered, light brownish grey, coarse grained, slightly fractured rock.	3.00m – 4.00m	100 Refusal 3.0 cm Pentn.	*SPT-3	3.00-3.03
		NX rotary drilling from 3.00m to 16.50m	R1	3.00–4.00 CR=50% RQD=35%
Moderately to slightly weathered / fresh, light brownish grey, coarse to medium grained, slightly fractured rock.	4.00m – 16.50m		R2	4.00–5.00 CR=60% RQD=40%
			R3	5.00–6.00 CR=73% RQD=42%
			R4	6.00–7.50 CR=89% RQD=81%
			R5	7.50–9.00 CR=84% RQD=78%
			R6	9.00–10.50 CR=86% RQD=84%
			R7	10.50–12.00 CR=85% RQD=79%
			R8	12.00–13.50 CR=92% RQD=84%
			R9	13.50–15.00 CR=100% RQD=95%
			R10	15.00–16.50 CR=100% RQD=96%

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.57

Co-ordinates E=2179.433 N=1346.843

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	6
		Water Sample (WS)	0

Commencement Date : 21/01/18
Completion Date : 31/01/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground :
Water Struck At :
Standing Water Level : 6.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Reddish brown, silty clay / clayey silt with sand mixture. Obs. boulder, moorum & rock fragments.	0.00m – 1.00m		DS–1	0.50
			DS–2	1.00
Hard, reddish brown, clayey silt with sand mi.ture. Obs. kankars.	1.00m – 3.00m	8 16 22 (38)	SPT–1	1.50–1.95
			DS–3	2.50
Dense to very dense, reddish brown to brownish grey, silty sand. Obs. kankars.	3.00m – 8.00m	12 18 23 (41)	SPT–2	3.00–3.45
			DS–4	4.00
		11 19 24 (43)	SPT–3	4.50–4.95
			DS–5	5.50
		15 21 29 (50)	SPT–4	6.00–6.45
			DS–6	7.00
		28 100 5.0 cm Penth. (≥100)	SPT–5	7.50–7.70
		100 4.0 cm Penth. Refusal	*SPT–6	7.80–7.84
Moderately weathered to fresh, whitish grey, coarse grained, slightly fractured rock.	8.00m – 16.50m	100 3.0 cm Penth. Refusal	*SPT–7	8.00–8.03
		NX rotary drilling from 8.00m to 16.50m	R1	CR=58% RQD=10% (8.00–9.00)
			R2	CR=63% RQD=42% (9.00–10.00)
			R3	CR=75% RQD=60% (10.00–11.00)
			R4	CR=83% RQD=58% (11.00–12.00)
			R5	CR=84% RQD=70% (12.00–13.50)
			R6	CR=100% RQD=95% (13.50–15.00)
			R7	CR=100% RQD=94% (15.00–16.50)

N.B. – '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 29/01/2018**	**Sheet No:**

BORE LOG DATA SHEET	BORE HOLE NO.58	Co-ordinates E=2160.318 N=1236.302

Field Test	Nos	Samples	Nos	
Penetrometer (SPT)	5	Undisturbed (UDS)	1	Commencement Date : 23/01/18
Cone (Pc)		Penetrometer (SPT)	5	Completion Date : 25/01/18
Vane (V)		Disturbed (DS)	3	Bore Hole Diameter : 150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground : 908.833 M.
				Water Struck At :
				Standing Water Level : 4.80 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Hard, reddish brown, silty clay with sand mi.ture / clayey silty sand. Obs. moorum & decomposed rock.	0.00m. – 4.50m.		DS-1	0.50
		11 19 20 — 39	SPT-1	1.00-1.45
			DS-2	2.00
			*UDS-1	2.50-2.66
		18 24 27 — 51	SPT-2	3.00-3.45
			DS-3	4.00
Very dense, reddish brown, clayey silty sand.	4.50m. – 5.00m.	27 52 41 — ≥100, 3.0 cm Pentn.	SPT-3	4.56-4.89
		100 — Refusal, 3.0 cm Pentn.	*SPT-4	4.90-4.93
		100 — Refusal, 2.0 cm Pentn.	*SPT-5	5.00-5.02
Fresh, light brownish grey to whitish grey, medium to coarse grained, highly to moderately fractured ock.	5.00m. – 9.00m.	NX rotary drilling from 5.00m to 9.00m	R1	CR=80% RQD=55% (5.00 – 6.00)
			R2	CR=100% RQD=92% (6.00 – 7.50)
			R3	CR=100% RQD=94% (7.50 – 9.00)

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.59

Co-ordinates E=2159.328 N=1117.064

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	4	Undisturbed (UDS)	1	Commencement Date :	19/01/18
Cone (Pc)		Penetrometer (SPT)	4	Completion Date :	23/01/18
Vane (V)		Disturbed (DS)	4	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	913.592 M.
				Water Struck At :	
				Standing Water Level :	4.20 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Hard, reddish brown, silty clay / clayey silt with sand mi.ture & moorum.	0.00m		DS-1	0.50
			DS-2	1.00
		10 18 19 — 37	SPT-1	1.50-1.95
			DS-3	2.50
			*UDS-1	3.00-3.15
		22 30 39 — 69	SPT-2	3.40-3.85
			DS-4	4.40
		100 Refusal 4.0 cm Pentn.	*SPT-3	4.80-4.84
Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	5.00m	100 Refusal 3.0 cm Pentn.	*SPT-4	5.00-5.03
		NX rotary drilling from 5.00m to 11.00m	R1	5.00–6.00 CR=62% RQD=34%
			R2	6.00–7.00 CR=75% RQD=58%
Fresh, light brownish grey to whitish grey, medium to coarse grained, slightly fractured rock.	7.00m		R3	7.00–8.00 CR=92% RQD=86%
			R4	8.00–9.50 CR=100% RQD=95%
			R5	9.50–11.00 CR=100% RQD=96%
	11.00m			

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.60

Co-ordinates E=2014.777 N=1118.306

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	0	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	0
Vane (V)		Disturbed (DS)	0
		Water Sample (WS)	0

Commencement Date : 16/01/18
Completion Date : 19/01/18
Bore Hole Diameter : 150mm / N.X.
Level Of Ground : 921.400 M.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m – 2.00m: Moderately weathered, light brownish grey, medium to coarse grained, highly fractured rock. Obs. rigid pavement made of reinforced concreate up to 0.15m.		NX rotary drilling from 0.00m to 13.00m	R1	0.00–1.00 CR=41% RQD=NIL
			R2	1.00–2.00 CR=48% RQD=NIL
2.00m – 6.00m: Moderately to slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.			R3	2.00–3.00 CR=55% RQD=24%
			R4	3.00–4.50 CR=66% RQD=57%
			R5	4.50–6.00 CR=73% RQD=61%
6.00m – 13.00m: Fresh, light brownish grey, medium to coarse grained, moderately to slighlty fractured rock.			R6	6.00–7.50 CR=82% RQD=65%
			R7	7.50–9.00 CR=92% RQD=80%
			R8	9.00–10.00 CR=98% RQD=90%
			R9	10.00–12.50 CR=100% RQD=94%
			R10	12.50–13.00 CR=100% RQD=95%

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 25/01/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.61	Co-ordinates E=1977.133 N=1111.988

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	0	Undisturbed (UDS)	0	Commencement Date :	14/01/18
Cone (Pc)		Penetrometer (SPT)	0	Completion Date :	20/01/18
Vane (V)		Disturbed (DS)	0	Bore Hole Diameter :	150mm / N.X.
		Water Sample (WS)	0	Level Of Ground :	918.420 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)	
0.00m.		NX rotary drilling from 0.00m to 9.00m			0.00
Moderately weathered, whitish grey, coarse grained, moderately fractured rock.			R1	CR=49% RQD=36%	
1.00m.					1.00
			R2	CR=66% RQD=38%	
					2.00
			R3	CR=73% RQD=47%	
					3.00
Moderately weathered / fresh, whitish grey, coarse grained, moderately fractured rock			R4	CR=80% RQD=64%	
					4.50
			R5	CR=90% RQD=81%	
					6.00
			R6	CR=100% RQD=93%	
					7.50
			R7	CR=100% RQD=94%	
9.00m.					9.00

BH-61/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095 | **Created by : Chandrani** | **Created on : 25/01/2018** | **Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.62

Co-ordinates E=1976.292 N=1082.838

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	0	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	0
Vane (V)		Disturbed (DS)	0
		Water Sample (WS)	0

Commencement Date : 11/01/18
Completion Date : 15/01/18
Bore Hole Diameter : 150mm / N.X.
Level Of Ground : 918.790 M.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Slightly weathered, light browish grey to whitish grey, medium to coarse grained moderately fractured rock. 6.50m.		NX rotary drilling from 0.00m to 12.50m	R1	CR=65% RQD=54% (0.00 – 1.00)
			R2	CR=72% RQD=60% (1.00 – 2.00)
			R3	CR=77% RQD=69% (2.00 – 3.50)
			R4	CR=76% RQD=53% (3.50 – 5.00)
			R5	CR=74% RQD=65% (5.00 – 6.50)
Fresh, light brownish grey to whitish grey, moderately to slightly weathered, fractured rock. 12.50m.			R6	CR=60% RQD=75% (6.50 – 8.00)
			R7	CR=88% RQD=83% (8.00 – 9.50)
			R8	CR=100% RQD=93% (9.50 – 11.00)
			R9	CR=100% RQD=96% (11.00 – 12.50)

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 24/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.63

Co-ordinates E=2028.209 N=1082.909

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	0	Undisturbed (UDS)	0	Commencement Date :	11/01/18
Cone (Pc)		Penetrometer (SPT)	0	Completion Date :	13/01/18
Vane (V)		Disturbed (DS)	0	Bore Hole Diameter :	150mm / N.X.
		Water Sample (WS)	0	Level Of Ground :	923.170 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Slightly weathered, light brownish grey to whitish grey, medium to coarse grained, moderately fractured rock. 11.00m.		NX rotary drilling from 0.00m to 17.00m	R1	0.00 – 1.00 CR=63% RQD=47%
			R2	1.00 – 2.00 CR=65% RQD=50%
			R3	2.00 – 3.50 CR=68% RQD=59%
			R4	3.50 – 5.00 CR=74% RQD=54%
			R5	5.00 – 6.50 CR=76% RQD=62%
			R6	6.50 – 8.00 CR=70% RQD=63%
			R7	8.00 – 9.50 CR=75% RQD=60%
			R8	9.50 – 11.00 CR=71% RQD=53%
Fresh, light brownish grey to whitish grey, medium to coarse grained, moderately to slightly weathered fractured rock. 17.00m.			R9	11.00 – 12.50 CR=81% RQD=68%
			R10	12.50 – 14.00 CR=92% RQD=85%
			R11	14.00 – 15.50 CR=100% RQD=92%
			R12	15.50 – 17.00 CR=100% RQD=97%

BH-63/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 24/01/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.64	Co-ordinates E=2051.470 N=1086.474

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	2	Undisturbed (UDS)	0	Commencement Date :	10/01/18
Cone (Pc)		Penetrometer (SPT)	2	Completion Date :	12/01/18
Vane (V)		Disturbed (DS)	1	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	920.240 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Filled up soil consists of moorum, brick bats, soda ash & construction garbage.	0.00m. – 0.50m.	100 Refusal 3.0 cm Pentn.; 100 Refusal 2.0 cm Pentn.	DS-1 *SPT-1 *SPT-2	0.20 0.30-0.33 0.50-0.52
Slightly weathered, light brownish grey to whitish grey, medium to coarse grained, moderately fractured rock.	0.50m. – 4.50m.	NX rotary drilling from 0.50m to 16.50m	R1	CR=61% RQD=30% (0.50–1.50)
			R2	CR=77% RQD=62% (1.50–3.00)
			R3	CR=79% RQD=74% (3.00–4.50)
Fresh, light brownish grey to whitish grey, medium to coarse grained, slightly fractured rock.	4.50m. – 16.50m.		R4	CR=82% RQD=78% (4.50–6.00)
			R5	CR=92% RQD=81% (6.00–7.50)
			R6	CR=90% RQD=86% (7.50–9.00)
			R7	CR=94% RQD=90% (9.00–10.50)
			R8	CR=98% RQD=95% (10.50–12.00)
			R9	CR=99% RQD=96% (12.00–13.50)
			R10	CR=100% RQD=98% (13.50–15.00)
			R11	CR=100% RQD=96% (15.00–16.50)

N.B. — '*' means sample could not be recovered.

BH-64/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. **CETEST**

Job No : 4095	Created by : Chandrani	Created on : 29/01/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.65

Co-ordinates E=1958.170 N=1047.392

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	7
		Water Sample (WS)	0

Commencement Date :	13/01/18
Completion Date :	25/01/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	917.947 M.
Water Struck At :	
Standing Water Level :	Not found

Depth	DESCRIPTION	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m–3.50m	Very stiff, reddish brown, clayey silt with kankars. Obs. sand mixture.			DS-1	0.50
				DS-2	1.00
		8 8 12	20	SPT-1	1.50-1.95
				DS-3	2.50
		10 12 16	28	SPT-2	3.00-3.45
3.50m–8.00m	Hard, reddish brown, clayey silt with kankars. Obs. sand mixture.			UDS-1	3.60-4.05
		11 16 19	35	SPT-3	4.05-4.50
				DS-4	5.00
		13 19 22	41	SPT-4	5.50-5.95
				DS-5	6.50
		15 28 39	67	SPT-5	7.00-7.45
8.00m–11.00m	Very dense, light reddish brown, clayey silty sand with decomposed rock.			DS-6	8.00
		18 34 62	96	SPT-6	8.50-8.95
				DS-7	9.50
		100 — 5.0 cm Penth.	Refusal	*SPT-7	10.00-10.05
11.00m		100 — 4.0 cm Penth.	Refusal	*SPT-8	11.00-11.04
11.00m–13.00m	Highly to moderately weathered, light brownish grey to whitish grey, coarse to medium grained, fractured rock.	NX rotary drilling from 11.00m to 19.00m		R1	11.00–12.00 CR=35% RQD=20%
				R2	12.00–13.00 CR=41% RQD=10%
13.00m–19.00m	Slightly weathered to fresh, light brownish grey / whitish grey, coarse to medium grained, fractured rock.			R3	13.00–14.00 CR=58% RQD=55%
				R4	14.00–15.00 CR=73% RQD=50%
				R5	15.00–16.00 CR=83% RQD=67%
				R6	16.00–17.50 CR=100% RQD=99%
				R7	17.50–19.00 CR=100% RQD=97%
19.00m					

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	CETEST

Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.66	Co-ordinates E=1952.769 N=923.664

Field Test	Nos	Samples	Nos		
				Commencement Date :	01/02/18
				Completion Date :	03/02/18
Penetrometer (SPT)	3	Undisturbed (UDS)	0	Bore Hole Diameter :	150 mm. / N.X.
Cone (Pc)		Penetrometer (SPT)	3	Level Of Ground :	920.070 M.
		Disturbed (DS)	3	Water Struck At :	
Vane (V)		Water Sample (WS)	0	Standing Water Level :	Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)	Core run (m)
	0.00m				
Filled up soil consists of boulder & moorum.			DS-1	0.50	
			DS-2	1.00	
		2, 4, 8 — 12	SPT-1	1.50-1.95	
	2.50m		DS-3	2.50	
Very dense, reddish brown, clayey silty sand with decomposed rock.		100 — Refusal 4.0 cm Penth.	*SPT-2	3.00-3.04	
	3.10m	100 — Refusal 3.0 cm Penth.	*SPT-3	3.10-3.13	3.10
Highly to moderately weathered, whitish grey, medium grained, fractured rock.		NX rotary drilling from 3.10m to 15.50m	R1	CR=37% RQD=13%	4.10
			R2	CR=39% RQD=19%	5.10
			R3	CR=46% RQD=31%	6.10
			R4	CR=45% RQD=19%	7.10
	7.10m				
Slightly weathered to fresh, whitish grey, coarse grained, slightly fractured rock.			R5	CR=60% RQD=36%	8.10
			R6	CR=67% RQD=37%	9.50
			R7	CR=62% RQD=56%	11.00
			R8	CR=80% RQD=70%	12.50
			R9	CR=100% RQD=98%	14.00
			R10	CR=100% RQD=96%	15.50
	15.50m				

N.B. — '*' means sample could not be recovered.

BH-66/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/02/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.67

Co-ordinates E=1961.774 N=722.427

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	2	Commencement Date :	27/01/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	30/01/18
Vane (V)		Disturbed (DS)	4	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	917.947 m.
				Water Struck At :	
				Standing Water Level :	8.50 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
Very stiff, reddish brown, silty clay / clayey silt with sand mi.ture. Obs. moorum.	0.00m				DS-1	0.50
					DS-2	1.00
			6 9 14	23	SPT-1	1.50-1.95
					UDS-1	2.50-2.95
			9 12 17	29	SPT-2	3.10-3.55
					DS-3	4.00
Hard, reddish brown, silty clay / clayey silt with sand mi.ture & moorum. Obs. decomposed rock.	4.50m		11 16 19	35	SPT-3	4.50-4.95
					UDS-2	5.50-5.95
			12 18 22	40	SPT-4	6.10-6.55
					DS-4	7.00
			14 21 26	47	SPT-5	7.50-7.95
			100	Refusal 3.0 cm Pentn.	*SPT-6	8.20-8.23
Slightly weathered, light brownish grey, medium to coarse grained, highly to moderately fractured rock.	8.30m		100	Refusal 2.0 cm Pentn.	*SPT-7	8.30-8.32
			NX rotary drilling from 8.30m to 13.00m		R1	8.30 – 9.80 CR=61% RQD=39%
Fresh, light brownish grey, medium to fine grained, moderately fractured rock.	9.80m				R2	9.80 – 11.30 CR=100% RQD=91%
					R3	11.30 – 13.00 CR=100% RQD=94%
	13.00m					

N.B. — '*' means sample could not be recovered.

BH-67/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.68

Co-ordinates E=2003.705 N=720.664

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	9	Undisturbed (UDS)	2	Commencement Date :	30/01/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date :	01/02/18
Vane (V)		Disturbed (DS)	7	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	906.844 M
				Water Struck At :	
				Standing Water Level :	10.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Depth (m)
Very stiff, reddish brown, silty clay / clayey silt with sand mi.ture & moorum.	0.00m			DS-1	0.50
				DS-2	1.00
		6 10 15	25	SPT-1	1.50-1.95
				DS-3	2.50
		8 12 17	29	SPT-2	3.00-3.45
				UDS-1	4.00-4.45
Hard, reddish brown to yellowish brwon, silty clay / clayey silt with sand mixture & moorum. Obs. decomposed rock.	4.55m	10 14 19	33	SPT-3	4.55-5.00
				DS-4	5.50
		13 20 25	45	SPT-4	6.00-6.45
				*UDS-2	7.50-7.59
		14 21 28	49	SPT-5	7.70-8.15
				DS-5	9.00
		15 22 30	52	SPT-6	9.50-9.95
				DS-6	10.50
		18 30 37	67	SPT-7	11.00-11.45
				DS-7	12.00
		100 2.0 cm Penth.	Refusal	*SPT-8	13.40-13.42
Slightly weathered to fresh, light brownish grey to whitish grey, medium to coarse grained, moderately fractured rock.	13.50m	100 2.0 cm Penth.	Refusal	*SPT-9	13.50-13.52
		NX rotary drilling from 13.50m to 18.00m		R1	CR=76%/RQD=26% (13.50-14.00)
				R2	CR=91% RQD=63% (14.00-15.00)
				R3	CR=100% RQD=94% (15.00-16.50)
				R4	CR=100% RQD=96% (16.50-18.00)
	18.00m				

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 14/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.69

Co-ordinates E=2003.306 N=537.241

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 01/02/18
Completion Date : 05/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 898.601 M
Water Struck At :
Standing Water Level : 3.30 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very stiff, reddish brown, silty clay with moorum.			DS-1	0.50
			DS-2	1.00
		4 8 12 — 20	SPT-1	1.50-1.95
			UDS-1	2.50-2.95
		6 10 14 — 24	SPT-2	2.95-3.40
			DS-3	4.00
4.95m.		10 12 18 — 30	SPT-3	4.50-4.95
Hard, reddish brown, silty clay with moorum.			UDS-2	5.50-5.95
		12 18 23 — 41	SPT-4	5.95-6.40
			DS-4	7.00
		14 20 27 — 47	SPT-5	7.50-7.95
			*UDS-3	8.50-8.60
		19 27 36 — 63	SPT-6	9.00-9.45
10.00m.			DS-5	10.00
Very dense, whitish grey, silty sand with decomposed rock.		100 Refusal 3.0 cm Pentn.	*SPT-7	10.50-10.53
11.00m.		100 Refusal 2.0 cm Pentn.	*SPT-8	11.00-11.02
Moderately weathered to fresh, whitish grey, medium grained, fractured rock.		NX rotary drilling from 11.00m to 18.00m	R1	11.00 – 12.00 CR=46% RQD=10%
			R2	12.00 – 13.00 CR=45% RQD=NIL
13.00m. Moderately weathered to fresh, whitish grey, medium grained, slightly fractured rock.			R3	13.00 – 14.00 CR=55% RQD=NIL
			R4	14.00 – 15.00 CR=76% RQD=NIL
			R5	15.00 – 16.50 CR=100% RQD=93%
18.00m.			R6	16.50 – 18.00 CR=100% RQD=94%

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.		CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 14/02/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.70

Co-ordinates E=1909.697 N=459.667

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 06/02/18
Completion Date : 09/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 902.624 M.
Water Struck At :
Standing Water Level : 5.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Very stiff, reddish brown, silty clay with moorum.	0.00m		DS-1	0.50
			DS-2	1.00
	1.95m	6 8 18 — 26	SPT-1	1.50-1.95
Hard, reddish brown, silty clay with moorum.			UDS-1	2.50-2.95
		8 19 26 — 45	SPT-2	2.95-3.40
			DS-3	4.00
		12 24 29 — 53	SPT-3	4.50-4.95
			DS-4	5.50
	6.00m	14 30 38 — 68	SPT-4	6.00-6.45
Very dense, whitish grey, silty sand with decomposed rock.			DS-5	7.00
		100 Refusal 3.0 cm Pentn.	*SPT-5	7.30-7.33
	7.50m	100 Refusal 2.0 cm Pentn.	*SPT-6	7.50-7.52
Highly to moderately weathered, whitish grey, medium grained, highly to moderately fractured rock.		NX rotary drilling from 7.50m to 15.00m	R1	CR=30% RQD=NIL (7.50-8.00)
			R2	CR=35% RQD=24% (8.00-9.00)
			R3	CR=42% RQD=15% (9.00-10.00)
	11.00m		R4	CR=46% RQD=40% (10.00-11.00)
Slightly weathered to fresh, whitish grey, medium grained, slightly fractrured rock.			R5	CR=62% RQD=56% (11.00-12.00)
			R6	CR=100% RQD=92% (12.00-13.50)
	15.00m		R7	CR=100% RQD=93% (13.50-15.00)

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.71

Co-ordinates E=1878.984 N=406.758

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date	:	15/02/18
Completion Date	:	19/02/18
Bore Hole Diameter	:	150 mm. / N.X.
Level Of Ground	:	906.105 M.
Water Struck At	:	
Standing Water Level	:	3.90 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Very stiff, reddish brown, silty clay with moorum.	0.00m. – 2.50m.		DS-1	0.50
			DS-2	1.00
		10 12 18 — 30	SPT-1	1.50-1.95
Dense, reddish brown, silty sand with traces of mica.	2.50m. – 4.00m.		DS-3	2.50
		16 20 27 — 47	SPT-2	3.00-3.45
Very dense, light grey, silty sand with decomposed rock.	4.00m. – 4.60m.		DS-4	4.00
		100 4.0 cm Pentn. Refusal	*SPT-3	4.50-4.54
		100 3.0 cm Pentn. Refusal	*SPT-4	4.60-4.63
Highly to moderately weathered, whitish grey, medium grained, fractured rock.	4.60m. – 7.60m.	NX rotary drilling from 4.60m to 12.60m	R1	CR=30% RQD=NIL 4.60 – 5.60
			R2	CR=32% RQD=18% 5.60 – 6.60
			R3	CR=42% RQD=39% 6.60 – 7.60
Fresh, whitish grey, medium grained, slightly fractured rock.	7.60m. – 12.60m.		R4	CR=54% RQD=50% 7.60 – 8.60
			R5	CR=80% RQD=70% 8.60 – 9.60
			R6	CR=100% RQD=95% 9.60 – 11.10
			R7	CR=100% RQD=94% 11.10 – 12.60

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 03/03/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.72

Co-ordinates E=1420.073 N=466.705

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 15/02/18
Completion Date : 17/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 959.753 M.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Hard, reddish brown, silty clay with decomposed rock.	0.00m – 2.10m		DS-1	0.50
			DS-2	1.00
		20 42 50 (≥100) 3.0 cm Pentn.	SPT-1	1.50-1.83
		100 Refusal 4.0 cm Pentn.	*SPT-2	2.00-2.04
		100 Refusal 3.0 cm Pentn.	*SPT-3	2.10-2.13
Highly weathered, reddish brown, medium grained, fractured rock.	2.10m – 15.10m	NX rotary drilling from 2.10m to 19.10m	R1	2.10-3.10 CR=24% RQD=19%
			R2	3.10-4.10 CR=26% RQD=NIL
			R3	4.10-5.10 CR=28% RQD=NIL
			R4	5.10-6.10 CR=30% RQD=NIL
			R5	6.10-7.10 CR=25% RQD=NIL
			R6	7.10-8.10 CR=26% RQD=NIL
			R7	8.10-9.10 CR=25% RQD=NIL
			R8	9.10-10.10 CR=29% RQD=NIL
			R9	10.10-11.10 CR=30% RQD=NIL
			R10	11.10-12.10 CR=32% RQD=NIL
			R11	12.10-13.10 CR=36% RQD=NIL
			R12	13.10-14.10 CR=39% RQD=NIL
			R13	14.10-15.10 CR=50% RQD=NIL
Slightly weathered to fresh, reddish brown, slightly fractured rock.	15.10m – 19.10m		R14	15.10-16.10 CR=78% RQD=NIL
			R15	16.10-17.60 CR=100% RQD=94%
			R16	17.60-19.10 CR=100% RQD=95%

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.73

Co-ordinates E=1457.693 N=515.175

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	6	Undisturbed (UDS)	0	Commencement Date :	12/02/18
Cone (Pc)		Penetrometer (SPT)	6	Completion Date :	15/02/18
Vane (V)		Disturbed (DS)	6	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	956.326 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Filled up soil consists of road meterial with pcc.	0.00m – 1.00m			DS-1	0.50
				DS-2	1.00
Hard, reddish brown, silty clay with moorum & boulder.	1.00m – 7.50m		14 18 22 — 40	SPT-1	1.50-1.95
				DS-3	2.50
			16 22 28 — 50	SPT-2	3.00-3.45
				DS-4	4.00
			20 26 27 — 53	SPT-3	4.50-4.95
				DS-5	5.50
			19 36 50 — ≥100; 6.0 cm Pentn.	SPT-4	6.00-6.36
				DS-6	7.00
			100 — Refusal; 3.0 cm Pentn.	*SPT-5	7.40-7.43
Highly weathered, reddish brown, medium grained, fractured rock.	7.50m – 12.50m		100 — Refusal; 2.0 cm Pentn.	*SPT-6	7.50-7.52
			NX rotary drilling from 7.50m to 16.50m	R1	7.50 – 8.50; CR=24% RQD=NIL
				R2	8.50 – 9.50; CR=26% RQD=NIL
				R3	9.50 – 10.50; CR=29% RQD=NIL
				R4	10.50 – 11.50; CR=36% RQD=NIL
				R5	11.50 – 12.50; CR=40% RQD=25%
Slightly weathered to fresh, reddish brown, coarse grained, slightly fractured rock.	12.50m – 16.50m			R6	12.50 – 13.50; CR=76% RQD=60%
				R7	13.50 – 15.00; CR=100% RQD=93%
				R8	15.00 – 16.50; CR=100% RQD=94%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.74

Co-ordinates E=1562.210 N=632.905

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 17/02/18
Completion Date : 21/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 921.108 M
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Hard, reddish brown, silty clay with decomposed rock.	0.00m – 2.10m		DS-1	0.50
			DS-2	1.00
		26 39 50 ≥100	SPT-1	1.50-1.86
		100 — 6.0 cm Pentn. Refusal	*SPT-2	2.00-2.04
		100 — 4.0 cm Pentn. Refusal	*SPT-3	2.10-2.13
Highly to moderaely weathered, reddish brown, medium grained, fractured rock.	2.10m – 12.10m	3.0 cm Pentn.	R1	2.10–3.10 CR=28% RQD=NIL
		NX rotary drilling from 2.10m to 17.10m	R2	3.10–4.10 CR=25% RQD=NIL
			R3	4.10–5.10 CR=26% RQD=NIL
			R4	5.10–6.10 CR=28% RQD=NIL
			R5	6.10–7.10 CR=26% RQD=12%
			R6	7.10–8.10 CR=24% RQD=NIL
			R7	8.10–9.10 CR=45% RQD=NIL
			R8	9.10–10.10 CR=39% RQD=NIL
			R9	10.10–11.10 CR=38% RQD=NIL
			R10	11.10–12.10 CR=36% RQD=13%
Slightly weathered / fresh, reddish brown, medium grained, slightly fractured rock.	12.10m – 17.10m		R11	12.10–13.10 CR=62% RQD=NIL
			R12	13.10–14.10 CR=72% RQD=NIL
			R13	14.10–15.60 CR=100% RQD=94%
			R14	15.60–17.10 CR=100% RQD=92%

N.B. — '*' means sample could not be recovered.

BH-74/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.75

Co-ordinates E=1498.876 N=668.828

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date :	20/02/18
Completion Date :	22/02/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	919.815 M
Water Struck At :	
Standing Water Level :	Not found

Depth	DESCRIPTION	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m–4.50m	Hard, reddish brown, silty clay with moourm & boulder.		DS-1	0.50
			DS-2	1.00
		6, 20, 22 — 42	SPT-1	1.50-1.95
			*UDS-1	2.50-2.60
		10, 22, 28 — 50	SPT-2	2.95-3.40
			DS-3	4.00
4.50m–5.10m	Hard, yellowish grey, silty clay with decomposed rock.	30, 39, 50 — ≥100, 6.0 cm Pentn.	SPT-3	4.50-4.86
		100 Refusal 4.0 cm Pentn.	*SPT-4	5.00-5.04
		100 Refusal 3.0 cm Pentn.	*SPT-5	5.10-5.13
5.10m–13.10m	Highly weathered, reddish brown, medium grained, fractured rock.	NX rotary drilling from 5.10m to 19.60m	R1	5.10–6.10 CR=26% RQD=NIL
			R2	6.10–7.10 CR=29% RQD=NIL
			R3	7.10–8.10 CR=24% RQD=NIL
			R4	8.10–9.10 CR=28% RQD=NIL
			R5	9.10–10.10 CR=30% RQD=NIL
			R6	10.10–11.10 CR=32% RQD=NIL
			R7	11.10–12.10 CR=27% RQD=NIL
			R8	12.10–13.10 CR=33% RQD=NIL
13.10m–19.60m	Moderarely weathered / fresh, reddish brown, medium grained, slightly fractured rock.		R9	13.10–14.10 CR=56% RQD=NIL
			R10	14.10–15.10 CR=74% RQD=NIL
			R11	15.10–16.60 CR=79% RQD=25%
			R12	16.60–18.10 CR=100% RQD=93%
			R13	18.10–19.60 CR=100% RQD=95%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.76

Co-ordinates E=1507.410 N=632.705

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 22/02/18
Completion Date : 24/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 921.816 M
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Hard, reddish brown, silty clay with decomposed rock.	0.00m. – 1.10m.		DS-1	0.50
		100 Refusal 4.0 cm Pentn.	*SPT-1	1.00-1.04
		100 Refusal 3.0 cm Pentn.	*SPT-2	1.10-1.13
Highly to moderately weathered, light reddish brown, medium grained, fractured rock.	1.10m. – 16.10m.	NX rotary drilling from 1.10m to 20.10m	R1	1.10 – 2.10, CR=24% RQD=NIL
			R2	2.10 – 3.10, CR=26% RQD=NIL
			R3	3.10 – 4.10, CR=23% RQD=NIL
			R4	4.10 – 5.10, CR=28% RQD=NIL
			R5	5.10 – 6.10, CR=33% RQD=12%
			R6	6.10 – 7.10, CR=29% RQD=NIL
			R7	7.10 – 8.10, CR=30% RQD=NIL
			R8	8.10 – 9.10, CR=35% RQD=NIL
			R9	9.10 – 10.10, CR=32% RQD=NIL
			R10	10.10 – 11.10, CR=28% RQD=NIL
			R11	11.10 – 12.10, CR=30% RQD=NIL
			R12	12.10 – 13.10, CR=34% RQD=NIL
			R13	13.10 – 14.10, CR=37% RQD=NIL
			R14	14.10 – 15.10, CR=36% RQD=12%
			R15	15.10 – 16.10, CR=45% RQD=10%
Slightly weathered / fresh, light reddish brown, medium grained, fractured rock.	16.10m. – 20.10m.		R16	16.10 – 17.10, CR=76% RQD=NIL
			R17	17.10 – 18.60, CR=100% RQD=92%
			R18	18.60 – 20.10, CR=100% RQD=93%

N.B. — '*' means sample could not be recovered.

BH-76/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.81

Co-ordinates E=648.006 N=584.563

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	6
		Water Sample (WS)	0

Commencement Date : 16/02/18
Completion Date : 17/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 893.442 M.
Water Struck At :
Standing Water Level : 4.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	Ref. No	Depth (m)
Filled up soil consists of brownish grey, grey, sandy silt with clay. Obs. calcareous nodules.	0.00m – 1.30m		DS-1	0.50
			DS-2	1.00
Stiff, light yellowish brown, silty clay. Obs. sand.	1.30m – 3.00m	4 6 8 (14)	SPT-1	1.50-1.95
			DS-3	2.50
Hard, reddish brown / yellowish brown, clayey silt with sand mixture & decomposed rock fragments.	3.00m – 7.50m		*UDS-1	3.00-3.45
		9 14 22 (36)	SPT-2	3.60-4.05
			DS-4	4.50
		9 14 24 (38)	SPT-3	5.00-5.45
			DS-5	6.00
		13 19 37 (56)	SPT-4	6.50-6.95
Very dense, brownish grey, silty sand with decomposed & disintegrated rock fragments. Obs. black spots.	7.50m – 8.00m		DS-6	7.50
		31 52 (≥100) 4.0 cm Pentn.	SPT-5	8.00-8.19
Highly weathered, whitish grey / greyish, fine to medium grained, fractured rock.	8.00m – 9.00m		R1	8.00 – 9.00 CR=24% RQD=NIL
Highly to moderately weathered, whitish grey / greyish, fine to medium grained, fractured rock. Obs. yellowish to blackish spots.	9.00m – 16.00m	NX rotary drilling from 8.00m to 20.00m	R2	9.00 – 10.00 CR=41% RQD=34%
			R3	10.00 – 11.00 CR=30% RQD=20%
			R4	11.00 – 12.00 CR=31% RQD=20%
			R5	12.00 – 13.00 CR=32% RQD=19%
			R6	13.00 – 14.00 CR=33% RQD=22%
			R7	14.00 – 15.00 CR=57% RQD=34%
			R8	15.00 – 16.00 CR=48% RQD=34%
Slightly weathered to fresh, grey, medium to coarse grained, slightly fractured rock. Obs. blackish spots & water stain.	16.00m – 20.00m		R9	16.00 – 17.00 CR=62% RQD=24%
			R10	17.00 – 18.50 CR=100% RQD=92%
			R11	18.50 – 20.00 CR=100% RQD=93%

N.B. — '*' means sample could not be recovered.

BH-81/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.82

Co-ordinates E=671.754 N=655.301

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	11	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	11
Vane (V)		Disturbed (DS)	10
		Water Sample (WS)	0

Commencement Date : 13/02/18
Completion Date : 15/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 891.785 M.
Water Struck At :
Standing Water Level : 3.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)			N	SAMPLES Ref. No	Depth (m)
0.00m. Filled up soil consists of ash, boulder, gravels & moorum.						DS-1	0.50
						DS-2	1.00
		2	4	5	9	SPT-1	1.50-1.95
						DS-3	2.50
		3	3	4	7	SPT-2	3.00-3.45
						DS-4	4.00
						*UDS-1	4.50-4.95
		2	4	2	6	SPT-3	5.20-5.65
						DS-5	6.00
6.50m. Very stiff, reddish brown, silty clay / clayey with moorum. Obs. kankars.		4	7	9	16	SPT-4	6.50-6.95
						DS-6	7.50
		5	7	11	18	SPT-5	8.00-8.45
						DS-7	9.00
						UDS-2	9.50-9.95
		7	10	14	24	SPT-6	10.10-10.55
11.00m. Hard, reddish brown, silty clay / clayey with moorum. Obs. kankars.						DS-8	11.00
		10	13	20	33	SPT-7	12.00-12.45
13.00m.						DS-9	13.00

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.82

Co-ordinates E=671.754 N=655.301

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	11	Undisturbed (UDS)	2	Commencement Date :	13/02/18
Cone (Pc)		Penetrometer (SPT)	11	Completion Date :	15/02/18
Vane (V)		Disturbed (DS)	10	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	891.785 M.
				Water Struck At :	
				Standing Water Level :	3.90 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown, silty clay / clayey with moorum. Obs. kankars.	13.00m. – 13.50m.			
Very dense, whitish grey / blackish grey, silty sand with decomposed rock.	13.50m. – 16.00m.	15 28 36 (64)	SPT-8	13.50–13.95
			DS-10	14.50
		16 30 39 (69)	SPT-9	15.00–15.45
		100 Refusal 3.0 cm Penth.	*SPT-10	15.85–15.88
		100 Refusal 2.0 cm Penth.	*SPT-11	16.00–16.02
Highly to moderately weathered, light blackish grey, medium to coarse grained, moderately fractured rock.	16.00m. – 19.00m.	NX rotary drilling from 16.00m to 25.00m	R1	16.00–17.00 CR=37% RQD=23%
			R2	17.00–18.00 CR=45% RQD=31%
			R3	18.00–19.00 CR=49% RQD=30%
Slightly weathered to fresh, light blackish grey, medium to coarse grained, slightly fractured rock	19.00m. – 25.00m.		R4	19.00–20.00 CR=51% RQD=50%
			R5	20.00–21.00 CR=70% RQD=64%
			R6	21.00–22.00 CR=85% RQD=68%
			R7	22.00–23.50 CR=100% RQD=95%
			R8	23.50–25.00 CR=100% RQD=98%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.				CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018		Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.85

Co-ordinates E=691.854 N=721.598

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	13	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	13
Vane (V)		Disturbed (DS)	11
		Water Sample (WS)	0

Commencement Date : 18/02/18
Completion Date : 20/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 892.139 M.
Water Struck At :
Standing Water Level : 12.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	SAMPLES Ref. No	Depth (m)
Stiff to very stiff, reddish brown, silty clay / clayey silt. Obs. kankars.	0.00m					DS-1	0.50
		3	4	7	11	SPT-1	1.00-1.45
						DS-2	2.00
						UDS-1	2.50-2.95
		4	6	9	15	SPT-2	2.95-3.40
						DS-3	4.00
		3	5	5	10	SPT-3	4.50-4.95
						*UDS-2	5.50-5.95
		5	6	12	18	SPT-4	6.10-6.55
						DS-4	7.00
		6	9	14	23	SPT-5	7.50-7.95
Hard, brownish grey, silty clay with traces of sand. Obs. black spots.	8.50m					DS-5	8.50
		7	11	24	35	SPT-6	9.00-9.45
						DS-6	10.00
		7	13	23	36	SPT-7	10.50-10.95
						DS-7	11.50
		8	17	26	43	SPT-8	12.00-12.45
						DS-8	13.00
		11	21	29	50	SPT-9	13.50-13.95
						DS-9	14.50
		13	23	34	57	SPT-10	15.00-15.45
						DS-10	16.00
	16.50m						

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.		CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.85

Co-ordinates E=691.854 N=721.598

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	13	Undisturbed (UDS)	2	Commencement Date :	18/02/18
Cone (Pc)		Penetrometer (SPT)	13	Completion Date :	20/02/18
Vane (V)		Disturbed (DS)	11	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	892.139 M.
				Water Struck At :	
				Standing Water Level :	12.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
16.50m. Hard, brownish grey, silty clay with traces of sand. Obs. black spots.		17 29 38 <u>67</u>	SPT-11	16.50-16.95
		Refusal	DS-11	17.50
		78 5.0 cm Penth.	*SPT-12	17.80-17.85
18.00m. Moderately weathered, reddish brown, medium grained, decomposed rock.		98 Refusal 5.0 cm Penth.	*SPT-13	18.00-18.05
		NX rotary drilling from 18.00m to 32.00m	R1	18.00 – 19.00 CR=48% RQD=40%
19.00m. Highly weathered, reddish brown to yellowish brown, medium to coarse grained, highly fractured rock.			R2	19.00 – 20.00 CR=28% RQD=NIL
			R3	20.00 – 21.00 CR=30% RQD=25%
			R4	21.00 – 22.00 CR=33% RQD=23%
			R5	22.00 – 23.00 CR=28% RQD=20%
			R6	23.00 – 24.00 CR=28% RQD=15%
24.00m. Highly to moderately weathered, whitish grey, medium to coarse grained, moderately fractured rock.			R7	24.00 – 25.00 CR=33% RQD=15%
			R8	25.00 – 26.00 CR=33% RQD=12%
			R9	26.00 – 27.00 CR=34% RQD=13%
			R10	27.00 – 28.00 CR=38% RQD=NIL
			R11	28.00 – 29.00 CR=50% RQD=36%
29.00m. Fresh, whitish grey, medium to coarse grained, moderately fractured rock.			R12	29.00 – 30.50 CR=100% RQD=97%
32.00m.			R13	30.50 – 32.00 CR=100% RQD=98%

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.86

Co-ordinates E=716.627 N=803.306

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	20
		Water Sample (WS)	0

Commencement Date : 20/02/18
Completion Date : 23/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 895.717 M.
Water Struck At :
Standing Water Level : 4.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Depth (m)
Filled up soil consists of reddish brown, silty clay / clayey silt with boulders, stone chips.	0.00m. – 4.00m.			DS−1	0.50
				DS−2	1.00
		6 8 9	17	SPT−1	1.50−1.95
				DS−3	2.30
				UDS−1	2.50−2.95
		5 5 10	15	SPT−2	3.00−3.45
Stiff to very stiff, reddish brown, silty clay / clayey silt. Obs. kankars.	4.00m. – 7.00m.			DS−4	4.00
		3 4 7	11	SPT−3	4.50−4.95
				DS−5	5.30
				UDS−2	5.55−6.00
		4 8 10	18	SPT−4	6.00−6.45
Hard, reddish brown, silty clay / clayey silt. Obs. kankars.	7.00m. – 13.00m.			DS−6	7.00
		9 15 16	31	SPT−5	7.50−7.95
				DS−7	8.50
		10 14 18	32	SPT−6	9.00−9.45
				DS−8	10.00
		12 18 22	40	SPT−7	10.50−10.95
				DS−9	11.50
		14 20 26	46	SPT−8	12.00−12.45
Dense to very dense, brownish grey, silty sand.	13.00m. – 17.50m.			DS−10	13.00
		16 21 24	45	SPT−9	13.50−13.95
				DS−11	14.50
		8 22 32	54	SPT−10	15.00−15.45
				DS−12	16.00
		19 32 35	67	SPT−11	16.50−16.95
				DS−13	17.50

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.				CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:	

BORE LOG DATA SHEET — BORE HOLE NO.86

Co-ordinates E=716.627 N=803.306

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	18	Undisturbed (UDS)	2	Commencement Date :	20/02/18
Cone (Pc)		Penetrometer (SPT)	18	Completion Date :	23/02/18
Vane (V)		Disturbed (DS)	20	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	895.717 M.
				Water Struck At :	
				Standing Water Level :	4.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Dense to very dense, brownish grey, silty sand.	17.50m. – 21.50m.	22 33 39 — 72	SPT−12	18.00−18.45
			DS−14	19.00
		28 37 45 — 82	SPT−13	19.50−19.95
			DS−15	20.50
		≥100; 100 10.0 cm Pentn.	SPT−14	21.00−21.10
Completely to highly weathered, brownish grey, fine grained, fully decomposed & disintegrated rock.	21.50m. – 27.50m.	Refusal; 100 5.0 cm Pentn.	*SPT−15	21.50−21.55
			R1	21.50 – 22.50 CR=22% RQD=NIL
			R2	22.50 – 23.50 CR=NIL RQD=NIL
			DS−16	
		Refusal; 100 5.0 cm Pentn.	*SPT−16	23.50−23.55
			R3	23.50 – 24.50 CR=NIL RQD=NIL
			DS−17	
			R4	24.50 – 25.50 CR=NIL RQD=NIL
			DS−18	
		Refusal; 100 4.0 cm Pentn.	*SPT−17	25.50−25.54
			R5	25.50 – 26.50 CR=NIL RQD=NIL
			DS−19	
			R6	26.50 – 27.50 CR=NIL RQD=NIL
			DS−20	
Highly weathered, whitish grey, medium grained, slightly fractured rock.	27.50m. – 30.50m.	Refusal; 100 3.0 cm Pentn.	*SPT−18	27.50−27.53
			R7	27.50 – 28.50 CR=26% RQD=NIL
		NX rotary drilling from 21.50m to 34.00m	R8	28.50 – 29.50 CR=24% RQD=NIL
			R9	29.50 – 30.50 CR=40% RQD=NIL
Slighty weathered to fresh, whitish grey, medium grained, slightly fractured rock.	30.50m. – 34.00m.		R10	30.50 – 31.50 CR=60% RQD=NIL
			R11	31.50 – 32.50 CR=100% RQD=93%
			R12	32.50 – 34.00 CR=100% RQD=92%

N.B. — '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.87	Co-ordinates E=732.704 N=856.333

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	2	Commencement Date :	12/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	15/02/18
Vane (V)		Disturbed (DS)	23	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.260 M.
				Water Struck At :	
				Standing Water Level :	9.80 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)
0.00m							
Filled up soil consists of fly ash, rubbish, gravels & boulder.						DS-1	0.50
						DS-2	1.00
		1	2	2	4	SPT-1	1.50-1.95
						DS-3	2.50
		0	1	1	2	SPT-2	3.00-3.45
						DS-4	4.00
						*UDS-1	4.50-4.95
		1	2	3	5	SPT-3	5.20-5.65
						DS-5	6.50
		2	3	5	8	SPT-4	7.00-7.45
						DS-6	8.00
		1	3	3	6	SPT-5	8.50-8.95
						DS-7	9.50
		2	3	4	7	SPT-6	10.00-10.45
						DS-8	11.00
		1	2	4	6	SPT-7	11.50-11.95
						DS-9	12.50
						*UDS-2	12.80-13.25
13.45m							
Stiff to very stiff, reddish brown to yellowish grey, silty clay / clayey silt. Obs. sand mixture & kankars.		3	6	7	13	SPT-8	13.45-13.90
						DS-10	14.50
		4	5	7	12	SPT-9	15.50-15.95
						DS-11	16.50
		7	9	8	17	SPT-10	17.00-17.45
						DS-12	18.00
		6	9	11	20	SPT-11	18.50-18.95
						DS-13	19.50
		8	10	11	21	SPT-12	20.00-20.45
20.50m							

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.87	Co-ordinates E=732.704 N=856.333

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	2	Commencement Date :	12/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	15/02/18
Vane (V)		Disturbed (DS)	23	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.260 M.
				Water Struck At :	
				Standing Water Level :	9.80 m.

DESCRIPTION	Depth	N-VALUE EACH DIVN. = 15CM.				SAMPLES Ref. No	SAMPLES Depth (m)
Stiff to very stiff, reddish brown to yellowish grey, silty clay / clayey silt. Obs. sand mixture & kankars.	20.50m					DS-14	21.00
		9	12	15	27	SPT-13	21.50-21.95
						DS-15	22.50
		8	10	15	25	SPT-14	23.00-23.45
						DS-16	24.50
		9	11	16	27	SPT-15	25.00-25.45
						DS-17	26.00
		11	10	19	29	SPT-16	26.50-26.95
						DS-18	27.50
Hard, yellowish grey, silty clay with sand mixture.	28.00m	11	14	17	31	SPT-17	28.00-28.45
						DS-19	29.00
		12	16	20	36	SPT-18	29.50-29.95
						DS-20	30.50
		14	19	23	42	SPT-19	31.00-31.45
						DS-21	32.50
		13	18	22	40	SPT-20	33.00-33.45
						DS-22	34.50
		20	29	35	64	SPT-21	35.00-35.45
Very dense, whitish grey / blackish grey, silty sand wtih clay binder & decomposed rock	35.50m					DS-23	36.50
		27	39	47	86	SPT-22	37.00-37.45
		100	1.0 cm Penth.		Refusal	*SPT-23	37.85-37.86
Completely to highly weathered, yellowish grey / whitish grey, medium to coarse grained, decomposed rock.	38.00m	100	2.0 cm Penth.		Refusal	*SPT-24	38.00-38.02
		NX rotary drilling from 38.00m to 40.00m				R1	38.00 CR=15% RQD=NIL 39.00
	40.00m					R2	CR=22% RQD=NIL 40.00

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.88

Co-ordinates E=758.290 N=940.723

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	27	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	27
Vane (V)		Disturbed (DS)	25
		Water Sample (WS)	0

Commencement Date :	21/02/18
Completion Date :	23/02/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	905.049 M.
Water Struck At :	
Standing Water Level :	9.40 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)
0.00m. Filled up soil consists of reddish brown, silty clay / clayey silt with moourm, boulder & concrete pieces.						DS−1	0.50
						DS−2	1.00
		2	3	4	7	SPT−1	1.50−1.95
						DS−3	2.50
		5	12	15	27	SPT−2	3.00−3.45
						DS−4	4.00
		4	5	6	11	SPT−3	4.50−4.95
						DS−5	5.50
						*UDS−1	6.00−6.45
		2	3	5	8	SPT−4	6.55−7.00
						DS−6	7.50
		8	12	7	19	SPT−5	8.00−8.45
						*UDS−2	9.00−9.45
		2	3	4	7	SPT−6	9.60−10.05
10.50m. Stiff, reddish brown, silty clay. Obs. moorum.						DS−7	10.50
		3	5	7	12	SPT−7	11.00−11.45
						DS−8	12.00
		4	6	9	15	SPT−8	12.50−12.95
						*UDS−3	13.50−13.95
14.00m. Hard, reddish brown, silty clay / clayey silt. Obs. sand mixture. kankars & yellowish spots.		7	13	19	32	SPT−9	14.10−14.55
						DS−9	15.00
		8	15	22	37	SPT−10	15.50−15.95
						DS−10	16.50
		9	17	21	38	SPT−11	17.00−17.45
						DS−11	18.00
		11	16	24	40	SPT−12	18.50−18.95
						DS−12	19.50
20.50m.		12	17	25	42	SPT−13	20.00−20.45

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			**CETEST**
Job No : 4095	**Created by : Chandrani**	**Created on : 03/03/2018**	**Sheet No:**

BORE LOG DATA SHEET	BORE HOLE NO.88	Co-ordinates E=758.290 N=940.723

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	27	Undisturbed (UDS)	3	Commencement Date :	21/02/18
Cone (Pc)		Penetrometer (SPT)	27	Completion Date :	23/02/18
Vane (V)		Disturbed (DS)	25	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	905.049 M.
				Water Struck At :	
				Standing Water Level :	9.40 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
	20.50m				
Hard, reddish brown, silty clay / clayey silt. Obs. sand mixture. kankars & yellowish spots.				DS−13	21.00
		14 19 25	44	SPT−14	21.50−21.95
				DS−14	22.50
		13 18 26	44	SPT−15	23.00−23.45
	24.00m			DS−15	24.00
Hard, yellowish grey, silty clay / clayey silt. Obs. decomposed rock & sand mixture.		17 22 29	51	SPT−16	24.50−24.95
				DS−16	25.50
		20 25 32	57	SPT−17	26.00−26.45
				DS−17	27.00
		19 29 35	64	SPT−18	27.50−27.95
				DS−18	28.50
		21 27 36	63	SPT−19	29.00−29.45
				DS−19	30.00
		23 29 40	69	SPT−20	30.50−30.95
				DS−20	31.50
		25 31 46	77	SPT−21	32.00−32.45
				DS−21	33.00
		26 33 49	82	SPT−22	33.50−33.95
				DS−22	34.50
		65 5.0 cm Pentn.	Refusal	*SPT−23	34.90−34.95
	35.10m	78 5.0 cm Pentn.	Refusal	*SPT−24	35.10−35.15
Completely to highly weathered, brownish grey, medium grained, fully decomposed rock particles collected as sludge.				R1	CR=NIL RQD=NIL 35.10 → 36.00
				DS−23	
		80 5.0 cm Pentn.	Refusal	*SPT−25	36.00−36.05
				R2	CR=NIL RQD=NIL 36.00 → 37.00
				DS−24	
		85 4.0 cm Pentn.	Refusal	*SPT−26	37.00−37.04
				R3	CR=NIL RQD=NIL 37.00 → 38.00
				DS−25	
		100 4.0 cm Pentn.	Refusal	*SPT−27	38.00−38.04
				R4	CR=23% RQD=NIL 38.00 → 39.00
	39.00m				
Highly weathered, yellowish grey, medium grained, decomposed rock.		NX rotary drilling from 35.10m to 40.00m		R5	CR=27% RQD=NIL 39.00 → 40.00
	40.00m				

N.B. − '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.				CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018		Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.89

Co-ordinates E=778.516 N=1029.230

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	3	Commencement Date :	05/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	10/02/18
Vane (V)		Disturbed (DS)	22	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	904.100 M
				Water Struck At :	
				Standing Water Level :	11.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
Filled up soil consists of silty clay with moorum. Obs. sand mixture, gravels, boulders & metal pieces.	0.00m			DS–1	0.50
				DS–2	1.00
		2 3 5	8	SPT–1	1.50–1.95
				DS–3	2.50
		3 4 4	8	SPT–2	3.00–3.45
				DS–4	4.00
		2 3 4	7	SPT–3	4.50–4.95
				DS–5	5.50
				UDS–1	6.00–6.45
		3 10 17	27	SPT–4	6.55–7.00
				DS–6	7.50
		2 4 5	9	SPT–5	8.00–8.45
				*UDS–2	9.20–9.65
Stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.	9.80m	4 6 7	13	SPT–6	9.80–10.25
				DS–7	11.00
		3 5 7	12	SPT–7	11.50–11.95
				DS–8	12.50
		4 6 8	14	SPT–8	13.00–13.45
				DS–9	14.00
Very stiff, reddish brown to yellowish grey, silty clay / clayey silt. Obs. sand mixture & whitish grey patches.	15.00m	6 8 15	23	SPT–9	15.00–15.45
				DS–10	16.50
		4 9 12	21	SPT–10	17.00–17.45
				DS–11	18.00
		4 10 14	24	SPT–11	18.50–18.95
	20.50m			UDS–3	20.00–20.45

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 17/02/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.89

Co-ordinates E=778.516 N=1029.230

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	3	Commencement Date :	05/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	10/02/18
Vane (V)		Disturbed (DS)	22	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	904.100 M
				Water Struck At :	
				Standing Water Level :	11.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	SAMPLES Ref. No	Depth (m)
Very stiff, reddish brown to yellowish grey, silty clay / clayey silt. Obs. sand mixture & whitish grey patches.	20.50m.	8	9	11	20	SPT−12	20.55−21.00
						DS−12	21.50
		8	11	15	26	SPT−13	22.00−22.45
						DS−13	23.50
Very stiff to hard, yellowish grey to whitish grey, silty clay with sand mixture.	24.00m.	10	13	19	32	SPT−14	24.00−24.45
						DS−14	25.50
		9	12	16	28	SPT−15	26.00−26.45
						DS−15	27.00
		11	16	19	35	SPT−16	28.00−28.45
						DS−16	29.50
Very dense, whitish grey to blackish grey, silty sand with clay binder & decomposed rock.	30.00m.	24	39	43	82	SPT−17	30.00−30.45
						DS−17	31.00
		33	41	49	90	SPT−18	31.50−31.95
						DS−18	32.50
		100	3.0 cm Pentn.		Refusal	*SPT−19	32.85−32.88
Completley weathered, whitish grey to yellowish grey, fine to medium grained, fully decomposed rock.	33.00m.	100	2.0 cm Pentn.		Refusal	*SPT−20	33.00−33.02
						R1	33.00 − 34.00 CR=NIL RQD=NIL
						DS−19	
		100	2.0 cm Pentn.		Refusal	*SPT−21	34.00−34.02
						R2	34.00 − 35.00 CR=NIL RQD=NIL
						DS−20	
		100	2.0 cm Pentn.		Refusal	*SPT−22	35.00−35.02
						R3	35.00 − 36.00 CR=NIL RQD=NIL
						DS−21	
		100	3.0 cm Pentn.		Refusal	*SPT−23	36.00−36.03
						R4	36.00 − 37.00 CR=NIL RQD=NIL
						DS−22	
Highly weathered, yellowish grey to whitish grey, fine to medium grained, decomposed rock.	37.00m.	100	2.0 cm Pentn.		Refusal	*SPT−24	37.00−37.02
						R5	37.00 − 38.00 CR=22% RQD=NIL
Highly weathered, yellowish grey to whitish grey, fine to medium grained, decomposed rock.	38.00m.	NX rotary drilling from 30.00m to 40.00m				R6	38.00 − 39.00 CR=27% RQD=NIL
						R7	39.00 − 40.00 CR=30% RQD=NIL
	40.00m.						

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.90	Co-ordinates E=810.413 N=1134.878

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	5	Commencement Date :	06/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	08/02/18
Vane (V)		Disturbed (DS)	21	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	904.180 M
				Water Struck At :	
				Standing Water Level :	11.70 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m							
Filled up soil consists of silty clay with moourm, rubbish, gravels & boulders.						DS-1	0.50
						DS-2	1.00
		3	2	5	7	SPT-1	1.50-1.95
						DS-3	2.50
						UDS-1	3.00-3.45
		2	3	5	8	SPT-2	3.55-4.00
						DS-4	4.50
		3	3	5	8	SPT-3	5.00-5.45
						DS-5	6.50
		3	4	5	9	SPT-4	7.00-7.45
						DS-6	8.00
						*UDS-2	8.50-8.95
9.05m							
Stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture & gravels.		2	4	5	9	SPT-5	9.05-9.50
						DS-7	10.00
		4	5	7	12	SPT-6	10.50-10.95
						DS-8	11.50
						*UDS-3	12.00-12.45
		6	6	8	14	SPT-7	12.55-13.00
						DS-9	13.50
14.00m							
Medium dense, yellowish grey, silty sand with clay binder.		7	9	11	20	SPT-8	14.00-14.45
15.50m							
Very stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.						UDS-4	15.50-15.95
		5	7	9	16	SPT-9	16.05-16.50
						DS-10	17.00
		6	8	11	19	SPT-10	17.50-17.95
						UDS-5	19.00-19.45
		6	8	10	18	SPT-11	20.05-20.50
20.50m							

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.90	Co-ordinates E=810.413 N=1134.878

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	24	Undisturbed (UDS)	5	Commencement Date :	06/02/18
Cone (Pc)		Penetrometer (SPT)	24	Completion Date :	08/02/18
Vane (V)		Disturbed (DS)	21	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	904.180 M
				Water Struck At :	
				Standing Water Level :	11.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)				SAMPLES Ref. No	SAMPLES Depth (m)
20.50m.							
Very stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.						DS-11	21.00
22.00m.		8	9	11	20	SPT-12	22.00-22.45
Very stiff, whitish grey to yellowish grey, silty clay with sand mixture.						DS-12	23.50
		9	10	12	22	SPT-13	24.00-24.45
25.00m.						DS-13	25.00
Hard, whitish grey to yellowish grey, silty clay with sand mixture.		11	16	18	34	SPT-14	25.50-25.95
						DS-14	26.50
		13	18	21	39	SPT-15	27.00-27.45
						DS-15	28.00
		12	17	22	39	SPT-16	28.50-28.95
						DS-16	29.50
		20	28	33	61	SPT-17	30.00-30.45
30.50m.							
Very dense, whitish grey to blackish grey, silty sand with clay binders & decomposed rock.						DS-17	31.50
		25	39	47	86	SPT-18	32.00-32.45
						DS-18	33.50
		33	41	52	93	SPT-19	34.00-34.45
		100	5.0 cm Pentn.		Refusal	*SPT-20	35.20-35.25
35.30m.		100	2.0 cm Pentn.		Refusal	*SPT-21	35.30-35.32
Completely weathered, whitish grey to yellowish grey, fine to medium grained, fully decomposed rock.						R1	35.30 ↓ 36.00 CR=NIL RQD=NIL
						DS-19	
		100	1.0 cm Pentn.		Refusal	*SPT-22	36.00-36.01
						R2	36.00 ↓ 37.00 CR=NIL RQD=NIL
						DS-20	
		100	2.0 cm Pentn.		Refusal	*SPT-23	37.00-37.02
						R3	37.00 ↓ 38.00 CR=NIL RQD=NIL
						DS-21	
38.00m.		100	2.0 cm Pentn.		Refusal	*SPT-24	38.00-38.02
Highly weathered, yellowish grey to whitish grey, fine to medium grained, decomposed rock.						R4	38.00 ↓ 39.00 CR=27% RQD=NIL
		NX rotary drilling from 35.3.0m to 40.00m				R5	39.00 ↓ 40.00 CR=31% RQD=NIL
40.00m.							
N.B. — '*' means sample could not be recovered.							

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.91

Co-ordinates E=845.002 N=1226.725

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	21	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	21
Vane (V)		Disturbed (DS)	21
		Water Sample (WS)	0

Commencement Date : 01/02/18
Completion Date : 03/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 903.400 M
Water Struck At :
Standing Water Level : 10.40 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.) 1	2	3	N	SAMPLES Ref. No	Depth (m)
Filled up soil conists of silty clay with moorum, sand mi.ture, rubbish, graves & boulders.	0.00m					DS-1	0.50
						DS-2	1.00
		3	2	4	6	SPT-1	1.50-1.95
						DS-3	2.50
						UDS-1	3.00-3.45
		1	4	4	8	SPT-2	3.55-4.00
						DS-4	4.50
		3	3	5	8	SPT-3	5.00-5.45
						DS-5	6.00
						UDS-2	6.50-6.95
		2	6	7	13	SPT-4	7.05-7.50
						DS-6	8.00
		4	4	7	11	SPT-5	8.50-8.95
						UDS-3	10.00-10.45
Stiff, reddish brown, silty clay / clayey silt. Obs. sand mi.ture.	10.55m	5	7	3	10	SPT-6	10.55-11.00
						DS-7	11.50
		2	6	6	12	SPT-7	12.50-12.95
						DS-8	13.50
		4	3	6	9	SPT-8	14.50-14.95
						DS-9	15.50
						*UDS-4	16.00-16.45
Very stiff, whitish grey, silty clay / clayey silt with sand mi.ture.	16.55m	3	5	10	15	SPT-9	16.55-17.00
						DS-10	17.50
		4	7	11	18	SPT-10	18.50-18.95
						DS-11	19.50
		5	9	11	20	SPT-11	20.50-20.95
	21.00m						

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by : Chandrani**	**Created on : 15/02/2018**	**Sheet No:**

BORE LOG DATA SHEET — BORE HOLE NO.91

Co-ordinates E=845.002 N=1226.725

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	21	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	21
Vane (V)		Disturbed (DS)	21
		Water Sample (WS)	0

Commencement Date : 01/02/18
Completion Date : 03/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 903.400 M
Water Struck At :
Standing Water Level : 10.40 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)
	21.00m.							
Very stiff, whitish grey, silty clay / clayey silt with sand mi.ture.							DS−12	21.50
	22.50m.		6	8	9	17	SPT−12	22.50−22.95
Very stiff, yellowish brown, silty clay / clayey silt with sand mixture.							DS−13	23.50
			8	10	13	23	SPT−13	24.50−24.95
							DS−14	25.50
			10	11	16	27	SPT−14	26.50−26.95
							DS−15	27.50
			11	13	17	30	SPT−15	28.00−28.45
	29.50m.						DS−16	29.50
Hard, yellowish brown, silty clay / clayey silt with sand mixture.			11	14	20	34	SPT−16	30.00−30.45
							DS−17	31.50
	32.50m.		14	19	29	48	SPT−17	32.50−32.95
Dense, yellowish brown, silty sand.							DS−18	34.00
			13	21	29	50	SPT−18	34.50−34.95
							DS−19	35.50
			12	18	28	46	SPT−19	36.50−36.95
	37.50m.						DS−20	37.50
Very dense, yellowish brown, silty sand.			29	42	53	95	SPT−20	38.00−38.45
							DS−21	39.50
	40.45m.		28	40	52	92	SPT−21	40.00−40.45

N.B. — '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:
BORE LOG DATA SHEET	BORE HOLE NO.92	Co-ordinates E=1028.056 N=1321.374	

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	1	Commencement Date :	04/02/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	06/02/18
Vane (V)		Disturbed (DS)	5	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.436 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	Depth (m)
	0.00m				
Filled up soil consists of reddish brown, brown, clayey silt with rubbish, moorum, rigid concrete pavement.				DS-1	0.50
				DS-2	1.00
		4 5 9	14	SPT-1	1.50-1.95
				DS-3	2.50
	3.00m	6 10 16	26	SPT-2	3.00-3.45
Very stiff, reddish brown, silty clay / clayey silt with sand mixture.				DS-4	4.00
		5 9 13	22	SPT-3	4.50-4.95
	5.50m			DS-5	5.50
Hard, reddish brown, silty clay / clayey silt with sand mixture.		10 16 18	34	SPT-4	6.00-6.45
				*UDS-1	7.50-7.70
		18 27 50	77	SPT-5	8.05-8.50
		100 3.0 cm Penth.	Refusal	*SPT-6	9.10-9.13
	9.30m	100 3.0 cm Penth.	Refusal	*SPT-7	9.30-9.33
Highly weathered, light blackish grey, medium grained, fractured rock.		NX rotary drilling from 9.30m to 21.00m		R1	9.30 CR=32% RQD=NIL 10.00
	10.50m				
Highly to moderately weathered, yellowish brown, medium grained, fractured rock.	11.00m			R2	CR=30% RQD=NIL 11.00

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.92

Co-ordinates E=1028.056 N=1321.374

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	1	Commencement Date :	04/02/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	06/02/18
Vane (V)		Disturbed (DS)	5	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.436 M.
				Water Struck At :	
				Standing Water Level :	Not found

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
11.00m. Highly to moderately weathered, yellowish brown, medium grained, fractured rock.			R3	CR=28% RQD=NIL — 12.00
			R4	CR=35% RQD=NIL — 13.00
14.00m.			R5	CR=42% RQD=30% — 14.00
Moderately to slightly weathered / fresh, light blackish grey, medium grained, light fractured rock.			R6	CR=58% RQD=56% — 15.00
			R7	CR=77% RQD=75% — 16.50
			R8	CR=81% RQD=75% — 18.00
			R9	CR=100% RQD=98% — 19.50
21.00m.			R10	CR=100% RQD=99% — 21.00

N.B. — '*' means sample could not be recovered.

BH-92/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.93

Co-ordinates E=1134.386 N=1263.134

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	12	Undisturbed (UDS)	2	Commencement Date :	28/01/18
Cone (Pc)		Penetrometer (SPT)	12	Completion Date :	31/01/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.396 M.
				Water Struck At :	
				Standing Water Level :	4.10 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)
0.00m. Filled up soil consists of whitish grey, silty clay with decomposed rock fragments. 0.60m.						DS-1	0.50
Hard, reddish brown, silty clay / clayey silt. Obs. sand mixture. (0.60m.–8.50m.)						DS-2	1.00
		8	12	18	30	SPT-1	1.50-1.95
						UDS-1	2.55-3.00
		10	14	20	34	SPT-2	3.00-3.45
						DS-3	4.00
		18	20	22	42	SPT-3	4.50-4.95
						*UDS-2	5.50-5.60
		20	24	26	50	SPT-4	6.00-6.45
						DS-4	7.00
		18	23	31	54	SPT-5	7.50-7.95
8.50m.						DS-5	8.50
Hard, reddish brown, clayey silt with sand mixture. Obs. decomposed rock dust. (8.50m.–15.50m.)		10	12	28	40	SPT-6	9.00-9.45
						DS-6	10.00
		13	16	33	49	SPT-7	10.50-10.95
						DS-7	11.50
		14	18	35	53	SPT-8	12.00-12.45
						DS-8	13.00
		12	19	37	56	SPT-9	13.50-13.95
		15	27	49	76	SPT-10	14.50-14.95
15.50m.						DS-9	15.50

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	CETEST

Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.93	Co-ordinates E=1134.386 N=1263.134

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	12	Undisturbed (UDS)	2	Commencement Date :	28/01/18
Cone (Pc)		Penetrometer (SPT)	12	Completion Date :	31/01/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.396 M.
				Water Struck At :	
				Standing Water Level :	4.10 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)	
	15.50m.					
Hard, reddish brown, clayey silt with sand mixture. Obs. decomposed rock dust.			100 Refusal 5.0 cm Pentn.	*SPT-11	16.00-16.05	
	16.50m.		100 Refusal 3.0 cm Pentn.	*SPT-12	16.50-16.53	16.50
Highly weathered, light brownish grey, medium to coarse grained, highly fractured rock.			NX rotary drilling from 16.50m to 30.00m	R1	CR=24% RQD=NIL	17.50
				R2	CR=25% RQD=NIL	18.50
				R3	CR=22% RQD=NIL	19.50
				R4	CR=30% RQD=NIL	20.50
				R5	CR=26% RQD=NIL	21.50
				R6	CR=25% RQD=NIL	22.50
	22.50m.					
Moderately weathered, light blackish grey, coarse grained, highly to moderately fractured rock.				R7	CR=56% RQD=NIL	23.50
				R8	CR=54% RQD=NIL	24.50
	24.50m.					
Slightly weathered, light blackish grey, coarse grained, moderately fractured rock.				R9	CR=64% RQD=NIL	25.50
				R10	CR=77% RQD=30%	27.00
	27.00m.					
Fresh, light blackish grey, coarse grained, slightly fractured rock.				R11	CR=100% RQD=97%	28.50
				R12	CR=100% RQD=95%	30.00
	30.00m.					

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.		CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.94

Co-ordinates E=1098.918 N=1235.653

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	9	Undisturbed (UDS)	2	Commencement Date :	29/01/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date :	01/02/18
Vane (V)		Disturbed (DS)	8	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	901.630 M.
				Water Struck At :	
				Standing Water Level :	3.90 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Sample Depth (m)
Very stiff to hard, reddish brown, silty clay / clayey silt. Obs. sand mi.ture.	0.00m			DS-1	0.50
				DS-2	1.00
		8 9 15	24	SPT-1	1.50-1.95
				UDS-1	2.55-3.00
		9 10 16	26	SPT-2	3.00-3.45
				DS-3	4.00
		11 15 19	34	SPT-3	4.50-4.95
				*UDS-2	5.50-5.60
Hard, reddish brown to yellowish brown, clayey silt with sand mi.ture. Obs. decomposed rock.	6.00m	10 15 20	35	SPT-4	6.00-6.45
				DS-4	7.00
		12 19 25	44	SPT-5	7.50-7.95
				DS-5	8.50
		15 25 37	62	SPT-6	9.00-9.45
				DS-6	10.00
		17 29 45	74	SPT-7	10.50-10.95
				DS-7	11.50
		100 6.0 cm Penth.	Refusal	*SPT-8	12.00-12.06
Highly weathered, yellowish brown, medium to fine grained, highly fractured rock.	12.50m	100 4.0 cm Penth.	Refusal	*SPT-9	12.50-12.54
		NX rotary drilling from 12.50m to 29.50m		R1	12.50 ↓ 13.50 CR=24% RQD=NIL
				R2	13.50 ↓ 14.50 CR=25% RQD=NIL
Highly weathered, yellowish brown, medium to fine grained, highly fractured rock.	14.50m			R3	14.50 ↓ CR=27% RQD=NIL
	15.00m				

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET	BORE HOLE NO.94	Co-ordinates E=1098.918 N=1235.653

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	9	Undisturbed (UDS)	2	Commencement Date :	29/01/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date :	01/02/18
Vane (V)		Disturbed (DS)	8	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	901.630 M.
				Water Struck At :	
				Standing Water Level :	3.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	Depth (m)
15.00m. Highly weathered, yellowish brown, medium to fine grained, highly fractured rock.				15.50
			R4	CR=30% RQD=NIL
				16.50
			R5	CR=27% RQD=NIL
				17.50
			R6	CR=26% RQD=NIL
				18.50
			R7	CR=31% RQD=NIL
				19.50
			R8	CR=33% RQD=NIL
20.50m. Highly to moderately weathered, light blackish grey, medium grained, highly to moderately fractured rock.				20.50
			R9	CR=46% RQD=NIL
				21.50
			R10	CR=48% RQD=19%
				22.50
			R11	CR=40% RQD=31%
				23.50
			R12	CR=45% RQD=NIL
24.50m. Slightly weathered to fresh, light blackish grey, medium grained, moderately to slightly fractured rock.				24.50
			R13	CR=55% RQD=NIL
				25.50
			R14	CR=77% RQD=18%
				26.50
			R15	CR=100% RQD=98%
				28.00
			R16	CR=100% RQD=96%
29.50m.				29.50

N.B. — '*' means sample could not be recovered.

BH-94/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.96

Co-ordinates E=1101.492 N=1175.304

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date :	29/01/18
Completion Date :	31/01/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	900.581 M
Water Struck At :	
Standing Water Level :	5.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
Very stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.	0.00m. – 3.45m.		DS-1	0.50
			DS-2	1.00
		7 11 14 (25)	SPT-1	1.50-1.95
			DS-3	2.50
Hard, reddish brown, silty clay / clayey silt. Obs. sand mixture.	3.45m. – 6.00m.	9 12 16 (28)	SPT-2	3.00-3.45
			*UDS-1	4.00-4.25
		10 23 28 (51)	SPT-3	4.45-4.90
			DS-4	5.50
Hard, yellowish brown, clayey silt with decomposed rock fragments.	6.00m. – 6.50m.	19 70 (≥100) 10.0 cm Pentn.	SPT-4	6.00-6.25
		Refusal 100 5.0 cm Pentn.	*SPT-5	6.35-6.40
Highly weathered, light blackish grey, coarse to medium grained, fractured rock.	6.50m. – 8.00m.	Refusal 100 3.0 cm Pentn.	*SPT-6	6.50-6.53
		NX rotary drilling from 6.50m to 23.50m	R1	6.50 – 7.50 CR=27% RQD=NIL
Highly weathered, yellowish brown, coarse grained, fractured rock.	8.00m. – 12.00m.		R2	7.50 – 8.50 CR=24% RQD=NIL
			R3	8.50 – 9.50 CR=27% RQD=NIL
			R4	9.50 – 10.50 CR=26% RQD=NIL
			R5	10.50 – 11.50 CR=24% RQD=NIL
	12.00m.			11.50 ~

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 15/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.96

Co-ordinates E=1101.492 N=1175.304

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	6	Undisturbed (UDS)	1	Commencement Date :	29/01/18
Cone (Pc)		Penetrometer (SPT)	6	Completion Date :	31/01/18
Vane (V)		Disturbed (DS)	5	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	900.581 M
				Water Struck At :	
				Standing Water Level :	5.30 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15CM.	SAMPLES Ref. No	SAMPLES Depth (m)
12.00m. Highly weathered, yellowish brown, coarse grained, fractured rock.			R6	CR=25% RQD=NIL 12.50
			R7	CR=32% RQD=NIL 13.50
13.50m. Highly wathered, light grey, medium grained, fractured rock.			R8	CR=30% RQD=NIL 14.50
			R9	CR=28% RQD=NIL 15.50
			R10	CR=36% RQD=12% 16.50
			R11	CR=30% RQD=NIL 17.50
			R12	CR=32% RQD=NIL 18.50
			R13	CR=38% RQD=15% 19.50
19.50m. Slightly weathered to fresh, light grey, medium grained, slightly fractured rock.			R14	CR=79% RQD=36% 20.50
			R15	CR=100% RQD=95% 22.00
			R16	CR=100% RQD=94% 23.50
23.50m.				

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.97

Co-ordinates E=1099.187 N=1133.684

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 25/01/18
Completion Date : 29/01/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 899.829 M
Water Struck At :
Standing Water Level : 4.10 m.

Depth	DESCRIPTION	N-VALUE (EACH DIVN. = 15CM.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m–1.30m	Filled up soil consists of concreate layer.		DS-1 DS-2	0.50 1.00
1.30m–3.00m	Medium dense, reddish brown, silty sand. Obs. decomposed rock.	8 12 12 = 24 100 4.0 cm Penth. = Refusal	SPT-1 DS-3 *SPT-2	1.50-1.95 2.50 2.80-2.84
3.00m–4.00m	Highly weathered, blackish grey, medium grained, highly fractured rock.	100 4.0 cm Penth. = Refusal NX rotary drilling from 3.00m to 19.50m	*SPT-3 R1	3.00-3.04 3.00–4.00 CR=24% RQD=NIL
4.00m–6.00m	Highly weathered, blackish grey, medium grained, highly fractured rock.		R2 R3	4.00–5.00 CR=30% RQD=NIL 5.00–6.00 CR=35% RQD=20%
6.00m–8.00m	Moderately weathered, blackish grey, medium grained, fractured rock.		R4 R5	6.00–7.00 CR=42% RQD=24% 7.00–8.00 CR=47% RQD=20%
8.00m–12.00m	Moderately weathered, blackish grey, medium grained, fractured rock.		R6 R7 R8 R9	8.00–9.00 CR=56% RQD=NIL 9.00–10.00 CR=47% RQD=18% 10.00–11.00 CR=52% RQD=15% 11.00–12.00 CR=53% RQD=12%
12.00m–16.50m	Highly to moderately weathered, yellowish brown, medium grained, fractured rock.		R10 R11 R12 R13	12.00–13.00 CR=35% RQD=NIL 13.00–14.00 CR=37% RQD=NIL 14.00–15.00 CR=55% RQD=NIL 15.00–16.50 CR=59% RQD=NIL
16.50m–19.50m	Fresh, blackish grey, medium grained, slightly fractured rock.		R14 R15	16.50–18.00 CR=100% RQD=90% 18.00–19.50 CR=100% RQD=93%

N.B. — '*' means sample could not be recovered.

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.98

Co-ordinates E=1251.836 N=1035.591

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	29	Undisturbed (UDS)	2	Commencement Date :	11/02/18
Cone (Pc)		Penetrometer (SPT)	29	Completion Date :	13/02/18
Vane (V)		Disturbed (DS)	28	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	897.889 M.
				Water Struck At :	
				Standing Water Level :	4.40 m.

DESCRIPTION	N-VALUE EACH DIVN. = 15CM.			N	SAMPLES Ref. No	Depth (m)
0.00m						
Stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.					DS−1	0.50
					DS−2	1.00
	3	4	7	11	SPT−1	1.50−1.95
					DS−3	2.20
					UDS−1	2.60−3.05
	3	5	7	12	SPT−2	3.05−3.50
					DS−4	4.00
	4	6	8	14	SPT−3	4.50−4.95
					DS−5	5.50
	3	3	6	9	SPT−4	6.00−6.45
					*UDS−2	7.00−7.35
	4	5	8	13	SPT−5	7.50−7.95
8.50m					DS−6	8.50
Medium dese to dense, yellowish brown / reddish brown, silty sand. Obs. kankars.	10	12	14	26	SPT−6	9.00−9.45
					DS−7	10.00
	11	13	18	31	SPT−7	10.50−10.95
					DS−8	11.50
	11	14	16	30	SPT−8	12.00−12.45
					DS−9	13.00
	14	16	18	34	SPT−9	13.50−13.95
					DS−10	14.50
	14	19	21	40	SPT−10	15.00−15.45
					DS−11	16.00
	12	17	22	39	SPT−11	16.50−16.95
					DS−12	17.50
	16	20	30	50	SPT−12	18.00−18.45
19.00m					DS−13	19.00
Hard, light grey, clayey sandy silt with decomposed rock.	13	21	28	49	SPT−13	19.50−19.95
20.50m					DS−14	20.50

BH−98/Sheet−1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.98

Co-ordinates E=1251.836 N=1035.591

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	29	Undisturbed (UDS)	2	Commencement Date :	11/02/18
Cone (Pc)		Penetrometer (SPT)	29	Completion Date :	13/02/18
Vane (V)		Disturbed (DS)	28	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	897.889 M.
				Water Struck At :	
				Standing Water Level :	4.40 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, light grey, clayey sandy silt with decomposed rock.	20.50m	14 22 33	55	SPT−14	21.50−21.95
				DS−15	22.50
		18 22 37	59	SPT−15	23.00−23.45
Very dense, light grey, silty sand with decomposed rock.	24.00m			DS−16	24.00
		17 25 35	60	SPT−16	24.50−24.95
				DS−17	25.50
		17 24 34	58	SPT−17	26.00−26.45
				DS−18	27.00
		20 29 38	67	SPT−18	27.50−27.95
				DS−19	28.50
		22 28 42	70	SPT−19	29.00−29.45
				DS−20	30.00
		30 38 51	89	SPT−20	31.50−31.95
				DS−21	32.50
		100 5.0 cm Pentn.	Refusal	*SPT−21	32.80−32.85
Completely weathered, brownish grey, medium grained, fully decompsed rock particles collected as sludge.	33.20m	100 4.0 cm Pentn.	Refusal	*SPT−22	33.20−33.24
				R1	33.20 CR=NIL RQD=NIL 34.00
				DS−22	
		100 4.0 cm Pentn.	Refusal	*SPT−23	34.00−34.04
				R2	34.00 CR=NIL RQD=NIL 35.00
				DS−23	
		100 4.0 cm Pentn.	Refusal	*SPT−24	35.00−35.04
				R3	35.00 CR=NIL RQD=NIL 36.00
				DS−24	
		100 3.0 cm Pentn.	Refusal	*SPT−25	36.00−36.03
				R4	36.00 CR=NIL RQD=NIL 37.00
				DS−25	
		100 4.0 cm Pentn.	Refusal	*SPT−26	37.00−37.04
				R5	37.00 CR=NIL RQD=NIL 38.00
				DS−26	
		100 3.0 cm Pentn.	Refusal	*SPT−27	38.00−38.03
				R6	38.00 CR=NIL RQD=NIL 39.00
				DS−27	
		100 3.0 cm Pentn.	Refusal	*SPT−28	39.00−39.03
				R7	39.00 CR=NIL RQD=NIL 40.00
				DS−28	
	40.00m	100 2.0 cm Pentn.	Refusal	*SPT−29	40.00−40.02

N.B. — '*' means sample could not be recovered.

NX rotary drilling from 33.20m to 40.00m

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.99

Co-ordinates E=1149.224 N=899.710

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	15	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	15
Vane (V)		Disturbed (DS)	13
		Water Sample (WS)	0

Commencement Date : 08/02/18
Completion Date : 12/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 892.349 M.
Water Struck At :
Standing Water Level : 3.20 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Depth (m)
Stiff, reddish brown, silty clay with moorum.	0.00m			DS-1	0.50
				DS-2	1.00
		3 4 7	11	SPT-1	1.50-1.95
				DS-3	2.50
				UDS-1	3.00-3.45
		2 4 8	12	SPT-2	3.45-3.90
Very stiff, greyish yellow, silty clay.	4.00m			DS-4	4.50
		4 8 10	18	SPT-3	5.00-5.45
				*UDS-2	6.00-6.45
		10 12 14	26	SPT-4	6.60-7.05
Hard, yellowish grey to light grey, clayey silt with sand mixture & decomposed rock.	7.50m			DS-5	7.50
		4 17 22	39	SPT-5	8.00-8.45
				DS-6	9.00
		10 18 20	38	SPT-6	9.50-9.95
				DS-7	10.50
		11 18 23	41	SPT-7	11.00-11.45
				DS-8	12.00
		14 19 26	45	SPT-8	12.50-12.95
				DS-9	13.50
		13 18 27	45	SPT-9	14.00-14.45
	14.50m				

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.99

Co-ordinates E=1149.224 N=899.710

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	15	Undisturbed (UDS)	2	Commencement Date :	08/02/18
Cone (Pc)		Penetrometer (SPT)	15	Completion Date :	12/02/18
Vane (V)		Disturbed (DS)	13	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	892.349 M.
				Water Struck At :	
				Standing Water Level :	3.20 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)	N	Ref. No	Depth (m)	Run
Hard, yellowish grey to light grey, clayey silt with sand mixture & decomposed rock.	14.50m.–21.20m.			DS-10	15.00	
		14 21 29	50	SPT-10	15.50-15.95	
				DS-11	16.50	
		17 23 30	53	SPT-11	17.00-17.45	
				DS-12	18.00	
		15 22 38	60	SPT-12	18.50-18.95	
				DS-13	19.50	
		24 39 42	81	SPT-13	20.00-20.45	
		100 4.0 cm Pentn.	Refusal	*SPT-14	21.00-21.04	
		100 3.0 cm Pentn.	Refusal	*SPT-15	21.20-21.23	
Moderately weathered, light blackish grey, coarse grained, fractured rock.	21.20m.–24.00m.	NX rotary drilling from 21.00m to 28.00m		R1	CR=50% RQD=25%	21.20–22.00
				R2	CR=55% RQD=10%	22.00–23.00
				R3	CR=53% RQD=10%	23.00–24.00
Fresh, light blackish grey, coarse grained, slightly fractured rock.	24.00m.–28.00m.			R4	CR=89% RQD=78%	24.00–25.00
				R5	CR=100% RQD=92%	25.00–26.50
				R6	CR=100% RQD=94%	26.50–28.00
	28.00m.				28.00	28.00

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 03/03/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.100

Co-ordinates E=1151.054 N=815.773

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	29	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	29
Vane (V)		Disturbed (DS)	28
		Water Sample (WS)	0

Commencement Date : 06/02/18
Completion Date : 09/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 893.111 M.
Water Struck At :
Standing Water Level : 1.70 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	SAMPLES Ref. No	Depth (m)
Very stiff, reddish brown, clayey silt with sand mixture.	0.00m – 3.10m					DS-1	0.50
						DS-2	1.00
		4	7	9	16	SPT-1	1.50-1.95
						UDS-1	2.50-2.95
Hard, steel grey to deep grey, silty clay.	3.10m – 11.00m	10	13	18	31	SPT-2	2.95-3.40
						DS-3	4.00
		12	18	24	42	SPT-3	5.00-5.45
						DS-4	6.00
		11	17	22	39	SPT-4	6.50-6.95
						DS-5	7.50
		13	20	25	45	SPT-5	8.00-8.45
						DS-6	9.00
		14	19	27	46	SPT-6	9.50-9.95
						DS-7	10.50
Hard, greyish yellow, clayey silt / silty clay. Obs. sand mixture& kankars.	11.00m – 20.50m	14	22	30	52	SPT-7	11.00-11.45
						DS-8	12.00
		12	20	29	49	SPT-8	12.50-12.95
		13	21	29	50	SPT-9	14.00-14.45
						DS-9	15.00
		15	22	35	57	SPT-10	15.50-15.95
						DS-10	16.50
		16	20	36	56	SPT-11	17.00-17.45
						DS-11	18.00
		14	27	32	59	SPT-12	18.50-18.95
						DS-13	19.50
		22	28	35	63	SPT-13	20.00-20.45

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			**CETEST**
Job No : 4095	**Created by : Chandrani**	**Created on : 03/03/2018**	**Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.100

Co-ordinates E=1151.054 N=815.773

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	29	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	29
Vane (V)		Disturbed (DS)	28
		Water Sample (WS)	0

Commencement Date : 06/02/18
Completion Date : 09/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 893.111 M.
Water Struck At :
Standing Water Level : 1.70 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15CM.)			N	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, greyish yellow, clayey silt / silty clay. Obs. sand mixture & kankars.	20.50m. – 21.00m.					DS−14	21.00
Hard, yellowish grey, clayey silt / silty clay.	21.00m. – 27.00m.	20	27	33	60	SPT−14	21.50−21.95
						DS−15	22.50
		20	28	34	62	SPT−15	23.00−23.45
						DS−16	24.00
		27	25	30	55	SPT−16	24.50−24.95
						DS−17	25.50
		21	29	31	60	SPT−17	26.00−26.45
Hard, yellowish grey, clayey silt with decomposed rock.	27.00m. – 35.00m.					DS−18	27.00
		25	30	38	68	SPT−18	27.50−27.95
						DS−19	28.50
		20	29	39	68	SPT−19	29.00−29.45
						DS−20	30.00
		22	28	35	63	SPT−20	30.50−30.95
						DS−21	31.50
		27	32	39	71	SPT−21	32.00−32.45
		NX rotary drilling from 35.00m to 40.00m				DS−22	33.00
		26	35	46	81	SPT−22	33.50−33.95
						DS−23	34.50
		100	5.0 cm Pentn.		Refusal	*SPT−23	34.80−34.85
Completely weathered, brownish grey, medium graind, fully decomposed rock paticals collected as sludge.	35.00m. – 40.00m.	100	4.0 cm Pentn.		Refusal	*SPT−24	35.00−35.04
						R1	**35.00** – **36.00** CR=NIL RQD=NIL
						DS−24	
		100	4.0 cm Pentn.		Refusal	*SPT−25	36.00−36.04
						R2	**36.00** – **37.00** CR=NIL RQD=NIL
						DS−25	
		100	3.0 cm Pentn.		Refusal	*SPT−26	37.00−37.03
						R3	**37.00** – **38.00** CR=NIL RQD=NIL
						DS−26	
		100	3.0 cm Pentn.		Refusal	*SPT−27	38.00−38.03
						R4	**38.00** – **39.00** CR=NIL RQD=NIL
						DS−27	
		100	4.0 cm Pentn.		Refusal	*SPT−28	39.00−39.04
						R5	**39.00** – **40.00** CR=NIL RQD=NIL
						DS−28	
		100	3.0 cm Pentn.			*SPT−29	40.00−40.03

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-1

Co-ordinates E=752.175 N=325.876

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	11	Undisturbed (UDS)	1	Commencement Date :	22/02/18
Cone (Pc)		Penetrometer (SPT)	11	Completion Date :	26/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	893.568 m.
				Water Struck At :	
				Standing Water Level :	6.80 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	N	SAMPLES Ref. No	SAMPLES Depth (m)
	0.00m.					
Filled up soil consists of steel grey, fly ash with moourm & kankars.					DS-1	0.50
					DS-2	1.00
	1.30m.					
Very stiff, reddish brown, silty clay / clayey silt. Obs. moorum & knakars.			7 14 18	32	SPT-1	1.50-1.95
					DS-3	2.50
			6 11 16	27	SPT-2	3.00-3.45
					DS-4	4.00
			8 12 18	30	SPT-3	4.50-4.95
	5.00m.					
Hard, reddish brown, silty clay / clayey silt. Obs. moourm & kankars.					*UDS-1	6.00-6.15
			11 19 30	49	SPT-4	6.50-6.95
					DS-5	7.50
			10 17 24	41	SPT-5	8.00-8.45
					DS-6	9.00
			12 18 25	43	SPT-6	9.50-9.95
					DS-7	10.50
	11.00m.		10 15 23	38	SPT-7	11.00-11.45
Hard, greyish brown, silty clay / clayey silt with decomposed rock.					DS-8	12.00
			14 19 23	42	SPT-8	12.50-12.95
					DS-9	13.50
			15 21 32	53	SPT-9	14.00-14.45
			100	Refusal 4.0 cm Pentn.	*SPT-10	14.60-14.64
	14.70m.		100	Refusal 3.0 cm Pentn.	*SPT-11	14.70-14.73
Slightly weathered to fresh, whitish grey, coarse grained, fractured rock.			NX rotary drilling from 14.70m to 19.00m		R1	CR=67% RQD=35% (14.70 - 15.00)
					R2	CR=73% RQD=49% (15.00 - 16.00)
					R3	CR=100% RQD=94% (16.00 - 17.50)
					R4	CR=100% RQD=94% (17.50 - 19.00)
	19.00m.					

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-2

Co-ordinates E=751.600 N=687.500

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	10
		Water Sample (WS)	0

Commencement Date :	17/02/18
Completion Date :	20/02/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	891.530 m.
Water Struck At :	
Standing Water Level :	9.40 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	Samples Ref. No	Samples Depth (m)
Medium, reddish brown, silty clay / clayey silt. Obs. kankars.	0.00m		DS-1	0.50
			DS-2	1.00
		2 3 5 (8)	SPT-1	1.50-1.95
			DS-3	2.50
			UDS-1	3.15-3.60
		2 4 4 (8)	SPT-2	3.60-4.05
Stiff, reddish brown, silty clay / clayey silt. Obs. kankars.	4.50m		DS-4	4.50
		3 4 5 (9)	SPT-3	5.00-5.45
			DS-5	6.00
		4 4 8 (12)	SPT-4	6.50-6.95
			DS-6	7.50
		4 5 9 (14)	SPT-5	8.00-8.45
Very stiff, reddish brown / brownish grey, silty clay with traces of sand.	9.00m		DS-7	9.00
		5 8 14 (22)	SPT-6	9.50-9.95
			DS-8	10.50
		6 14 14 (28)	SPT-7	11.00-11.45
Hard, reddish brown / brownish grey, silty clay with traces of sand.	12.00m		DS-9	12.00
		15 18 26 (44)	SPT-8	12.45-12.90
			DS-10	13.50
		21 34 80 10.0 cm Pentn. (≥100)	SPT-9	14.00-14.40
Slightly weathered to fresh, whitish grey, medium to coarse grained, slightly fractured rock.	15.00m	100 3.0 cm Pentn. Refusal	*SPT-10	15.00-15.03
		NX rotary drilling from 15.00m to 21.00m	R1	CR=62% RQD=58% (15.00-16.00)
			R2	CR=72% RQD=63% (16.00-17.00)
			R3	CR=61% RQD=42% (17.00-18.00)
			R4	CR=100% RQD=98% (18.00-19.50)
			R5	CR=100% RQD=93% (19.50-21.00)
N.B. — '*' means sample could not be recovered.	21.00m			

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-3

Co-ordinates E=865.575 N=1106.450

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	18
		Water Sample (WS)	0

Commencement Date : 17/02/18
Completion Date : 21/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 900.002 m.
Water Struck At :
Standing Water Level : 12.00 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.				SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of reddish brown, silty clay / clayey silt with moourm, sand mixture, gravels & boulder.						DS-1	0.50
						DS-2	1.00
		3	7	5	12	SPT-1	1.50-1.95
						DS-3	2.50
		4	8	5	13	SPT-2	3.00-3.45
						DS-4	4.00
						*UDS-1	4.50-4.95
		2	2	4	6	SPT-3	5.10-5.55
						DS-5	6.00
		4	4	5	9	SPT-4	6.50-6.95
						DS-6	7.50
						*UDS-2	8.00-8.45
		3	5	5	10	SPT-5	8.60-9.05
						DS-7	9.50
		4	4	10	14	SPT-6	10.00-10.45
						DS-8	11.00
						*UDS-3	11.50-11.95
		5	5	6	11	SPT-7	12.10-12.55
12.60m. Very stiff, reddish brown, silty clay / clayey silt with moourm, sand mixture.						DS-9	13.00
		5	8	10	18	SPT-8	13.50-13.95
						DS-10	14.50
						*UDS-4	15.00-15.45
		7	8	12	20	SPT-9	15.60-16.05
16.50m. Hard, reddish brown / light grey, clayey silt. Obs. sand mixture, brown spots & decomposed rock.						DS-11	16.50
		12	17	20	37	SPT-10	17.00-17.45
						DS-12	18.00
		11	16	19	35	SPT-11	18.50-18.95
						DS-13	19.50
20.50m.		12	18	13	31	SPT-12	20.00-20.45

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:
BORE LOG DATA SHEET	BORE HOLE NO. MND-3	Co-ordinates	E=865.575 N=1106.450

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	18	Undisturbed (UDS)	4	Commencement Date :	17/02/18
Cone (Pc)		Penetrometer (SPT)	18	Completion Date :	21/02/18
Vane (V)		Disturbed (DS)	18	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	900.002 m.
				Water Struck At :	
				Standing Water Level :	12.00 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	N	SAMPLES Ref. No	SAMPLES Depth (m)
Hard, reddish brown / light grey, clayey silt. Obs. sand mixture, brown spots & decomposed rock.	20.50m. – 27.70m.			DS-14	21.00
		15 22 27	49	SPT-13	21.50-21.95
				DS-15	22.50
		19 23 30	53	SPT-14	23.00-23.45
				DS-16	24.00
		17 21 39	60	SPT-15	24.50-24.95
				DS-17	25.50
		29 48 65	≥100	SPT-16	26.00-26.45
				DS-18	27.00
		100	Refusal 4.0 cm Penth.	*SPT-17	27.50-27.54
Highly to moderately weathered, light brownish grey, medium grained, fractured rock.	27.70m. – 36.70m.	89	Refusal 4.0 cm Penth.	*SPT-18	27.70-27.74
		NX rotary drilling from 27.70m to 40.00m		R1	27.70–28.70 CR=24% RQD=NIL
				R2	28.70–29.70 CR=27% RQD=NIL
				R3	29.70–30.70 CR=25% RQD=NIL
				R4	30.70–31.70 CR=28% RQD=NIL
				R5	31.70–32.70 CR=31% RQD=NIL
				R6	32.70–33.70 CR=29% RQD=NIL
				R7	33.70–34.70 CR=35% RQD=10%
				R8	34.70–35.70 CR=40% RQD=NIL
				R9	35.70–36.70 CR=47% RQD=18%
Moderately to slightly weathered, light brownish grey, medium grained, fractured rock.	36.70m. – 40.00m.			R10	36.70–37.70 CR=54% RQD=20%
				R11	37.70–38.70 CR=59% RQD=15%
				R12	38.70–40.00 CR=62% RQD=34%

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. **CETEST**

Job No : 4095 | Created by : Chandrani | Created on : 17/02/2018 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-4

Co-ordinates E=974.957 N=1124.599

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	10	Undisturbed (UDS)	2	Commencement Date :	10/02/18
Cone (Pc)		Penetrometer (SPT)	10	Completion Date :	12/03/18
Vane (V)		Disturbed (DS)	8	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	898.603 M
				Water Struck At :	
				Standing Water Level :	8.70 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	N	SAMPLES Ref. No	Depth (m)
	0.00m.				
Filled up soil consists of gravels & stock pile of coal.				DS-1	0.50
				DS-2	1.00
		4 6 10	16	SPT-1	1.50-1.95
	2.50m.			DS-3	2.50
Hard, reddish brown to yellowish grey, silty clay with moorum.		10 17 18	35	SPT-2	3.00-3.45
				UDS-1	4.00-4.45
		17 20 23	43	SPT-3	4.45-4.90
				DS-4	5.50
		18 19 20	39	SPT-4	6.00-6.45
				*UDS-2	7.00-7.12
		18 20 21	41	SPT-5	7.50-7.95
				DS-5	8.50
		19 21 24	45	SPT-6	9.00-9.45
				DS-6	10.00
	10.50m.	18 21 26	47	SPT-7	10.50-10.95
Hard, yellowish grey to whitish grey, silty clay with decomposed rock.				DS-7	11.50
		20 22 30	52	SPT-8	12.00-12.45
				DS-8	12.70
		100 4.0 cm Pentn.	Refusal	*SPT-9	12.80-12.84
	12.90m.	100 4.0 cm Pentn.	Refusal	*SPT-10	12.90-12.94
Highly weathered, yellowish grey to whitish grey, medium to coarse grained, highly fractured rock.		NX rotary drilling from 12.90m to 36.00m		R1	12.90-14.00 CR=23% RQD=NIL
				R2	14.00-15.00 CR=22% RQD=NIL
				R3	15.00-16.00 CR=28% RQD=NIL
				R4	16.00-17.00 CR=24% RQD=NIL
				R5	17.00-18.00 CR=22% RQD=NIL
	18.50m.			R6	18.00- CR=30% RQD=NIL

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. MND-4

Co-ordinates E=974.957 N=1124.599

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	8
		Water Sample (WS)	0

Commencement Date : 10/02/18
Completion Date : 12/03/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 898.603 M.
Water Struck At :
Standing Water Level : 8.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
18.50m.				19.00
Highly weathered, yellowish grey to whitish grey, medium to coarse grained, highly fractured rock.			R7	CR=23% RQD=NIL (19.00–20.00)
			R8	CR=26% RQD=NIL (20.00–21.00)
			R9	CR=25% RQD=NIL (21.00–22.00)
			R10	CR=32% RQD=NIL (22.00–23.00)
			R11	CR=28% RQD=NIL (23.00–24.00)
			R12	CR=29% RQD=NIL (24.00–25.00)
			R13	CR=27% RQD=NIL (25.00–26.00)
			R14	CR=29% RQD=NIL (26.00–27.00)
			R15	CR=25% RQD=NIL (27.00–28.00)
			R16	CR=34% RQD=NIL (28.00–29.00)
			R17	CR=30% RQD=NIL (29.00–30.00)
			R18	CR=32% RQD=15% (30.00–31.00)
31.00m.				
Slightly weathered to fresh, light blackish grey, medium grained, slightly fractured rock.			R19	CR=51% RQD=31% (31.00–32.00)
			R20	CR=76% RQD=43% (32.00–33.00)
			R21	CR=100% RQD=97% (33.00–34.50)
			R22	CR=100% RQD=98% (34.50–36.00)
36.00m.				36.00

N.B. — '*' means sample could not be recovered.

BH-4/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-5

Co-ordinates E=972.075 N=1248.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	11	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	11
Vane (V)		Disturbed (DS)	7
		Water Sample (WS)	0

Commencement Date : 08/02/18
Completion Date : 10/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 900.141 M.
Water Struck At :
Standing Water Level : 4.30 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE EACH DIVN. = 15cm.			N	SAMPLES Ref. No	Depth (m)
Filled up soil consists of coal dust, boulder.	0.00m						DS-1	0.50
							DS-2	1.00
			4	6	12	18	SPT-1	1.50-1.95
							DS-3	2.50
Very stiff, reddish brown, silty clay with moorum.	3.00m		6	10	12	22	SPT-2	3.00-3.45
Hard, reddish brown, silty clay with moorum.	4.00m						UDS-1	4.00-4.45
			8	14	18	32	SPT-3	4.45-4.90
							DS-4	5.50
			10	16	20	36	SPT-4	6.00-6.45
							UDS-2	7.00-7.45
			12	16	24	40	SPT-5	7.45-7.90
							DS-5	8.50
			14	18	26	44	SPT-6	9.00-9.45
							*UDS-3	10.00-10.12
			13	20	29	49	SPT-7	10.50-10.95
							DS-6	11.50
			18	18	27	45	SPT-8	12.00-12.45
Hard, reddish brown, silty clay / clayey silt with decomposed rock fragments.	13.00m					≥100	DS-7	13.00
			28	36	50		SPT-9	13.50-13.86
			100	6.0 cm Pentn.		Refusal	*SPT-10	14.00-14.03
Highly to moderately weathered, yellowish grey, coarse grained, fractured rock.	14.10m		100	3.0 cm Pentn.		Refusal	*SPT-11	14.10-14.14
				4.0 cm Pentn.			R1	14.10-15.00 CR=34% RQD=NIL
			NX rotary drilling from 14.10m to 36.00m				R2	15.00-16.00 CR=36% RQD=12%
							R3	16.00-17.00 CR=28% RQD=15%
							R4	17.00-18.00 CR=38% RQD=NIL
	18.50m						R5	18.00- CR=39% RQD=20%

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-5

Co-ordinates E=972.075 N=1248.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	11	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	11
Vane (V)		Disturbed (DS)	7
		Water Sample (WS)	0

Commencement Date : 08/02/18
Completion Date : 10/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 900.141 M.
Water Struck At :
Standing Water Level : 4.30 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	Ref. No	Samples	Depth (m)
Highly to moderately weathered, yellowish grey, coarse grained, fractured rock.	18.50m. – 30.00m.		R6	CR=45% RQD=15%	19.00 – 20.00
			R7	CR=33% RQD=NIL	20.00 – 21.00
			R8	CR=32% RQD=20%	21.00 – 22.00
			R9	CR=28% RQD=12%	22.00 – 23.00
			R10	CR=32% RQD=NIL	23.00 – 24.00
			R11	CR=26% RQD=NIL	24.00 – 25.00
			R12	CR=24% RQD=NIL	25.00 – 26.00
			R13	CR=25% RQD=NIL	26.00 – 27.00
			R14	CR=28% RQD=NIL	27.00 – 28.00
			R15	CR=30% RQD=NIL	28.00 – 29.00
			R16	CR=28% RQD=NIL	29.00 – 30.00
Highly weathered, whitish grey, medium grained, slightly fractured rock.	30.00m. – 32.00m.		R17	CR=39% RQD=NIL	30.00 – 31.00
			R18	CR=40% RQD=NIL	31.00 – 32.00
Slightly weathered to fresh, whitish grey, medium grained, slightly fractured rock.	32.00m. – 36.00m.		R19	CR=75% RQD=50%	32.00 – 33.00
			R20	CR=100% RQD=93%	33.00 – 34.50
			R21	CR=100% RQD=94%	34.50 – 36.00

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-6

Co-ordinates E=1050.985 N=1261.850

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	10	Undisturbed (UDS)	2	Commencement Date :	06/02/18
Cone (Pc)		Penetrometer (SPT)	10	Completion Date :	08/02/18
Vane (V)		Disturbed (DS)	7	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	901.763 M
				Water Struck At :	
				Standing Water Level :	4.10 m.

Depth	DESCRIPTION	N-VALUE (EACH DIVN. = 15cm.)			N	Ref. No	Depth (m)
0.00m.	Very stiff, reddish brown, silty clay with moorum.					DS-1	0.50
						DS-2	1.00
		4	8	12	20	SPT-1	1.50-1.95
						UDS-1	2.50-2.95
		6	12	16	28	SPT-2	2.95-3.40
4.00m.	Hard, reddish brown, silty clay with moorum.					DS-3	4.00
		8	16	24	40	SPT-3	4.50-4.95
						*UDS-2	5.50-5.60
		12	19	29	48	SPT-4	6.00-6.45
						DS-4	7.00
		12	22	32	54	SPT-5	7.50-7.95
						DS-5	8.50
		14	19	33	52	SPT-6	9.00-9.45
						DS-6	10.00
10.50m.	Hard, yellowish brown, silty clay with decomposed rock fragments.	16	22	36	58	SPT-7	10.50-10.95
						DS-7	11.50
		45	65		≥100	SPT-8	11.70-11.90
		100	5.0 cm Pentn.		Refusal	*SPT-9	12.00-12.03
12.10m.	Highly weathered, yellowish brown, medium grained, fractured rock.	100	3.0 cm Pentn.		Refusal	*SPT-10	12.10-12.13
12.50m.			3.0 cm Pentn.			R1	CR=26% RQD=NIL

12.10

BH-6/Sheet-1

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-6

Co-ordinates E=1050.985 N=1261.850

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	7
		Water Sample (WS)	0

Commencement Date : 06/02/18
Completion Date : 08/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 901.763 M
Water Struck At :
Standing Water Level : 4.10 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	Ref. No	Sample	Depth (m)
Highly weathered, yellowish brown, medium grained, fractured rock.	12.50m – 16.10m	NX rotary drilling from 12.10m to 24.10m	R2	CR=24% RQD=NIL	13.10 – 14.10
			R3	CR=30% RQD=NIL	14.10 – 15.10
			R4	CR=26% RQD=NIL	15.10 – 16.10
Moderately weathered, light blackish grey, medium to coarse grained, fractured rock.	16.10m – 19.10m		R5	CR=42% RQD=NIL	16.10 – 17.10
			R6	CR=52% RQD=16%	17.10 – 18.10
			R7	CR=49% RQD=10%	18.10 – 19.10
Moderately weathered to fresh, light blackish grey, medium to coarse grained, fractured rock.	19.10m – 24.10m		R8	CR=67% RQD=NIL	19.10 – 20.10
			R9	CR=79% RQD=50%	20.10 – 21.10
			R10	CR=100% RQD=95%	21.10 – 22.60
			R11	CR=100% RQD=98%	22.60 – 24.10

N.B. — '*' means sample could not be recovered.

BH-6/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-7

Co-ordinates E=1103.042 N=1253.554

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	9
		Water Sample (WS)	0

Commencement Date : 01/02/18
Completion Date : 03/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 902.128 M.
Water Struck At :
Standing Water Level : 3.90 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)	N	SAMPLES Ref. No	SAMPLES Depth (m)
Very stiff, reddish brown, silty clay / clayey silt. Obs. sand mixture.	0.00m			DS−1	0.50
				DS−2	1.00
		5 7 14	21	SPT−1	1.50−1.95
				DS−3	2.50
				UDS−1	3.00−3.45
		8 10 15	25	SPT−2	3.45−3.90
				DS−4	4.50
Hard, reddish brown to yellowish brown, clayey silt. Obs. mica & decomposed rock.	5.00m	9 14 18	32	SPT−3	5.00−5.45
				DS−5	6.00
		10 16 21	37	SPT−4	6.50−6.95
				DS−6	7.50
		15 22 28	50	SPT−5	8.00−8.45
				DS−7	9.00
		14 23 31	54	SPT−6	9.50−9.95
				DS−8	10.50
		19 29 49	78	SPT−7	11.00−11.45
		100 5.0 cm Pentn.	Refusal	*SPT−8	12.00−12.05
				DS−9	12.45
Highly weathered, light yellowish brown, medium to fine grained fractured rock.	12.50m	100 4.0 cm Pentn.	Refusal	*SPT−9	12.50−12.54
		NX rotary drilling from 12.50m to 28.50m		R1	12.50 − 13.50 CR=26% RQD=NIL
	14.50m			R2	13.50 − 14.50 CR=25% RQD=NIL

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-7

Co-ordinates E=1103.042 N=1253.554

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	9	Undisturbed (UDS)	1	Commencement Date :	01/02/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date :	03/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	902.128 M.
				Water Struck At :	
				Standing Water Level :	3.90 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
14.50m. Highly weathered, light yellowish brown, medium to fine grained fractured rock.			R3	CR=26% RQD=NIL 15.50
			R4	CR=29% RQD=NIL 16.50
			R5	CR=35% RQD=NIL 17.50
			R6	CR=38% RQD=NIL 18.50
			R7	CR=34% RQD=NIL 19.50
			R8	CR=36% RQD=NIL 20.50
			R9	CR=32% RQD=NIL 21.50
			R10	CR=37% RQD=10% 22.50
23.50m.			R11	CR=36% RQD=NIL 23.50
Moderately weathered, light blackish grey, medium grained, moderately fractured rock. 24.50m.			R12	CR=46% RQD=NIL 24.50
Slightly weathered to fresh, light blackish grey, medium grained, moderately fractured rock.			R13	CR=72% RQD=NIL 25.50
			R14	CR=100% RQD=93% 26.50
			R15	CR=100% RQD=98% 27.50
28.50m.			R16	CR=100% RQD=99% 28.50

N.B. — '*' means sample could not be recovered.

BH-7/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-10

Co-ordinates E=1103.245 N=1070.270

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	2	Commencement Date :	11/02/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	13/02/18
Vane (V)		Disturbed (DS)	7	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	899.744 M.
				Water Struck At :	
				Standing Water Level :	5.35 m.

Depth	DESCRIPTION	N-VALUE (EACH DIVN. = 15cm.)	N	SAMPLES Ref. No	Depth (m)
0.00m – 4.00m	Stiff, reddish brown, silty clay / clayey silt with traces of fine sand mixture. Obs. kankars.			DS-1	0.50
				DS-2	1.00
		3 4 7	11	SPT-1	1.50-1.95
				DS-3	2.20
				UDS-1	2.50-2.95
		4 4 9	13	SPT-2	2.95-3.40
4.00m – 6.00m	Very stiff, brownish grey, silty clay / clayey silt with sand mixture.			DS-4	4.00
		5 8 12	20	SPT-3	4.50-4.95
				DS-5	5.30
				*UDS-2	5.50-5.80
6.00m – 7.50m	Dense, brownish grey, silty fine to medium grained sand.	9 14 18	32	SPT-4	6.00-6.45
				DS-6	7.00
7.50m – 10.00m	Very dense, grey, silty sand with decomposed & disintegrated rock fragments.	17 29 52 (5.0 cm Pentn.)	≥100	SPT-5	7.50-7.85
				DS-7	8.50
		18 31 50 (4.0 cm Pentn.)	≥100	SPT-6	9.00-9.34
10.00m – 11.00m	Highly weathered, yellowish brown, fine to medium grained, highly fractured rock.	52 (4.0 cm Pentn.)	Refusal	*SPT-7	10.00-10.04
		NX rotary drilling from 10.00m to 21.00m		R1	CR=21% RQD=NIL (10.00 – 11.00)

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Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-10

Co-ordinates E=1103.245 N=1070.270

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	7	Undisturbed (UDS)	2	Commencement Date :	11/02/18
Cone (Pc)		Penetrometer (SPT)	7	Completion Date :	13/02/18
Vane (V)		Disturbed (DS)	7	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	899.744 M.
				Water Struck At :	
				Standing Water Level :	5.35 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES	Depth (m)
11.00m. Highly weathered, yellowish brown, fine to medium grained, highly fractured rock. 12.00m.			R2	CR=32% RQD=NIL	12.00
Highly weathered, grey, fine to medium grained, highly fractured rock. 18.00m.			R3	CR=26% RQD=NIL	13.00
			R4	CR=28% RQD=20%	14.00
			R5	CR=43% RQD=25%	15.00
			R6	CR=30% RQD=NIL	16.00
			R7	CR=32% RQD=NIL	17.00
			R8	CR=37% RQD=27%	18.00
Fresh, light blackish grey, medium grained, slightly fractured rock. 21.00m.			R9	CR=100% RQD=90%	19.50
			R10	CR=100% RQD=98%	21.00

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095 | Created by : Chandrani | Created on : 17/02/2018 | Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-11

Co-ordinates E=1087.882 N=1026.070

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	8	Undisturbed (UDS)	2	Commencement Date :	08/02/18
Cone (Pc)		Penetrometer (SPT)	8	Completion Date :	10/02/18
Vane (V)		Disturbed (DS)	8	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	898.032 M
				Water Struck At :	
				Standing Water Level :	5.10 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE EACH DIVN. = 15cm.			N	SAMPLES Ref. No	Depth (m)
Stiff to very stiff, reddish brown, silty clay / clayey silt. Obs. fine sand mixture.	0.00m.						DS-1	0.50
							DS-2	1.00
			3	4	8	12	SPT-1	1.50-1.95
							UDS-1	2.50-2.95
			5	8	13	21	SPT-2	2.95-3.40
							DS-3	4.00
			9	12	18	30	SPT-3	4.50-4.95
Stiff to very stiff, yellowish brown, clayey silt with fine to medium grained, sand.	5.50m.						DS-4	5.50
			4	4	5	9	SPT-4	6.00-6.45
							*UDS-2	7.00-7.45
							DS-5	7.80
			4	6	8	14	SPT-5	8.20-8.65
							DS-6	9.00
			6	8	10	18	SPT-6	9.50-9.95
							DS-7	10.50
Residual soil.	11.00m. - 11.50m.		12	20	34	54	SPT-7	11.00-11.45

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 17/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-11

Co-ordinates E=1087.882 N=1026.070

Field Test	Nos	Samples	Nos		
				Commencement Date :	08/02/18
				Completion Date :	10/02/18
Penetrometer (SPT)	8	Undisturbed (UDS)	2	Bore Hole Diameter :	150 mm. / N.X.
Cone (Pc)		Penetrometer (SPT)	8	Level Of Ground :	898.032 M
		Disturbed (DS)	8	Water Struck At :	
Vane (V)		Water Sample (WS)	0	Standing Water Level :	5.10 m.

DESCRIPTION	Depth	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)	
Residual soil.	11.50m.			DS-8	12.00	
	12.50m.		52 Refusal 6.0 cm Pentn.	*SPT-8	12.50-12.56	12.50
Highly weathered, light whitish grey / grey, fine to medium grained, fractured rock.			NX rotary drilling from 12.50m to 22.50m	R1	CR=25% RQD=NIL	13.50
				R2	CR=24% RQD=NIL	14.50
	14.50m.			R3	CR=39% RQD=10%	15.50
Moderately to slightly weathered, yellowish grey / grey, fine to medium grained, fractured rock.				R4	CR=68% RQD=55%	16.50
				R5	CR=65% RQD=12%	17.50
				R6	CR=54% RQD=15%	18.50
				R7	CR=50% RQD=13%	19.50
	19.50m.			R8	CR=100% RQD=93%	21.00
Fresh, grey, fine to medium grained, fractured rock.				R9	CR=100% RQD=95%	22.50
	22.50m.					

N.B. – '*' means sample could not be recovered.

BH-11/Sheet-2

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-12

Field Test	Nos	Samples	Nos	
Penetrometer (SPT)	9	Undisturbed (UDS)	1	Commencement Date : 04/02/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date : 07/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter : 150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground : 895.298 M
				Water Struck At :
				Standing Water Level : 6.20 m.

DESCRIPTION	Depth	N-VALUE (EACH DIVN. = 15cm.)				SAMPLES Ref. No	Depth (m)
Very stiff, reddish brown, silty clay / clayey silt.	0.00m					DS-1	0.50
						DS-2	1.00
		5	10	14	24	SPT-1	1.50-1.95
						DS-3	2.50
						UDS-1	3.05-3.55
		8	12	17	29	SPT-2	3.55-4.00
						DS-4	4.50
Hard, reddish brown, silty clay / clayey silt.	5.00m	11	16	25	41	SPT-3	5.05-5.50
						DS-5	6.00
Hard, brownish grey, clayey silt.	6.50m	13	19	32	51	SPT-4	6.55-7.00
						DS-6	7.50
		16	22	35	57	SPT-5	8.00-8.45
						DS-7	9.00
		16	23	38	61	SPT-6	9.50-9.95
						DS-8	11.50
		18	36	44	80	SPT-7	12.00-12.45
						DS-9	12.80
		100	5.0 cm Pentn.		Refusal	*SPT-8	13.00-13.05
Highly weathered, yellowish brown, medium grained, fractured rock.	13.50m	100	4.0 cm Pentn.		Refusal	*SPT-9	13.50-13.54
		NX rotary drilling from 13.50m to 30.50m				R1	13.50 CR=27% RQD=NIL 14.50
						R2	CR=28% RQD=NIL 15.50
	16.00m					R3	CR=27% RQD=NIL

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 16/02/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-12

Field Test	Nos	Samples	Nos		
Penetrometer (SPT)	9	Undisturbed (UDS)	1	Commencement Date :	04/02/18
Cone (Pc)		Penetrometer (SPT)	9	Completion Date :	07/02/18
Vane (V)		Disturbed (DS)	9	Bore Hole Diameter :	150 mm. / N.X.
		Water Sample (WS)	0	Level Of Ground :	895.298 M
				Water Struck At :	
				Standing Water Level :	6.20 m

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No		Depth (m)
16.00m. Highly weathered, yellowish brown, medium grained, fractured rock.			R4	CR=28% RQD=NIL	16.50 – 17.50
			R5	CR=26% RQD=NIL	17.50 – 18.50
			R6	CR=27% RQD=NIL	18.50 – 19.50
			R7	CR=28% RQD=NIL	19.50 – 20.50
			R8	CR=29% RQD=NIL	20.50 – 21.50
			R9	CR=31% RQD=NIL	21.50 – 22.50
23.00m. Highly weathered, yellowish grey, medium grained, highly fractured rock.			R10	CR=27% RQD=NIL	22.50 – 23.50
			R11	CR=39% RQD=NIL	23.50 – 24.50
			R12	CR=35% RQD=NIL	24.50 – 25.50
			R13	CR=37% RQD=NIL	25.50 – 26.50
26.50m. Slighlty weathered to fresh, blackish grey, coarse grained, slightly fractured rock.			R14	CR=78% RQD=39%	26.50 – 27.50
			R15	CR=100% RQD=97%	27.50 – 29.00
30.50m.			R16	CR=100% RQD=97%	29.00 – 30.50

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:

BORE LOG DATA SHEET | BORE HOLE NO. MND-13

Co-ordinates E=1507.562 N=950.629

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	23
		Water Sample (WS)	0

Commencement Date :	14/02/18
Completion Date :	16/02/18
Bore Hole Diameter :	150 mm. / N.X.
Level Of Ground :	898.164 M.
Water Struck At :	
Standing Water Level :	11.30 m.

DESCRIPTION	Depth	N-VALUE EACH DIVN. = 15cm.				SAMPLES Ref. No	SAMPLES Depth (m)
Filled up with road materials.	0.00m. – 0.50m.					DS-1	0.50
Very stiff, reddish brown, silty clay. Obs. sand traces in occassionaly.	0.50m. – 4.50m.					DS-2	1.00
		6	8	10	18	SPT-1	1.50-1.95
						DS-3	2.50
						UDS-1	3.00-3.45
		10	12	16	28	SPT-2	3.45-3.90
Hard, reddish brown, silty clay. Obs. sand traces in occassionaly.	4.50m. – 12.00m.					DS-4	4.50
		12	15	19	34	SPT-3	5.00-5.45
						*UDS-2	6.00-6.14
		14	18	22	40	SPT-4	6.50-6.95
						DS-5	7.50
		16	19	24	43	SPT-5	8.00-8.45
						DS-6	9.00
		17	22	26	48	SPT-6	9.50-9.95
						DS-7	10.50
		17	21	31	52	SPT-7	11.00-11.45
Hard, reddish brown to brownish grey, silty clay. Obs. kankars.	12.00m. – 13.60m.					DS-8	12.00
		19	24	32	56	SPT-8	12.50-12.95
Hard, reddish brown, silty clay with whitish spots. Obs. fine sand.	13.60m. – 15.50m.					DS-9	13.50
		22	33	54	87	SPT-9	14.00-14.45
						DS-10	15.00
Completely to highly weathered, reddish brown, medium to coarse grained, decomposed & disintegrated rock fragments.	15.50m. – 20.50m.	27	52 15.0 cm Pentn.		≥100 Refusal	SPT-10	15.50-15.80
		54 5.0 cm Pentn.				*SPT-11	16.50-16.55
		NX rotary drilling from 16.50m to 40.00m				R1	16.50 – 17.50 CR=27% RQD=12%
						R2	17.50 – 18.50 CR=20% RQD=NIL
						R3	18.50 – 19.50 CR=21% RQD=NIL
						R4	19.50 – 20.50 CR=24% RQD=15%

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 22/03/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. MND-13

Co-ordinates E=1507.562 N=950.629

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	18	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	18
Vane (V)		Disturbed (DS)	23
		Water Sample (WS)	0

Commencement Date : 14/02/18
Completion Date : 16/02/18
Bore Hole Diameter : 150 mm. / N.X.
Level Of Ground : 898.164 M.
Water Struck At :
Standing Water Level : 11.30 m.

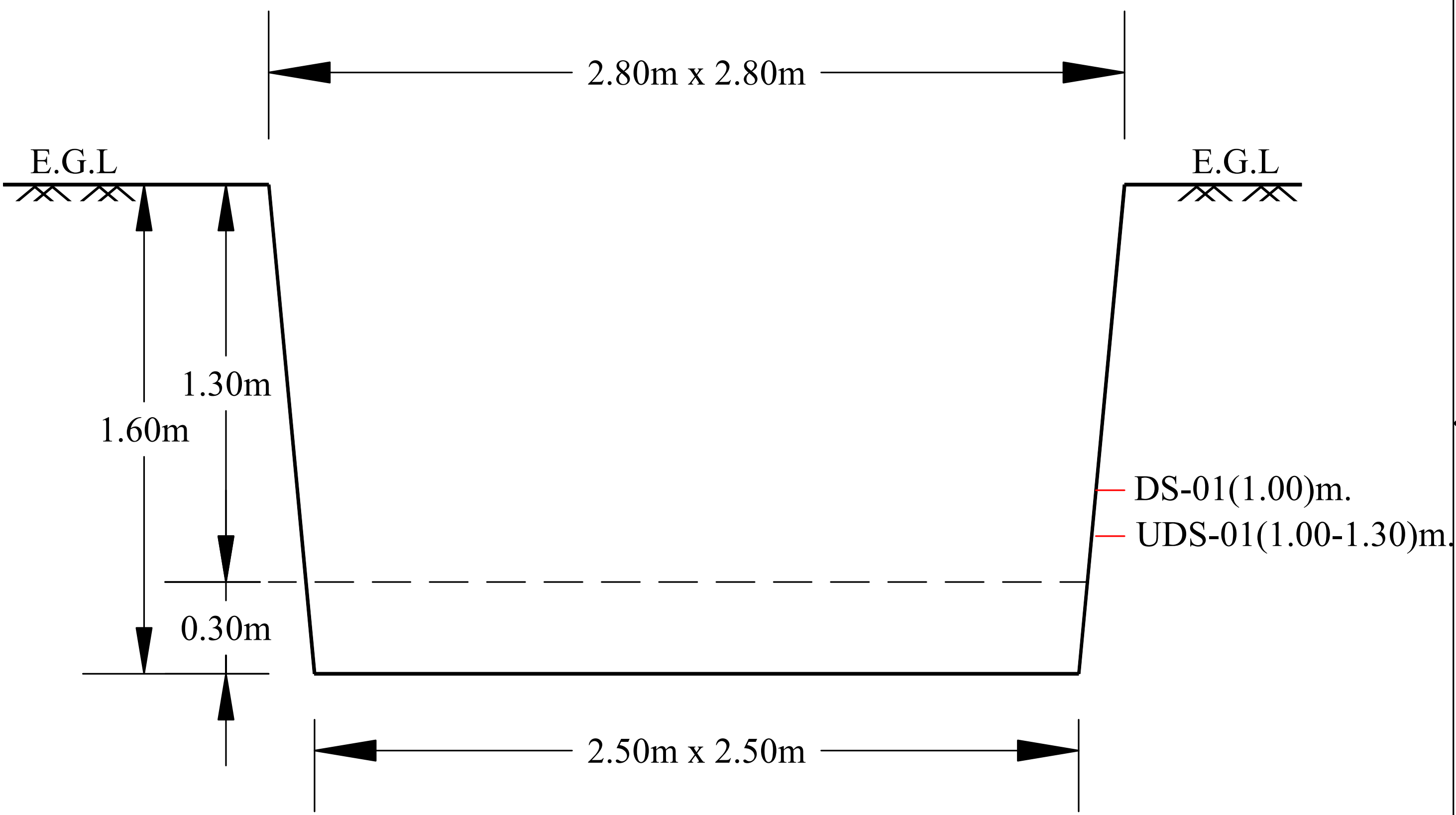
DESCRIPTION	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No		Depth (m)
20.50m. Completely to highly weathered, reddish brown, medium to coarse grained, decomposed & disintegrated rock fragments.		R5	CR=21% RQD=20%	21.50
		R6	CR=21% RQD=12%	22.50
		R7	CR=38% RQD=16%	23.50
		R8	CR=21% RQD=10%	24.50
		R9	CR=23% RQD=NIL	25.50
		R10	CR=37% RQD=28%	26.50
		R11 DS-11	CR=NIL RQD=NIL	27.50
	54 Refusal 4.0 cm Penth.	R12 DS-12 *SPT-12	CR=NIL RQD=NIL 28.50-28.54	28.50
		R13 DS-13	CR=NIL RQD=NIL	29.50
	50 Refusal 3.0 cm Penth.	R14 DS-14 *SPT-13	CR=NIL RQD=NIL 30.50-30.53	30.50
		R15 DS-15	CR=NIL RQD=NIL	31.50
	55 Refusal 6.0 cm Penth.	R16 DS-16 *SPT-14	CR=NIL RQD=NIL 32.50-32.56	32.50
		R17 DS-17	CR=NIL RQD=NIL	33.50
	54 Refusal 4.0 cm Penth.	R18 DS-18 *SPT-15	CR=NIL RQD=NIL 34.50-34.54	34.50
		R19 DS-19	CR=NIL RQD=NIL	35.50
	55 Refusal 7.0 cm Penth.	R20 DS-20 *SPT-16	CR=NIL RQD=NIL 36.50-36.57	36.50
		R21 DS-21	CR=NIL RQD=NIL	37.50
	54 Refusal 5.0 cm Penth.	R22 DS-22 *SPT-17	CR=NIL RQD=NIL 38.50-38.55	38.50
40.43m.	52 Refusal 3.0 cm Penth.	R23 DS-23 *SPT-18	CR=NIL RQD=NIL 40.00-40.03	40.00

N.B. — '*' means sample could not be recovered.

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 2041.660M.
N = 1594.187M.
RL = 924.910M.

SWL = Not found



Description of Soil:-

(EGL-1.30)m:- Reddish brown, silty clay / clayey silt. Obs. kankars.

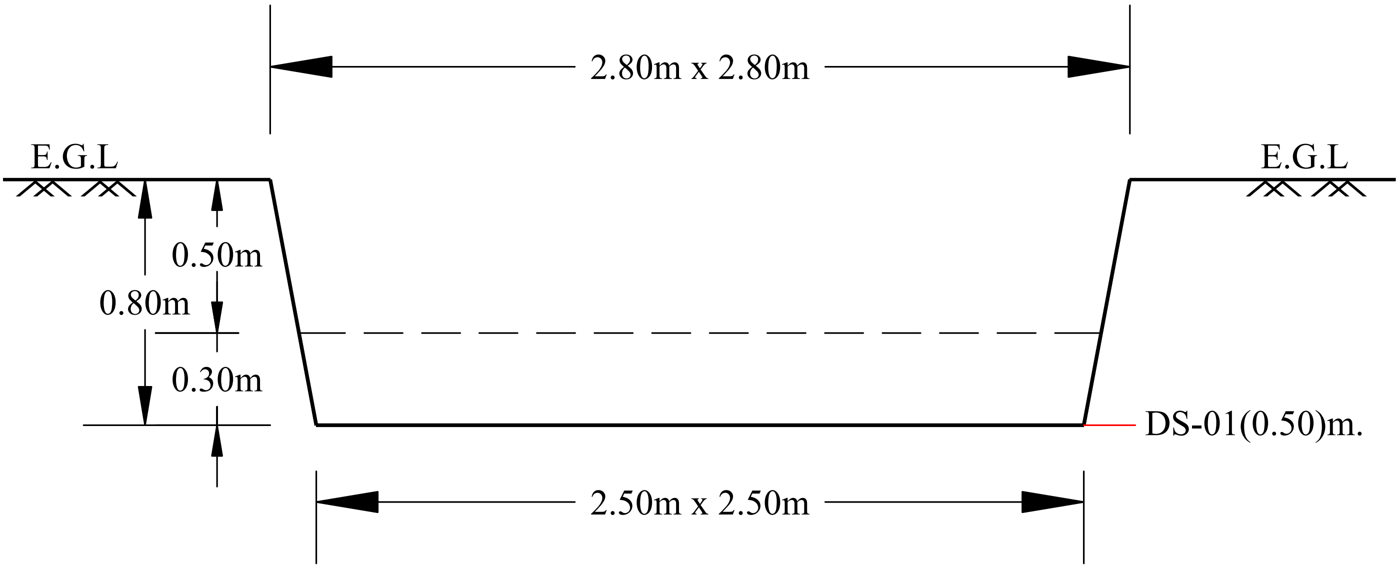
(1.30-1.60)m:- Grey, silty sand with decomposed rock.

PIT LOG OF TP - 04

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 1950.998M.
N = 1081.572M.
RL = 918.223M.

SWL = Not found



Description of Soil:-

(EGL-0.50)m:- Reddish brown, silty clay / clayey silt. Obs. sand mixture.

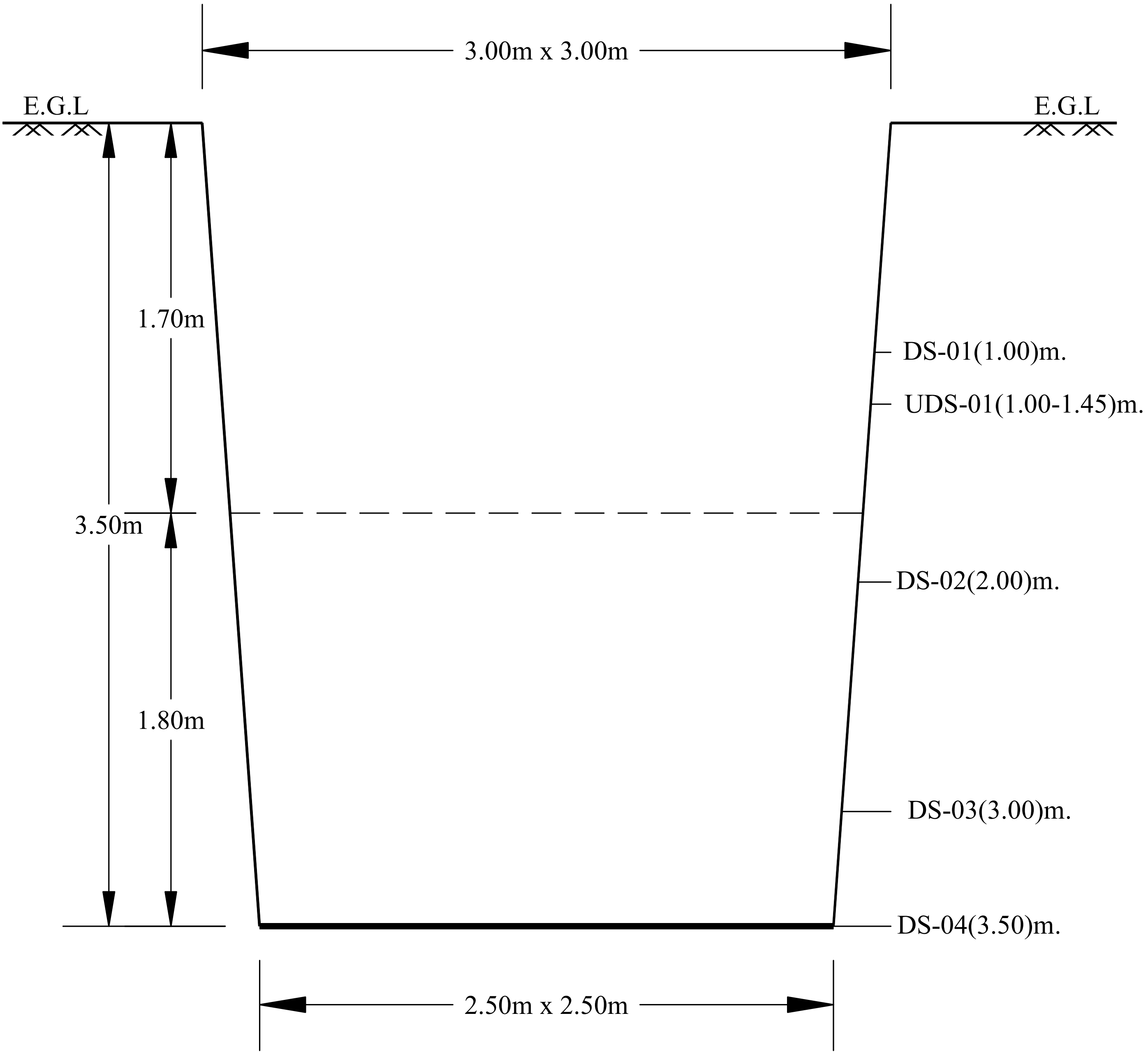
(0.50-1.10)m:- Light yellowish brown, silty sand with highly weathered rock.

PIT LOG OF TP - 05

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 02 / 2018	Sheet No:

Co-ordinates:
E = 1862.570M.
N = 444.903M.
RL = 907.020M.

SWL = Not found



Description of Soil:-

(EGL-1.70)m:- Reddish brown, silty clay with moorum.

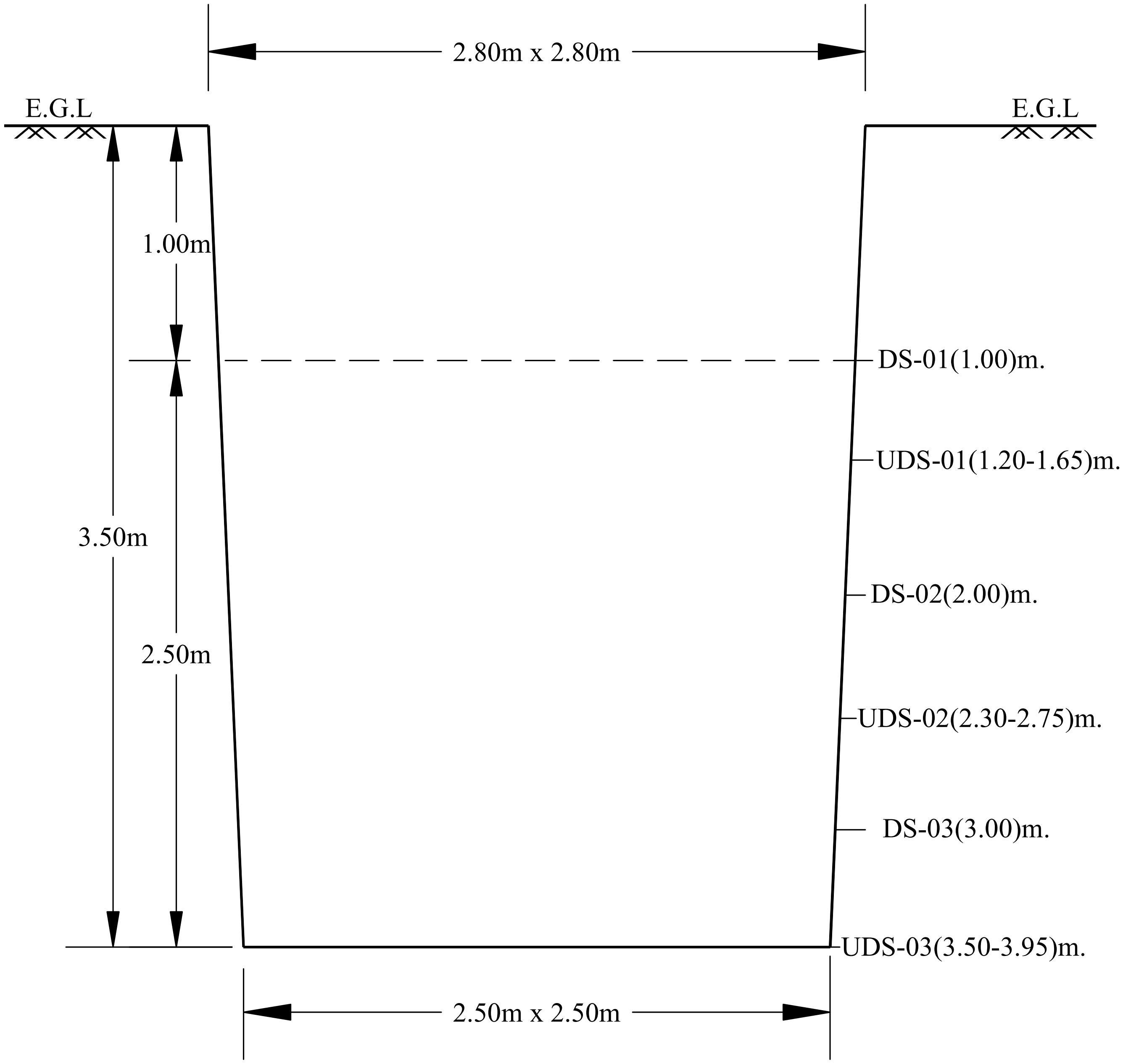
(1.70-3.50)m:- Yellowish brown to whitish grey, silty clay / clayey silt with kankars.

PIT LOG OF TP - 06

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4 0 9 5	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 717.981M.
N = 776.546M.
RL = 897.460M.

SWL = Not found



Description of Soil:-

(EGL-1.00)m:- Reddish brown, silty clay / clayey silt with boulder (filled up soil).

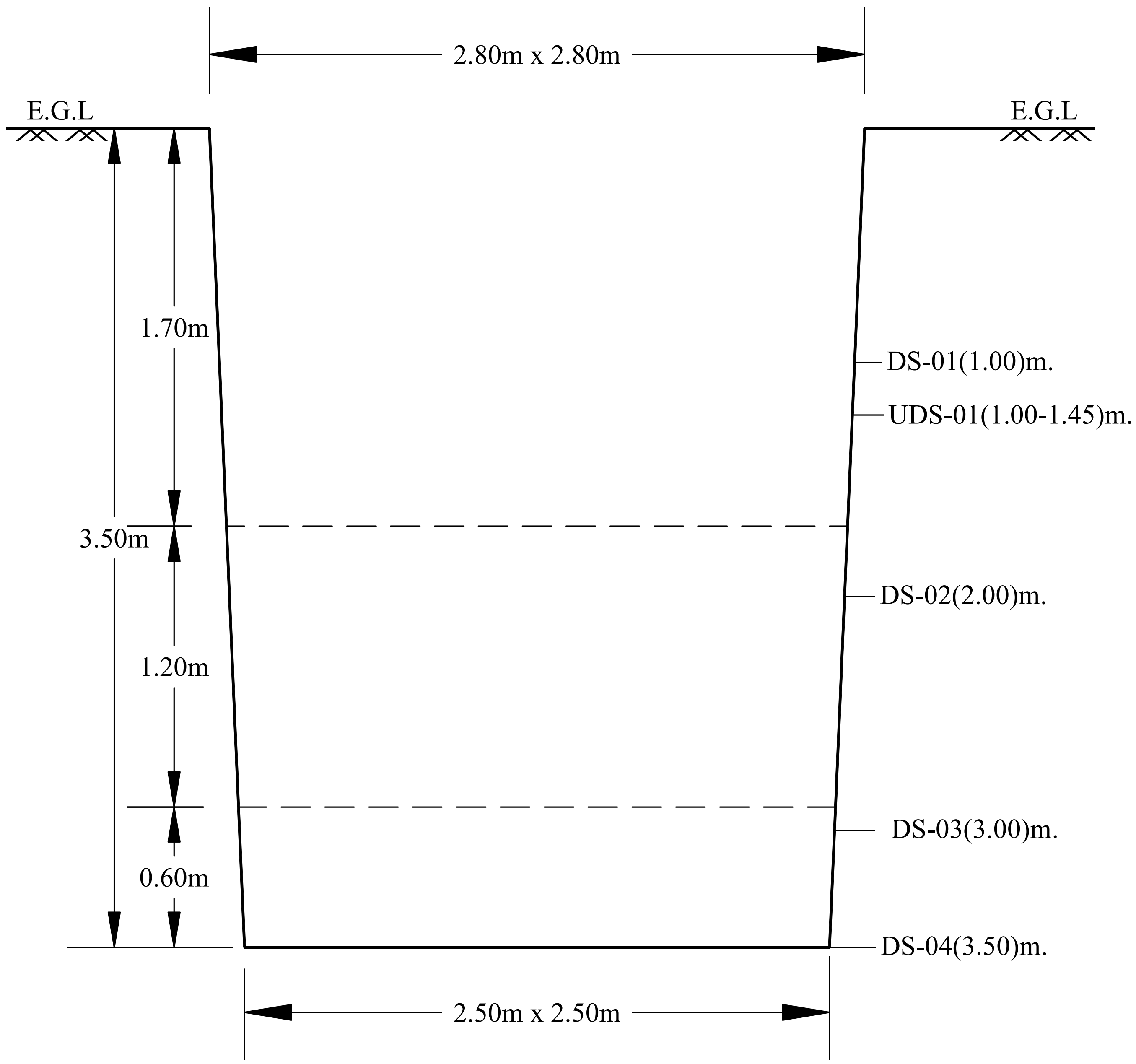
(1.00-2.50)m:- Reddish brown, clayey silt with boulder, kankars, iron rod (filled up soil).

PIT LOG OF TP - 07

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 1129.369M.
N = 907.525M.
RL = 892.280M.

SWL = Not found



Description of Soil:-

(EGL-1.70)m:- Reddish brown, silty clay / clayey silt. Obs. kankars.

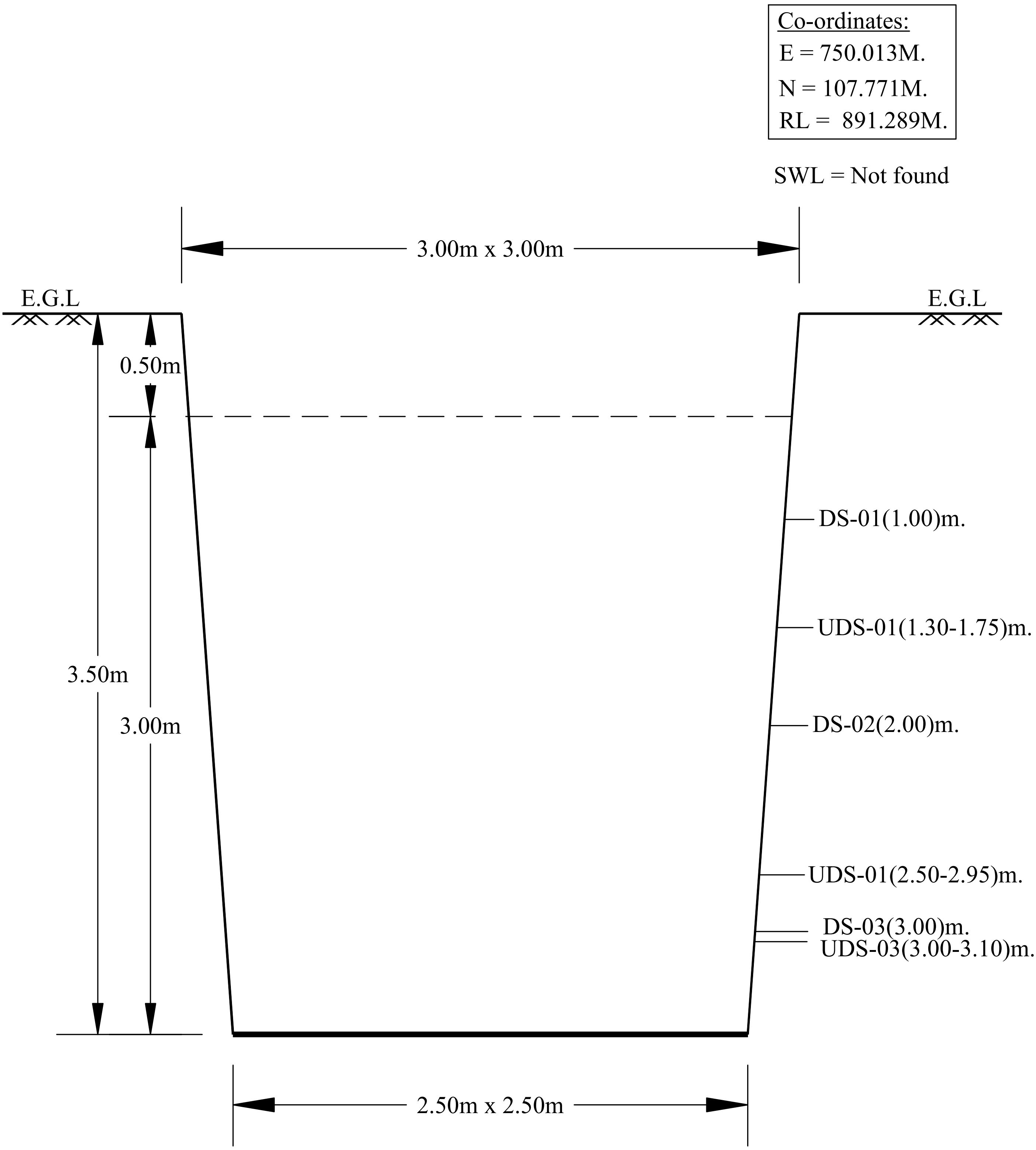
(1.70-2.90)m:- Yellowish brown / brownish grey, clayey silt with traces of fine sand.

(2.90-3.50)m:- Yellowish brown, silty clay / clayey silt. Obs. kankars.

PIT LOG OF TP - 08

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. CETEST

Job No : 4095	Created by : Chandrani	Created on : 06 / 02 / 2018	Sheet No:



Description of Soil:-

(EGL-0.50)m:- Reddish brown, clayey silt with moourm & kankars.

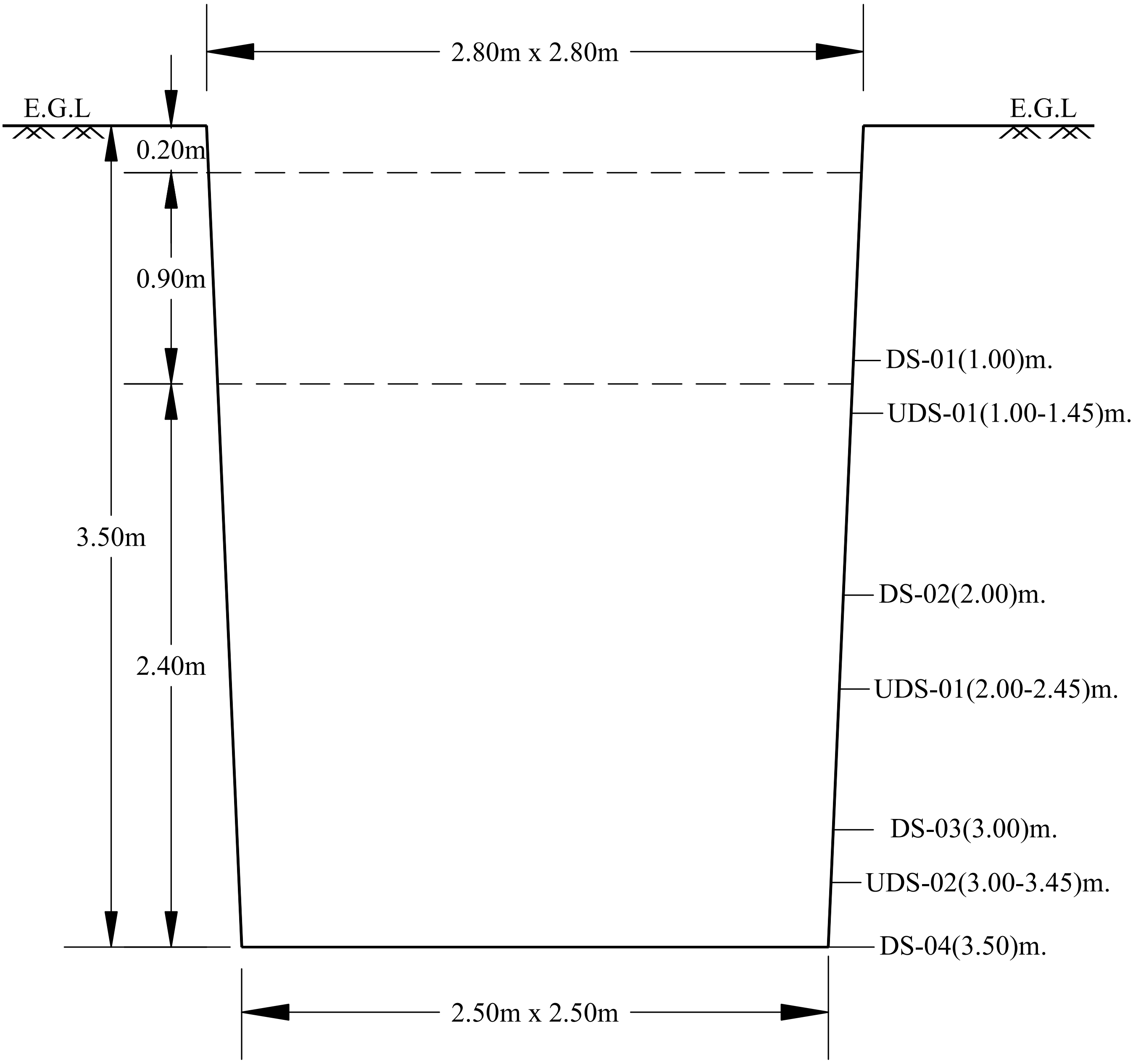
(0.50-3.50)m:- Yellowish brown, clayey silt with decomposed rock.

PIT LOG OF TP - (MND) 01

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			
Job No : 4 0 9 5	Created by : Chandrani	Created on : 06 / 02 / 2018	Sheet No:

Co-ordinates:
E = 1061.908M.
N = 1176.219M.
RL = 900.078M.

SWL = Not found



Description of Soil:-

(EGL-0.20)m:- Brownish grey, silty clay with kankars (filled up).

(0.20-1.10)m:- Filled up soil consists of calcium dust.

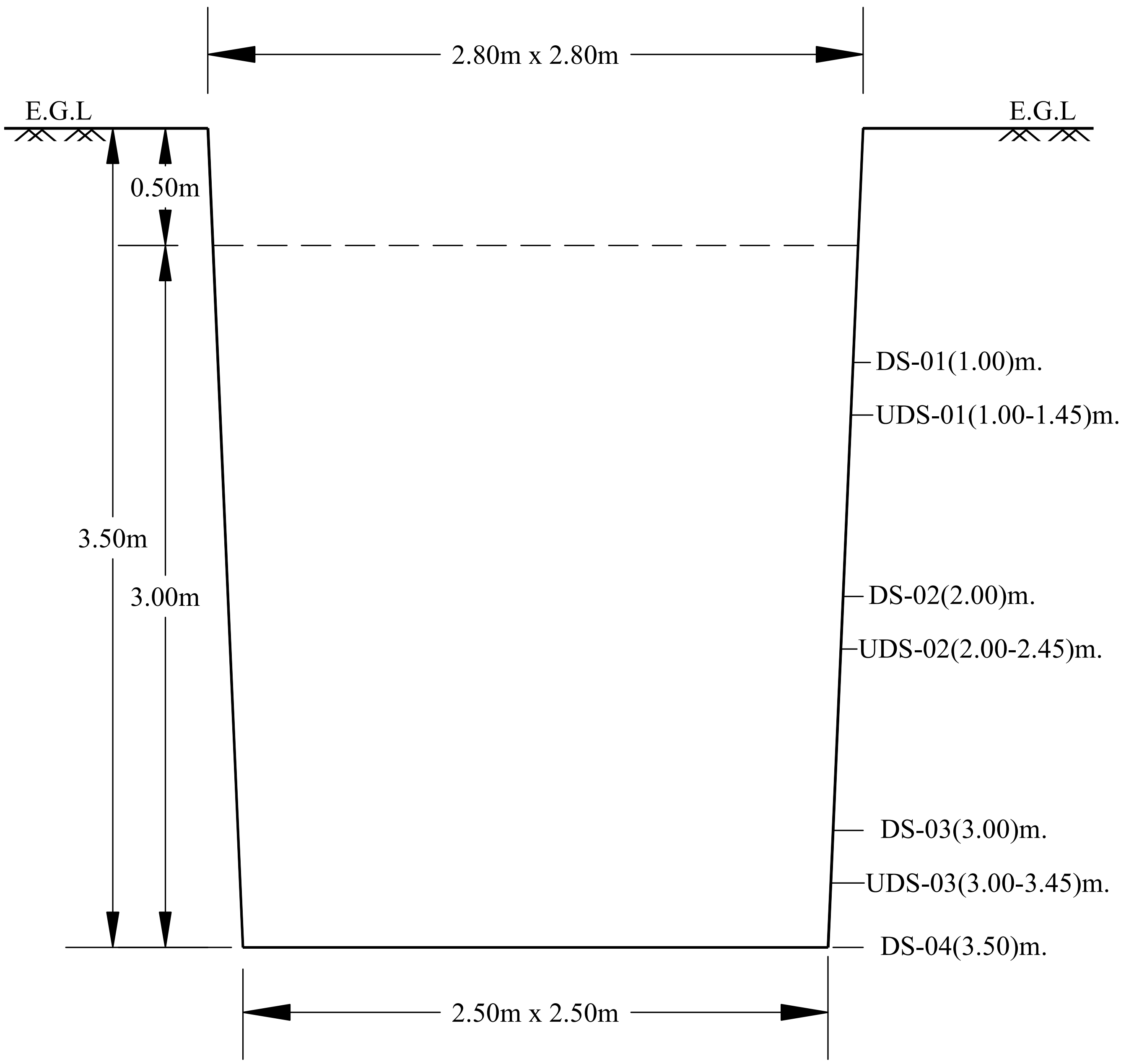
(1.10-2.40)m:- Reddish brown, silty clay / clayey silt. Obs. kankars.

PIT LOG OF TP - (MND) 02

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 1130.080M.
N = 1261.109M.
RL = 902.600M.

SWL = Not found



Description of Soil:-

(EGL-0.50)m:- Filled up with whitish grey, calcium dust.

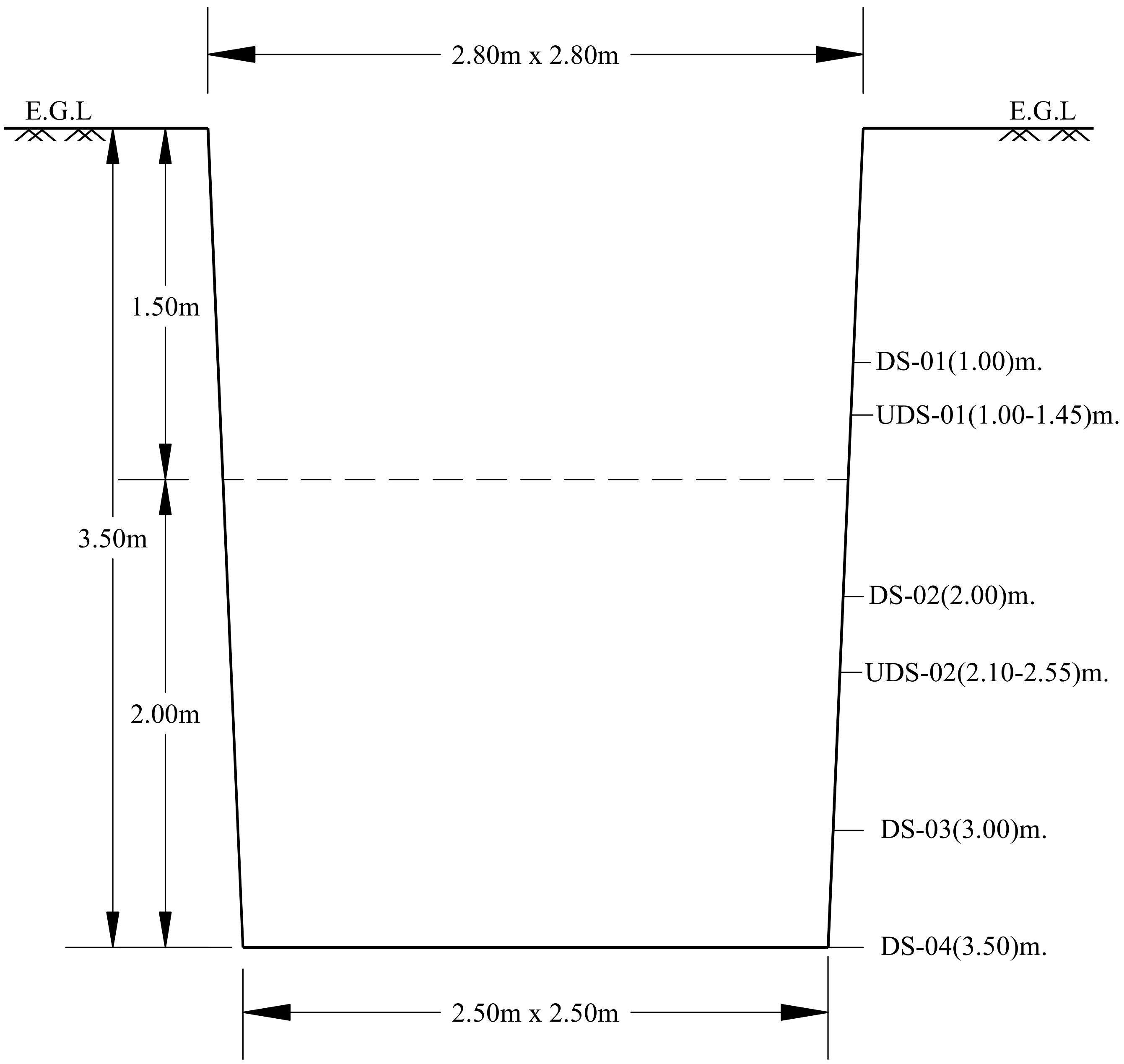
(0.50-3.50)m:- Reddish brown, clayey silt / silty clay. Obs. fine sand.

PIT LOG OF TP - (MND) 03

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 02 / 2018	Sheet No:

Co-ordinates:
E = 1112.011M.
N = 1181.943M.
RL = 900.735M.

SWL = Not found



Description of Soil:-

(EGL-1.50)m:- Light reddish brown, clayey silt with sand mixture.

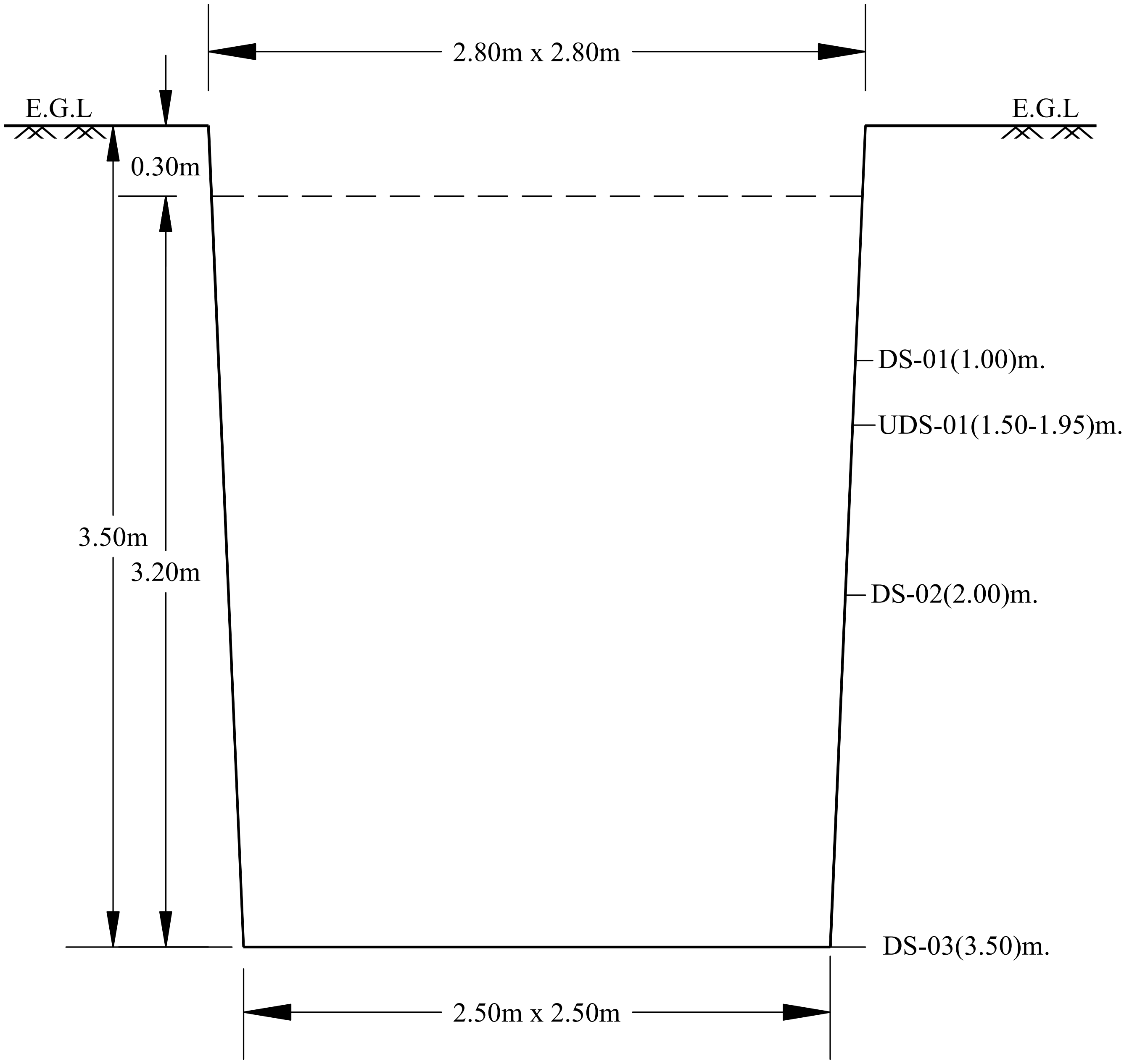
(1.50-2.00)m:- Reddish brown, silty clay / clayey silt.

PIT LOG OF TP - (MND) 04

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 1067.227M.
N = 1072.026M.
RL = 897.331M.

SWL = Not found



Description of Soil:-

(EGL-0.30)m:- Black, coal dust (filling).

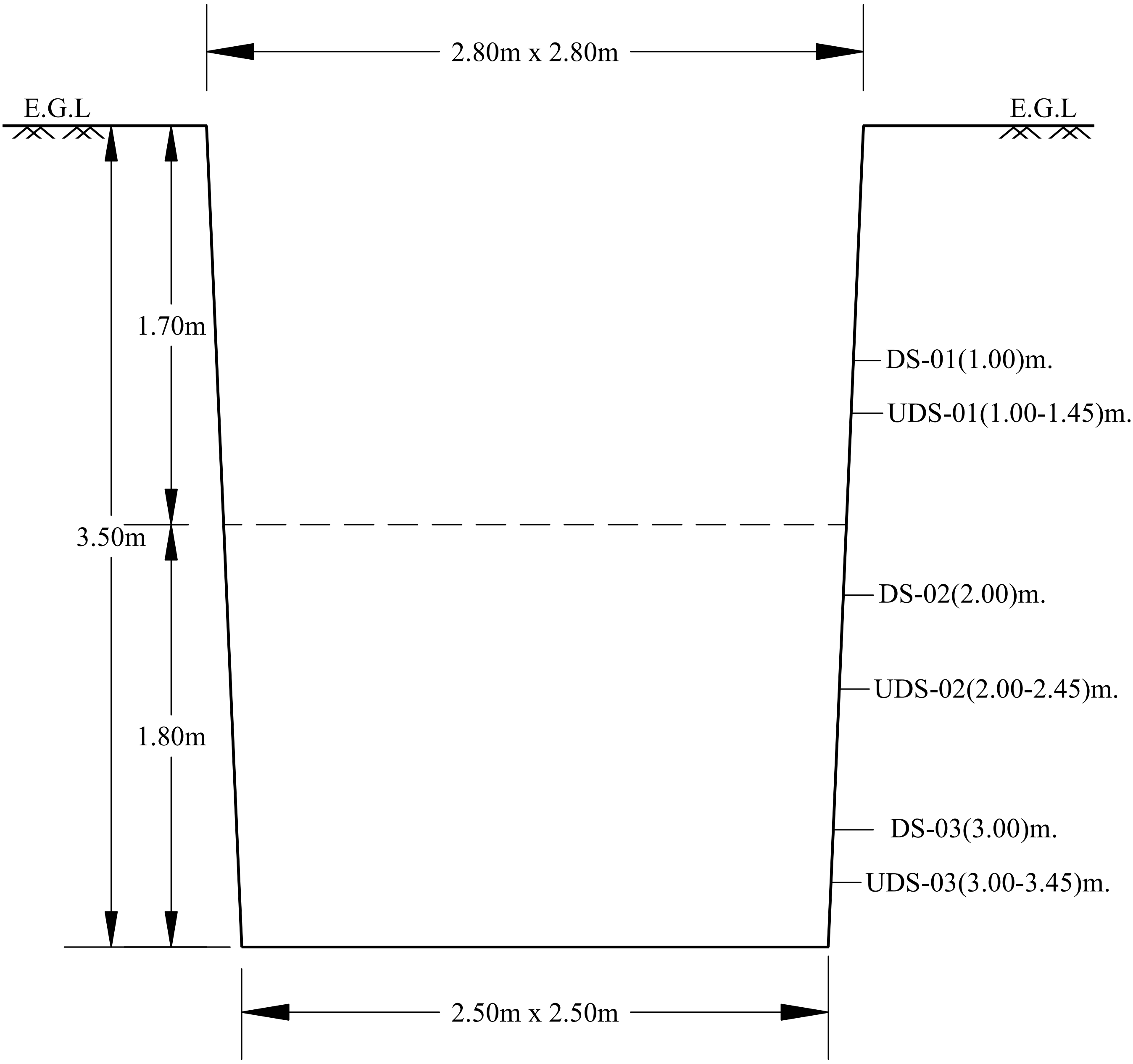
(0.30-3.20)m:- Rddish brown, silty clay / clayey silt. Obs. sand & kankars.

PIT LOG OF TP - (MND) 05

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

Co-ordinates:
E = 1498.204M.
N = 903.623M.
RL = 898.443M.

SWL = Not found



Description of Soil:-

(EGL-1.70)m:- Reddish brown, silty clay / clayey silt. Obs. kankars.

(1.70-3.50)m:- Reddish brown, clayey silt with moorum.

PIT LOG OF TP - (MND) 06

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	**Created by :** Chandrani	**Created on :** 06 / 02 / 2018	**Sheet No:**

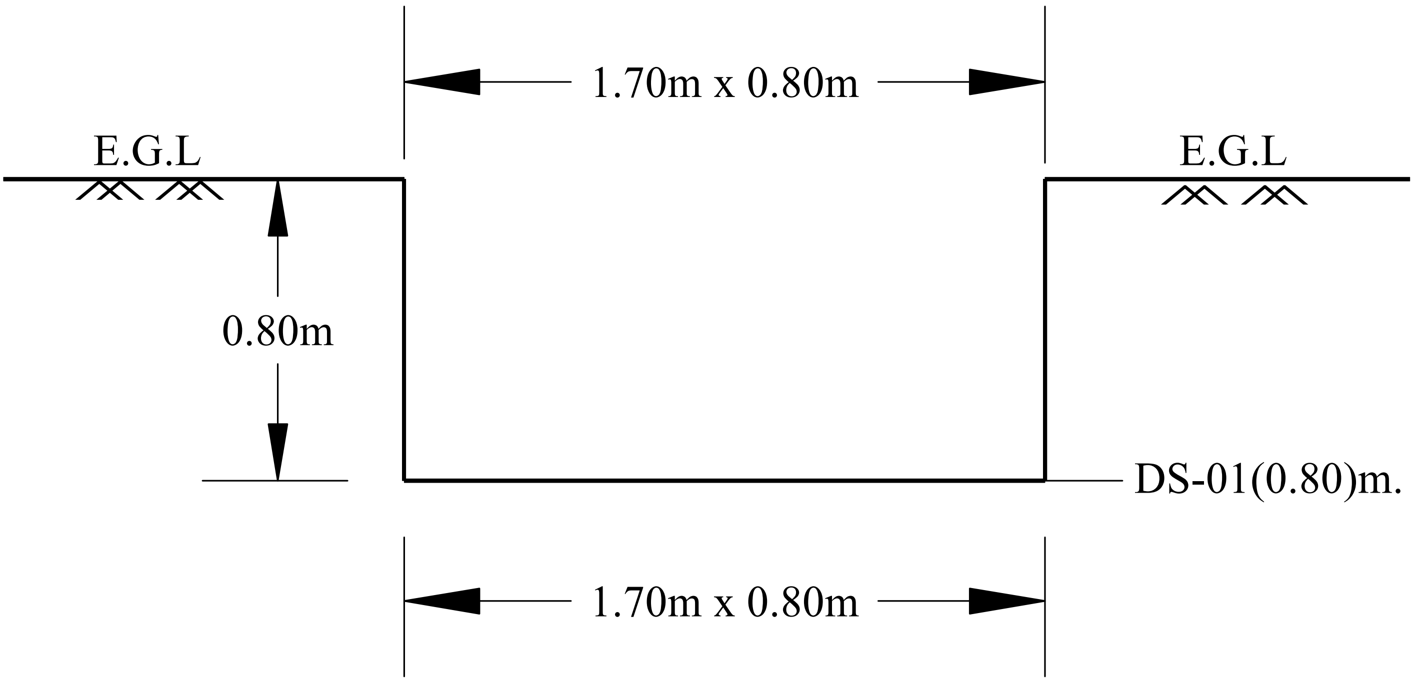
Co-ordinates:

E =1483.948M.

N = 1643.399M.

RL = 921.420M.

SWL = Not found



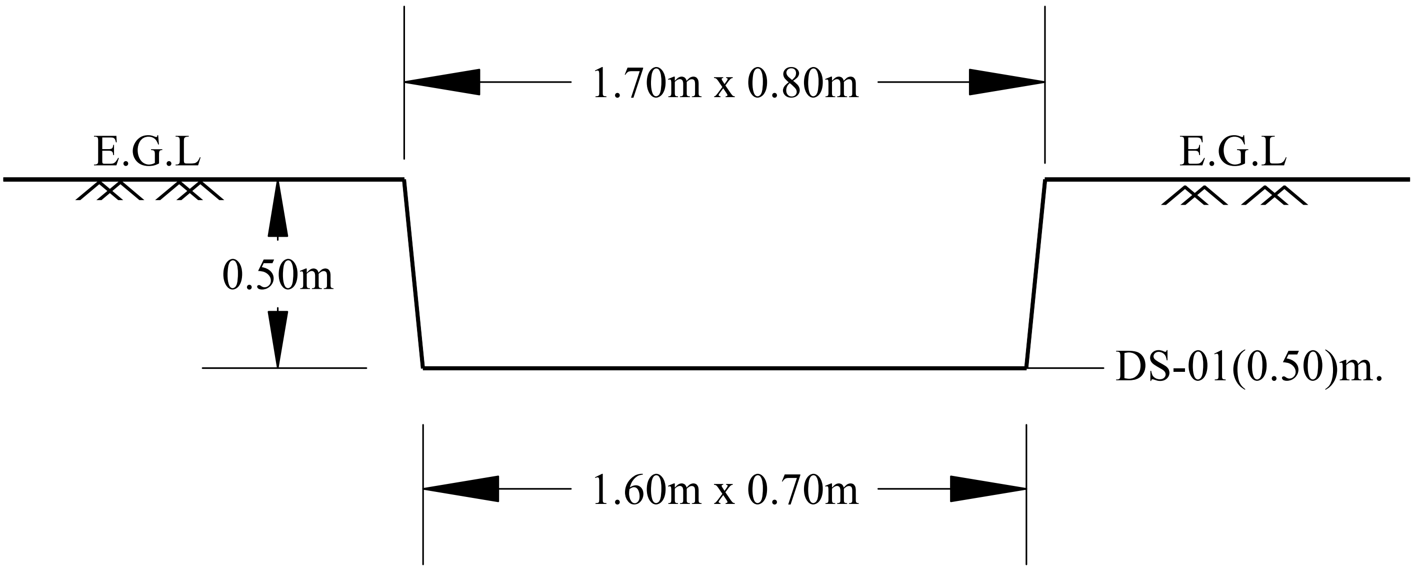
Description of Soil:-

(EGL-0.80)m:- Brownish grey, silty clay with traces of fine sand. Obs. kankars.

PIT LOG OF CBR - 02

Co-ordinates:
E =1921.028M.
N = 1649.156M.
RL = 926.420M.

SWL = Not found



Description of Soil:-

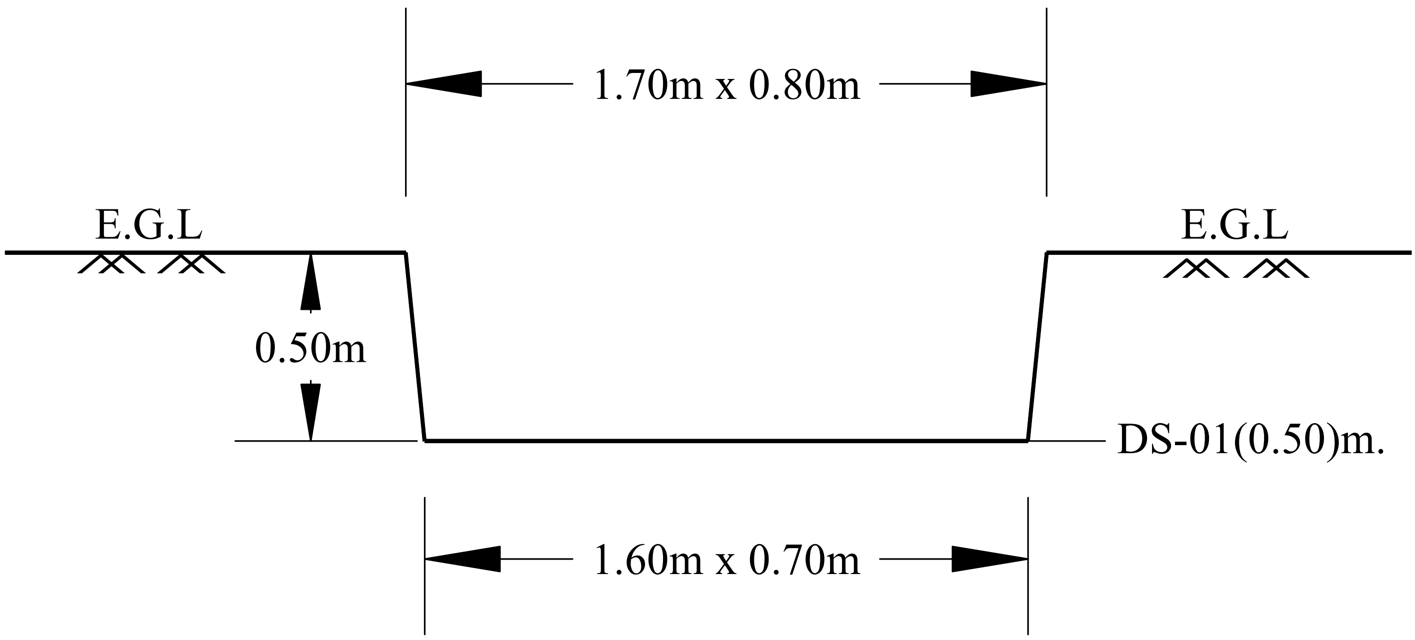
(EGL-0.50)m:- Reddish brown, silty clay with moourm.

PIT LOG OF CBR - 04

Project : Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No : 4095	Created by : Chandrani	Created on : 06 / 02 / 2018	Sheet No:

Co-ordinates:
E = 2151.449M.
N = 1704.949M.
RL = 923.066 M.

SWL = Not found



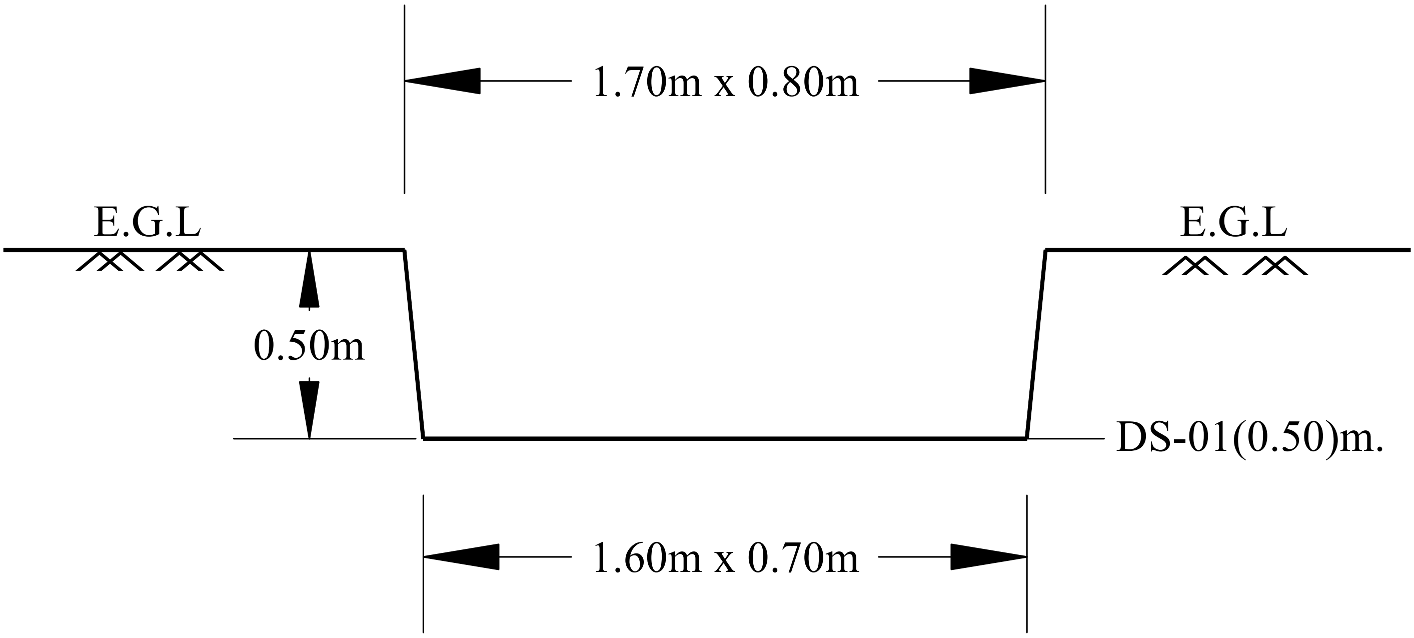
Description of Soil:-

(EGL-0.50)m:- Reddish brown, silty clay with moorum.

PIT LOG OF CBR - 08

Co-ordinates:
E = 1587.995M.
N = 2210.678M.
RL = 911.560M.

SWL = Not found



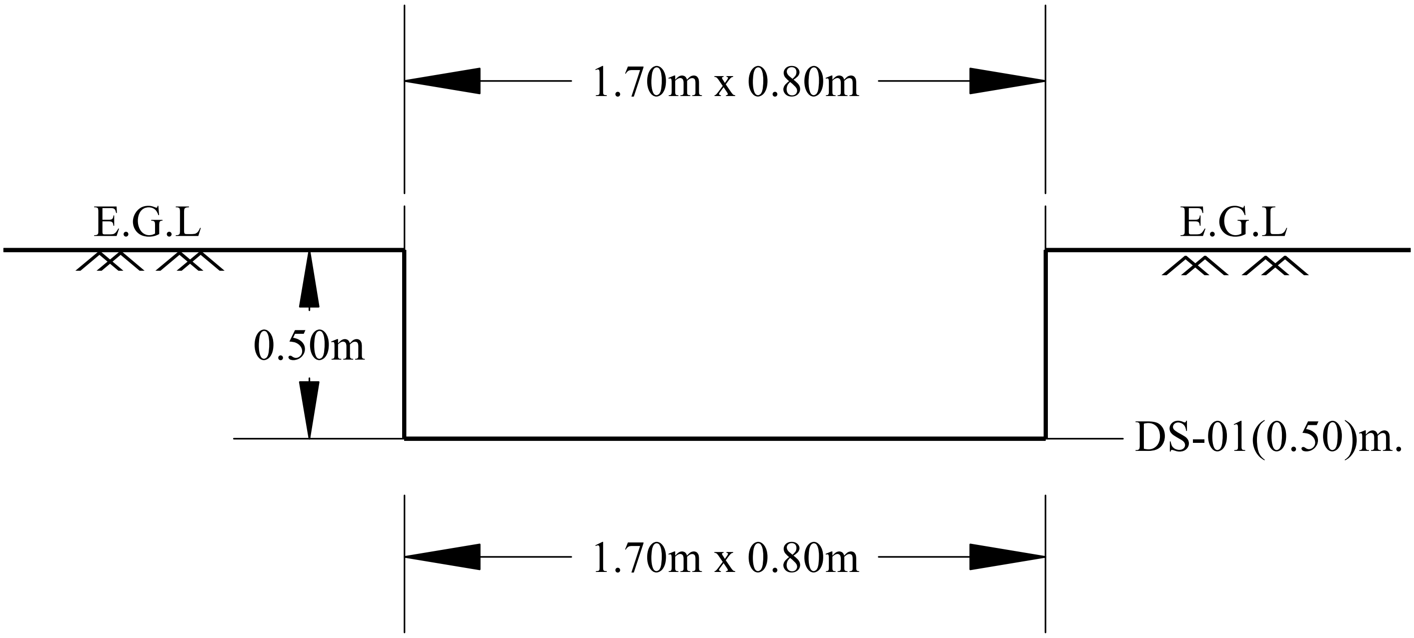
Description of Soil:-

(EGL-0.50)m:- Reddish brown, clayey silt / silty clay with calcareous nodules & moorum. Obs. sand mixture.

PIT LOG OF CBR - 09

Co-ordinates:
E = 869.240M.
N = 1199.608M.
RL = 898.300M.

SWL = Not found



Description of Soil:-

(EGL-0.50)m:- Reddish brown, silty clay / clayey silt. Obs. fine sand.

PIT LOG OF CBR - 10

Summarised Field Density Test Results

Test Location	Depth of Test (M)	Avg. Field Bulk Density (gm/cc)	Avg. Field Dry Density (gm/cc)	Moisture Content (%)
TP-04	1.00	1.510	1.340	12
TP-06	1.00	1.620	1.550	5
	2.00	1.650	1.560	6
	3.00	1.650	1.560	6
TP-07	1.00	1.540	1.450	6
	2.00	1.640	1.550	5
	3.00	1.630	1.540	6
TP-08	1.00	1.560	1.510	3
	2.00	1.580	1.510	5
	3.00	1.630	1.550	6
TP-MND-01	1.00	1.510	1.400	8
	2.00	1.570	1.490	5
	3.00	1.700	1.530	12
TP-MND-02	2.00	1.760	1.520	16
	3.00	1.970	1.710	15
TP-MND-03	1.00	1.590	1.380	15
	2.00	1.550	1.310	18
	3.00	1.630	1.410	16
TP-MND-04	1.00	1.650	1.560	6
	2.00	1.690	1.600	6
	3.00	1.760	1.620	8
TP-MND-05	1.00	1.730	1.630	6
	2.00	1.630	1.540	6
	3.00	1.710	1.610	6
TP-MND-06	1.00	1.320	1.170	13
	2.00	1.600	1.400	15
	3.00	1.850	1.630	13

Summarised Field CBR Test Results

Test Location	Depth of Test (M)	Field CBR (%)					
		Unsokaed			Soaked		
		For 2.5mm Pentn.	For 5.0mm Pentn.	Average FCBR	For 2.5mm Pentn.	For 5.0mm Pentn.	Average FCBR
FCBR-02	0.50	19.86 20.40 19.91	19.26 19.04 19.52	20.06	19.69 18.87 19.88	19.64 18.88 19.11	19.48
FCBR-04	0.50	14.67 15.30 15.25	15.00 14.77 14.90	15.07	7.95 8.05 7.78	7.12 7.67 6.87	7.93
FCBR-08	0.50	14.67 15.30 15.25	15.00 14.77 14.90	15.07	3.08 3.48 3.33	3.11 3.31 3.08	3.30
FCBR-09	0.50	10.78 11.73 11.24	9.55 10.96 10.63	11.25	6.59 7.15 6.73	5.66 6.11 5.76	6.82
FCBR-10	0.50	7.20 7.38 7.86	7.59 6.35 7.29	7.48	2.65 3.51 3.01	2.48 3.46 3.17	3.06

PART II: LABORATORY TEST RESULTS

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH01	SPT02	3.00	Reddish brown clayey silt with traces of sand mixture.										45	23	19	CI					* See the Note
BH01	DS04	4.00	Reddish brown clayey silt with sand mixture.			2.74										CI*		43	37	20	Do
BH01	SPT03	4.80	Light grey clayey sandy silt / clayey silty sand with traces of kankar & decomposed rock fragments.													CI*		55**	45(Silt+Clay)		Do
BH01	SPT04	6.00	Light grey clayey sandy silt / clayey silty sand with decomposed rock fragments.													CI*		53**	47(Silt+Clay)		Do
BH01	SPT05	7.50	Reddish brown clayey silt with sand mixture.			2.75										CI*		52**	39	9	Do
BH01	SPT07	10.50	Light grey clayey sandy silt / clayey silty sand with decomposed rock fragments.													CI*		68**	32(Silt+Clay)		Do
BH01	DS10	13.00	Yellowish grey clayey silt with traces of sand mixture.			2.74										CI*		40	42	18	Do
BH19	SPT01	1.50	Reddish brown clayey silt with traces of sand mix.										36	23	21	CI					Do
BH19	SPT02	3.00	Reddish brown clayey silt with sand mixture.			2.66										CI*		55**	33	12	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH19	SPT03	4.50	Reddish brown clayey silt with sand mixture.			2.68										CI*		54**	32	14	Do
BH19	SPT05	6.00	Reddish brown clayey silt with traces of sand mixture.										31	15	14	CL					Do
BH19	SPT06	9.50	Reddish brown clayey silt with kankar.										31	19	17	SC		58**	42(Silt+Clay)		Do
BH19	SPT07	11.00	Brownish grey clayey silty sand.			2.65										SM		73	27(Silt+Clay)		Do
BH20	DS01	0.50	Brownish grey clayey silt with sand & traces of kankars.															43	57(Silt+Clay)		Do
BH20	SPT01	1.50	Reddish brown clayey silt with traces of sand mixture.			2.75										CI*		36	42	22	Do
BH20	DS03	2.50	Reddish brown clayey silt with sand mixture.										42	21	17	CI					Do
BH20	SPT02	3.00	Reddish brown clayey silt with sand mixture.			2.73										CI*		47	36	17	Do
BH20	DS04	4.00	Brownish grey clayey silt.										39	27	26	MI					Do
BH20	DS05	6.00	Brownish grey clayey silt.										42	26	23	MI					Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH20	SPT04	6.50	Brownish grey clayey sandy silt.			2.68										CI*		49	51(Silt+Clay)		Do
BH20	SPT07	11.00	Light grey silty sand with traces of clay binder & decomposed rock fragments.													SM		62	38(Silt+Clay)		Do
BH21	SPT01	1.50	Yellowish grey, clayey silt with sand mixture with decomposed rock fragments.			2.71										CI*		64**	31	5	Do
BH21	SPT02	3.40	Yellowish brown, clayey silt with traces of sand mixture.										49	28	25	MI					Do
BH21	SPT05	8.00	Brownish grey, clayey silt with sand mixture.			2.61										CI*		35	50	15	Do
BH21	SPT07	11.00	Yellowish brown, clayey silt with traces of sand mixture.										49	27	24	CI					Do
BH21	SPT09	14.00	Brownish grey, clayey silt with sand mixture.			2.51										CI*		33	51	16	Do
BH21	SPT10	15.50	Reddish brown, clayey silt with traces of fine sand mixture.										47	27	25	CI					Do
BH21	SPT11	17.00	Light grey silty sand.	1.89	1.64		15DR		DRSH-CU		0.15	38				SM		82	18(Silt+Clay)		Do
									0.5	0.514											
									1.0	0.980											
									2.0	1.712											

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results: Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits: LL %	PL %	SL %	IS Classification	Grain Size: Gravl %	Sand %	Silt %	Clay %	Test Method
BH21	SPT12	18.50	Light grey, silty sand with clay binder.													SM		81	19(Silt+Clay)		Do
BH22	SPT01	1.50	Reddish brown, clayey silt with traces of fine sand mixture.										47	25	24	CI					Do
BH22	SPT03	4.50	Yellowish grey, clayey sandy silt.			2.63										CI*		49	46	5	Do
BH22	SPT06	9.00	Light grey, clayey silt with sand mixture.													CI*		38	62(Silt+Clay)		Do
BH22	SPT08	12.00	Brownish grey, clayey sandy silt.			2.66										CI*		44	45	11	Do
BH22	SPT14	21.00	Reddish brown, clayey silt with traces of fine sand mixture.										49	28	25	MI					Do
BH22	SPT15	22.50	Light grey, silty sand with decomposed rock fragments.			2.74										SM		57	43(Silt+Clay)		Do
BH22	SPT17	25.50	Light grey silty sand with clay binder.	1.90	1.54		23DR		DRSH-CU		0.09	37				SM		81	19(Silt+Clay)		Do
									0.5	0.471											
									1.0	0.848											
									2.0	1.619											
BH22	SPT18	27.00	Light grey silty sand with clay binder.	1.89	1.55		22DR		DRSH-CU		0.07	37				SM		80	20(Silt+Clay)		Do
									0.5	0.454											
									1.0	0.807											
									2.0	1.585											
BH30	SPT01	1.00	Reddish brown clayey silt with traces of sand.			2.69							49	24	18	CI					Do

Bore	Sample	Depth	Sample Description	Bulk	Dry	Spec.	Nat.	Void	Strength Test Results				Atter. Limits			IS	Grain Size				Test Method
Hole	Number	M		Dens.	Dens.	Grav.	Mois.	Ratio	Pc/Pn	Shear	Cohesn	Frictn	LL	PL	SL	Classific	Gravl	Sand	Silt	Clay	
				gms/cc	gms/cc		%		kg/sqcm	kg/sqcm	kg/sqcm	Deg.	%	%	%	ation	%	%	%	%	
BH30	UDS02	4.00	Reddish brown clayey silt with decomposed rock fragments.	1.89	1.69	2.70	12 S	0.665	DRSH-CU		0.11	47	37	19	16	SC		63**	30	7	Do
							12DR		0.5	0.618											
							12 C		1.0	1.203											
									2.0	2.228											
									TRSH-CD		0.00	36									
									2.89	4.262											
									1.96	2.844											
									0.96	1.421											
BH30	DS03	5.50	Reddish brown clayey silty sand with traces of kankar.			2.78										SM		73	21	6	Do
BH37	DS01	0.50	Reddish brown silty sand with clay binders and traces of kankars.			2.76										SM		80	17	3	Do
BH40	UDS01	2.05	Reddish brown clayey silt with decomposed rock fragments.	1.89	1.67	2.69	14 S	0.680	DRSH-CU		0.20	45	41	22	15	SC		55**	32	13	Do
							14 C		0.5	0.673											
							13DR		1.0	1.244											
									2.0	2.181											
									TRSH-CD		0.00	34									
									2.79	3.789											
									1.98	2.532											
									0.97	1.258											
BH40	DS02	3.50	Reddish brown clayey silt with sand mixture.										41	23	16	CI					Do
BH40	SPT03	4.00	Brownish grey clayey silt with sand mixture & decomposed rock fragments.										36	16	14	CI					Do
BH40	DS03	5.00	Yellowish grey silty sandwith clay binders & traces of kankars.			2.75										SM		77	17	6	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH44	DS02	1.00	Reddish brown clayey silt with sand mixture & decomposed rock dust.			2.72							43	21	18	CI					Do
BH47	DS01	0.50	Reddish brown clayey silt with kankar, gravel & sand mixture.			2.88										CI*	37	40	19	4	Do
BH48	DS01	0.50	Reddish brown clayey silt with sand mixture & decomposed rock dust.										35	20	17	CI					Do
BH48	DS02	1.00	Reddish brown clayey silty sand with kankars.			2.75										SM	11	66	18	5	Do
BH48	SPT01	1.50	Brownish grey silty sand with traces of kankar & rock dust.													SP		96	4(Silt+Clay)		Do
BH48	SPT03	4.50	Brownish grey silty sand with traces of kankars, rock dust & clay binder.													SM		85	15(Silt+Clay)		Do
BH48	SPT05	7.50	Brownish grey silty sand with rock dust.	1.82	1.42		28DR		DRSH-CU		0.10	42				SM*					Do
									0.5	0.566											
									1.0	0.960											
									2.0	1.898											
BH49	DS01	0.50	Reddish brown clayey silt.										45	26	18	CI					Do
BH49	SPT01	1.00	Reddish brown clayey silt with sand mixture.			2.70										CI*		38	47	15	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH49	UDS01	2.50	Reddish brown clayey silt with sand mixture & moorum.	1.94	1.59	2.75	20 S	0.679	TRSH-UU		1.08	12				CI*		52**	30	18	Do
							22 T		3.0	2.118											
							21 C		2.0	1.849											
									1.0	1.590											
									UNCONFD		1.15	0									
									0.0	1.173											
									0.0	1.145											
									0.0	1.132											
									REMOULD		0.92	0									
									0.0	0.943											
									0.0	0.921											
									0.0	0.896											
BH49	SPT03	4.50	Reddish brown clayey silt with traces of rock pieces.										42	22	17	CI					Do
BH49	SPT04	5.70	Reddish brown clayey silt with sand mixture & kankar.			2.79										CI*		52**	36	12	Do
BH50	DS01	0.50	Reddish brown clayey silty sand with traces of kankars.			2.79										SM		58	30	12	Do
BH50	DS02	1.00	Brownish grey silty sand with traces of mica.			2.70										SM-SP		91	9(Silt+Clay)		Do
BH50	SPT01	1.30	Brownish grey silty sand with traces of kankar & clay binder.			2.67										SM		87	13(Silt+Clay)		Do
BH51	DS01	0.50	Reddish brown clayey silt with sand mixture.			2.69							53	24	19	CH					Do
BH51	DS02	1.00	Reddish brown clayey silt with sand mixture &			2.81										CI*		49	39	12	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH51	SPT01	1.50	Reddish brown clayey silty sand with traces of kankars.			2.80										SM		60	31	9	Do
BH52	DS01	0.50	Reddish brown rock pieces & rock dust.													SM-SP	24	71	5(Silt+Clay)		Do
BH52	SPT01	1.00	Brownish grey silty sand.	2.00	1.74		15DR		DRSH-CU		0.24	35				SM-SP		93	7(Silt+Clay)		Do
									0.5	0.558											
									1.0	1.012											
									2.0	1.645											
BH52	SPT02	3.00	Reddish brown silty sand.	1.83	1.59		15DR		DRSH-CU		0.30	32				SM					Do
									0.5	0.548											
									1.0	0.996											
									2.0	1.496											
BH52	SPT03	4.50	Reddish brown clayey sandy silt with traces of kankars.			2.68										SM		53	38	9	Do
BH52	SPT04	6.00	Reddish brown clayey silty sand with traces of kankar.			2.75										SM		66	27	7	Do
BH52	SPT06	9.00	Yellowish brown clayey silty sand & traces of kankar.			2.70										SM		50	35	15	Do
BH52	SPT07	10.50	Yellowish grey clayey sandy silt with traces of kankars.			2.64										SM		56	30	14	Do
BH52	SPT08	12.00	Yellowish brown clayey silty sand.			2.74										SM		57	29	14	Do

Project: Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha CETEST

Job No. : 4095 **Sheet No.**

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH53	DS01	0.50	Brownish grey, clayey sandy silt.			2.72										CI*		54**	39	7	Do
BH53	SPT01	1.00	Reddish brown clayey silt with sand mixture.										26	17	15	CL					Do
BH53	DS02	2.00	Brownish grey, clayey silty sand.			2.71										SM		71	24	5	Do
BH53	SPT02	3.00	Greyish brown, rock dust & rock pcs.													SM-SP	25	65	10(Silt+Clay)		Do
BH54	SPT01	1.00	Reddish brown, clayey sandy silt with traces of kankars.			2.71										CI*		53**	42	5	Do
BH54	UDS01	2.50	Reddish brown clayey silt with sand mixture.	1.64	1.42	2.73	14 S	0.553	TRSH-UU		1.20	11	38	21	17	SC		52**	36	12	Do
							15 T		3.0	2.162											
							15 C		2.0	1.919											
									1.0	1.694											
									UNCONFD		1.18	0									
									0.0	1.203											
									0.0	1.174											
									0.0	1.143											
									REMOULD		0.98	0									
									0.0	1.003											
									0.0	0.979											
									0.0	0.958											
BH54	SPT02	2.95	Brownish grey, clayey sandy silt.			2.59										CI*		36	38	26	Do
BH54	DS03	4.00	Reddish brown, clayey silt with traces of sand										40	24	19	CI					Do

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH54	SPT03	4.50	Reddish brown, clayey silt with traces of sand mixture.										40	23	19	CI					Do
BH55	SPT01	1.50	Reddish brown clayey silt with sand mixture.			2.70										CI*		31	50	19	Do
BH55	UDS01	2.55	Reddish brown silty clay with decomposed rock fragments.	2.02	1.63	2.71	19 S	0.948	TRSH-UU		1.95	9	46	23	19	CI		30	53	17	Do
							24 T		3.0	2.833											
							19 C		2.0	2.648											
									1.0	2.469											
									UNCONFD		1.22	0									
									0.0	1.243											
									0.0	1.214											
									0.0	1.203											
									REMOULD		1.03	0									
									0.0	1.053											
									0.0	1.028											
									8.0	1.009											
BH55	SPT03	4.50	Greyish brown, clayey silt with traces of sand mixture.										40	24	19	CI					Do
BH55	SPT05	7.50	Greyish brown, clayey silt.										40	23	20	CI					Do
BH55	DS06	8.50	Reddish brown silty sand with traces of kankars.													SM		76	24(Silt+Clay)		Do
BH55	SPT06	9.00	Reddish brown, silty sand with decomposed rock fragments.	1.70	1.55		10DR		DRSH-CU		0.01	38				SM-SP		92	8(Silt+Clay)		Do
									0.5	0.399											
									1.0	0.781											
									2.0	1.582											

Project: Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha CETEST

Job No. : 4095 | **Sheet No.**

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH56	DS02	1.00	Reddish brown silty sand with traces of kankar & clay binder.			2.74										SM		76	24(Silt+Clay)		Do
BH56	SPT01	1.50	Reddish brown silty sand with traces of kankar & clay binder.	1.68	1.57	2.72	7DR		DRSH-CU		0.03	36				SM		83	17(Silt+Clay)		Do
									0.5	0.392											
									1.0	0.766											
									2.0	1.473											
BH56	DS03	2.50	Reddish brown silty sand with traces of kankar & clay binder.			2.70										SM		78	22(Silt+Clay)		Do
BH57	DS01	0.50	Reddish brown clayey silt with traces of rock pieces.										47	30	22						Do
BH57	DS02	1.00	Reddish brown clayey silt with sand mixture & traces of kankar.			2.63										CI*		41	42	17	Do
BH57	SPT01	1.50	Reddish brown clayey silt.										44	26	18	CI					Do
BH57	SPT02	3.00	Reddish brown silty sand with traces of kankar & clay binder.			2.69										SM		68	32(Silt+Clay)		Do
BH57	SPT03	4.50	Reddish brown, silty sand with traces of clay binders & kankars.	1.75	1.62		8DR		DRSH-CU		0.05	37				SM	5	66	29(Silt+Clay)		Do
									0.5	0.416											
									1.0	0.813											
									2.0	1.557											
BH57	SPT04	6.00	Reddish brown silty sand with traces of kankar & clay binder.			2.70										SM		82	18(Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH57	SPT05	7.50	Light grey, silty sand with clay binder & traces of kankars.	1.72	1.56		10DR		DRSH-CU		0.04	41				SM		70	30(Silt+Clay)		Do
									0.5	0.473											
									1.0	0.919											
									2.0	1.768											
BH58	SPT01	1.00	Reddish brown clayey silt with sand mixture.										24	19	16	CL-ML					Do
BH58	DS02	2.00	Reddish brown clayey sandy silt.			2.75										CI*		50**	41	9	Do
BH58	SPT02	3.00	Brownish grey clayey silty sand with traces of kankar.			2.69										CI*		47	37	16	Do
BH58	DS03	4.00	Greyish brown, clayey silt with traces of sand mixture.										34	20	19	CL					Do
BH58	SPT03	4.56	Reddish brown, clayey silty sand.			2.76										SM		77	17	6	Do
BH59	DS01	0.50	Reddish brown clayey sandy silt.			2.75										CI*		34	47	19	Do
BH59	SPT01	1.50	Reddish brown clayey silt with traces of rock pieces.										53	28	26	CH					Do
BH59	SPT02	3.40	Reddish brown clayey silt with sand mixture.			2.71							24	19	15	CL-ML					Do
BH59	DS04	4.40	Reddish brown clayey silt with sand mixture.										30	15	13	CL					Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH65	SPT01	1.50	Brownish grey clayey sandy silt.			2.66										CI*		39	40	21	Do
BH65	SPT02	3.00	Reddish brown clayey silt with traces of sand mixture.										55	31	25	MH					Do
BH65	UDS01	3.60	Reddish brown clayey silt with sand mixture & kankar.	2.01	1.68	2.72	18 S	0.646	TRSH-UU		1.15	5	51	24	20	CH		49	31	20	Do
							20 T		3.0	1.539											
							19 C		2.0	1.442											
									1.0	1.353											
									UNCONFD		1.02	0									
									0.0	1.043											
									0.0	1.018											
									0.0	0.999											
									REMOULD		0.85	0									
									0.0	0.873											
									0.0	0.850											
									0.0	0.825											
BH65	SPT05	7.00	Reddish brown clayey silt with traces of sand mixture.										47	25	23	CI					
BH65	SPT06	8.50	Reddish brown silty sand.	1.86	1.59		18DR		DRSH-CU		0.17	38				SM-SP		89	11(Silt+Clay)		
									0.5	0.535											
									1.0	0.998											
									2.0	1.722											
BH65	DS07	9.50	Reddish brown silty sand with traces of kankar.			2.70										SM		87	13(Silt+Clay)		
BH66	DS02	1.00	Reddish brown clayey silt with sand mixture.			2.71												54	37	9	

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH66	SPT01	1.50	Brownish grey clayey sandy silt.			2.70												54	30	16	Do
BH66	DS03	2.50	Reddish brown clayey silt.										47	24	20						Do
BH67	SPT01	1.50	Reddish brown clayey silt.										48	30	22	MI					Do
BH67	UDS01	2.50	Reddish brown clayey silt with traces of sand mixture.	1.94	1.58	2.76	23 S	0.691	TRSH-UU		1.20	8	54	26	15	CH		23	52	25	Do
							22 T		3.0	1.858											
							22 C		2.0	1.704											
									1.0	1.542											
									UNCONFD		1.05	0									
									0.0	1.073											
									0.0	1.048											
									0.0	1.029											
									REMOULD		0.95	0									
									0.0	0.973											
									0.0	0.950											
									0.0	0.927											
BH67	SPT03	4.50	Reddish brown clayey silt with sand.			2.67										CI*		25	65	10	Do
BH67	UDS02	5.50	Reddish brown clayey silt with traces of yellow patches & kankars.	1.92	1.54	2.75	24 S	0.870	TRSH-UU		1.04	13	50	26	22	CH		47	37	16	Do
							25 T		3.0	2.183											
							27 C		2.0	1.885											
									1.0	1.597											
									UNCONFD		1.22	0									
									0.0	1.243											
									0.0	1.214											
									0.0	1.203											
									REMOULD		0.94	0									
									0.0	0.963											
									0.0	0.940											

Project: Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha

Job No. : 4095 | **Sheet No.**

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH68	SPT01	1.50	Brownish grey clayey silt with traces of sand mixture.			2.74										CI*		40	37	23	Do
BH68	UDS01	4.00	Reddish brown clayey silt with decomposed rock fragments.	1.97	1.60	2.73	23 S	0.668	TRSH-UU		1.23	12	51	30	23	MH		30	49	21	Do
							23 T		3.0	2.304											
							22 C		2.0	2.044											
									1.0	1.778											
									UNCONFD		1.08	0									
									0.0	1.103											
									0.0	1.077											
									0.0	1.060											
									REMOULD		0.90	0									
									0.0	0.923											
									0.0	0.901											
									0.0	0.876											
BH68	SPT04	6.00	Reddish brown clayey silt with traces of rock pieces.										53	27	22	CH					Do
BH68	SPT06	9.50	Reddish brown clayey silt with sand mixture.			2.72										CI*		38	47	15	Do
BH68	SPT07	11.00	Reddish brown, clayey silt with traces of rock pieces.										67	38	26	MH					Do
BH69	SPT01	1.50	Reddish brown, clayey silt with traces of sand mixture.										45	23	17	CI					Do
BH69	UDS01	2.50	Reddish brown clayey moorum.	2.00	1.63	2.76	24 S	0.714	TRSH-UU		0.80	10	41	21	18	SC		60**	33	7	Do
							23 T		3.0	1.578											
							22 C		2.0	1.373											
									1.0	1.162											

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
									UNCONFD		1.02	0									
									0.0	1.043											
									0.0	1.018											
									0.0	0.999											
									REMOULD		0.91	0									
									0.0	0.933											
									0.0	0.911											
									0.0	0.886											
BH69	UDS02	5.50	Reddish brown clayey	2.01	1.64	2.79	24 S	0.706	DRSH-CU		0.32	26	39	20	16	SC	28	35	28	9	Do
			silt with traces of sand				22 C		0.5	0.543											
			mixture.				23DR		1.0	0.841											
									2.0	1.289											
BH69	SPT06	9.00	Reddish brown, clayey			2.66										CI*		39	45	16	Do
			sandy silt.																		
BH69	DS05	10.00	Reddish brown clayey													CI*		34	66(Silt+Clay)		Do
			silt with traces of sand																		
			mixture.																		
BH70	UDS01	2.50	Reddish brown silty clay	1.98	1.64	2.72	20 T		TRSH-UU		1.24	0				CI*		50**	28	22	Do
			with decomposed rock						3.0	1.318											
			fragments.						2.0	1.205											
									1.0	1.194											
BH70	SPT02	2.95	Reddish brown clayey			2.67										CI*		40	39	21	Do
			sandy silt.																		
BH70	DS03	4.00	Brownish grey clayey silt			2.63										CI*		58**	28	14	Do
			with sand mixture &																		
			moorum.																		
BH70	SPT03	4.50	Reddish brown silty clay										44	24	21	CI					Do
			with moorum.																		

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH70	SPT04	6.00	Whitish grey silty sand with decomposed rock fragments.			2.67										SM-SP	8	82	10(Silt+Clay)		Do
BH71	DS01	0.50	Reddish brown clayey silt with rock fragments.										49	27	19	CI					Do
BH71	DS02	1.00	Reddish brown silty sand with traces of mica.			2.64		.								SM-SP		93	7(Silt+Clay)		Do
BH71	SPT01	1.50	Reddish brown, clayey silt with rock fragments.										49	27	19	CI					Do
BH71	DS03	2.50	Reddish brown silty sand with traces of mica.			2.63										SM-SP		91	9(Silt+Clay)		Do
BH71	SPT02	3.00	Reddish brown silty sand with traces of mica.													SM-SP		92	8(Silt+Clay)		Do
BH71	DS04	4.00	Reddish brown silty sand with traces of mica.			2.65										SM-SP		95	5(Silt+Clay)		Do
BH72	DS01	0.50	Reddish brown silty clay with decomposed rock fragments.			2.72										CI*		54**	32	14	Do
BH72	DS02	1.00	Reddish brown silty clay with sand mixture & decomposed rock fragments.										45	23	20	CI					Do
BH72	SPT01	1.50	Reddish brown clayey silt with decomposed			2.75										CI*		52**	36	12	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH73	SPT01	1.50	Brownish grey clayey silt with traces of sand mixture.			2.70										CI*		35	46	19	Do
BH73	DS04	4.00	Reddish brown silty clay with moorum & boulder.										48	24	21	CI					Do
BH73	SPT03	4.50	Reddish brown clayey silt with traces of sand mixture.			2.73										CI*		37	44	19	Do
BH73	DS05	5.50	Reddish brown clayey silt.										43	17	16	CI					Do
BH73	SPT04	6.00	Reddish brown clayey silt with traces of decomposed rock fragments.			2.78										CI*		40	40	20	Do
BH73	DS06	7.00	Reddish brown clayey silt with sand mixture & decomposed rock fragments.										43	21	18	CI					Do
BH74	DS01	0.50	Reddish brown silty clay / clayey silt with traces of kankar.			2.75										CI*		45	36	19	Do
BH74	DS02	1.00	Reddish brown clayey silt with decomposed rock fragments.										42	22	19	CI					Do
BH74	SPT01	1.50	Reddish brown silty clay / clayey silt with traces of kankar.			2.74										CI*		43	36	21	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results: Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits: LL %	PL %	SL %	IS Classification	Grain Size: Gravl %	Sand %	Silt %	Clay %	Test Method
BH75	DS01	0.50	Reddish brown clayey silt with sand mixture.			2.69										CI*		13	56	31	Do
BH75	DS02	1.00	Reddish brown clayey silt with traces of sand mixtures.													CI*		19	81(Silt+Clay)		Do
BH75	SPT01	1.50	Brownish grey clayey sandy silt.			2.74										CI*		36	52	12	Do
BH75	SPT02	2.95	Reddish brown clayey silt with sand mixture.													CI*		29	71(Silt+Clay)		Do
BH75	DS03	4.00	Reddish brown sandy silt with traces of clay binders.													CI*		45	55(Silt+Clay)		Do
BH75	SPT03	4.50	Light grey clayey silt with clay binders.			2.74										CI*		39	61(Silt+Clay)		Do
BH76	DS01	0.50	Reddish brown silty clay with decomposed rock fragments.										45	23	20	CI					Do
BH81	SPT01	1.50	Brownish grey clayey sandy silt.			2.69										CI*		44	40	16	Do
BH81	SPT02	3.60	Brownish grey clayey silt with sand mixtures & decomposed rock fragments.			2.73										CI*	7	39	54(Silt+Clay)		Do
BH81	SPT03	5.00	Yellowish brown, clayey silt with sand mixture.	1.71	1.34		27DR		DRSH-CU		0.17	33				CI*					Do
									0.5	0.504											
									1.0	0.809											

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Job No. : 4095 | **Sheet No.**

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH81	SPT04	6.50	Yellowish grey clayey silt with sand mixture & decomposed rock fragments.			2.70										CI*	7	49	44(Silt+Clay)		Do
BH82	SPT04	6.50	Reddish brown clayey silt with traces of fine sand mixture.			2.74										CI*		33	45	22	Do
BH82	SPT05	8.00	Reddish brown clayey siltwith traces of rock fragments.										46	24	17	CI					Do
BH82	UDS02	9.50	Reddish brown clayey silt with moorum & rock fragments			2.73	18 S						38	23	17	CI		37	53	10	Do
BH82	SPT06	10.10	Brownish grey clayey silt with traces of sand mixture.			2.79										CI*		35	46	19	Do
BH82	SPT07	12.00	Reddish brown clayey silt with traces of rock fragments.										46	24	19	CI					Do
BH82	SPT08	13.50	Light grey silty sand with traces of clay binder & decomposed rock fragments.													SM		68	32(Silt+Clay)		Do
BH85	UDS01	2.50	Reddish brown clayey silt with traces of decomposed rock fragments.			2.64	16 S						41	24	17	CI		28	55	17	Do
BH85	SPT02	2.95	Reddish brown clayey silt with traces of rock fragments.										50	25	20	CH					Do

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH85	SPT04	6.10	Reddish brown clayey silt with sand mixture.			2.80										CI*		25	48	27	Do
BH85	SPT06	9.00	Reddish brown clayey silt with sand mixtures.			2.81										CI*		26	48	26	Do
BH85	SPT08	12.00	Reddish brown clayey silt with traces of rock fragments & sand mixture.										56	26	22	CH					Do
BH85	SPT10	15.00	Reddish brown clayey silt with traces of sand mixture.			2.75										CI*		15	54	31	Do
BH85	SPT11	16.50	Reddish brown clayey silt with rock fragments.										56	27	18	CH					Do
BH86	UDS01	2.50	Reddish brown silty clay with kankars.	2.00	1.62	2.76	23 S		UNCONFD		1.37	0	39	21	17			20	54	26	Do
							24 T		0.0	1.722											
									0.0	1.314											
									0.0	1.075											
									REMOULD		1.11	0									
									0.0	1.400											
									0.0	1.070											
									0.0	0.871											
BH86	UDS02	5.55	Reddish brown silty clay / clayey silt with sand mixture.	1.95	1.55	2.80	24 S	0.824	TRSH-UU		0.73	0	47	23	16	CI		34	44	22	Do
							26 T		3.0	0.750											
							25 C		2.0	0.729											
									1.0	0.712											
									UNCONFD		0.58	0									
									0.0	0.598											
									0.0	0.583											
									0.0	0.559											

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Bore	Sample	Depth	Sample Description	Bulk	Dry	Spec.	Nat.	Void	Strength Test Results				Atter. Limits			IS	Grain Size				Test Method
Hole	Number	M		Dens.	Dens.	Grav.	Mois.	Ratio	Pc/Pn	Shear	Cohesn	Frictn	LL	PL	SL	Classific	Gravl	Sand	Silt	Clay	
				gms/cc	gms/cc		%		kg/sqcm	kg/sqcm	kg/sqcm	Deg.	%	%	%	ation	%	%	%	%	
									REMOU;D		0.48	0									
									0.0	0.503											
									0.0	0.491											
									0.0	0.446											
BH86	SPT08	12.00	Reddish brown clayey silt										43	17	17	CI					Do
BH86	SPT09	13.50	Brownish grey silty sand.			2.62										SP		97	3(Silt+Clay)		Do
BH86	SPT13	19.50	Brownish grey silty sand with traces of mica.													SP		99	1(Silt+Clay)		Do
BH87	SPT08	13.45	Brownish grey clayey silt with traces of sand mixture.			2.70										CI*		20	43	37	Do
BH87	SPT12	20.00	Brownish grey silty clay / clayey silt.										44	16	15	CI					Do
BH87	SPT14	23.00	Brownish grey clayey silt with sand mixture.			2.69										CI*		17	49	34	Do
BH87	SPT16	26.50	Brownish grey clayey silt / silty clay.										42	15	14	CI					Do
BH87	SPT18	29.50	Yellowish grey clayey silt with sand mixture.			2.65										CI*		32	42	26	Do
BH87	SPT20	33.00	Yellowish grey, clayey silt with decomposed										52	30	23	MH					Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH87	SPT21	35.00	Brownish grey clayey silt with sand mixture & decomposed rock fragments.			2.72		.								CI*		48	52(Silt+Clay)		Do
BH88	SPT07	11.00	Reddish brown clayey silt with sand mixture.			2.77										CI*		38	43	19	Do
BH88	SPT08	12.50	Reddish brown clayey silt with traces of rock fragments.										48	22	18	CI					Do
BH88	SPT11	17.00	Yellowish brown clayey silt with sand mixture.			2.63										CI*		39	35	26	Do
BH88	SPT14	21.50	Reddish brown,clayey silt with traces of rock pieces & sand mixture.										50	23	17	CH					Do
BH88	SPT18	27.50	Brownish grey clayey silt with sand mixture.			2.68										CI*		34	41	25	Do
BH88	SPT22	33.50	Yellowish grey, clayey silt with decomposed rock fragments.										51	29	23	MH					Do
BH89	UDS01	6.00	Reddish brown clayey silt with decomposed rock fragments.	1.96	1.56	2.76	26 S		UNCONFD		0.27	0	43	25	20			40	42	18	Do
							25 T		0.0	0.338											
									0.0	0.238											
									0.0	0.221											
									REMOULD		0.18	0									
									0.0	0.236											
									0.0	0.161											
									0.0	0.138											

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH89	SPT06	9.80	Reddish brown, clayey silt with traces of rock fragments.										61	26	24	CH					Do
BH89	UDS03	20.00	Reddish brown clayey silt with traces of moorum.	1.91	1.46	2.72	28 S	0.744	TRSH-UU		0.85	0	50	25	21	CH		36	33	31	Do
							31 T		3.0	0.910											
							26 C		2.0	0.850											
									1.0	0.794											
									UNCONFD		0.59	0									
									0.0	0.555											
									0.0	0.597											
									0.0	0.613											
									REMOULD		0.48	0									
									0.0	0.500											
									0.0	0.483											
									0.0	0.456											
BH89	SPT15	26.00	Yellowish grey clayey silt with traces of fine sand mixture.			2.65										CI*		36	45	19	Do
BH89	SPT17	30.00	Light grey silty sand with traces of clay binders & decomposed rock fragments.													SM	2	58	40(Silt+Clay)		Do
BH90	UDS01	3.00	Reddish brown clayey silt with moorum & rock fragments.			2.80	15 S	0.930					40	23	20			40	48	12	Do
							29 C														
BH90	UDS04	15.50	Yellowish grey clayey silt with traces of sand mixture.	1.72	1.19	2.66	46 T		TRSH-UU		0.58	0				CI*		17	58	25	Do
									3.0	0.607											
									2.0	0.584											
									1.0	0.544											
BH90	UDS05	19.00	Reddish brown clayey silt with traces of sand mixture, kankars.	1.94	1.53	2.74	29 S	0.930	TRSH-UU		0.80	8	50	25	19	CH		35	36	29	Do
							27 T		3.0	1.450											
							29 C		2.0	1.193											

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
									UNCONFD		1.26	0									
									0.0	1.409											
									0.0	1.253											
									0.0	1.117											
									REMOULD		0.98	0									
									0.0	1.101											
									0.0	0.982											
									0.0	0.870											
									TRSH-CD		0.00	32									
									2.95	3.049											
									1.96	2.105											
									0.98	1.092											
BH90	SPT12	22.00	Yellowish grey, clayey silt with sand mixture & decomposed rock fragments.										37	19	17	CI					Do
BH90	SPT16	28.50	Brownish grey clayey silt with sand & kankar.			2.70										CI*		56**	28	16	Do
BH90	SPT17	30.00	Light grey clayey silty sand / clayey silt with sand mixture & decomposed rock fragments.													CI*		57	43(Silt+Clay)		Do
BH91	UDS01	3.00	Reddish brown silty clay with traces of kankar.	1.99	1.60	2.75	25 T	0.892	TRSH-UU		0.34	7						31	46	23	Do
							27 C		3.0	0.765											
									2.0	0.754											
									1.0	0.493											
BH91	UDS02	6.50	Reddish brown silty clay with traces of decomposed rock fragments.	2.00	1.63	2.74	21 S		TRSH-UU		2.31	0	50	23	19			28	44	28	Do
							22 T		3.0	2.374											
									2.0	2.295											
									1.0	2.249											

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH91	UDS03	10.00	Reddish brown clayey silt with decomposed rock fragments.	1.78	1.54	2.74	15 S		DRSH-CU		0.13	45						62	33	5	Do
							16DR		0.5	0.646											
									1.0	1.092											
									2.0	2.126											
BH91	SPT06	10.55	Reddish brown clayey silt with traces of sand mixture.										41	22	19	CI					Do
BH91	SPT10	18.50	Light grey clayey silt with traces of sand mixture.			2.65										CI*		33	32	35	Do
BH91	SPT13	24.50	Yellowish grey clayey silt with sand mixture & mica.													CI*		34	66(Silt+Clay)		Do
BH91	SPT16	30.00	Brownish grey clayey silt with sand mixture & decomposed rock fragments.													CI*		22	78(Silt+Clay)		Do
BH91	SPT17	32.50	Brownish grey silty sand with traces of mica.													SM		79	21(Silt+Clay)		Do
BH91	SPT20	38.00	Brownish grey silty sand with traces of mica.													SM-SP		91	9(Silt+Clay)		Do
BH92	DS02	1.00	Reddish brown clayey silt with sand mixture.										45	25	21						Do
BH92	SPT02	3.00	Reddish brown silty clay / clayey silt with sand mixture.			2.72										CI*		35	45	20	Do
BH92	DS04	4.00	Reddish brown silty clay / clayey silt with sand										52	24	20	CH					Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH92	SPT03	4.50	Brownish grey silty clay / clayey silt. Obs. sand mixture.			2.75										CI*		30	46	24	Do
BH92	DS05	5.50	Reddish brown clayey silt with sand mixture.										48	21	18	CI					Do
BH92	SPT05	8.05	Reddish brown clayey silt with sand mixture & kankar.			2.78										CI*		36	46	18	Do
BH93	DS01	0.50	Whitish grey, decomposed rock dust.														13	63	24(Silt+Clay)		Do
BH93	UDS01	2.55	Reddish brown clayey silt with traces of sand mixture & kankar	1.93	1.60	2.71	23 S	0.740	TRSH-UU		1.00	11	41	22	19	SC		53**	35	12	Do
							21 T		3.0	1.900											
							23 C		2.0	1.672											
									1.0	1.442											
									UNCONFD		1.06	0									
									0.0	1.083											
									0.0	1.057											
									0.0	1.040											
									REMOULD		0.89	0									
									0.0	0.913											
									0.0	0.891											
									0.0	0.866											
BH93	SPT03	4.50	Reddish brown, clayey silt with traces of sand mixture.			2.77										CI*		11	55	34	Do
BH93	SPT05	7.50	Reddish brown, clayey silt with traces of rock fragments.										66	37	29	MH					Do
BH93	SPT06	9.00	Brownish grey, clayey silt with traces of rock													CI*		30	70(Silt+Clay)		Do

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH93	SPT10	14.50	Greyish brown, clayey silt with rock fragments.													CI*		30	70(Silt+Clay)		Do
BH94	SPT01	1.50	Reddish brown, clayey silt.										72	37	28	MH					Do
BH94	UDS01	2.55	Reddish grey silty clay with kankar & decomposed rock fragments.	1.94	1.61	2.78	19 S	0.841	TRSH-UU		1.48	15	36	23	18	SC		56**	32	12	Do
							20 T		3.0	2.944											
							20 C		2.0	2.632											
									1.0	2.272											
									UNCONFD		1.22	0									
									0.0	1.243											
									0.0	1.214											
									0.0	1.203											
									REMOULD		0.94	0									
									0.0	0.963											
									0.0	0.940											
									0.0	0.917											
BH94	SPT03	4.50	Reddish brown clayey silt with traces of fine sand mixture.			2.76										CI*		22	57	21	Do
BH94	SPT05	7.50	Yellowish brown, clayey silt with traces of sand mixture.										68	33	25	MH					Do
BH94	SPT07	10.50	Yellowish grey clayey silt with fine sand mixture.			2.73										CI*		36	54	10	Do
BH96	DS02	1.00	Reddish brown, clayey silt with kankar & sand mixture. Obs. decomposed rock fragments.			2.76										CI*		34	55	11	Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH96	DS03	2.50	Reddish brown, clayey silt with sand mixture. Obs.decomposed rock fragments.			2.70										CI*		37	47	16	Do
BH96	SPT03	4.45	Brownish grey, clayey silt with sand mixture.			2.66										CI*		23	61	16	Do
BH96	SPT04	6.00	Reddish brown clayey silt with traces of sand mixture. Obs. decomposed rock fragments.										56	30	28	MH					Do
BH97	SPT01	1.50	Reddish brown silty sand with decomposed rock fragments & kankar.	1.80	1.62		11DR		DRSH-CU		0.12	29				SM		62	38(Silt+Clay)		Do
									0.5	0.407											
									1.0	0.666											
									2.0	1.228											
BH97	DS03	2.50	Reddish brown silty sand with traces of kankar.			2.74										SM		86	14(Silt+Clay)		Do
BH98	UDS01	2.60	Reddish brown clayey silt with moorum & rock fragments.	1.60	1.43	2.74	12 S		DRSH-CU		0.18	32	33	23	21	SC		57**	36	7	Do
							12DR		0.5	0.482											
									1.0	0.814											
									2.0	1.430											
BH98	SPT05	7.50	Reddish brown clayey silt with sand mixture.													CI*		29	71(Silt+Clay)		Do
BH98	SPT06	9.00	Reddish brown,silty sand with traces of mica & clay binder.	1.71	1.49		15DR		DRSH-CU		0.06	33				SM		79	21(Silt+Clay)		Do
									0.5	0.374											
									1.0	0.719											
									2.0	1.358											
BH98	SPT13	19.50	Yellowish grey clayey silt with sand mixture.			2.67										CI*		49	40	11	Do

Project: Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha

Job No. : 4095 | **Sheet No.**

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results: Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits: LL %	PL %	SL %	IS Classification	Grain Size: Gravl %	Sand %	Silt %	Clay %	Test Method
BH98	SPT15	23.00	Brownish grey silty clay with sand & decompsoed rock fragments.													CI*		50**	50(Silt+Clay)		Do
BH98	SPT16	24.50	Whitish grey silty sand with rock fragments & clay binder.													SM		66	34(Silt+Clay)		Do
BH98	SPT20	31.50	Whitish grey silty sand with rock fragments													SM		69	31(Silt+Clay)		Do
BH99	UDS01	3.00	Reddish brown silty clay with decomposed rock fragments.	1.90	1.56	2.67	22 T	0.851	TRSH-UU		0.50	16				CI*		39	42	19	Do
							26 C		3.0	1.804											
									2.0	1.419											
									1.0	1.042											
									UNCONFD		1.10	0									
									0.0	1.477											
									0.0	0.977											
									0.0	0.859											
									REMOULD		0.83	0									
									0.0	0.853											
									0.0	0.833											
									0.0	0.804											
BH99	SPT04	6.60	Brownish grey, clayey silt.										50	30	25	MH					Do
BH99	SPT07	11.00	Light grey clayey silt with sand mixture.			2.72										CI*		37	53	10	Do
BH99	SPT10	15.50	Light grey clayey silt with sand mixtures & decomposed rock fragments.													CI*		45	55(Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BH99	SPT12	18.50	Light grey clayey sandy silt.			2.66										CI*		48	40	12	Do
BH100	UDS01	2.50	Reddish brown clayey silt with decomposed rock fragments.	1.79	1.55	2.72	15 S		DRSH-CU		0.19	34	41	19	17	CI		40	41	19	Do
							15DR		0.5	0.537											
									1.0	0.854											
									2.0	1.540											
BH100	SPT03	5.00	Brownish grey clayey silt with traces of sand mixture.													CI*		10	90(Silt+Clay)		Do
BH100	SPT07	11.00	Whitish grey clayey silty sand / clayey silt with sand mxiture & decomposed rock fragments.			2.76										Ci*		55**	31	14	Do
BH100	SPT13	20.00	Yellowish grey, clayey silt with traces of kankars.										46	27	23	CI					Do
BH100	SPT20	30.50	Light grey clayey silt with sand mixture & decomposed rock fragments			2.67										CI*		51	38	11	Do
BHMND-01	SPT01	1.50	Reddish brown clayey silt with traces of sand mixture, kankar & decomposed rock fragments.			2.67										CI*		67**	25	8	Do
BHMND-01	SPT03	4.50	Reddish brown,clayey silt with traces of rock pieces & sand mixture.										39	17	16	CI					Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BHMND-01	SPT06	9.50	Yellowish brown clayey silt with sand mixture.			2.73										CI*		45	45	10	Do
BHMND-01	SPT07	11.00	Brownish grey clayey silt traces of fine sand mixture.										42	27	25	MI					Do
BHMND-01	SPT08	12.50	Greyish brown clayey silt with sand mixture.			2.74										CI*		45	48	7	Do
BHMND-01	SPT09	14.00	Brownish gray,clayey silt with traces of sand mixture & decomposed rock fragments										35	22	20	CI					Do
BHMND-02	UDS01	3.15	Reddish brown clayey silt / silty clay with	1.88	1.53	2.75	22 S	0.655	TRSH-UU		0.28	15	42	21	14	CI		20	48	32	Do
			traces of moorum.				24 T		3.0	1.414											
							22 C		2.0	1.059											
									1.0	0.734											
									UNCONFD		0.70	0									
									0.0	0.737											
									0.0	0.707											
									0.0	0.640											
									REMOULD		0.47	0									
									0.0	0.498											
									0.0	0.473											
									0.0	0.444											
BHMND-02	SPT03	5.00	Reddish brown clayey silt with sand mixture.			2.82										CI*		28	49	23	Do
BHMND-02	SPT05	8.00	Reddish brown clayey silt with rock pieces & traces of sand mixture.										48	21	18	CI					Do

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Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BHMND-02	SPT07	11.00	Reddish brown clayey silt with traces of sand mixture.			2.78										CI*		12	58	30	Do
BHMND-02	SPT09	14.00	Reddish brown clayey silt with sand mixture & decomposed rock fragments.													CI*	4	19	77(Silt+Clay)		Do
BHMND-03	SPT05	8.60	Reddish brown clayey silt with sand mixture.			2.78												26	53	21	Do
BHMND-03	SPT08	13.50	Reddish brown clayey sandy silt / clayey silty sand with decomposed rock fragments & moorum.													CI*		61**	39(Silt+Clay)		Do
BHMND-03	SPT10	17.00	Reddish brown clayey silt with sand mixture & decomposed rock fragments.			2.67										CI*		56**	29	15	Do
BHMND-03	SPT12	20.00	Light grey clayey silty sand / clayey sandy silt with decomposed rock fragments & moorum.													Ci*		55**	45(Silt+Clay)		Do
BHMND-03	SPT14	23.00	Reddish brown clayey sandy silt with moorum & decomposed rock fragments.			2.70										CI*		59**	39	2	Do
BHMND-03	SPT16	26.00	Light grey clayey silt with sand mixture & decomposed rock													CI*		48	52(Silt+Clay)		Do

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BHMND-04	SPT02	3.00	Reddish brown clayey silt with sand mixture.			2.74										CI*		13	58	29	Do
BHMND-04	UDS01	4.00	Reddish brown clayey silt with moorum & rock fragments.			2.64	10 S						34	20	19	CL		43	49	8	Do
BHMND-04	SPT05	7.50	Reddish brown clayey silt with traces of sand mixture.										39	17	16	CI					Do
BHMND-04	SPT07	10.50	Brownish grey clayey silt with sand mixture & kankar.			2.69										CI*		54**	37	9	Do
BHMND-04	SPT08	12.00	Light grey clayey sandy silt / clayey silty sand with decomposed rock fragments & moorum.													CI*		60**	40(Silt+Clay)		Do
BHMND-05	UDS01	4.00	Reddish brown clayey silt with moorum & rock fragments.	1.78	1.58	2.71	12 S		DRSH-CU		0.35	31	37	25	21	MI	20	29	43	8	Do
							12DR		0.5	0.648											
									1.0	0.951											
									2.0	1.550											
BHMND-05	UDS02	7.00	Reddish brown clayey silt with moorum & rock fragments.	1.80	1.61	2.68	12 S		DRSH-CU		0.56	32	37	25	21	MI	20	34	36	10	Do
							12DR		0.5	0.818											
									1.0	1.269											
									2.0	1.788											
BHMND-05	SPT06	9.00	Reddish brown clayey silty sand / sandy silt with decomposed rock fragments			2.75										Ci*		64**	22	14	Do
BHMND-05	SPT09	13.50	Reddish brown clayey silt.										39	18	16	CI					Do

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BHMND-06	DS02	1.00	Reddish brown silty clay.										48	20	19	CI					Do
BHMND-06	UDS01	2.50	Reddish brown silty clay with rock pieces.	1.99	1.71	2.76	16 S	0.818	TRSH-UU		1.09	9	40	22	15	CI		38	46	16	Do
							17 T		3.0	1.828											
							21 C		2.0	1.644											
									1.0	1.459											
									UNCONFD		1.02	0									
									0.0	1.043											
									0.0	1.018											
									0.0	0.999											
									REMOULD		0.86	0									
									0.0	0.883											
									0.0	0.862											
									0.0	0.835											
BHMND-06	SPT03	4.50	Reddish brown clayey silt with traces of sand mixture.			2.72										CI*		18	67	15	Do
BHMND-06	SPT05	7.50	Reddish brown,clayey silt with traces of sand mixture.										58	32	24	MH					Do
BHMND-06	SPT06	9.00	Brownish grey clayey silt.			2.77										CI*		16	59	25	Do
BHMND-06	SPT07	10.50	Reddish brown clayey sandy silt with decomposed rock fragments.													Ci*		56**	44(Silt+Clay)		Do
BHMND-07	DS02	1.00	Reddish brown, clayey sandy silt.			2.68										CI*		42	45	13	Do

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BHMND-07	UDS01	3.00	Reddish brown clayey silt with decomposed rock fragments.	1.81	1.54	2.77	18 S	0.847	TRSH-UU		0.79	17	37	21	17	SC		54**	37	9	Do
							17 T		3.0	2.303											
							19 C		2.0	1.885											
									1.0	1.476											
									UNCONFD		0.93	0									
									0.0	0.953											
									0.0	0.930											
									0.0	0.907											
									REMOULD		0.75	0									
									0.0	0.773											
									0.0	0.755											
									0.0	0.722											
BHMND-07	SPT03	5.00	Reddish brown, clayey silt.										72	38	29	MH					Do
BHMND-07	SPT05	8.00	Brownish grey, clayey silt.			2.70										CI*		11	73	16	Do
BHMND-07	SPT07	11.00	Reddish brown, clayey sandy silt with decomposed rock fragments.													CI*		43	57(Silt+Clay)		Do
BHMND-10	DS01	0.50	Reddish brown clayey silt with traces of rock fragments										55	25	19	CH					Do
BHMND-10	SPT01	1.50	Reddish brown clayey silt with sand mixture.			2.71										CI*		31	47	22	Do
BHMND-10	UDS01	2.50	Reddish brown clayey silt with decomoposed rock fragments.	1.96	1.60	2.75	24 S	0.760	TRSH-UU		0.45	24	43	24	20	CI		35	40	25	Do
							23 T		3.0	2.763											
							24 C		2.0	2.076											
									1.0	1.387											

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									UNCONFD		1.61	0									
									0.0	1.835											
									0.0	1.606											
									0.0	1.383											
									REMOULD		1.40	0									
									0.0	1.514											
									0.0	1.408											
									0.0	1.264											
BHMND-10	DS04	4.00	Reddish brown, clayey silt										52	26	22	CH					Do
BHMND-10	SPT03	4.50	Yellowish grey clayey silt with sand mixture & traces of kankar.													CI*		26	74(Silt+Clay)		Do
BHMND-10	SPT04	6.00	Brownish gray silty sand with decomposed rock fragments.	1.71	1.38		24DR		DRSH-CU		0.02	40				SM*					Do
									0.5	0.429											
									1.0	0.909											
									2.0	1.719											
BHMND-10	SPT06	9.00	Yellowish grey silty sand with decomposed rock fragments.													SM		64	36(Silt+Clay)		Do
BHMND-11	SPT01	1.50	Reddish brown clayey silt /silty clay.										55	25	22	CH					Do
BHMND-11	UDS01	2.50	Reddish brown clayey silt with rock fragments.	1.93	1.58	2.71	23 S	0.749	TRSH-UU		0.98	5	45	24	23	CI		36	43	21	Do
							22 T		3.0	1.349											
							24 C		2.0	1.262											
									1.0	1.160											
									UNCONFD		0.94	0									
									0.0	0.963											
									0.0	0.940											
									0.0	0.917											

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									REMOULD		0.78	0									
									0.0	0.803											
									0.0	0.784											
									0.0	0.753											
BHMND-11	SPT04	6.00	yellowish brown silty clay.			2.73										CI*		8	65	27	Do
BHMND-11	SPT05	8.20	Yellowish brown clayey silt.										54	21	20	CH					Do
BHMND-11	SPT06	9.50	Yellowish grey clayey silty sand / clayey silt with sand. Obs. decomposed rock fragments.			2.70										CI*		61**	34	5	Do
BHMND-12	SPT01	1.50	Reddish brown clayey silt with sand mixture.			2.63										CI*		37	45	18	Do
BHMND-12	UDS01	3.05	Reddish brown clayey	1.93	1.57	2.69	21 S	0.708	TRSH-UU		1.59	5	42	22	19	CI		44	37	19	Do
			silt with rock fragments				22 T		3.0	2.013											
			& traces of moorum.				23 C		2.0	1.918											
									1.0	1.830											
									UNCONFD		1.53	0									
									0.0	1.640											
									0.0	1.523											
									0.0	1.441											
									REMOULD		1.24	0									
									0.0	1.339											
									0.0	1.213											
									0.0	1.179											
BHMND-12	SPT04	6.55	Brownish grey clayey silt with traces of sand mixture.										43	26	24	CI					Do

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BHMND-12	SPT06	9.50	Yellowish grey clayey silt with sand mixture.			2.65										CI*		37	50	13	Do
BHMND-12	SPT07	12.00	Brownish gray,clayey silt with traces of sand mixture.										43	27	24	MI					Do
BHMND-13	UDS01	3.00	Reddish brown clayey silt / silty clay with moorum.	1.96	1.59	2.75	24 S	0.800	TRSH-UU		0.34	22	46	21	19	CI		19	54	27	Do
							23 T		3.0	2.260											
							26 C		2.0	1.687											
									1.0	1.092											
									UNCONFD		1.31	0									
									0.0	1.363											
									0.0	1.314											
									0.0	1.264											
									REMOULD		0.98	0									
									0.0	1.028											
									0.0	0.971											
									0.0	0.944											
BHMND-13	SPT04	6.50	Reddish brown clayey silt.										47	18	16	CI					Do
BHMND-13	SPT07	11.00	Reddish brown clayey silt with sand mixture.			2.72										CI*		34	42	24	Do
BHMND-13	DS08	12.00	Brownish grey clayey sandy silt / clayey silty sand with decomposed rock fragments.													CI*		68**	32(Silt+Clay)		Do
BHMND-13	SPT08	12.50	Reddish brown,clayey silt with sand mixture.	1.81	1.53		18DR		DRSH-CU		0.25	36				CI*					Do
									0.5	0.623											
									1.0	0.966											
									2.0	1.706											

Bore Hole	Sample Number	Depth M	Sample Description	Bulk Dens. gms/cc	Dry Dens. gms/cc	Spec. Grav.	Nat. Mois. %	Void Ratio	Strength Test Results Pc/Pn kg/sqcm	Shear kg/sqcm	Cohesn kg/sqcm	Frictn Deg.	Atter. Limits LL %	PL %	SL %	IS Classification	Grain Size Gravl %	Sand %	Silt %	Clay %	Test Method
BHMND-13	SPT09	14.00	Reddish brown clayey silt with sand mixture & traces of kankar.													CI*		39	61(Silt+Clay)		Do

* - Classification in this case is based on average layer properties.

** - The apparent high percentage of sand content is mainly due to presence of decomposed rock fragments, kankar, moorum etc.

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
1	1	13.70 - 14.70	Highly weathered, yellowish grey, medium grained, fractured rock.	--	--	--	--	2.639	--	--	--	15.45	--	* See the Note
1	4	16.70 - 17.70	Moderately weathered, light grey, medium grained, fractured rock.	--	--	--	--	2.790	--	--	--	--	--	Do
1	9	22.00 - 23.50	Fresh, light blackish grey, medium to coarse grained, fractured rock.	2.921	2.919	0.057	0.244	2.926	847	832	0.98	--	30839	Do
19	1	14.00 - 15.00	Highly weathered,light blackish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	3.644	--	--	--	44.36	--	Do
19	5	18.00 - 19.00	Moderately weathered,light blackish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	3.450	--	--	--	--	--	Do
19	8	21.50 - 23.00	Fresh, light blackish grey, medium to coarse grained, moderately fractured rock.	3.820	3.819	0.050	0.354	3.832	712	671	0.94	--	33383	Do
20	7	18.00 - 19.50	Fresh, light blackish grey, medium to fine grained, moderately fractured rock.	3.216	3.213	0.093	0.503	3.229	634	562	0.89	--	46398	Do
20	8	19.50 - 21.00	Fresh, light blackish grey, medium to fine grained, moderately fractured rock.	--	--	--	--	3.772	--	--	--	38.32	--	Do
21	2	20.00 - 21.00	Moderately weathered, yellowish grey, medium grained, fractured rock.	--	--	--	--	2.720	--	--	--	24.51	--	Do
21	5	23.50 - 25.00	Fresh, whitish grey, coarse grained, slightly fractured rock.	3.229	3.227	0.065	0.429	2.900	723	630	0.871	--	3424	Do
22	1	28.00 - 29.00	Fresh, whitish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.690	--	--	--	46.66	--	Do
22	3	30.50 - 32.00	Fresh, whitish grey, coarse grained, slightly fractured rock.	2.744	2.739	0.177	0.996	2.750	723	588	0.813	--	41120	Do
30	1	5.70 - 6.70	Fresh, whitish grey, medium grained, fractured rock.	2.672	2.669	0.124	1.033	2.696	457	451	0.987	--	38873	Do
30	5	9.70 - 10.70	Fresh, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.792	--	--	--	44.55	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
30	10	14.70 - 15.70	Moderately weathered, whitish grey, medium grained, fractured rock.	--	--	--	--	2.688	--	--	--	--	--	Do
37	2	2.10 - 3.10	Slightly weathered, light brownish grey, moderately fractured rock.	--	--	--	--	2.847	--	--	--	11.14	--	Do
37	8	5.10 - 6.10	Fresh, light whitish grey, coarse to medium grained, moderately fractured rock.	2.926	2.924	0.072	0.533	2.940	426	293	0.688	--	22318	Do
37	14	17.60 - 19.10	Fresh, light whitish grey, coarse to medium grained, fractured rock.	--	--	--	--	2.810	--	--	--	--	--	Do
40	6	10.00 - 11.00	Highly weathered, light brownish grey, coarse grained, fractured rock.	2.803	2.799	0.127	0.865	2.824	958	605	0.631	--	46545	Do
40	8	12.50 - 13.70	Slightly weathered, light brownish grey, coarse grained, rock.	--	--	--	--	2.696	--	--		93.09	--	Do
40	11	15.70 - 17.20	Fresh, light brownish grey, coarse grained, rock.	--	--	--	--	2.740	--	--	--	--	--	Do
44	2	3.40 - 4.40	Moderately weathered, light brownish grey, coarse grained, highly to moderately fractured rock.	2.789	2.784	0.177	1.116	2.815	--	--	--	27.21	--	Do
44	6	7.40 - 8.40	Slightly weathered, light brownish grey, coarse grained, highly to moderately fractured rock.	--	--	--	--	2.728	--	249	--	--	10320	Do
44	8	9.90 - 11.40	Moderately weathered, light brownish grey, coarse grained, highly fractured rock.	--	--	--	--	2.960	--	--	--	--	--	Do
47	2	2.00 - 3.00	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.719	--	--	--	14.36	--	Do
47	5	5.00 - 6.00	Fresh, whitish grey, coarse to medium grained, slightly fractured rock.	2.757	2.755	0.095	0.837	2.778	--	248	--	72.17	39287	Do
47	7	7.50 - 9.00	Fresh, whitish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.640	--	--	--	--	--	Do
48	1	8.30 - 9.00	Slightly weathered, whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.710	--	--	--	15.66	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content (%)	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry				Dry	Saturated				
48	3	10.00 - 11.50	Fresh, whitish grey, coarse to medium grained, moderately fractured rock.	2.810	2.808	0.086	0.512	2.822	--	518	--	--	21230	Do
48	4	11.50 - 13.00	Fresh, whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.660	--	--	--	--	--	Do
49	1	7.30 - 8.00	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	2.940	2.937	0.099	0.773	3.010	614	474	0.772	--	30700	Do
49	3	9.50 - 11.00	Fresh, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.788	--	--	--	--	--	Do
49	4	11.00 - 12.50	Fresh, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.710	--	--	--	84.22	--	Do
50	2	3.00 - 4.00	Slightly weathered, whitish grey, coarse grained, moderately fractured rock.	2.735	2.731	0.126	0.877	2.756	325	307	0.945	--	30976	Do
50	4	5.50 - 7.00	Moderately weathered, whitish grey, coarse grained, moderately fractured rock.	--	--	--	--	2.737	--	--	--	38.66	--	Do
50	8	10.50 - 12.00	Fresh, whitish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.720	--	--	--	--	--	Do
51	4	6.50 - 8.00	Moderately weathered, light brownish grey, coarse to medium grained, fractured rock.	2.682	2.679	0.124	1.152	2.710	--	226	--	47.71	14871	Do
51	5	8.00 - 9.50	Fresh, light brownish grey, coarse to medium grained, fractured rock.	--	--	--	--	2.769	--	--	--	50.64	--	Do
51	6	9.50 - 11.00	Fresh, light whitish grey, coarse to medium grained, fractured rock.	--	--	--	--	2.720	--	--	--	--	--	Do
52	2	14.00 - 15.00	Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	2.717	2.709	0.292	1.527	2.752	--	--	--	51.96	--	Do
52	6	18.00 - 19.00	Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.752	--	349	--	--	26447	Do
52	9	21.00 - 22.00	Moderately weathered, whitish grey, coarse grained, medium fractured rock.	--	--	--	--	2.678	216	--	--	--	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
53	2	5.00 - 6.50	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	3.012	--	--	--	51.31	--	Do
53	3	6.50 - 8.00	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	3.098	3.095	0.086	0.612	3.160	895	584	0.653	--	55740	Do
53	4	8.00 - 9.50	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.754	--	--	--	--	--	Do
54	1	5.90 - 6.90	Highly weathered, yellowish brown, medium grained, fractured rock.	2.674	2.649	0.951	4.753	2.890	--	--	--	7.33	--	Do
54	3	7.90 - 8.90	Slightly weathered, whitish grey, coarse grained, slightly fractured rock.	--	--	--	--	--	689	434	0.630	49.48	27133	Do
54	6	11.00 - 12.50	Fresh, whitish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.862	--	--	--	--	--	Do
55	1	9.90 - 10.90	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.774	--	--	--	--	--	Do
55	3	11.90 - 13.00	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	2.847	2.844	0.092	0.577	2.861	813	395	0.485	--	52749	Do
55	5	14.50 - 16.00	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.780	--	--	--	38.92	--	Do
56	1	3.00 - 4.00	Moderately weathered, light brownish grey, coarse grained, slightly fractured rock.	2.961	2.959	0.071	0.467	2.973	661	553	0.837	--	53218	Do
56	4	6.00 - 7.50	Fresh, light brownish grey, medium to coarse grained, slightly fractured rock.	;--	;--	;--	;--	2.760	--	--	--	--	--	Do
56	7	10.50 - 12.00	Fresh, light brownish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.810	--	--	--	51.49	--	Do
57	2	9.00 - 10.00	Moderately weathered, whitish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.767	544	469	0.861	--	53034	Do
57	5	12.00 - 13.50	Fresh, whitish grey, coarse grained, slightly fractured rock.	2.744	2.741	0.102	0.518	2.755	--	--	--	46.66	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
57	7	15.00 - 16.50	Fresh, whitish grey, coarse grained, slightly fractured rock.	;--	;--	;--	;--	2.742	--	--	--	--	--	Do
58	1	5.00 - 6.00	Fresh, light brownish grey, medium to coarse grained, highly fractured rock.	2.708	2.704	0.152	1.020	2.732	--	--	--	58.54	--	Do
58	3	7.50 - 9.00	Fresh, whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.755	670	590	0.879	--	55621	Do
59	1	5.00 - 6.00	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.782	--	--	--	53.66	--	Do
59	3	7.00 - 8.00	Fresh, light brownish grey, mediu to coarse grained, slightly fracture rock.	2.739	2.737	0.101	0.715	2.680	688	597	0.867	--	49168	Do
59	5	9.50 - 11.00	Fresh, whitish grey, mediu to coarse grained, slightly fracture rock.	;--	;--	;--	;--	2.758	--	--	--	--	--	Do
60	1	0.00 - 1.00	Moderately weathered, light brownish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.703	--	--	--	5.35	--	Do
60	4	3.00 - 4.50	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	2.766	2.763	0.080	0.537	2.778	522	323	0.619	--	50487	Do
60	7	7.50 - 9.00	Fresh, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.730	--	--	--	--	--	Do
61	2	1.00 - 2.00	Slightly weathered, whitish grey, coarse grained, moderately fractured rock.	2.743	2.739	0.134	1.821	2.790	--	--	--	23.73	--	Do
61	6	6.00 - 7.50	Fresh, whitish grey, coarse grained, moderately fractured rock.	--	--	--	--	2.786	344	271	0.788	--	22573	Do
61	7	7.50 - 9.00	Fresh, whitish grey, coarse grained, moderately fractured rock.	--	--	--	--	2.700	--	--	--	--	--	Do
62	1	0.00 - 1.00	Moderately weathered, whitish grey, coarse grained, moderately fractured rock.	2.717	2.714	0.099	0.705	2.733	--	569	--	--	54733	Do
62	4	3.50 - 5.00	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.760	--	--	--	--	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content (%)	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry				Dry	Saturated				
62	6	6.50 - 8.00	Moderately weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.779	--	--	--	15.95	--	Do
63	1	0.00 - 1.00	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.781	--	--	--	--	--	Do
63	5	5.00 - 6.50	Slightly weathered, light whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.782	--	--	--	20.77	--	Do
63	10	12.50 - 14.00	Fresh, light brownish grey, coarse to medium grained, moderately fractured rock.	2.765	2.762	0.098	0.656	--	587	431	0.735	--	43142	Do
63	12	15.50 - 17.00	Fresh, light brownish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.700	--	--	--	--	--	Do
64	1	0.50 - 1.50	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	2.716	2.711	0.186	0.957	2.737	367	291	0.792	--	35889	Do
64	4	4.50 - 6.00	Fresh, light brownish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.710	--	--	--	--	--	Do
64	9	12.00 - 13.50	Fresh, light brownish grey, coarse to medium grained, slightly fractured rock.	--	--	--	--	2.694	--	--	--	77.05	--	Do
65	1	11.00 - 12.00	Highly weathered, light brownish grey, medium to coarse grained, fractured rock.	;--	;--	;--	;--	2.778	--	--	--	51.90	--	Do
65	4	14.00 - 15.00	Slightly weathered, light brownish grey, medium to coarse grained, fractured rock.	2.763	2.759	0.120	0.803	2.730	753	618	0.820	--	40533	Do
65	7	17.50 - 19.00	Slightly weathered, whitish grey, medium to coarse grained, fractured rock.	;--	;--	;--	;--	2.764	--	--	--	--	--	Do
66	2	4.10 - 5.10	Highly weathered, whitish grey, medium grained, fractured rock.	2.790	2.785	0.170	0.768	2.807	--	--	--	44.55	--	Do
66	5	7.10 - 8.10	Moderately weathered, whitish grey, coarse grained, slightly fractured rock.	;--	;--	;--	;--	2.767	594	394	0.663	--	31738	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
66	8	11.00 - 12.50	Fresh, whitish grey, coarse grained, slightly fractured rock.	;--	;--	;--	;--	2.779	--	--	--	--	--	Do
67	1	8.30 - 9.80	Slightly weathered, light brownish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.802	--	--	--	--	--	Do
67	2	9.80 - 11.30	Fresh, light brownish grey, medium to fine grained, moderately fractured rock.	2.805	2.802	0.108	0.697	2.821	693	591	0.853	--	36056	Do
67	3	11.30 - 13.00	Fresh, light brownish grey, medium to fine grained, moderately fractured rock.	--	--	--	--	2.814	--	--	--	35.00	--	Do
68	1	13.50 - 14.00	Slightly weathered, light brownish grey, medium to coarse grained, moderately fractured rock.	2.799	2.795	0.143	0.741	2.816	--	--	--	61.79	--	Do
68	2	14.00 - 15.00	Fresh, whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.822	--	--	--	--	--	Do
68	3	15.00 - 16.50	Fresh, whitish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.792	928	768	0.828	--	53358	Do
69	1	11.00 - 12.00	Moderately weathered, whitish grey, medium grained, fractured rock.	--	--	--	--	2.771	--	--	--	--	--	Do
69	4	14.00 - 15.00	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.805	--	--	--	62.11	--	Do
69	6	16.50 - 18.00	Fresh, whitish grey, medium grained, slightly fractured rock.	2.778	2.775	0.119	0.790	2.797	844	719	0.852	--	57061	Do
70	2	8.00 - 9.00	Highly weathered, whitish grey, medium grained, highly fractured rock.	--	--	--	--	2.799	--	--	--	36.45	--	Do
70	5	11.00 - 12.00	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	2.666	2.664	0.077	0.618	2.681	799	787	0.99	--	26604	Do
70	7	13.50 - 15.00	Fresh, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.800	--	--	--	--	--	Do
71	2	5.60 - 6.60	Highly weathered, whitish grey, medium grained, fractured rock.	--	--	--	--	2.824	--	--	--	66.49	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
71	4	7.60 - .60	Moderately weathered, whitish grey, medium grained, fractured rock.	2.794	2.791	0.093	0.593	2.808	647	555	0.86	--	38939	Do
71	6	9.60 - 11.10	Fresh, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.890	--	--	--	--	--	Do
72	7	8.10 - 9.10	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.174	--	--	--	5.09	--	Do
72	15	16.10 - 17.60	Fresh, reddish brown, medium grained, slightly fractured rock.	2.260	2.232	1.234	9.288	2.461	168	147	0.87	--	5572	Do
72	16	17.60 - 19.10	Fresh, reddish brown, medium grained, slightly fractured rock.	--	--	--	--	2.820	--	--	--	--	--	Do
73	2	8.50 - 9.50	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.597	--	--	--	4.93		Do
73	5	11.50 - 12.50	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.910	--	--	--	--	--	Do
73	8	15.00 - 16.50	Fresh, reddish brown, coarse grained, slightly fractured rock.	2.808	2.805	0.100	0.653	2.774	152	114	0.75	--	7778	Do
74	1	2.10 - 3.10	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.189	--	--	--	5.27		Do
74	10	11.10 - 12.10	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.920	--	--	--	--	--	Do
74	14	15.60 - 17.10	Fresh, reddish brown, medium grained, slightly fractured rock.	2.531	2.482	1.985	8.685	2.718	503	136	0.27	--	11782	Do
75	1	5.10 - 6.10	Highly weathered, reddish brown, medium grained, fractured rock.	--	--	--	--	2.355	--	--	--	44.82	--	Do
75	9	13.10 - 14.10	Moderately weathered, reddish brown, medium grained, slightly fractured rock.	--	--	--	--	3.030	--	--	--	--	--	Do
75	12	16.60 - 18.10	Fresh, reddish brown, medium grained, slightly fractured rock.	2.015	1.976	1.962	13.023	2.272	60	37	0.61	--	4824	Do
76	2	2.10 - 3.10	Highly weathered, light reddish brown, medium grained, fractured rock.	--	--	--	--	2.345	--	--	--	20.62	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
76	14	14.10 - 15.10	Highly weathered, light reddish brown, medium grained, fractured rock.	--	--	--	--	2.760	--	--	--	--	--	Do
76	17	17.10 - 18.60	Fresh, light reddish brown, medium grained, fractured rock.	2.116	2.052	3.100	14.441	2.399	120	84	0.70	--	8477	Do
81	2	9.00 - 10.00	Highly weathered, whitish grey, fine to medium grained, fractured rock.	--	--	--	--	2.660	--	--	--	--	--	Do
81	5	11.00 - 12.00	Highly weathered, whitish grey, fine to medium grained, fractured rock.	--	--	--	--	2.747	--	--	--	24.01	--	Do
81	7	14.00 - 15.00	Moderately weathered, greyish, fine to medium grained, fractured rock.	2.683	2.678	0.187	1.648	2.723	520	488	0.94	--	31169	Do
82	2	17.00 - 18.00	Moderately weathered, light blackish grey, medium to coarse grained, moderately fractured rock.	--	--	--	--	2.823	--	--	--	33.95		Do
82	5	20.00 - 21.00	Slightly weathered, light blackish grey, medium to coarse grained, slightly fractured rock.	2.830	2.828	0.075	0.320	2.837	501	496	0.99	--	43519	Do
82	8	23.50 - 25.00	Fresh, light blackish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.511	--	--	--	--	--	Do
85	1	18.00 - 19.00	Moderately weathered, reddish brown, medium to coarse grained, highly fractured rock.	--	--	--	--	2.687	--	--	--	--	--	Do
85	5	22.00 - 23.00	Highly weathered, reddish brown, medium to coarse grained, highly fractured rock.	--	--	--	--	2.782	--	--	--	8.136	--	Do
85	13	30.50 - 32.00	Fresh, whitish grey, medium to coarse grained, moderately fractured rock.	2.661	2.657	0.160	1.145	2.687	781	760	0.97	--	18535	Do
86	1	21.50 - 22.50	Highly weathered, brownish grey, fine grained, decomposed rock.	--	--	--	--	2.647	--	--	--	2.59		Do
86	9	29.50 - 30.00	Highly weathered, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.870	--	--	--	--	--	Do
86	12	32.50 - 34.00	Fresh, whitish grey, medium grained, slightly fractured rock.	2.854	2.849	0.170	1.203	2.883	811	572	0.71	--	39290	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
87	1	38.00 - 39.00	Completely weathered, yellowish grey, medium to coarse grained, decomposed rock.	2.008	1.984	1.204	2.744	2.040	--	--	--	1.63		Do
87	2	39.00 - 40.00	Highly weathered, whitish grey, medium to coarse grained, decomposed rock.	--	--	--	--	2.610	--	--	--	--	--	Do
88	4	38.00 - 39.00	Highly weathered, brownish grey, medium grained, decomposed rock.	1.740	1.714	1.542	5.885	1.821	--	--	--	1.71		Do
88	5	39.00 - 40.00	Highly weathered, yellowish grey, medium grained, decomposed rock.	--	--	--	--	3.030	--	--	--	--	--	Do
89	5	37.00 - 38.00	Highly weathered, yellowish grey, fine to medium grained, decomposed rock.	2.220	2.187	1.508	5.237	2.308	--	--	--	2.80	--	Do
89	6	38.00 - 39.00	Highly weathered, yellowish grey, fine to medium grained, decomposed rock.	--	--	--	--	2.610	--	--	--	--	--	Do
89	7	39.00 - 40.00	Highly weathered, whitish grey, fine to medium grained, decomposed rock.	--	--	--	--	2.410	--	--	--	--	--	Do
90	4	38.00 - 39.00	Highly weathered, yellowish grey, fine to medium grained, decomposed rock.	2.065	2.043	1.094	3.252	2.111	--	--	--	1.08	--	Do
90	5	39.00 - 40.00	Highly weathered, yellowish grey, fine to medium grained, decomposed rock.	--	--	--	--	2.740	--	--	--	--	--	Do
92	2	10.00 - 11.00	Highly weathered, light blackish grey, medium grained, fractured rock.	--	--	--	--	2.794	--	--	--	--	--	Do
92	6	14.00 - 15.00	Moderately weathered, light blackish grey, medium grained, fractured rock.	--	--	--	--	2.993	--	--	--	128.73	--	Do
92	9	18.00 - 19.50	Fresh, light blackish grey, medium grained, fractured rock.	3.037	3.036	0.058	0.225	3.043	827	801	0.968	--	53392	Do
93	1	16.50 - 17.50	Highly weathered, light brownish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.884	--	--	--	--	--	Do
93	6	21.50 - 22.50	Highly weathered, light brownish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.784	--	--	--	0.92	--	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
93	11	27.00 - 28.50	Fresh, light blackish grey, coarse grained, slightly fractured rock.	3.088	3.087	0.038	0.222	3.094	792	782	0.988	--	60752	Do
94	1	12.50 - 13.50	Highly weathered, yellowish brown, medium to fine grained, highly fractured rock.	--	--	--	--	2.889	--	--	--	--	--	Do
94	10	21.50 - 22.50	Moderately weathered, light blackish grey, medium grained, highly fractured rock.	3.049	3.046	0.096	0.459	3.060	--	--	--	115.86	--	Do
94	16	28.00 - 29.50	Fresh, light blackish grey, medium grained, moderately to slightly fractured rock.	--	--	--	--	3.072	807	763	0.945	--	53475	Do
96	4	9.50 - 10.50	Highly weathered, yellowish brown, coarse grained, fractured rock.	--	--	--	--	3.061	--	--	--	--	--	Do
96	13	18.50 - 19.50	Highly weathered, light grey, medium grained, fractured rock.	--	--	--	--	3.116	--	--	--	128.84	--	Do
96	16	22.00 - 23.50	Fresh, light grey, medium grained, slightly fractured rock.	3.032	3.029	0.078	0.371	3.041	1062	919	0.865	--	44179	Do
97	2	4.00 - 5.00	Highly weathered, blackish grey, medium grained, highly fractured rock.	--	--	--	--	3.023	--	--	--	71.47	--	Do
97	8	10.00 - 11.00	Moderately weathered, blackish grey, medium grained, fractured rock.	--	--	--	--	2.990	938	--	--	--	--	Do
97	15	18.00 - 19.50	Fresh, blackish grey, medium grained, slightly fractured rock.	3.004	3.003	0.038	0.254	3.010	--	925	--	--	50798	Do
99	1	21.20 - 22.00	Moderately weathered, light blackish grey, coarse grained, fractured rock.	--	--	--	--	3.081	--	--	--	21.41	--	Do
99	4	24.00 - 25.00	Fresh, light blackish grey, coarse grained, slightly fractured rock.	3.035	3.034	0.027	0.161	3.039	797	793	1.00	--	36827	Do
99	6	26.50 - 28.00	Fresh, light blackish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.800	--	--	--	--	--	Do
MND01	1	14.70 - 15.00	Slightly weathered, whitish grey, coarse grained, fractured rock.	2.824	2.818	0.207	1.171	2.851	--	--	--	22.64	--	Do
MND01	4	17.50 - 19.00	Slightly weathered, whitish grey, coarse grained, fractured rock.	--	--	--	--	2.822	731	698	0.95	--	41507	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
MND02	1	15.00 - 16.00	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	2.747	2.742	0.177	0.823	2.765	788	704	0.89	--	54082	Do
MND02	4	18.00 - 19.50	Slightly weathered, whitish grey, medium to coarse grained, slightly fractured rock.	--	--	--	--	2.731	--	--	--	31.64	--	Do
MND03	1	27.70 - 28.70	Highly weathered, light brownish grey, medium grained, fractured rock.	--	--	--	--	2.754	--	--	--	4.93	--	Do
MND03	9	35.70 - 36.70	Highly weathered, light brownish grey, medium grained, fractured rock.	--	--	--	--	2.870	--	--	--	--	--	Do
MND03	12	38.70 - 40.00	Slightly weathered, light brownish grey, medium grained, fractured rock.	2.756	2.752	0.167	1.051	2.781	502	467	0.93	--	36951	Do
MND04	2	14.00 - 15.00	Highly weathered, yellowish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	0.659	--	--	--	25.44	--	Do
MND04	16	28.00 - 29.00	Highly weathered, whitish grey, medium to coarse grained, highly fractured rock.	--	--	--	--	2.700	--	--	--	--	--	Do
MND04	22	34.50 - 36.00	Fresh, light blackish grey, medium grained, slightly fractured rock.	2.785	2.783	0.087	0.345	2.792	628	598	0.95	--	38897	Do
MND05	1	14.10 - 15.00	Highly weathered, yellowish grey, coarse grained, fractured rock.	2.127	2.067	2.908	3.630	2.681	--	--	--	1.91	--	Do
MND05	8	21.00 - 22.00	Highly weathered, yellowish grey, coarse grained, fractured rock.	--	--	--	--	2.500	--	--	--	--	--	Do
MND05	19	32.00 - 33.00	Slightly weathered, whitish grey, medium grained, slightly fractured rock.	--	--	--	--	2.791	1200	1177	0.98	--	37684	Do
MND06	1	12.10 - 13.10	Highly weathered, yellowish brown, medium grained, fractured rock.	--	--	--	--	2.787	--	--	--	0.83	--	Do
MND06	6	17.10 - 18.10	Moderately weathered, light blackish grey, medium to coarse grained, fractured rock.	--	--	--	--	2.960	--	--	--	--	--	Do
MND06	9	20.10 - 21.10	Slightly weathered, light blackish grey, medium to coarse grained, fractured rock.	3.088	3.085	0.091	0.298	3.094	904	828	0.92	--	32792	Do

LABORATORY ROCK TEST RESULTS

BH No.	Run No.	Depth (M)	Description	Density (gm/cc)		Water Content	Porosity %	Specific Gravity	Unconfined Compressive Strength (kg/sqcm)		Coefficient of softening	Point Load Strength Index (kg/sqcm)	Young's Modulus, kg/sqcm	Test Method
				Bulk	Dry	(%)			Dry	Saturated				
MND-07	1	12.50 - 13.50	Highly weathered, light yellowish brown, medium to fine grained, fractured rock.	--	--	--	--	2.942	--	--	--	--	--	Do
MND-07	14	25.50 - 26.50	Fresh, light blackish grey, medium grained, moderately fractured rock.	--	--	--	--	3.015	--	--	--	128.73	--	Do
MND-07	16	27.50 - 28.50	Fresh, light blackish grey, medium grained, moderately fractured rock.	3.051	3.050	0.033	0.224	3.057	811	797	0.983	--	39908	Do
MND10	1	10.00 - 11.00	Highly weathered, yellowish brown, fine to medium grained, highly fractured rock.	--	--	--	--	0.678	--	--	--	33.42	--	Do
MND10	5	14.00 - 15.00	Modertely weathered, grey, fine to medium grained, highly fractured rock.	--	--	--	--	3.070	--	--	--	--	--	Do
MND10	9	18.00 - 19.50	Fresh, light blackish grey, medium grained, slightly fractured rock.	3.160	3.159	0.026	0.106	3.162	869	690	0.79	--	64118	Do
MND11	1	12.50 - 13.50	Highly weathered, light whitsih grey, fine to medium grained, fractured rock.	--	--	--	--	2.791	--	--	--	21.72	--	Do
MND11	6	17.50 - 18.50	Modertely weathered, yellowish grey, fine to medium grained, fractured rock.	--	--	--	--	2.980	--	--	--	--	--	Do
MND11	9	21.00 - 22.50	Fresh, grey, fine to medium grained, fractured rock.	3.074	3.073	0.028	0.105	3.076	870	828	0.95	--	52409	Do
MND12	2	14.50 - 15.50	Highly weathered, yellowish brown, medium grained, fractured rock.	--	--	--	--	2.740	--	--	--	15.66	--	Do
MND12	14	26.50 - 27.50	Slightly weathered, blackish grey, coarse grained, slightly fractured rock.	--	--	--	--	2.910	--	--	--	--	--	Do
MND12	15	27.50 - 29.00	Fresh, blackish grey, coarse grained, slightly fractured rock.	3.112	3.111	0.026	0.109	3.114	847	832	0.98	--	54100	Do
MND13	1	16.50 - 17.50	Highly weathered, reddish brown, medium to coarse grained, decomposed rock.	1.999	1.893	5.607	12.858	2.172	--	108	--	--	4204	Do
MND13	2	17.50 - 18.50	Highly weathered, reddish brown, medium to coarse grained, decomposed rock.	--	--	--	--	2.750	--	--	--	--	--	Do
														Do

SWELLING TEST RESULTS

Bore Hole No.	Sample No.	Depth (M)	Description	Free Swell Index, (%)	Swelling Pressure, (kg/sqcm)	PI (%)	Test Method
BH-01	SPT-04	6.00	Light grey clayey sandy silt / clayey silty sand with decomposed rock fragments.	0.00	--	--	* See the Note
BH-19	SPT-02	3.00	Reddish brown clayey silt with sand mixture.	0.00	--	--	Do
BH-20	DS-01	0.50	Brownish grey clayey silt with sand & traces of kankars.	0.00	--	--	Do
BH-21	SPT-03	5.00	Reddish brown clayey silt with sand mixture.	0.00	--	--	Do
BH-22	SPT-05	7.50	Reddish brown clayey silt with sand mixture.	6.90	--	--	Do
BH-30	UDS-02	4.00	Reddish brown clayey silt with sand mixture.	4.65	0.12	18	Do
BH-37	DS-01	0.50	Reddish brown silty sand with clay binders and traces of kankars	0.00	--	--	Do
BH-40	UDS-01	2.05	Reddish brown clayey silt with sand mixture.	7.14	0.145	19	Do
BH-44	DS-01	0.50	Reddish brown clayey silt with sand mixture.	2.44	--	--	Do
BH-47	DS-01	0.50	Reddish brown clayey silt with kankar, gravel & sand mixture.	4.55	--	--	Do
BH-48	SPT-05	7.50	Brownish grey silty sand with rock dust.	0.00	--	--	Do
BH-50	DS-01	0.50	Reddish brown clayey silty sand with traces of kankars.	0.00	--	--	Do
BH-51	DS-02	1.00	Reddish brown clayey silt with sand mixture & kankars.	4.55	--	--	Do
BH-52	SPT-07	10.50	Yellowish grey clayey sandy silt with traces of kankars.	4.35	--	--	Do
BH-53	SPT-01	1.00	Reddish brown clayey silt with sand mixture.	2.63	--	--	Do
BH-54	UDS-01	2.50	Reddish brown clayey silt with traces of sand mixture & rock pieces.	7.14	0.62	17	Do
BH-55	UDS-01	2.55	Greyish brown clayey silt with traces of sand mixture.	4.76	0.33	23	Do
BH-56	DS-02	1.00	Reddish brown silty sand with traces of kankar & clay binder.	0.00	--	--	Do

SWELLING TEST RESULTS

Bore Hole No.	Sample No.	Depth (M)	Description	Free Swell Index, (%)	Swelling Pressure, (kg/sqcm)	PI (%)	Test Method
BH-57	SPT-02	3.00	Reddish brown silty sand with traces of kankar & clay binder.	0.00	--	--	Do
BH-58	SPT-02	3.00	Brownish grey clayey silty sand with traces of kankar.	9.09	--	--	Do
BH-59	SPT-01	1.00	Reddish brown clayey silt with traces of rock pieces.	0.00	--	--	Do
BH-65	UDS-01	3.60	Reddish brown clayey silt with sand mixture & kankar.	3.12	0.45	27	Do
BH-66	SPT-01	1.00	Brownish grey clayey sandy silt.	2.27	--	--	Do
BH-67	UDS-01	2.50	Reddish brown silty clay / clayey silt with traces of sand mixture.	13.04	0.56	28	Do
BH-67	UDS-02	5.50	Reddish brown clayey silt with traces of sand mixture & rock pieces.	4.00	0.08	24	Do
BH-68	UDS-01	4.00	Reddish brown clayey silt with traces of sand mixture.	4.17	0.62	21	Do
BH-69	UDS-02	5.50	Reddish brown clayey silt with traces of sand mixture.	1.74	0.13	19	Do
BH-70	UDS-01	2.50	Reddish brown clayey silt with sand mixture.	0.00	0.24	--	Do
BH-71	SPT-01	1.50	Reddish brown, clayey silt with rock fragments.	13.64	--	--	Do
BH-72	DS-02	1.00	Reddish brown silty clay with sand mixture & decomposed rock fragments.	5.55	--	--	Do
BH-73	SPT-02	3.00	Reddish brown clayey silt with traces of sand mixture.	12.00	--	--	Do
BH-74	DS-02	1.00	Reddish brown clayey silt with decomposed rock fragments.	0.00	--	--	Do
BH-75	DS-03	4.00	Reddish brown clayey silt with traces of sand mixtures.	10.25	--	--	Do
BH-81	SPT-03	5.00	Yellowish brown, clayey silt with sand mixture.	6.67	--	--	Do
BH-82	UDS-02	9.50	Reddish brown clayey silt with moorum & rock fragments	0.00	0.00	15	Do
BH-85	SPT-03	4.50	Reddish brown clayey silt with sand mixture.	9.09	--	--	Do

SWELLING TEST RESULTS

Bore Hole No.	Sample No.	Depth (M)	Description	Free Swell Index, (%)	Swelling Pressure, (kg/sqcm)	PI (%)	Test Method
BH-86	UDS-02	5.55	Reddish brown silty clay / clayey silt with sand mixture.	7.64	0.01	24	Do
BH-88	SPT-09	14.10	Reddish brown clayey silt with traces of rock fragments.	8.33	--	--	Do
BH-89	UDS-03	20.00	Yellowish brown clayey silt with sand mixture.	8.33	0.00	25	Do
BH-90	UDS-05	19.00	Reddish brown clayey silt with sand mixture.	2.08	0.00	25	Do
BH-91	UDS-01	3.00	Reddish brown clayey silt with sand mixture.	0.00	0.12	--	Do
BH-93	UDS-01	2.55	Reddish brown clayey silt with traces of sand mixture.	6.52	0.00	19	Do
BH-94	UDS-01	2.55	Reddish brown clayey silt with traces of sand mixture.	4.55	0.00	13	Do
BH-98	UDS-01	2.60	Reddish brown clayey silt with moorum & rock fragments.	9.09	0.22	10	Do
BH-99	UDS-01	3.00	Reddish brown clayey silt with sand mixture.	4.35	0.10	--	Do
BH-100	UDS-01	2.50	Reddish brown clayey silt with decomposed rock fragments.	4.35	0.00	22	Do
MND-01	SPT-04	6.50	Reddish brown,clayey silt with traces of rock pieces & sand mixture.	7.32	--	--	Do
MND-02	UDS-01	3.15	Reddish brown clayey silt / silty clay with sand mixture & kankars.	42.86	0.37	21	Do
MND-03	SPT-13	21.50	Light grey clayey silty sand / clayey sandy silt with decomposed rock fragments & moorum.	2.50	--	--	Do
MND-04	UDS-01	4.00	Reddish brown clayey silt with moorum & rock fragments.	6.67	0.22	14	Do
MND-05	UDS-01	4.00	Reddish brown clayey silt with moorum & rock fragments.	0.00	0.00	12	Do
MND-05	UDS-02	7.00	Reddish brown clayey silt with moorum & rock fragments.	0.00	0.00	12	Do
MND-06	UDS-01	2.50	Reddish brown clayey silt with sand mixture.	2.13	0.12	18	Do
MND-07	UDS-01	3.00	Brownish grey clayey silt with traces of sand mixture.	9.09	0.20	16	Do

SWELLING TEST RESULTS

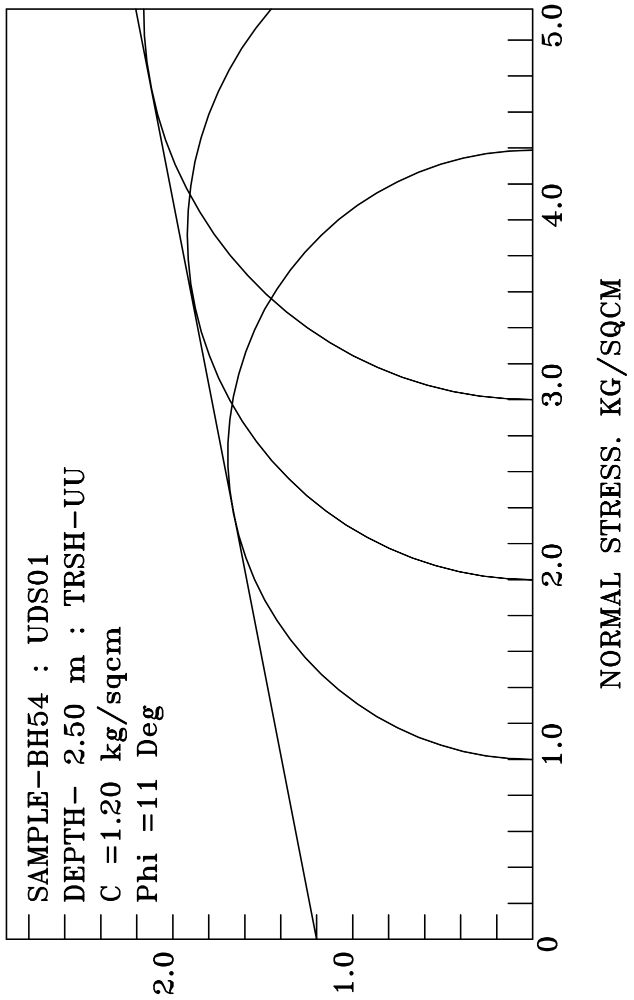
Bore Hole No.	Sample No.	Depth (M)	Description	Free Swell Index, (%)	Swelling Pressure, (kg/sqcm)	PI (%)	Test Method
MND-10	UDS-01	2.50	Reddish brown clayey silt with sand mixture.	8.33	0.15	19	Do
MND-11	UDS-01	2.50	Reddish brown clayey silt with sand mixture.	0.00	0.15	21	Do
MND-12	UDS-01	3.05	Reddish brown clayey silt with sand mixture.	18.18	0.24	20	Do
MND-13	UDS-01	3.00	Reddish brown clayey silt with traces of sand mixture.	9.09	0.27	25	Do

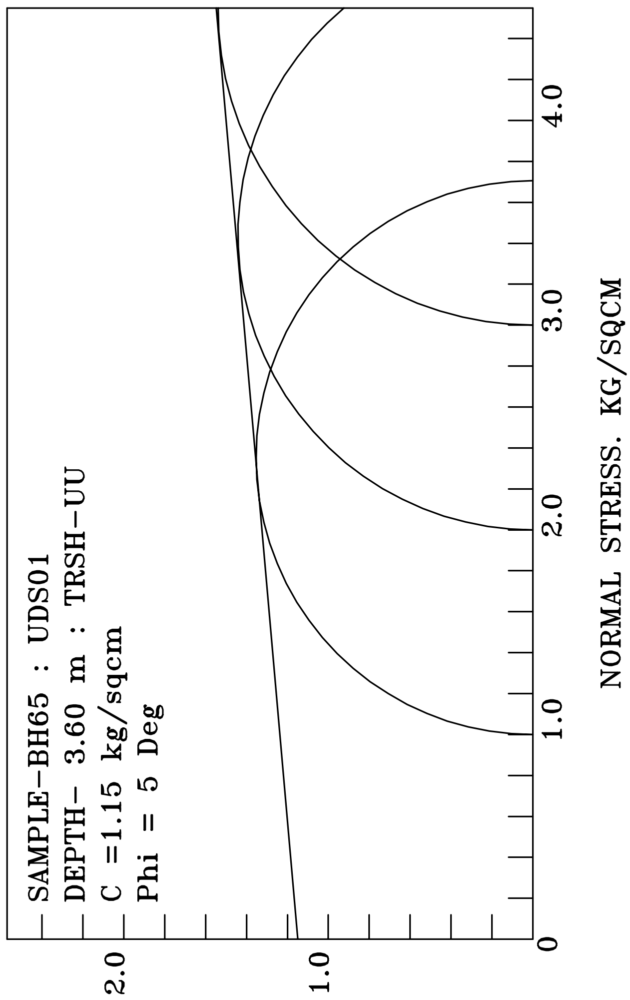
SUMMERISED LABORATORY COMPACTION AND CBR TEST RESULTS

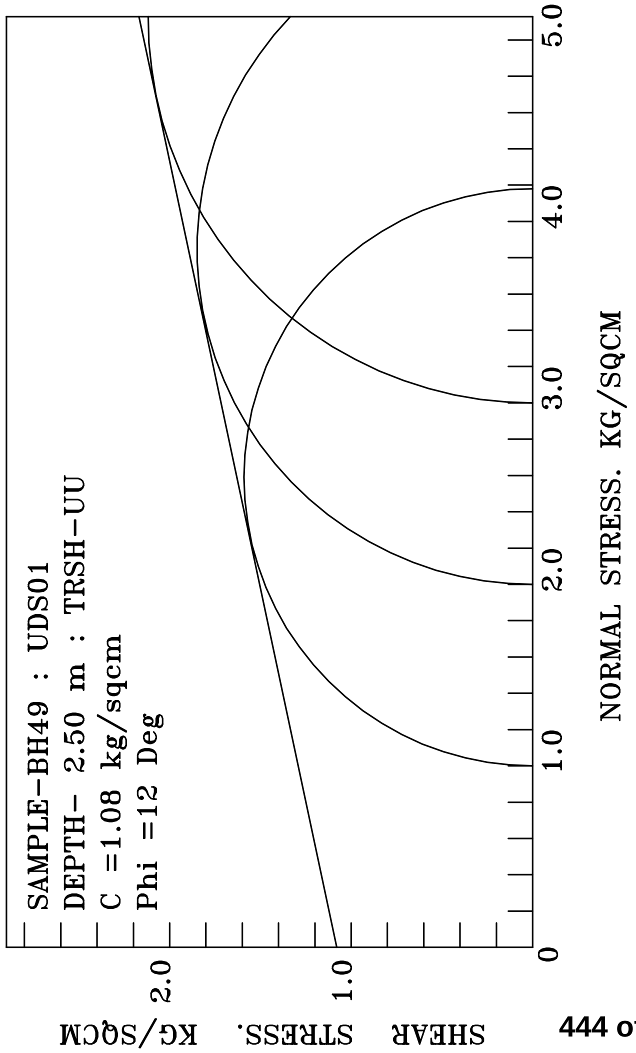
SL No	Sample No	Depth (M)	Description	Standard Proctor Compaction Test		Soaked CBR Value at 95% of MDD (%)		Recommended Soaked CBR (%)	Permeability on samples compacted at MDD/OMC (cm/sec)
				OMC (%)	MDD (gm/cc)	2.50mm Penetration	5.00mm Penetration		
1	TP04/DS01	1.00	Reddish brown clayey silt with traces of sand mixture.	25.50	1.552	9.18	7.33	9	--
2	TP05/DS01	0.50	Reddish brown clayey silt with traces of decomposed rock fragments.	19.75	1.709	--	--	--	1.70×10^{-05}
3	TP07/DS02	2.00	Reddish brown clayey silt / silty clay with traces of sand mixture & kankar.	19.60	1.590	8.51	7.42	8	5.20×10^{-06}
4	TP08/DS03	3.00	Reddish brown clayey silt with traces of sand mixture & kankar.	30.05	1.437	--	--	--	1.78×10^{-06}
5	TP-MND-01/DS01	1.00	Reddish brown clayey silt / silty clay with traces of sand mixture & kankar.	24.90	1.604	8.16	6.48	8	8.23×10^{-07}
6	CBR-02/DS01	0.80	Greyish brown clayey silt.	30.10	1.421	3.63	3.22	3	--
7	CBR-09/DS01	0.50	Reddish brown clayey silt.	23.10	1.572	--	--	--	1.46×10^{-06}
8	CBR-10/DS01	0.50	Reddish brown clayey silt.	23.40	1.578	8.42	6.68	8	--

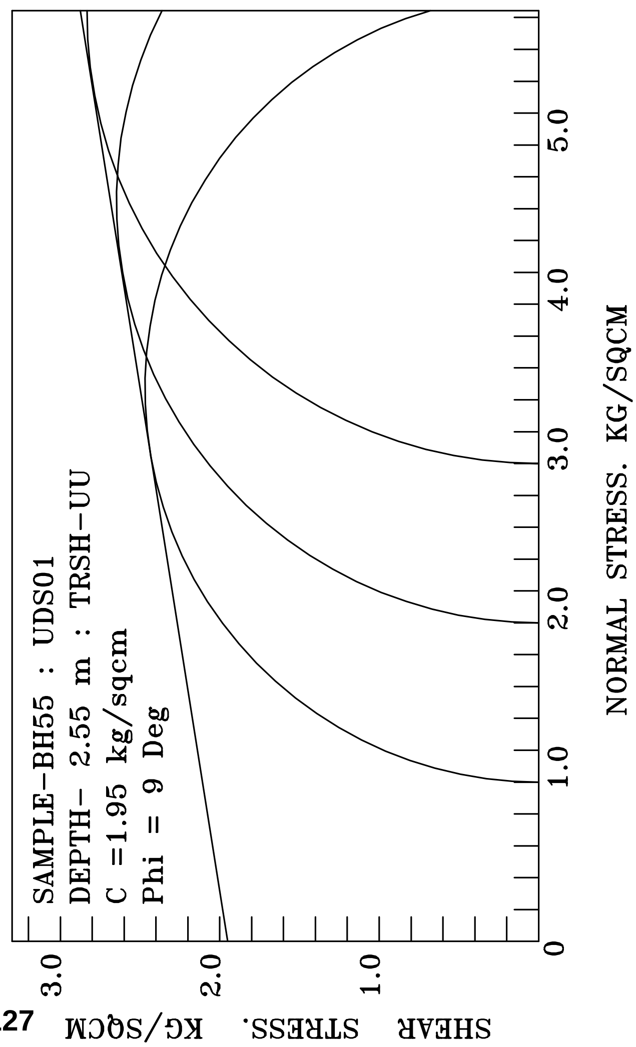
PART III: CHARTS & GRAPHS

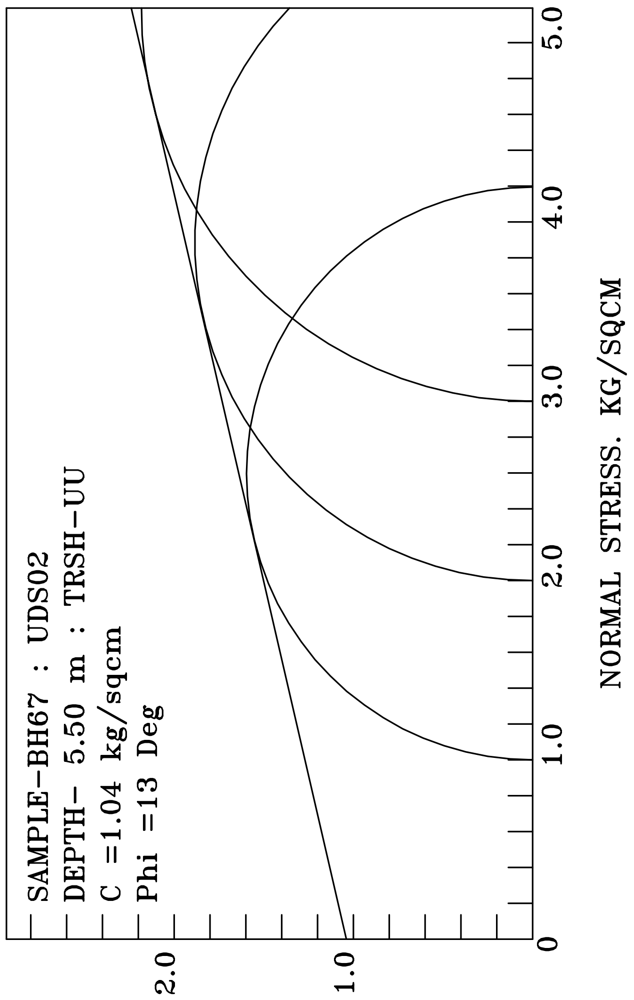
Project :Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha			CETEST
Job No :4095	Created by : Srabanti	Created on :	Sheet No:



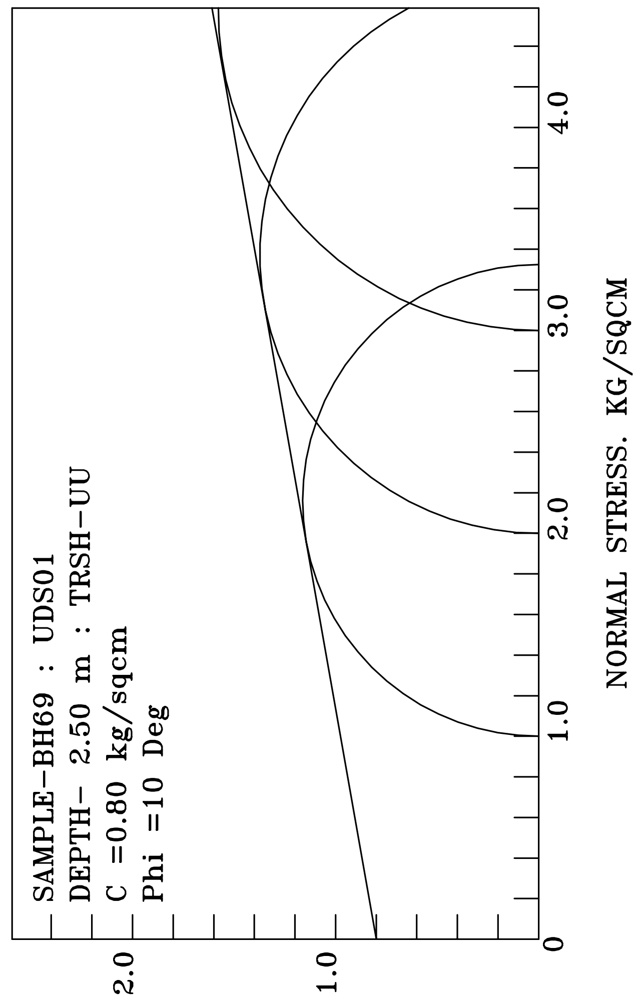




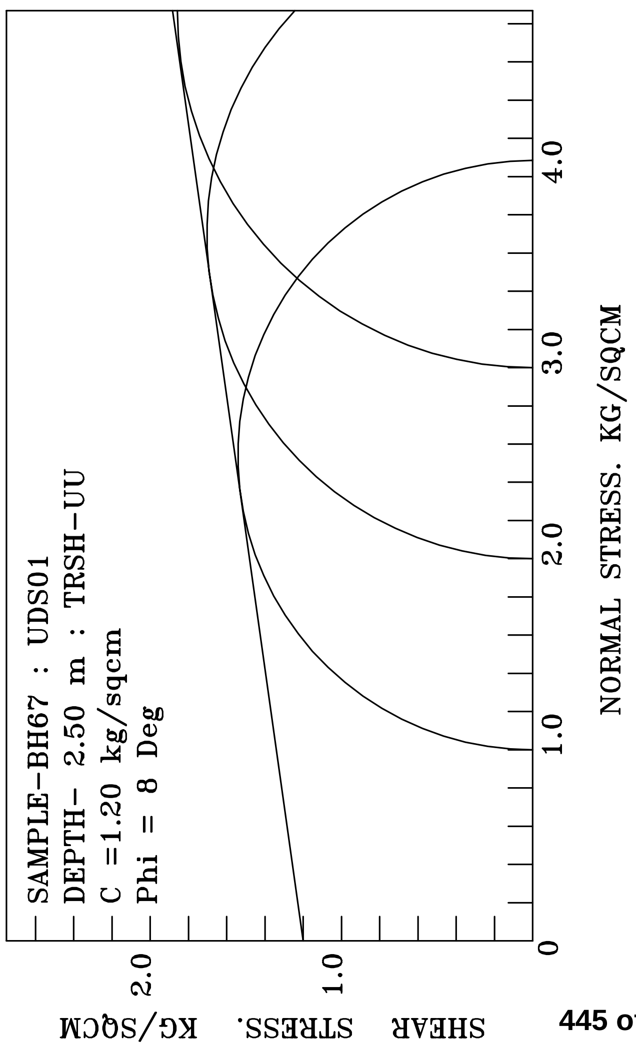




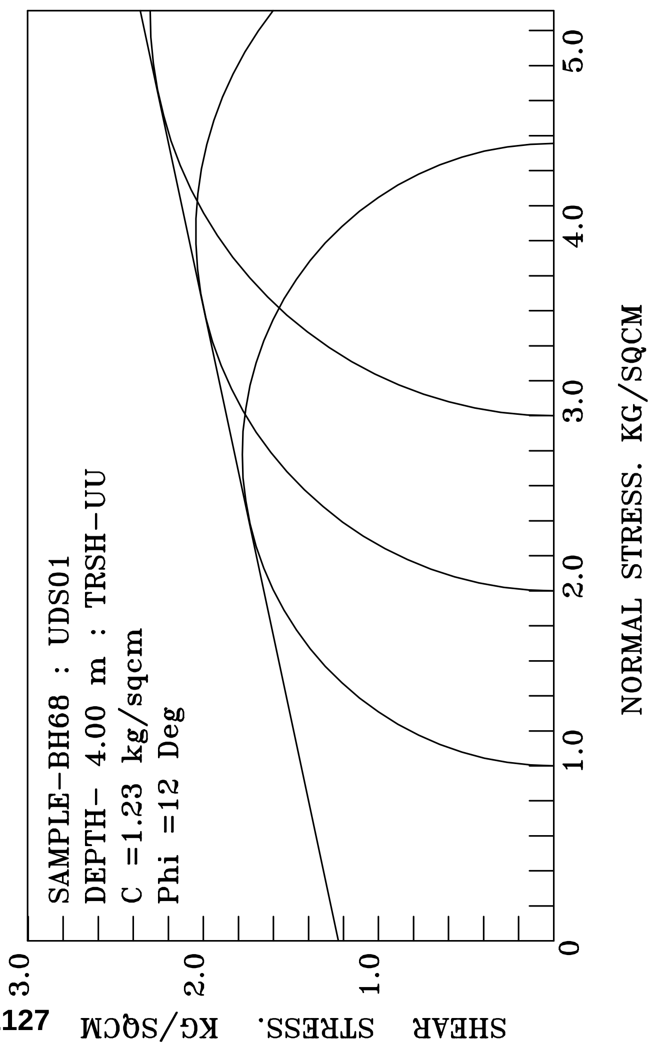
SAMPLE-BH67 : UDS02
DEPTH- 5.50 m : TRSH-UU
C =1.04 kg/sqcm
Phi =13 Deg
NORMAL STRESS. KG/SQCM



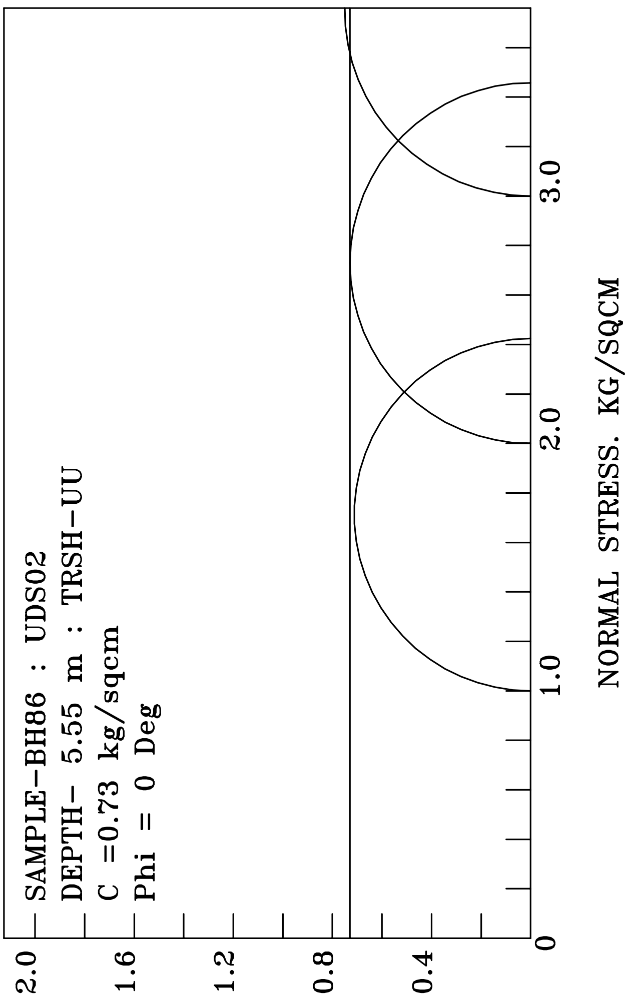
SAMPLE-BH69 : UDS01
DEPTH- 2.50 m : TRSH-UU
C =0.80 kg/sqcm
Phi =10 Deg
NORMAL STRESS. KG/SQCM

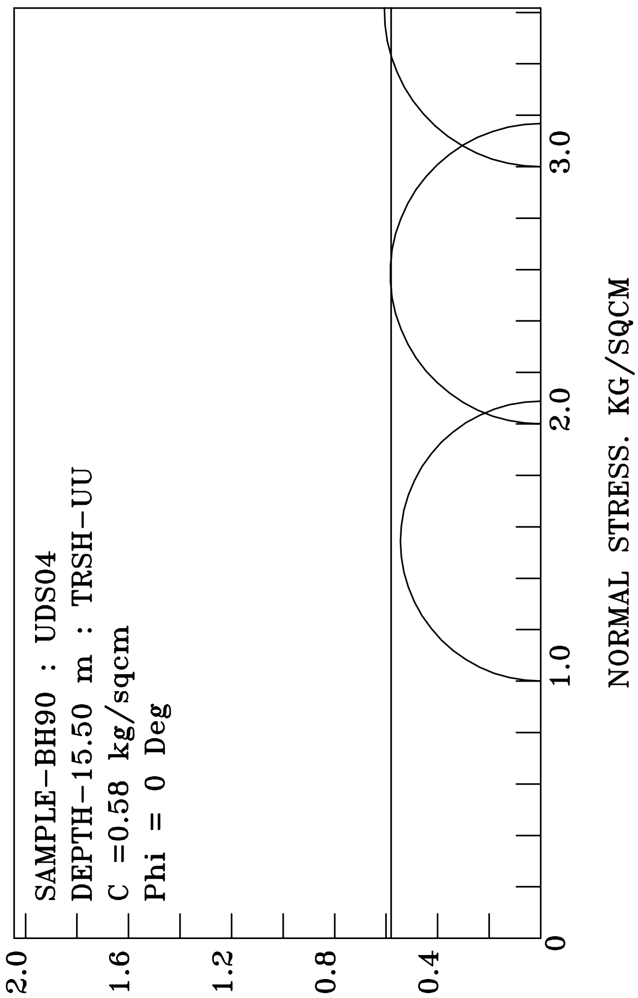


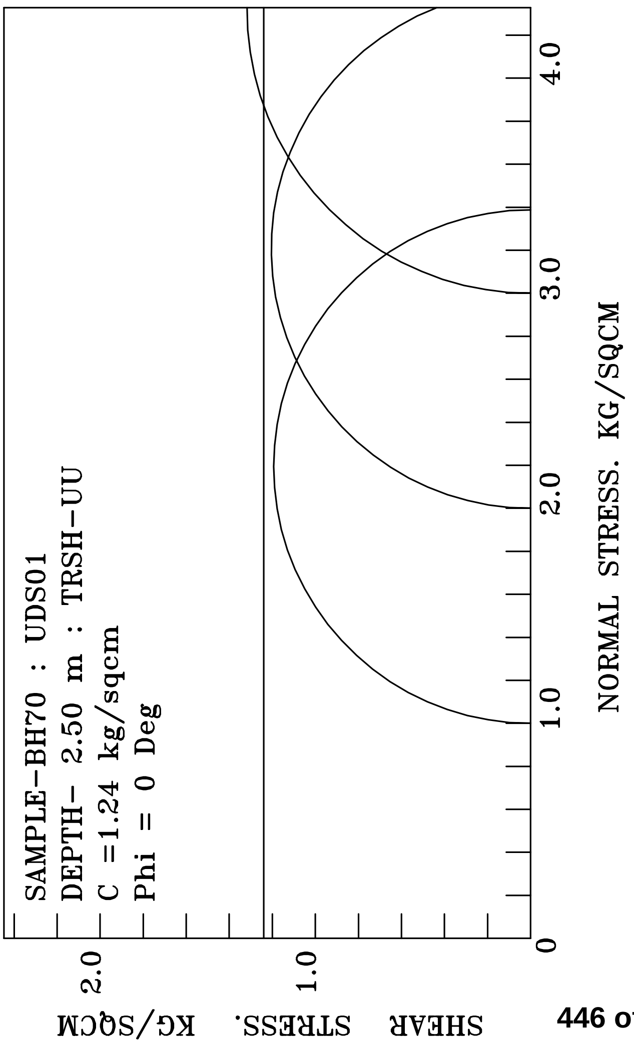
SAMPLE-BH67 : UDS01
DEPTH- 2.50 m : TRSH-UU
C =1.20 kg/sqcm
Phi = 8 Deg
NORMAL STRESS. KG/SQCM
SHEAR STRESS. KG/SQCM

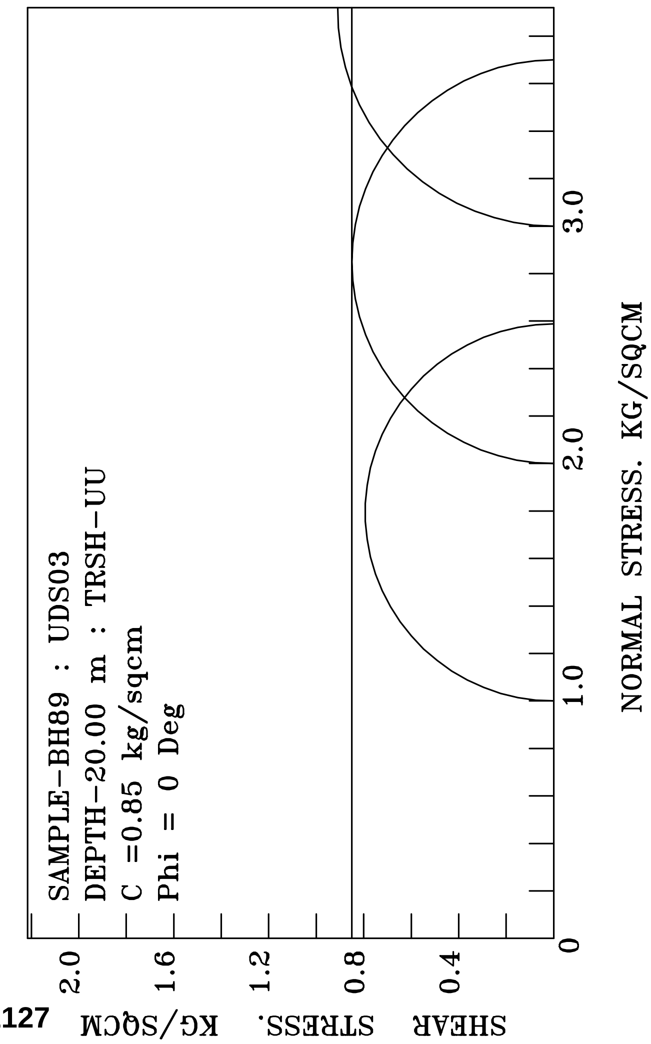


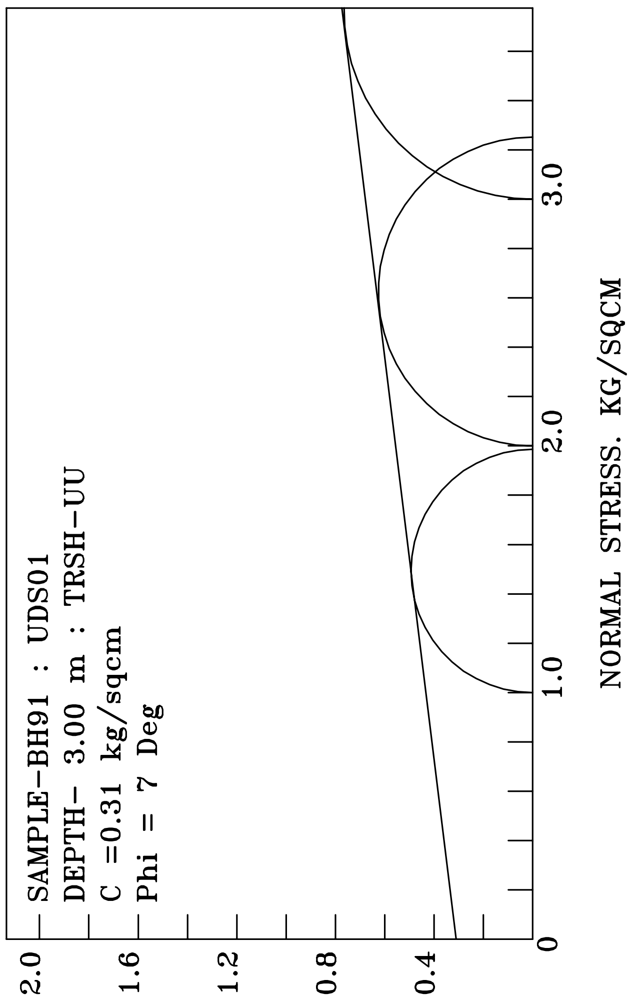
SAMPLE-BH68 : UDS01
DEPTH- 4.00 m : TRSH-UU
C =1.23 kg/sqcm
Phi =12 Deg
NORMAL STRESS. KG/SQCM
SHEAR STRESS. KG/SQCM

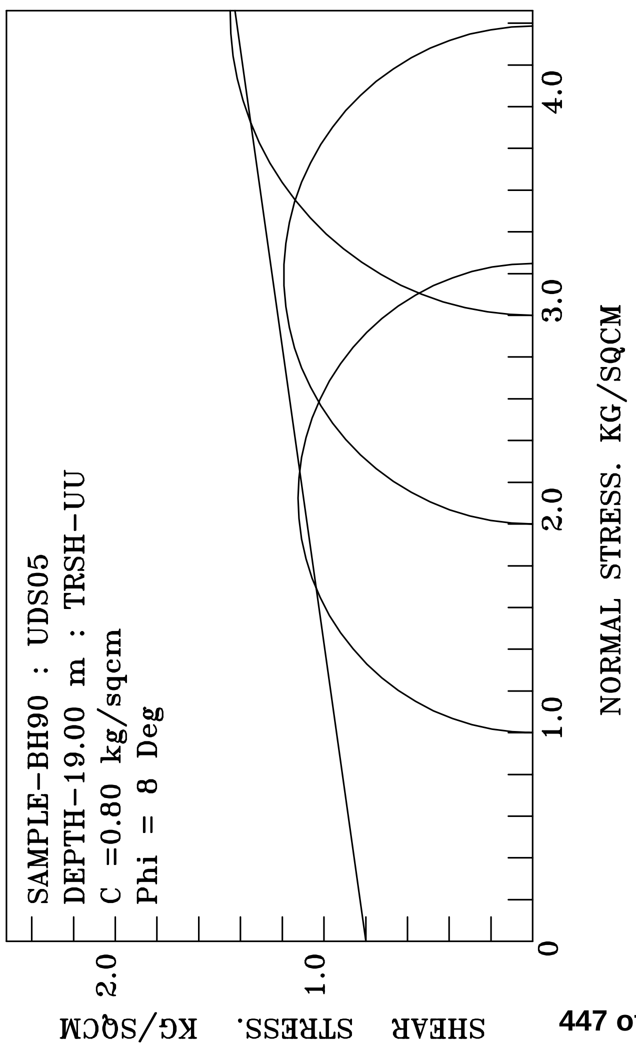

SAMPLE-BH86 : UDS02
DEPTH- 5.55 m : TRSH-UU
C =0.73 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
0.4
0.8
1.2
1.6
2.0

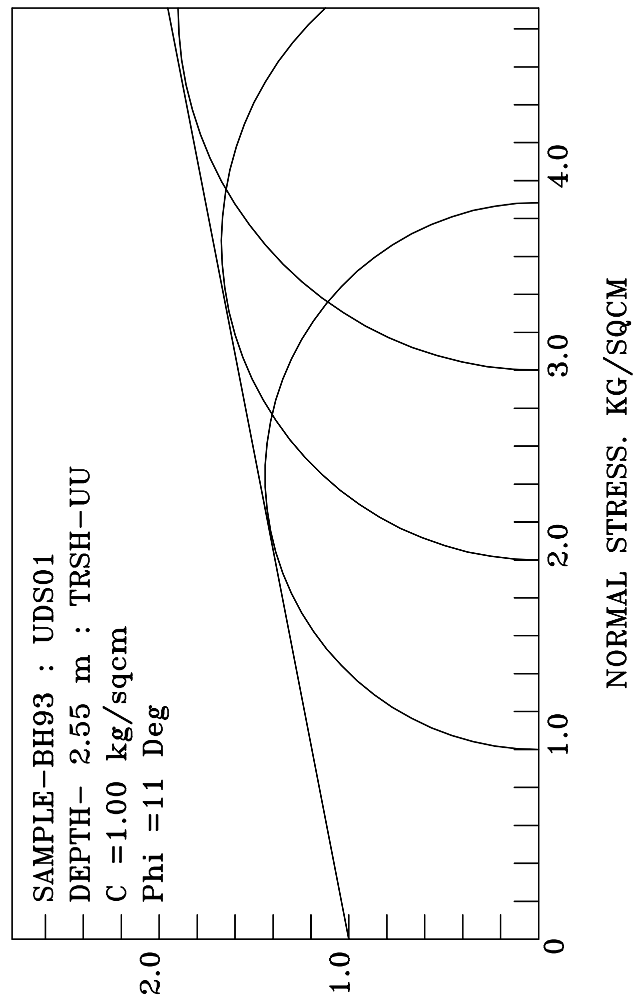

SAMPLE-BH90 : UDS04
DEPTH-15.50 m : TRSH-UU
C =0.58 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
0.4
0.8
1.2
1.6
2.0

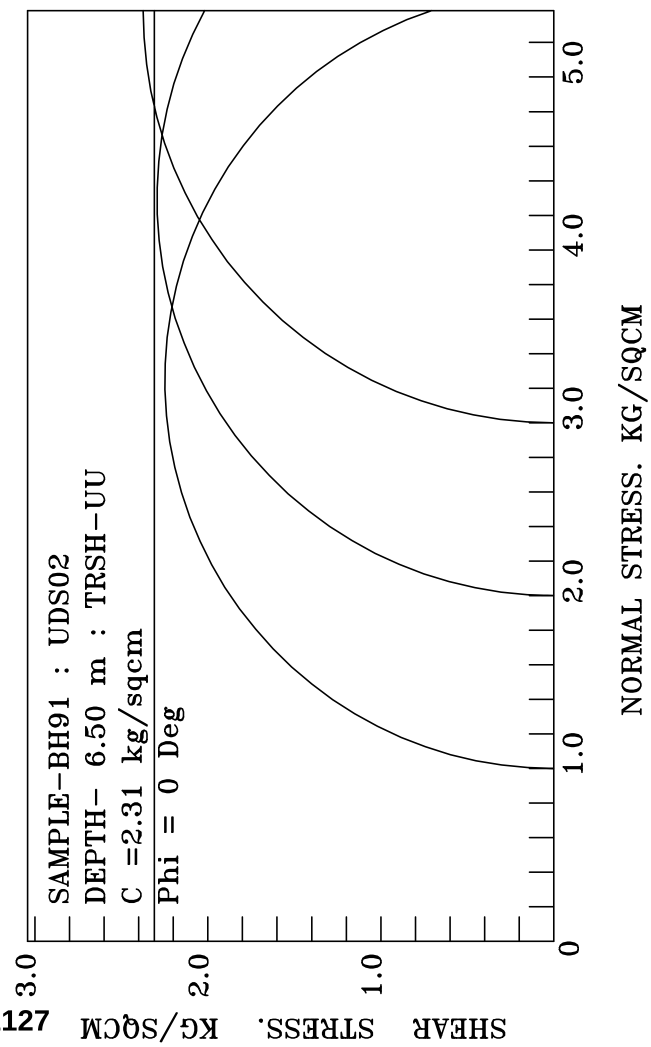

SAMPLE-BH70 : UDS01
DEPTH- 2.50 m : TRSH-UU
C =1.24 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
1.0
2.0
SHEAR STRESS. KG/SQCM

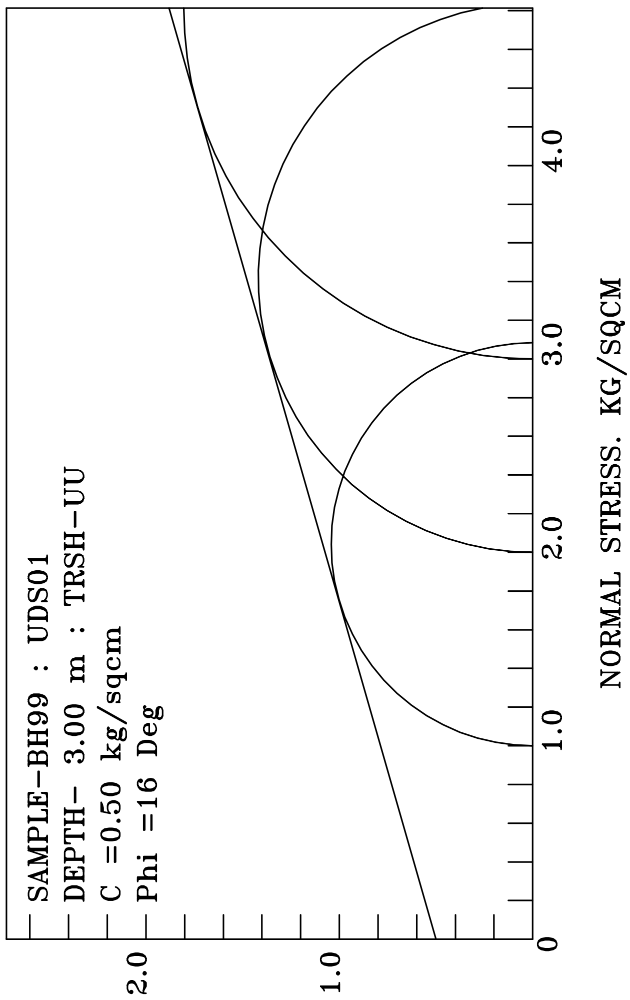

SAMPLE-BH89 : UDS03
DEPTH-20.00 m : TRSH-UU
C =0.85 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
0.4
0.8
1.2
1.6
2.0
SHEAR STRESS. KG/SQCM

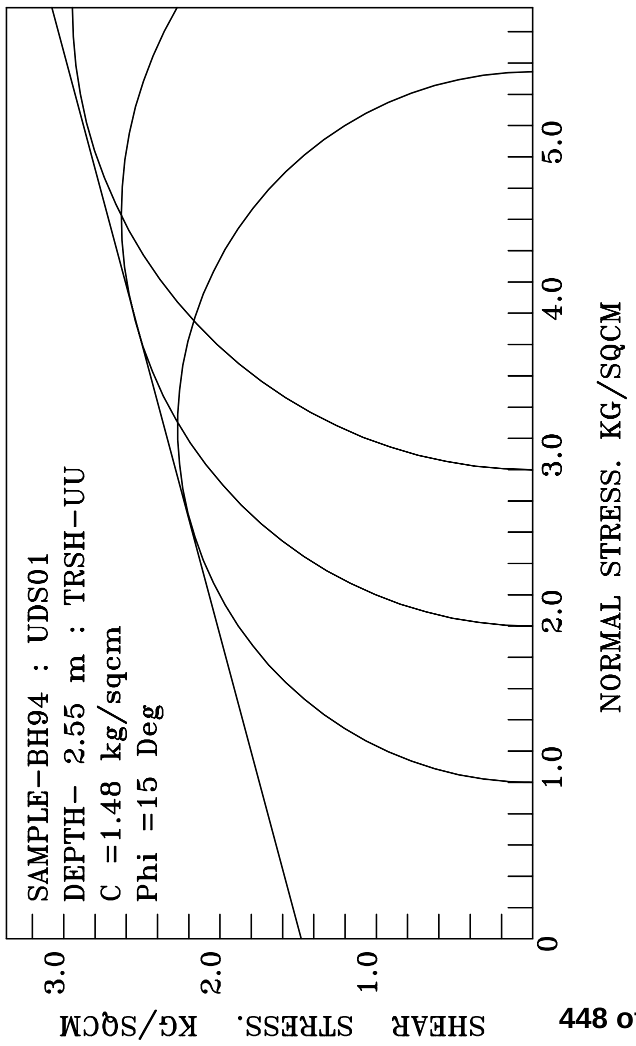

SAMPLE-BH91 : UDS01
DEPTH- 3.00 m : TRSH-UU
C =0.31 kg/sqcm
Phi = 7 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
0.4
0.8
1.2
1.6
2.0


SAMPLE-BH90 : UDS05
DEPTH-19.00 m : TRSH-UU
C =0.80 kg/sqcm
Phi = 8 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
1.0
2.0
SHEAR STRESS. KG/SQCM


SAMPLE-BH93 : UDS01
DEPTH- 2.55 m : TRSH-UU
C =1.00 kg/sqcm
Phi =11 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
1.0
2.0


SAMPLE-BH91 : UDS02
DEPTH- 6.50 m : TRSH-UU
C =2.31 kg/sqcm
Phi = 0 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
5.0
1.0
2.0
3.0
SHEAR STRESS. KG/SQCM


SAMPLE-BH99 : UDS01
DEPTH- 3.00 m : TRSH-UU
C =0.50 kg/sqcm
Phi =16 Deg
NORMAL STRESS. KG/SQCM


SAMPLE-BH94 : UDS01
DEPTH- 2.55 m : TRSH-UU
C =1.48 kg/sqcm
Phi =15 Deg
NORMAL STRESS. KG/SQCM
SHEAR STRESS. KG/SQCM

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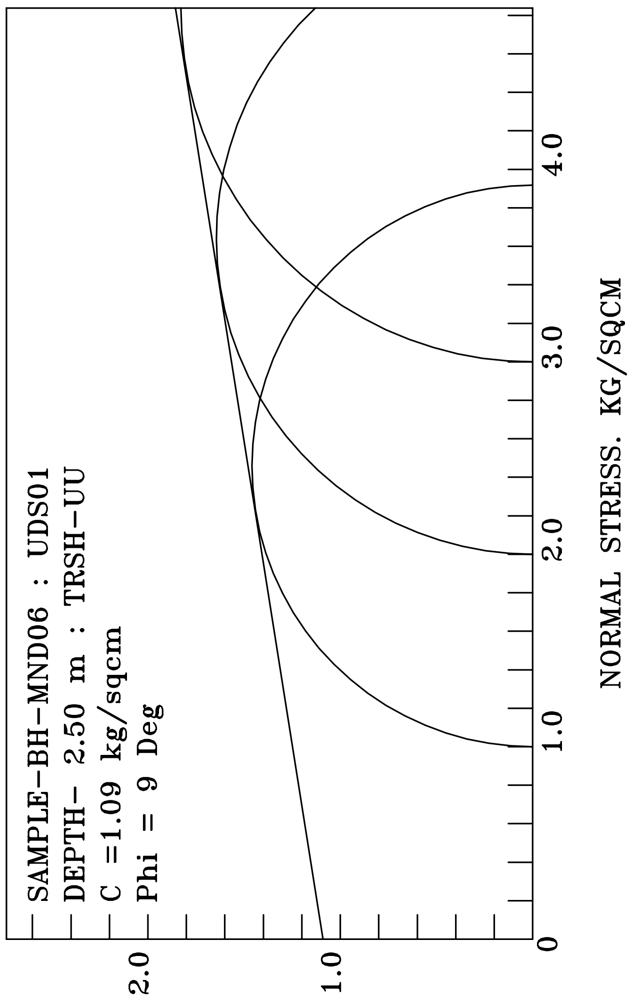
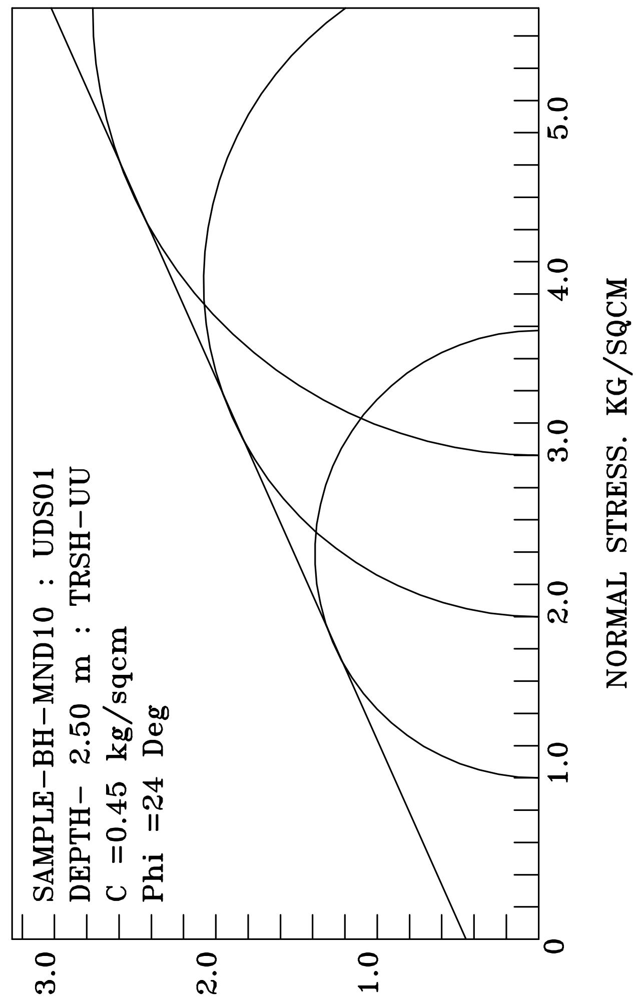
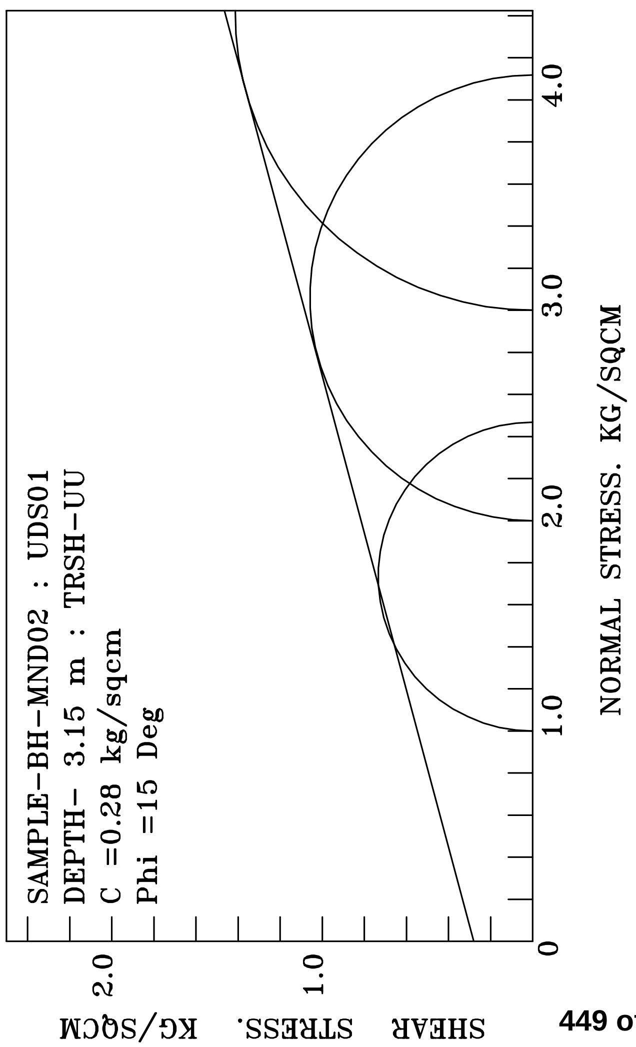
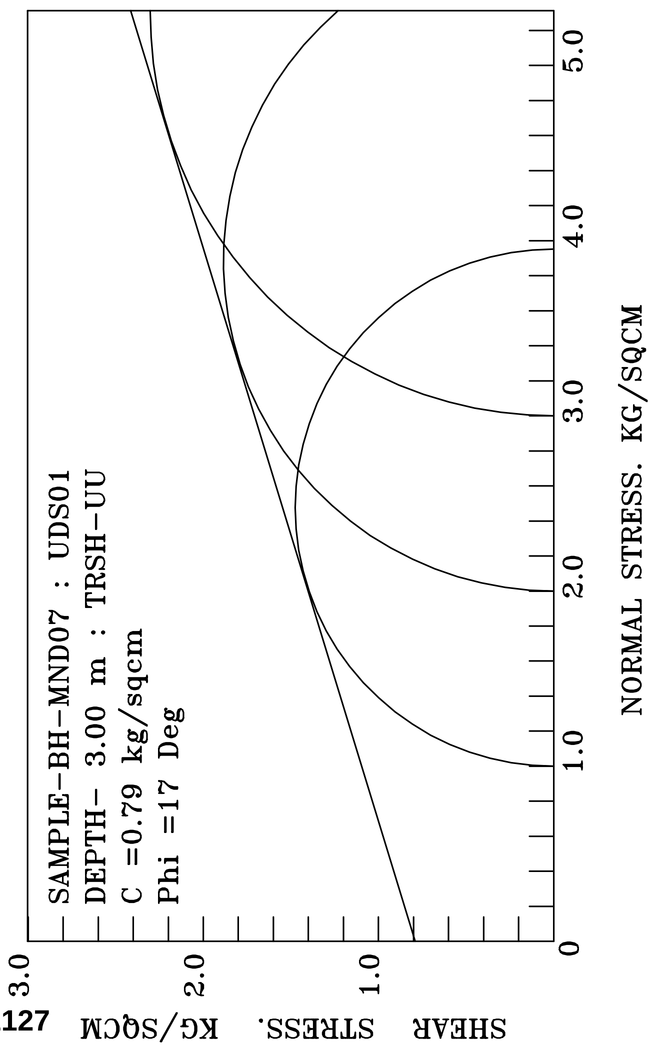
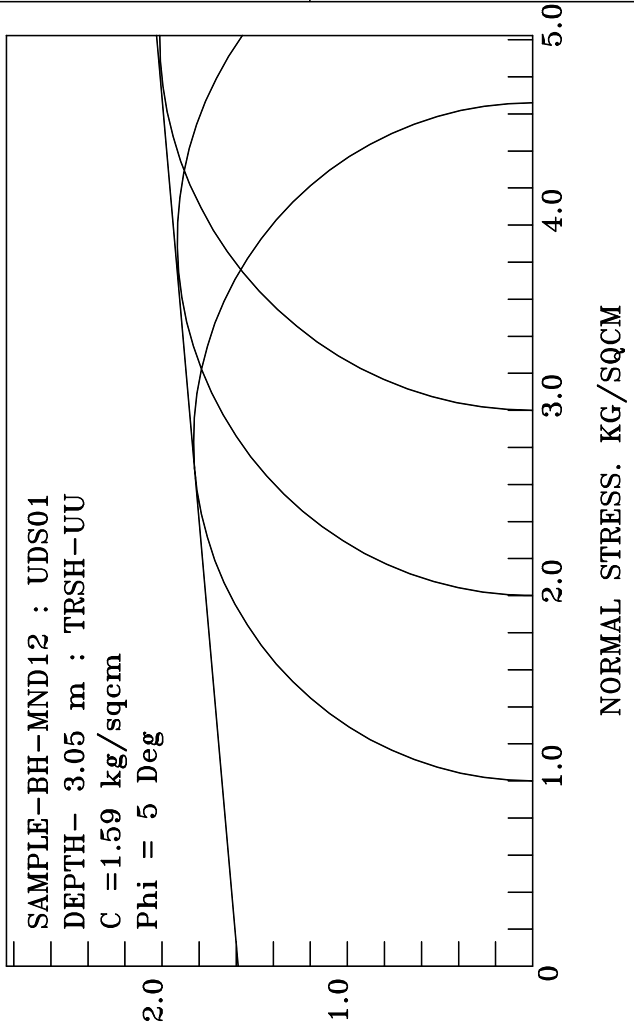
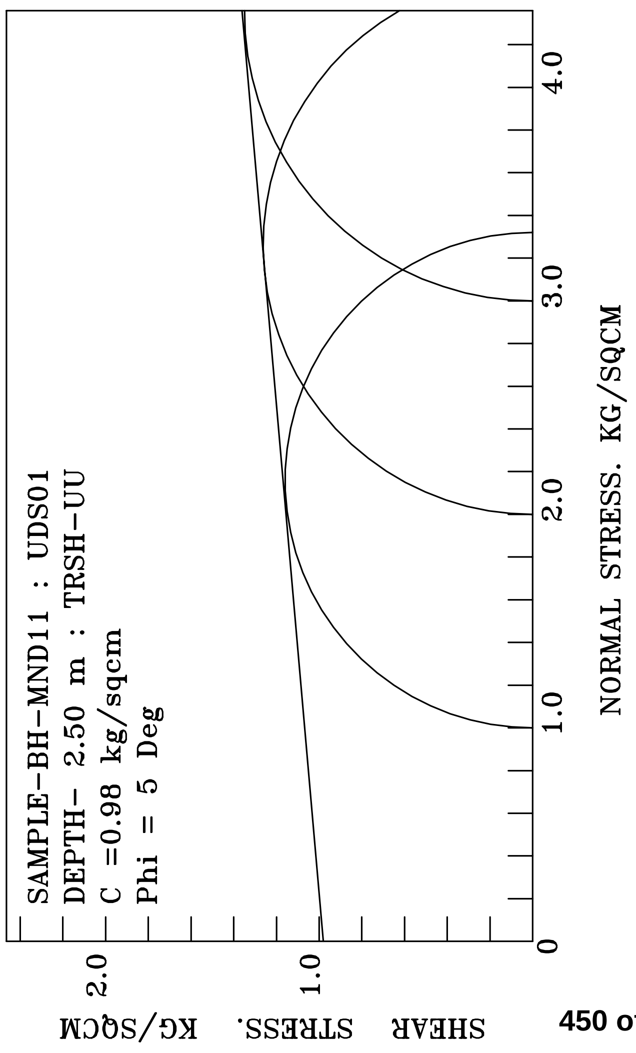


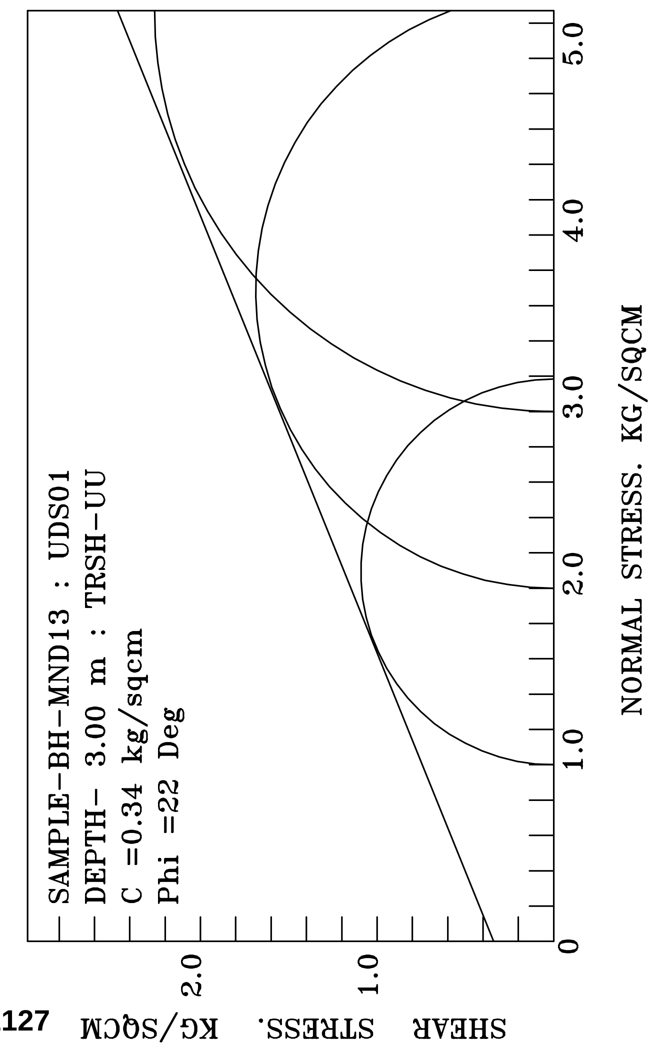







SAMPLE-BH-MND12 : UDS01
DEPTH- 3.05 m : TRSH-UU
C =1.59 kg/sqcm
Phi = 5 Deg
NORMAL STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
5.0
1.0
2.0


SAMPLE-BH-MND11 : UDS01
DEPTH- 2.50 m : TRSH-UU
C =0.98 kg/sqcm
Phi = 5 Deg
NORMAL STRESS. KG/SQCM
SHEAR STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
1.0
2.0


SAMPLE-BH-MND13 : UDS01
DEPTH- 3.00 m : TRSH-UU
C =0.34 kg/sqcm
Phi =22 Deg
NORMAL STRESS. KG/SQCM
SHEAR STRESS. KG/SQCM
0
1.0
2.0
3.0
4.0
5.0
1.0
2.0

Project :Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
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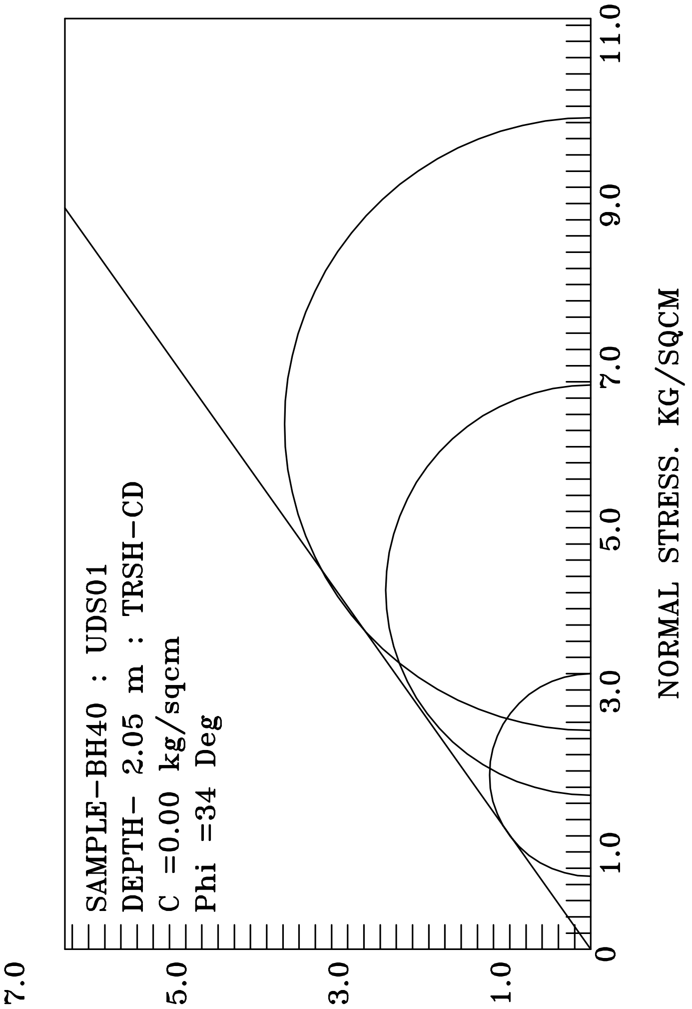
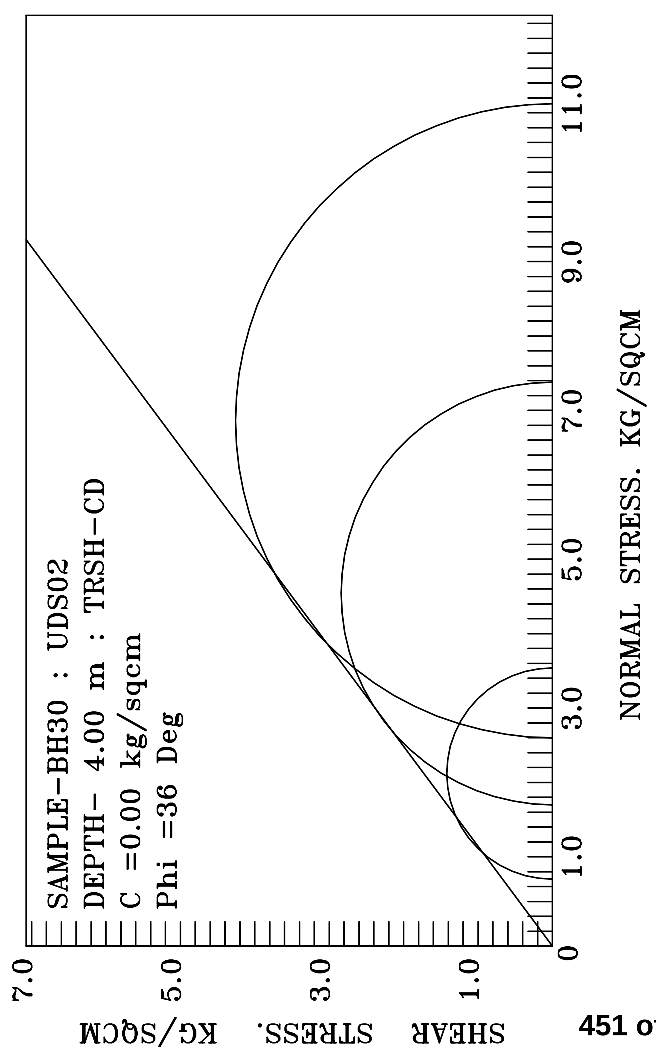
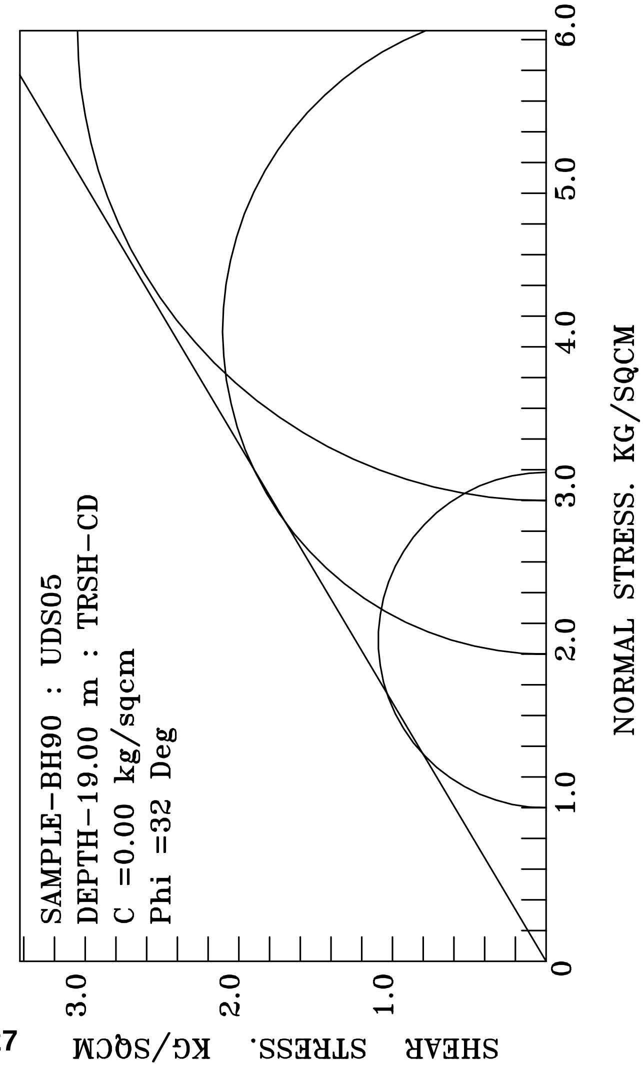
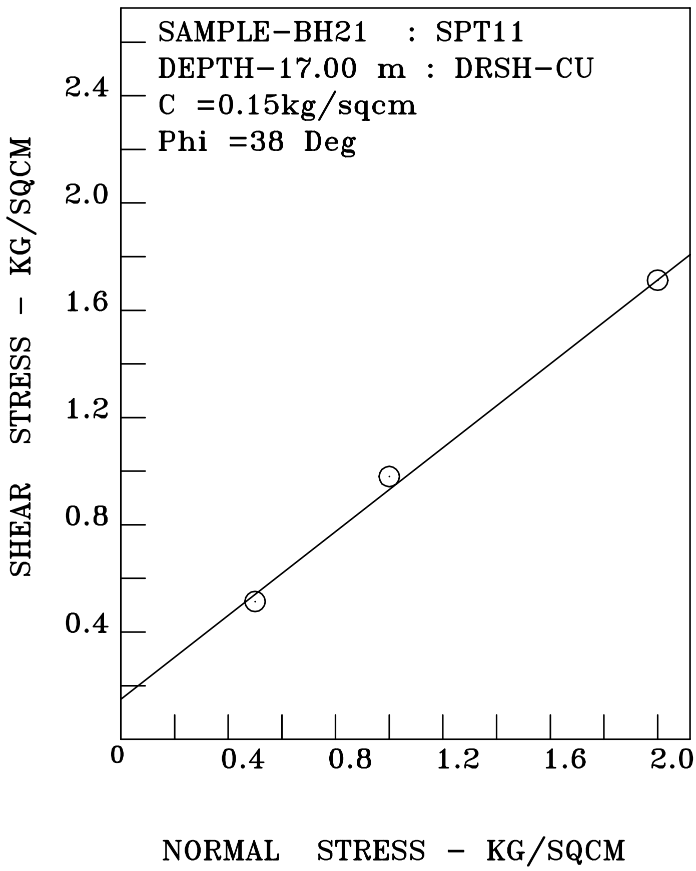
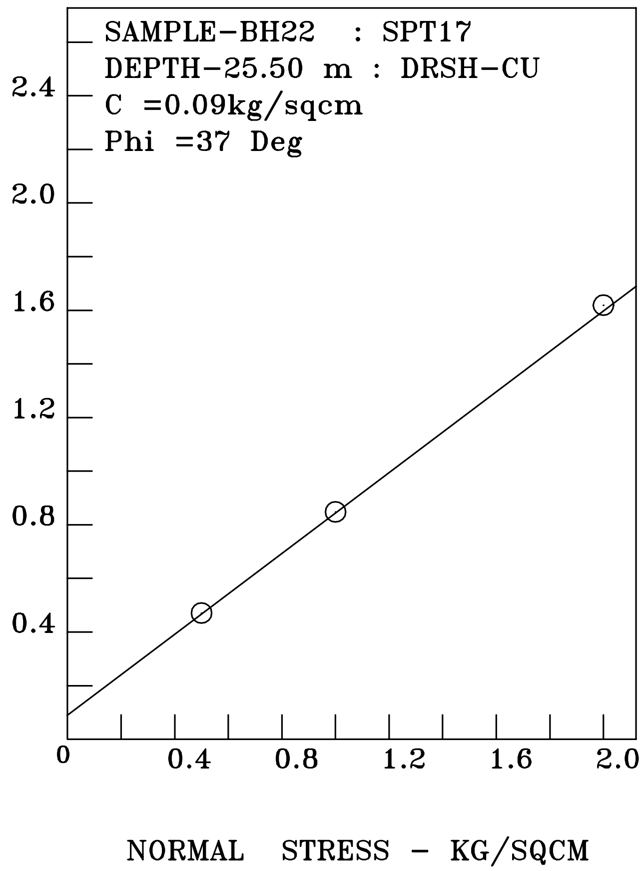




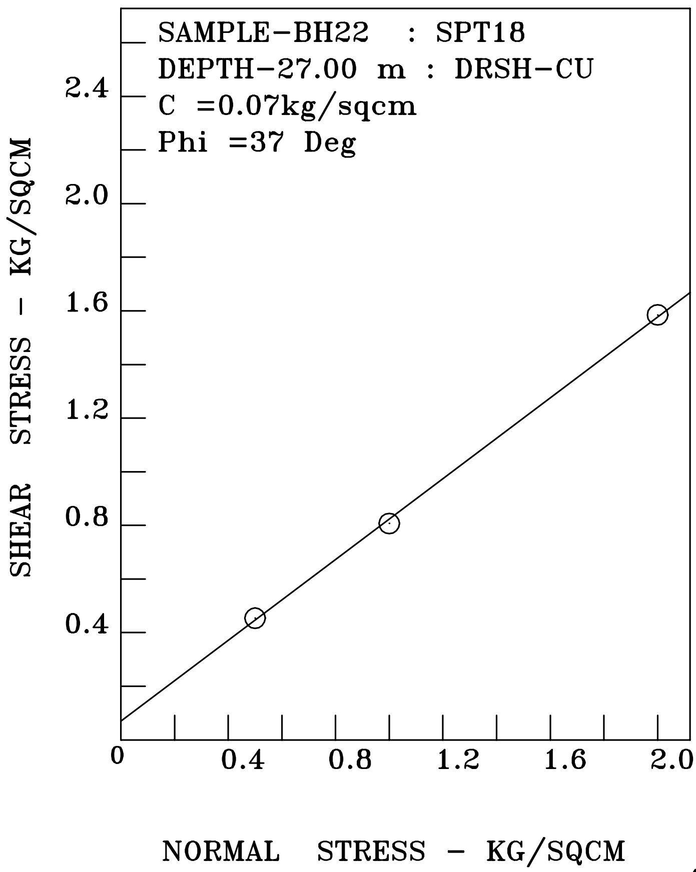




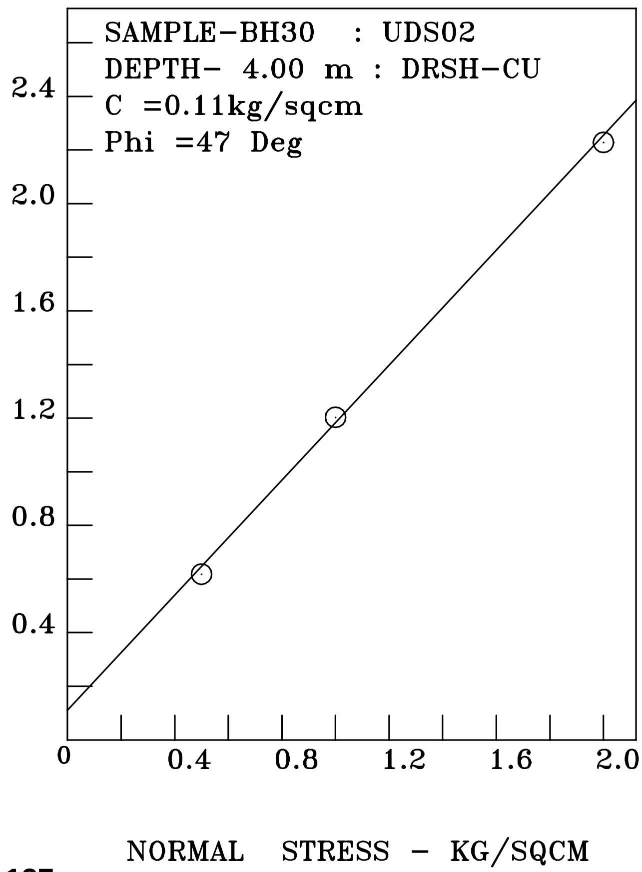
SAMPLE-BH21 : SPT11
DEPTH-17.00 m : DRSH-CU
C =0.15kg/sqcm
Phi =38 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM



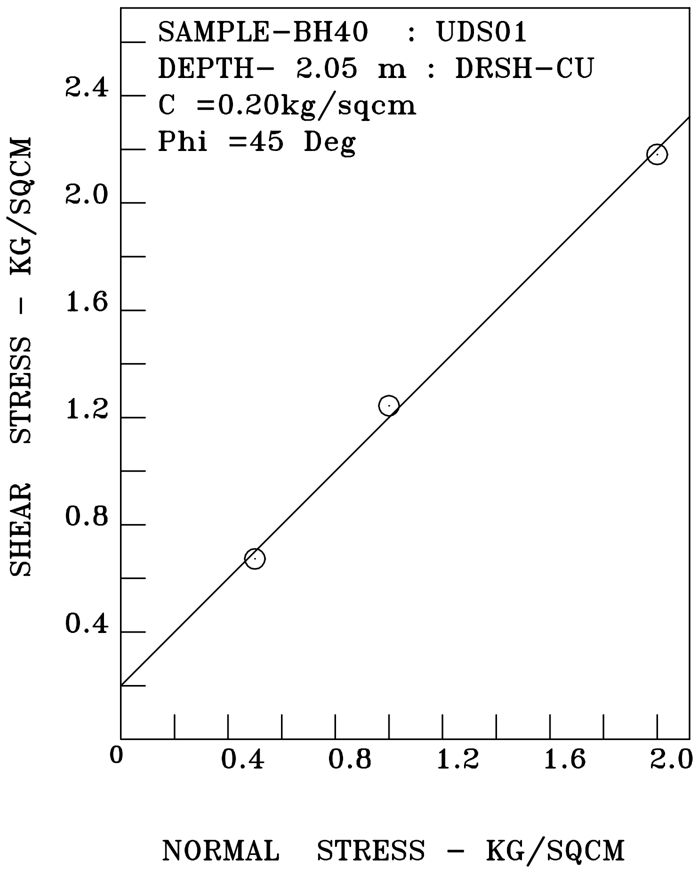
SAMPLE-BH22 : SPT17
DEPTH-25.50 m : DRSH-CU
C =0.09kg/sqcm
Phi =37 Deg
NORMAL STRESS - KG/SQCM

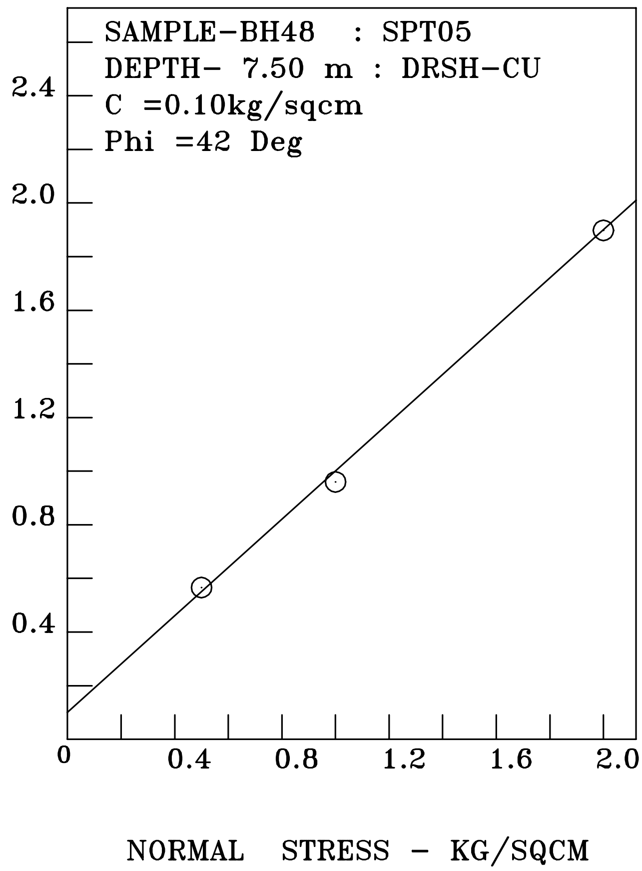


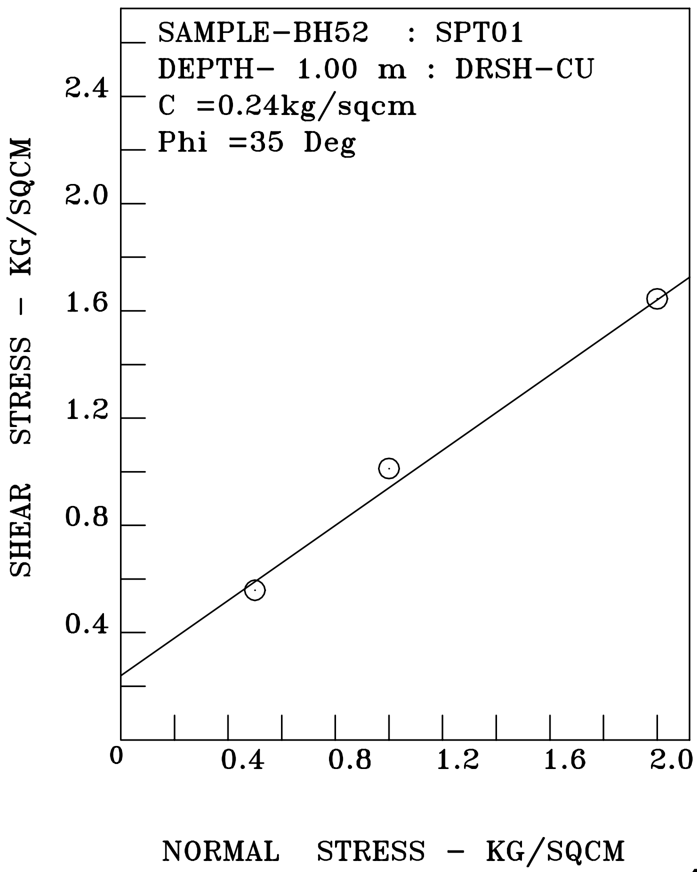
SAMPLE-BH22 : SPT18
DEPTH-27.00 m : DRSH-CU
C =0.07kg/sqcm
Phi =37 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM

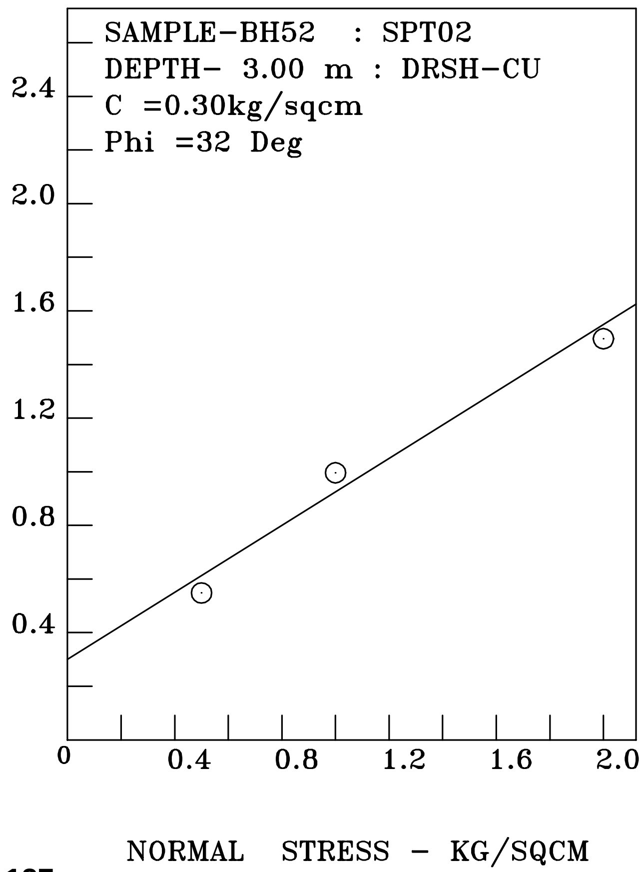


SAMPLE-BH30 : UDS02
DEPTH- 4.00 m : DRSH-CU
C =0.11kg/sqcm
Phi =47 Deg
NORMAL STRESS - KG/SQCM


SAMPLE-BH40 : UDS01
DEPTH- 2.05 m : DRSH-CU
C =0.20kg/sqcm
Phi =45 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM


SAMPLE-BH48 : SPT05
DEPTH- 7.50 m : DRSH-CU
C =0.10kg/sqcm
Phi =42 Deg
NORMAL STRESS - KG/SQCM


SAMPLE-BH52 : SPT01
DEPTH- 1.00 m : DRSH-CU
C =0.24kg/sqcm
Phi =35 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM


SAMPLE-BH52 : SPT02
DEPTH- 3.00 m : DRSH-CU
C =0.30kg/sqcm
Phi =32 Deg
NORMAL STRESS - KG/SQCM

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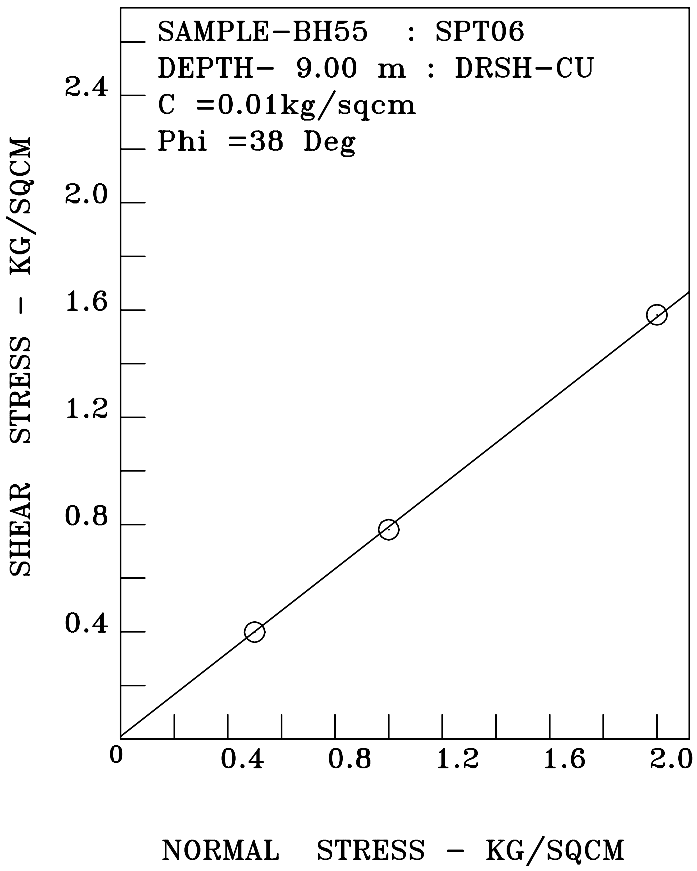
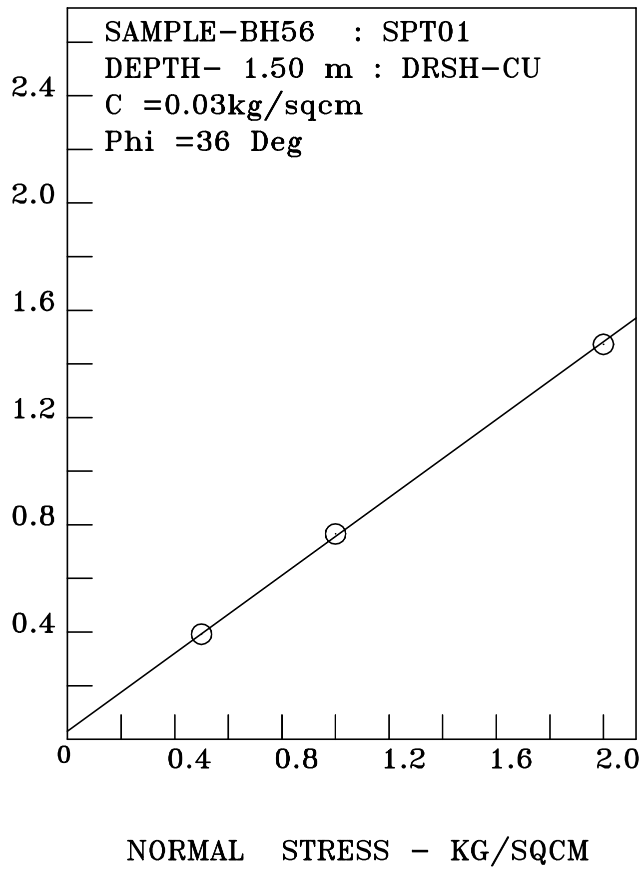
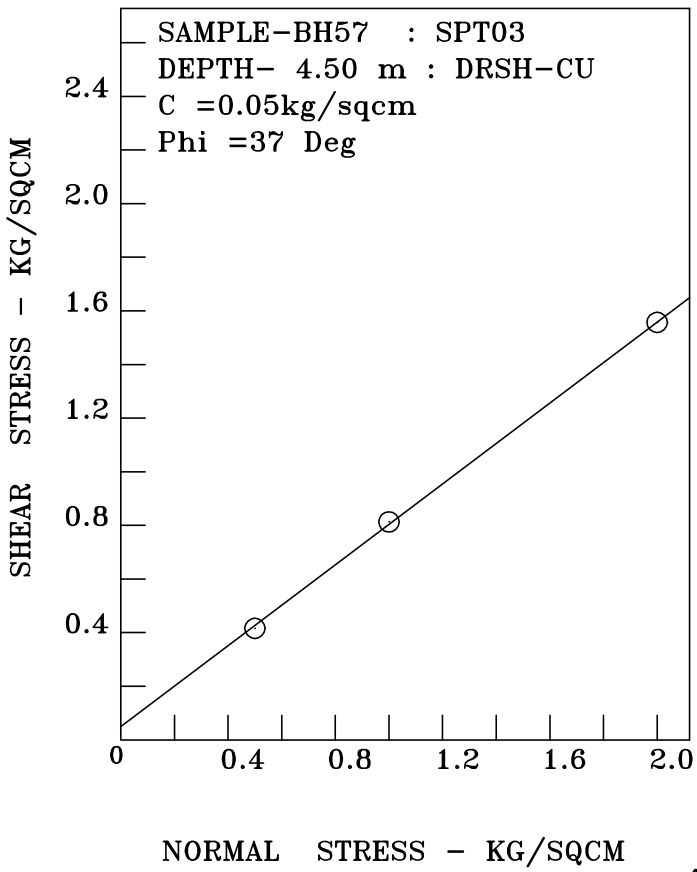
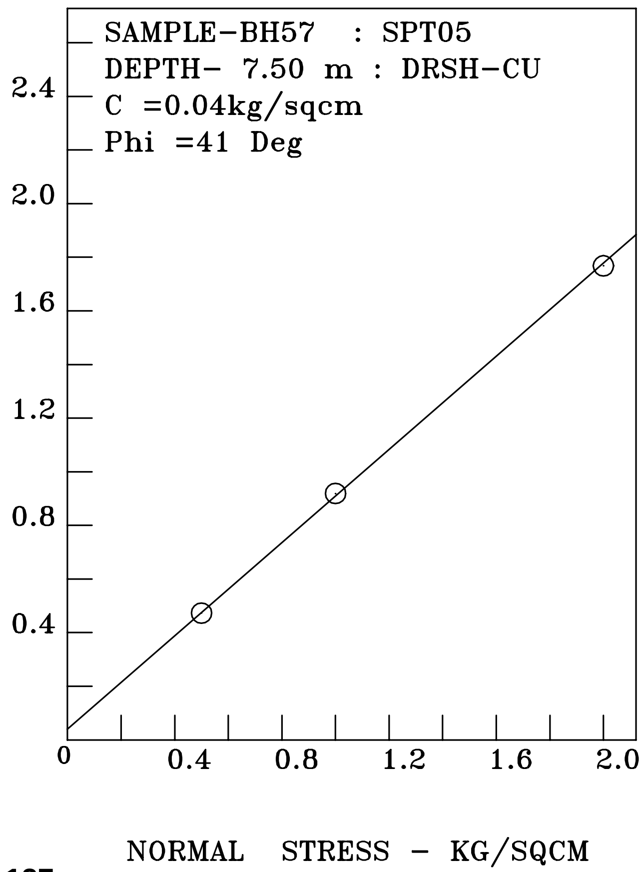
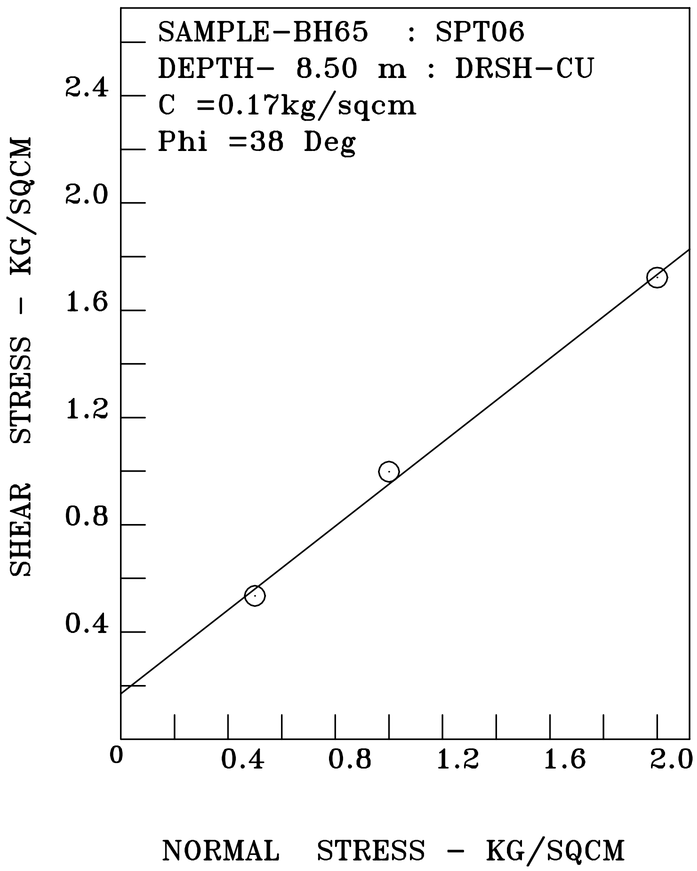


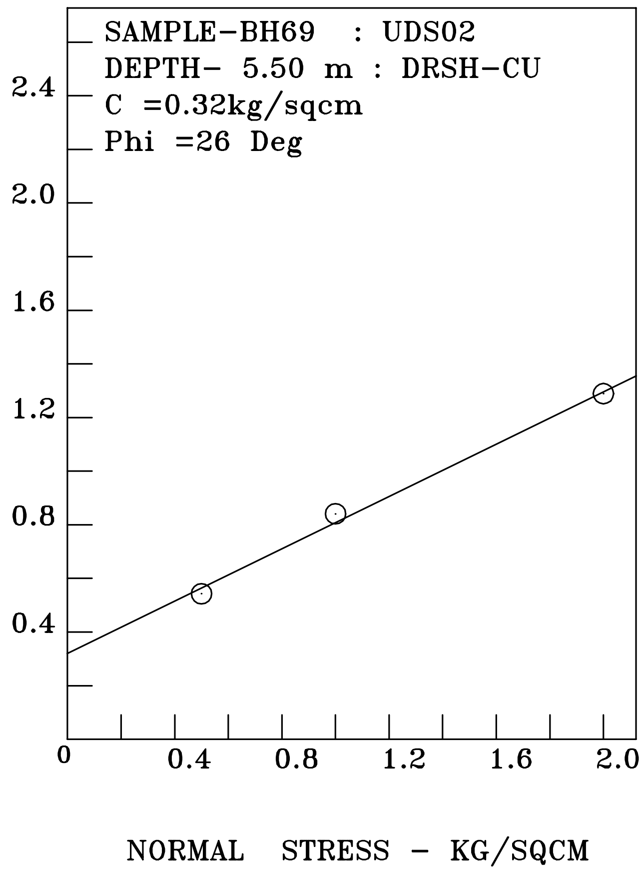


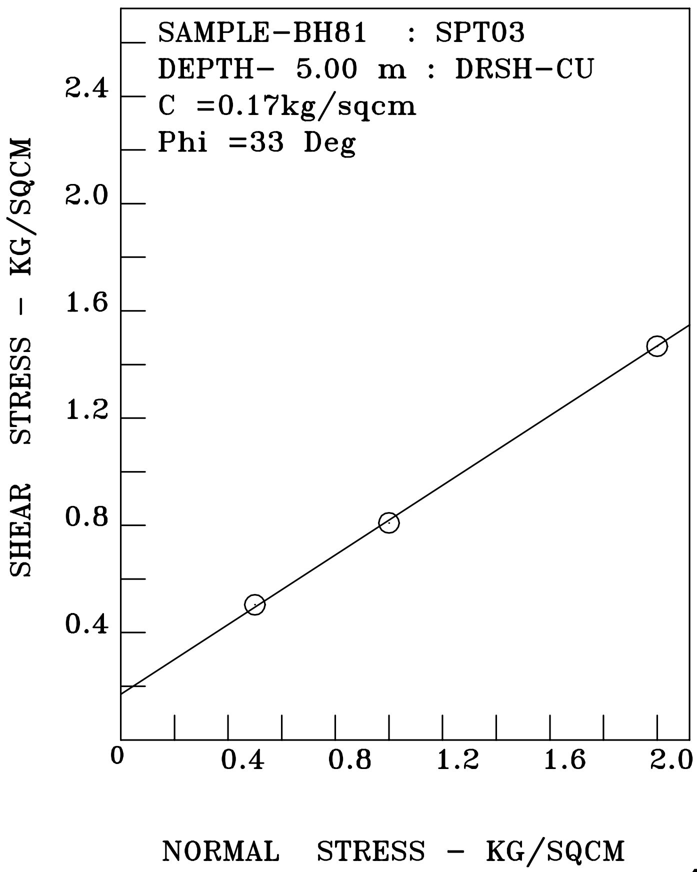


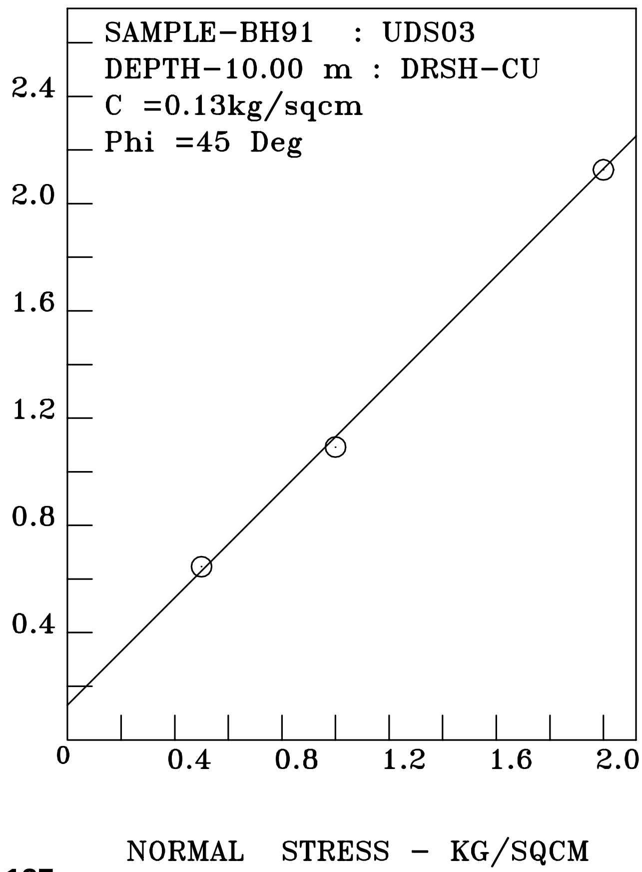


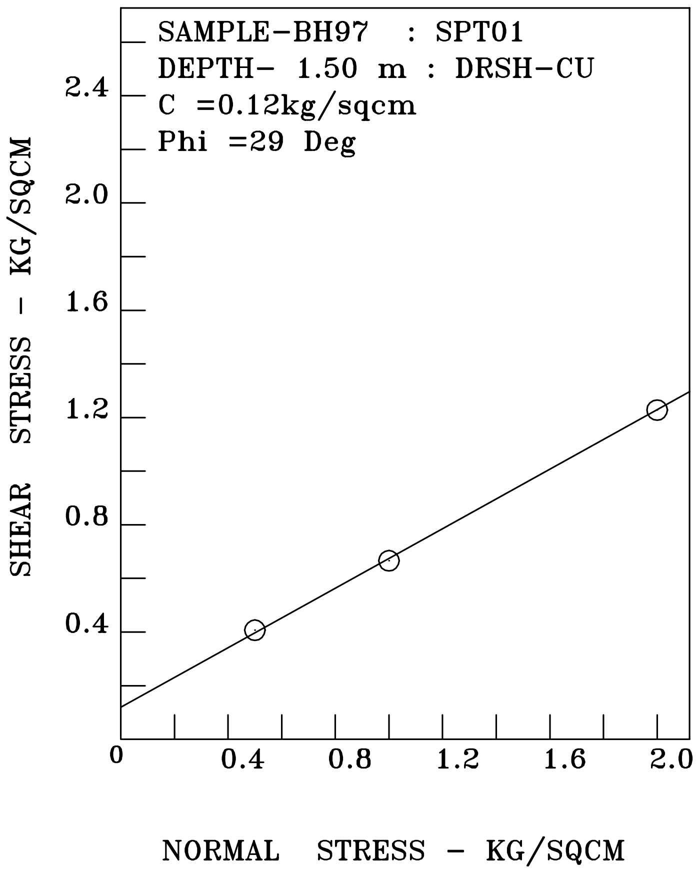
Project :Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.			CETEST
Job No :4095	Created by : Srabanti	Created on :	Sheet No:



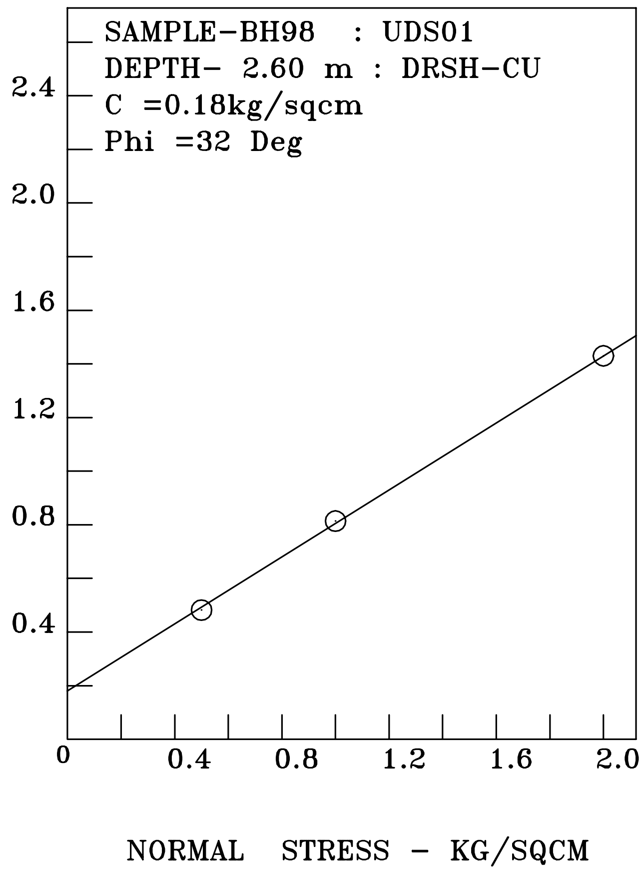




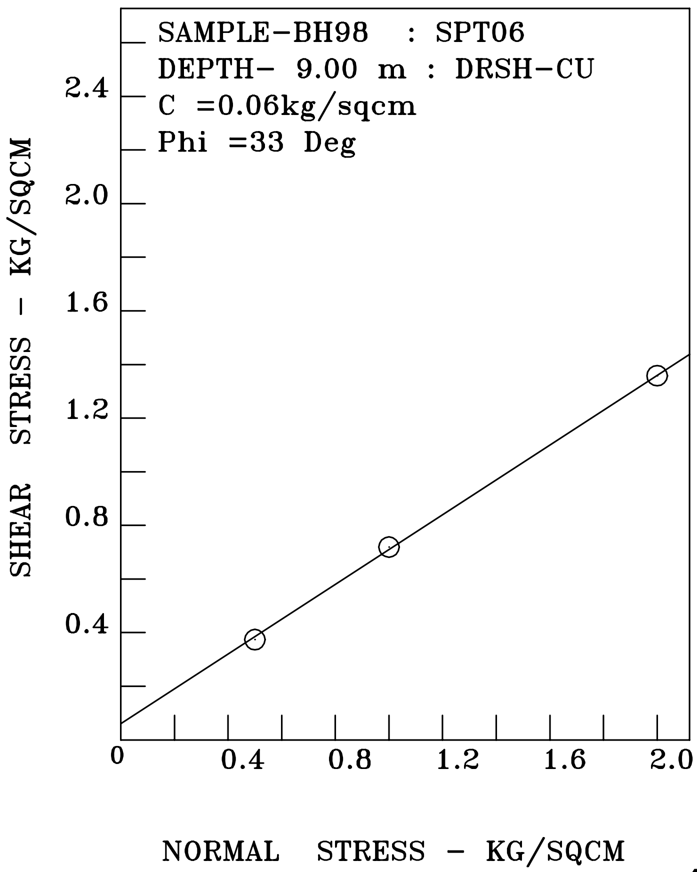




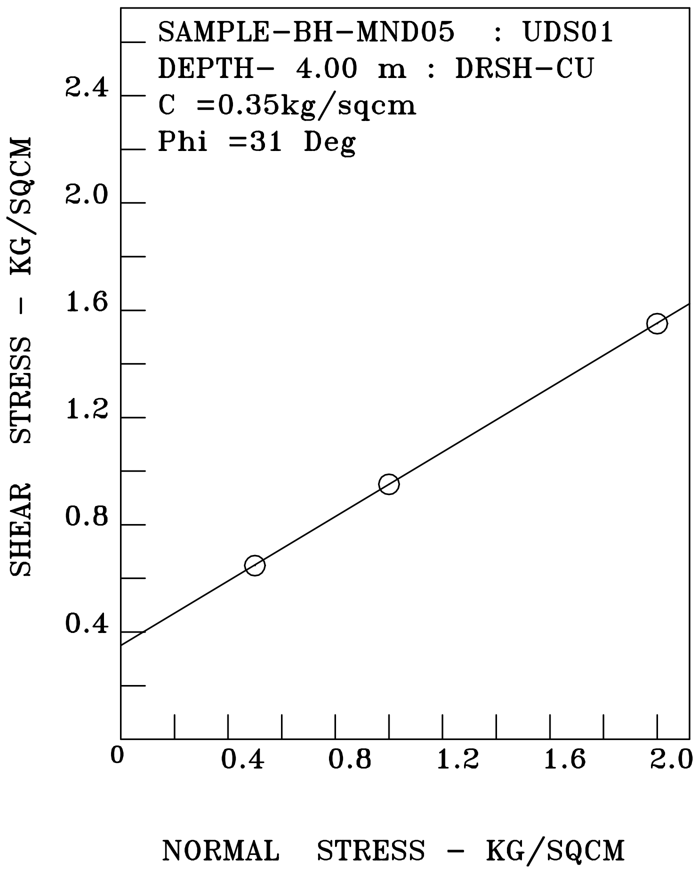
SAMPLE-BH97 : SPT01
DEPTH- 1.50 m : DRSH-CU
C =0.12kg/sqcm
Phi =29 Deg
SHEAR STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0
NORMAL STRESS - KG/SQCM

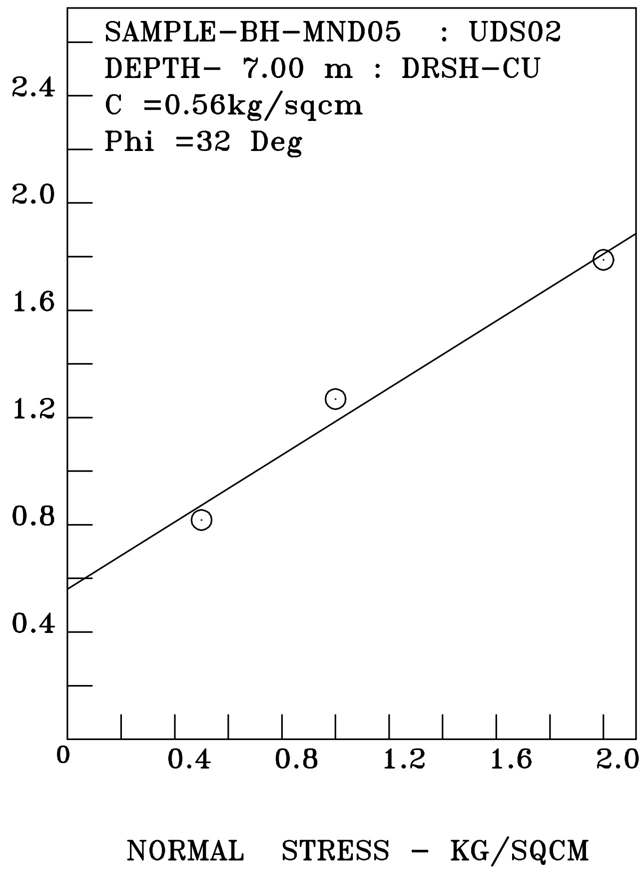


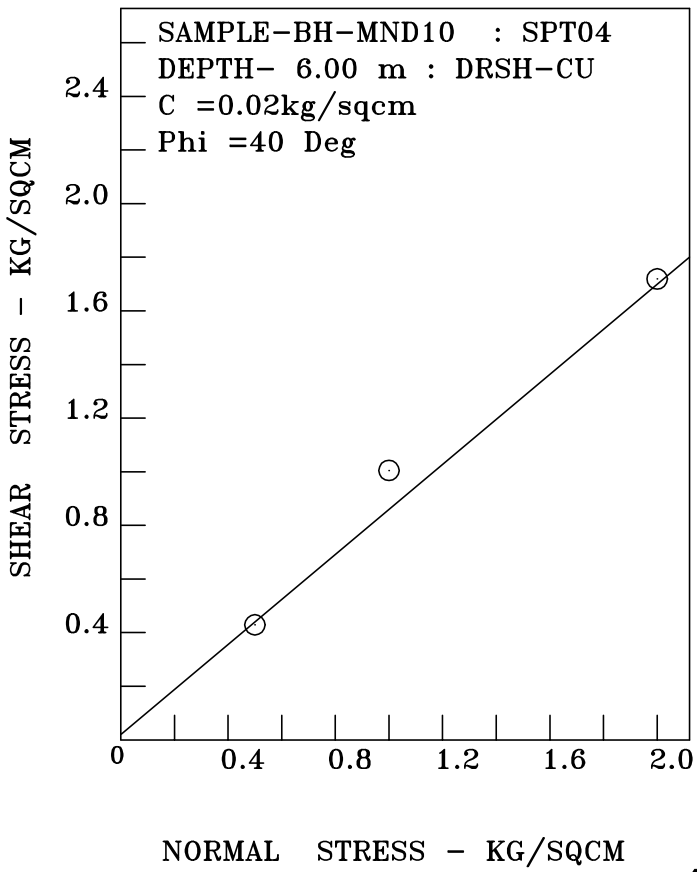
SAMPLE-BH98 : UDS01
DEPTH- 2.60 m : DRSH-CU
C =0.18kg/sqcm
Phi =32 Deg
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0
NORMAL STRESS - KG/SQCM

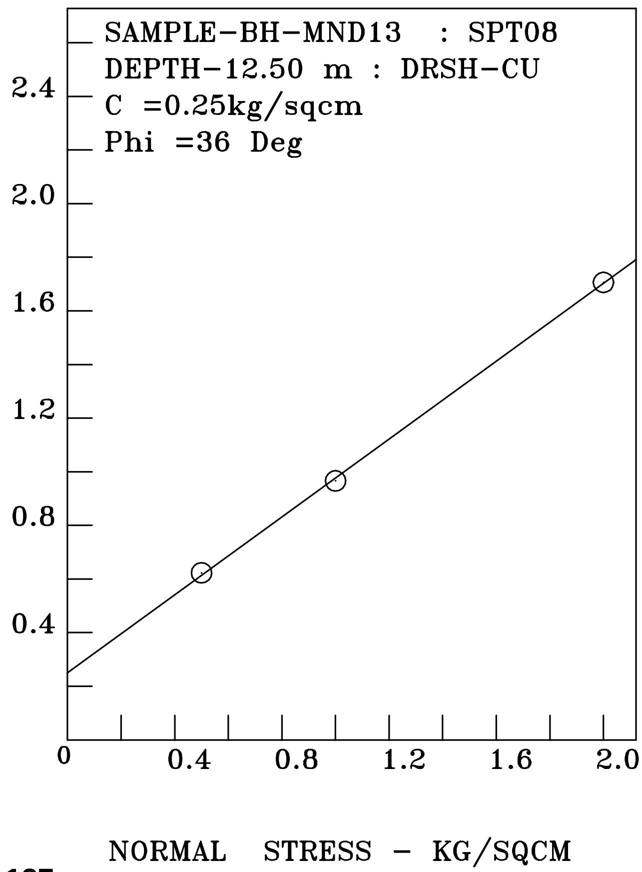


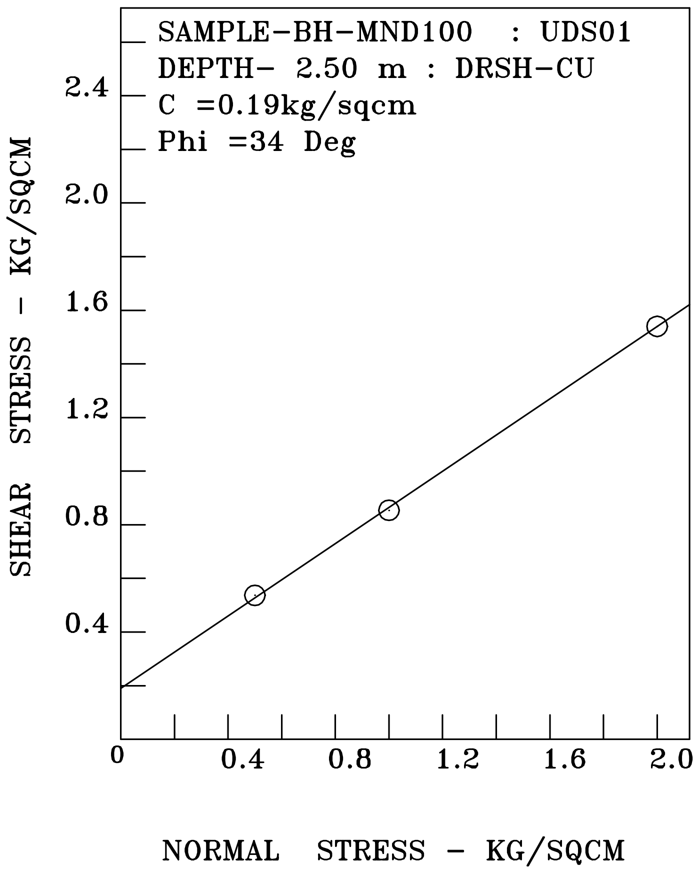
SAMPLE-BH98 : SPT06
DEPTH- 9.00 m : DRSH-CU
C =0.06kg/sqcm
Phi =33 Deg
SHEAR STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0
NORMAL STRESS - KG/SQCM


SAMPLE-BH-MND05 : UDS01
DEPTH- 4.00 m : DRSH-CU
C =0.35kg/sqcm
Phi =31 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0


SAMPLE-BH-MND05 : UDS02
DEPTH- 7.00 m : DRSH-CU
C =0.56kg/sqcm
Phi =32 Deg
NORMAL STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0


SAMPLE-BH-MND10 : SPT04
DEPTH- 6.00 m : DRSH-CU
C =0.02kg/sqcm
Phi =40 Deg
SHEAR STRESS - KG/SQCM
NORMAL STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0


SAMPLE-BH-MND13 : SPT08
DEPTH-12.50 m : DRSH-CU
C =0.25kg/sqcm
Phi =36 Deg
NORMAL STRESS - KG/SQCM
2.4
2.0
1.6
1.2
0.8
0.4
0
0.4
0.8
1.2
1.6
2.0


SAMPLE-BH-MND100 : UDS01
DEPTH- 2.50 m : DRSH-CU
C =0.19kg/sqcm
Phi =34 Deg
2.4
2.0
1.6
1.2
0.8
0.4
SHEAR STRESS - KG/SQCM
0
0.4
0.8
1.2
1.6
2.0
NORMAL STRESS - KG/SQCM

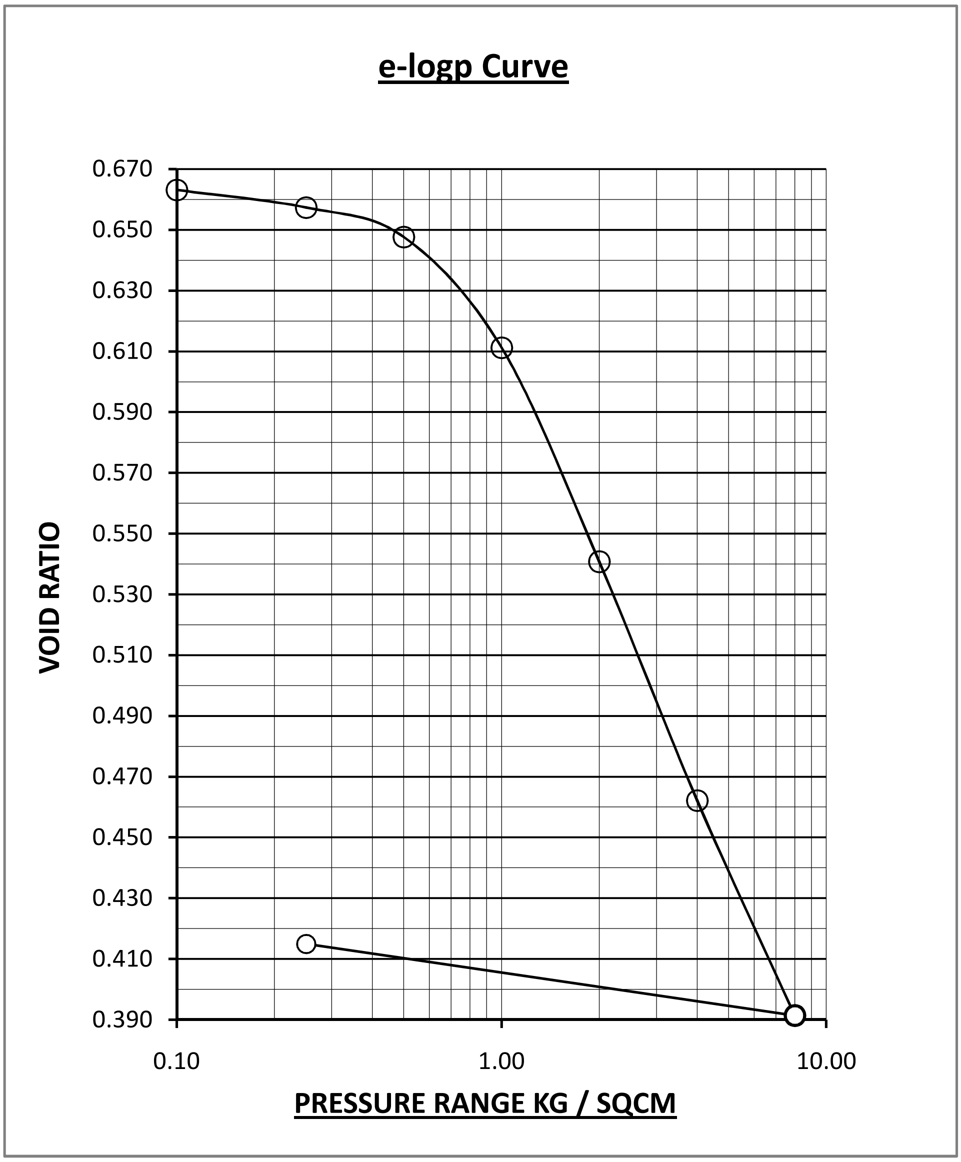
CONSOLIDATION TEST RESULTS

Sample Number:BH-30/UDS-02 Depth :4-4.45 meters

Description :Reddish brown clayey silt with sand mixture & kankar.

Water content:Initial=11.9% Final =16.3% Initial Void Ratio =0.665

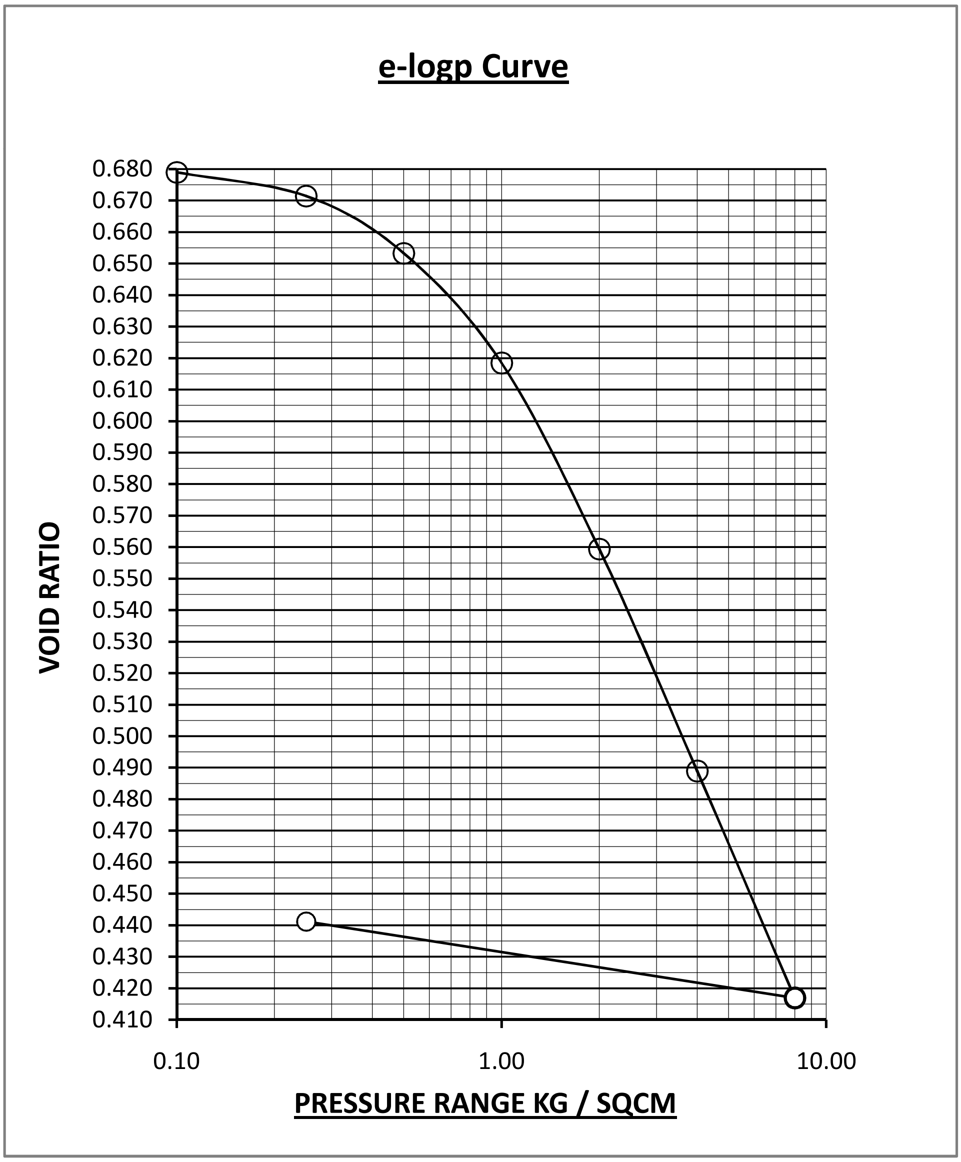
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	12	0.663	0.0120				
0.10 - 0.25	35	0.657	0.0233	31.43	0.0160	111.0	7.567
0.25 - 0.50	58	0.648	0.0233	37.93	0.0145	320.2	2.574
0.50 - 1.00	219	0.611	0.0442	81.74	0.0081	194.4	4.004
1.00 - 2.00	424	0.541	0.0438	79.25	0.0091	104.5	6.480
2.00 - 4.00	472	0.462	0.0255	72.88	0.0069	87.8	6.243
4.00 - 8.00	426	0.391	0.0121	79.58	0.0025	101.4	4.268
8.00 - 0.25	142	0.415	0.0022				



CONSOLIDATION TEST RESULTS

Sample Number:BH-40/UDS-01 Depth :2.05-2.5 meters
Description :Reddish brown clayey silt with sand mixture.
Water content:Initial=13.5% Final =17.7% Initial Void Ratio =0.68

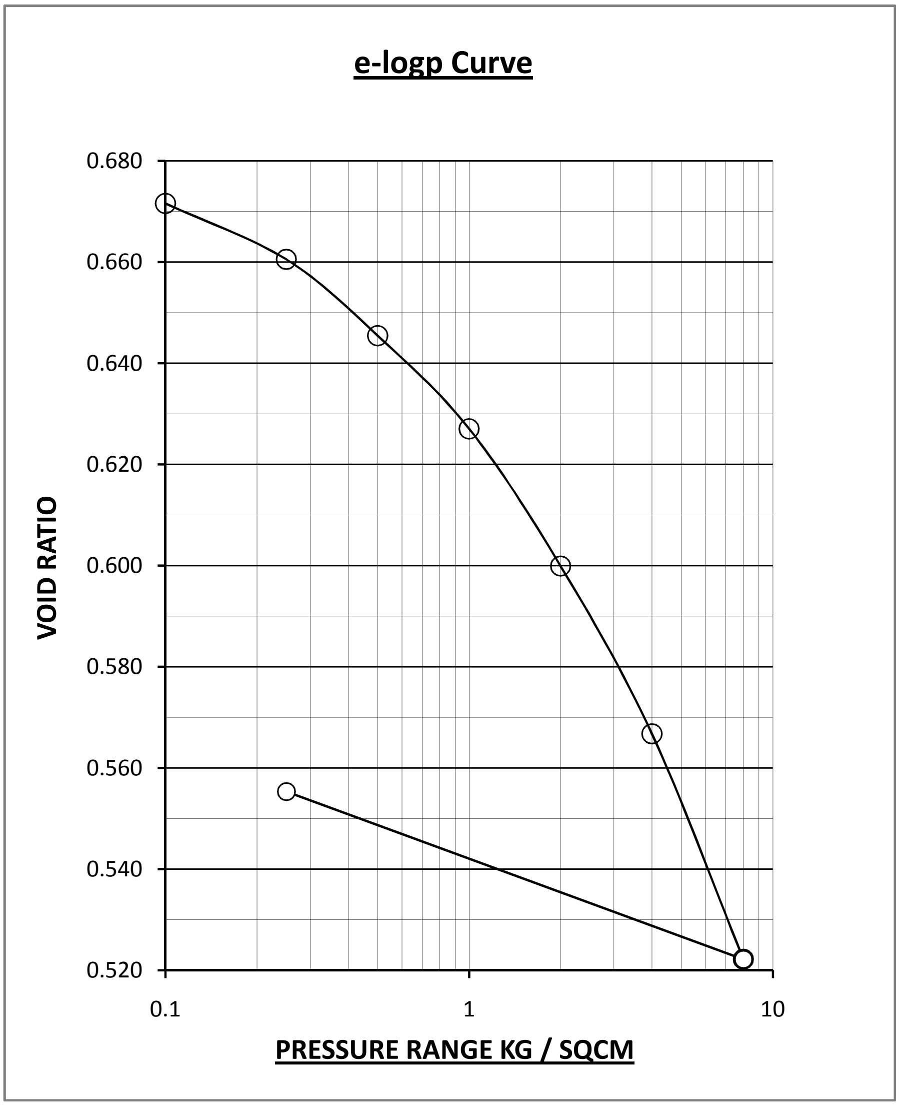
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	7	0.679	0.0070				
0.10 - 0.25	45	0.671	0.0300	46.67	0.0160	96.8	8.668
0.25 - 0.50	108	0.653	0.0434	52.78	0.0205	138.6	5.867
0.50 - 1.00	208	0.618	0.0423	58.17	0.0177	101.4	7.511
1.00 - 2.00	351	0.559	0.0364	71.51	0.0104	104.5	6.451
2.00 - 4.00	420	0.489	0.0226	82.62	0.0039	200.9	2.801
4.00 - 8.00	429	0.417	0.0121	79.72	0.0025	95.3	4.741
8.00 - 0.25	145	0.441	0.0022				



CONSOLIDATION TEST RESULTS

Sample Number:BH-49/UDS-01 Depth :2.5-2.95 meters
Description :Reddish brown silty clay with sand mixture.
Water content:Initial=21.2% Final =24.1% Initial Void Ratio =0.679

P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	26	0.672	0.0260				
0.10 - 0.25	66	0.661	0.0441	42.10	0.0255	105.1	7.889
0.25 - 0.50	90	0.645	0.0363	49.50	0.0183	241.5	3.326
0.50 - 1.00	110	0.627	0.0224	60.70	0.0088	135.8	5.674
1.00 - 2.00	162	0.600	0.0167	69.30	0.0051	136.8	5.315
2.00 - 4.00	198	0.567	0.0104	78.80	0.0022	175.7	3.823
4.00 - 8.00	266	0.522	0.0071	36.80	0.0045	227.1	2.657
8.00 - 0.25	198	0.555	0.0028				



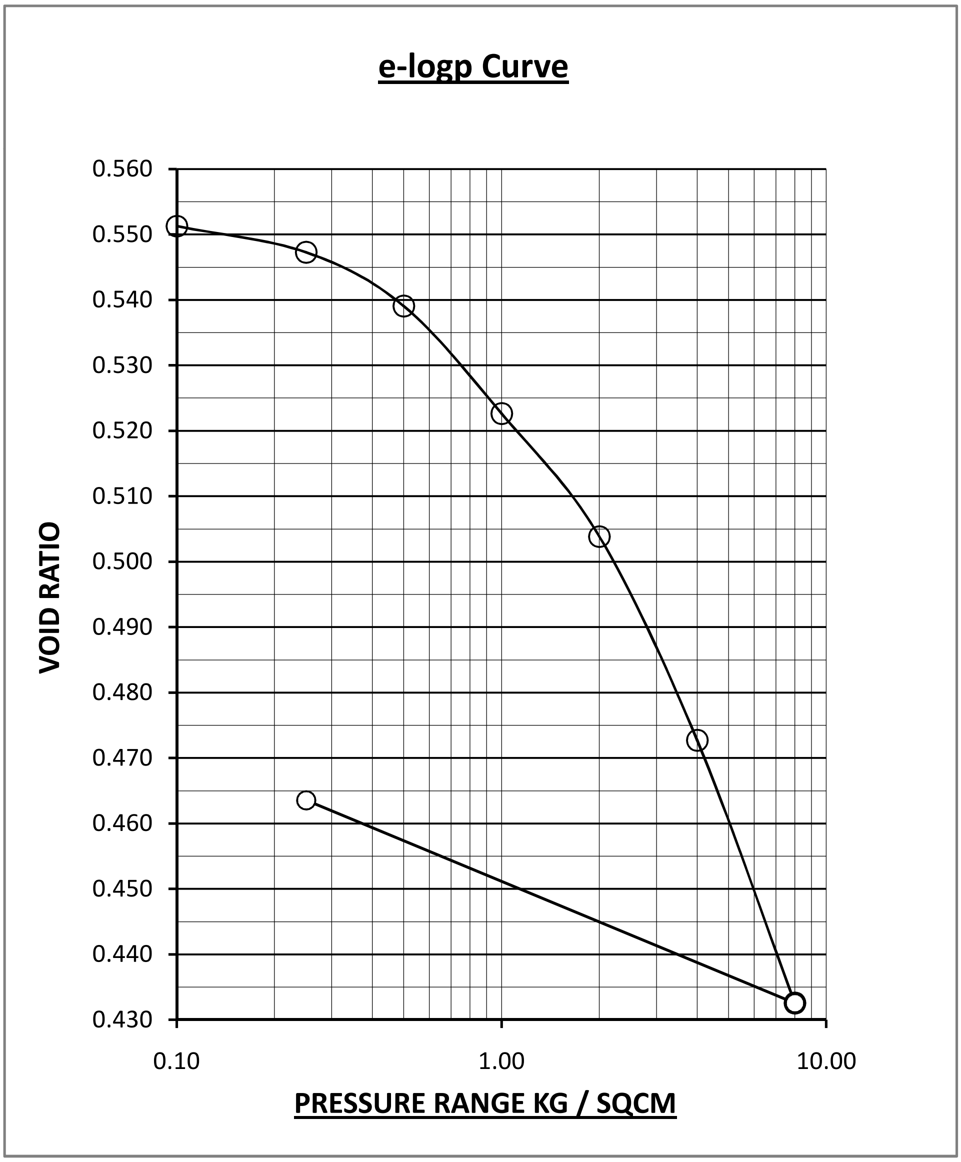
CONSOLIDATION TEST RESULTS

Sample Number:BH-54/UDS-01 Depth :2.5-2.95 meters

Description :Reddish brown clayey silt with traces of sand mixture & rock pieces.

Water content:Initial=14.5% Final =19.3% Initial Void Ratio =0.553

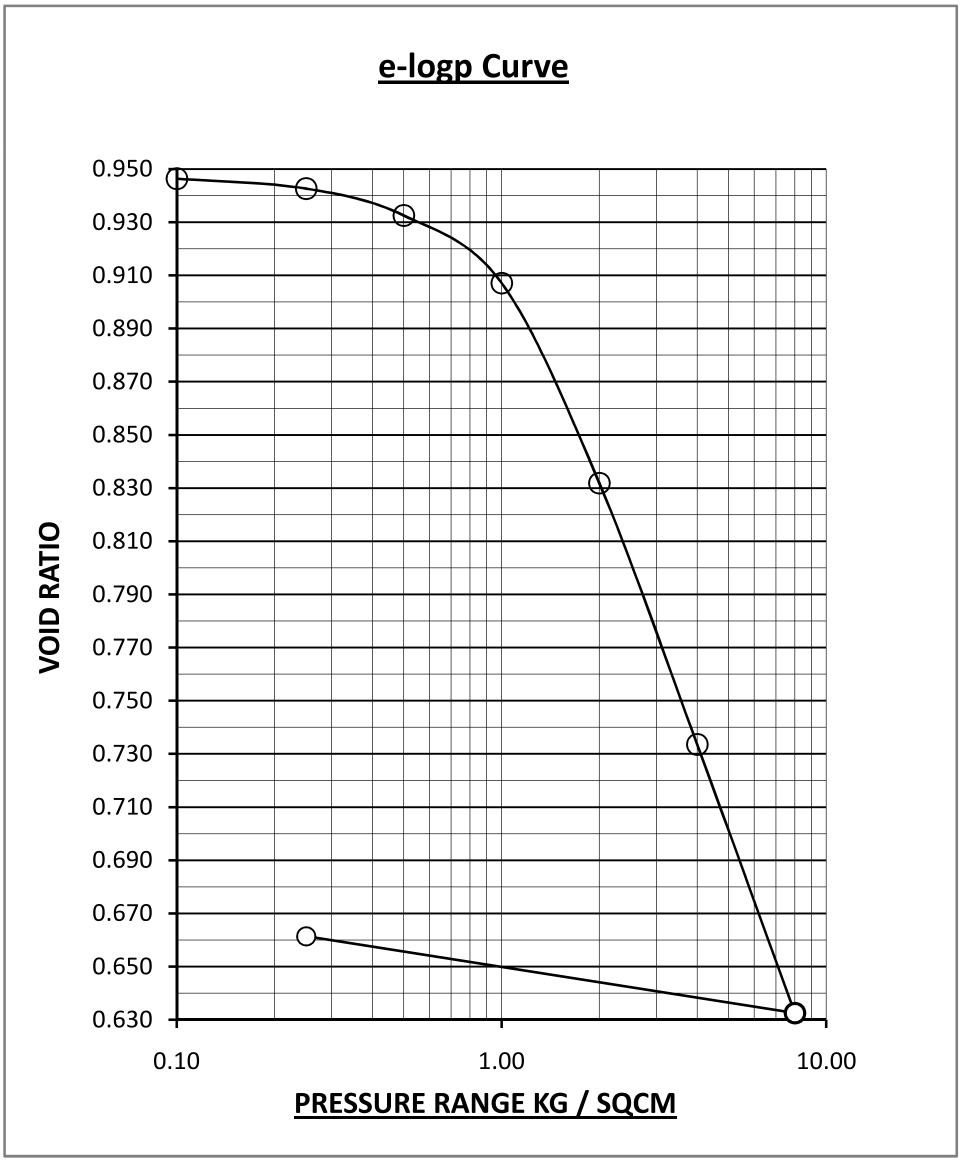
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	9	0.551	0.0090				
0.10 - 0.25	26	0.547	0.0173	38.46	0.0107	104.5	8.064
0.25 - 0.50	53	0.539	0.0212	45.28	0.0116	214.3	3.872
0.50 - 1.00	106	0.523	0.0214	61.32	0.0083	140.5	5.719
1.00 - 2.00	121	0.504	0.0123	52.07	0.0059	131.4	5.831
2.00 - 4.00	201	0.473	0.0104	69.65	0.0031	138.6	5.160
4.00 - 8.00	259	0.433	0.0068	72.97	0.0018	259.6	2.486
8.00 - 0.25	200	0.464	0.0028				



CONSOLIDATION TEST RESULTS

Sample Number:BH-55/UDS-01 Depth :2.55-3 meters
Description :Greyish brown clayey silt with traces of sand mixture.
Water content:Initial=18.6% Final =24% Initial Void Ratio =0.948

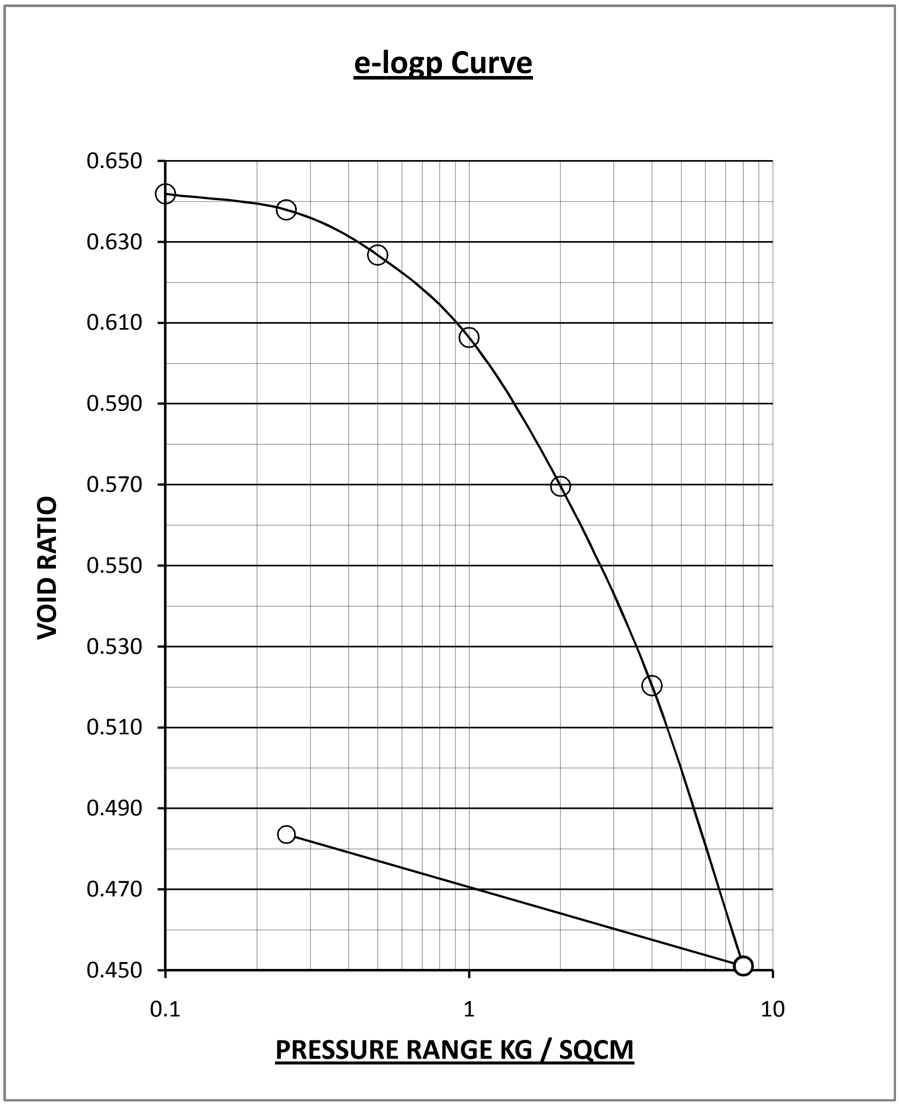
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	8	0.946	0.0080				
0.10 - 0.25	19	0.943	0.0127	36.84	0.0080	82.1	10.242
0.25 - 0.50	52	0.932	0.0209	44.23	0.0116	252.2	3.289
0.50 - 1.00	130	0.907	0.0262	70.77	0.0077	188.0	4.251
1.00 - 2.00	386	0.832	0.0394	75.65	0.0096	106.1	6.749
2.00 - 4.00	505	0.733	0.0269	84.16	0.0043	135.0	4.327
4.00 - 8.00	518	0.633	0.0146	80.69	0.0028	140.5	3.197
8.00 - 0.25	148	0.661	0.0023				



CONSOLIDATION TEST RESULTS

Sample Number:BH-65/UDS-01 Depth :3.6-4.05 meters
Description :Reddish brown clayey silt with sand mixture.
Water content:Initial=19.4% Final =23.7% Initial Void Ratio =0.646

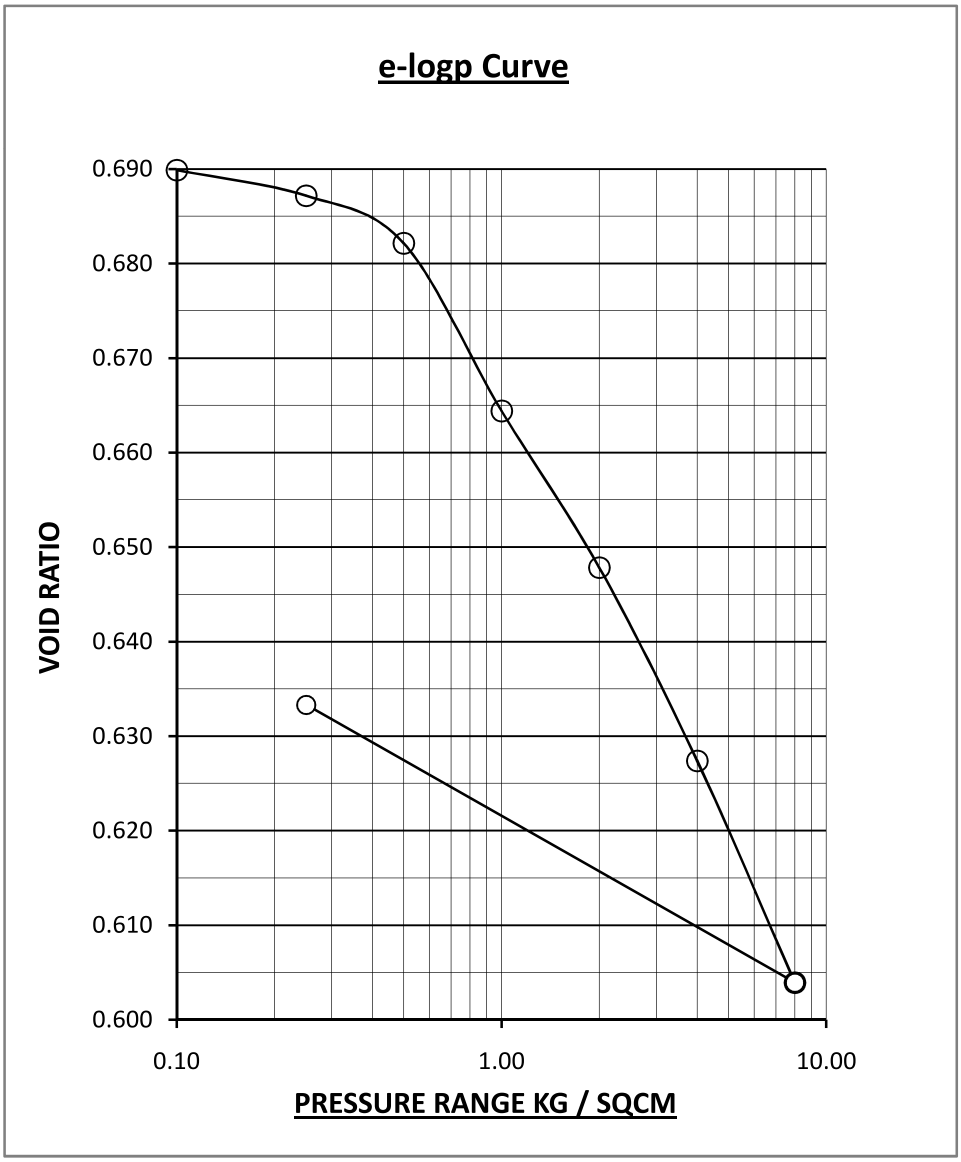
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	7	0.642	0.0070				
0.10 - 0.25	24	0.638	0.0160	58.90	0.0066	267.8	3.146
0.25 - 0.50	68	0.627	0.0273	46.50	0.0146	202.3	4.088
0.50 - 1.00	124	0.606	0.0250	40.00	0.0150	159.3	4.992
1.00 - 2.00	224	0.570	0.0229	40.40	0.0136	110.4	6.695
2.00 - 4.00	300	0.520	0.0157	55.60	0.0070	184.9	3.561
4.00 - 8.00	422	0.451	0.0114	75.80	0.0028	125.3	4.429
8.00 - 0.25	198	0.484	0.0029				



CONSOLIDATION TEST RESULTS

Sample Number:BH-67/UDS-01 Depth :2.5-2.95 meters
Description :Reddish brown clayey silt / silty clay with traces of sand mixture.
Water content:Initial=21.8% Final =24% Initial Void Ratio =0.691

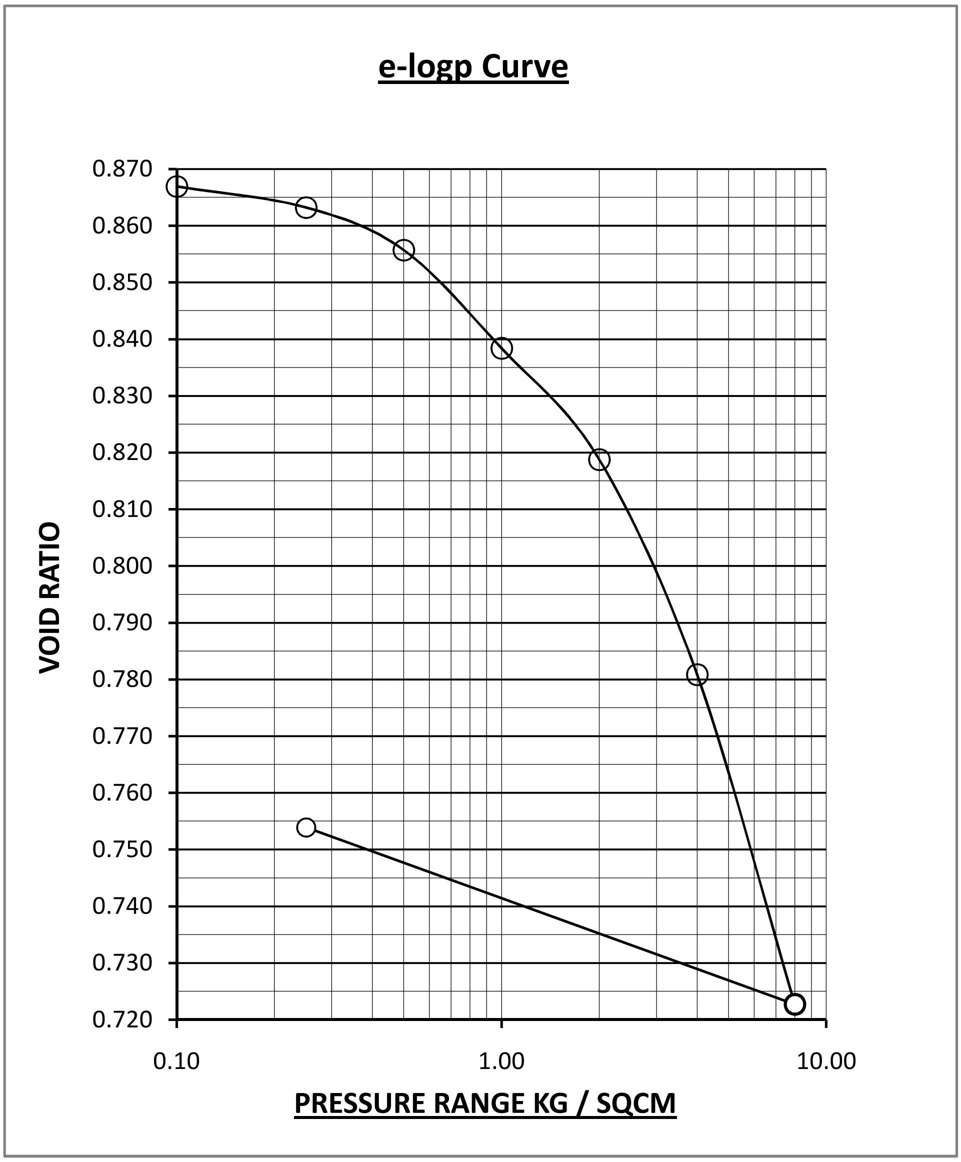
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	9	0.690	0.0090				
0.10 - 0.25	16	0.687	0.0107	50.00	0.0053	182.1	4.639
0.25 - 0.50	30	0.682	0.0120	43.33	0.0068	209.8	3.989
0.50 - 1.00	105	0.664	0.0211	86.67	0.0028	135.0	6.033
1.00 - 2.00	98	0.648	0.0099	85.71	0.0014	121.0	6.456
2.00 - 4.00	121	0.627	0.0062	79.34	0.0013	1901.8	0.392
4.00 - 8.00	139	0.604	0.0036	69.06	0.0011	196.6	3.587
8.00 - 0.25	174	0.633	0.0024				



CONSOLIDATION TEST RESULTS

Sample Number:BH-67/UDS-02 Depth :5.5-5.95 meters
Description :Reddish brown clayey silt with sand mixture & traces of rock pieces.
Water content:Initial=26.9% Final =28.3% Initial Void Ratio =0.87

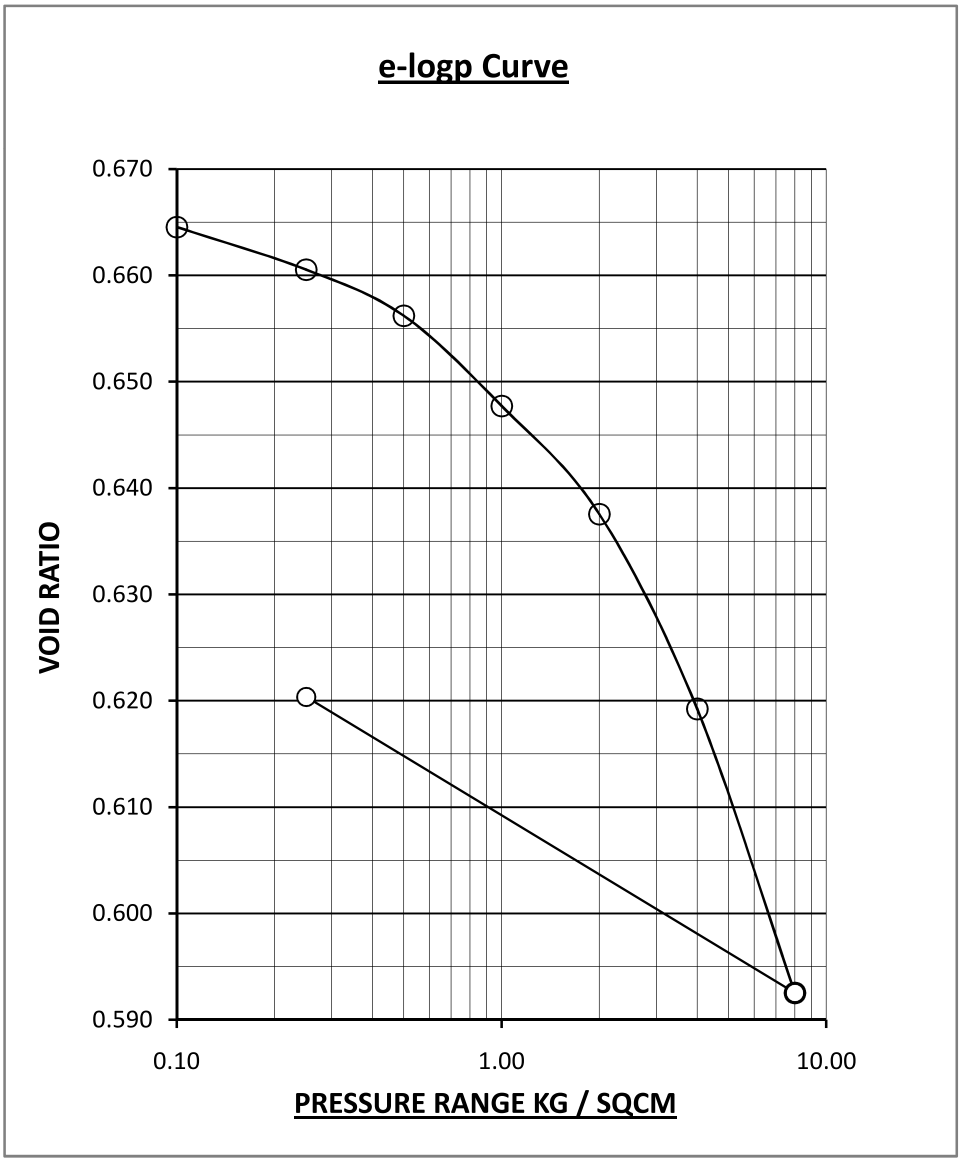
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	19	0.867	0.0190				
0.10 - 0.25	20	0.863	0.0133	45.00	0.0073	257.1	3.267
0.25 - 0.50	40	0.856	0.0160	52.50	0.0076	138.6	5.986
0.50 - 1.00	93	0.838	0.0187	67.60	0.0061	121.0	6.675
1.00 - 2.00	105	0.819	0.0107	64.52	0.0038	121.0	6.407
2.00 - 4.00	203	0.781	0.0104	78.33	0.0023	119.3	6.087
4.00 - 8.00	311	0.723	0.0082	80.06	0.0016	122.7	5.278
8.00 - 0.25	167	0.754	0.0023				



CONSOLIDATION TEST RESULTS

Sample Number:BH-68/UDS-01 Depth :4-4.45 meters
Description :Reddish brown clayey silt with traces of sand mixture.
Water content:Initial=22.4% Final =24% Initial Void Ratio =0.668

P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	20	0.665	0.0200				
0.10 - 0.25	24	0.661	0.0160	43.75	0.0090	87.8	9.540
0.25 - 0.50	26	0.656	0.0104	46.15	0.0056	135.0	6.145
0.50 - 1.00	51	0.648	0.0103	53.80	0.0047	135.0	6.050
1.00 - 2.00	61	0.638	0.0062	58.82	0.0025	188.0	4.246
2.00 - 4.00	110	0.619	0.0056	62.73	0.0021	203.1	3.792
4.00 - 8.00	160	0.593	0.0041	65.00	0.0014	214.3	3.393
8.00 - 0.25	167	0.620	0.0023				



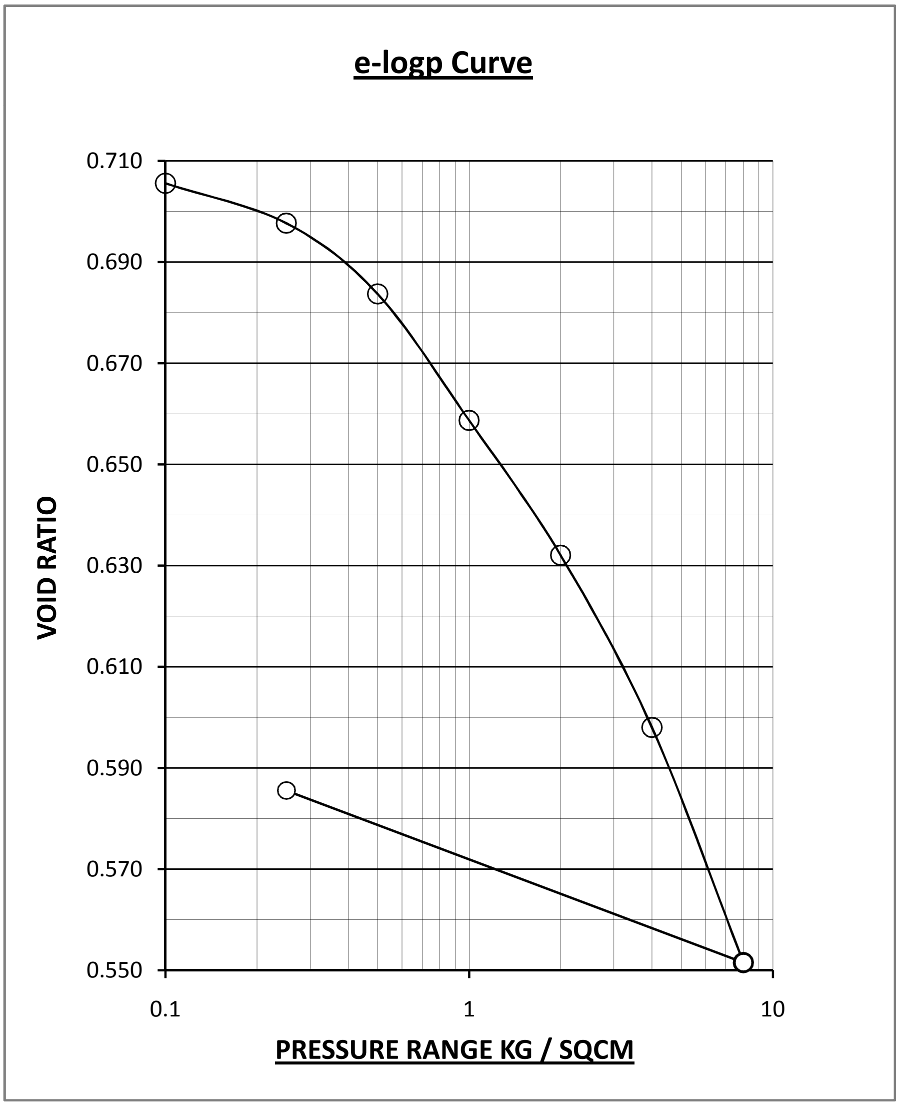
CONSOLIDATION TEST RESULTS

Sample Number:BH-69/UDS-01 Depth :2.5-2.95 meters

Description :Reddish brown clayey moorum

Water content:Initial=22.3% Final =25.1% Initial Void Ratio =0.714

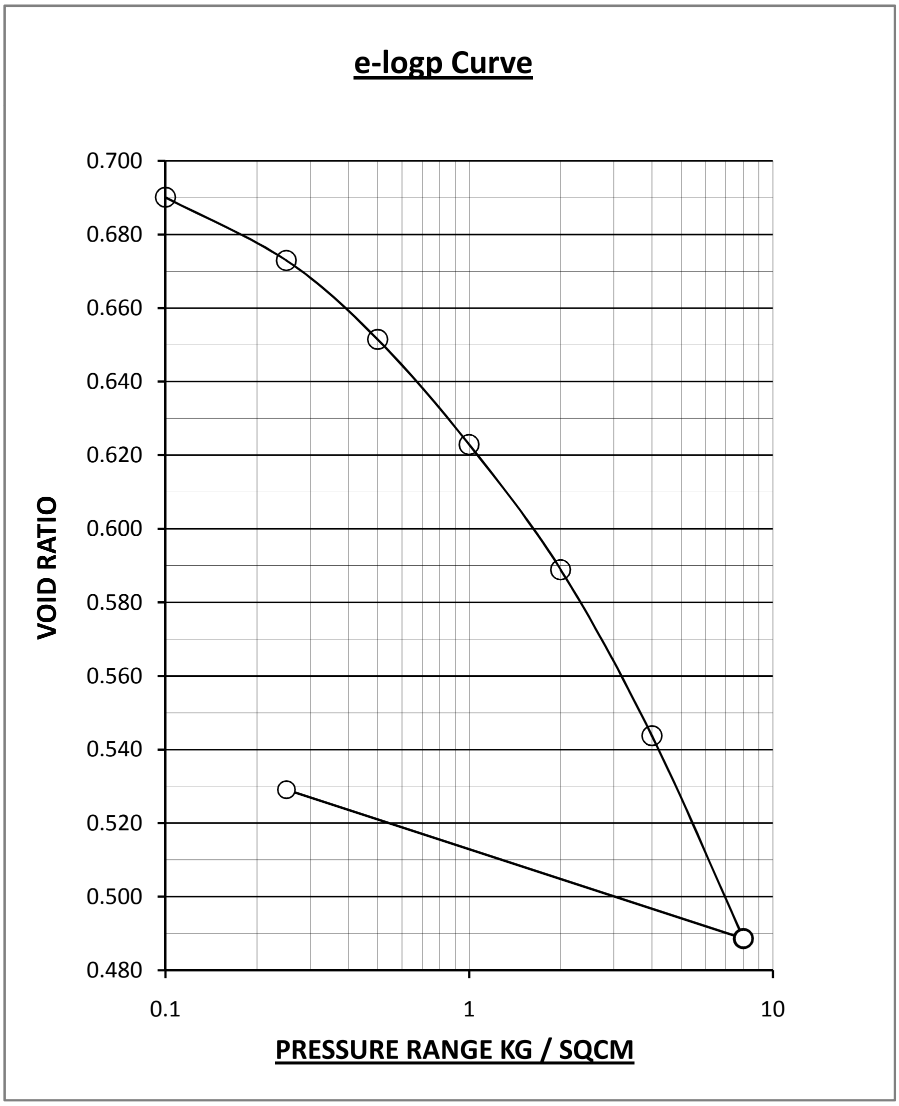
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	31	0.706	0.0310				
0.10 - 0.25	46	0.698	0.0307	42.40	0.0177	181.3	4.582
0.25 - 0.50	82	0.684	0.0330	47.10	0.0175	144.4	5.606
0.50 - 1.00	146	0.659	0.0297	50.80	0.0146	155.3	4.972
1.00 - 2.00	156	0.632	0.0161	66.80	0.0053	156.9	4.614
2.00 - 4.00	199	0.598	0.0104	58.00	0.0044	196.0	3.416
4.00 - 8.00	272	0.552	0.0073	44.60	0.0040	178.7	3.360
8.00 - 0.25	199	0.586	0.0028				



CONSOLIDATION TEST RESULTS

Sample Number:BH-69/UDS-02 Depth :2.5-2.95 meters
Description :Reddish brown clayey silt with sand mixture.
Water content:Initial=22% Final =24.5% Initial Void Ratio =0.706

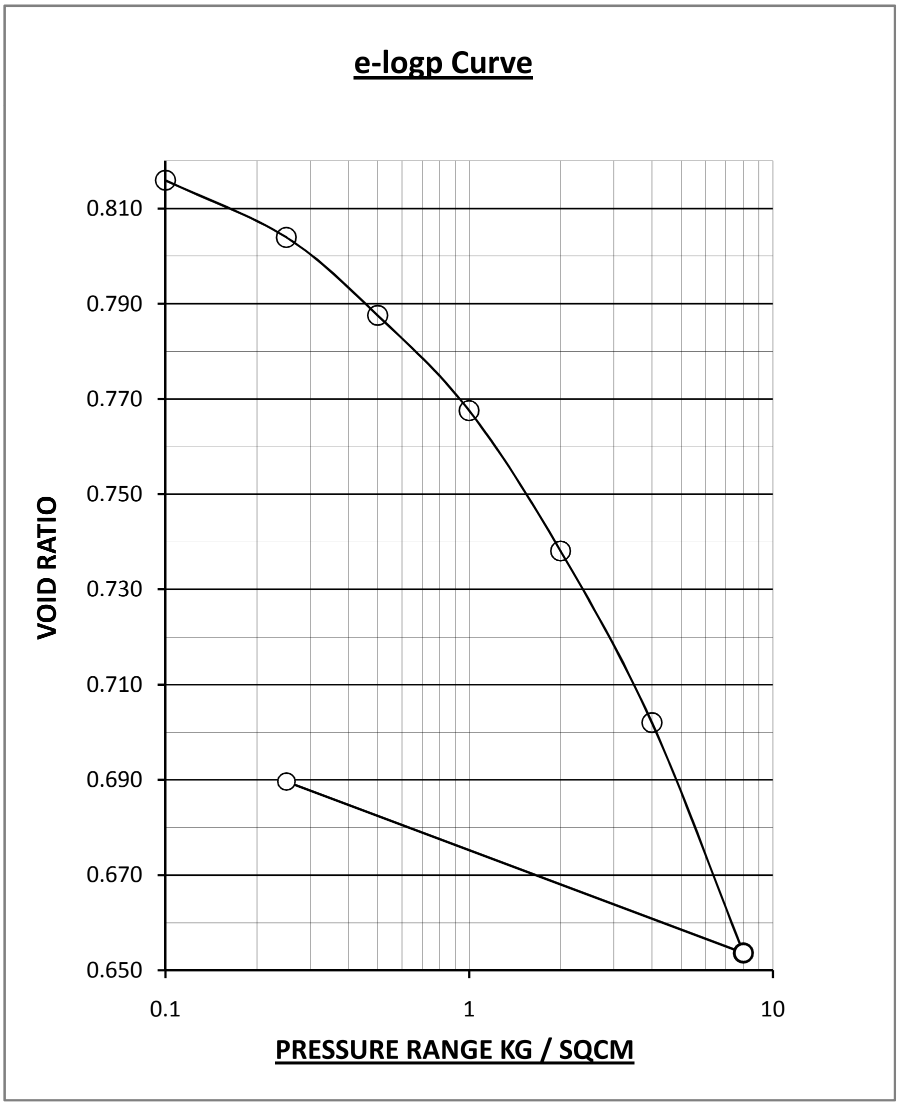
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	75	0.690	0.0750				
0.10 - 0.25	101	0.673	0.0678	82.30	0.0120	138.5	5.826
0.25 - 0.50	126	0.651	0.0513	70.30	0.0152	217.1	3.546
0.50 - 1.00	168	0.623	0.0346	74.00	0.0090	145.8	4.959
1.00 - 2.00	200	0.589	0.0210	59.10	0.0086	174.8	3.813
2.00 - 4.00	265	0.544	0.0142	55.80	0.0063	140.1	4.272
4.00 - 8.00	324	0.489	0.0089	44.20	0.0050	244.3	2.118
8.00 - 0.25	238	0.529	0.0035				



CONSOLIDATION TEST RESULTS

Sample Number:BH-86/UDS-02 Depth :5.55-6 meters
Description :Reddish brown silty clay / clayey silt with sand mixture.
Water content:Initial=25.3% Final =26% Initial Void Ratio =0.824

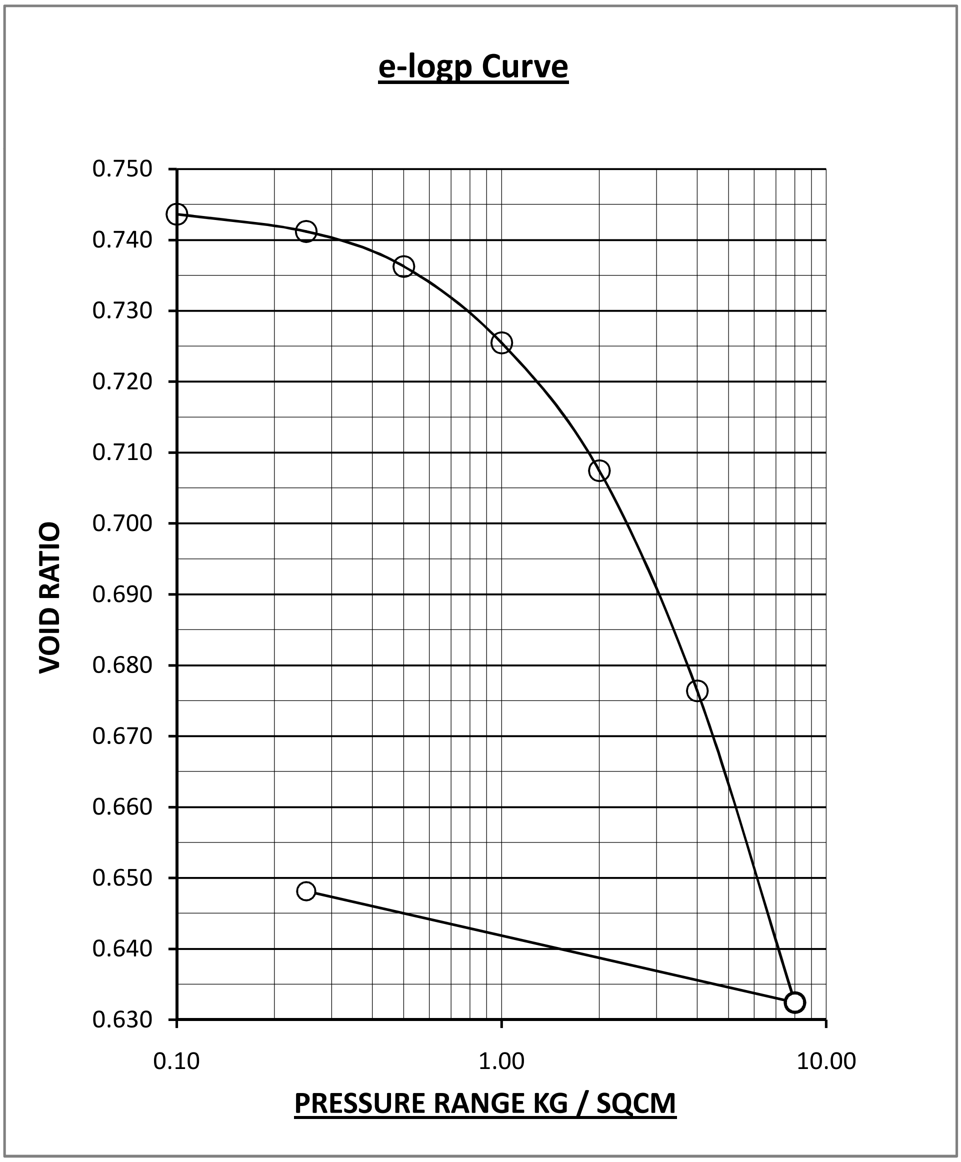
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	26	0.816	0.0260				
0.10 - 0.25	66	0.804	0.0441	47.30	0.0232	141.8	5.847
0.25 - 0.50	90	0.788	0.0363	34.60	0.0237	199.1	4.034
0.50 - 1.00	110	0.768	0.0224	49.10	0.0114	174.1	4.426
1.00 - 2.00	162	0.738	0.0167	44.30	0.0093	180.5	4.028
2.00 - 4.00	198	0.702	0.0104	35.70	0.0067	139.6	4.812
4.00 - 8.00	266	0.654	0.0071	29.40	0.0050	146.2	4.128
8.00 - 0.25	198	0.690	0.0028				



CONSOLIDATION TEST RESULTS

Sample Number:BH-89/UDS-03 Depth :20-20.45 meters
Description :Yellowish grey clayey silt with sand mixtures.
Water content:Initial=25.8% Final =22.6% Initial Void Ratio =0.744

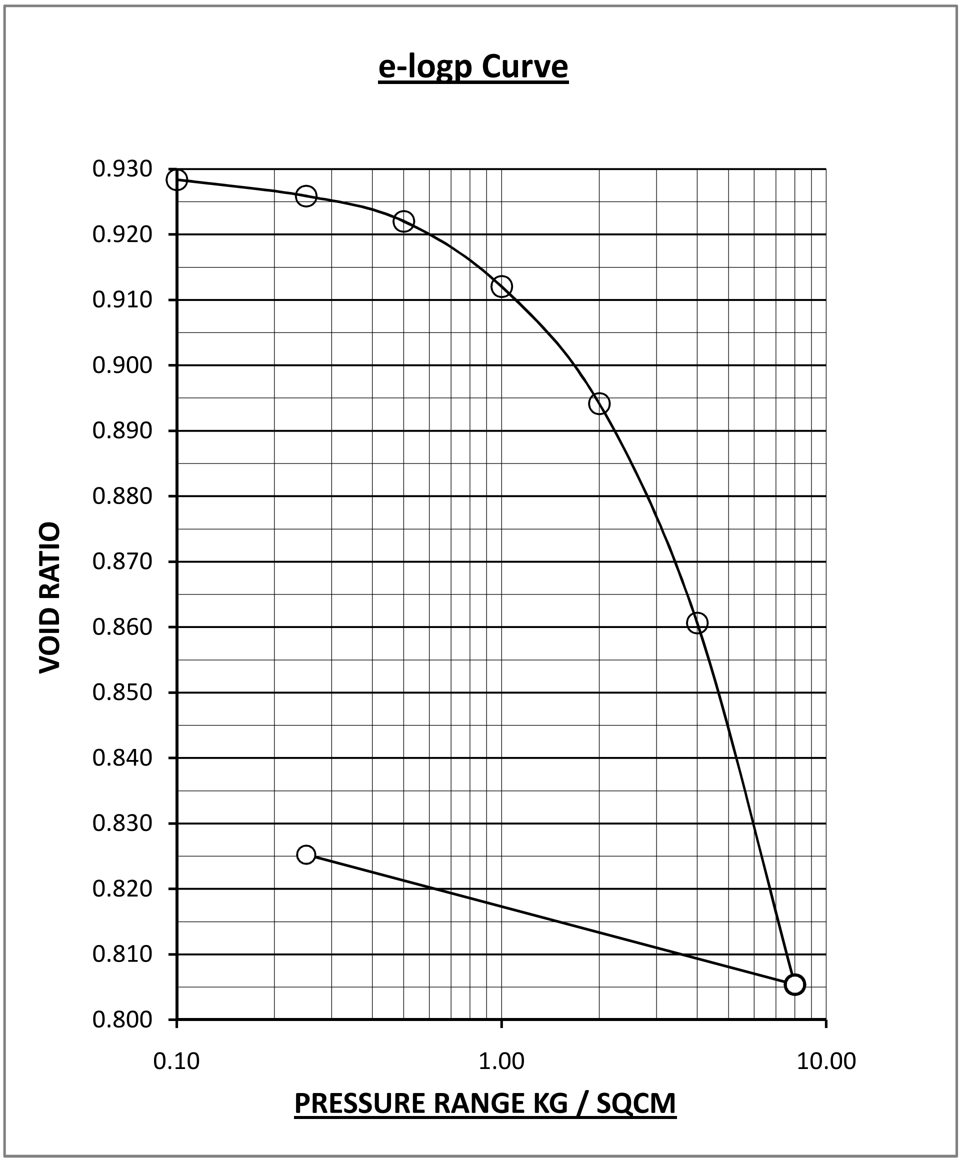
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	4	0.744	0.0040				
0.10 - 0.25	14	0.741	0.0093	21.43	0.0073	82.1	10.269
0.25 - 0.50	28	0.736	0.0112	10.71	0.0100	115.4	7.247
0.50 - 1.00	62	0.725	0.0125	27.70	0.0090	137.4	5.977
1.00 - 2.00	103	0.707	0.0104	25.24	0.0078	120.2	6.605
2.00 - 4.00	178	0.676	0.0091	34.83	0.0059	287.4	2.604
4.00 - 8.00	252	0.632	0.0066	30.95	0.0045	112.6	6.052
8.00 - 0.25	90	0.648	0.0012				



CONSOLIDATION TEST RESULTS

Sample Number:BH-90/UDS-05 Depth :19-19.45 meters
Description :Reddish brown clayey silt with sand mixtures.
Water content:Initial=29.2% Final =27.7% Initial Void Ratio =0.93

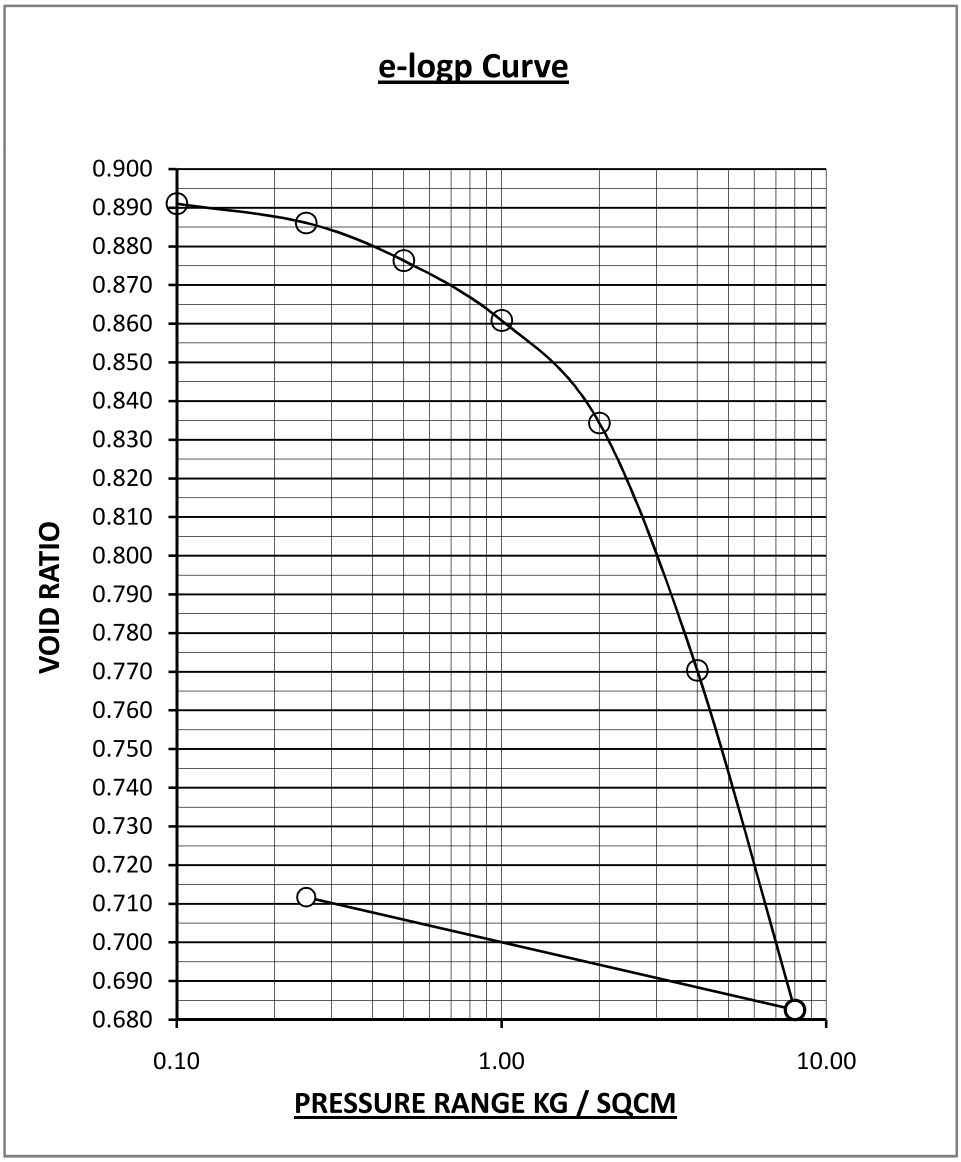
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	6	0.928	0.0060				
0.10 - 0.25	13	0.926	0.0087	23.08	0.0067	75.3	11.267
0.25 - 0.50	20	0.922	0.0080	25.00	0.0060	151.3	5.568
0.50 - 1.00	52	0.912	0.0104	23.50	0.0080	280.5	2.960
1.00 - 2.00	93	0.894	0.0094	30.11	0.0065	192.2	4.193
2.00 - 4.00	174	0.861	0.0088	53.45	0.0041	218.9	3.484
4.00 - 8.00	287	0.805	0.0074	54.70	0.0034	244.8	2.819
8.00 - 0.25	103	0.825	0.0014				



CONSOLIDATION TEST RESULTS

Sample Number:BH-91/UDS-01 Depth :3-3.45 meters
Description :Reddish brown, clayey silt with sand mixture.
Water content:Initial=26.6% Final =25.1% Initial Void Ratio =0.892

P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	4	0.891	0.0040				
0.10 - 0.25	26	0.886	0.0173	15.38	0.0146	440.6	1.919
0.25 - 0.50	52	0.876	0.0208	30.77	0.0144	314.6	2.646
0.50 - 1.00	82	0.861	0.0165	41.46	0.0097	165.3	4.900
1.00 - 2.00	140	0.834	0.0142	48.57	0.0073	216.6	3.572
2.00 - 4.00	339	0.770	0.0174	59.00	0.0072	159.4	4.379
4.00 - 8.00	465	0.683	0.0124	62.15	0.0047	163.4	3.550
8.00 - 0.25	154	0.712	0.0022				



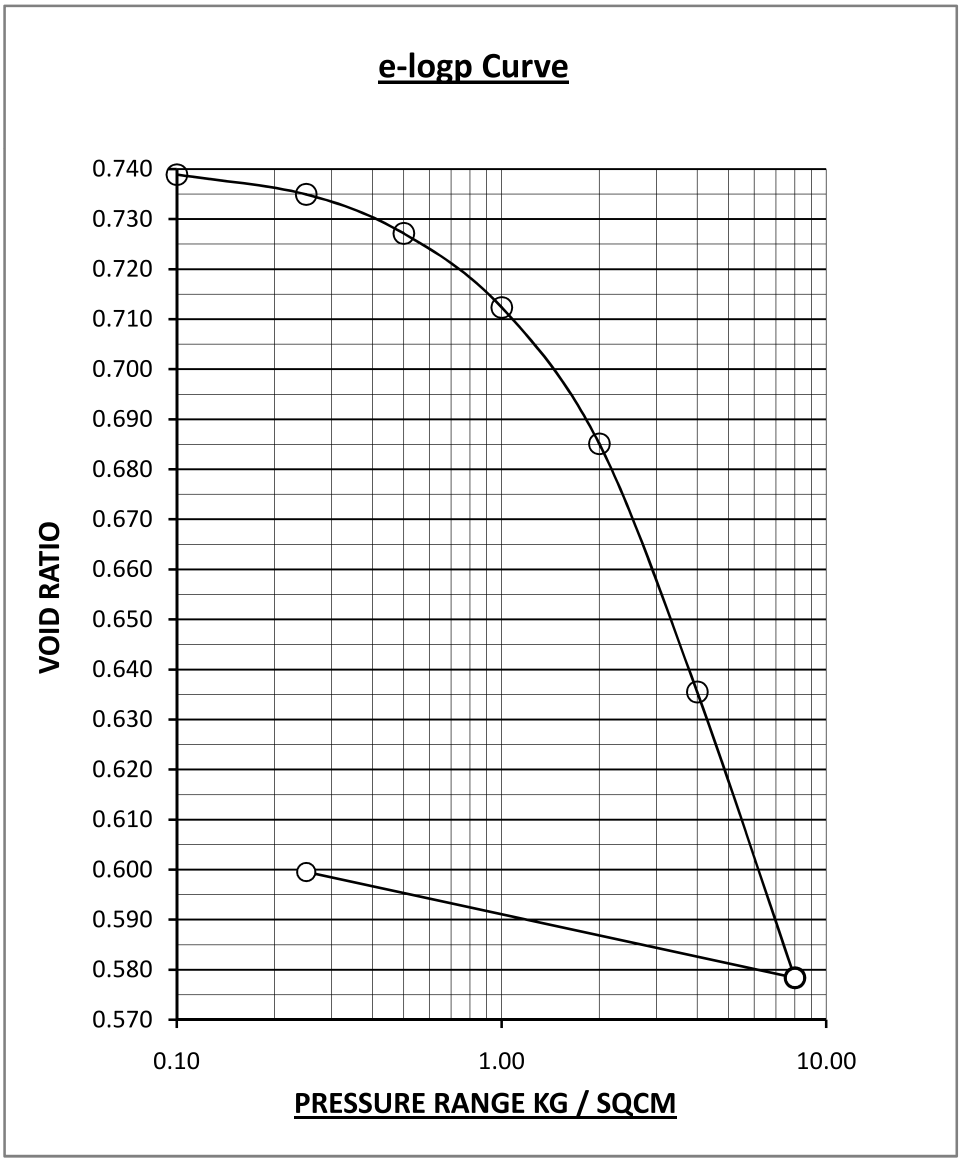
CONSOLIDATION TEST RESULTS

Sample Number:BH-93/UDS-01 Depth :2.55-3 meters

Description :Reddish brown clayey silt with traces of sand mixture.

Water content:Initial=22.9% Final =22.7% Initial Void Ratio =0.74

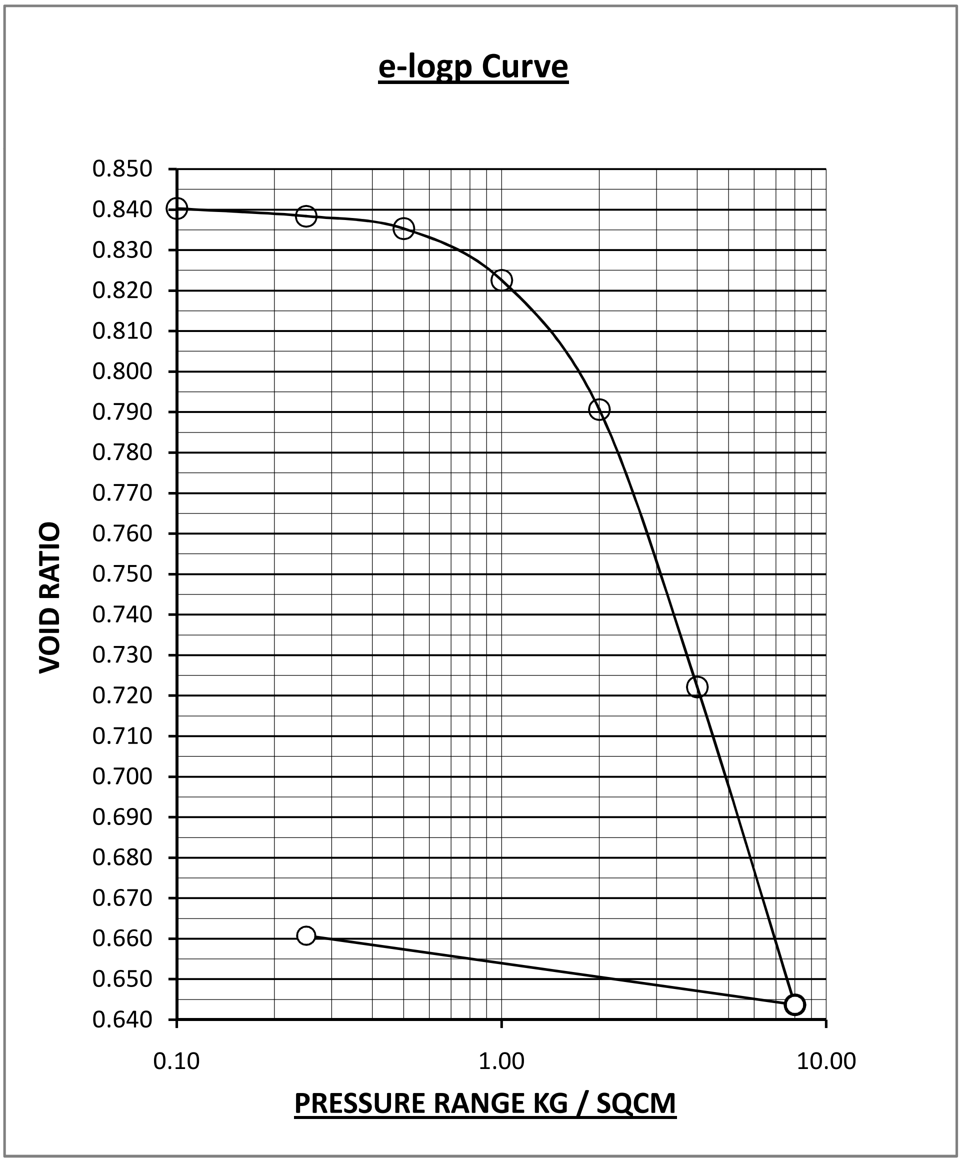
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	6	0.739	0.0060				
0.10 - 0.25	23	0.735	0.0153	60.87	0.0060	82.1	10.304
0.25 - 0.50	45	0.727	0.0180	55.56	0.0080	194.4	4.294
0.50 - 1.00	85	0.712	0.0171	55.29	0.0076	114.3	7.116
1.00 - 2.00	157	0.685	0.0159	78.34	0.0034	169.3	4.567
2.00 - 4.00	286	0.635	0.0147	79.02	0.0031	169.3	4.153
4.00 - 8.00	329	0.578	0.0087	73.56	0.0023	207.6	2.946
8.00 - 0.25	122	0.600	0.0017				



CONSOLIDATION TEST RESULTS

Sample Number:BH-94/UDS-01 Depth :2.55-3 meters
Description :Reddish brown clayey silt with traces of sand mixture.
Water content:Initial=19.9% Final =22.6% Initial Void Ratio =0.841

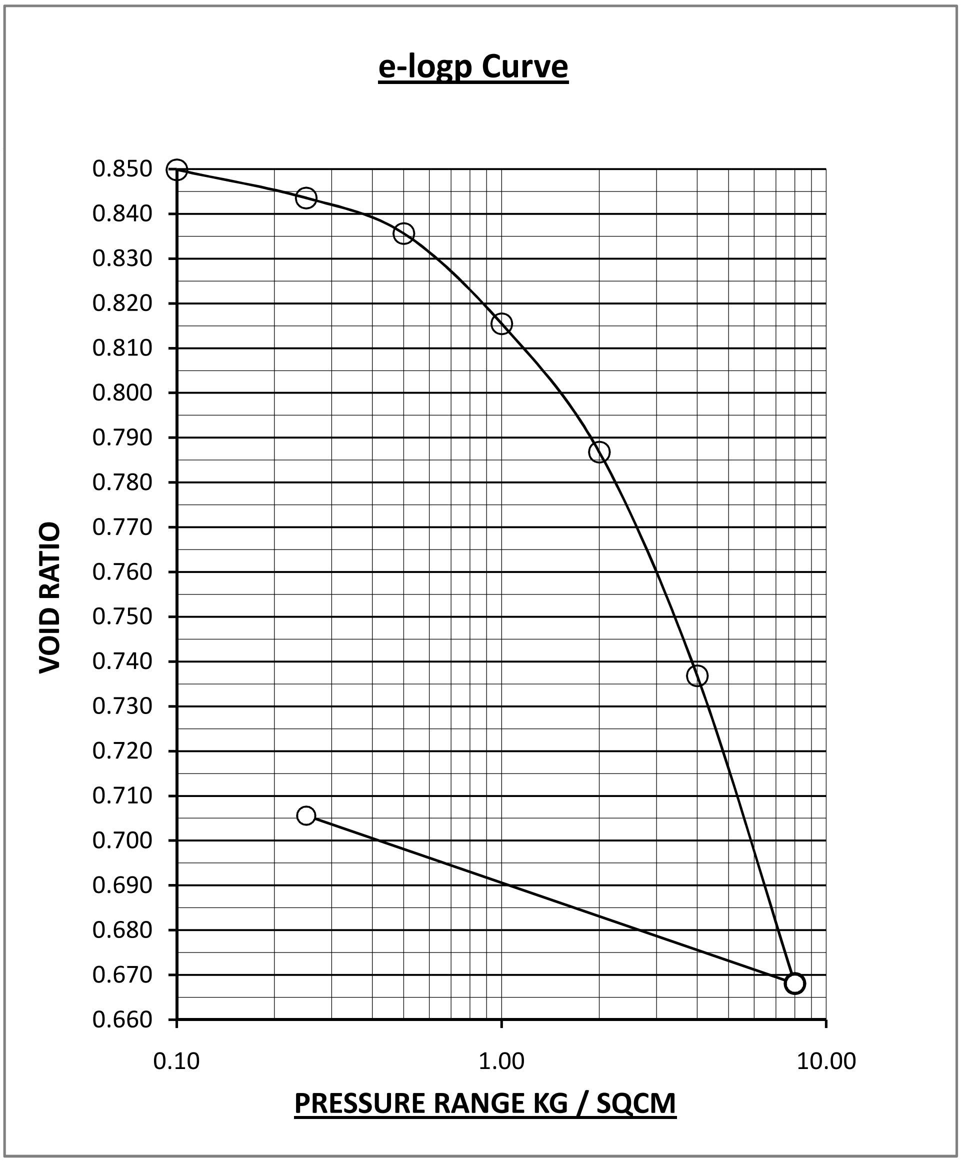
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	$1000.C_v$ sqcm/sec
0.00 - 0.10	4	0.840	0.0040				
0.10 - 0.25	10	0.838	0.0067	30.00	0.0047	92.3	9.200
0.25 - 0.50	17	0.835	0.0068	29.41	0.0048	103.4	8.168
0.50 - 1.00	69	0.823	0.0138	39.13	0.0084	135.0	6.149
1.00 - 2.00	174	0.791	0.0175	58.05	0.0074	138.6	5.698
2.00 - 4.00	373	0.722	0.0191	75.34	0.0047	228.2	3.081
4.00 - 8.00	427	0.644	0.0114	73.30	0.0030	203.1	2.879
8.00 - 0.25	93	0.661	0.0013				



CONSOLIDATION TEST RESULTS

Sample Number:BH-99/UDS-01 Depth :3-3.45 meters
Description :Reddish brown clayey silt with sand mixtures
Water content:Initial=25.9% Final =27.3% Initial Void Ratio =0.851

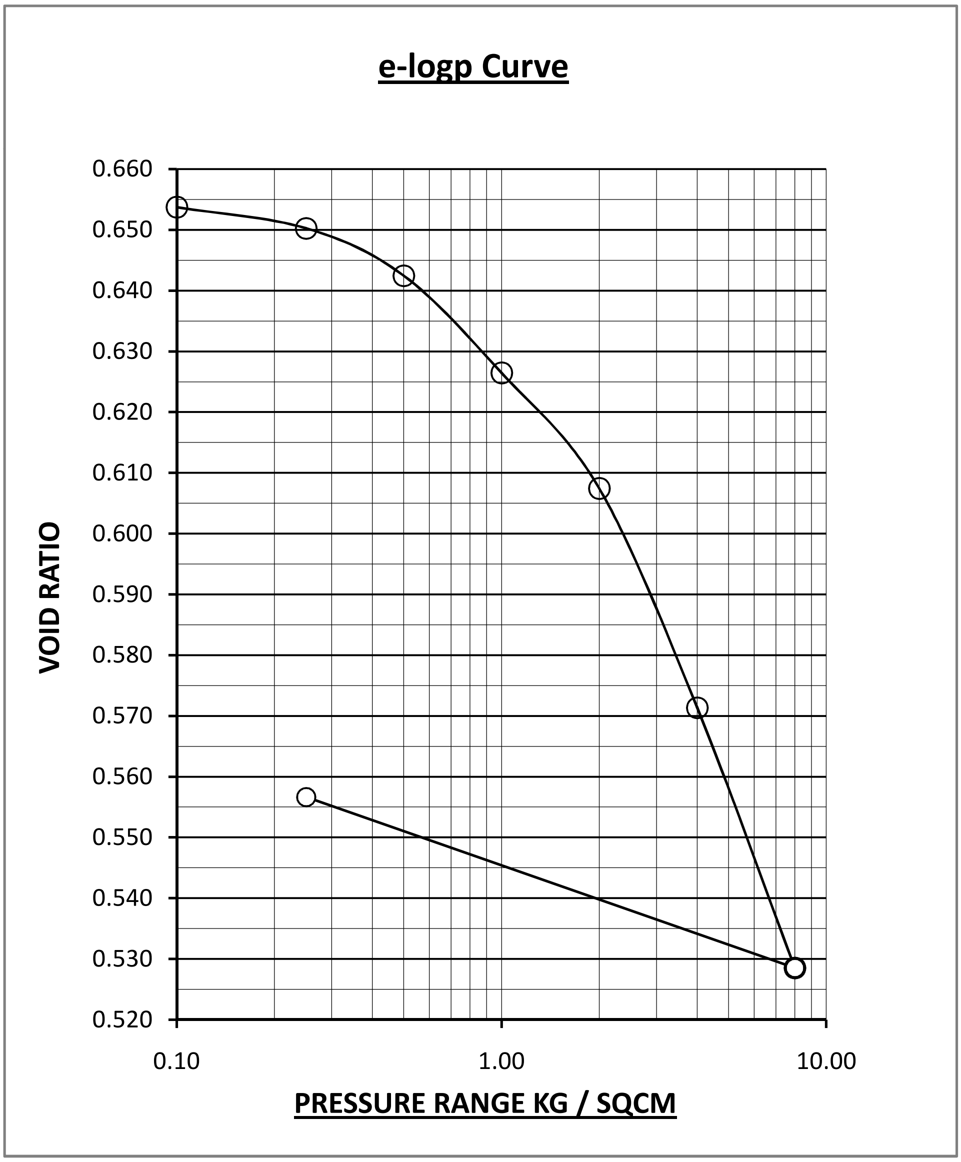
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	$1000.C_v$ sqcm/sec
0.00 - 0.10	7	0.850	0.0070				
0.10 - 0.25	34	0.844	0.0227	38.24	0.0140	177.5	4.741
0.25 - 0.50	43	0.836	0.0173	44.90	0.0095	127.9	6.479
0.50 - 1.00	109	0.815	0.0220	69.72	0.0066	111.0	7.239
1.00 - 2.00	155	0.787	0.0158	67.10	0.0052	144.2	5.275
2.00 - 4.00	270	0.737	0.0140	74.07	0.0036	115.9	5.983
4.00 - 8.00	372	0.668	0.0099	66.94	0.0033	101.4	5.904
8.00 - 0.25	203	0.706	0.0029				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND02/UDS-01 Depth :3.15-3.6 meters
Description :Reddish brown clayey silt / silty clay with sand mixtures & kankars.
Water content:Initial=21.7% Final =20.4% Initial Void Ratio =0.655

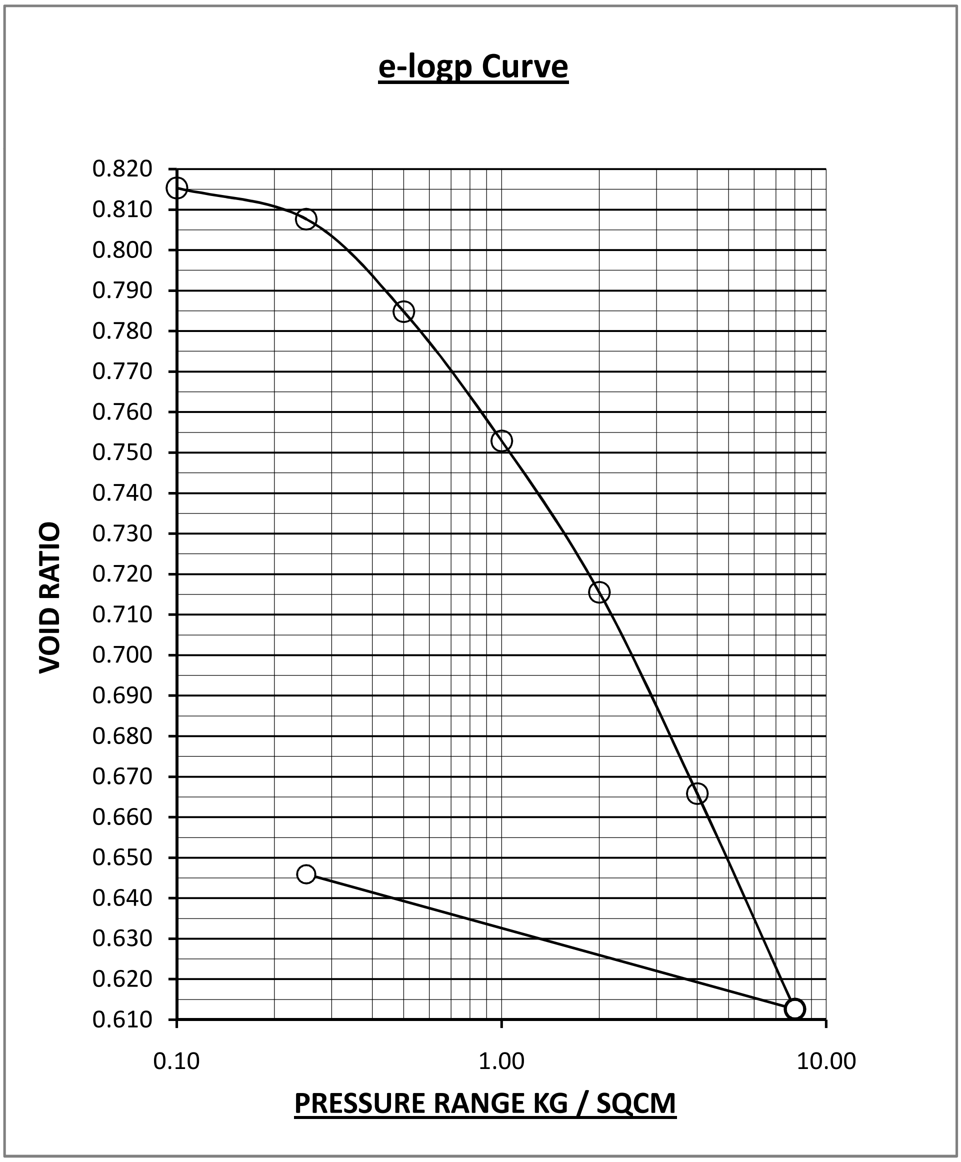
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	8	0.654	0.0080				
0.10 - 0.25	21	0.650	0.0140	52.38	0.0067	169.0	4.991
0.25 - 0.50	47	0.642	0.0188	29.79	0.0132	93.8	8.874
0.50 - 1.00	97	0.626	0.0195	36.08	0.0125	163.4	4.946
1.00 - 2.00	115	0.607	0.0117	34.78	0.0076	163.4	4.734
2.00 - 4.00	218	0.571	0.0112	44.04	0.0063	171.4	4.203
4.00 - 8.00	259	0.529	0.0068	40.93	0.0040	357.2	1.813
8.00 - 0.25	170	0.557	0.0024				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND06/UDS-01 Depth :2.5-2.95 meters
Description :Reddish brown clayey silt with sand mixtures.
Water content:Initial=21% Final =23% Initial Void Ratio =0.818

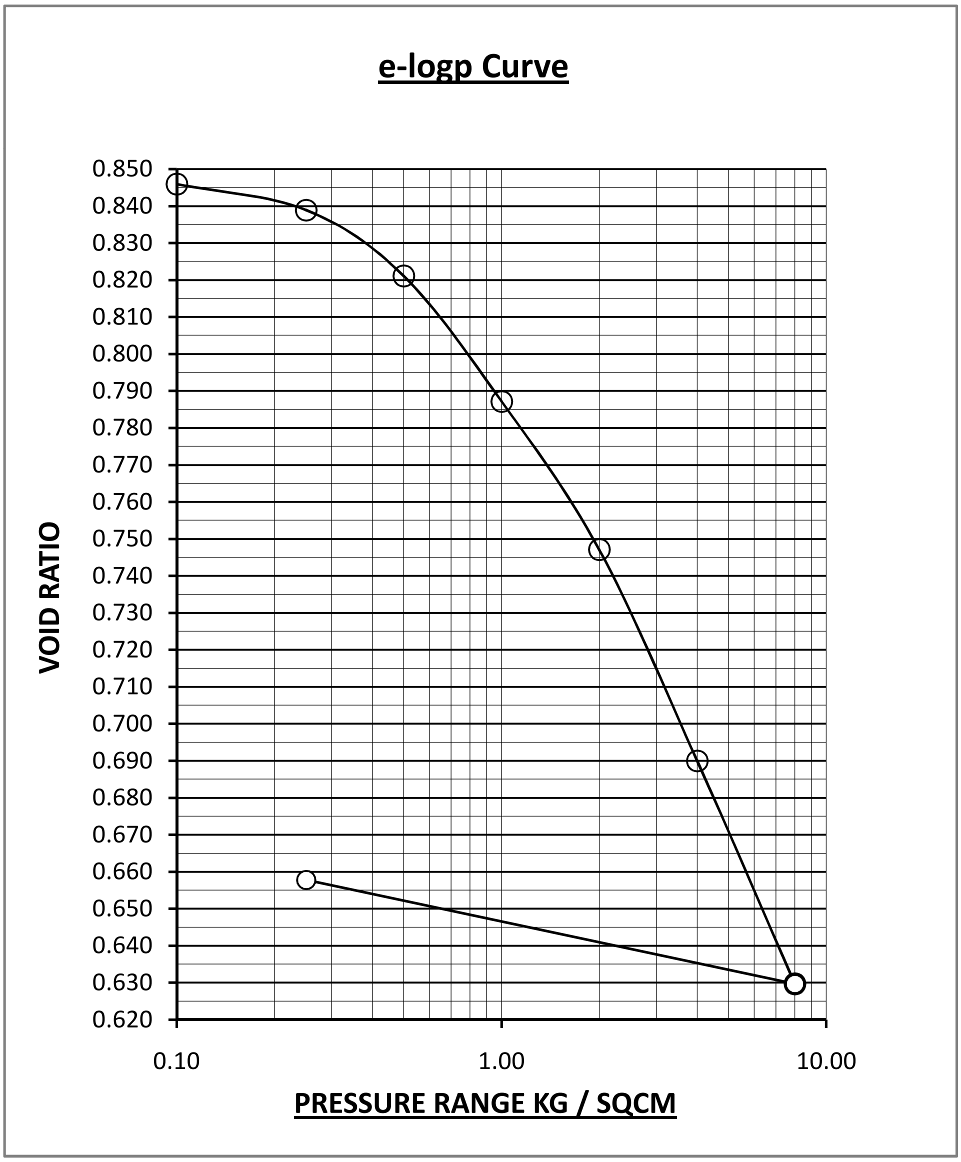
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	$1000.C_v$ sqcm/sec
0.00 - 0.10	14	0.815	0.0140				
0.10 - 0.25	42	0.808	0.0280	21.43	0.0220	254.6	3.301
0.25 - 0.50	126	0.785	0.0506	37.30	0.0317	173.4	4.684
0.50 - 1.00	176	0.753	0.0358	38.35	0.0220	114.3	6.677
1.00 - 2.00	206	0.716	0.0213	36.36	0.0136	153.6	4.575
2.00 - 4.00	274	0.666	0.0145	57.82	0.0061	161.4	3.907
4.00 - 8.00	294	0.613	0.0080	47.81	0.0042	279.9	1.965
8.00 - 0.25	184	0.646	0.0027				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND07/UDS-01 Depth :3-3.45 meters
Description :Brownish grey clayey silt with traces of sand mixture.
Water content:Initial=19.3% Final =22.2% Initial Void Ratio =0.847

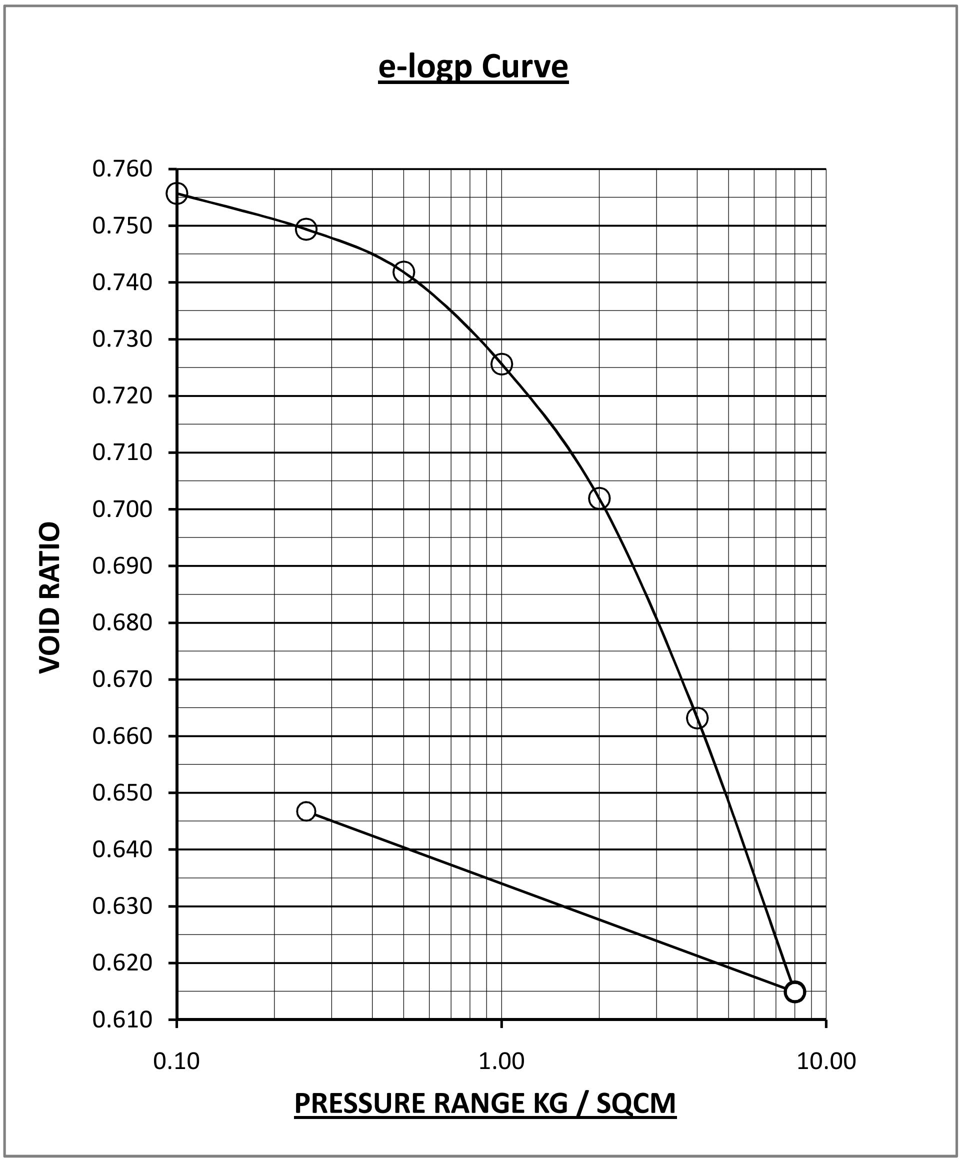
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	4	0.846	0.0040				
0.10 - 0.25	38	0.839	0.0253	47.37	0.0133	121.0	6.994
0.25 - 0.50	97	0.821	0.0388	45.36	0.0212	242.4	3.397
0.50 - 1.00	184	0.787	0.0372	38.04	0.0230	167.3	4.644
1.00 - 2.00	218	0.747	0.0224	41.74	0.0131	138.6	5.145
2.00 - 4.00	310	0.690	0.0163	60.32	0.0065	237.6	2.666
4.00 - 8.00	328	0.630	0.0089	57.01	0.0038	183.8	2.957
8.00 - 0.25	153	0.658	0.0022				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND10/UDS-01 Depth :2.5-2.95 meters
Description :Reddish brown clayey silt with sand mixtures.
Water content:Initial=23.5% Final =22.5% Initial Void Ratio =0.76

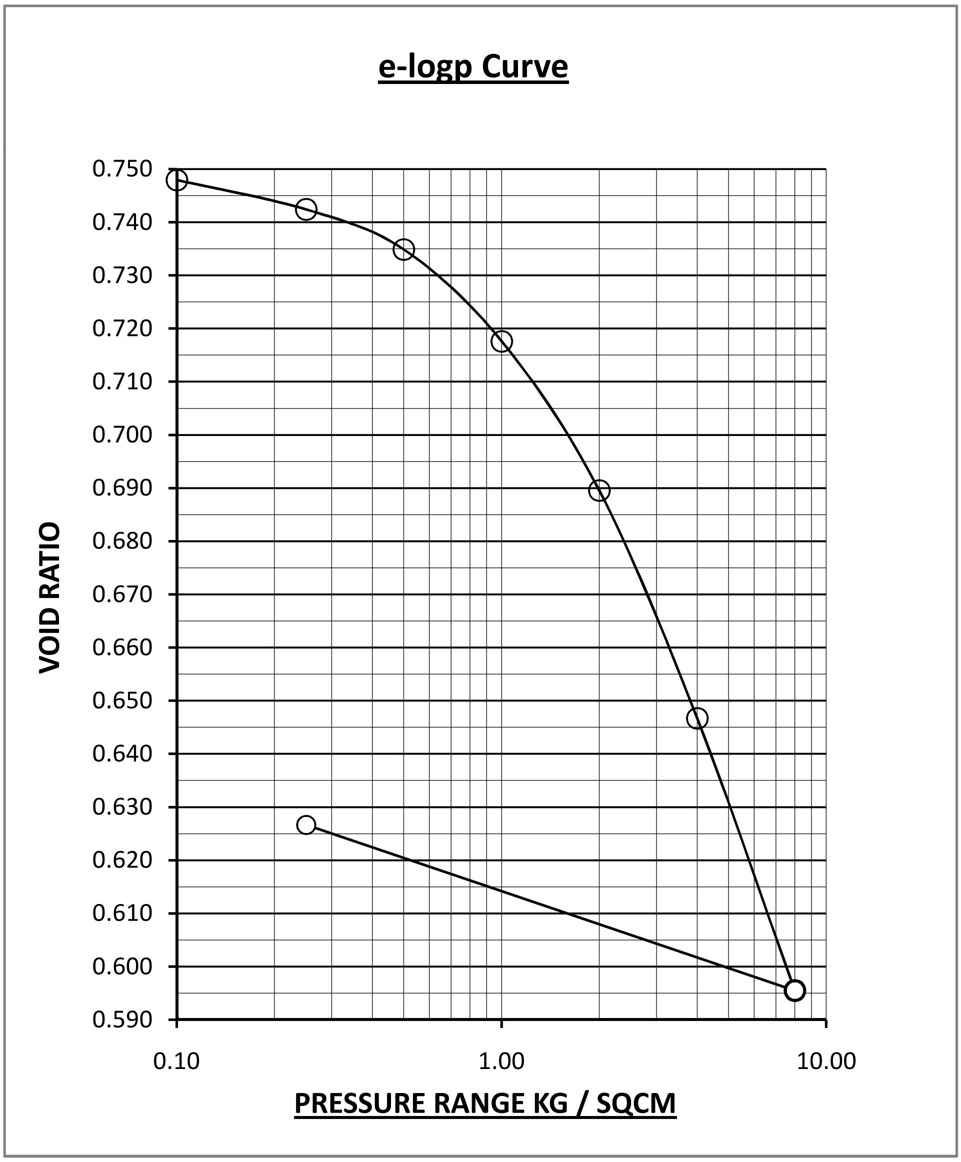
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	$1000.C_v$ sqcm/sec
0.00 - 0.10	26	0.756	0.0260				
0.10 - 0.25	36	0.749	0.0240	58.33	0.0100	127.9	6.534
0.25 - 0.50	43	0.742	0.0173	39.53	0.0104	252.2	3.262
0.50 - 1.00	92	0.726	0.0186	56.52	0.0081	179.6	4.455
1.00 - 2.00	135	0.702	0.0138	57.04	0.0059	151.7	5.031
2.00 - 4.00	220	0.663	0.0114	63.18	0.0042	228.2	3.099
4.00 - 8.00	275	0.615	0.0073	63.27	0.0027	185.9	3.403
8.00 - 0.25	181	0.647	0.0025				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND11/UDS-01 Depth :2.5-2.95 meters
Description :Reddish brown, clayey silt with sand mixture.
Water content:Initial=24% Final =24% Initial Void Ratio =0.749

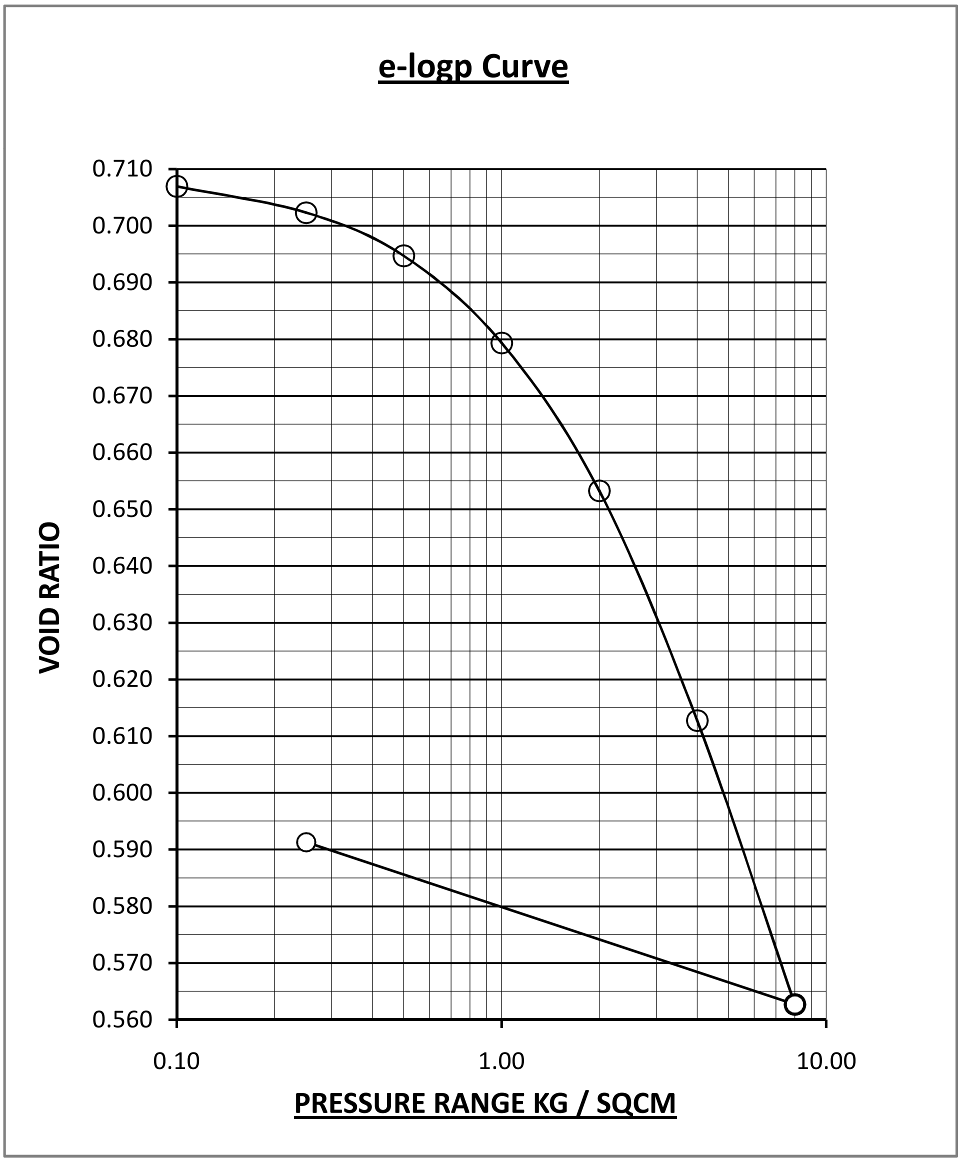
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	6	0.748	0.0060				
0.10 - 0.25	32	0.742	0.0213	46.88	0.0113	136.8	6.187
0.25 - 0.50	43	0.735	0.0172	37.21	0.0108	269.7	3.092
0.50 - 1.00	99	0.718	0.0199	57.58	0.0084	124.4	6.511
1.00 - 2.00	161	0.690	0.0163	62.73	0.0061	140.5	5.465
2.00 - 4.00	246	0.647	0.0127	70.73	0.0037	163.4	4.306
4.00 - 8.00	294	0.595	0.0078	68.37	0.0025	147.9	4.208
8.00 - 0.25	179	0.627	0.0025				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND12/UDS-01 Depth :3.05-3.5 meters
Description :Reddish brown clayey silt with sand mixtures.
Water content:Initial=22.8% Final =22.5% Initial Void Ratio =0.708

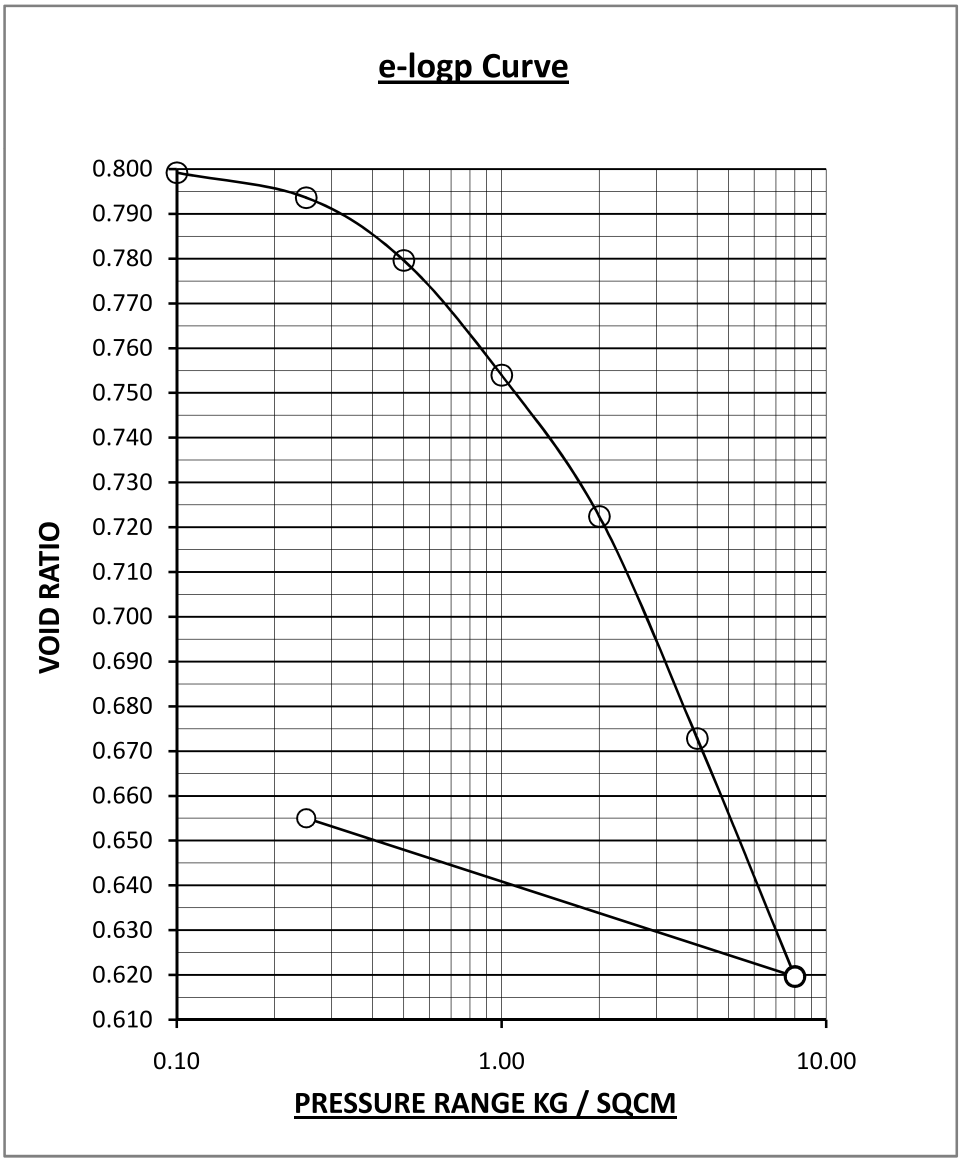
P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	9	0.707	0.0090				
0.10 - 0.25	27	0.702	0.0180	29.63	0.0126	181.7	4.659
0.25 - 0.50	45	0.695	0.0180	37.78	0.0112	151.7	5.499
0.50 - 1.00	90	0.679	0.0181	48.89	0.0092	119.3	6.804
1.00 - 2.00	153	0.653	0.0155	58.82	0.0064	196.6	3.926
2.00 - 4.00	238	0.613	0.0123	57.98	0.0051	235.2	3.018
4.00 - 8.00	294	0.563	0.0078	56.12	0.0034	325.7	1.933
8.00 - 0.25	168	0.591	0.0024				



CONSOLIDATION TEST RESULTS

Sample Number:BH-MND13/UDS-01 Depth :3-3.45 meters
Description :Reddish brown, clayey silt with traces of sand mixture.
Water content:Initial=25.5% Final =23.9% Initial Void Ratio =0.8

P_1-P_2 Kg/Sqcm	Dial Change	Void Ratio	M_v Sqcm/kg	Comprn %	M_{vc} sqcm/kg	T90 Sec	1000.C_v sqcm/sec
0.00 - 0.10	6	0.799	0.0060				
0.10 - 0.25	31	0.794	0.0206	35.48	0.0133	212.2	3.974
0.25 - 0.50	78	0.780	0.0313	23.08	0.0241	303.8	2.716
0.50 - 1.00	143	0.754	0.0289	36.36	0.0184	244.8	3.220
1.00 - 2.00	175	0.722	0.0179	37.14	0.0113	198.7	3.709
2.00 - 4.00	276	0.673	0.0144	52.70	0.0068	285.1	2.341
4.00 - 8.00	296	0.620	0.0080	35.16	0.0052	306.5	1.907
8.00 - 0.25	197	0.655	0.0028				



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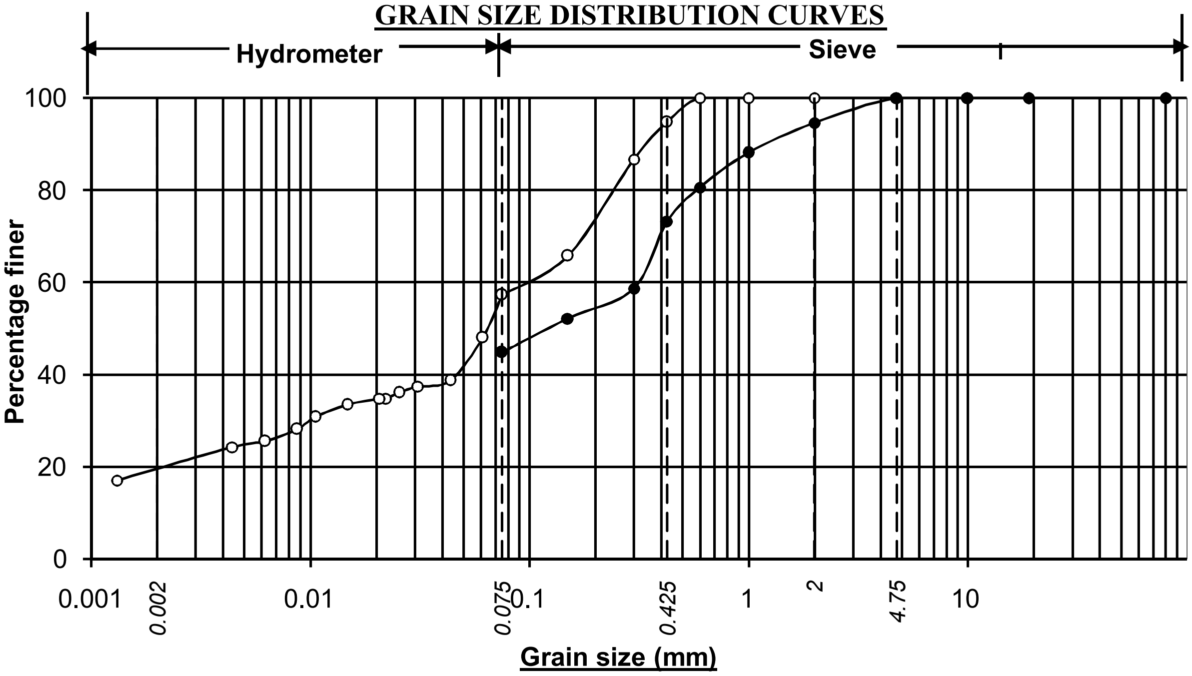
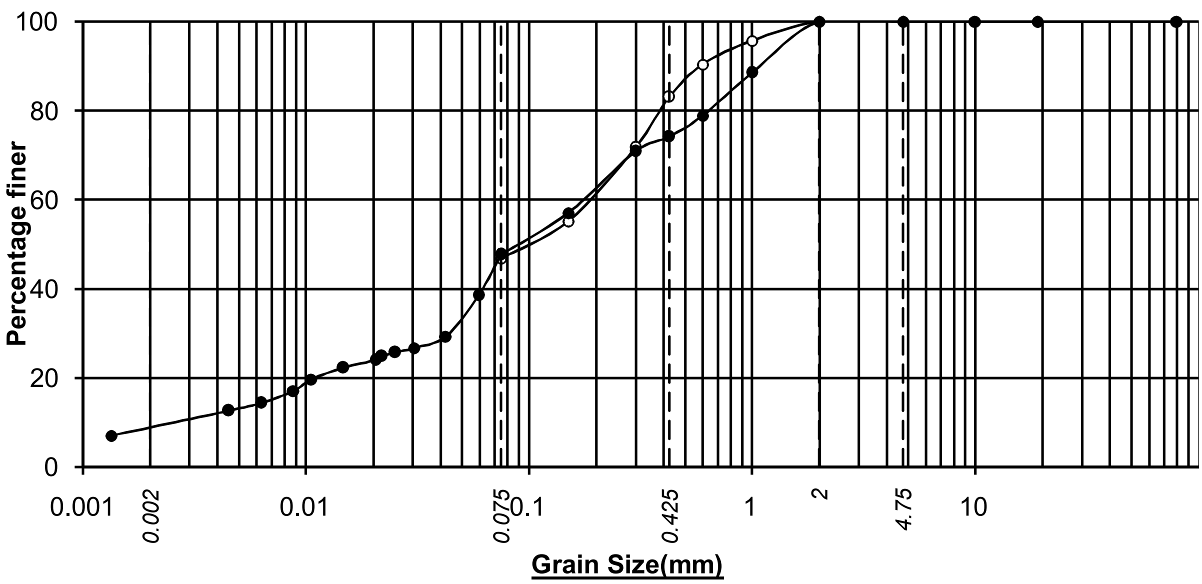


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-01,DS-04, 4.00M	19.6	37.8	37.4	5.2	0.0	42.6		0.0
BH-01,SPT-03, 4.80M		44.9	28.3	21.4	5.4	55.1		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-01,SPT-04, 6.00M		46.8	36.3	16.9	0.0	53.2		0.0
BH-01,SPT-05, 7.50M	8.9	38.9	26.4	25.8	0.0	52.2		0.0

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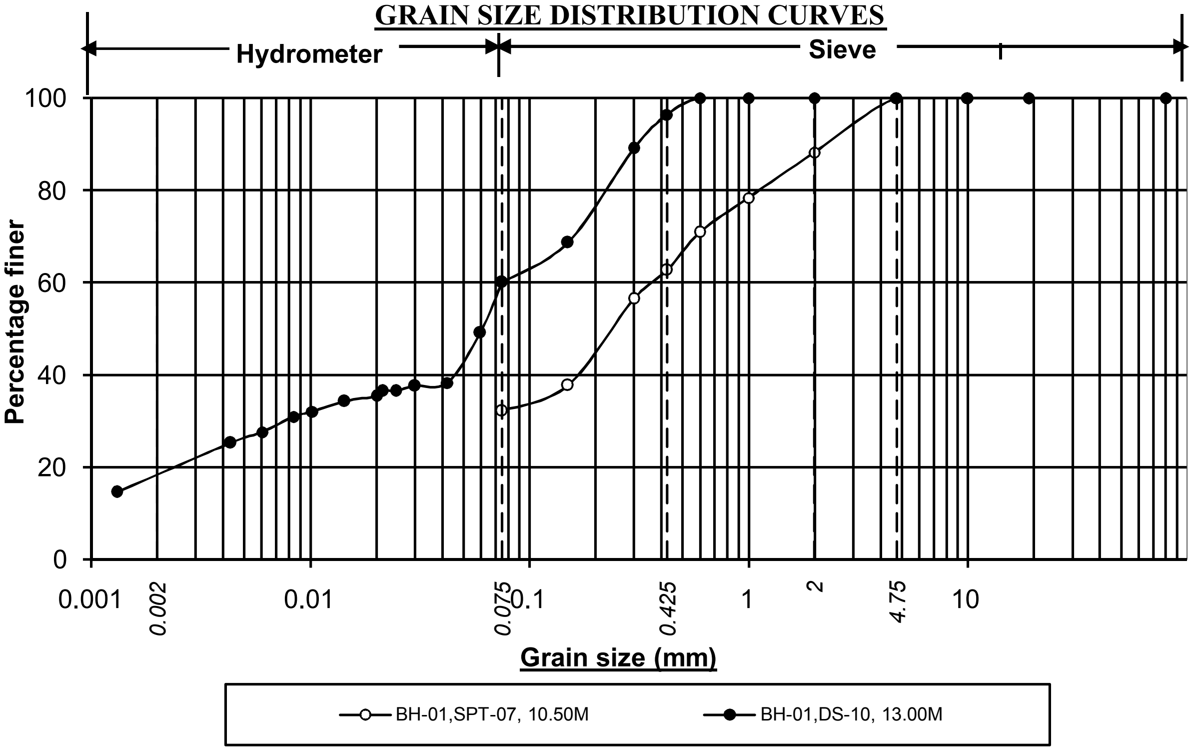
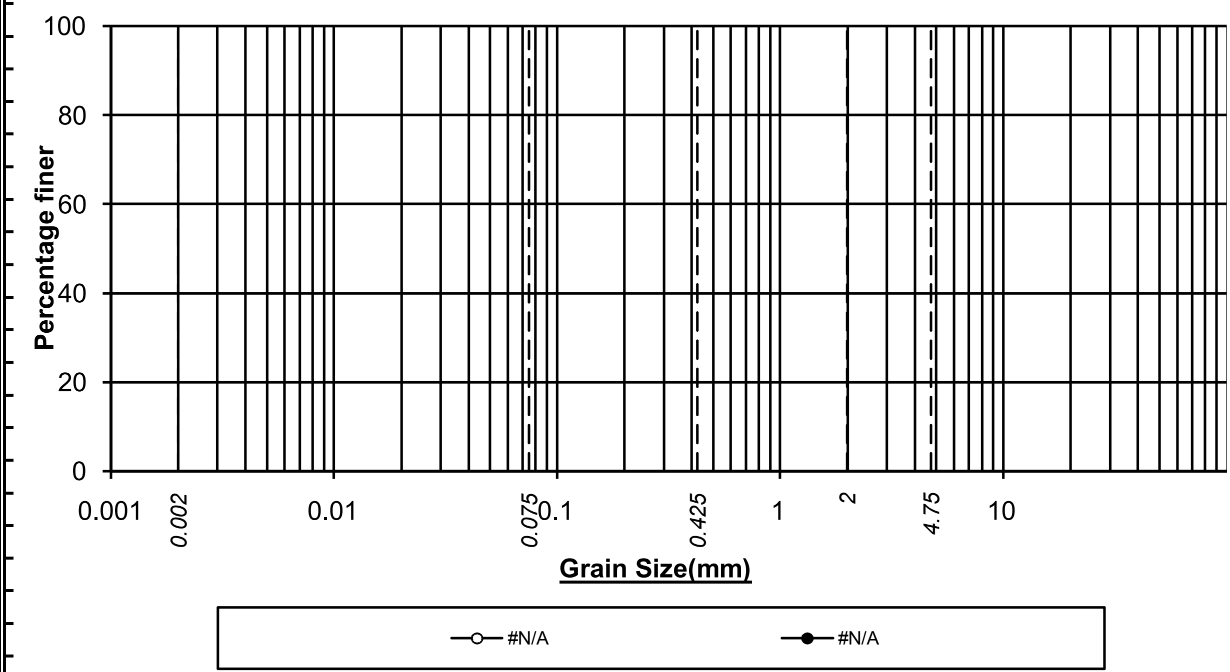


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-01,SPT-07, 10.50M		32.2	30.6	25.4	11.8	67.8		0.0
BH-01,DS-10, 13.00M	18.4	41.7	36.3	3.6	0.0	39.9		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

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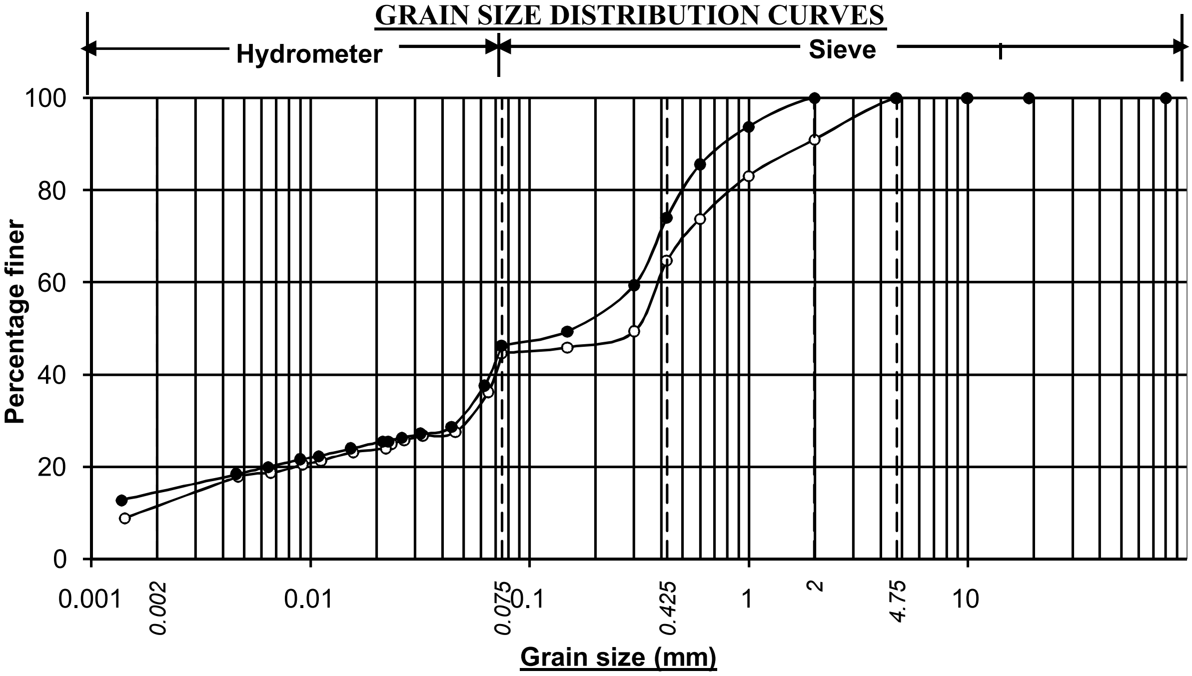
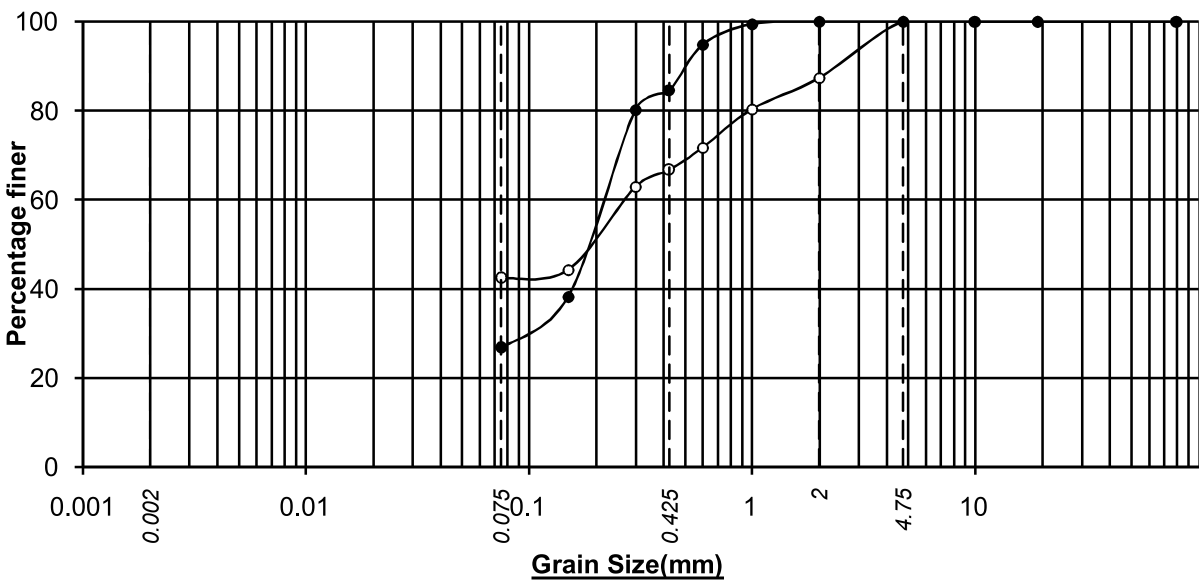


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-19,SPT-02, 3.00M	11.4	33.2	20.2	26.2	9.0	55.4		0.0
BH-19,SPT-03, 4.50M	14.5	31.8	27.8	25.9	0.0	53.7		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-19,SPT-06, 9.50M		42.4	24.3	20.7	12.6	57.6		0.0
BH-19,SPT-07, 11.00M		26.8	57.8	15.4	0.0	73.2		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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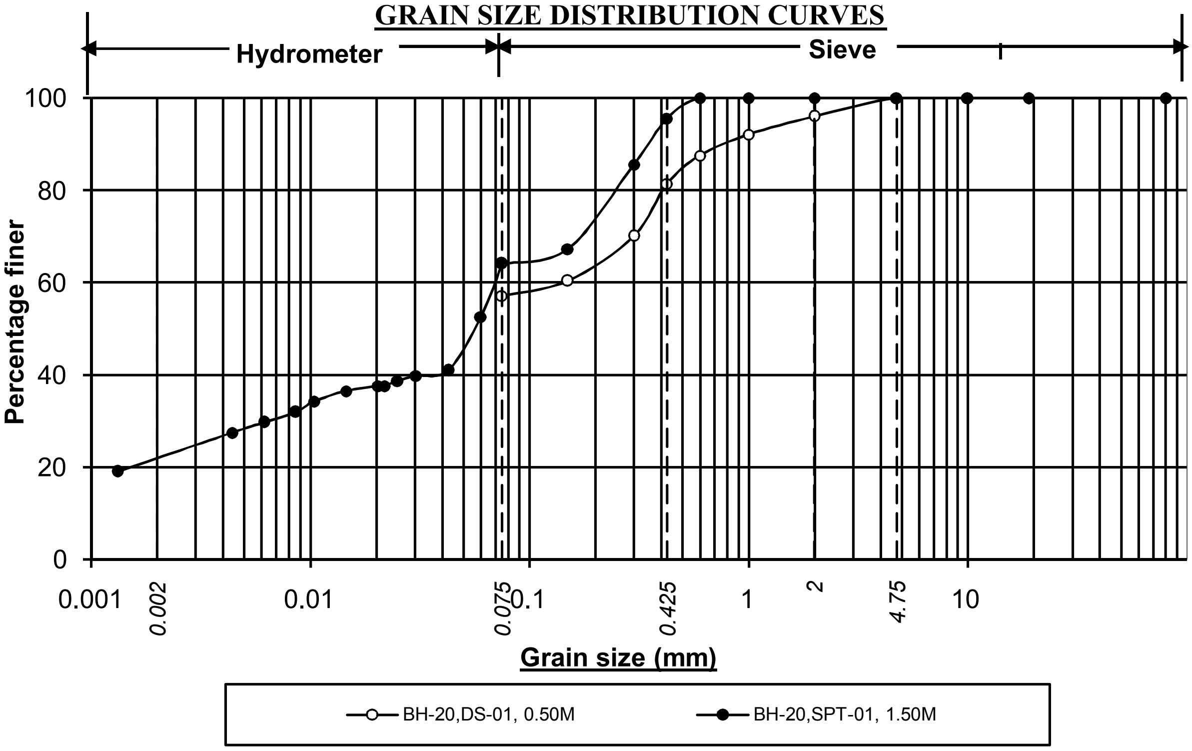
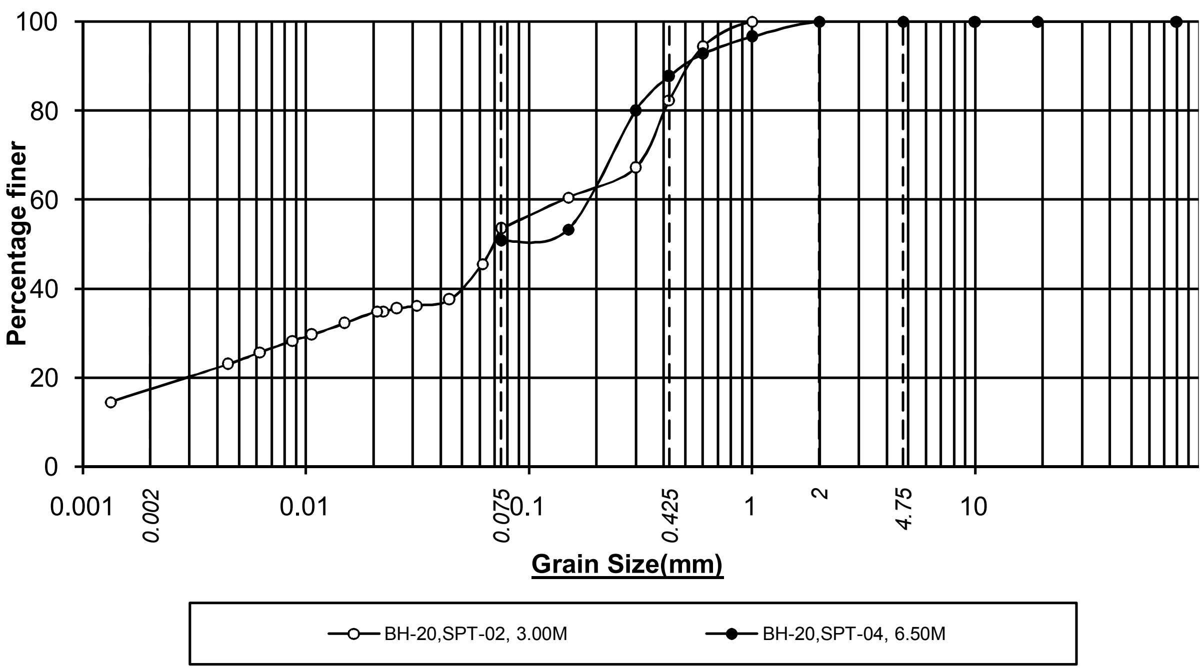
Sheet No.:



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-20,DS-01, 0.50M		57.2	24.3	14.6	3.9	42.8		0.0
BH-20,SPT-01, 1.50M	22.0	42.2	31.4	4.4	0.0	35.8		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-20,SPT-02, 3.00M	17.4	36.1	28.8	17.7	0.0	46.5		0.0
BH-20,SPT-04, 6.50M		50.7	37.1	12.2	0.0	49.3		0.0

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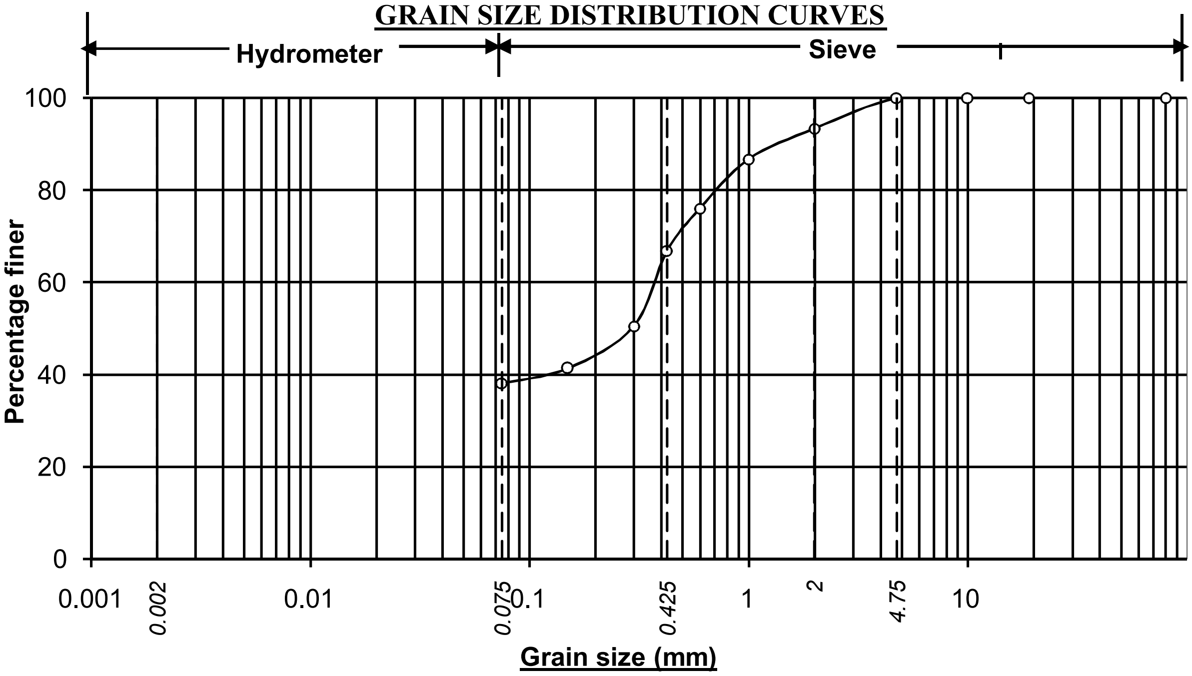
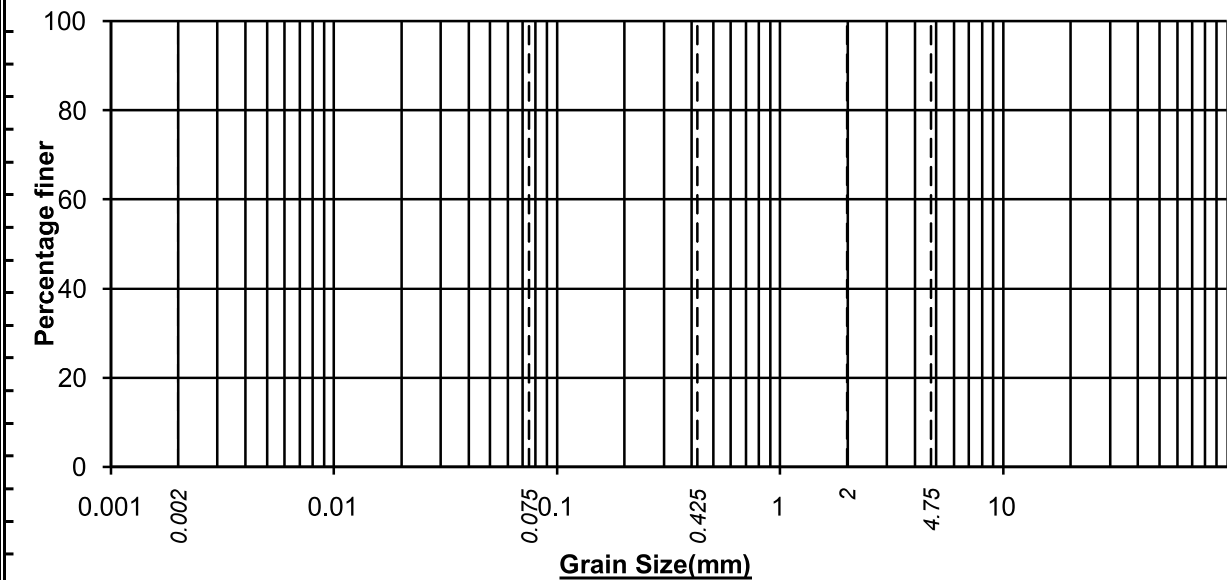


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-20,SPT-07, 11.00M		38.1	28.8	26.5	6.6	61.9		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

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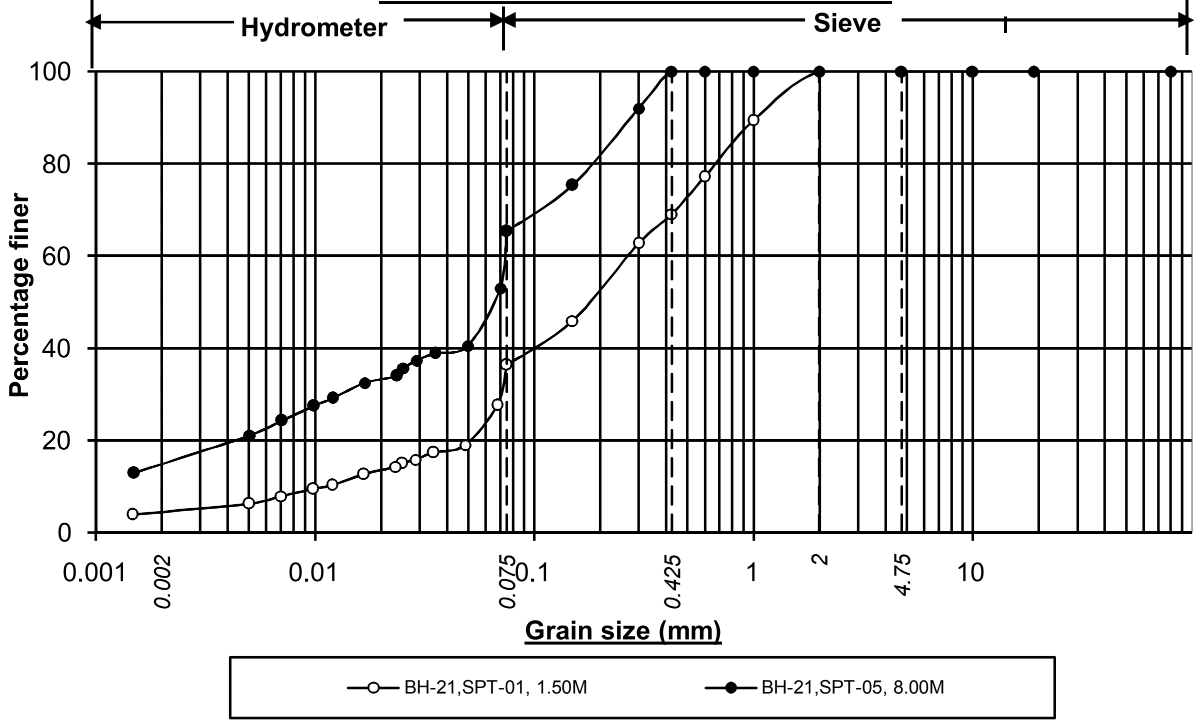
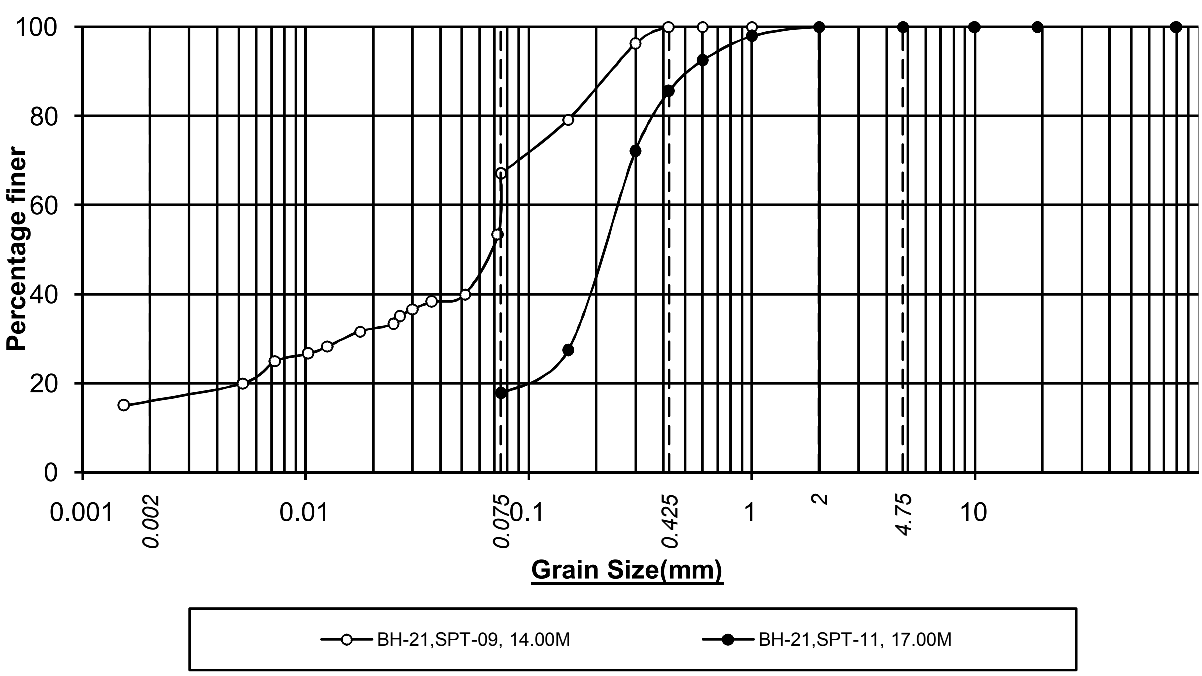


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-21,SPT-01, 1.50M	4.6	31.8	32.7	30.9	0.0	63.6		0.0
BH-21,SPT-05, 8.00M	14.9	50.5	34.6	0.0	0.0	34.6		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-21,SPT-09, 14.00M	16.0	51.0	33.0	0.0	0.0	33.0		0.0
BH-21,SPT-11, 17.00M		17.7	67.8	14.5	0.0	82.3		0.0

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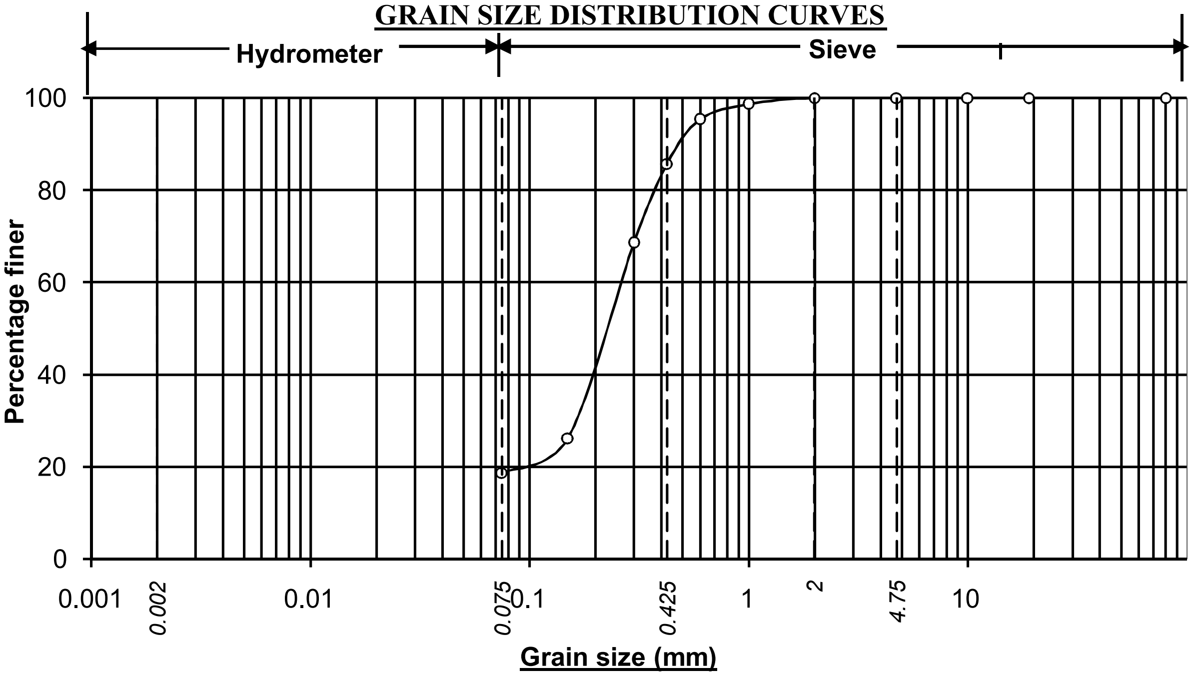
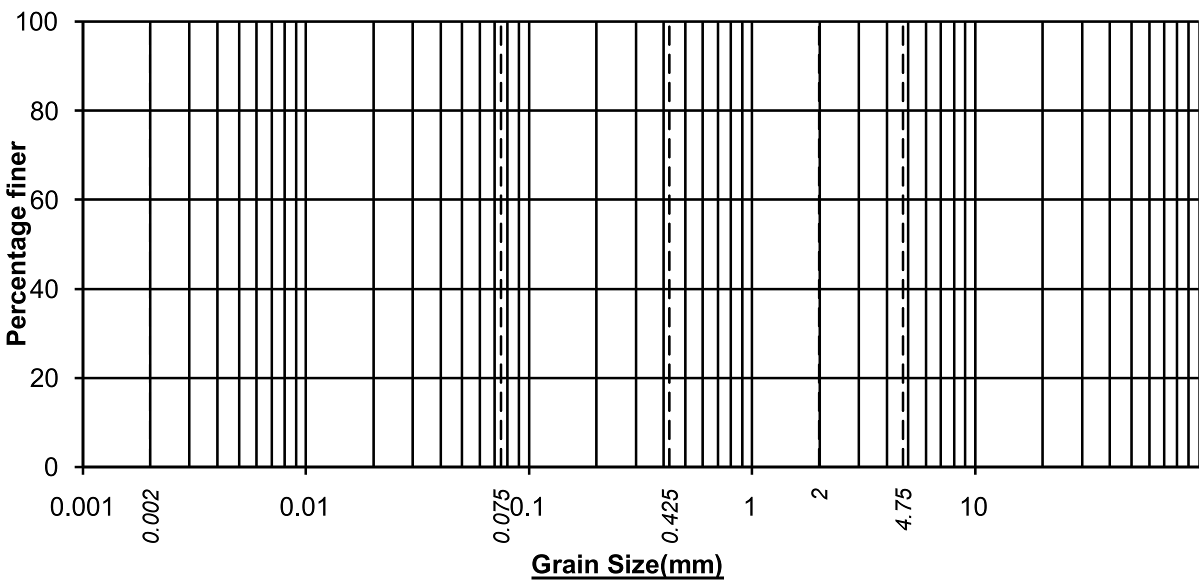


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-21,SPT-12, 18.50M		18.8	66.9	14.3	0.0	81.2		0.0



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

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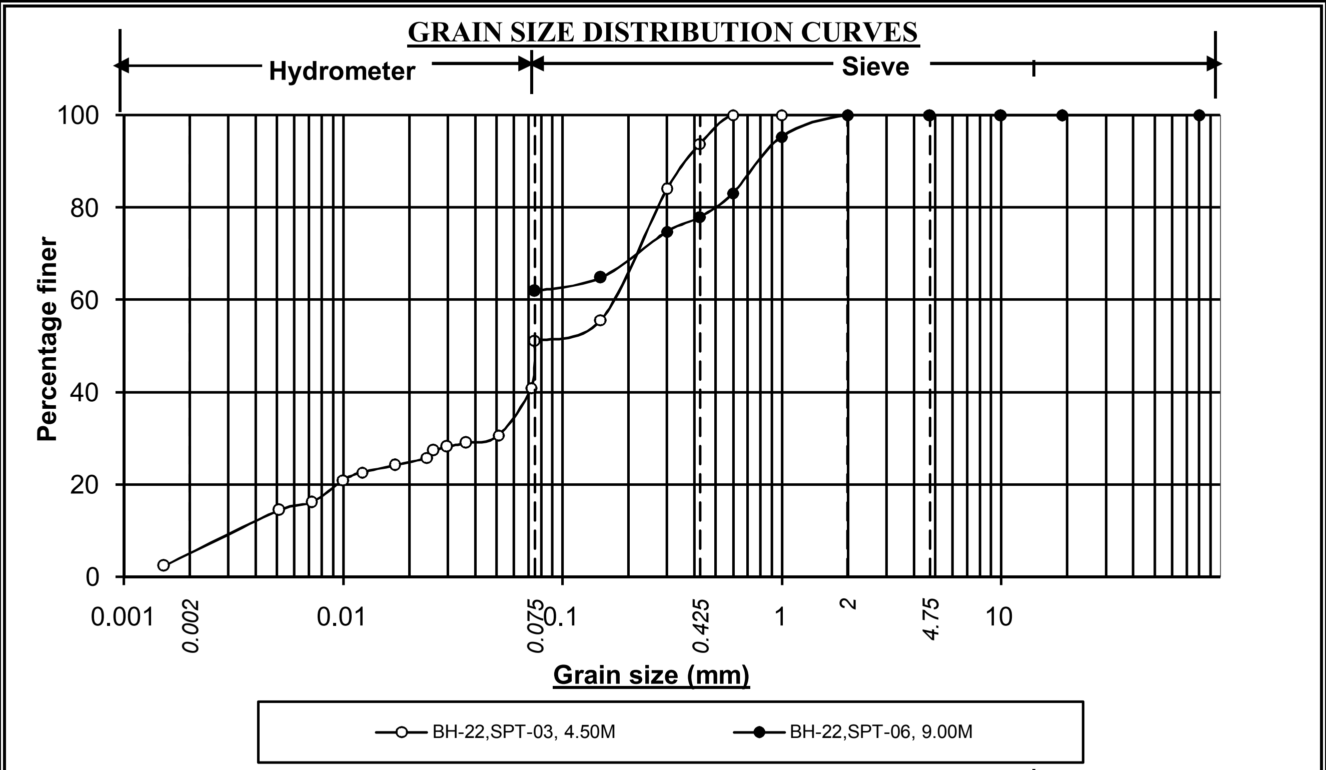
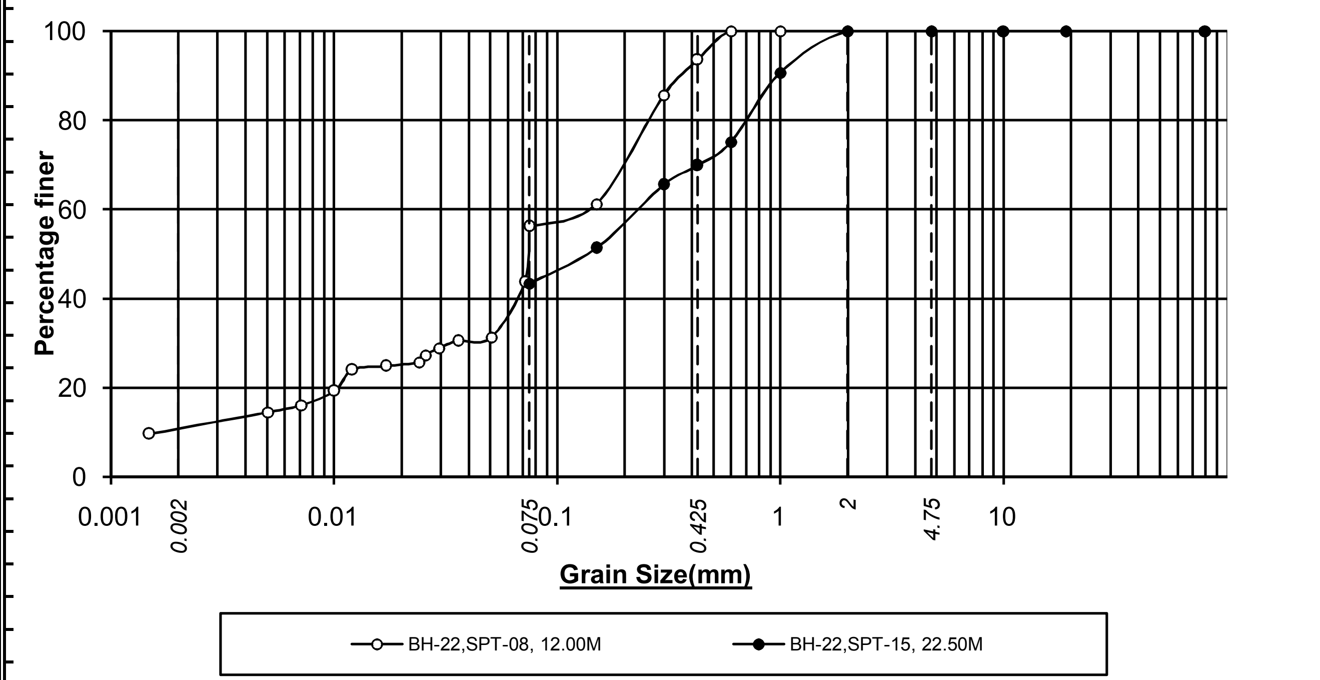


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-22,SPT-03, 4.50M	5.1	46.1	42.6	6.2	0.0	48.8		0.0
BH-22,SPT-06, 9.00M		62.0	15.9	22.1	0.0	38.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-22,SPT-08, 12.00M	10.8	45.4	37.4	6.4	0.0	43.8		0.0
BH-22,SPT-15, 22.50M		43.4	26.5	30.1	0.0	56.6		0.0

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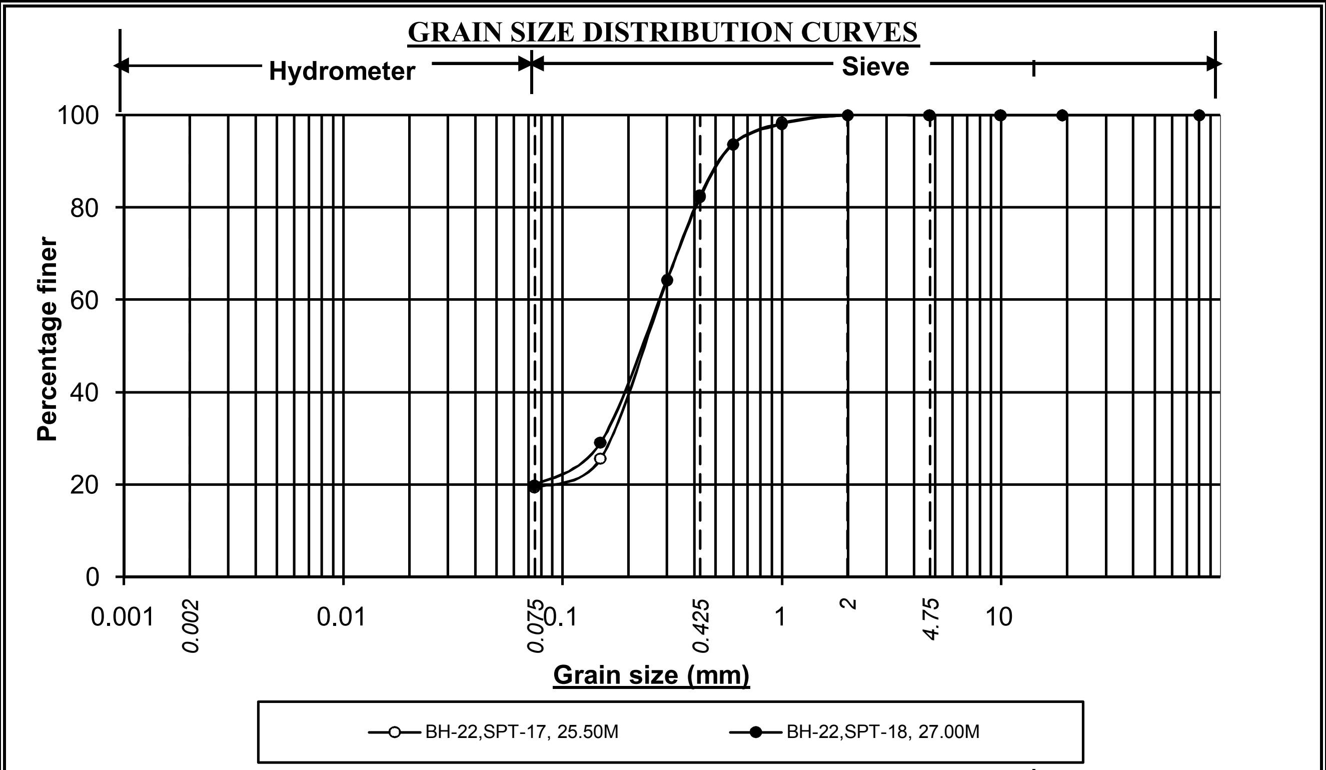
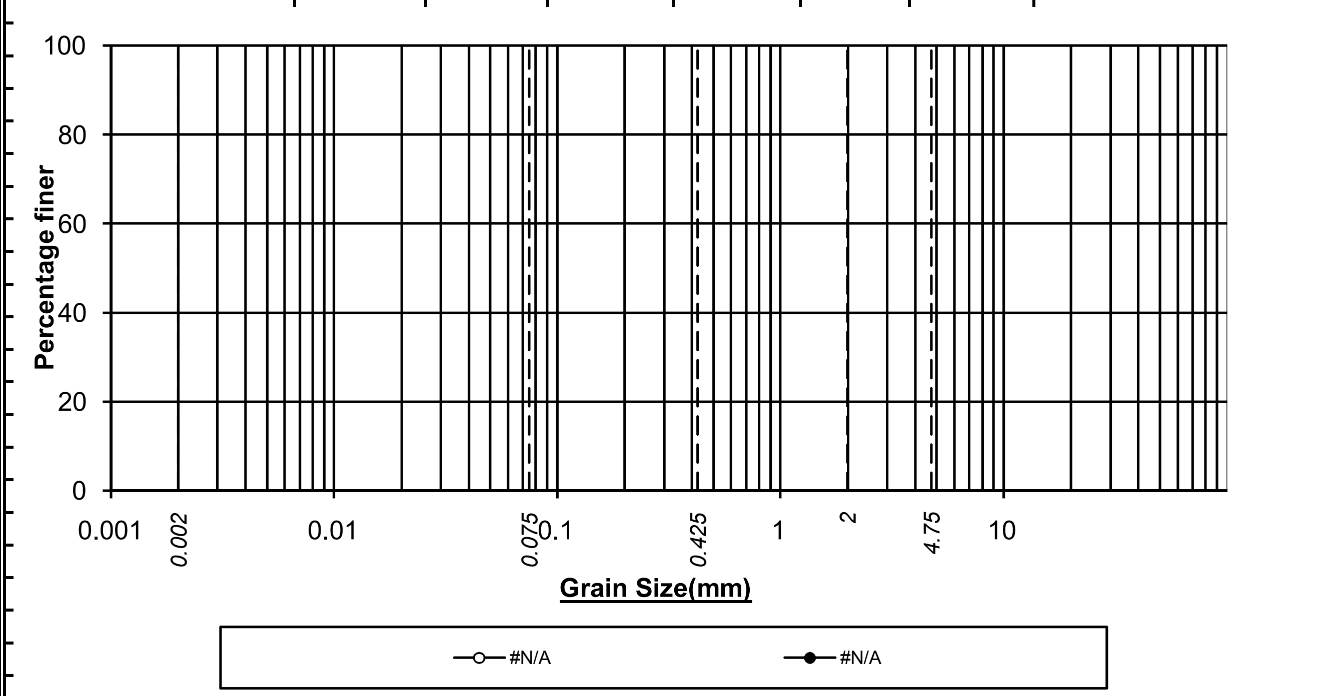


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-22,SPT-17, 25.50M		19.4	62.8	17.8	0.0	80.6		0.0
BH-22,SPT-18, 27.00M		19.9	62.6	17.5	0.0	80.1		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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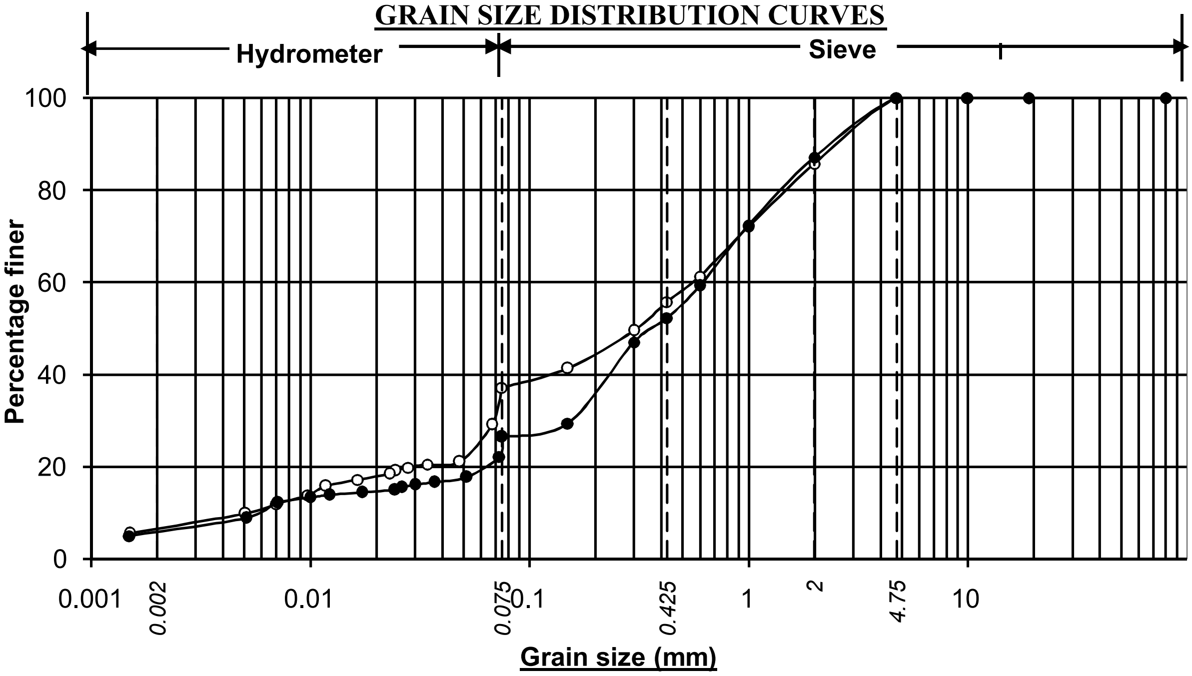
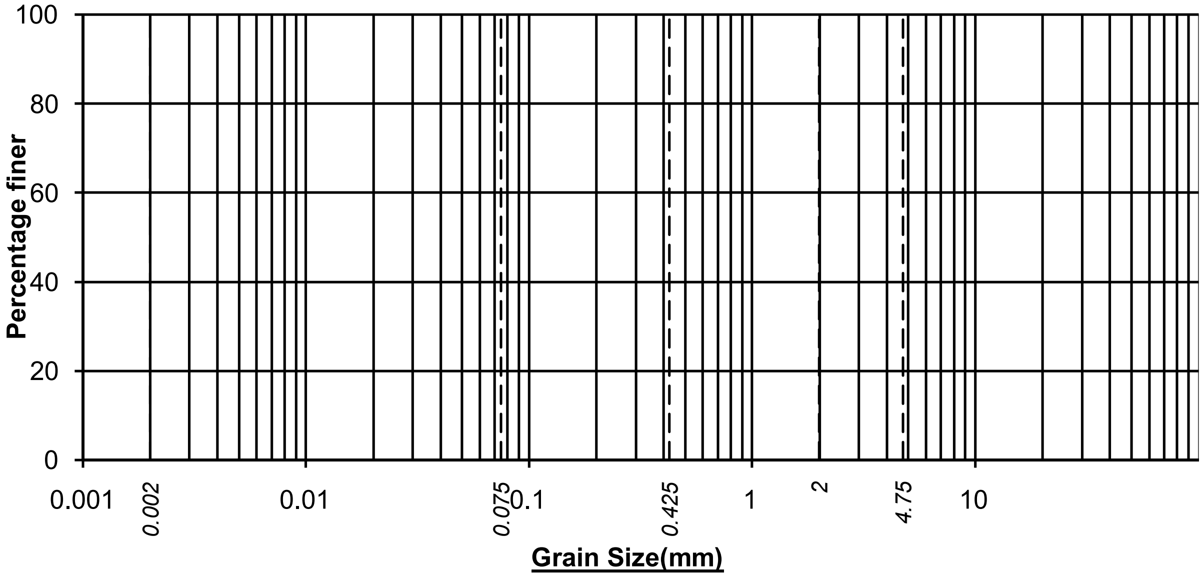
Sheet No.:



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-30,UDS-02, 4.00M	6.6	30.5	18.7	30.0	14.2	62.9		0.0
BH-30,DS-03, 5.50M	5.9	20.6	25.7	34.9	12.9	73.5	0.870	0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

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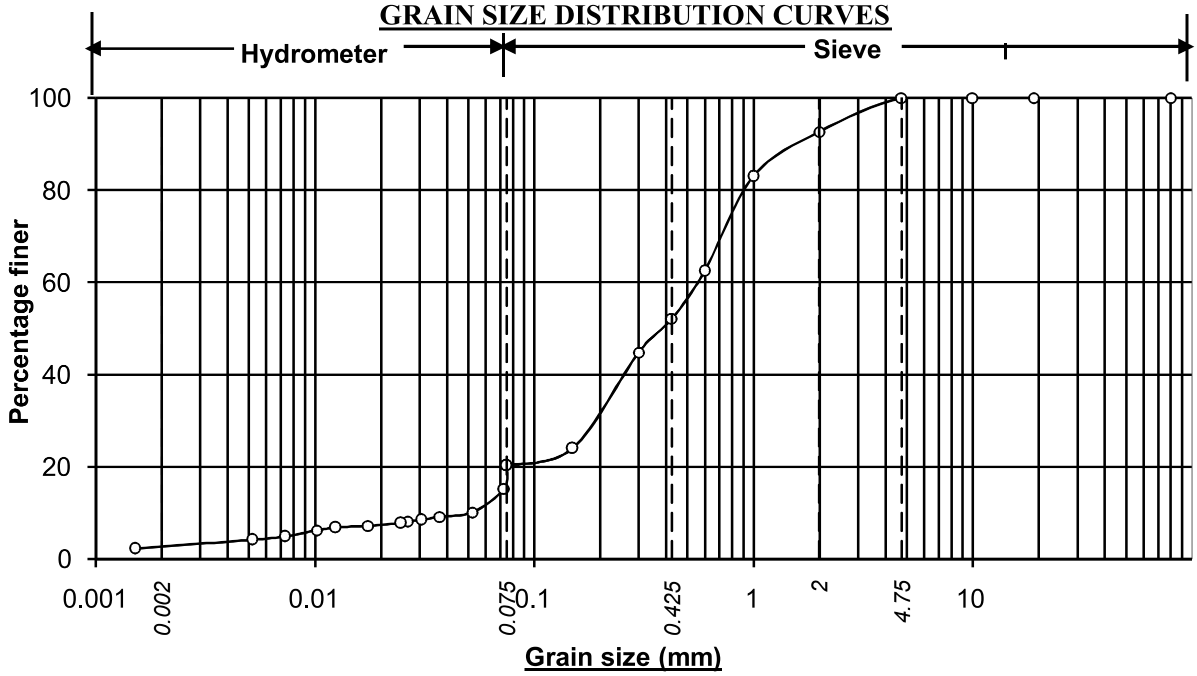
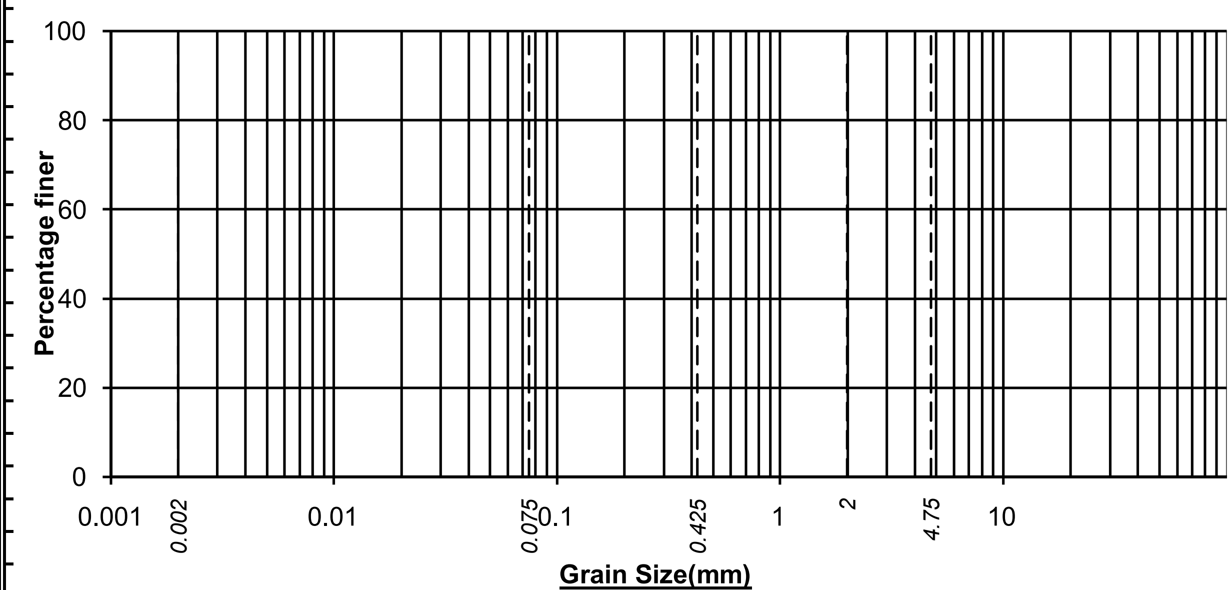
GRAIN SIZE DISTRIBUTION CURVES



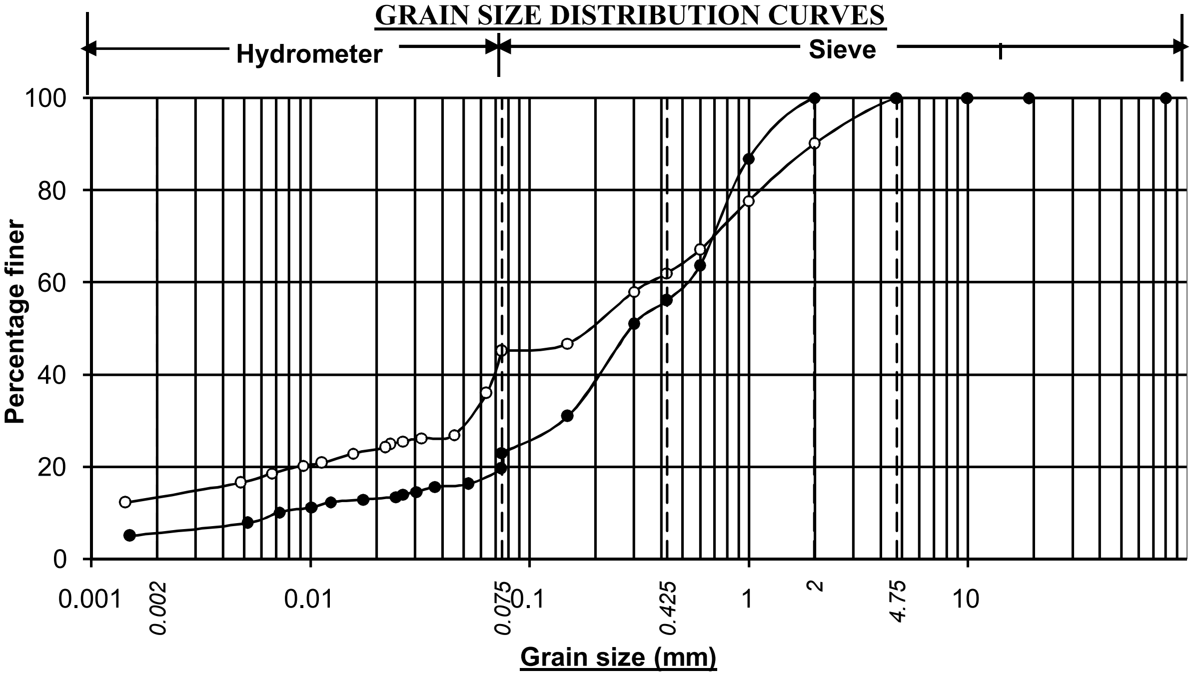
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-37,DS-01, 0.50M	2.7	17.6	31.9	40.5	7.3	79.7	0.697	0.0



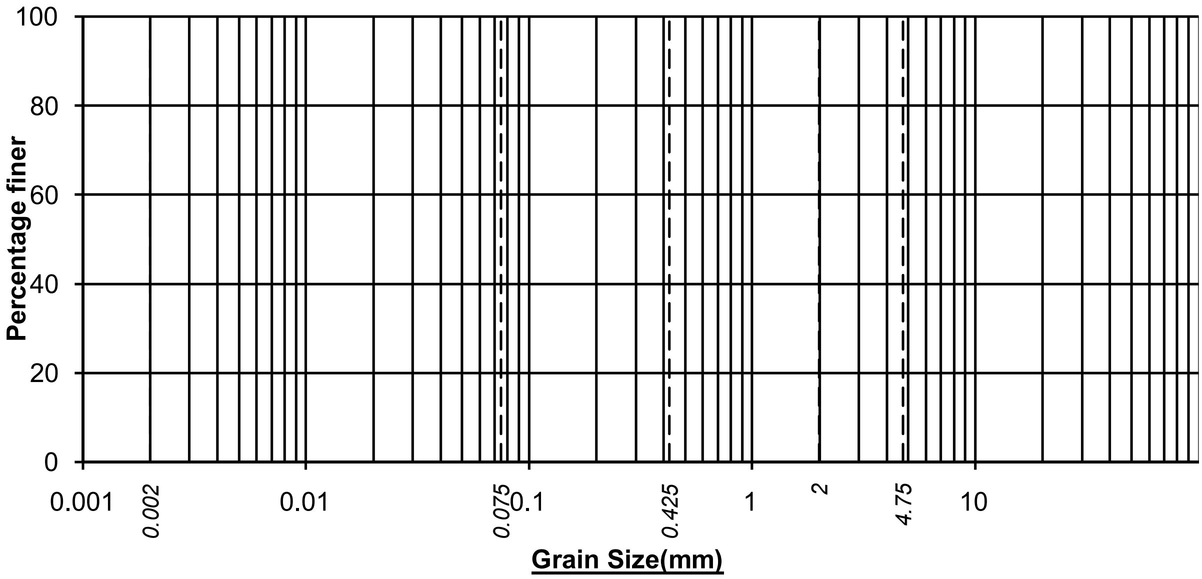
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-40,UDS-01, 2.05M	13.5	31.7	16.8	28.1	9.9	54.8		0.0
BH-40,DS-03, 5.00M	5.7	17.3	33.1	43.9	0.0	77.0	0.505	0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)

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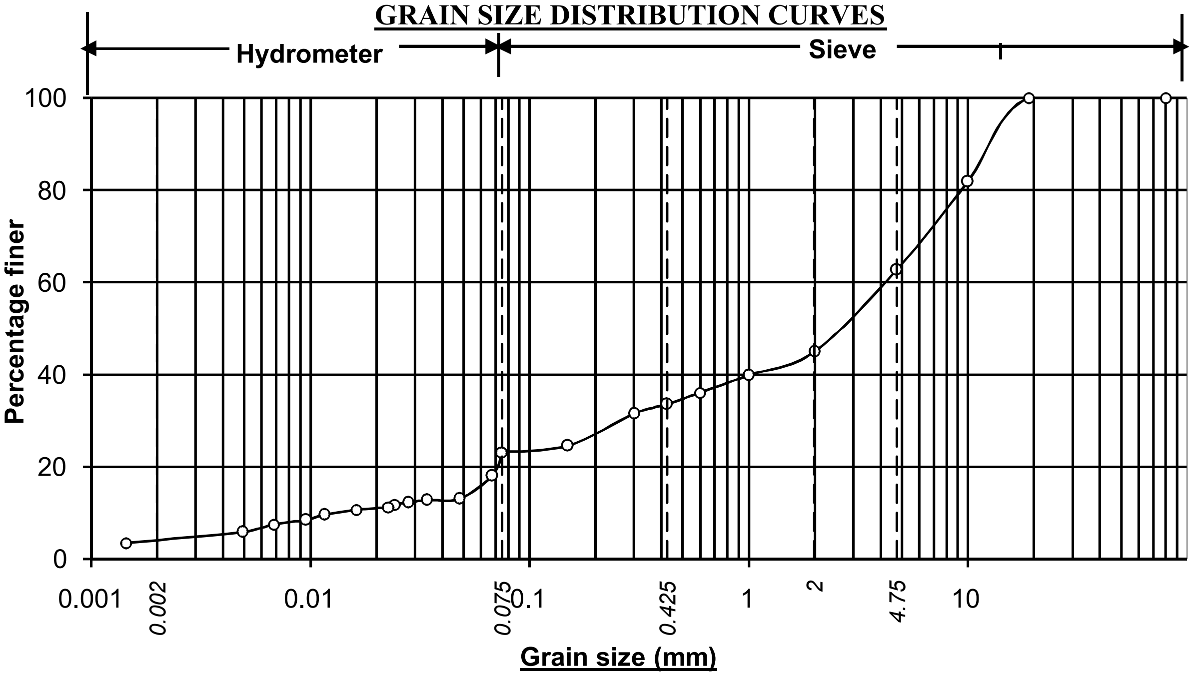
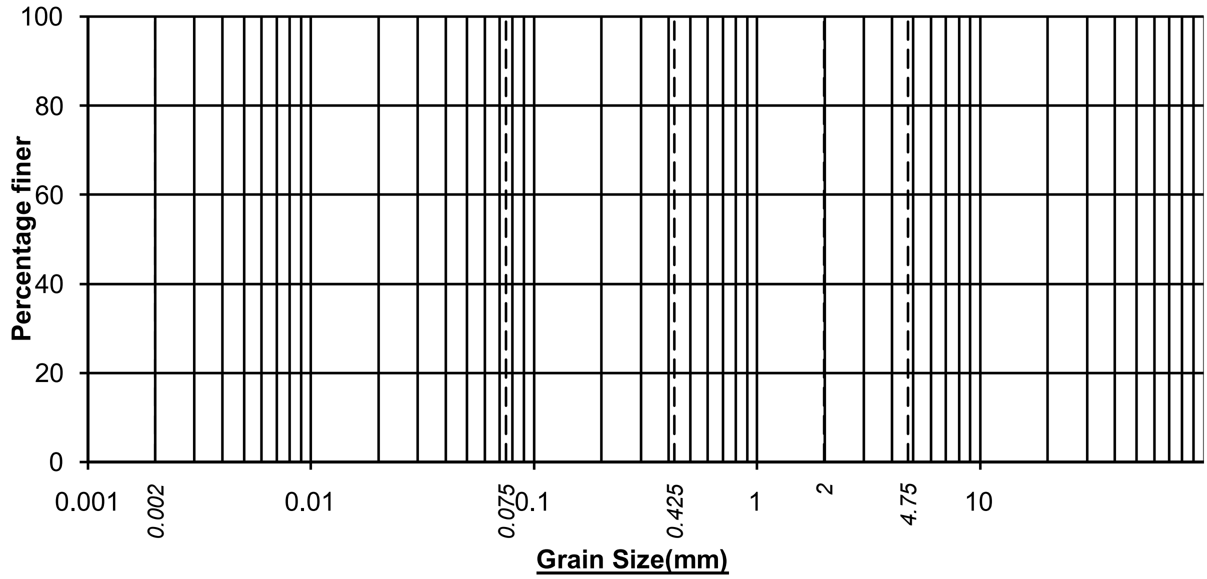
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Total sand	Weighted mean dia (mm)	Gravel (%)
BH-47,DS-01, 0.50M	4.1	19.0	10.5	11.4	17.8	39.7	2.524	37.2



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Total sand	Weighted mean dia (mm)	Gravel (%)

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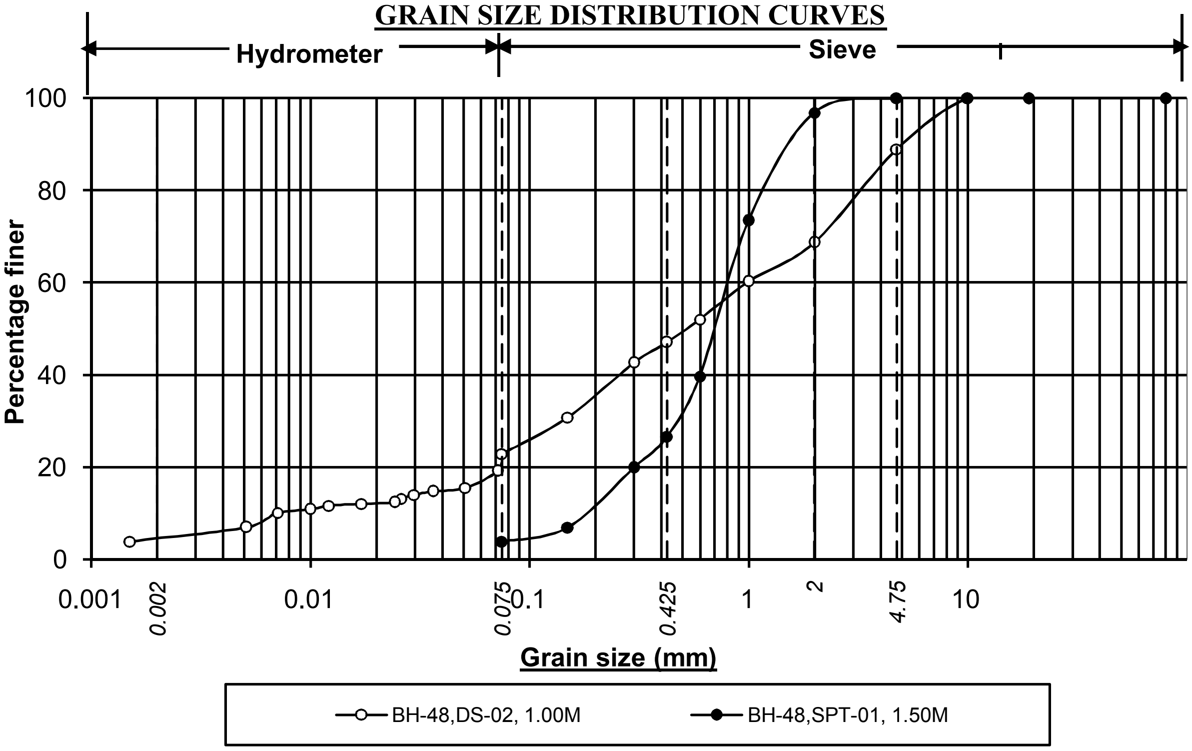
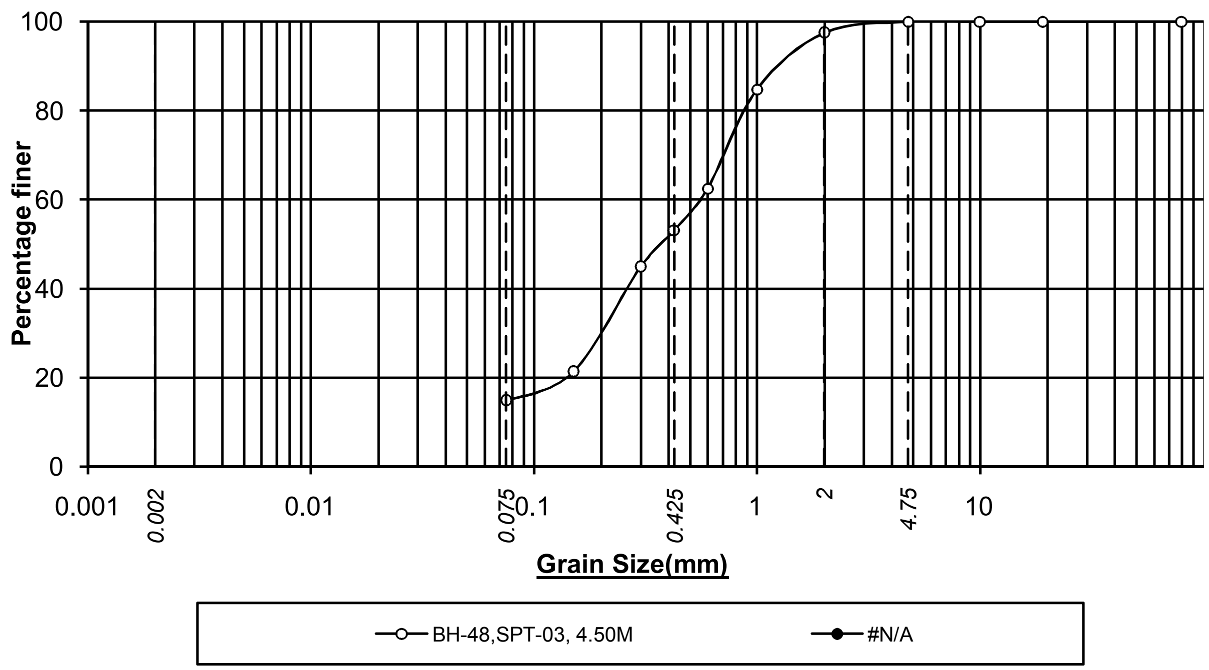
GRAIN SIZE DISTRIBUTION CURVES



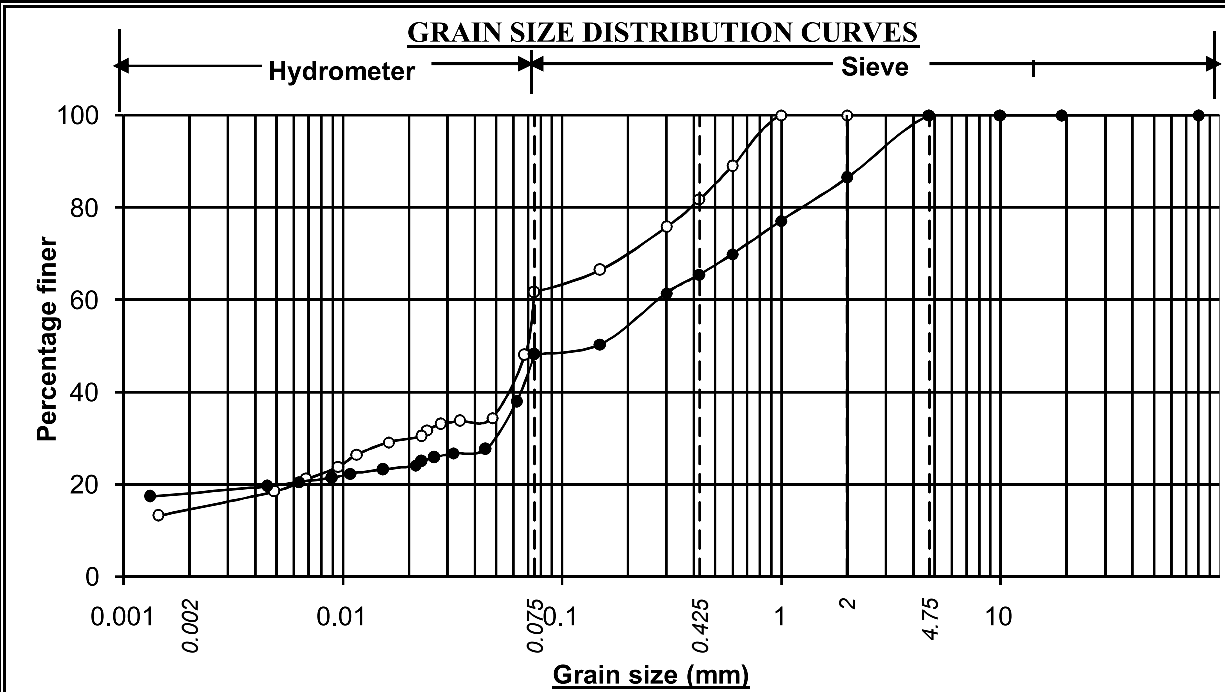
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-48,DS-02, 1.00M	4.6	18.3	24.3	21.6	20.1	66.0	1.489	11.1
BH-48,SPT-01, 1.50M		3.9	22.7	70.2	3.2	96.1	0.853	0.0



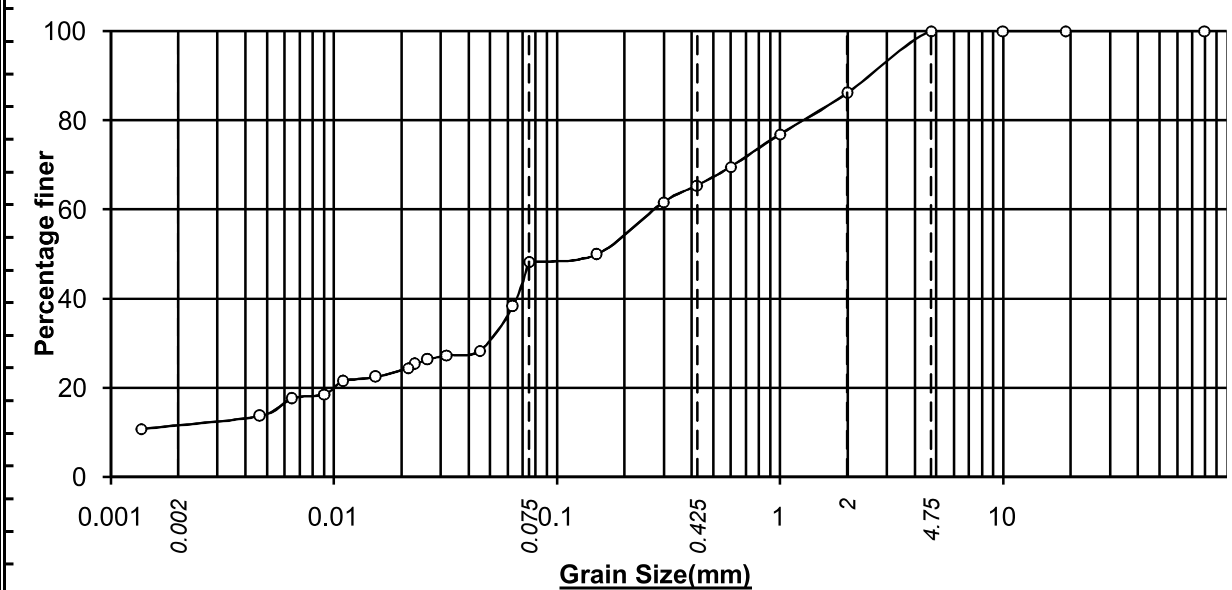
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-48,SPT-03, 4.50M		14.8	38.4	44.3	2.5	85.2	0.599	0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-49,SPT-01, 1.00M	14.7	47.0	20.1	18.2	0.0	38.3		0.0
BH-49,UDS-01, 2.50M	18.2	30.0	17.3	21.0	13.5	51.8		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-49,SPT-04, 5.70M	11.6	36.6	17.1	20.8	13.9	51.8		0.0

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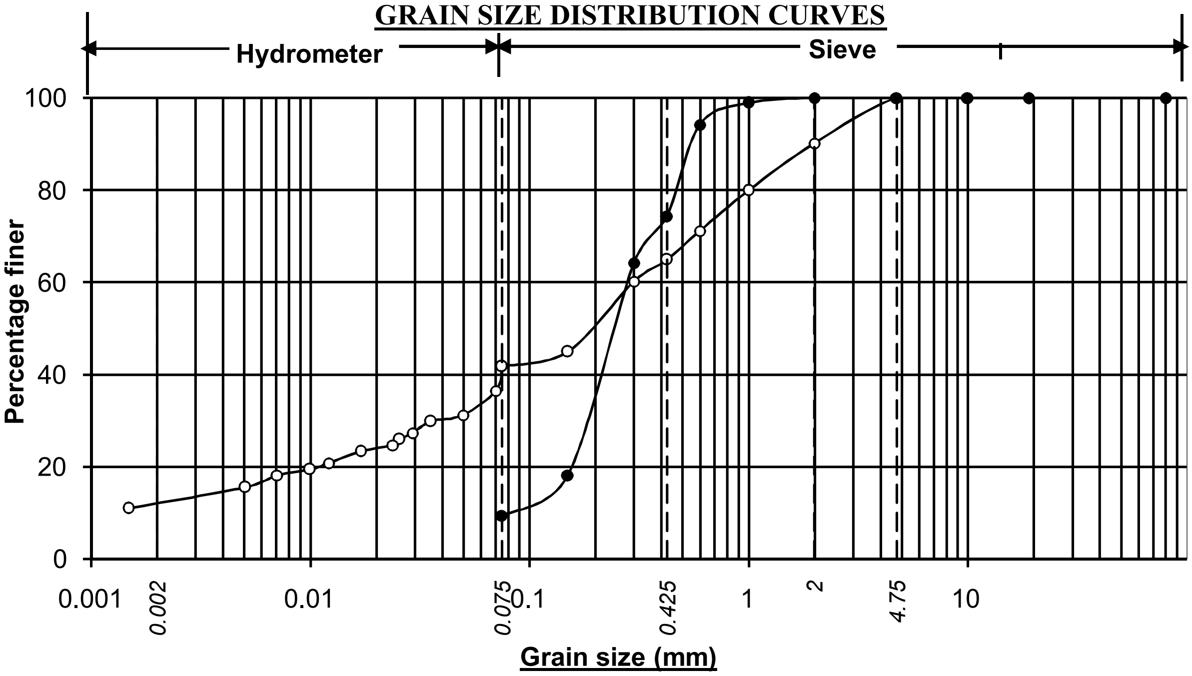
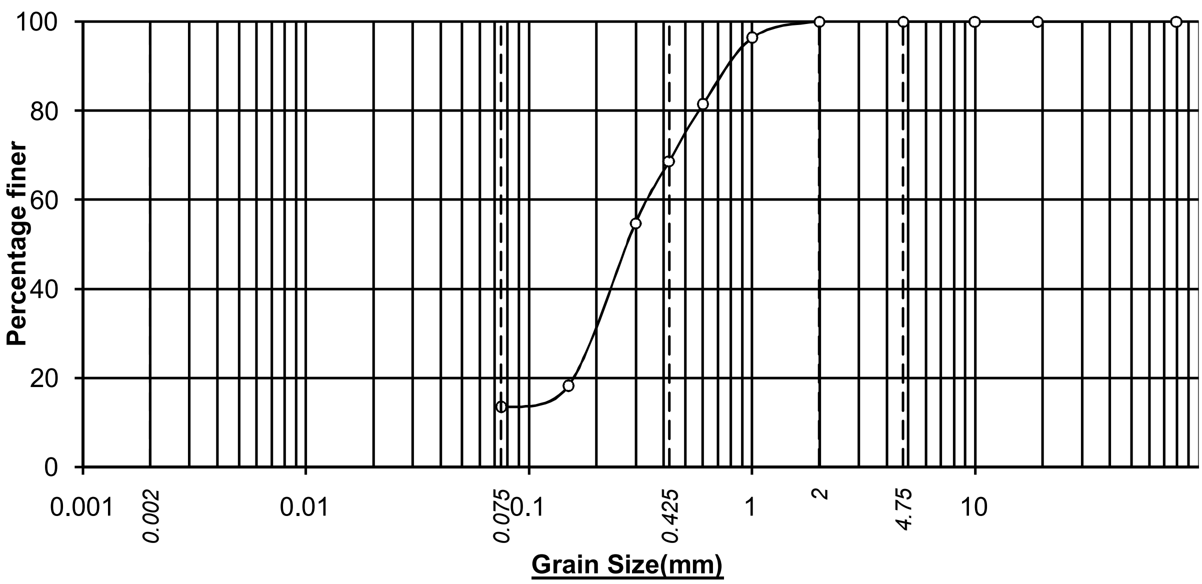
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-50,DS-01, 0.50M	12.1	29.7	23.2	25.2	9.8	58.2		0.0
BH-50,DS-02, 1.00M		9.4	64.9	25.7	0.0	90.6	0.310	0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-50,SPT-01, 1.30M		13.4	55.3	31.3	0.0	86.6	0.384	0.0

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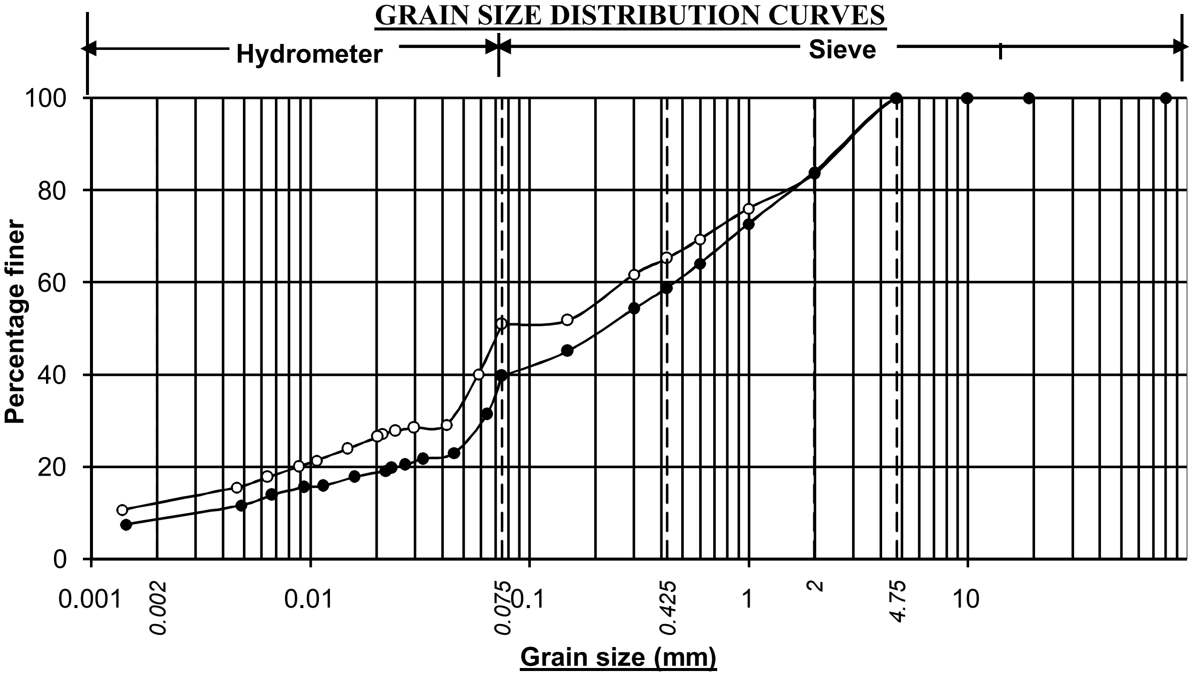
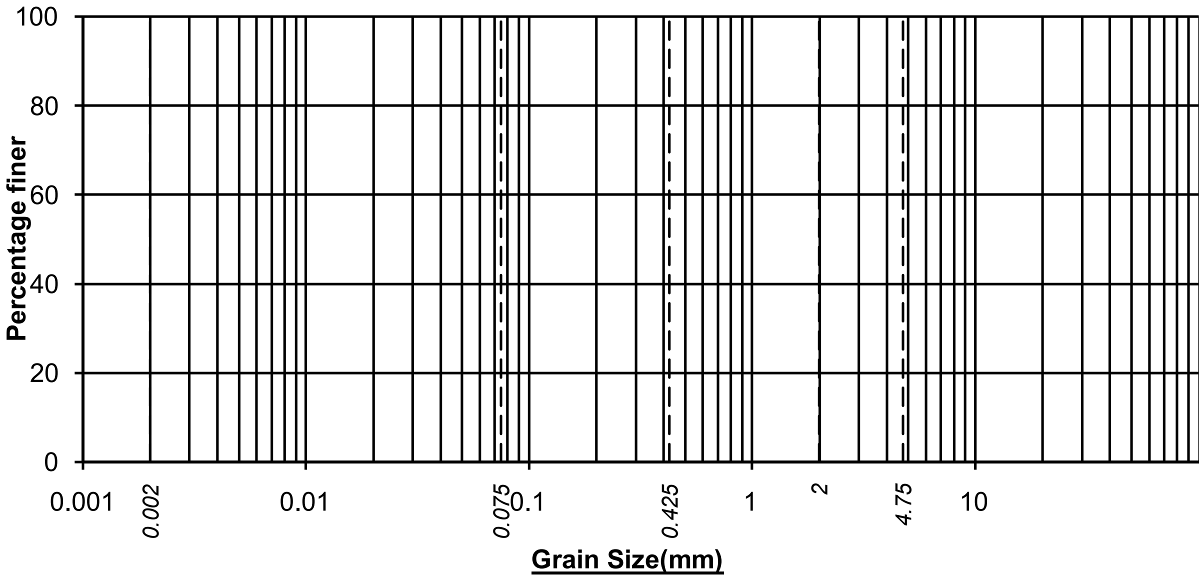


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-51,DS-02, 1.00M	12.2	38.8	14.3	18.3	16.4	49.0		0.0
BH-51,SPT-01, 1.50M	8.6	31.2	19.0	25.1	16.1	60.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)

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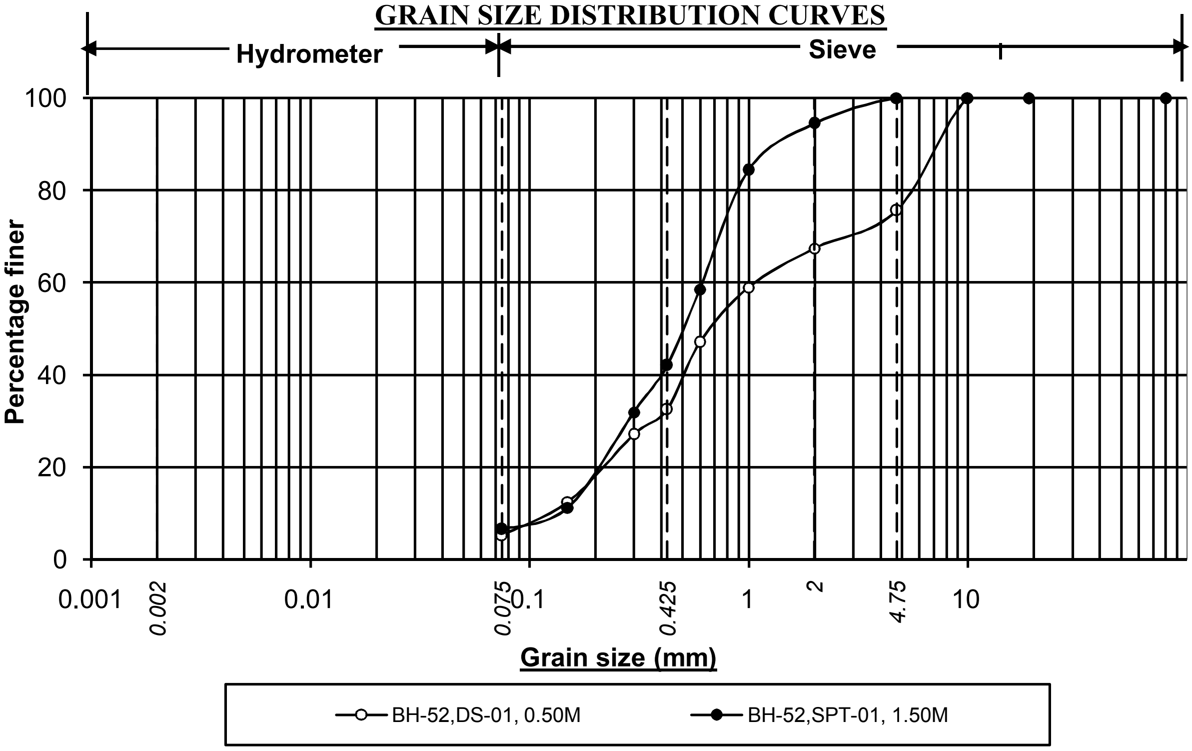
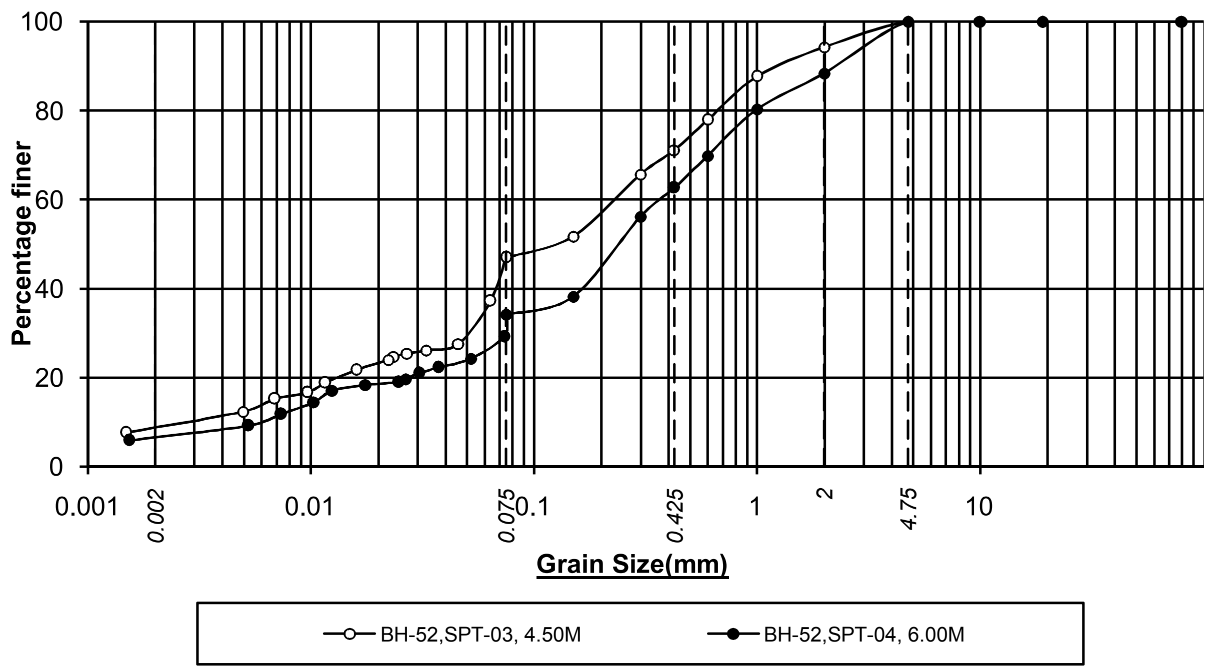
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-52,DS-01, 0.50M		5.2	27.3	34.8	8.3	70.4	1.795	24.4
BH-52,SPT-01, 1.50M		6.6	35.5	52.4	5.5	93.4	0.720	0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-52,SPT-03, 4.50M	8.8	38.2	24.1	23.2	5.7	53.0		0.0
BH-52,SPT-04, 6.00M	6.6	27.6	28.4	25.7	11.7	65.8		0.0

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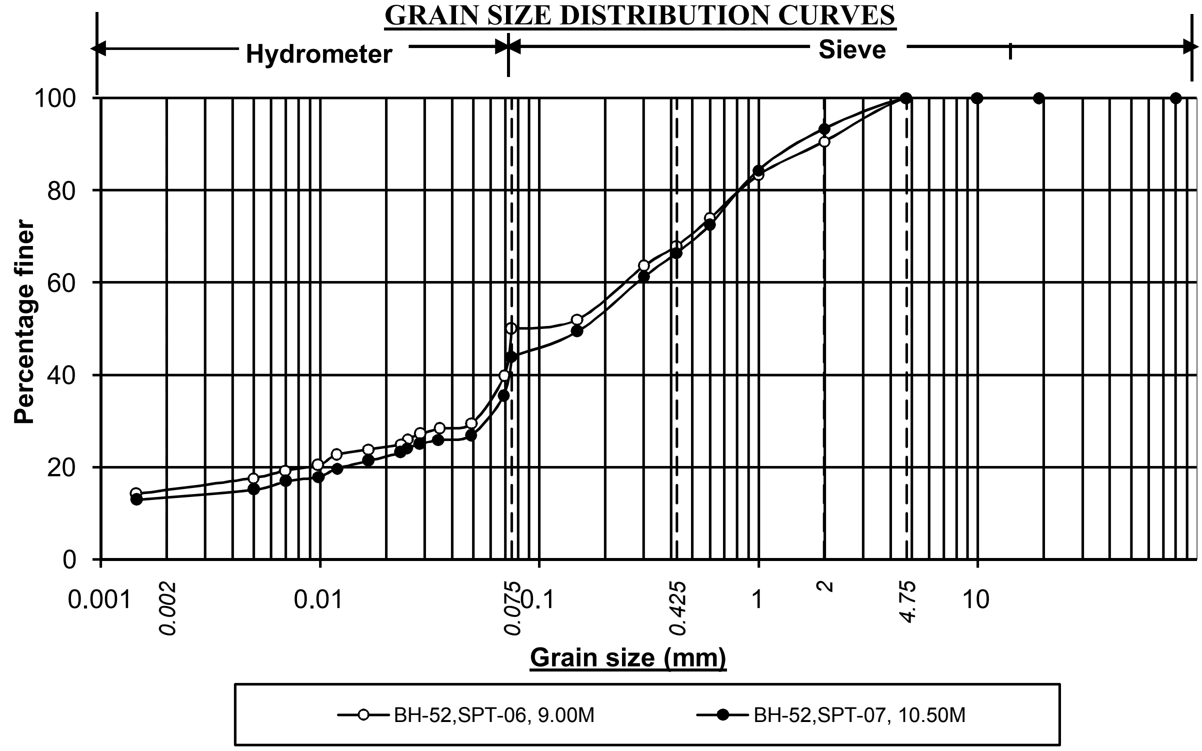
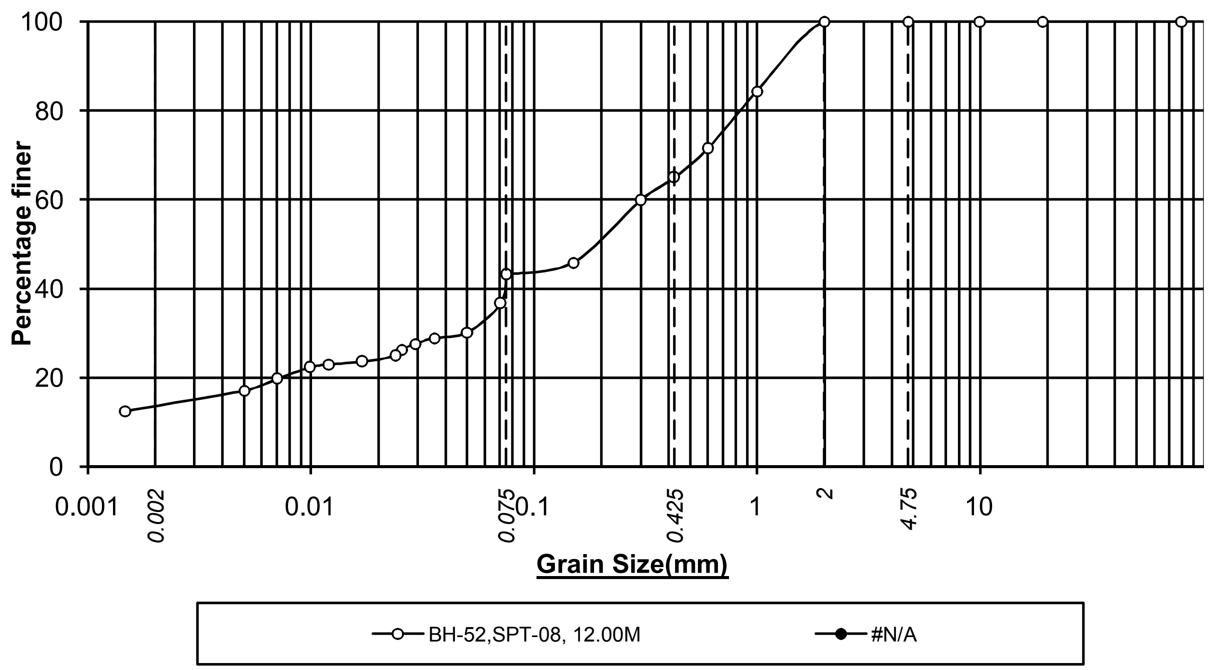


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-52,SPT-06, 9.00M	15.1	34.9	18.0	22.6	9.4	50.0		0.0
BH-52,SPT-07, 10.50M	13.5	30.5	22.4	26.9	6.7	56.0		0.0



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-52,SPT-08, 12.00M	13.6	29.6	21.8	35.0	0.0	56.8		0.0

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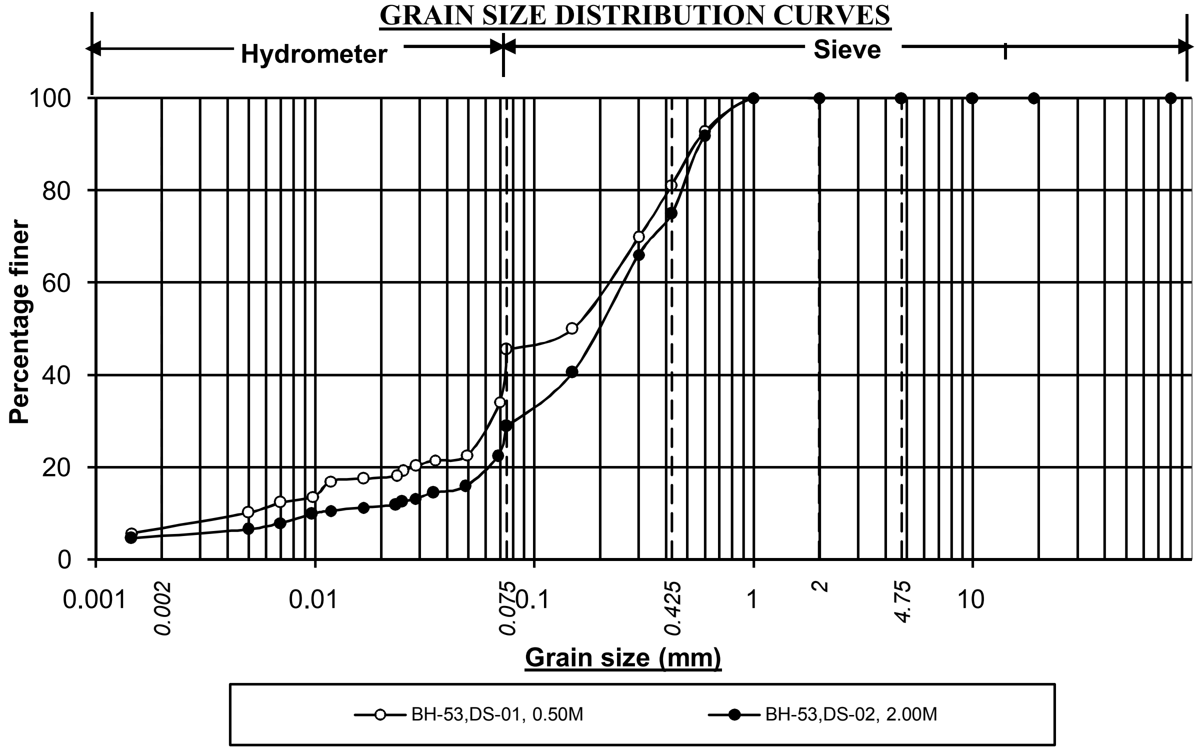
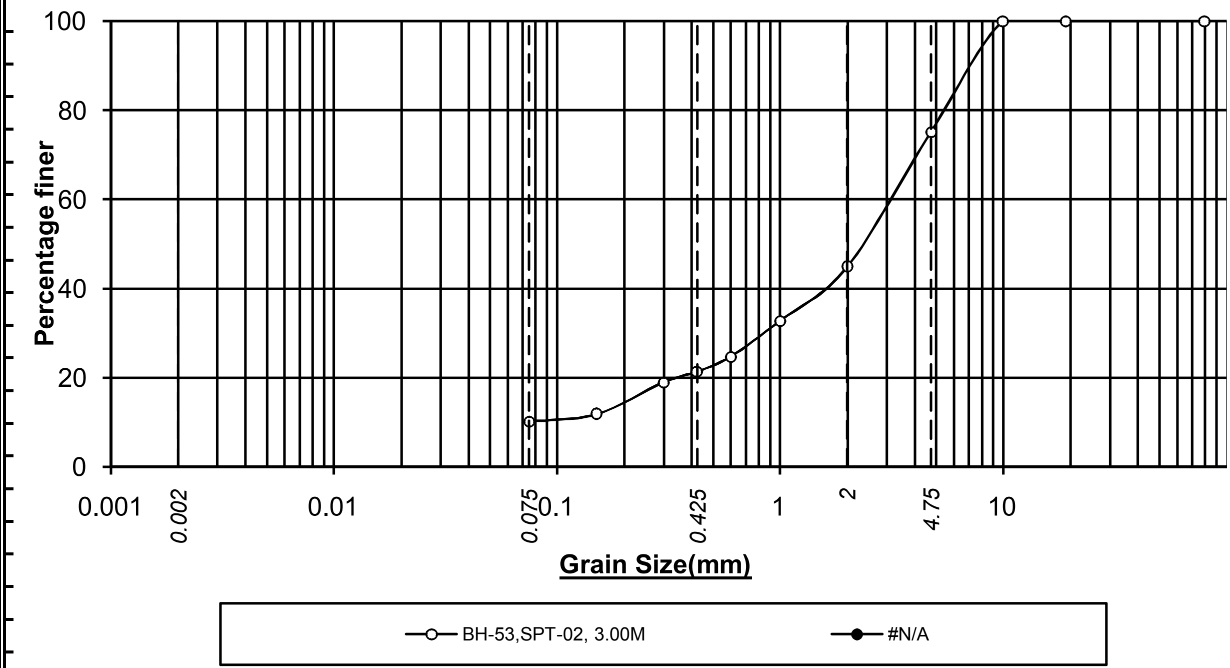


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-53,DS-01, 0.50M	6.8	38.8	35.5	18.9	0.0	54.4		0.0
BH-53,DS-02, 2.00M	5.1	23.8	46.1	25.0	0.0	71.1		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-53,SPT-02, 3.00M		10.2	11.2	23.5	30.3	65.0		24.8

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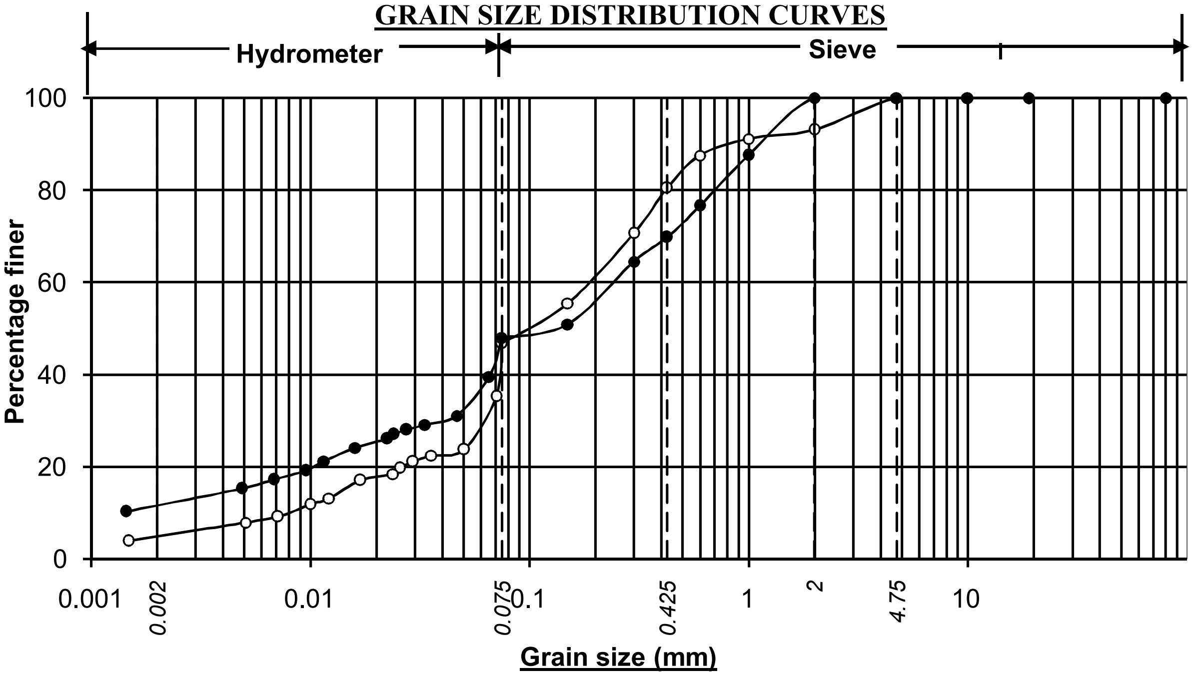
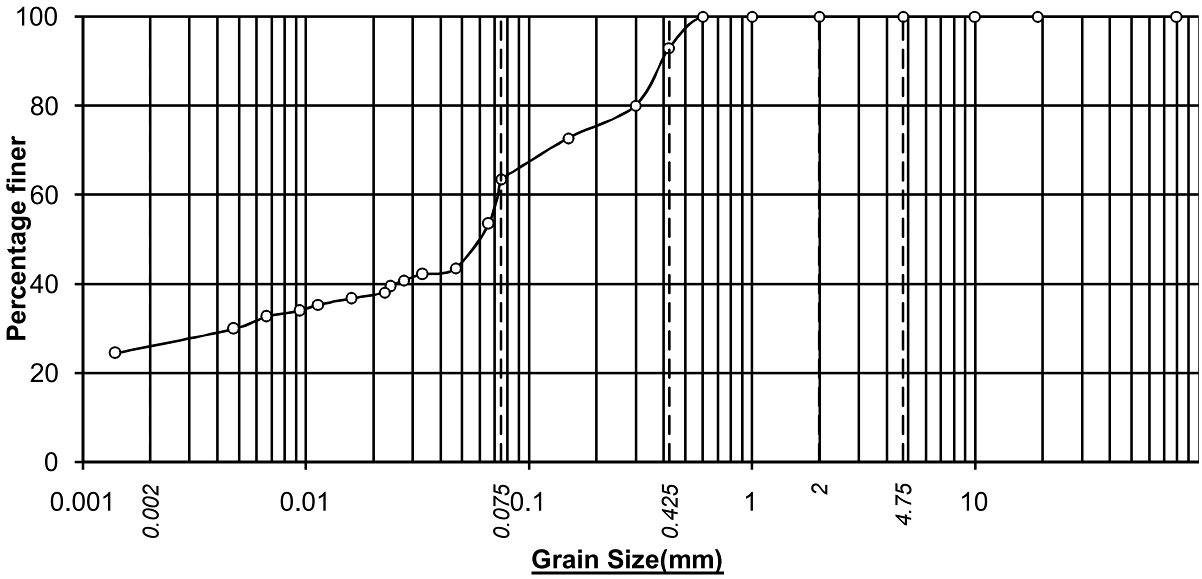


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-54,SPT-01, 1.00M	4.9	41.9	33.7	12.7	6.8	53.2		0.0
BH-54,UDS-01, 2.50M	11.7	36.3	21.9	30.1	0.0	52.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-54,SPT-02, 2.95M	26.0	37.5	29.5	7.0	0.0	36.5		0.0

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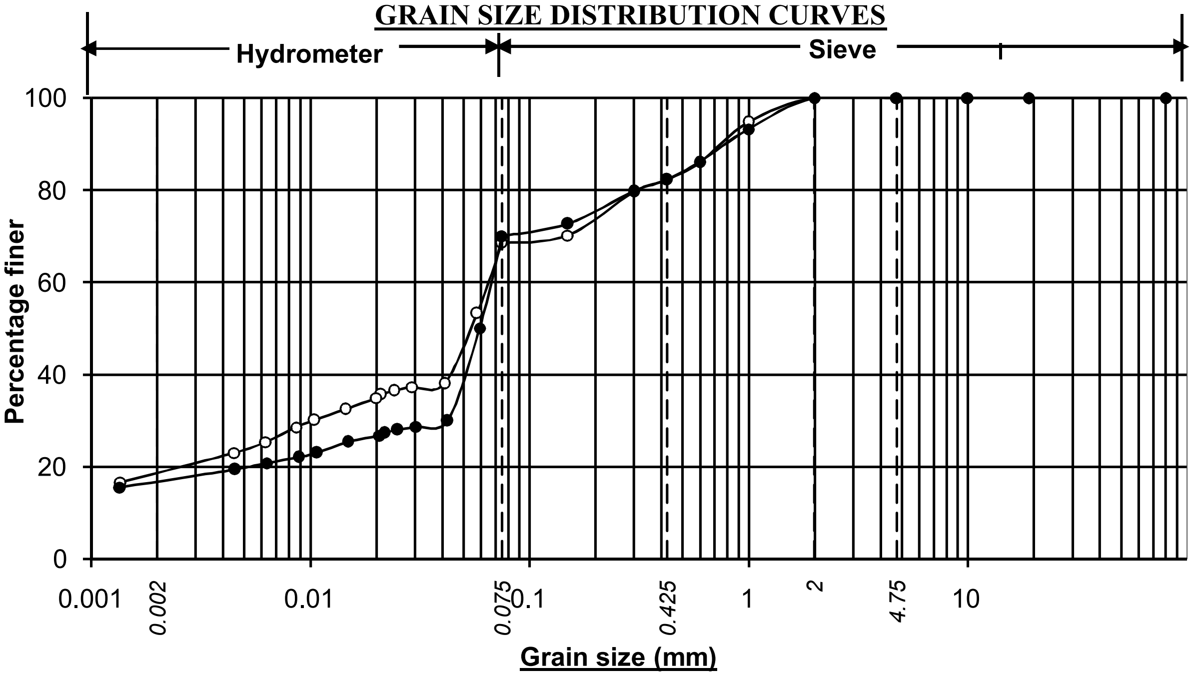
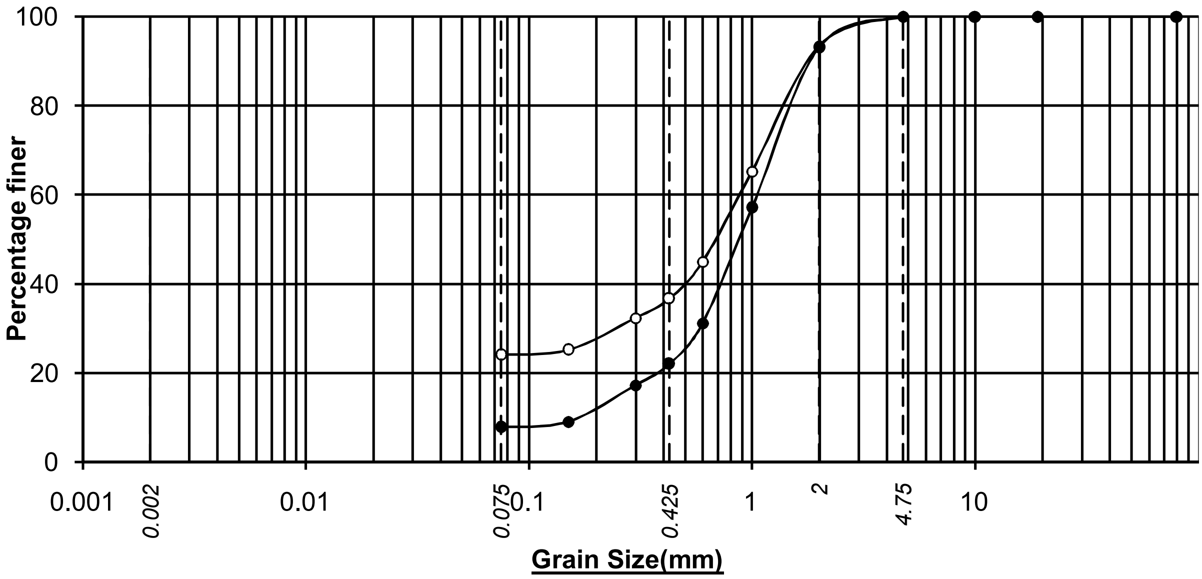


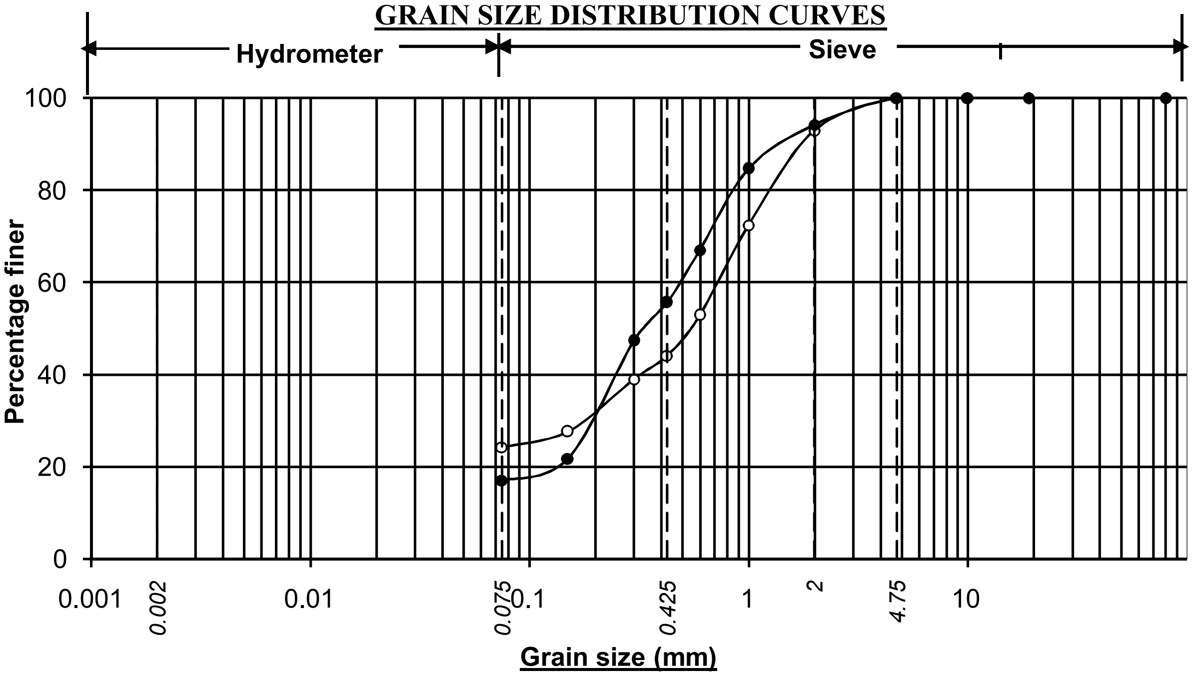
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-55,SPT-01, 1.50M	18.7	49.9	13.7	17.7	0.0	31.4		0.0
BH-55,UDS-01, 2.55M	16.8	53.3	12.2	17.7	0.0	29.9		0.0



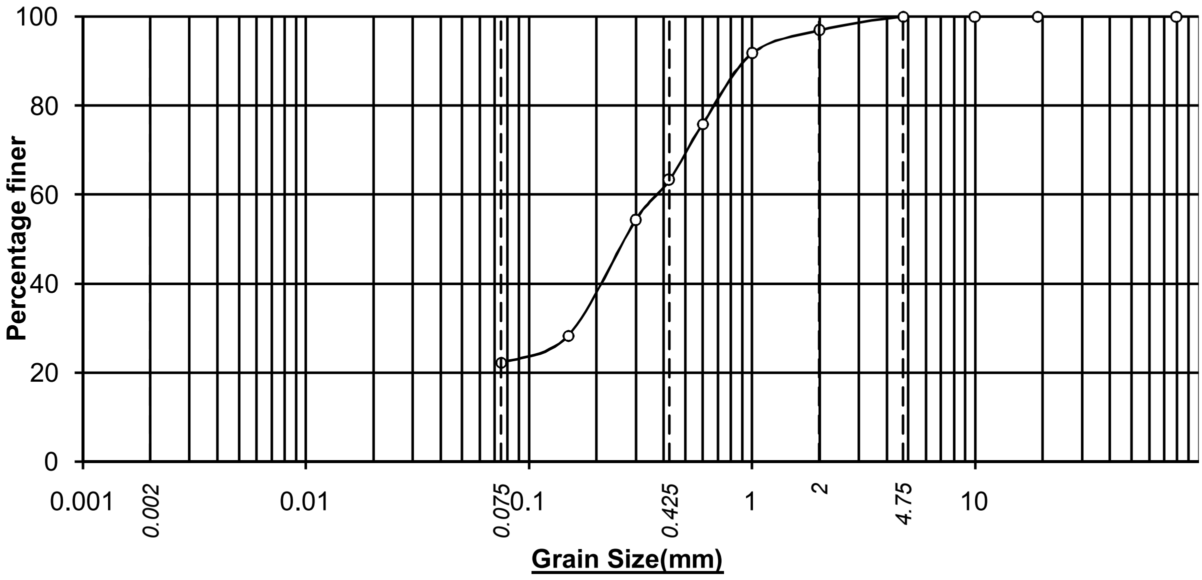
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-55,DS-06, 8.50M		24.0	12.6	56.8	6.6	76.0		0.0
BH-55,SPT-06, 9.00M		7.8	14.2	71.1	6.9	92.2		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-56,DS-02, 1.00M		24.3	19.7	48.9	7.1	75.7		0.0
BH-56,SPT-01, 1.50M		17.1	38.6	38.5	5.8	82.9		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-56,DS-03, 2.50M		22.2	41.0	33.7	3.1	77.8	0.482	0.0
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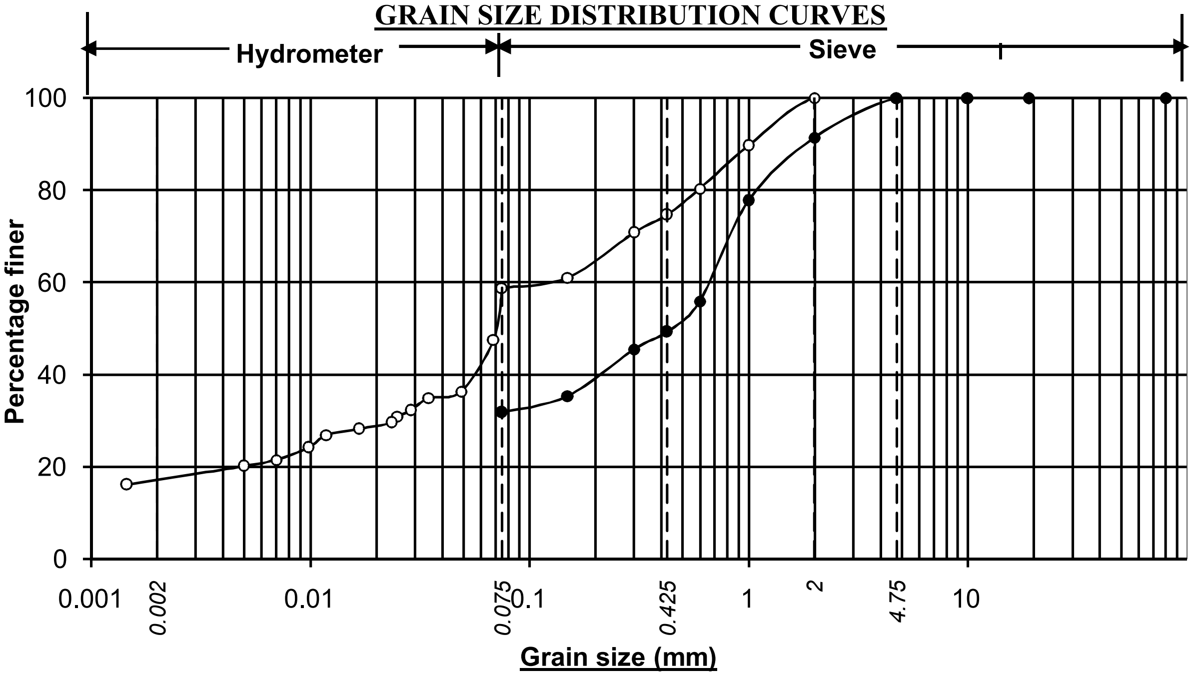
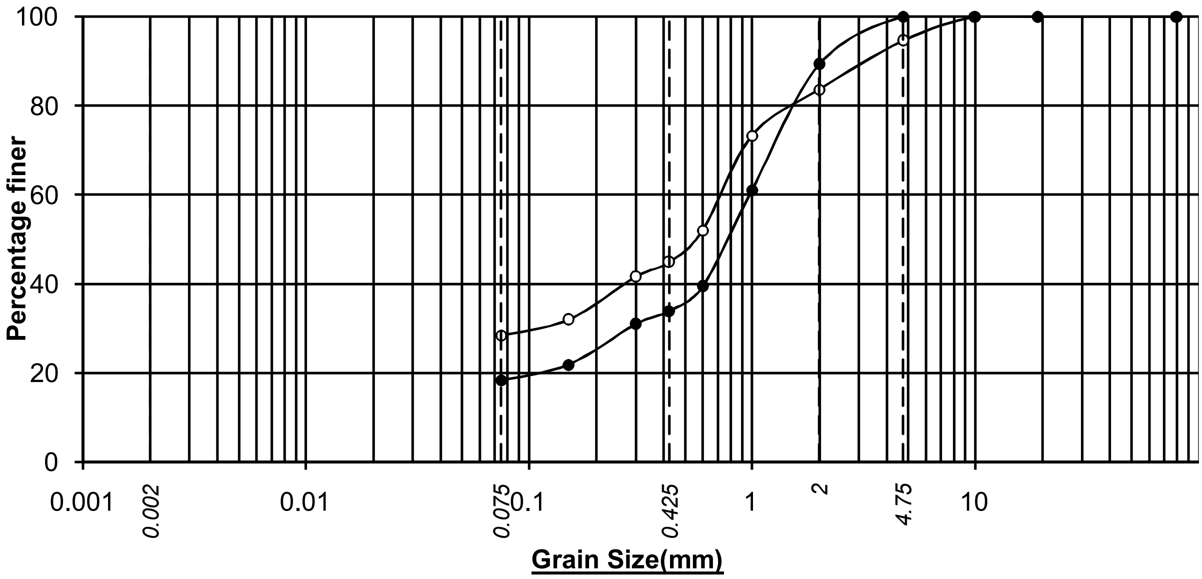
Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-57,DS-02, 1.00M	17.2	41.7	15.8	25.3	0.0	41.1		0.0
BH-57,SPT-02, 3.00M		31.8	17.5	42.1	8.6	68.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-57,SPT-03, 4.50M		28.4	16.4	38.8	11.0	66.2		5.4
BH-57,SPT-04, 6.00M		18.3	15.6	55.4	10.7	81.7		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

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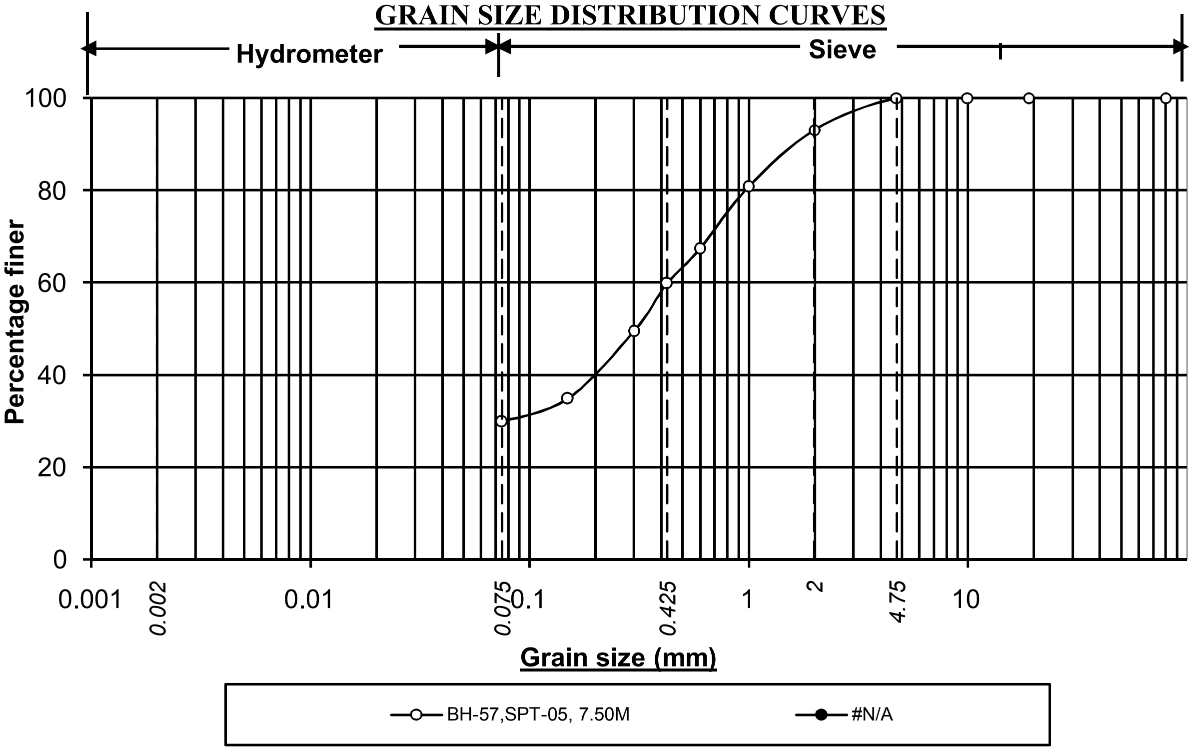
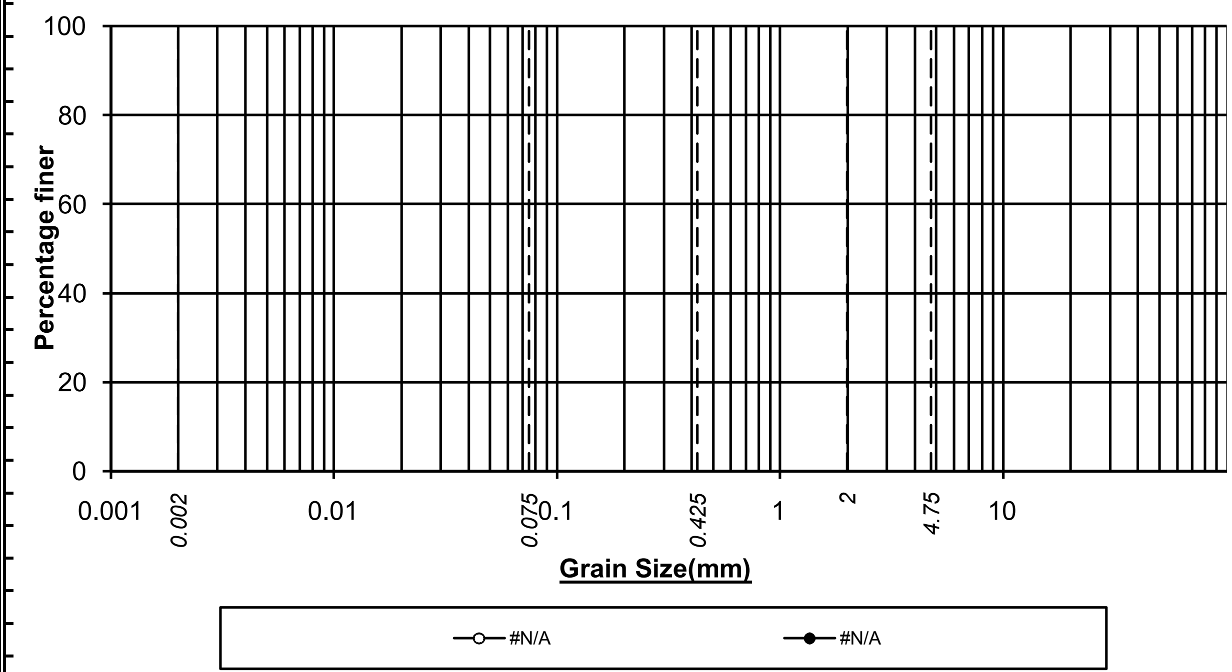
GRAIN SIZE DISTRIBUTION CURVES



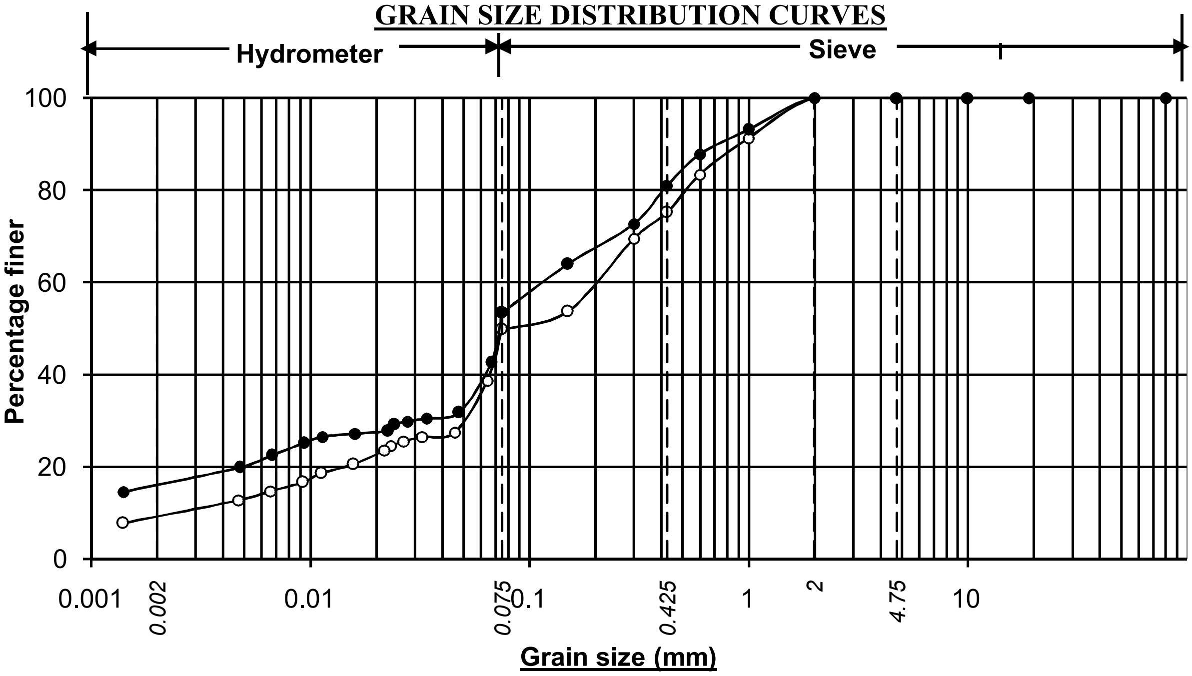
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-57,SPT-05, 7.50M		29.9	30.0	33.2	6.9	70.1		0.0



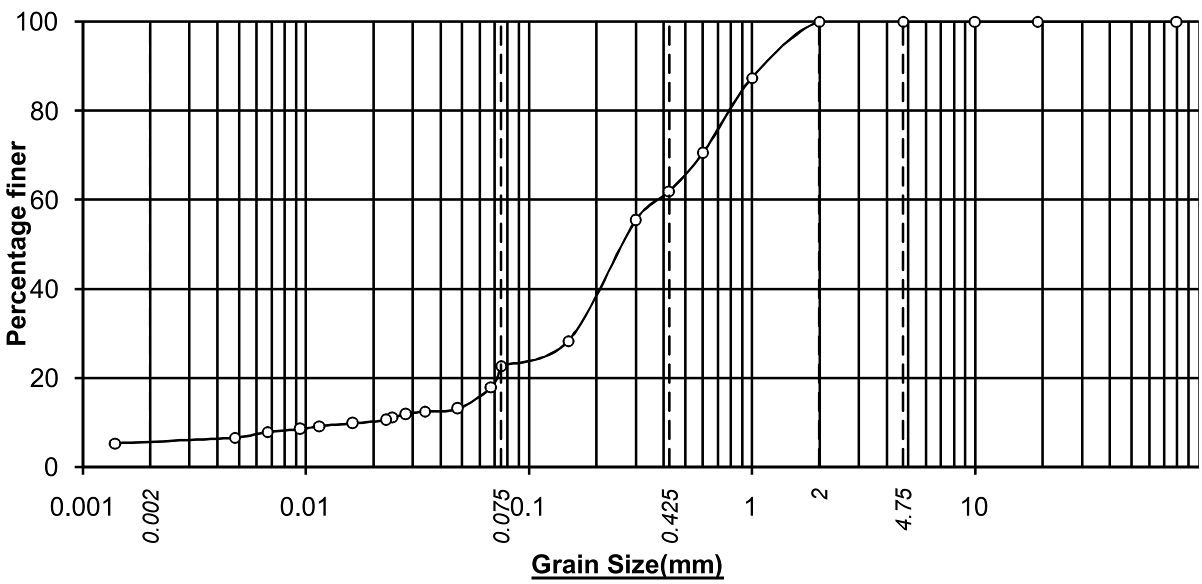
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

GRAIN SIZE DISTRIBUTION CURVES



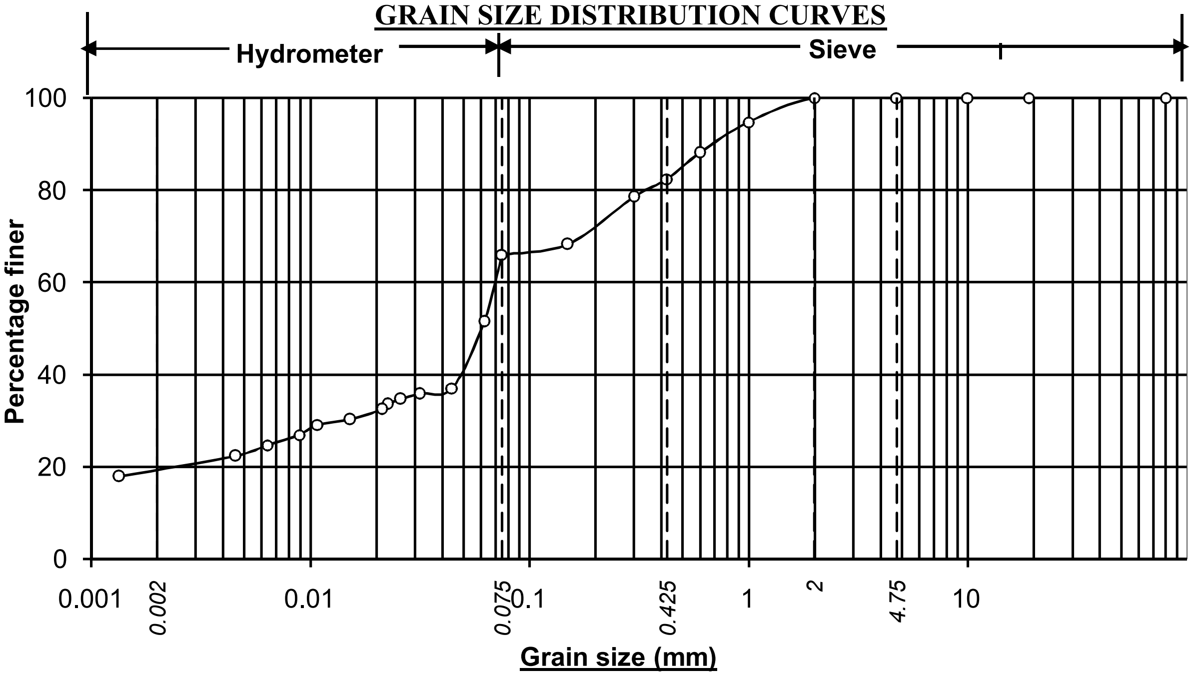
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-58,DS-02, 2.00M	9.3	40.6	25.4	24.7	0.0	50.1		0.0
BH-58,SPT-02, 3.00M	16.1	37.4	27.5	19.0	0.0	46.5		0.0



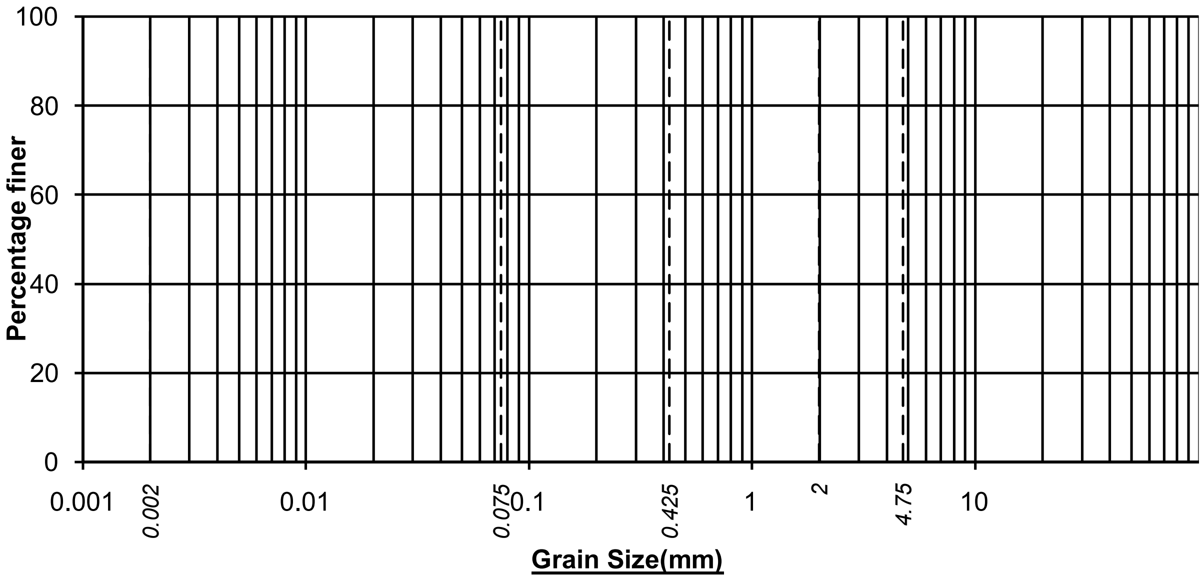
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-58,SPT-03, 4.56M	5.6	17.1	39.2	38.1	0.0	77.3		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-59,DS-01, 0.50M	19.4	46.6	16.4	17.6	0.0	34.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	Job No. 4095

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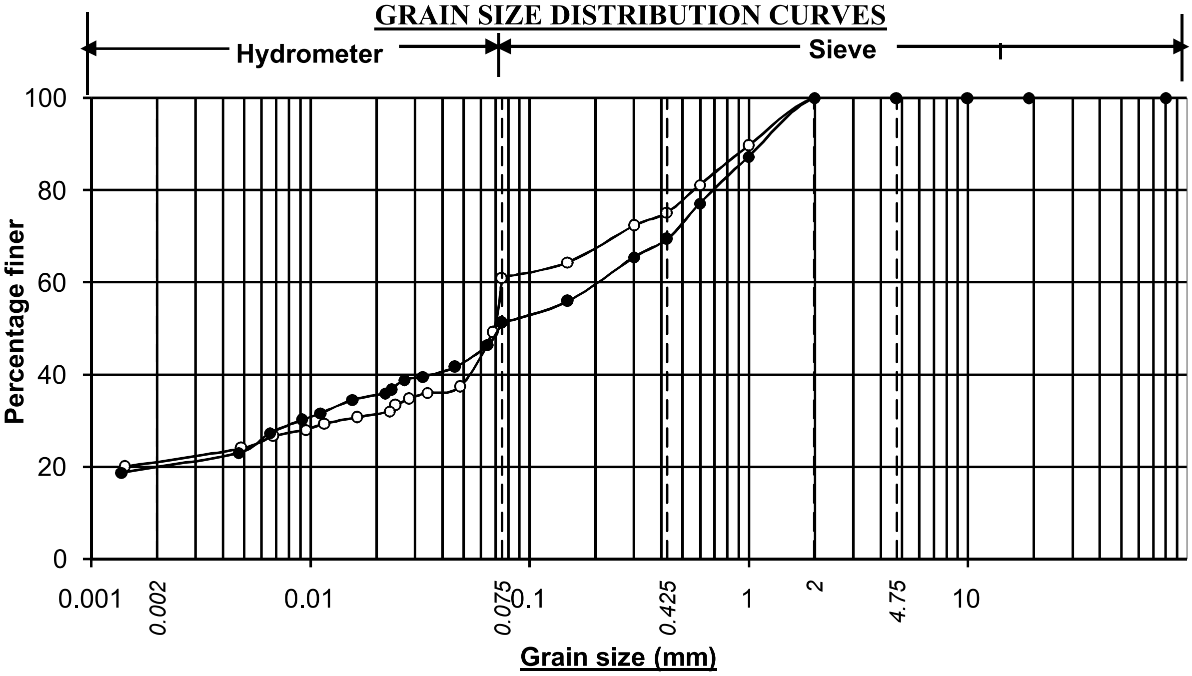
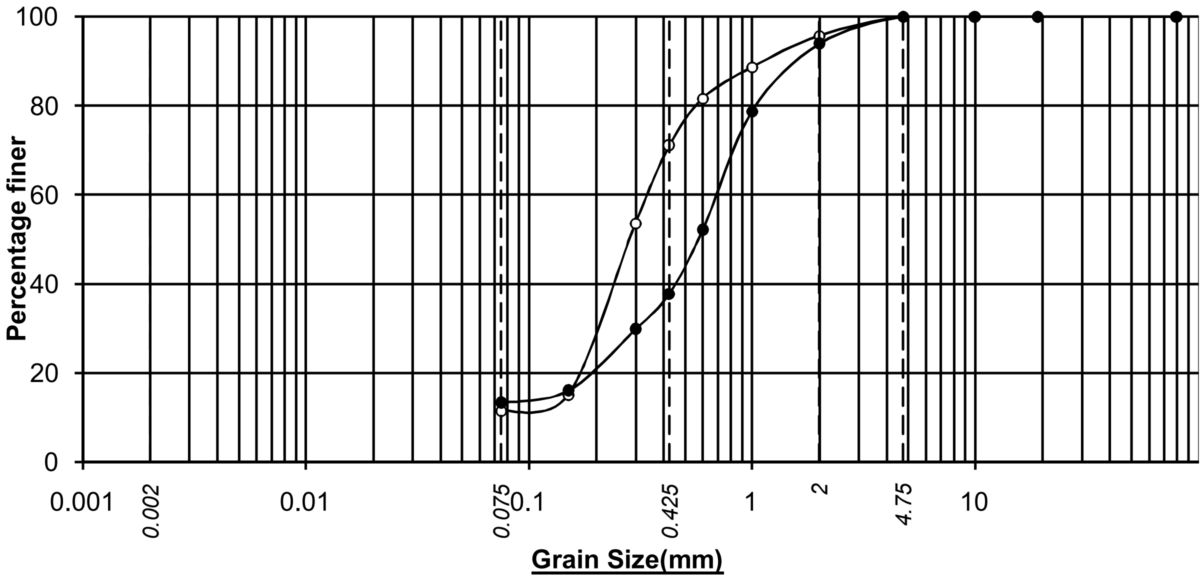
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-65,SPT-01, 1.50M	21.1	39.9	14.2	24.8	0.0	39.0		0.0
BH-65,UDS-01, 3.60M	20.0	31.3	18.2	30.5	0.0	48.7		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-65,SPT-06, 8.50M		11.4	59.6	24.7	4.3	88.6		0.0
BH-65,DS-07, 9.50M		13.3	24.4	56.2	6.1	86.7		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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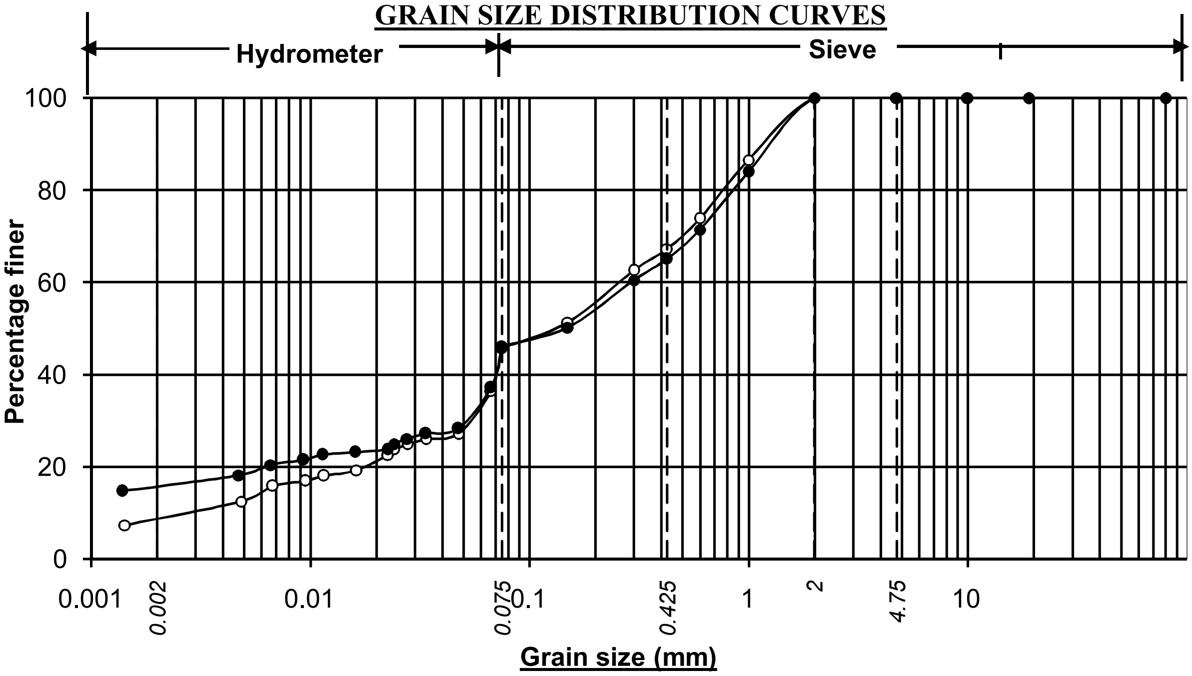
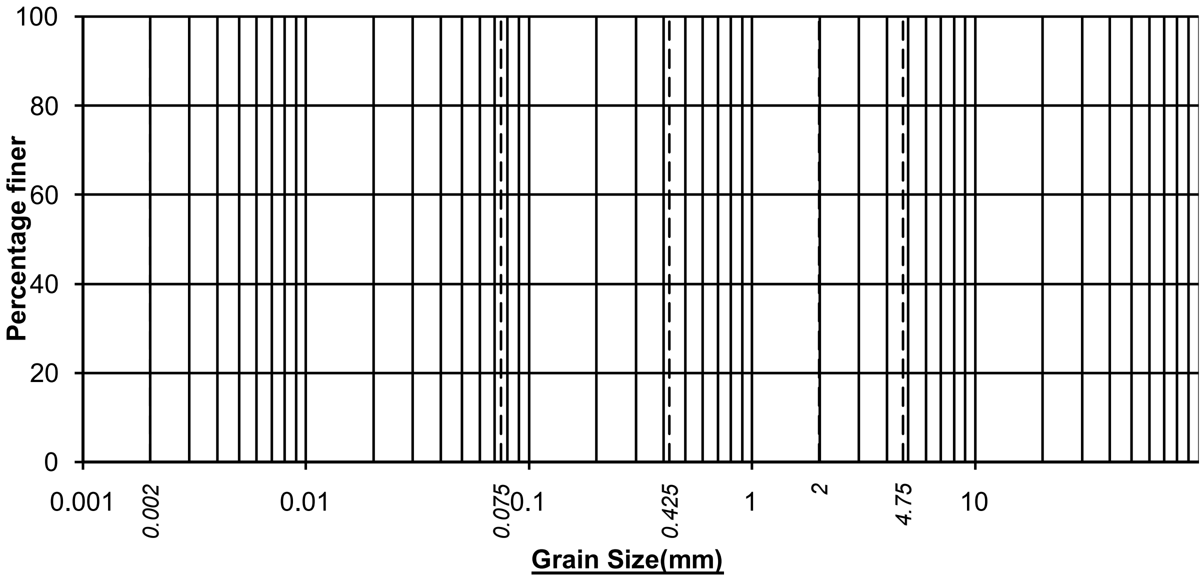
Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



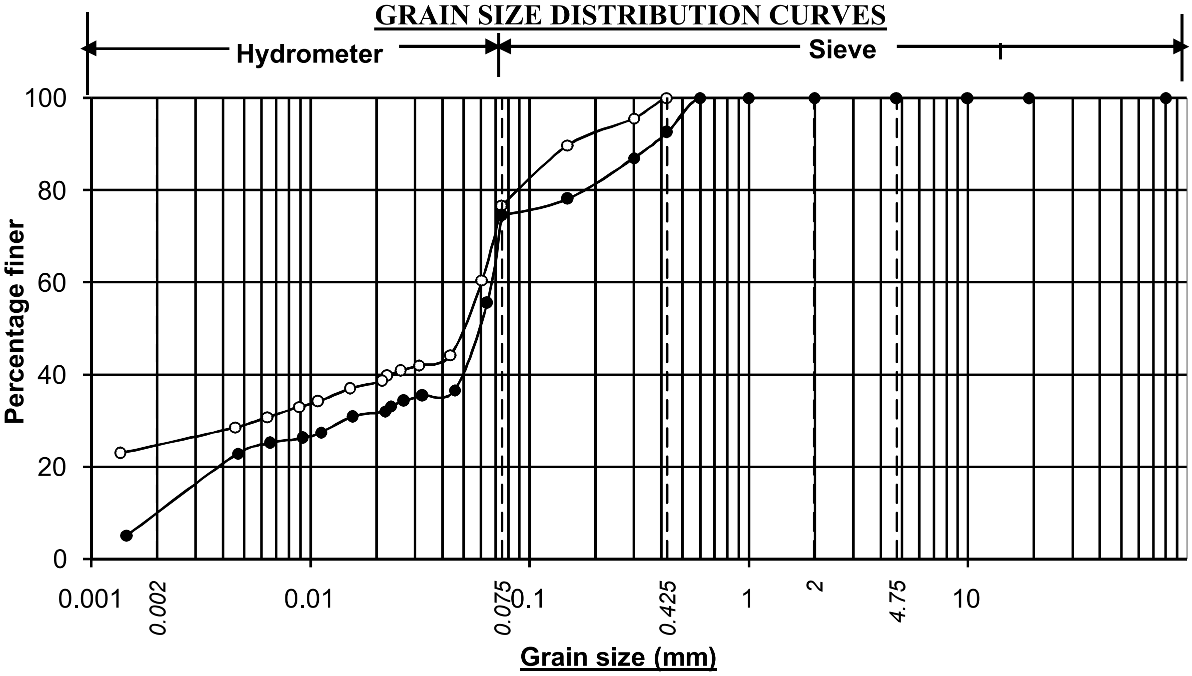
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-66,DS-02, 1.00M	8.8	37.0	21.5	32.7	0.0	54.2		0.0
BH-66,SPT-01, 1.50M	15.8	30.4	18.9	34.9	0.0	53.8		0.0



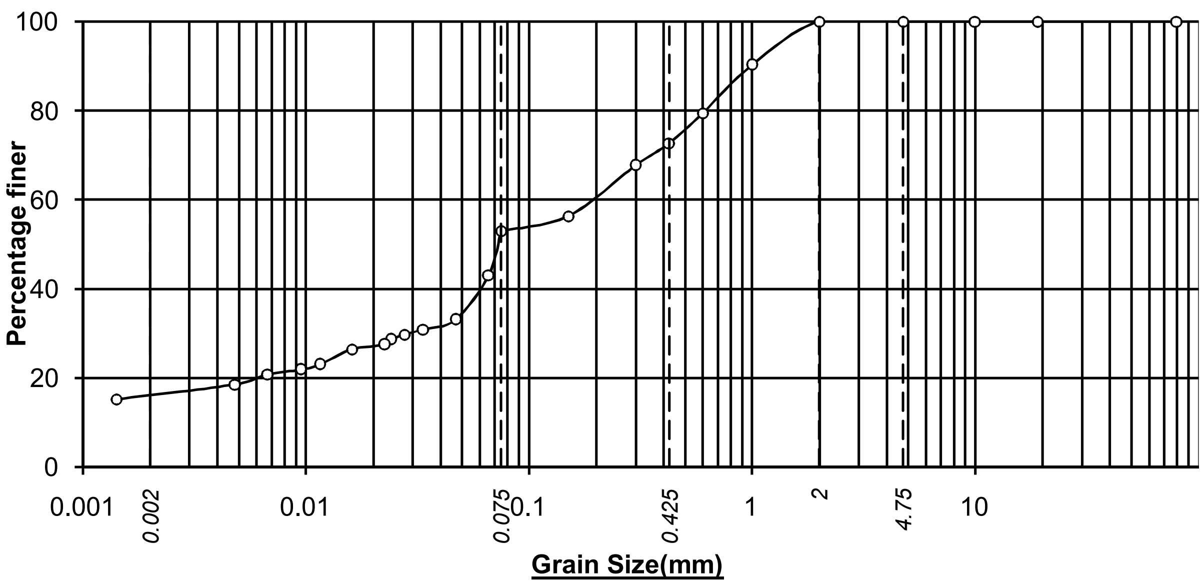
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-67,UDS-01, 2.50M	24.7	52.0	23.3	0.0	0.0	23.3		0.0
BH-67,SPT-03, 4.50M	9.9	64.7	18.0	7.4	0.0	25.4		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-67,UDS-02, 5.50M	16.1	36.9	19.7	27.3	0.0	47.0		0.0

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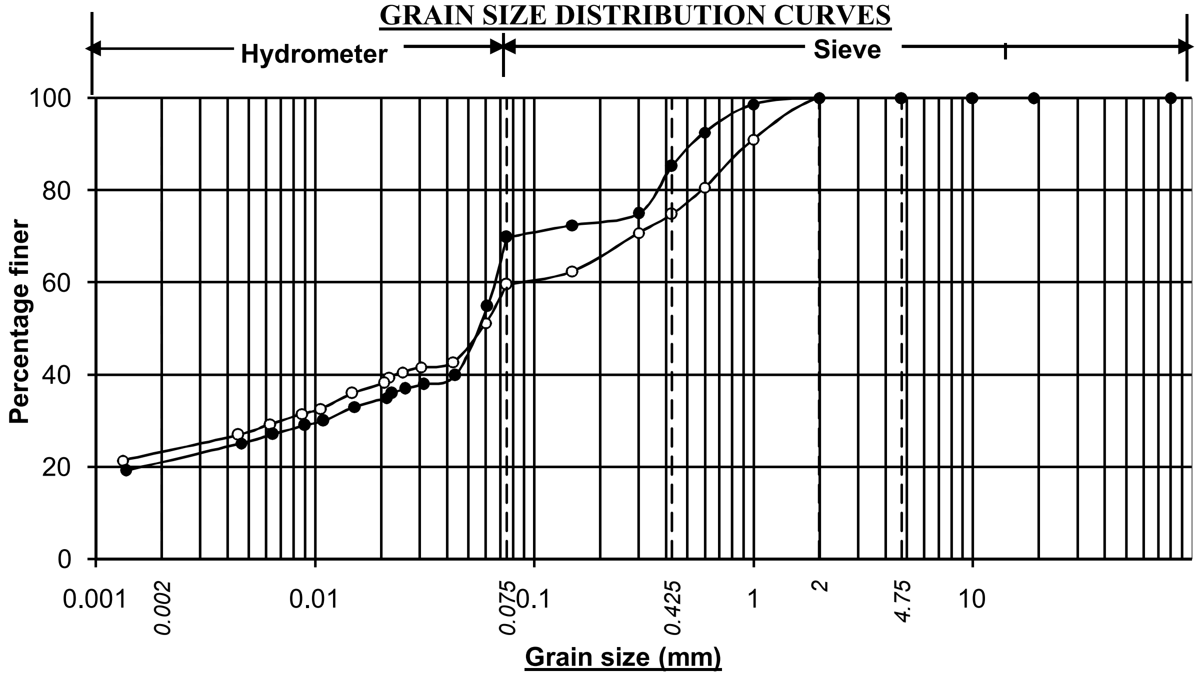
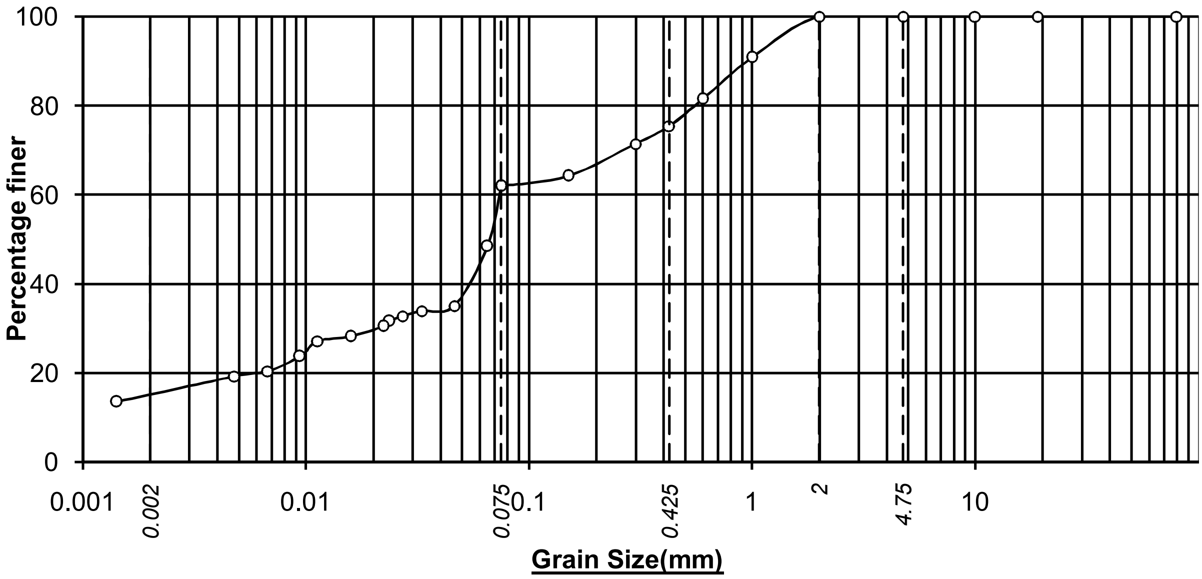
Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-68,SPT-01, 1.50M	23.3	36.3	15.3	25.1	0.0	40.4		0.0
BH-68,UDS-01, 4.00M	21.0	48.8	15.5	14.7	0.0	30.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-68,SPT-06, 9.50M	15.1	46.9	13.4	24.6	0.0	38.0		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	Job No. 4095

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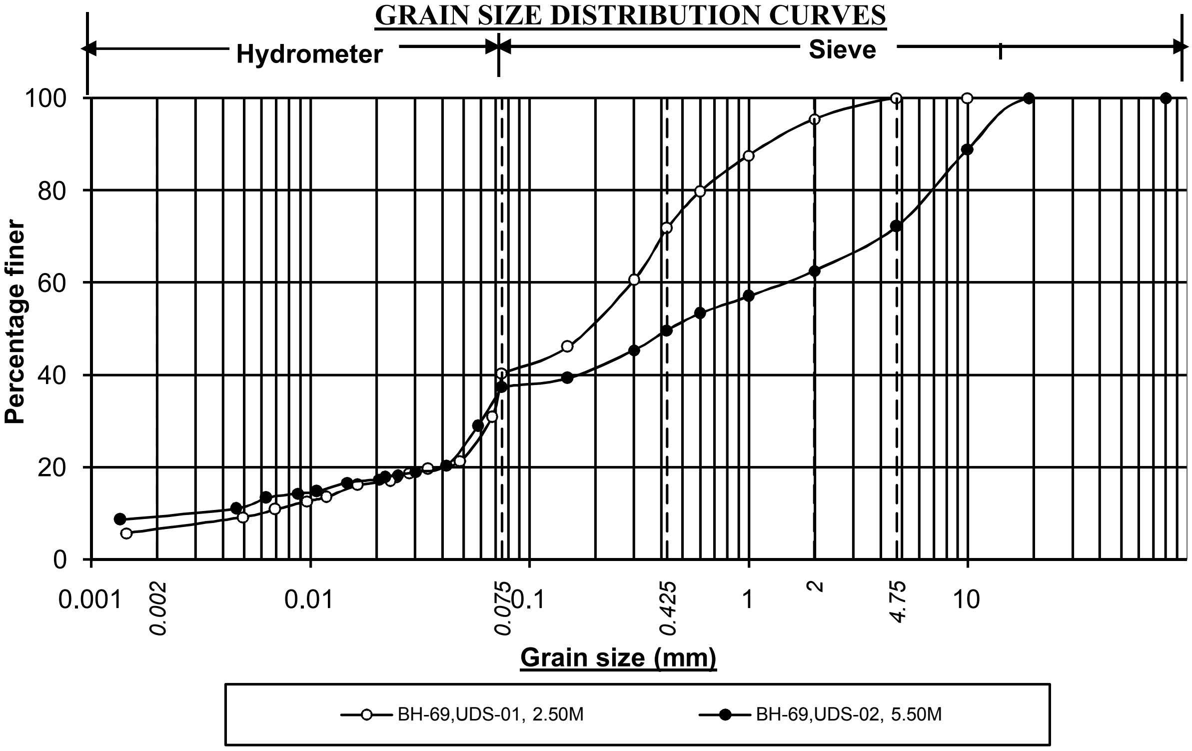
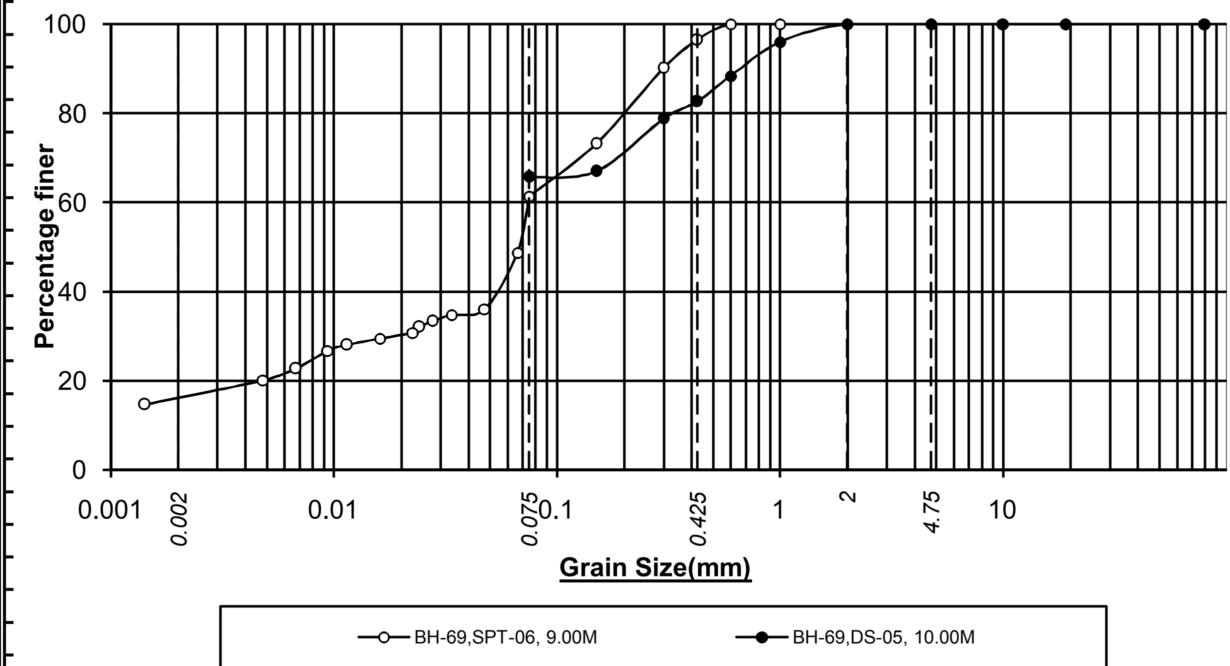
Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-69,UDS-01, 2.50M	6.6	33.8	31.3	23.7	4.6	59.6		0.0
BH-69,UDS-02, 5.50M	9.4	28.0	12.2	12.9	9.7	34.8		27.8



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-69,SPT-06, 9.00M	16.2	45.1	35.2	3.5	0.0	38.7		0.0
BH-69,DS-05, 10.00M		65.7	17.0	17.3	0.0	34.3		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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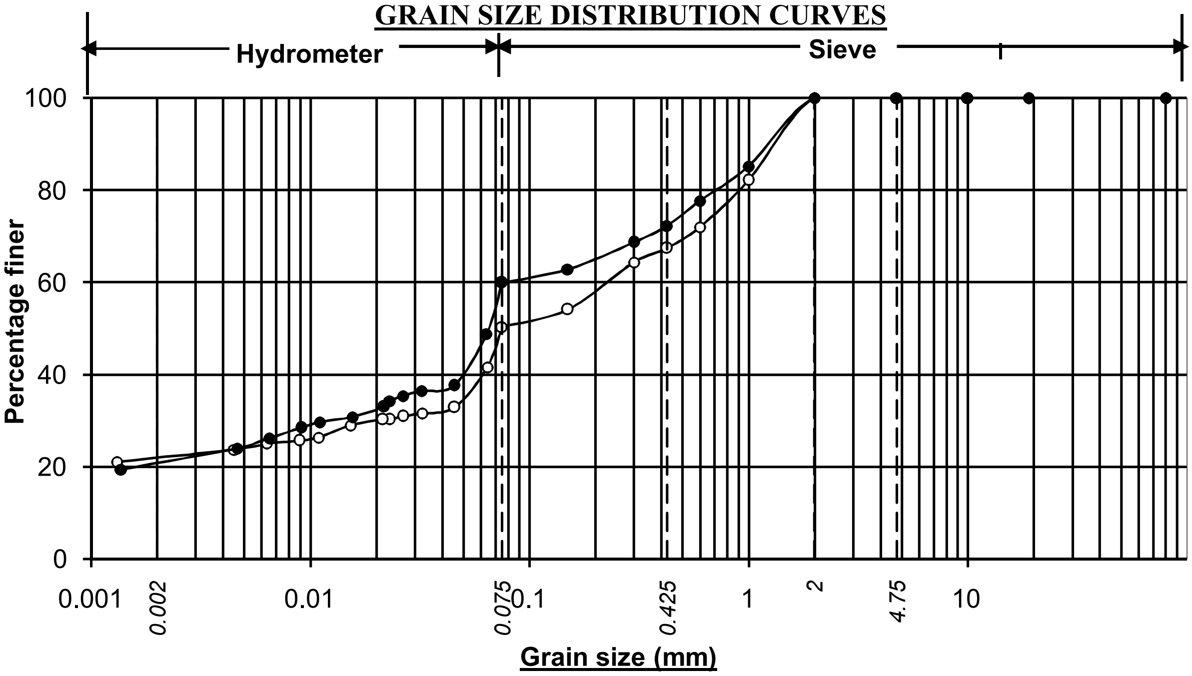
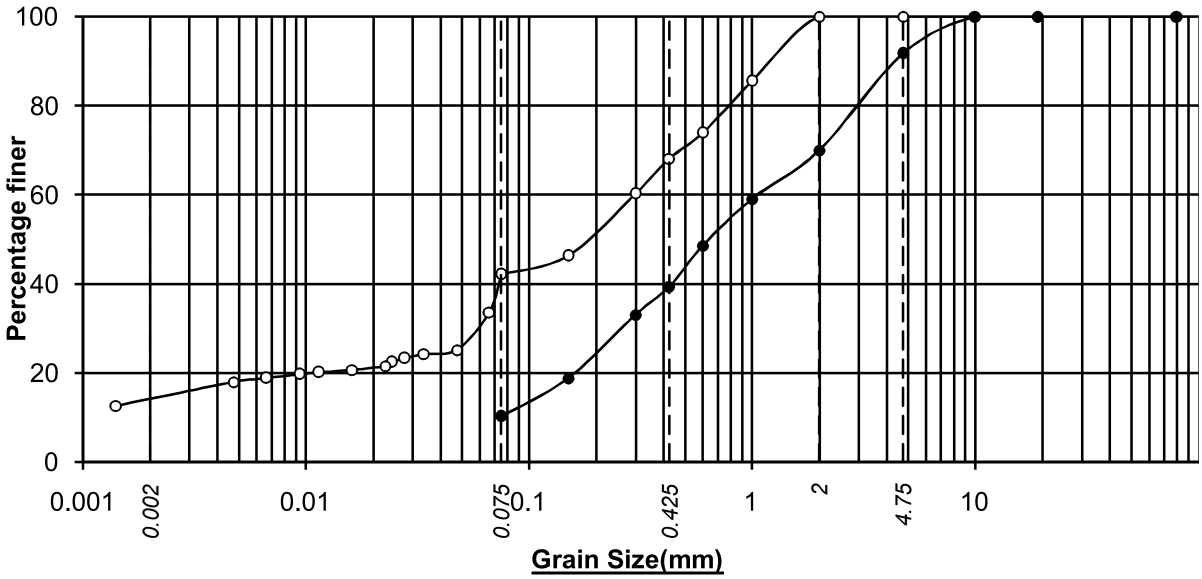
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-70,UDS-01, 2.50M	22.0	28.4	17.1	32.5	0.0	49.6		0.0
BH-70,SPT-02, 2.95M	20.8	39.2	12.3	27.7	0.0	40.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-70,DS-03, 4.00M	14.1	28.0	26.0	31.9	0.0	57.9		0.0
BH-70,SPT-04, 6.00M		10.2	29.1	30.6	21.8	81.5		8.3

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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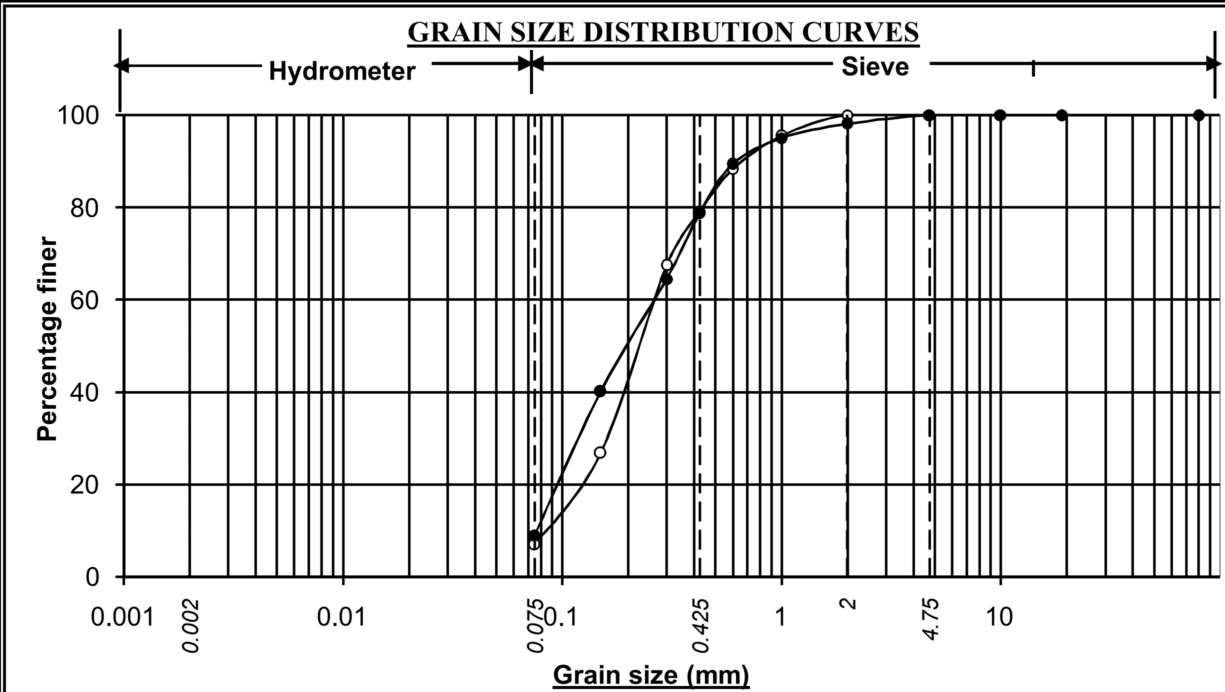
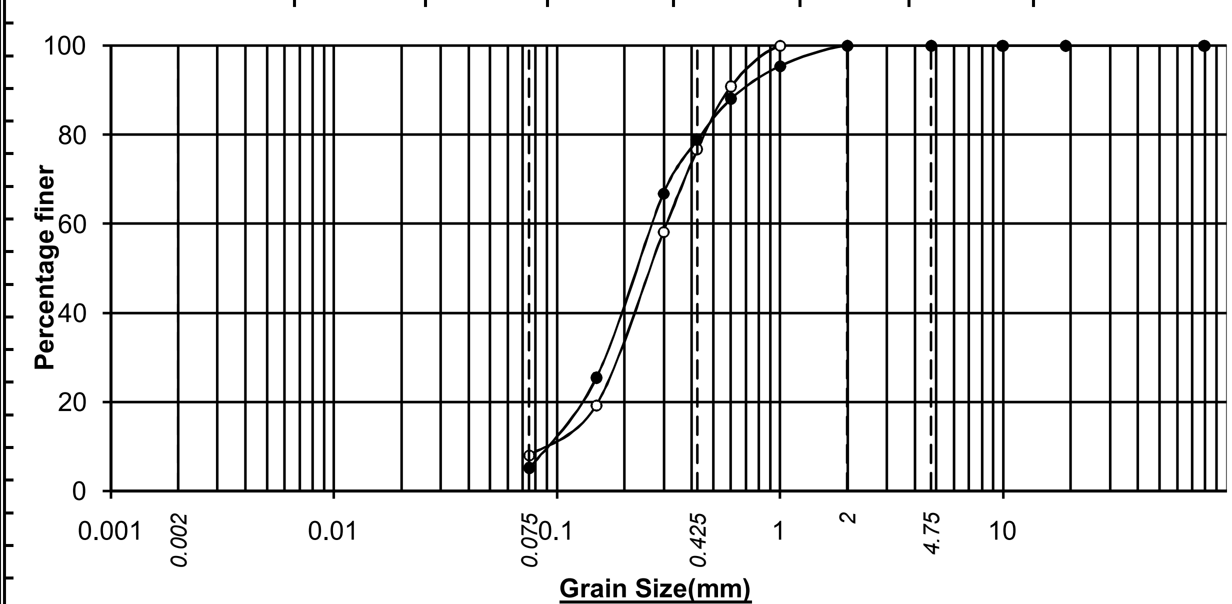
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-71,DS-02, 1.00M		7.0	72.2	20.8	0.0	93.0		0.0
BH-71,DS-03, 2.50M		9.0	69.8	19.3	1.9	91.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-71,SPT-02, 3.00M		8.0	68.6	23.4	0.0	92.0		0.0
BH-71,DS-04, 4.00M		5.0	73.8	21.2	0.0	95.0		0.0

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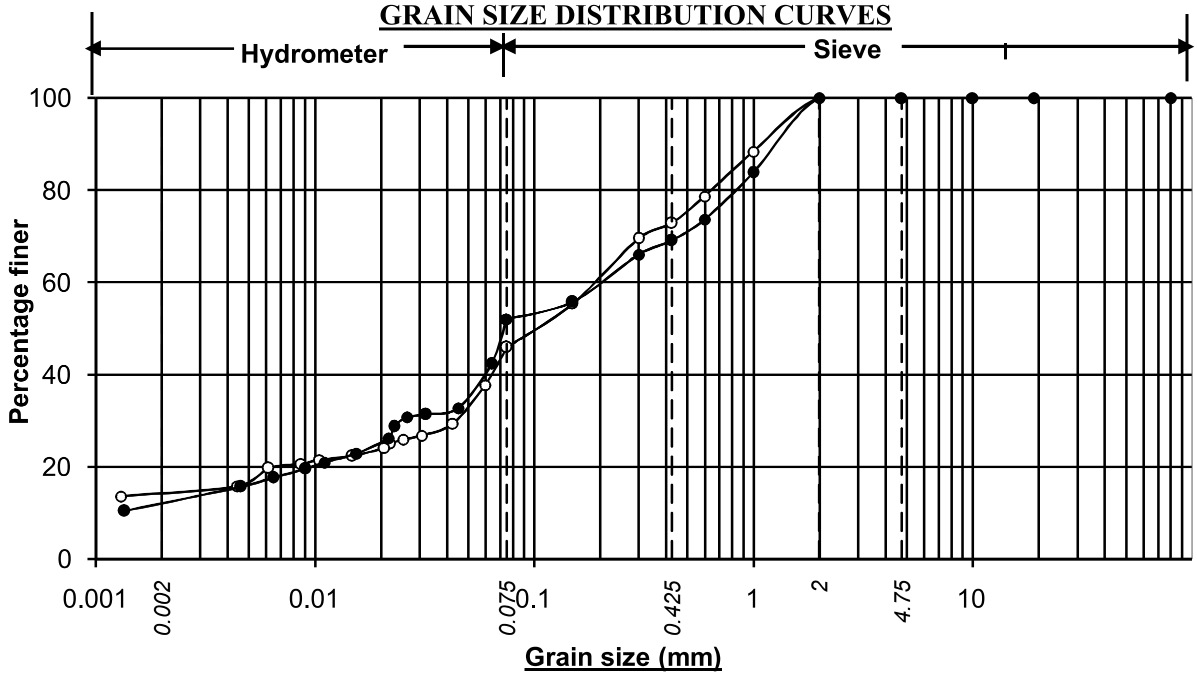
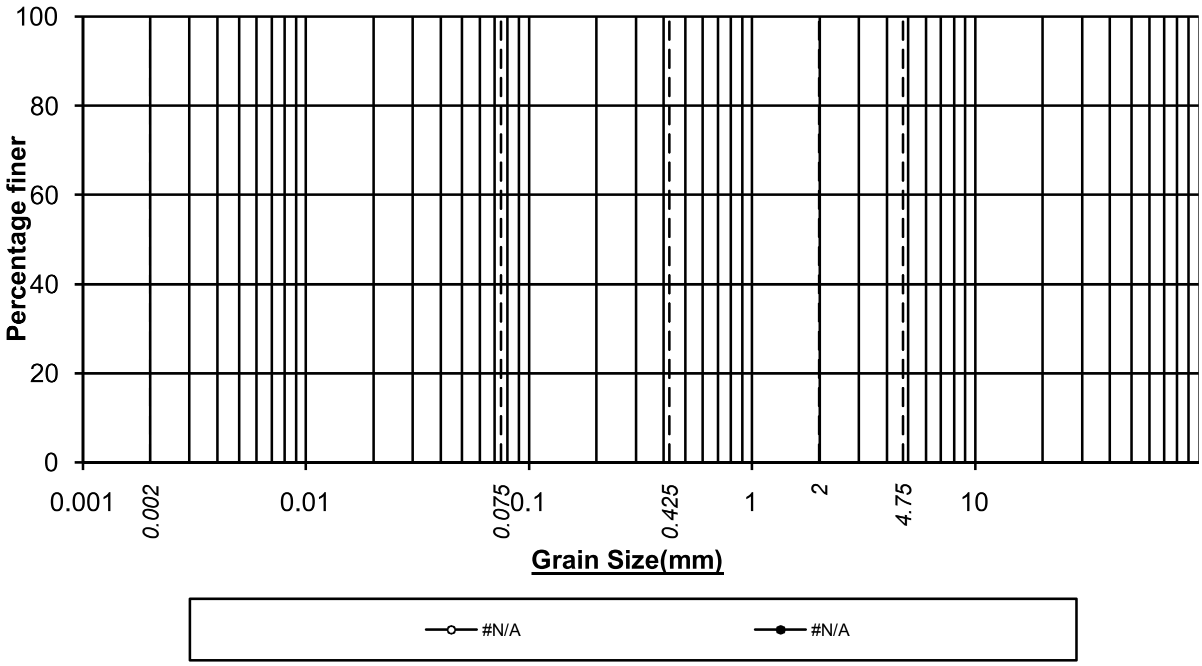
Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-72,DS-01, 0.50M	14.4	31.6	26.9	27.1	0.0	54.0		0.0
BH-72,SPT-01, 1.50M	12.1	39.9	17.2	30.8	0.0	48.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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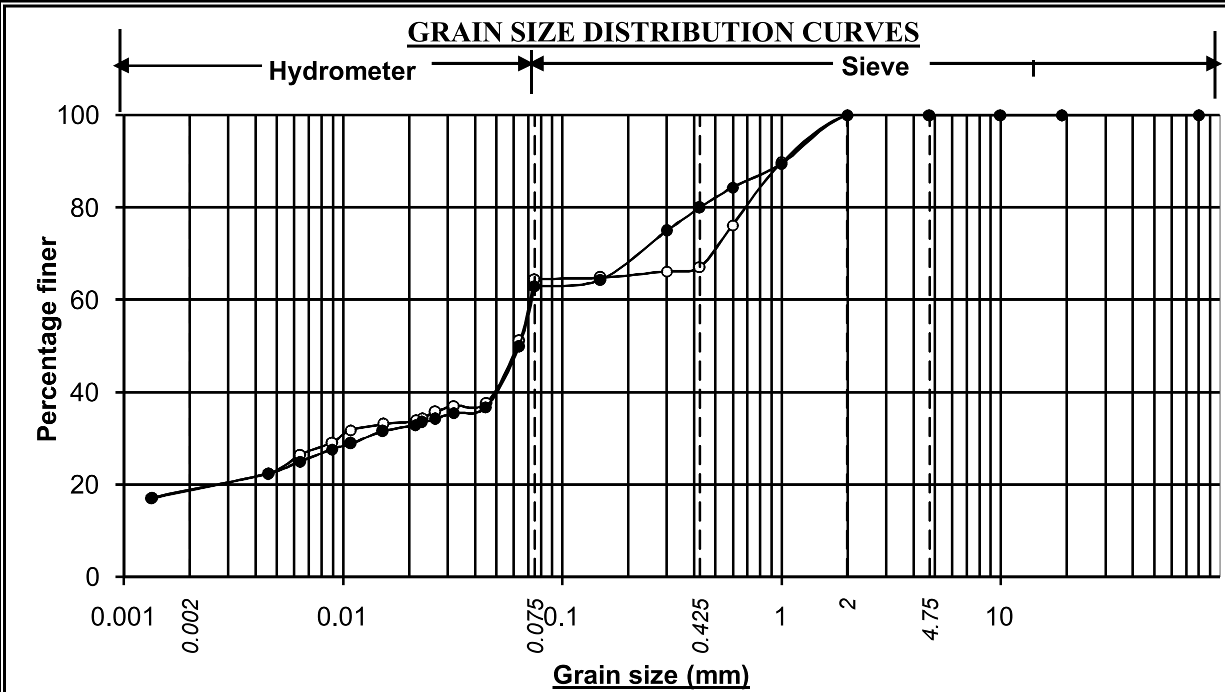
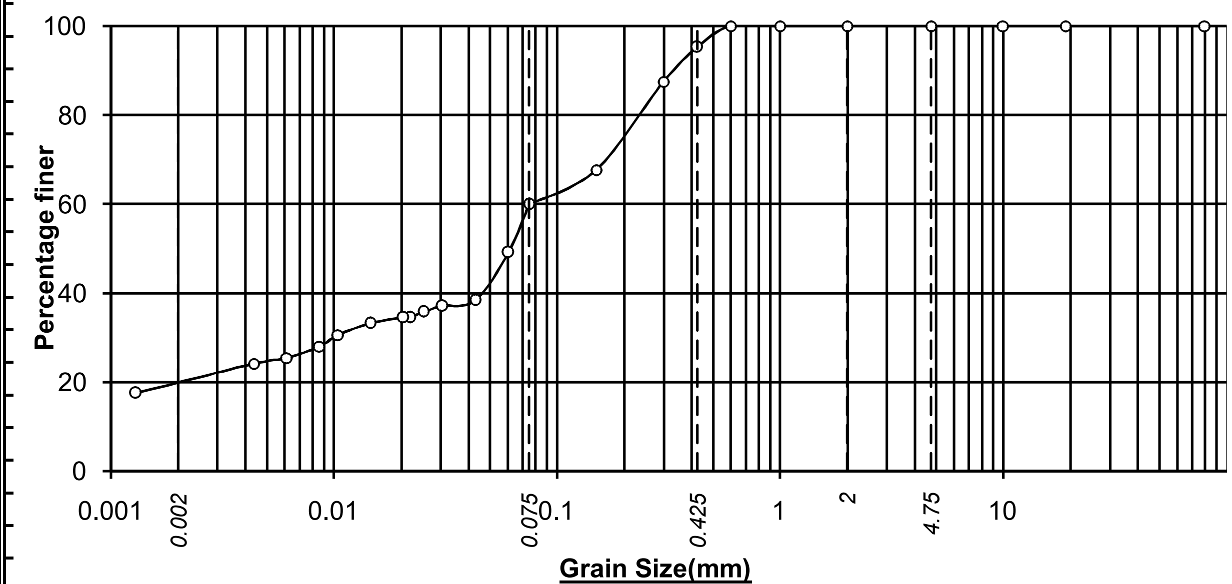
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-73,SPT-01, 1.50M	18.9	45.6	2.7	32.8	0.0	35.5		0.0
BH-73,SPT-03, 4.50M	18.8	44.2	17.0	20.0	0.0	37.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-73,SPT-04, 6.00M	19.9	40.1	35.3	4.7	0.0	40.0		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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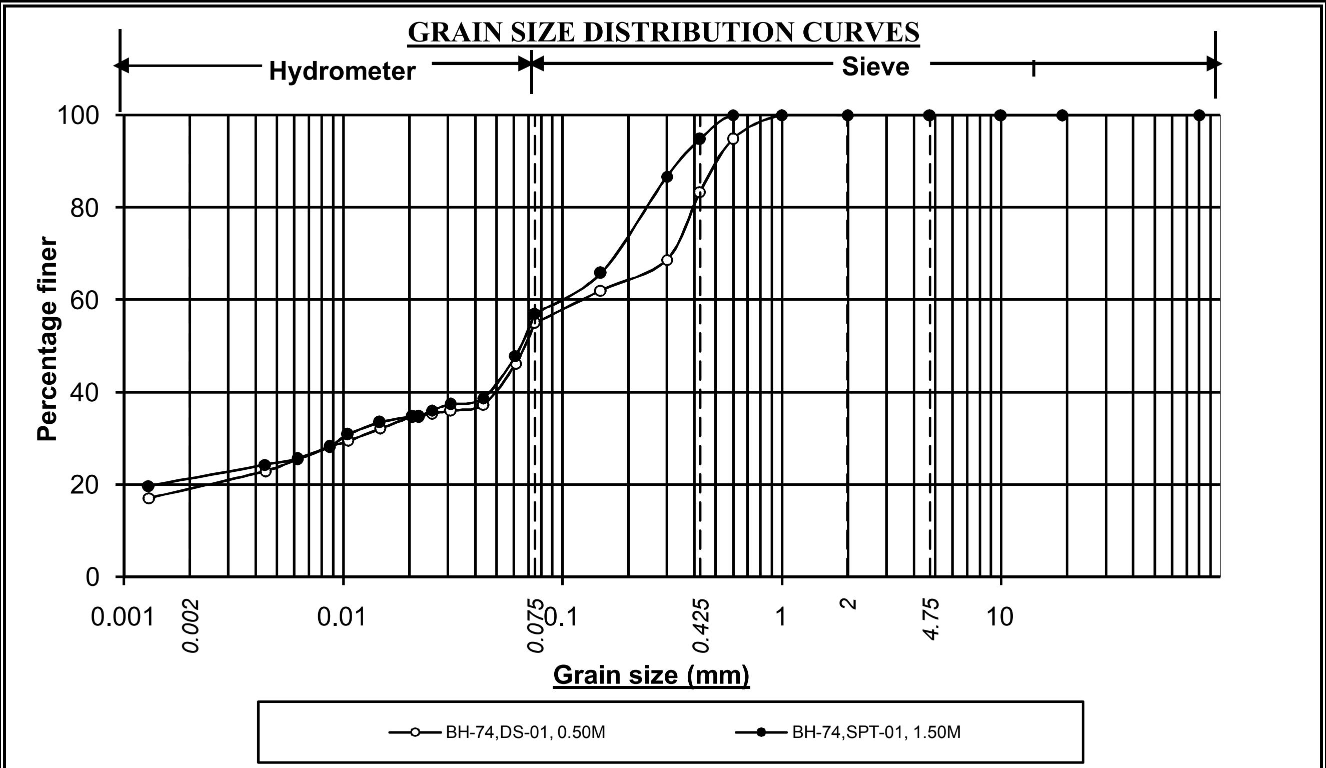
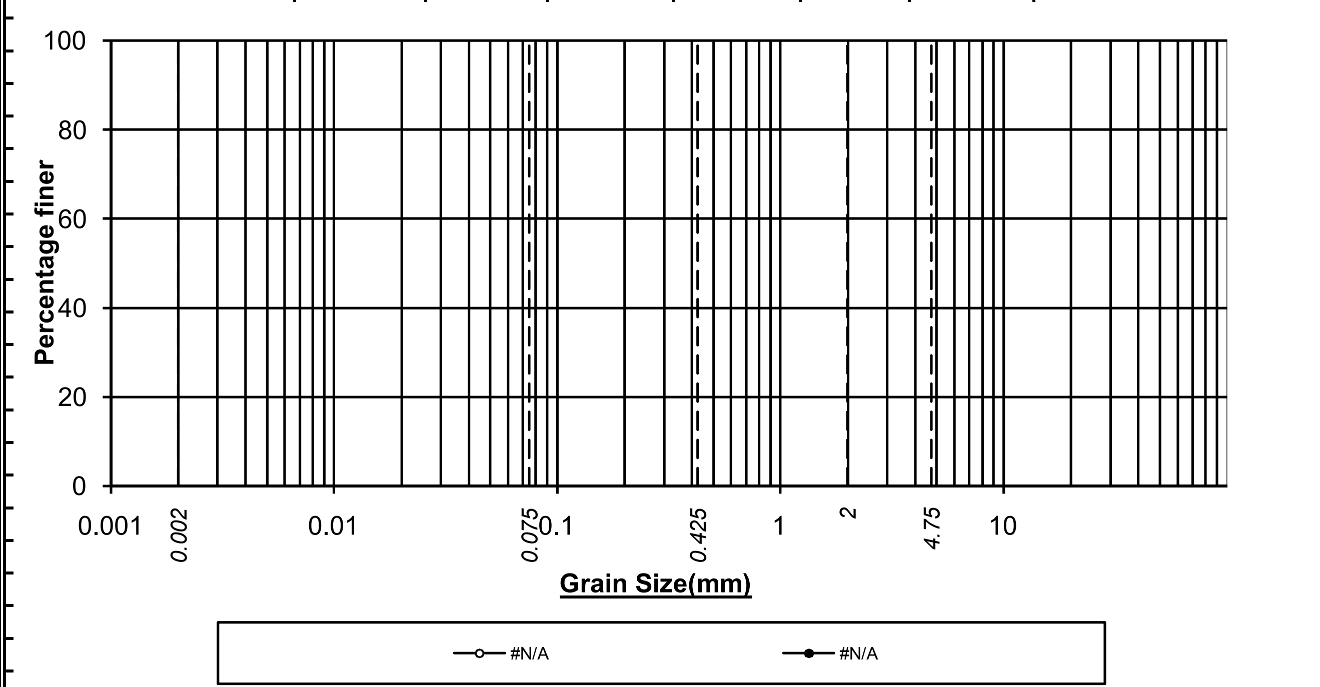
GRAIN SIZE DISTRIBUTION CURVES



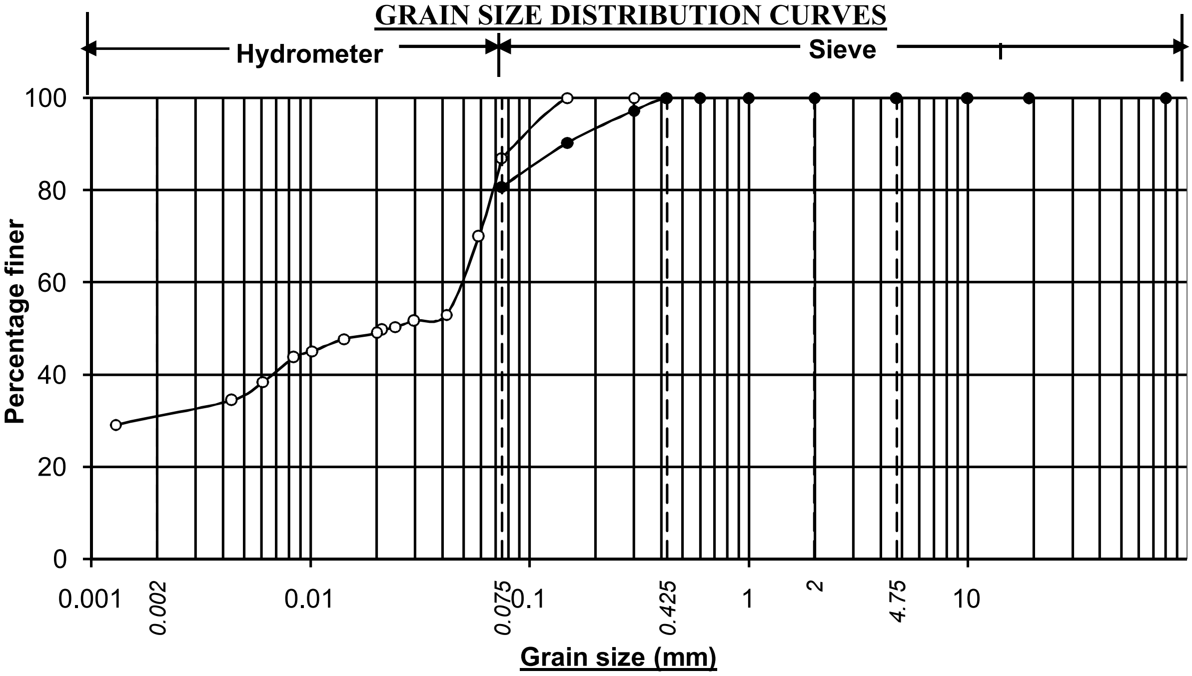
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-74,DS-01, 0.50M	19.1	35.9	28.3	16.7	0.0	45.0		0.0
BH-74,SPT-01, 1.50M	21.3	35.7	37.8	5.2	0.0	43.0		0.0



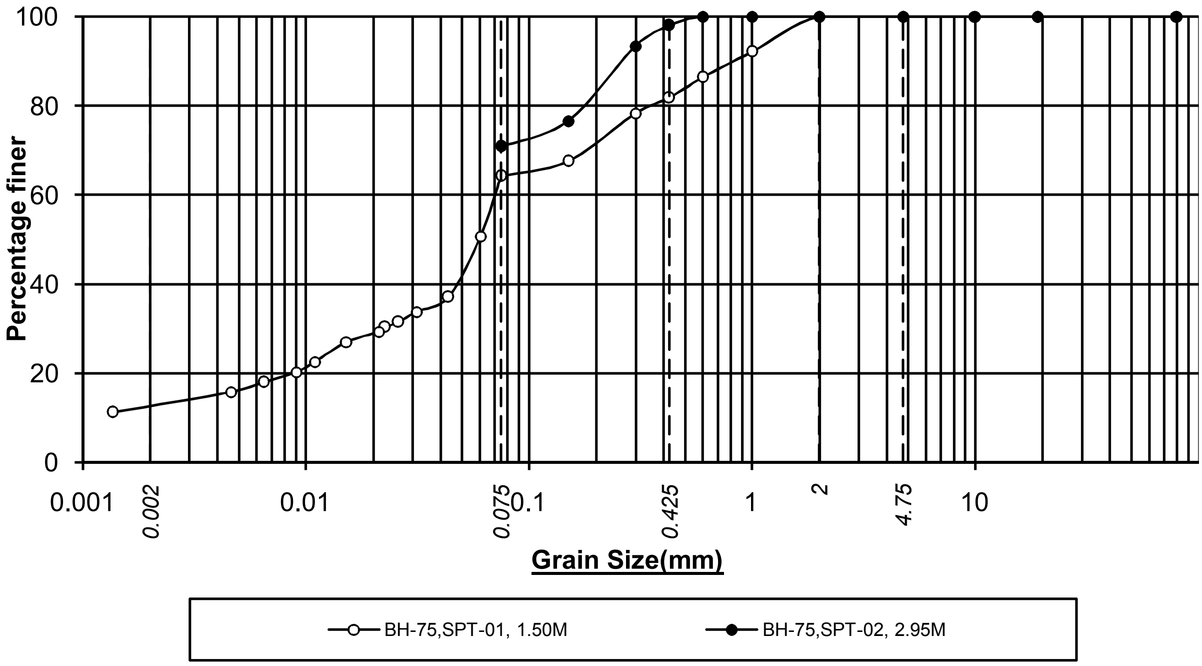
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-75,DS-01, 0.50M	31.0	56.0	13.0	0.0	0.0	13.0		0.0
BH-75,DS-02, 1.00M		80.7	19.3	0.0	0.0	19.3		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-75,SPT-01, 1.50M	12.7	51.6	17.6	18.1	0.0	35.7		0.0
BH-75,SPT-02, 2.95M		70.9	27.2	1.9	0.0	29.1		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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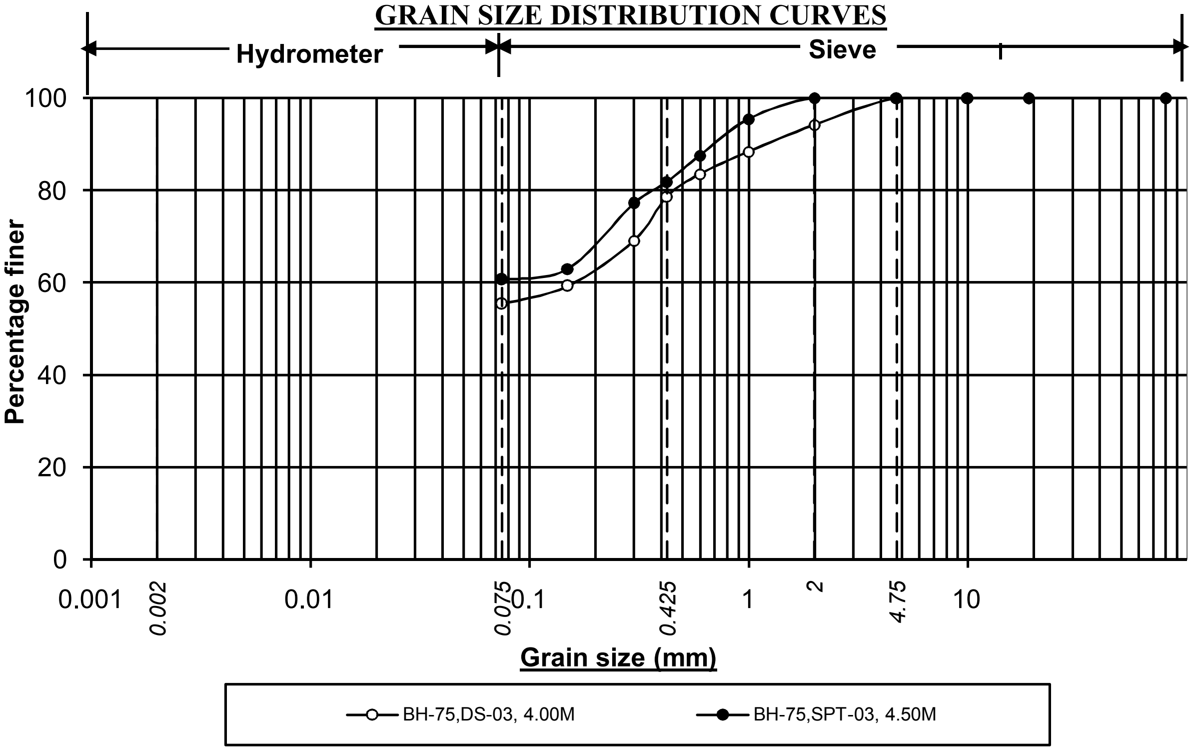
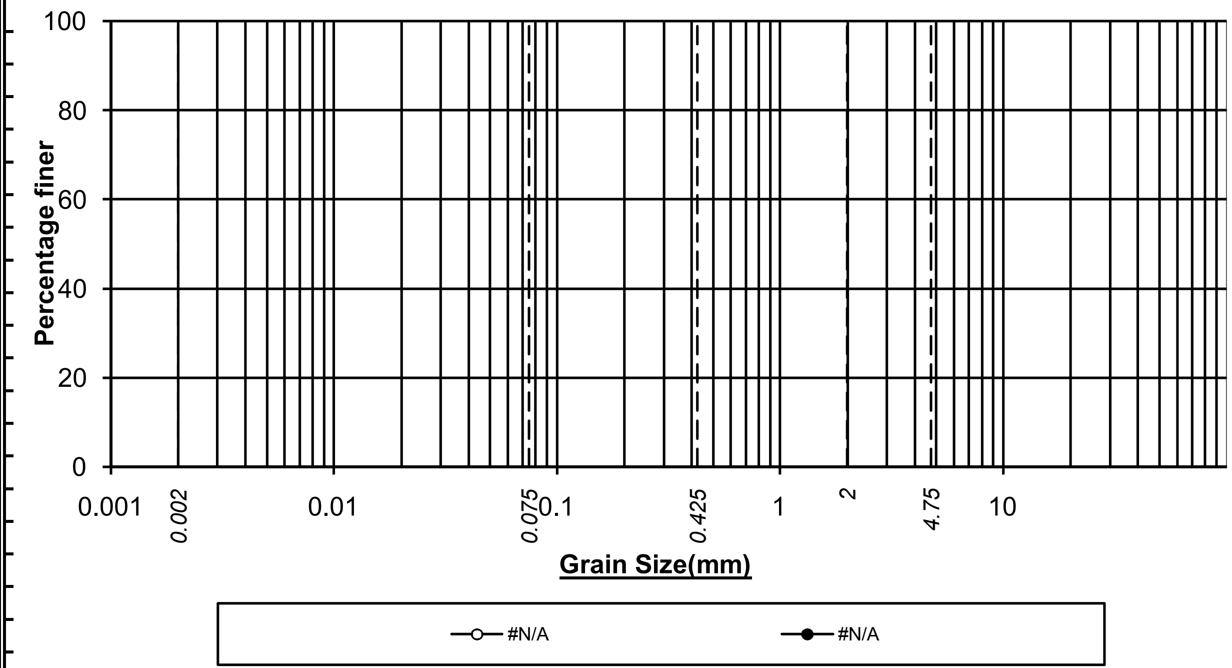


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-75,DS-03, 4.00M		55.4	23.3	15.5	5.8	44.6		0.0
BH-75,SPT-03, 4.50M		60.7	21.1	18.2	0.0	39.3		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

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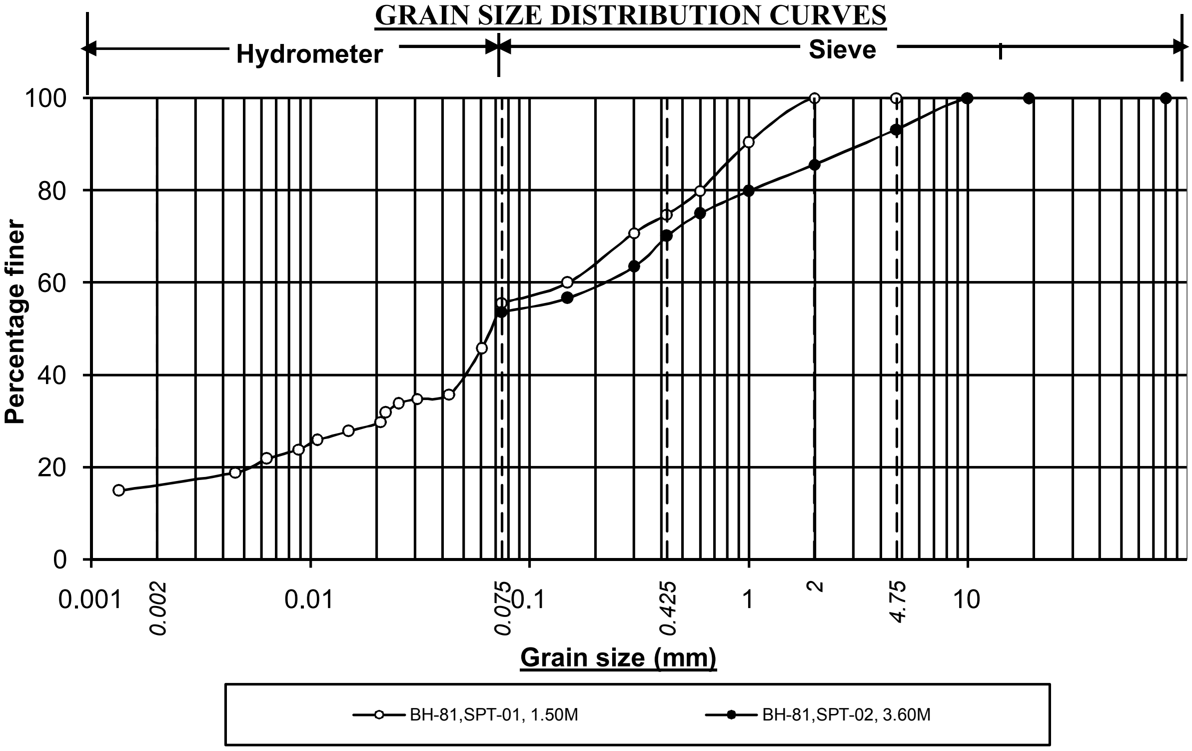
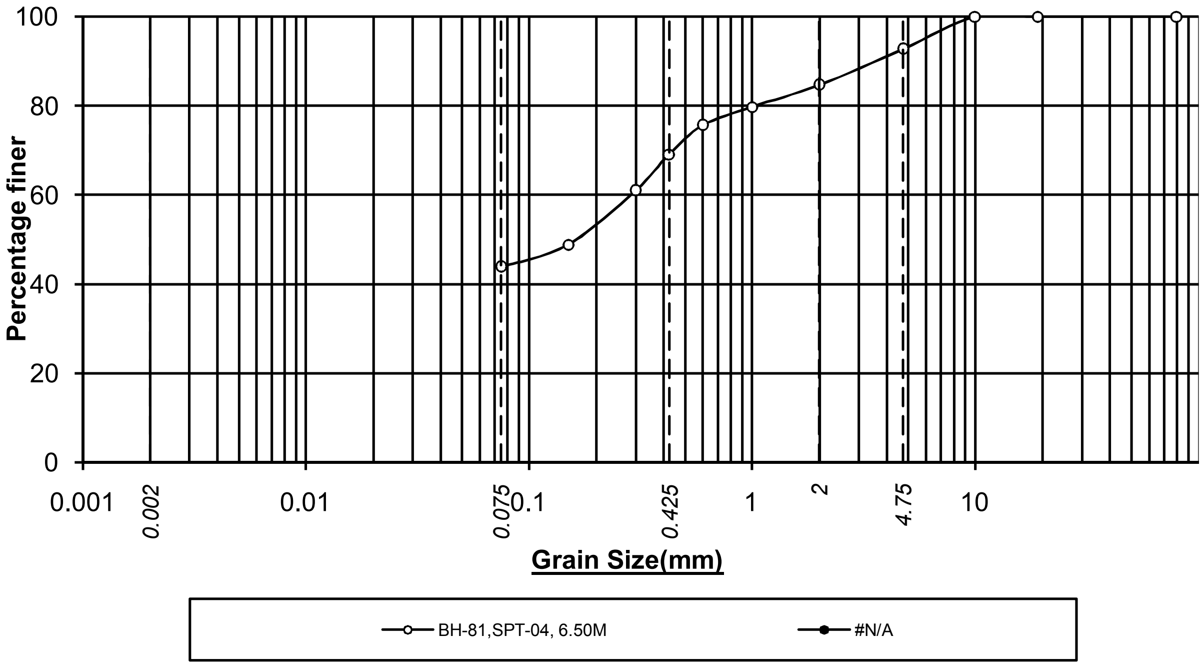
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Total sand	Weighted mean dia (mm)	Gravel (%)
BH-81,SPT-01, 1.50M	16.2	39.4	19.1	25.3	0.0	44.4		0.0
BH-81,SPT-02, 3.60M		53.7	16.4	15.5	7.6	39.5		6.8



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Total sand	Weighted mean dia (mm)	Gravel (%)
BH-81,SPT-04, 6.50M		43.9	25.1	15.6	8.1	48.8		7.3
						#VALUE!		

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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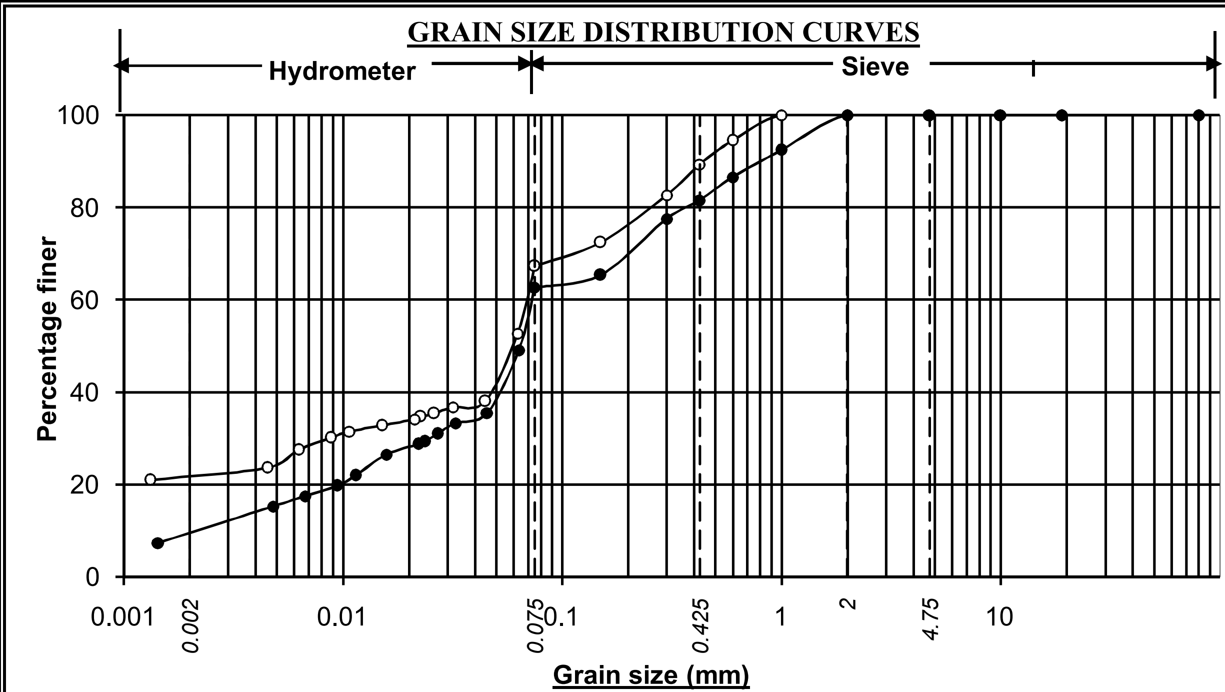
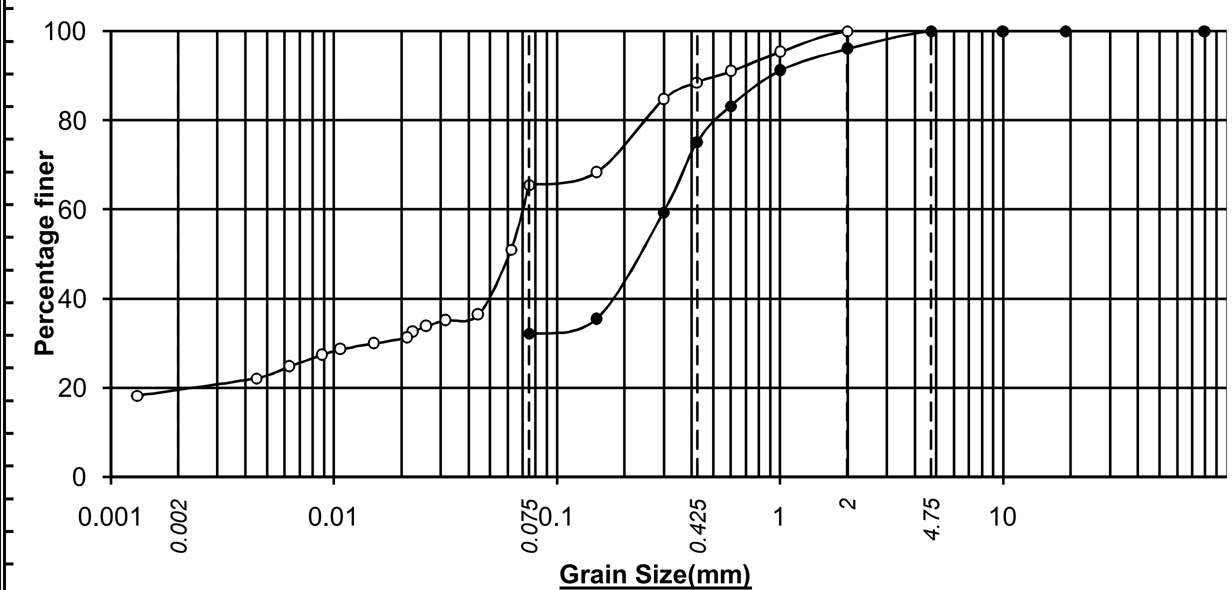
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-82,SPT-04, 6.50M	21.9	45.5	21.9	10.7	0.0	32.6		0.0
BH-82,UDS-02, 9.50M	9.5	53.2	18.9	18.4	0.0	37.3		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-82,SPT-06, 10.10M	19.5	46.0	23.0	11.5	0.0	34.5		0.0
BH-82,SPT-08, 13.50M		32.1	43.0	20.9	4.0	67.9		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

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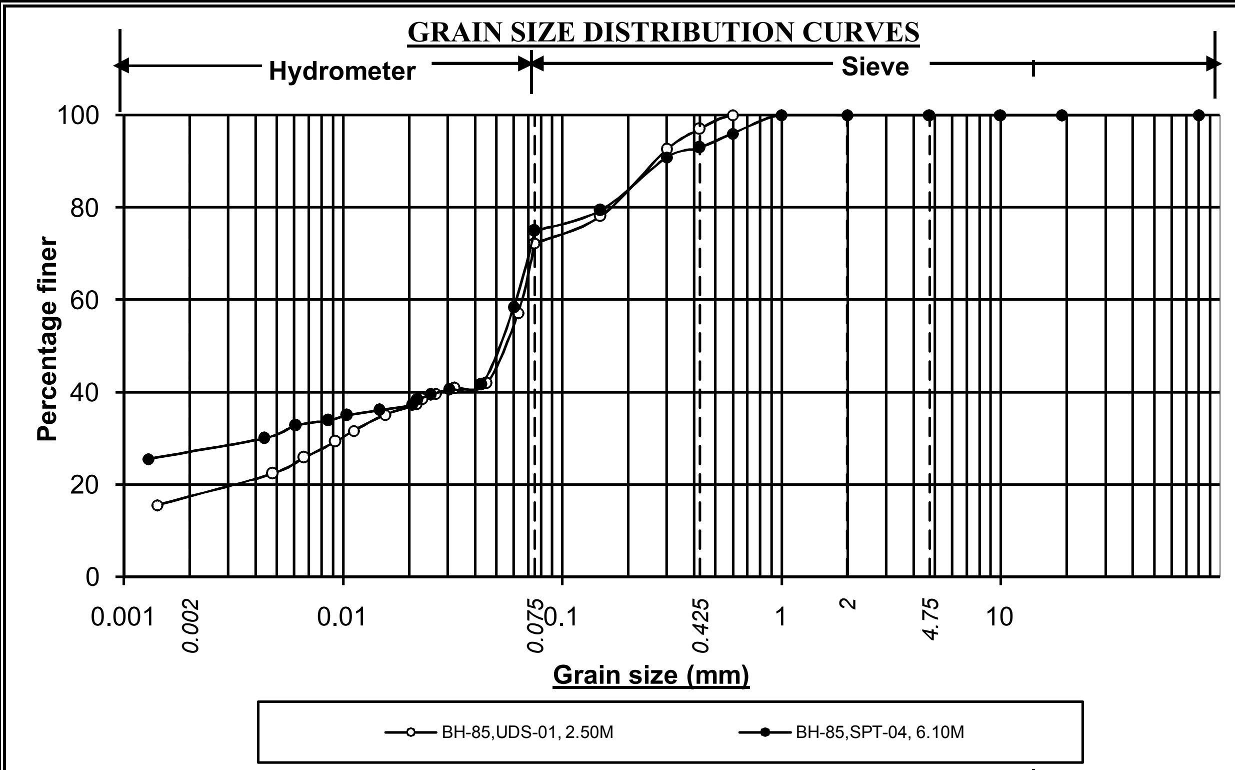
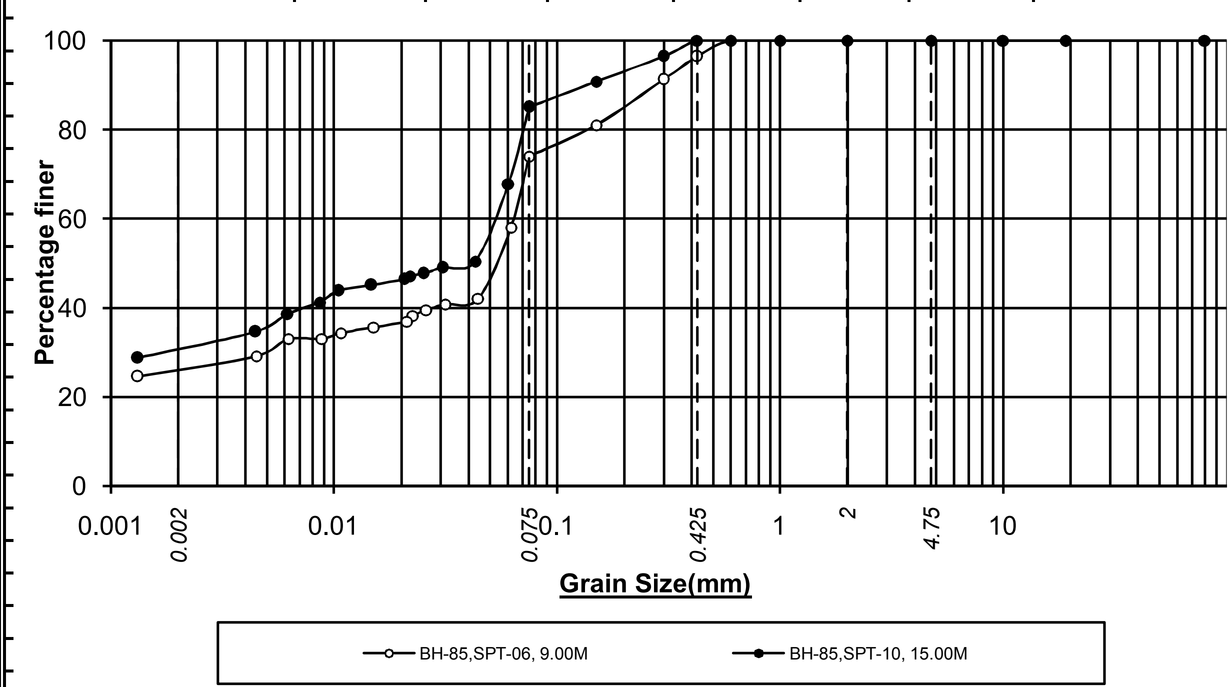
GRAIN SIZE DISTRIBUTION CURVES



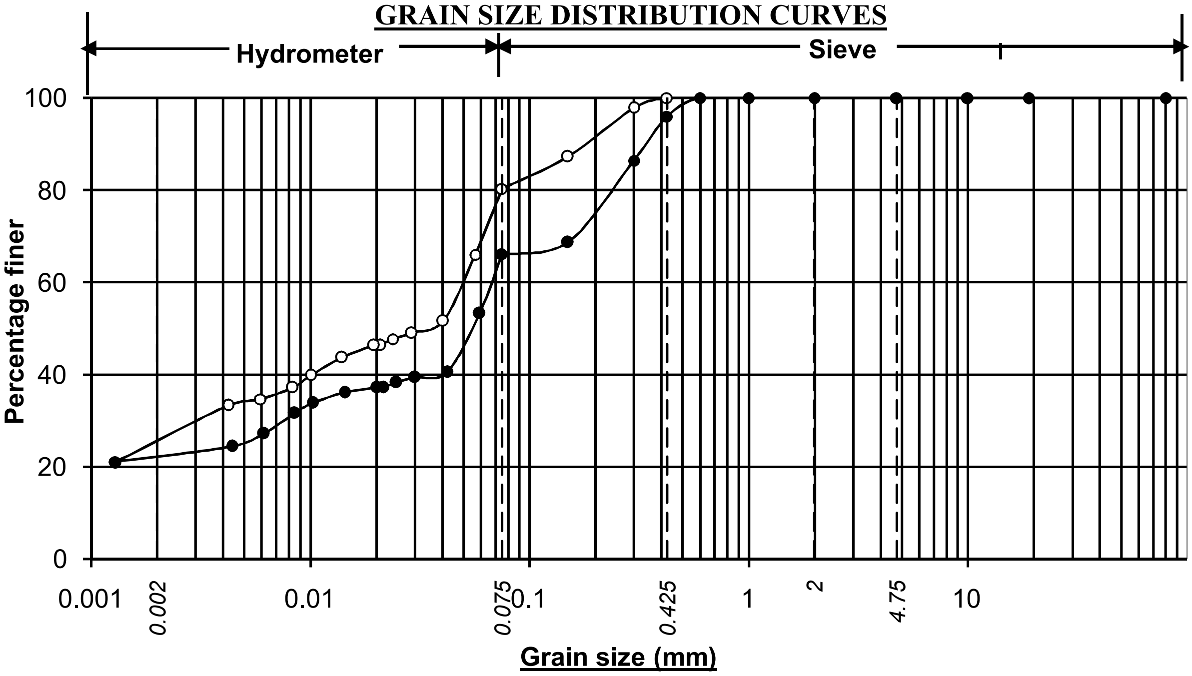
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-85,UDS-01, 2.50M	17.4	54.8	24.8	3.0	0.0	27.8		0.0
BH-85,SPT-04, 6.10M	27.1	47.9	18.0	7.0	0.0	25.0		0.0



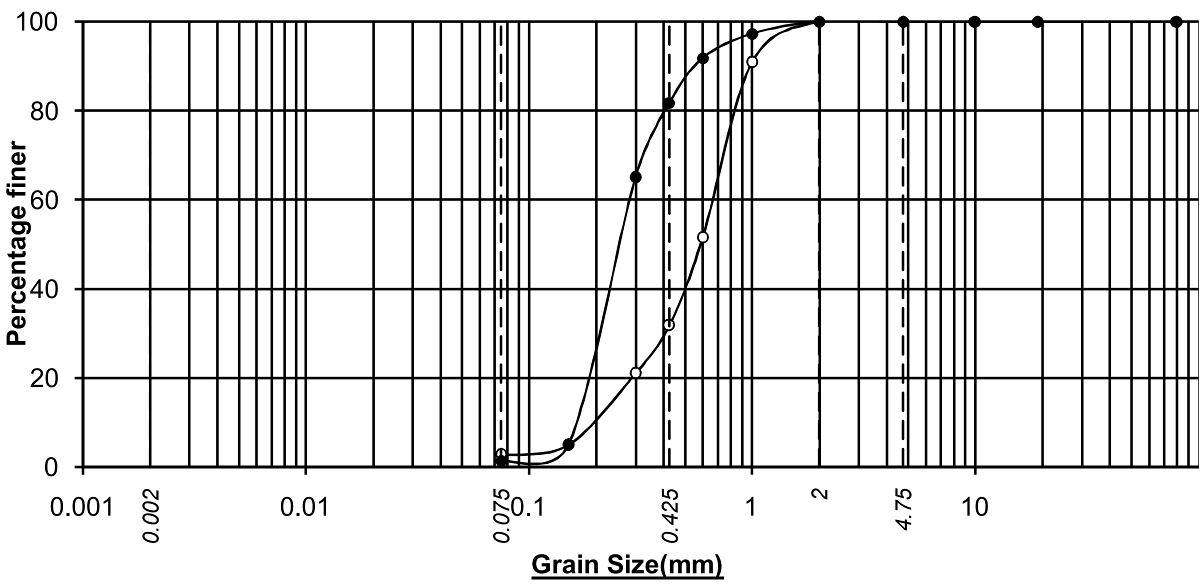
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-85,SPT-06, 9.00M	26.1	47.9	22.5	3.5	0.0	26.0		0.0
BH-85,SPT-10, 15.00M	30.8	54.4	14.8	0.0	0.0	14.8		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-86,UDS-01, 2.50M	25.5	54.8	19.7	0.0	0.0	19.7		0.0
BH-86,UDS-02, 5.55M	22.3	43.8	29.9	4.0	0.0	33.9		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-86,SPT-09, 13.50M		2.7	29.1	68.2	0.0	97.3		0.0
BH-86,SPT-13, 19.50M		1.4	80.3	18.3	0.0	98.6		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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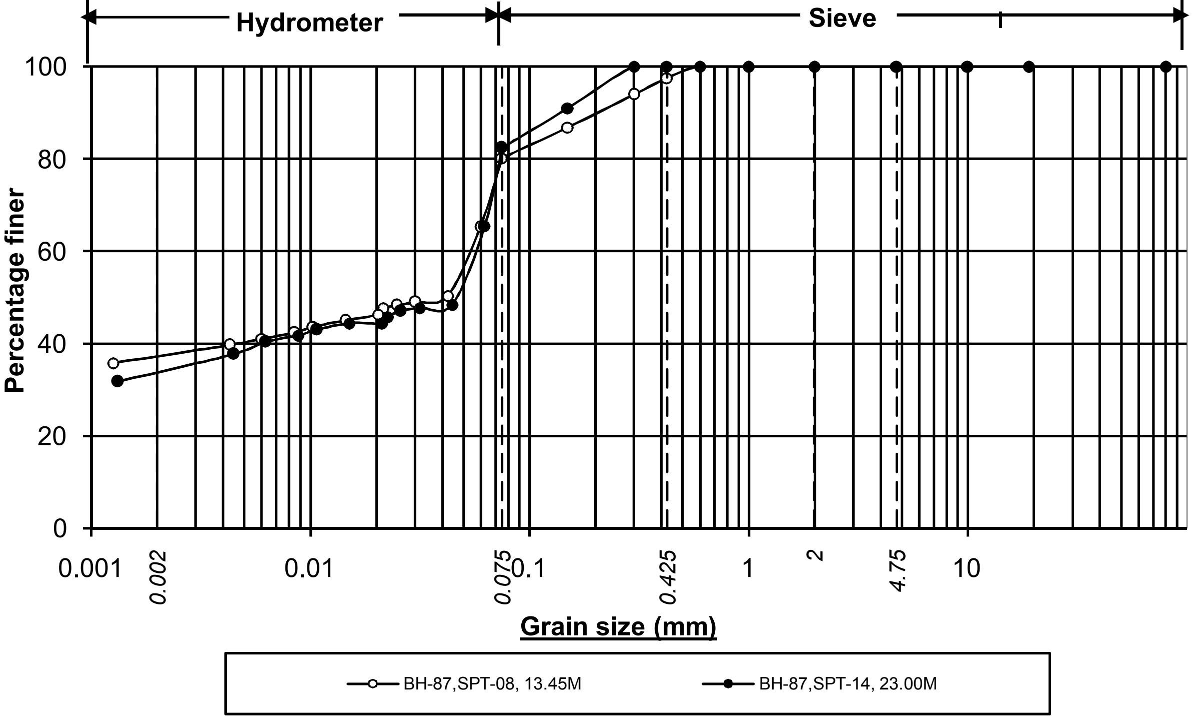
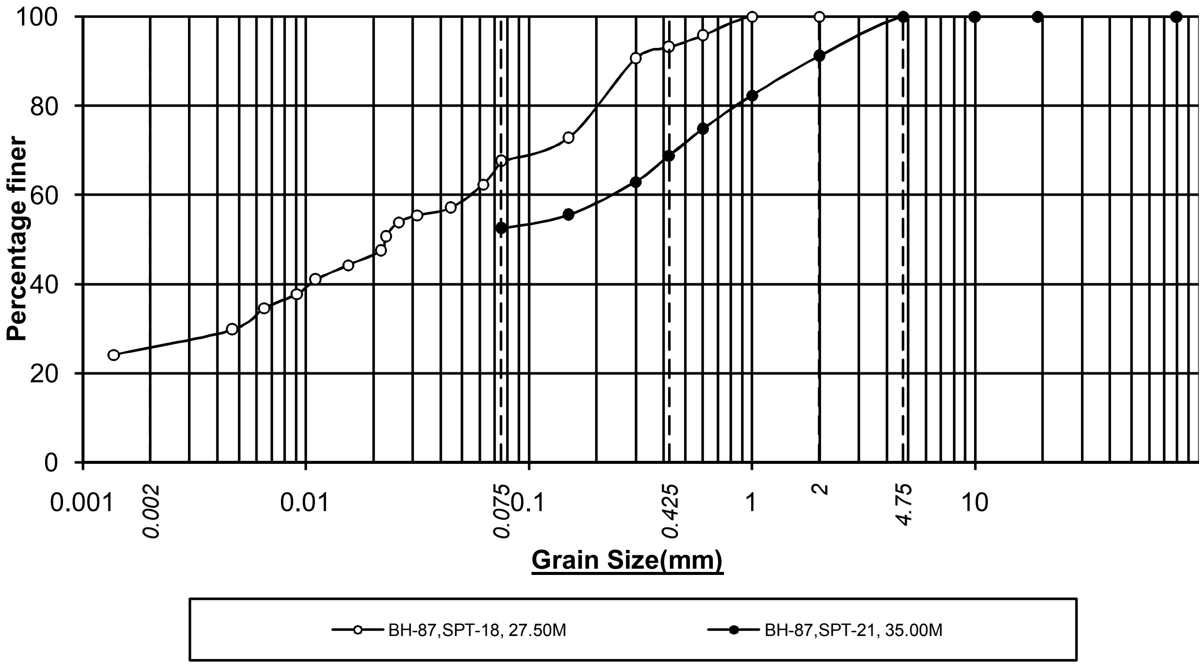
GRAIN SIZE DISTRIBUTION CURVES



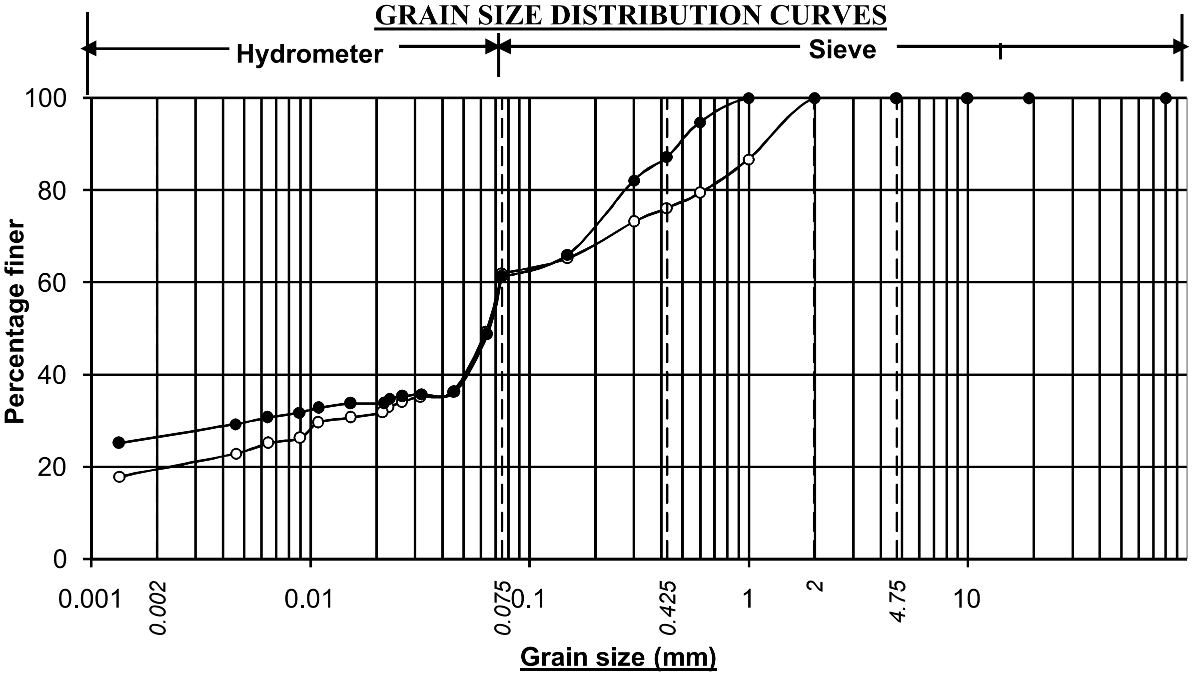
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-87,SPT-08, 13.45M	37.3	42.9	17.3	2.5	0.0	19.8		0.0
BH-87,SPT-14, 23.00M	33.8	48.7	17.5	0.0	0.0	17.5		0.0



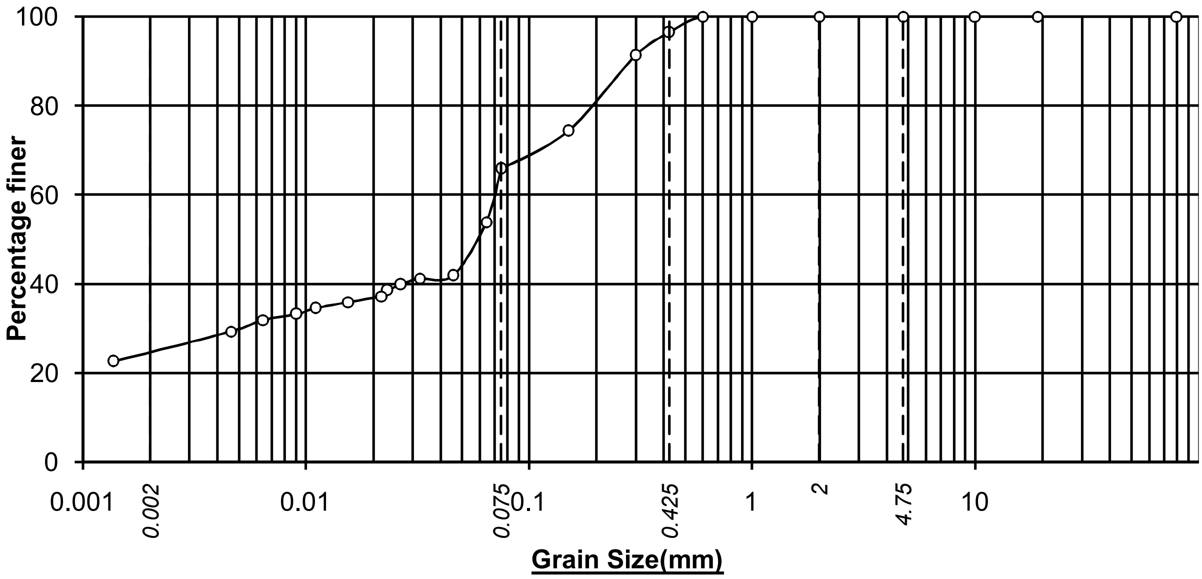
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-87,SPT-18, 27.50M	25.8	41.8	25.6	6.8	0.0	32.4		0.0
BH-87,SPT-21, 35.00M		52.5	16.4	22.3	8.8	47.5		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-88,SPT-07, 11.00M	19.5	42.5	14.1	23.9	0.0	38.0		0.0
BH-88,SPT-11, 17.00M	26.5	34.7	26.0	12.8	0.0	38.8		0.0



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-88,SPT-18, 27.50M	24.7	41.2	30.6	3.5	0.0	34.1		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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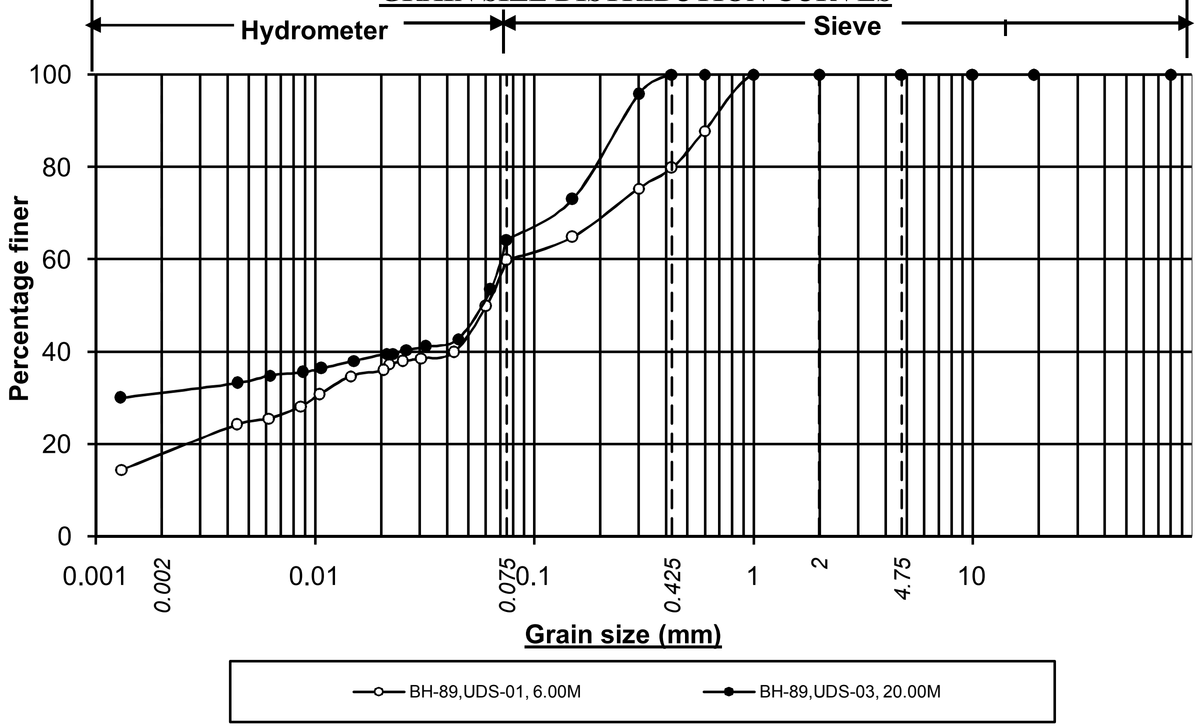
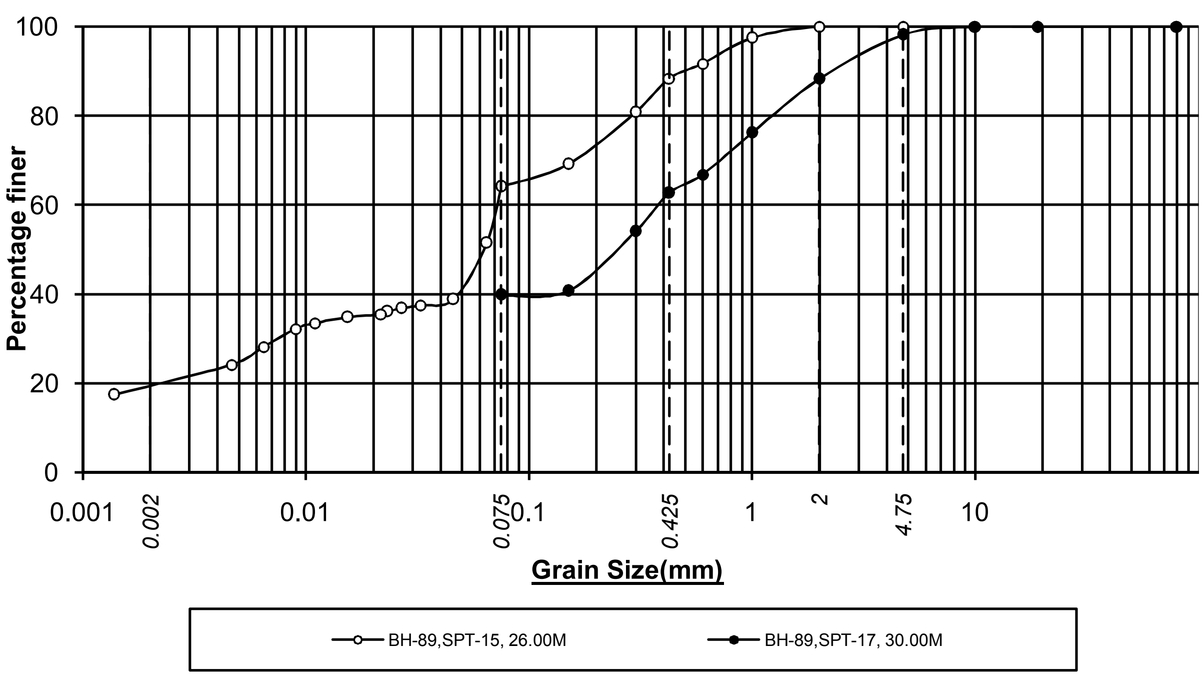
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-89,UDS-01, 6.00M	17.8	42.1	19.9	20.2	0.0	40.1		0.0
BH-89,UDS-03, 20.00M	31.2	33.0	35.8	0.0	0.0	35.8		0.0



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-89,SPT-15, 26.00M	19.4	44.7	24.2	11.7	0.0	35.9		0.0
BH-89,SPT-17, 30.00M		39.8	22.9	25.6	9.9	58.4		1.8

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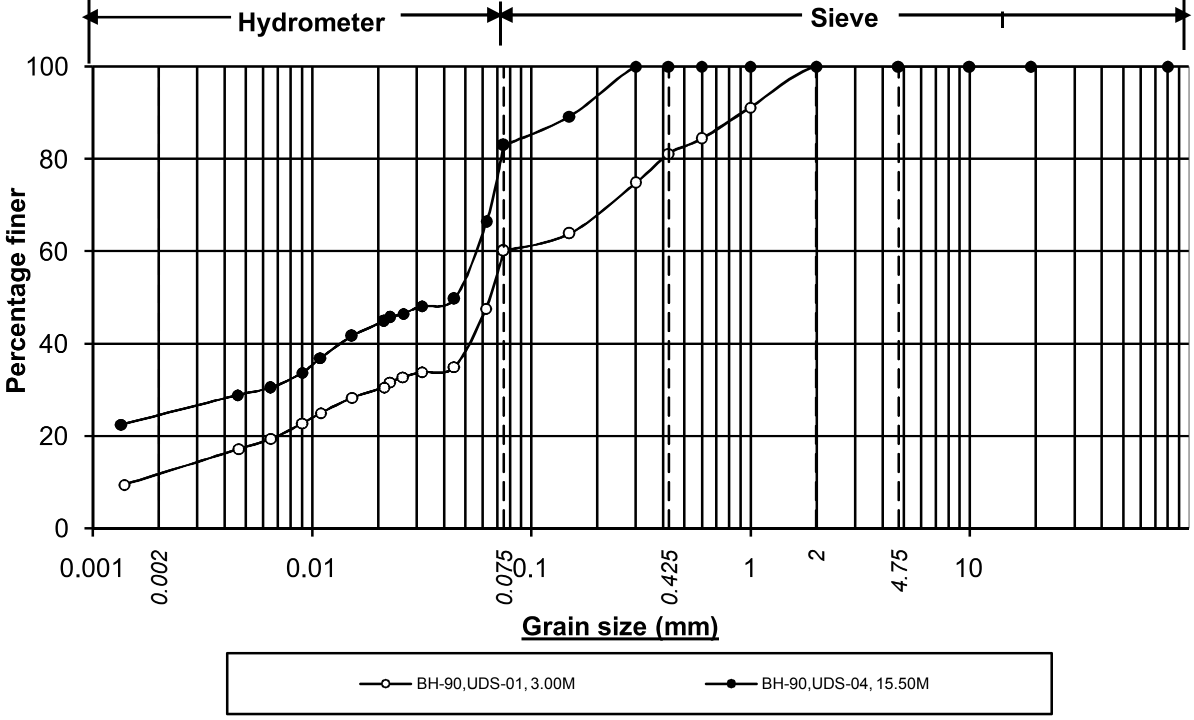
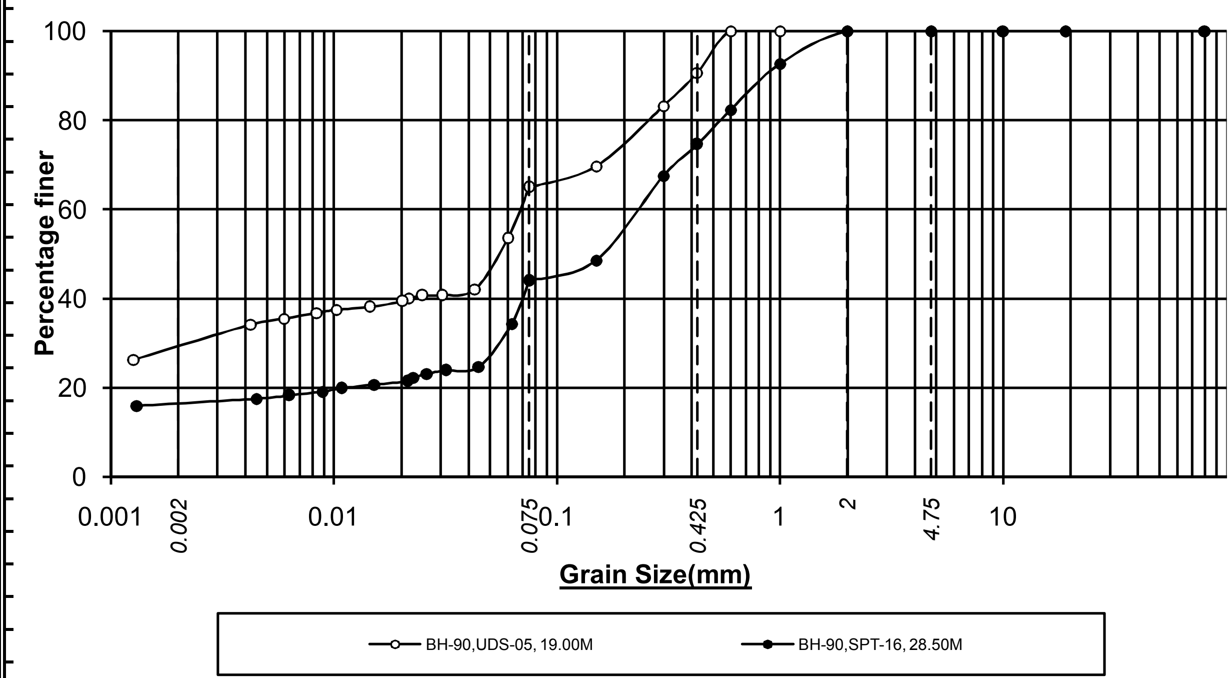
GRAIN SIZE DISTRIBUTION CURVES



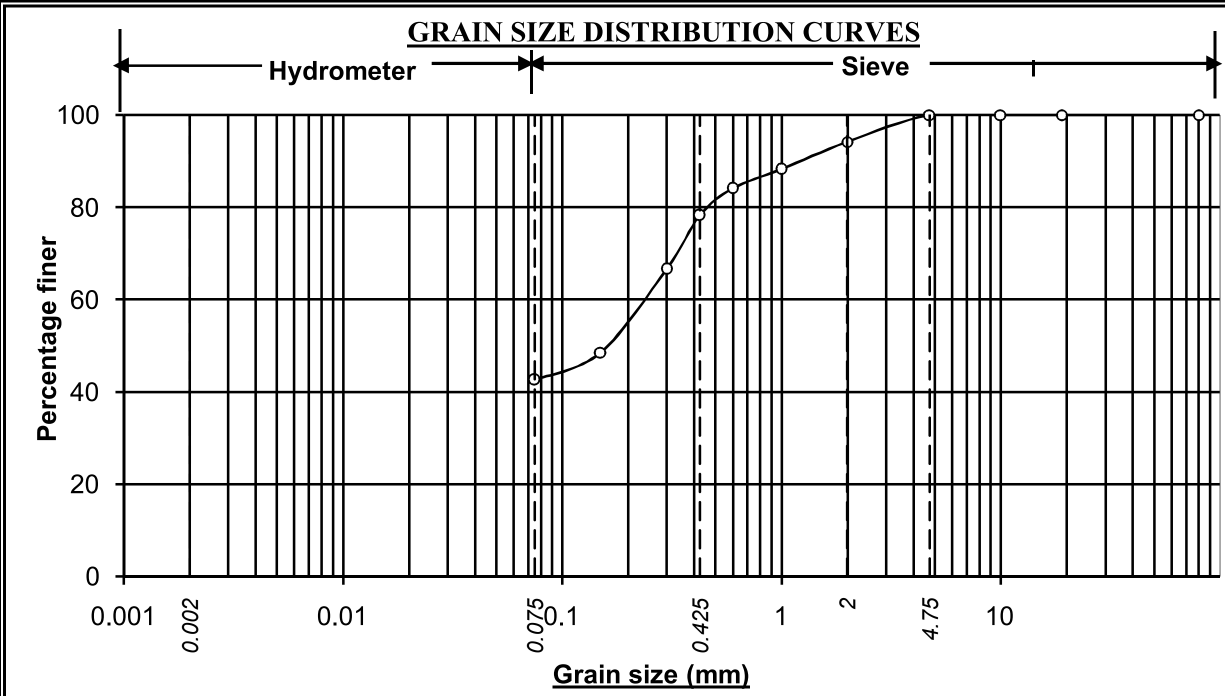
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-90,UDS-01, 3.00M	11.8	48.4	20.9	18.9	0.0	39.8		0.0
BH-90,UDS-04, 15.50M	24.5	58.5	17.0	0.0	0.0	17.0		0.0



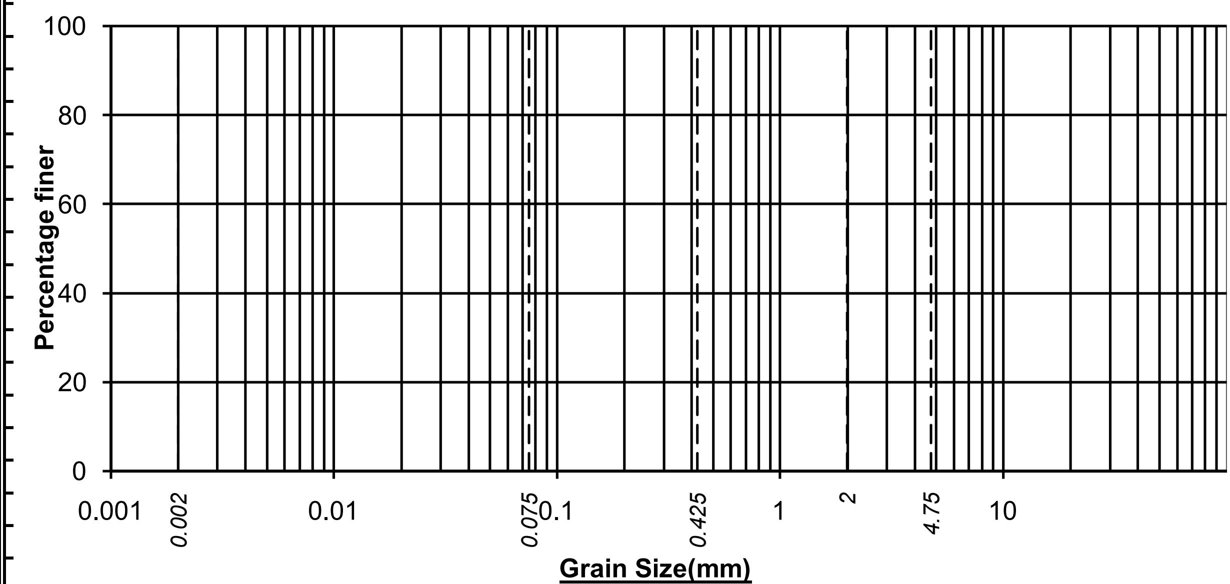
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-90,UDS-05, 19.00M	29.2	35.8	25.7	9.3	0.0	35.0		0.0
BH-90,SPT-16, 28.50M	16.4	27.6	30.6	25.4	0.0	56.0		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-90,SPT-17, 30.00M		42.7	35.6	15.9	5.8	57.3		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75			>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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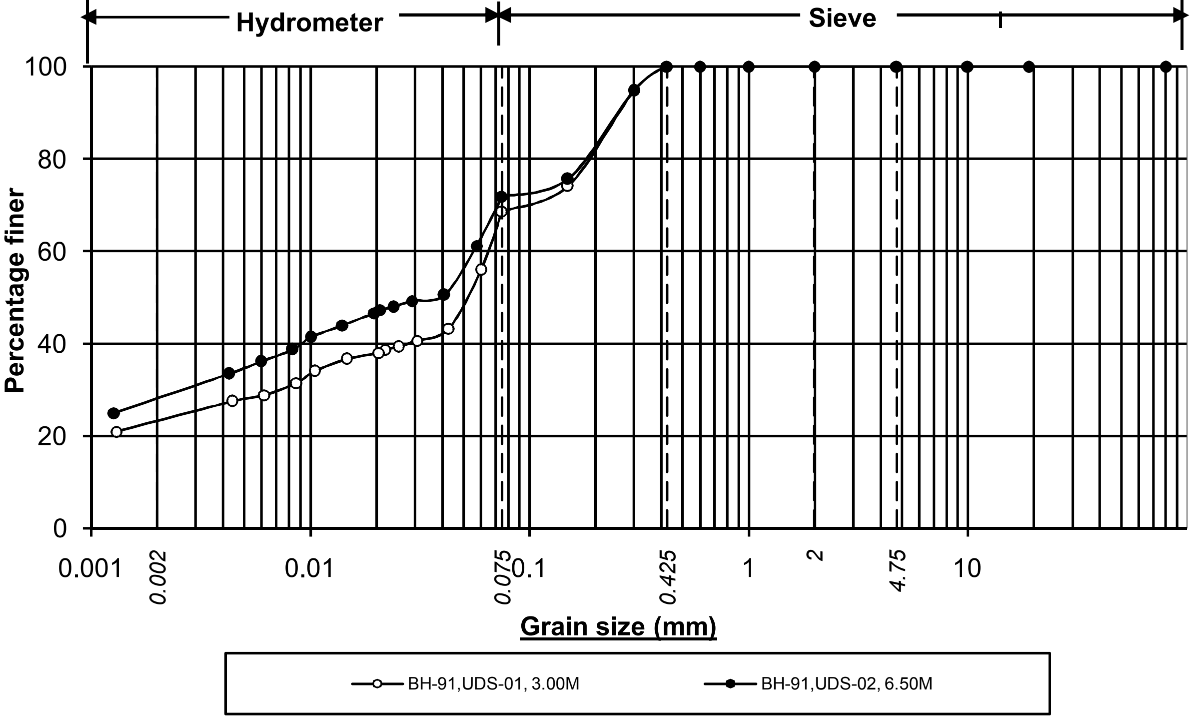
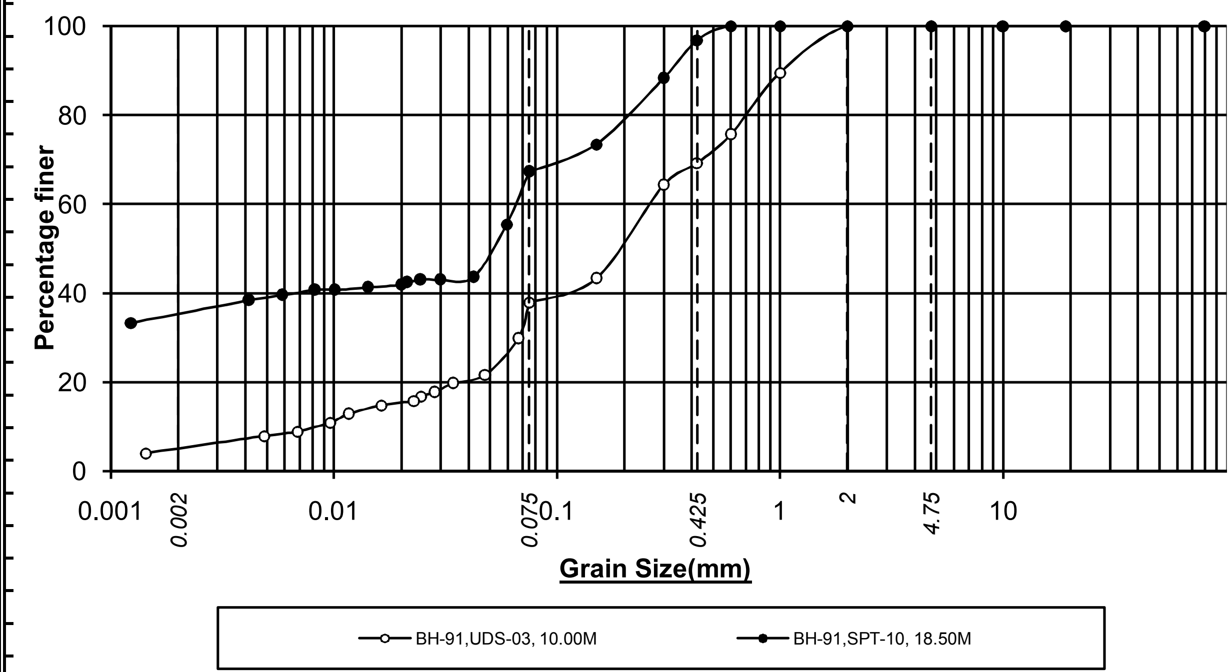


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-91,UDS-01, 3.00M	23.3	45.4	31.3	0.0	0.0	31.3		0.0
BH-91,UDS-02, 6.50M	28.1	43.7	28.2	0.0	0.0	28.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-91,UDS-03, 10.00M	5.0	32.9	31.3	30.8	0.0	62.1		0.0
BH-91,SPT-10, 18.50M	35.3	32.0	29.6	3.1	0.0	32.7		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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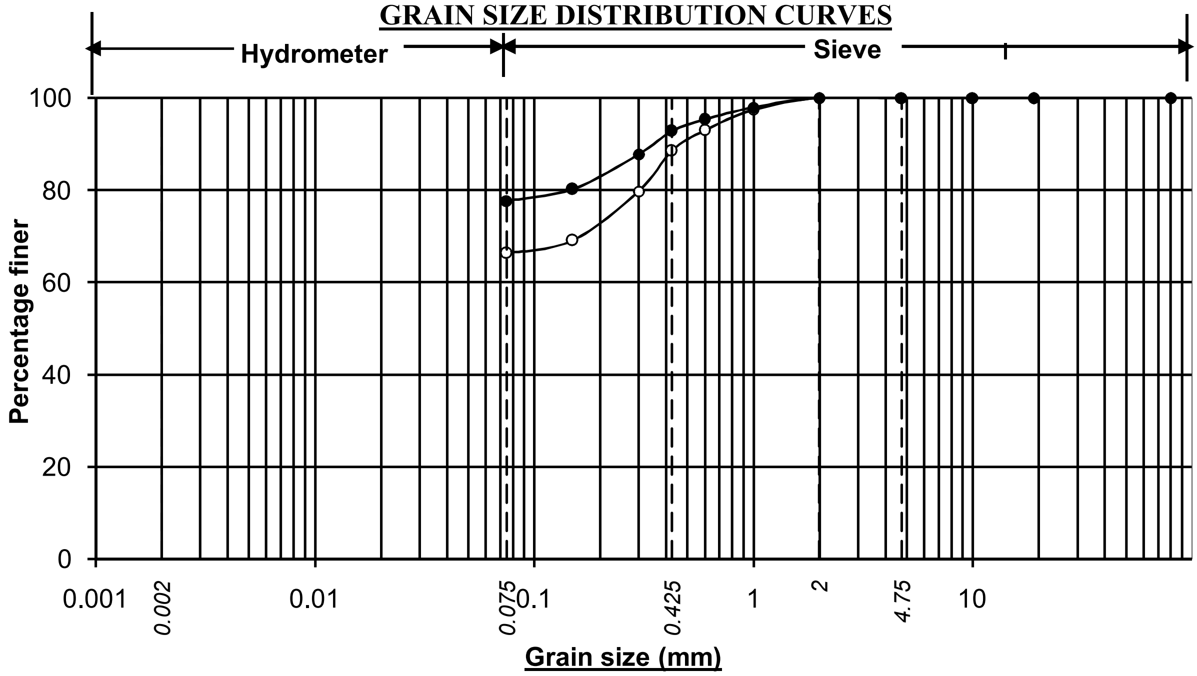
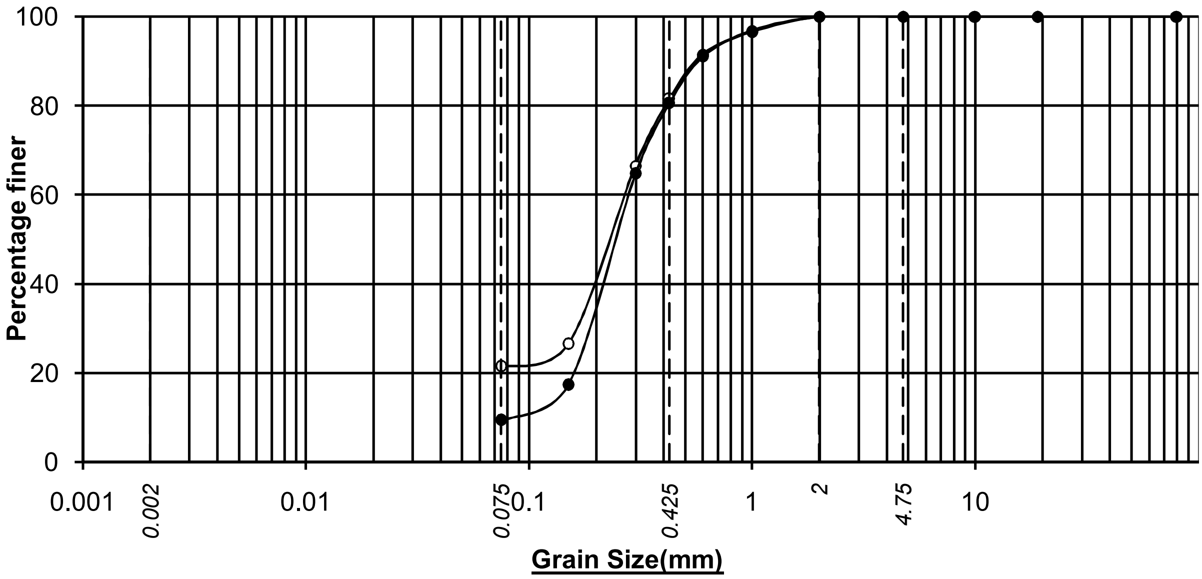
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-91,SPT-13, 24.50M		66.4	22.2	11.4	0.0	33.6		0.0
BH-91,SPT-16, 30.00M		77.7	15.2	7.1	0.0	22.3		0.0



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-91,SPT-17, 32.50M		21.4	60.1	18.5	0.0	78.6		0.0
BH-91,SPT-20, 38.00M		9.3	71.2	19.5	0.0	90.7		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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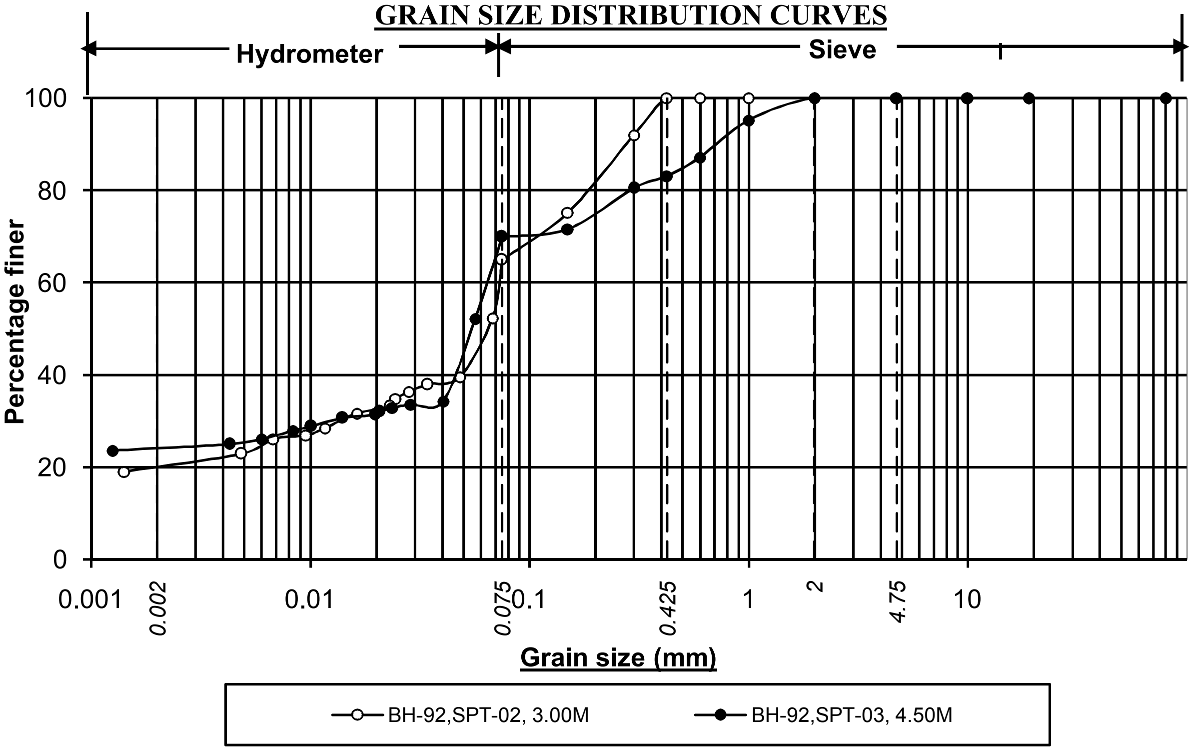
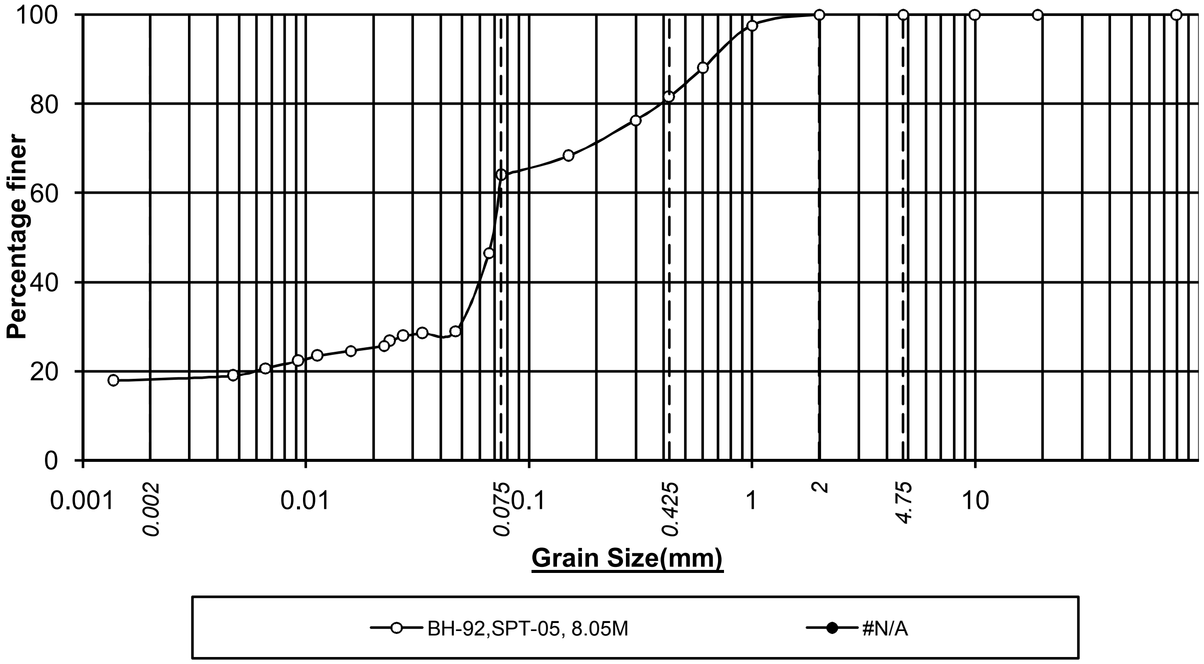


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-92,SPT-02, 3.00M	20.1	44.9	35.0	0.0	0.0	35.0		0.0
BH-92,SPT-03, 4.50M	24.1	45.9	13.1	16.9	0.0	30.0		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-92,SPT-05, 8.05M	18.2	45.8	17.6	18.4	0.0	36.0		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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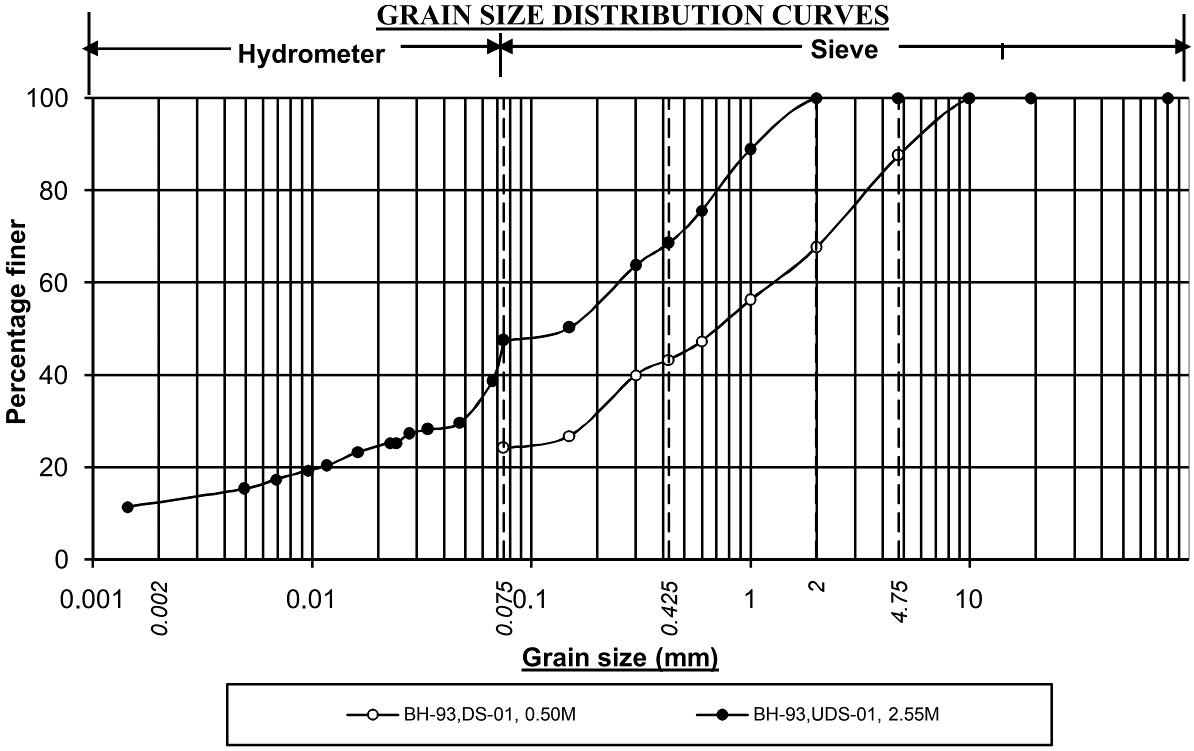
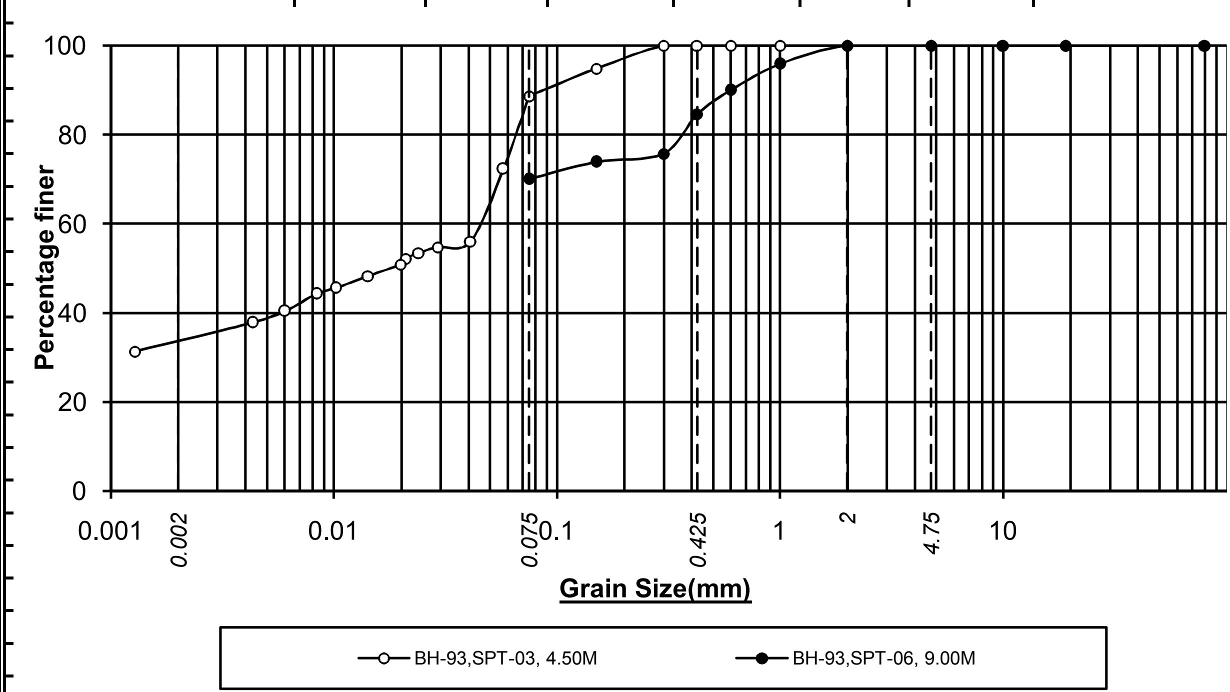


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-93,DS-01, 0.50M		24.2	19.2	24.3	19.9	63.4		12.4
BH-93,UDS-01, 2.55M	12.4	35.1	21.1	31.4	0.0	52.5		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-93,SPT-03, 4.50M	33.7	55.0	11.3	0.0	0.0	11.3		0.0
BH-93,SPT-06, 9.00M		70.0	14.6	15.4	0.0	30.0		0.0

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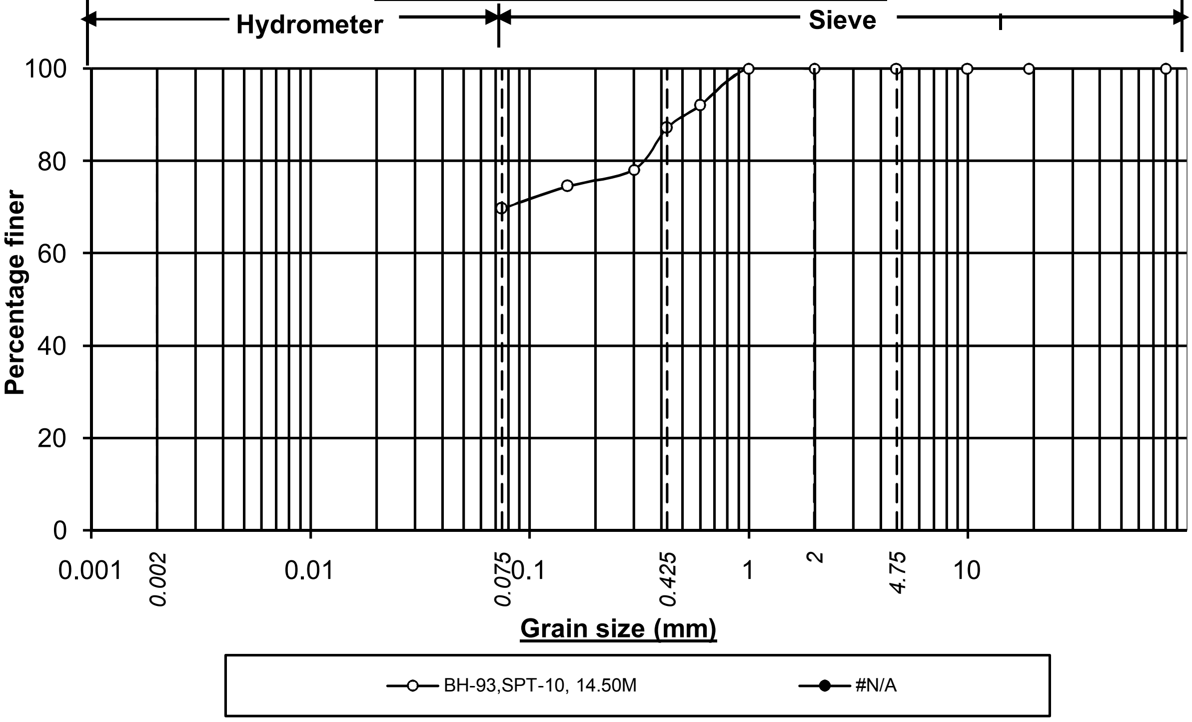
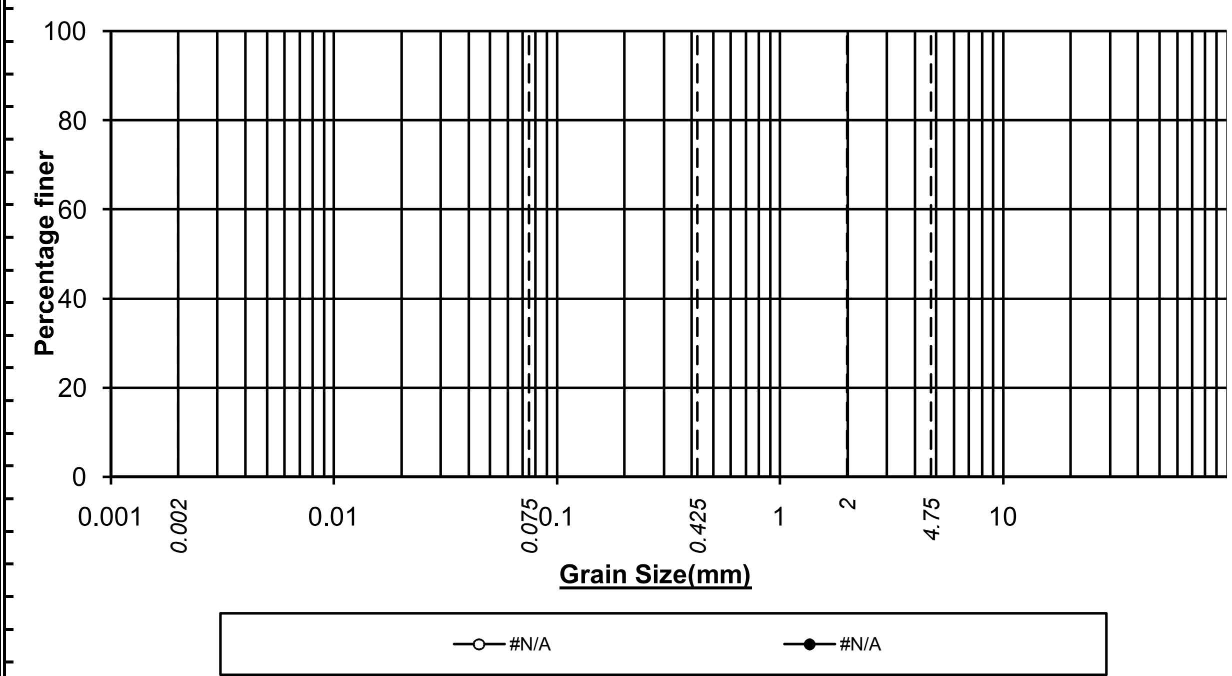
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-93,SPT-10, 14.50M		69.7	17.5	12.8	0.0	30.3		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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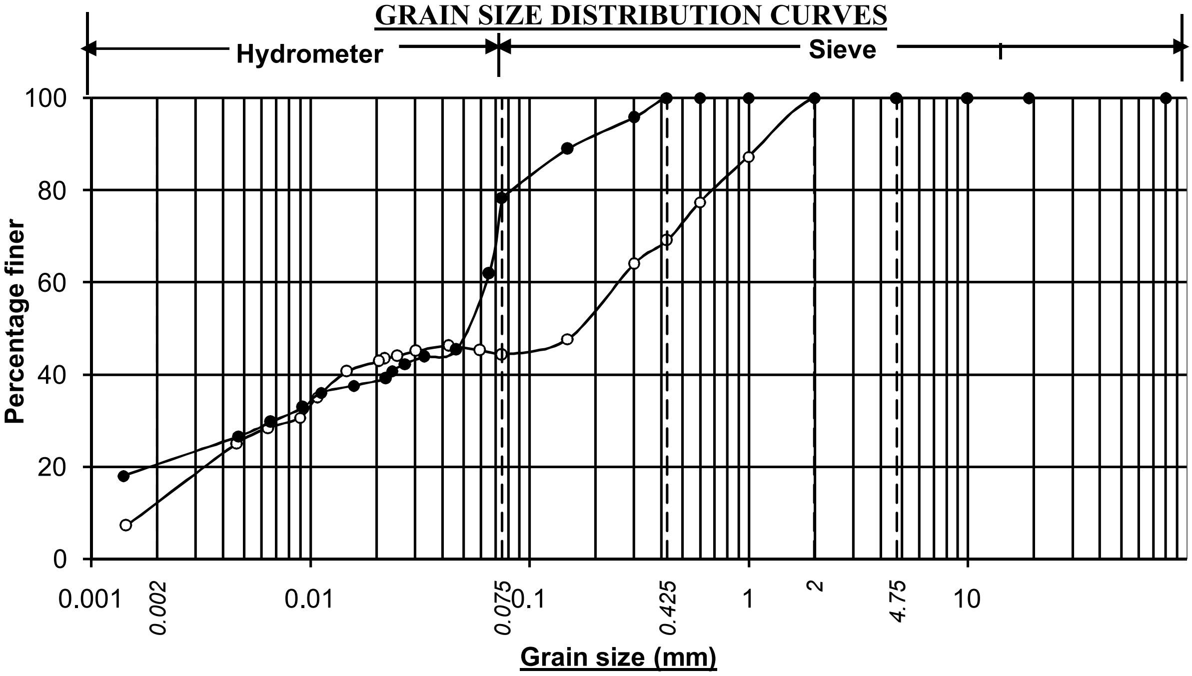
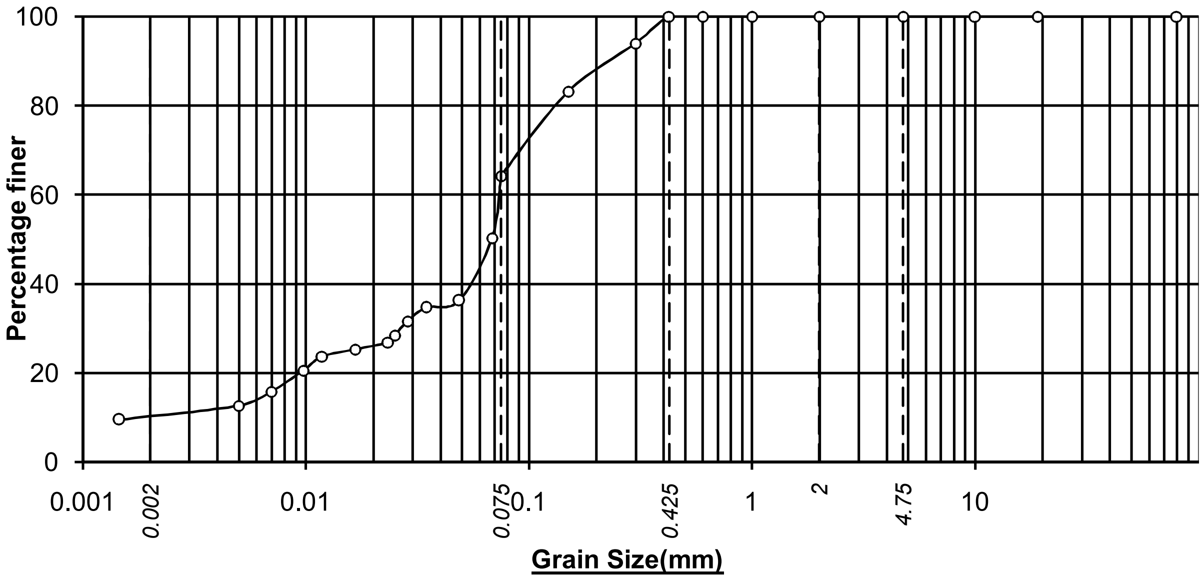
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-94,UDS-01, 2.55M	12.2	32.1	24.8	30.9	0.0	55.7		0.0
BH-94,SPT-03, 4.50M	20.5	57.9	21.6	0.0	0.0	21.6		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-94,SPT-07, 10.50M	10.3	53.9	35.8	0.0	0.0	35.8		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

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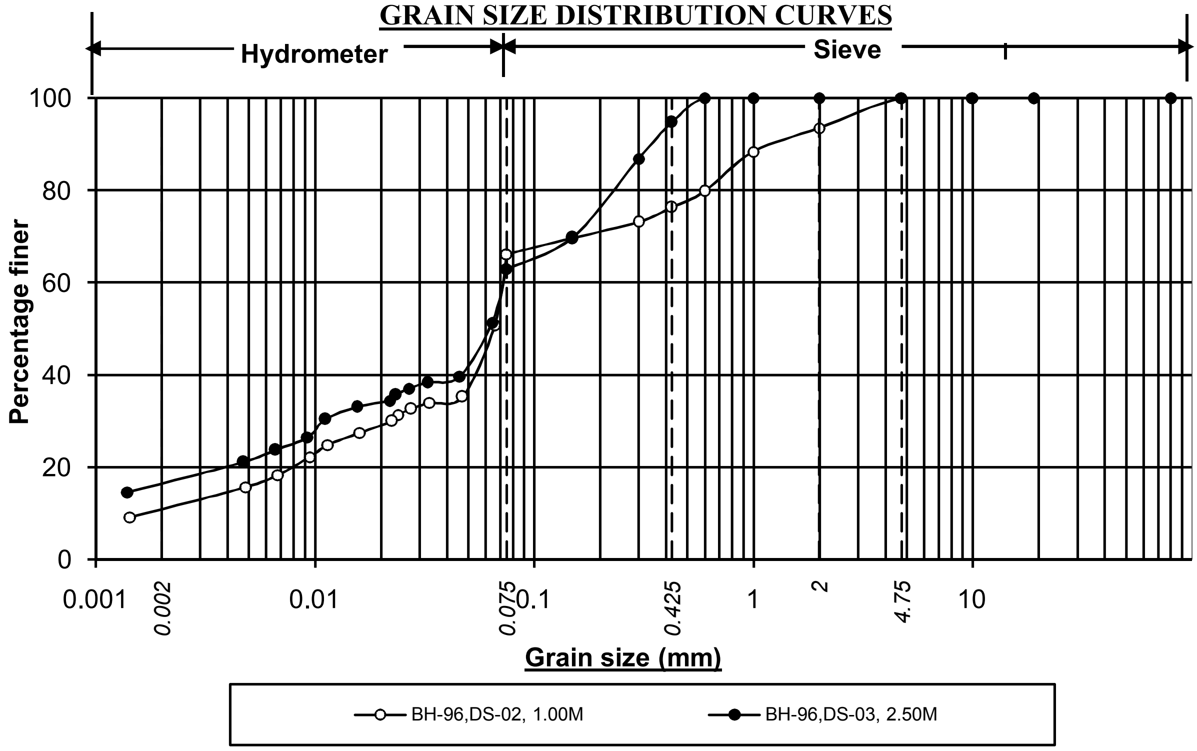
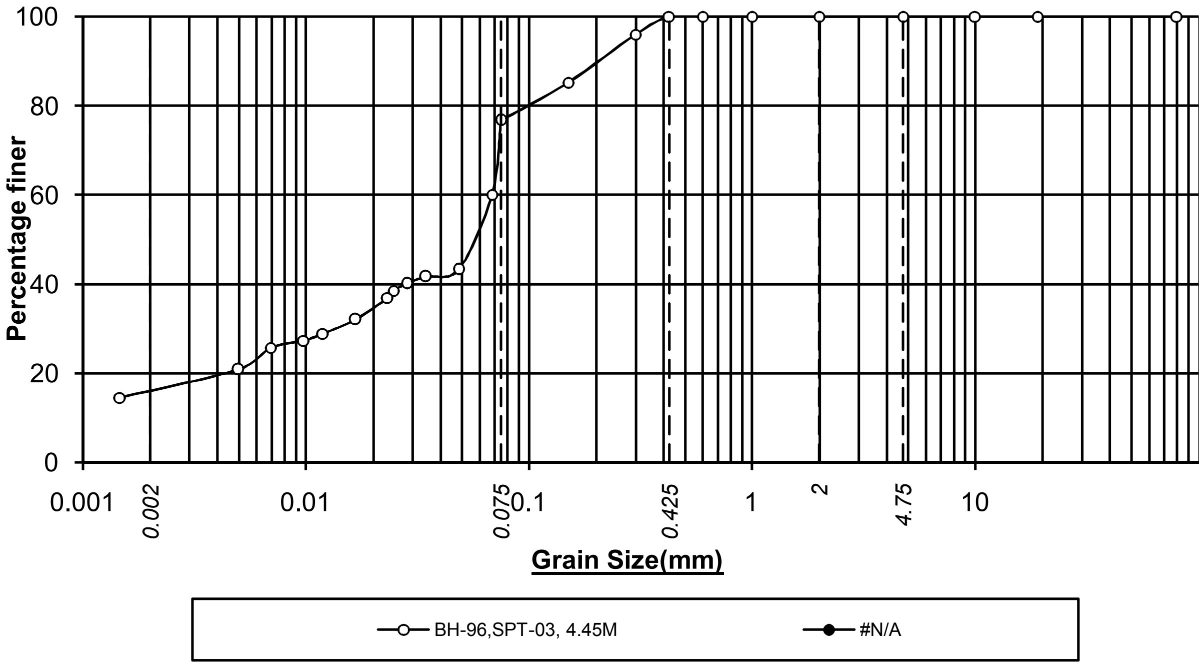


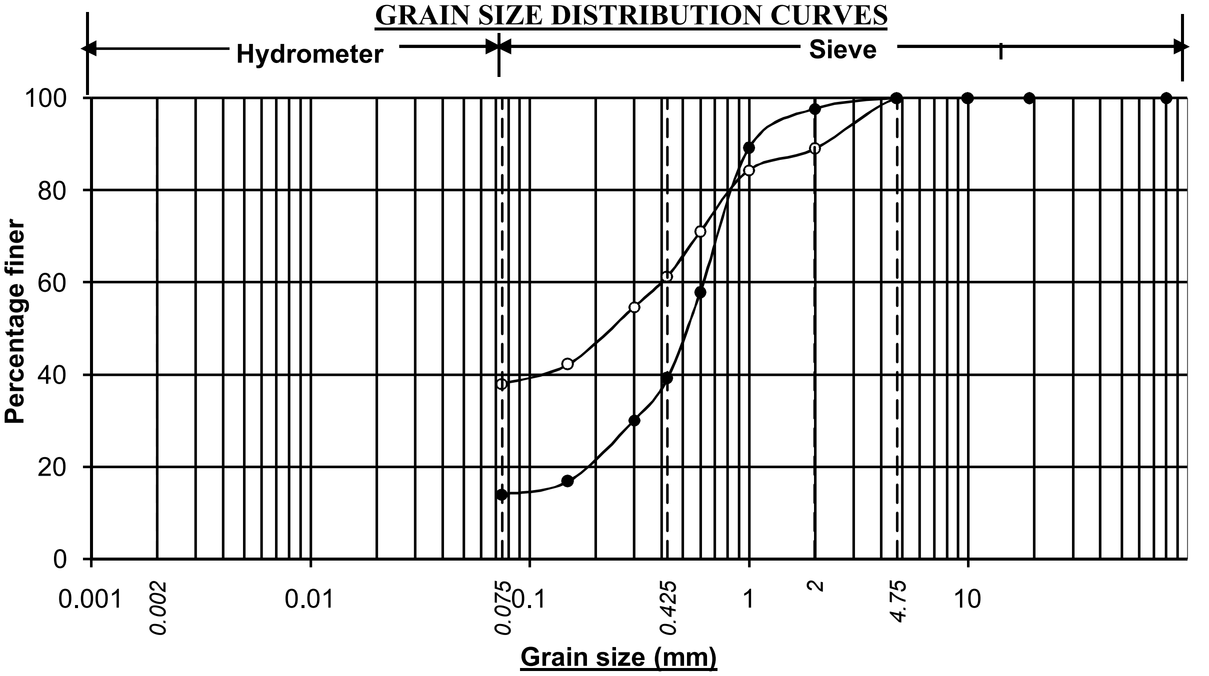
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*			*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-96,DS-02, 1.00M	10.9	55.2	10.2	17.2	6.5	33.9		0.0
BH-96,DS-03, 2.50M	16.5	46.5	31.8	5.2	0.0	37.0		0.0



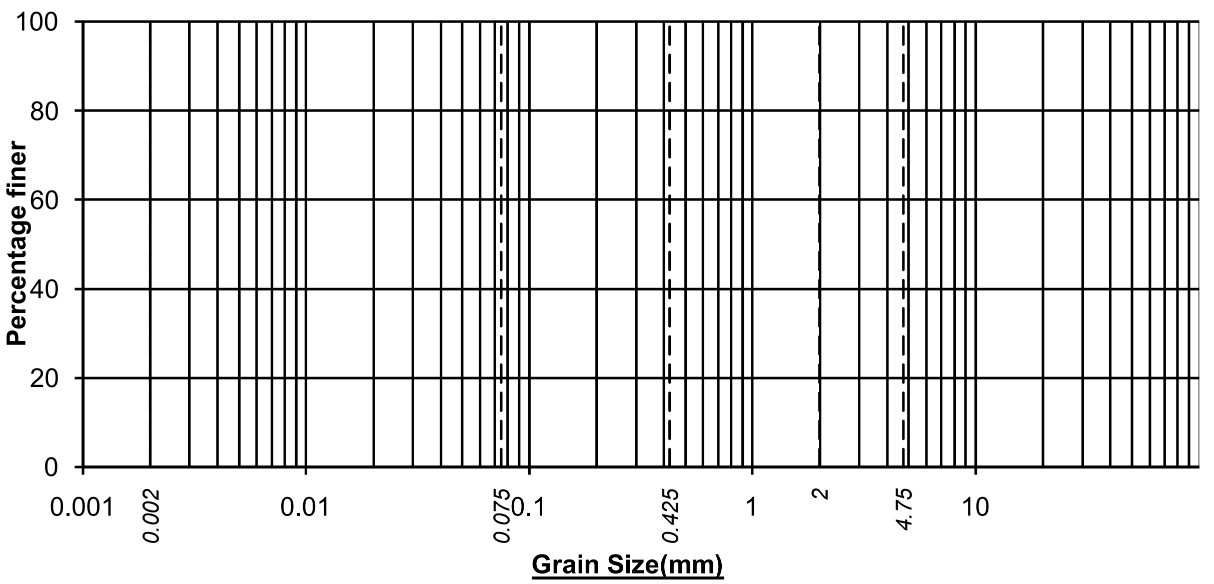
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*			*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**	**Total sand**	**Weighted mean dia (mm)**	**Gravel (%)**
BH-96,SPT-03, 4.45M	16.1	60.7	23.2	0.0	0.0	23.2		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

GRAIN SIZE DISTRIBUTION CURVES

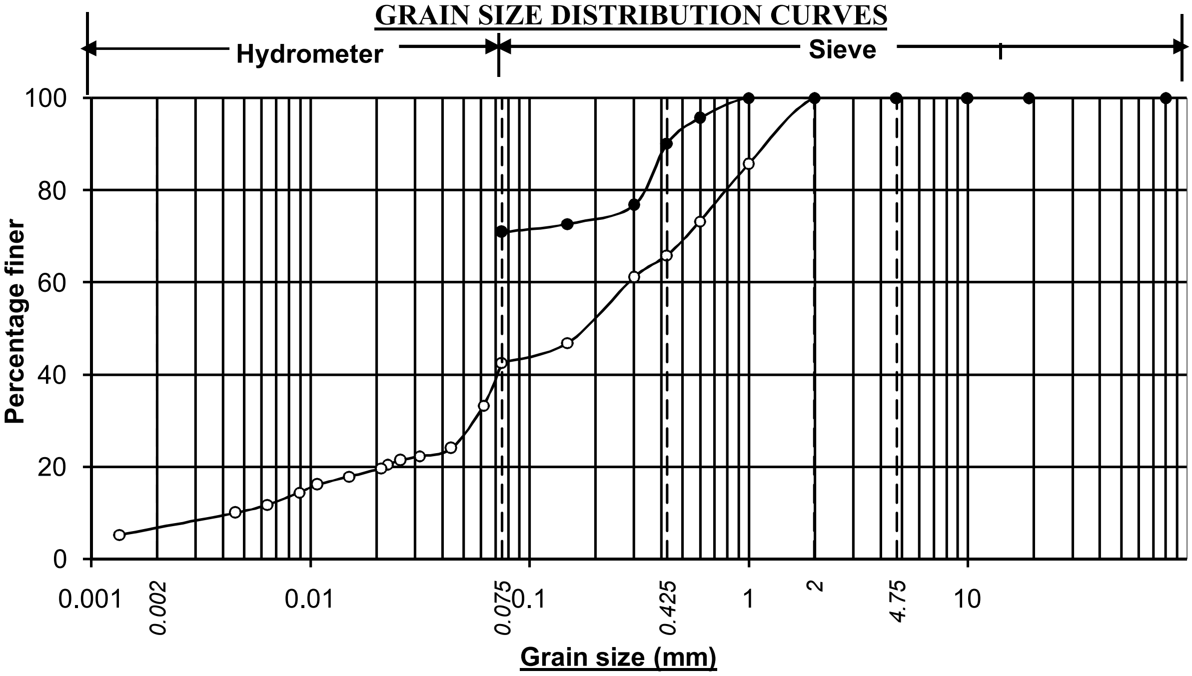


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-97,SPT-01, 1.7M		38.0	23.3	27.7	11.0	62.0		0.0
BH-97,DS-03, 2.50M		14.0	25.2	58.4	2.4	86.0		0.0

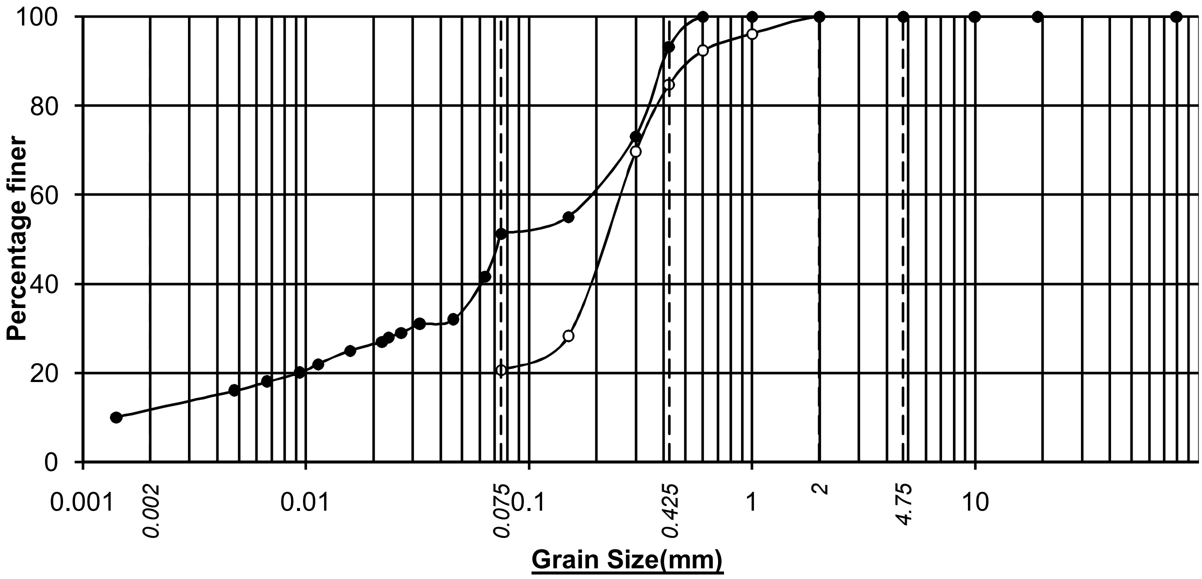


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**



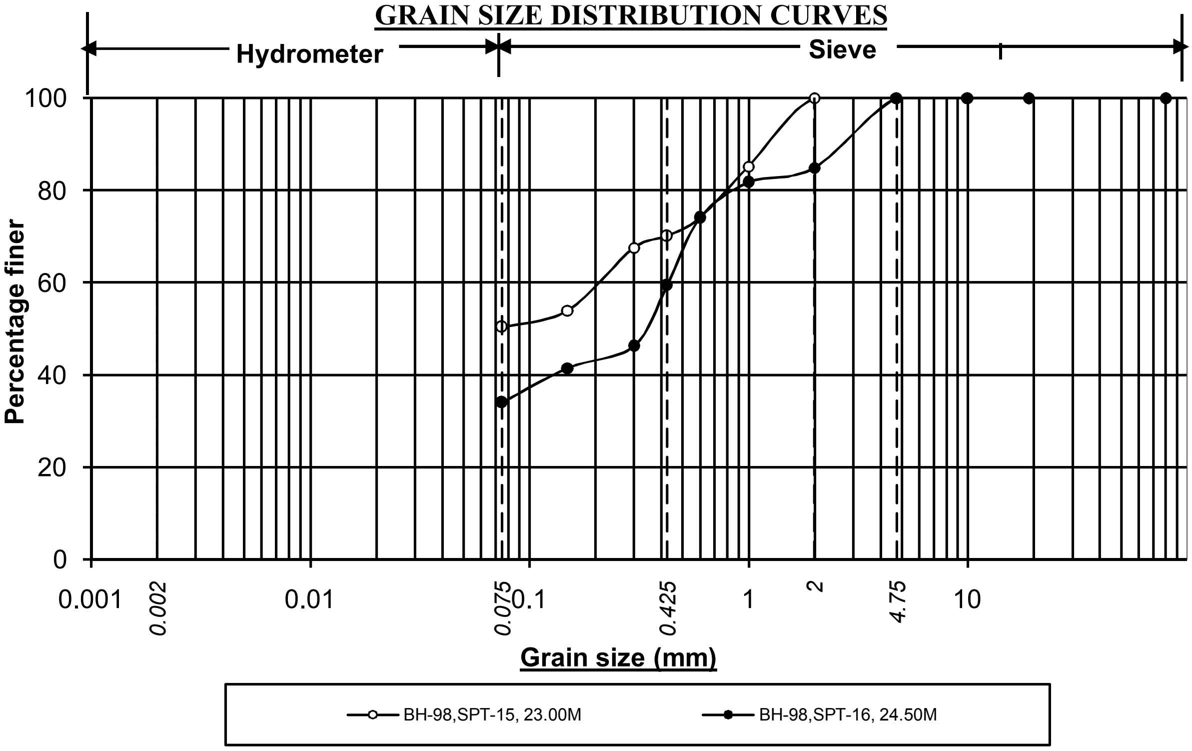
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-98,UDS-01, 2.60M	6.8	35.8	23.3	34.1	0.0	57.4		0.0
BH-98,SPT-05, 7.50M		70.9	19.2	9.9	0.0	29.1		0.0



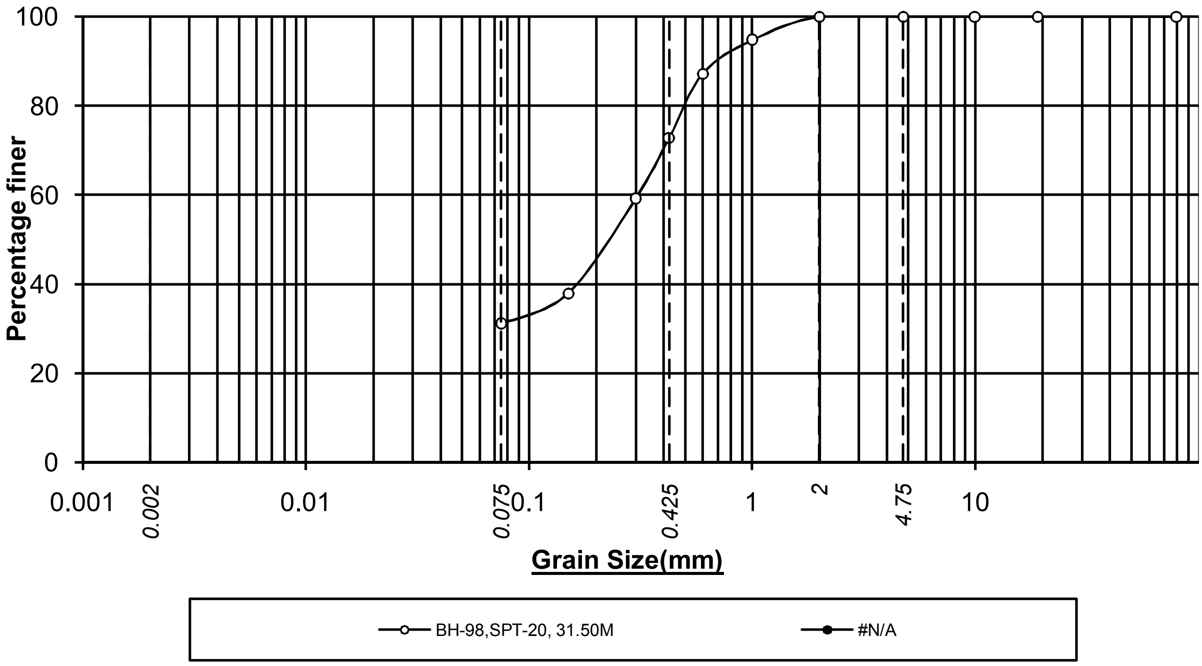
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-98,SPT-06, 9.00M		20.6	64.1	15.3	0.0	79.4		0.0
BH-98,SPT-13, 19.50M	11.7	39.6	41.9	6.8	0.0	48.7		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



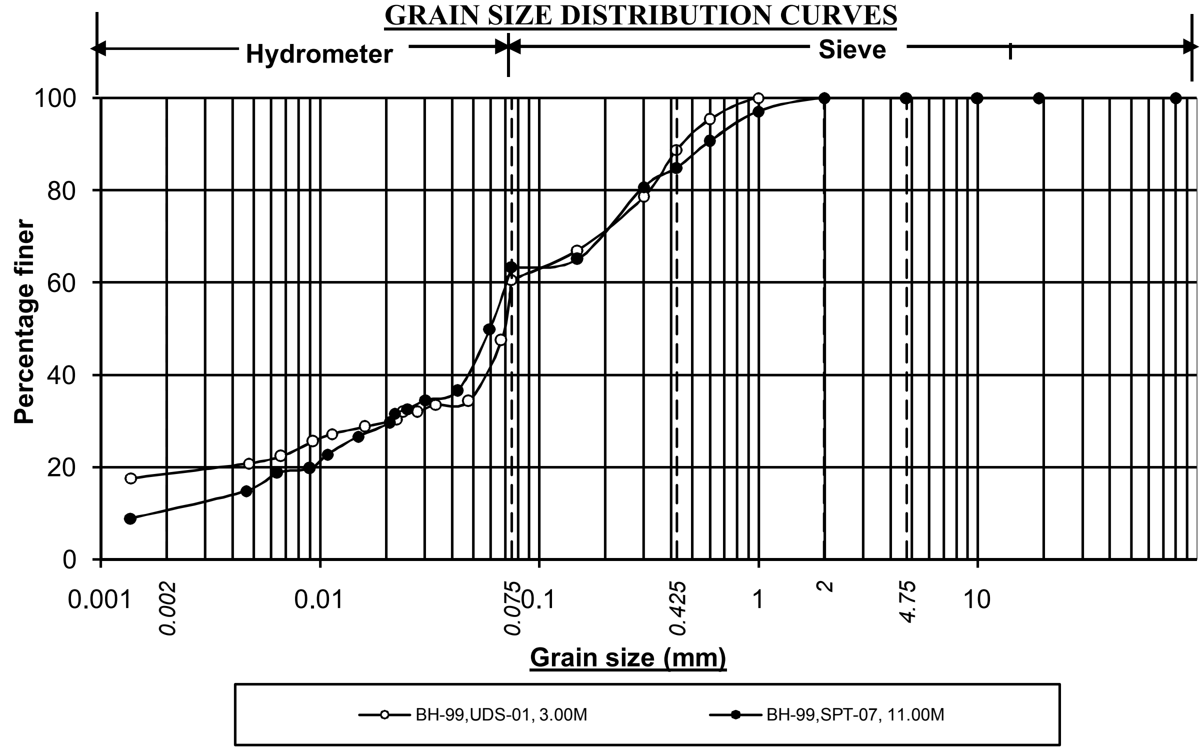
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-98,SPT-15, 23.00M		50.4	19.7	29.9	0.0	49.6		0.0
BH-98,SPT-16, 24.50M		34.0	25.4	25.5	15.1	66.0		0.0



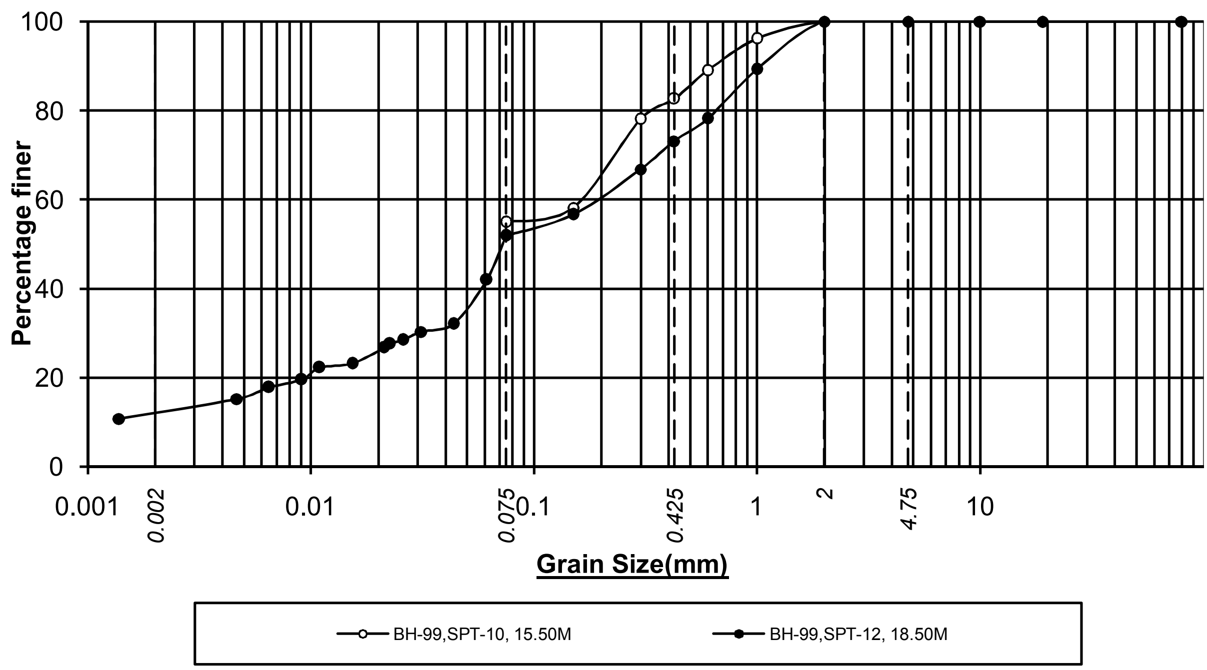
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	**Total sand**	**Weighted mean dia (mm)**	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-98,SPT-20, 31.50M		31.1	41.7	27.2	0.0	68.9		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. **Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-99,UDS-01, 3.00M	18.5	42.1	28.2	11.2	0.0	39.4		0.0
BH-99,SPT-07, 11.00M	10.7	52.7	21.5	15.1	0.0	36.6		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-99,SPT-10, 15.50M		54.9	27.8	17.3	0.0	45.1		0.0
BH-99,SPT-12, 18.50M	12.0	39.8	21.3	26.9	0.0	48.2		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	Job No. 4095

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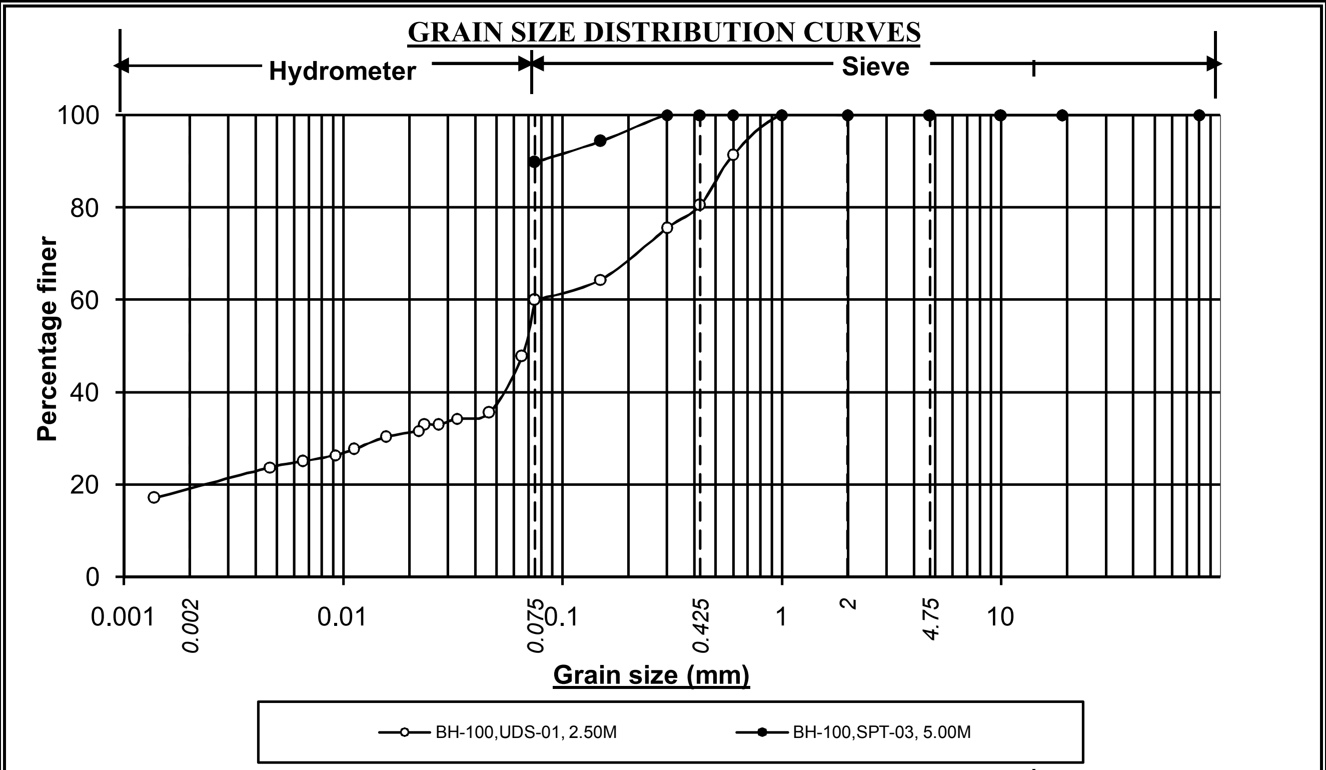
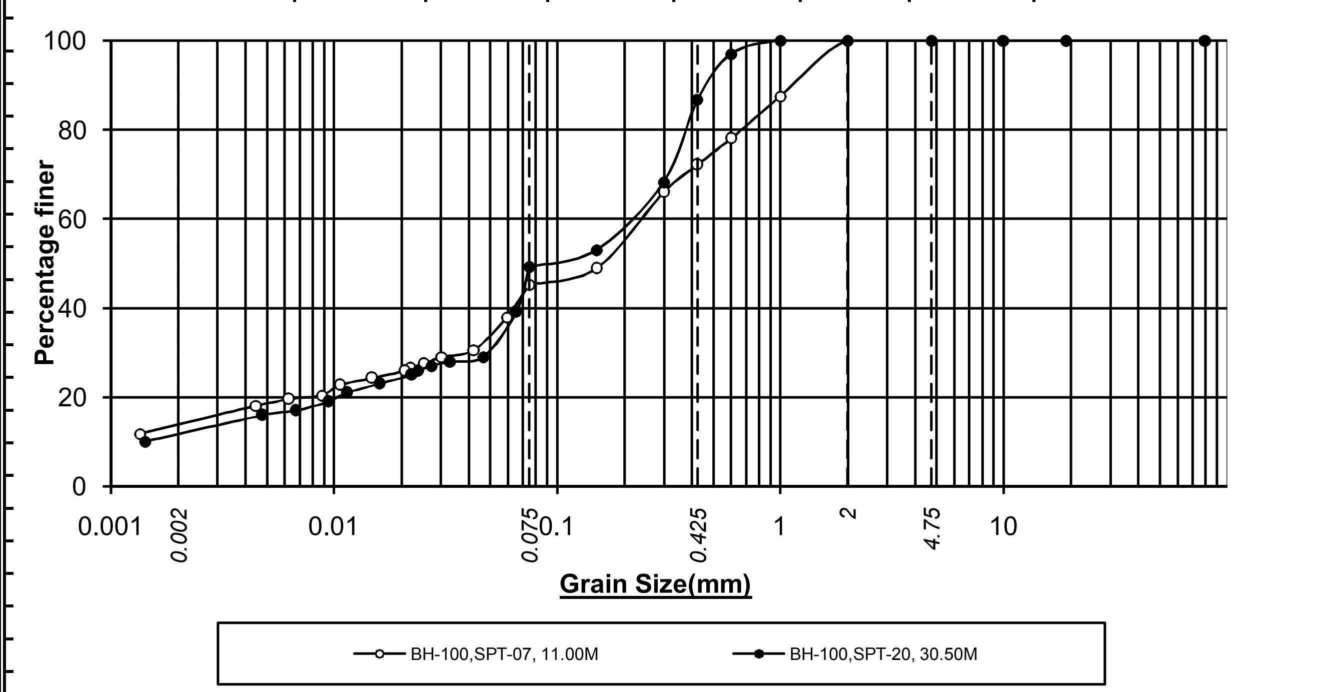


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-100,UDS-01, 2.50M	19.1	40.9	20.5	19.5	0.0	40.0		0.0
BH-100,SPT-03, 5.00M		89.8	10.2	0.0	0.0	10.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-100,SPT-07, 11.00M	13.8	31.4	27.0	27.8	0.0	54.8		0.0
BH-100,SPT-20, 30.50M	11.7	37.6	37.4	13.3	0.0	50.7		0.0

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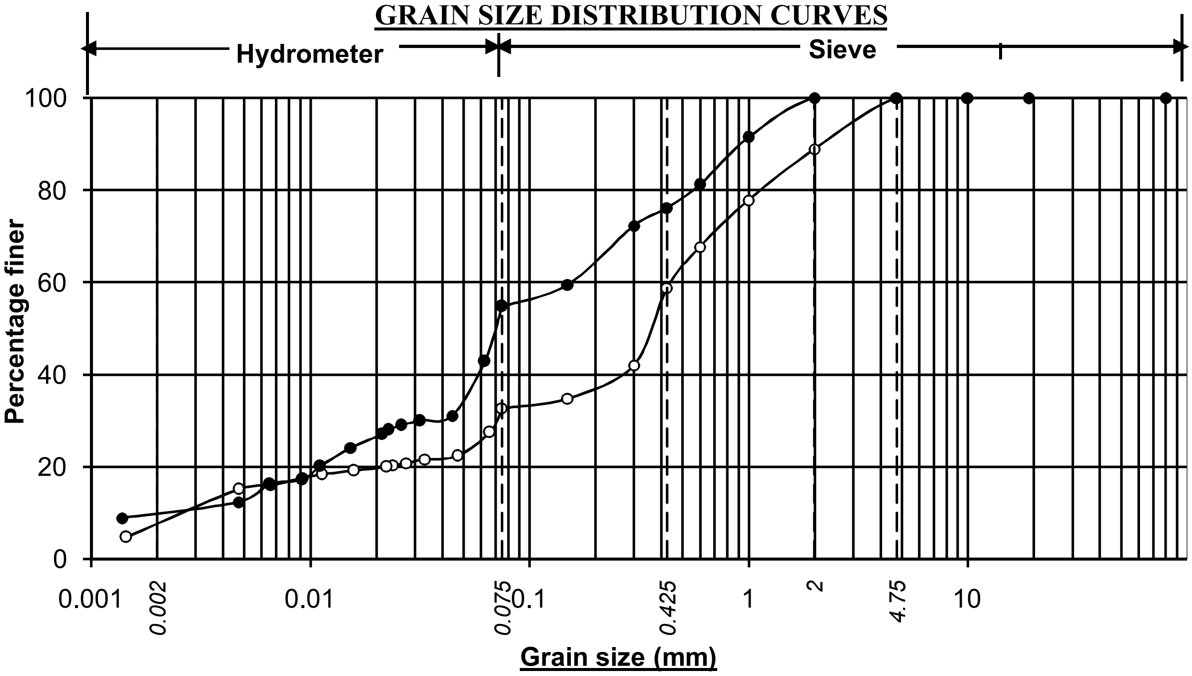
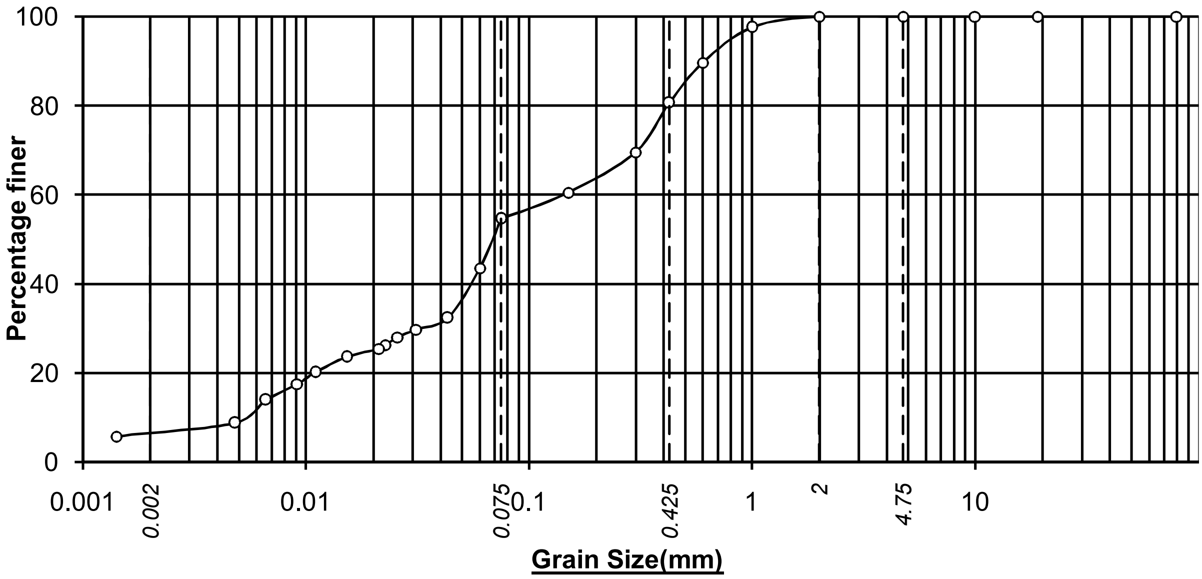
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND01,SPT-01, 1.50M	7.6	25.1	26.1	30.1	11.1	67.3		0.0
BH-MND01,SPT-06, 9.50M	9.9	45.0	21.2	23.9	0.0	45.1		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND01,SPT-08, 12.50M	6.5	48.1	26.1	19.3	0.0	45.4		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

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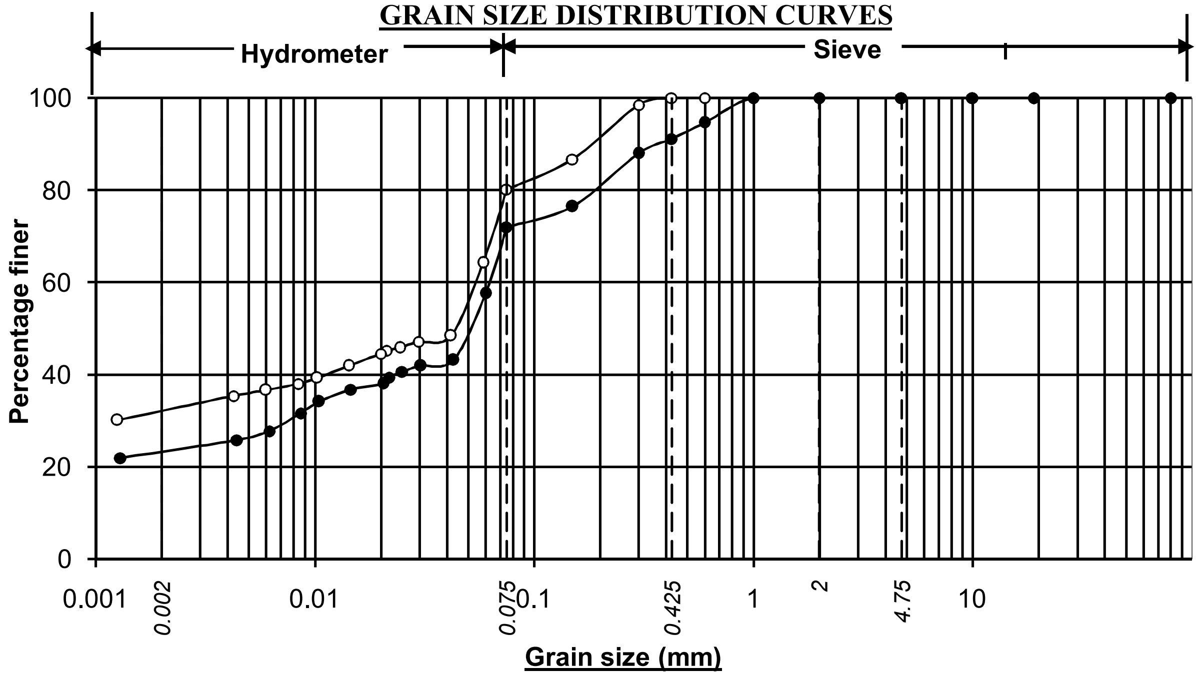
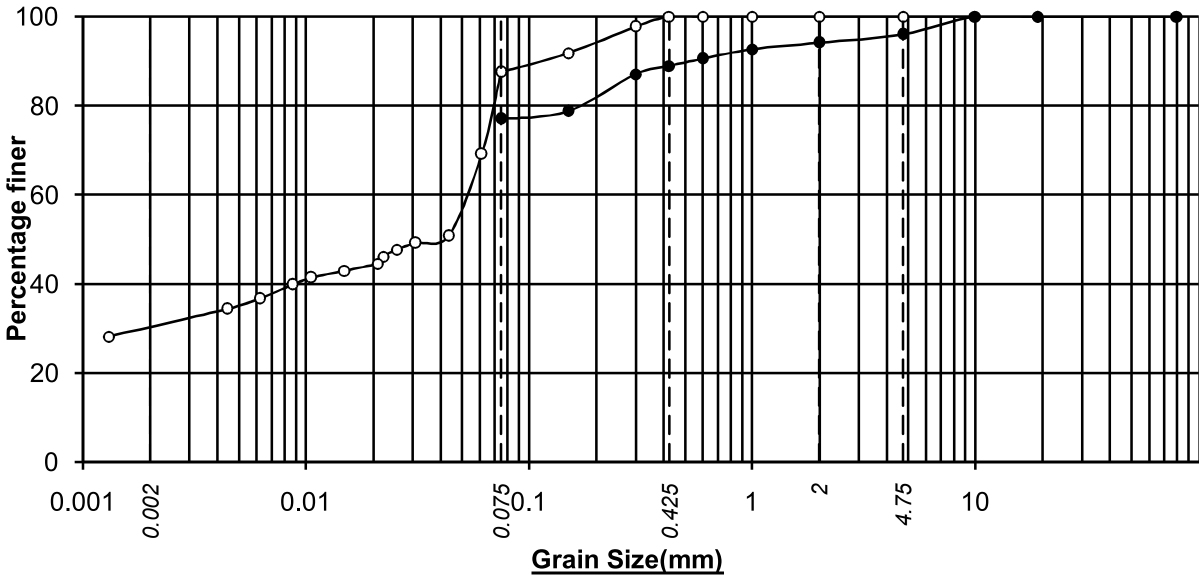
GRAIN SIZE DISTRIBUTION CURVES



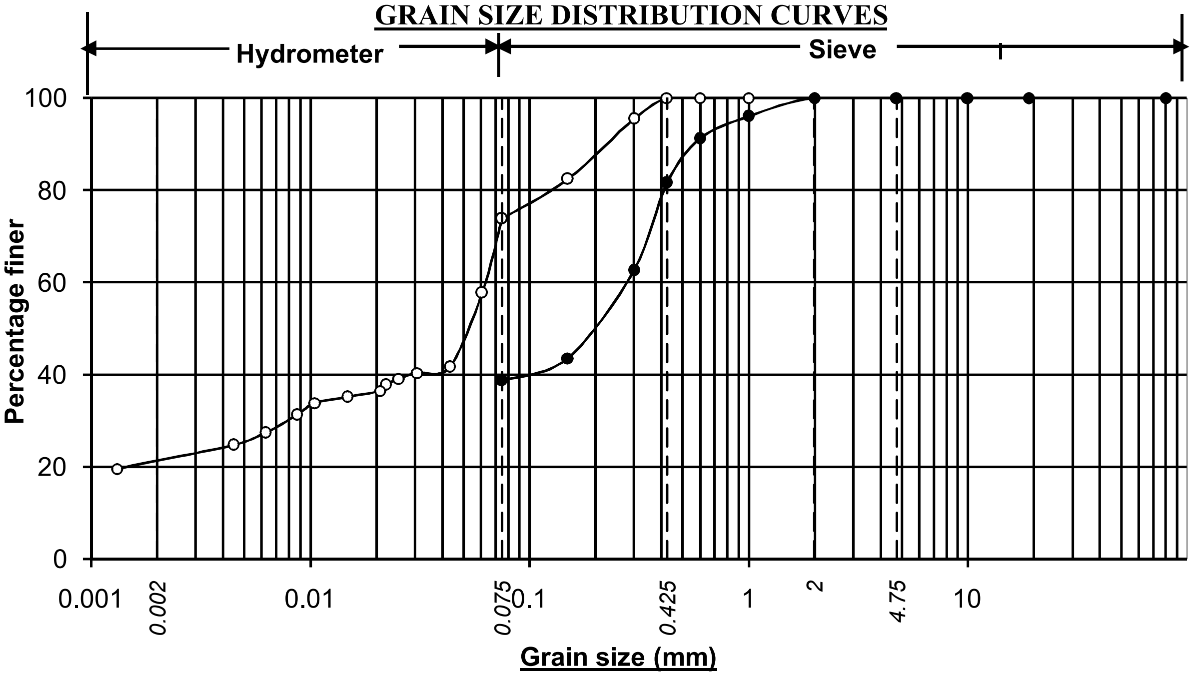
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND02,UDS-01, 3.15M	32.1	48.0	19.9	0.0	0.0	19.9		0.0
BH-MND02,SPT-03, 5.00M	23.3	48.7	19.2	8.8	0.0	28.0		0.0



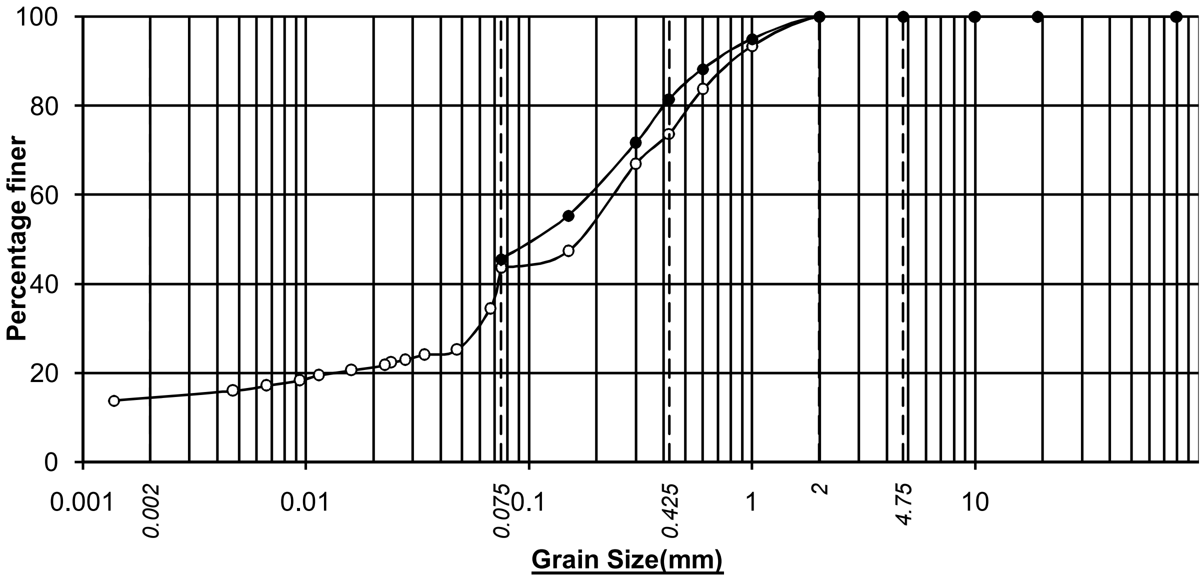
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND02,SPT-07, 11.00M	30.3	57.3	12.4	0.0	0.0	12.4		0.0
BH-MND02,SPT-09, 14.00M		77.1	11.8	5.3	1.8	18.9		4.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



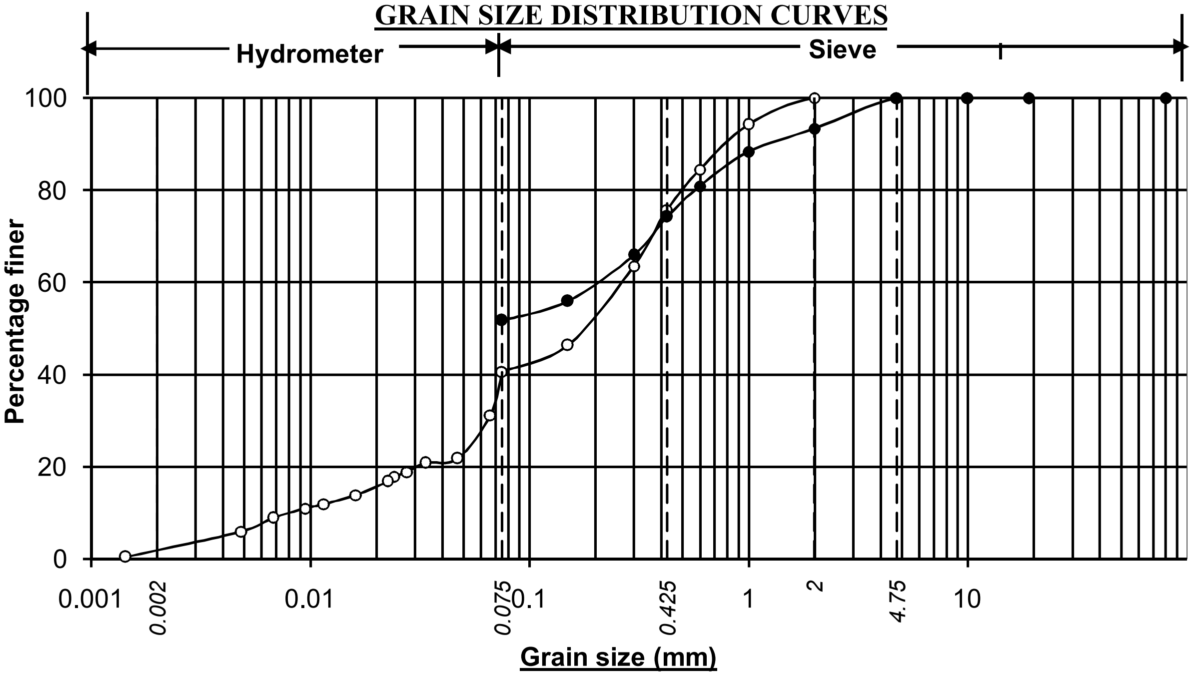
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND03,SPT-05, 8.60M	21.3	52.5	26.2	0.0	0.0	26.2		0.0
BH-MND03,SPT-08, 13.50M		38.8	42.8	18.4	0.0	61.2		0.0



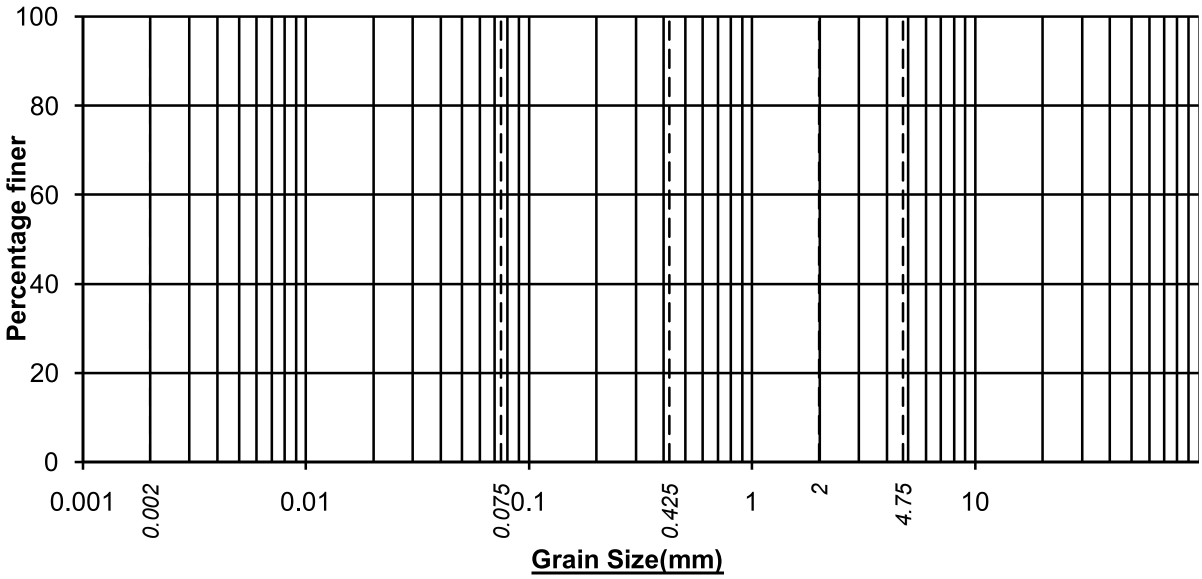
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND03,SPT-10, 17.00M	14.4	29.2	30.1	26.3	0.0	56.4		0.0
BH-MND03,SPT-12, 20.00M		45.5	36.0	18.5	0.0	54.5		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	Job No. 4095	

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND03,SPT-14, 23.00M	2.0	38.7	35.1	24.2	0.0	59.3		0.0
BH-MND03,SPT-16, 26.00M		51.8	22.5	19.1	6.6	48.2		0.0



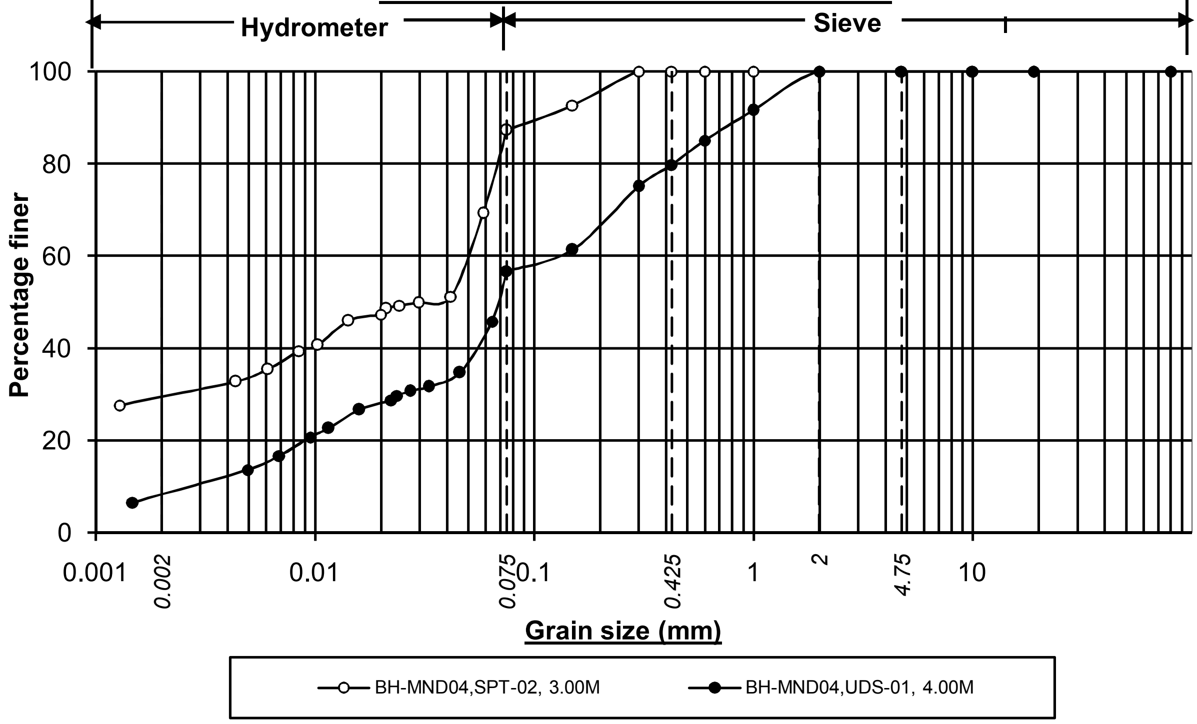
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	Job No. 4095

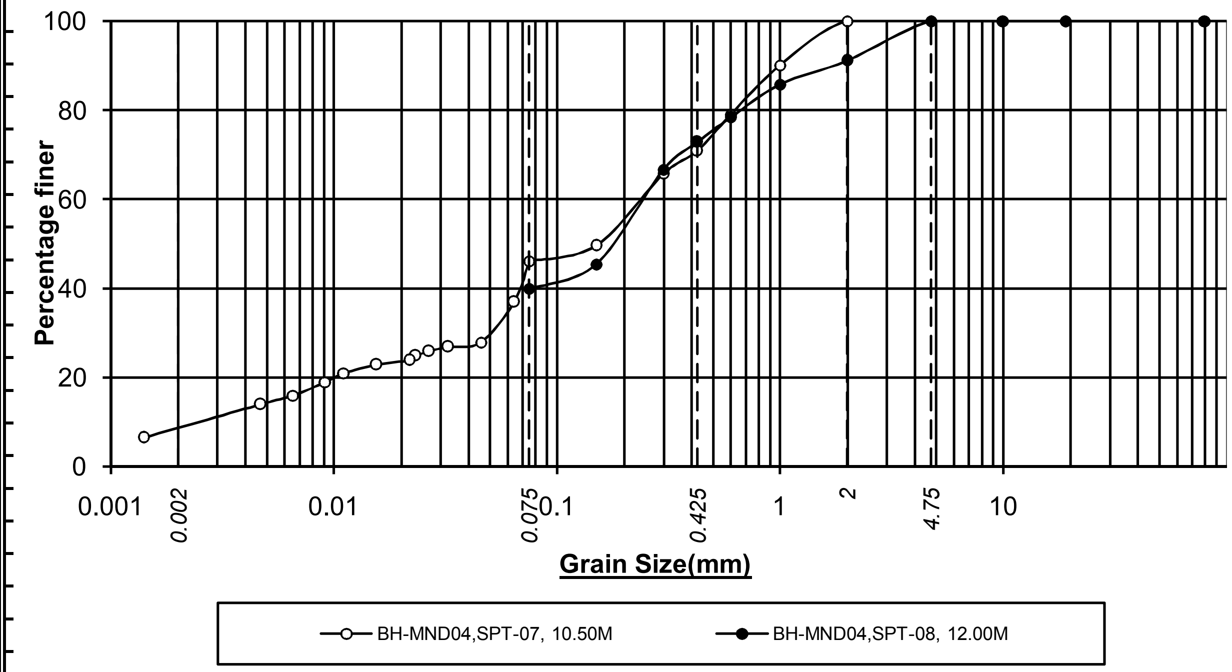
C. E. Testing Company Pvt. Ltd.

Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



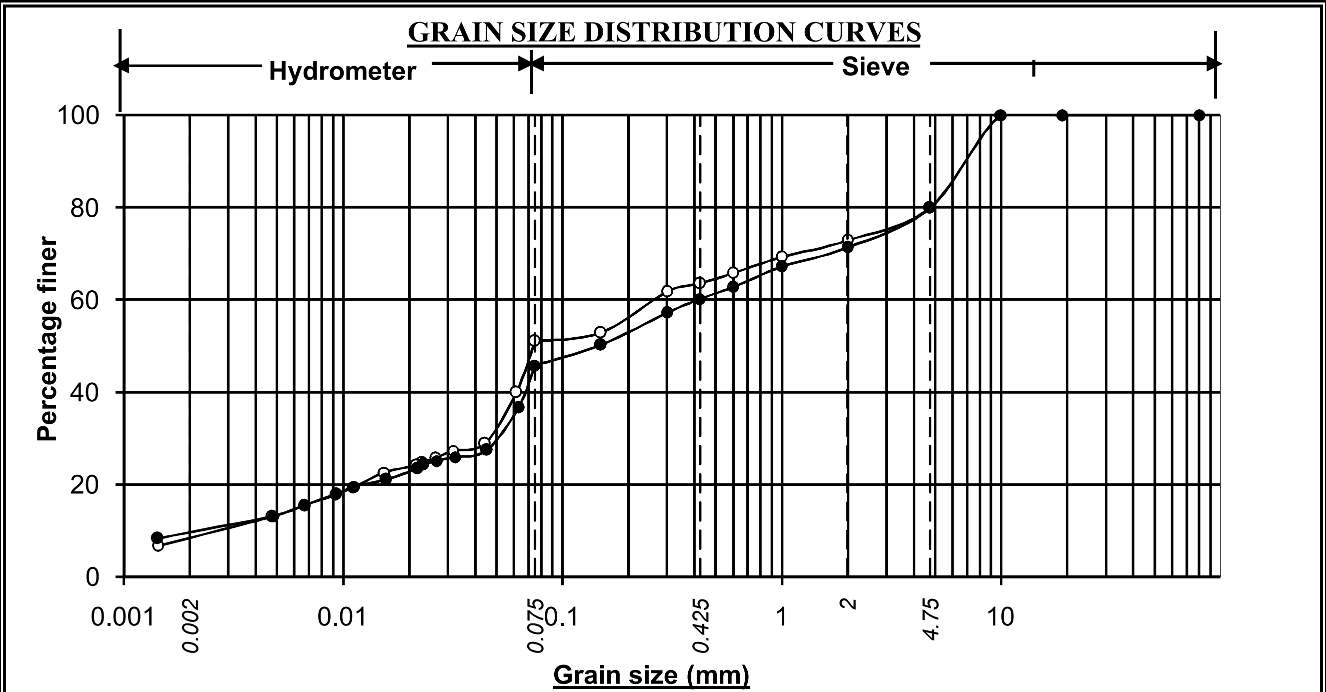
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND04,SPT-02, 3.00M	29.5	57.9	12.6	0.0	0.0	12.6		0.0
BH-MND04,UDS-01, 4.00M	8.3	48.4	23.1	20.2	0.0	43.3		0.0



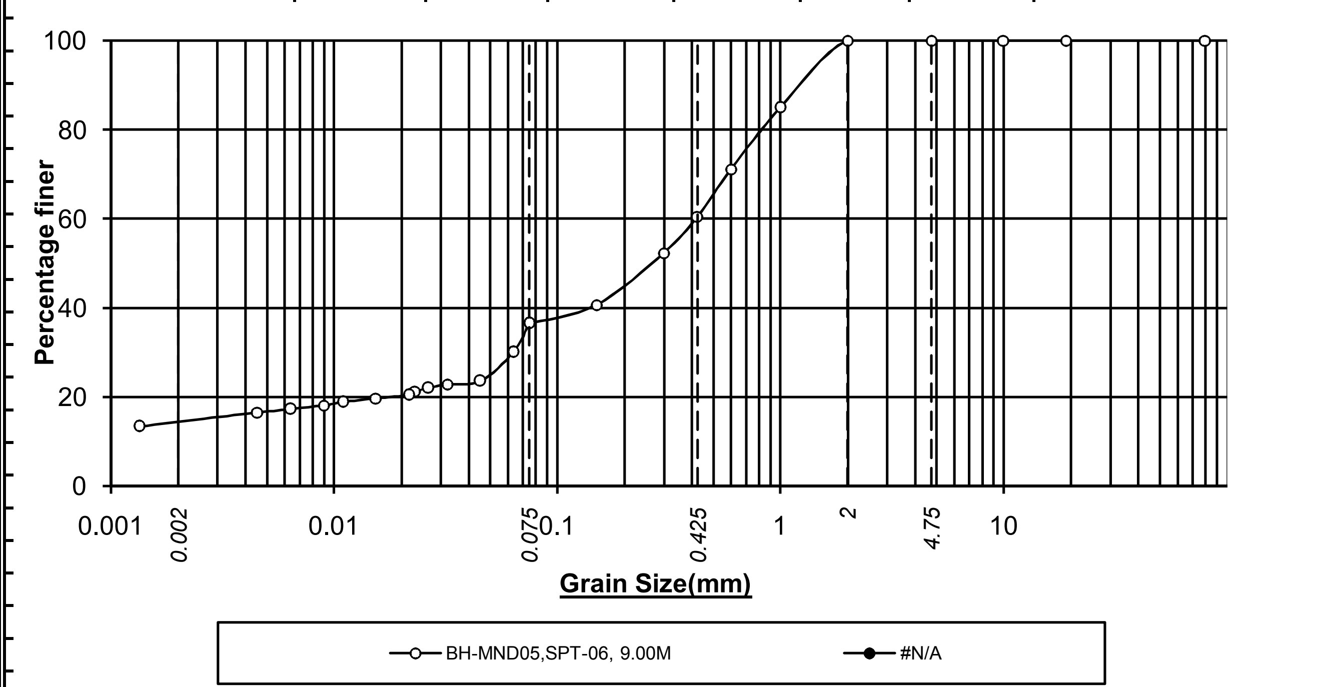
Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND04,SPT-07, 10.50M	8.7	37.5	24.7	29.1	0.0	53.8		0.0
BH-MND04,SPT-08, 12.00M		39.9	33.0	18.3	8.8	60.1		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	

C. E. Testing Company Pvt. Ltd.



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND05,UDS-01, 4.00M	8.5	42.6	12.5	9.3	7.1	28.9		20.0
BH-MND05,UDS-02, 7.00M	9.7	36.1	14.4	11.2	8.6	34.2		20.0

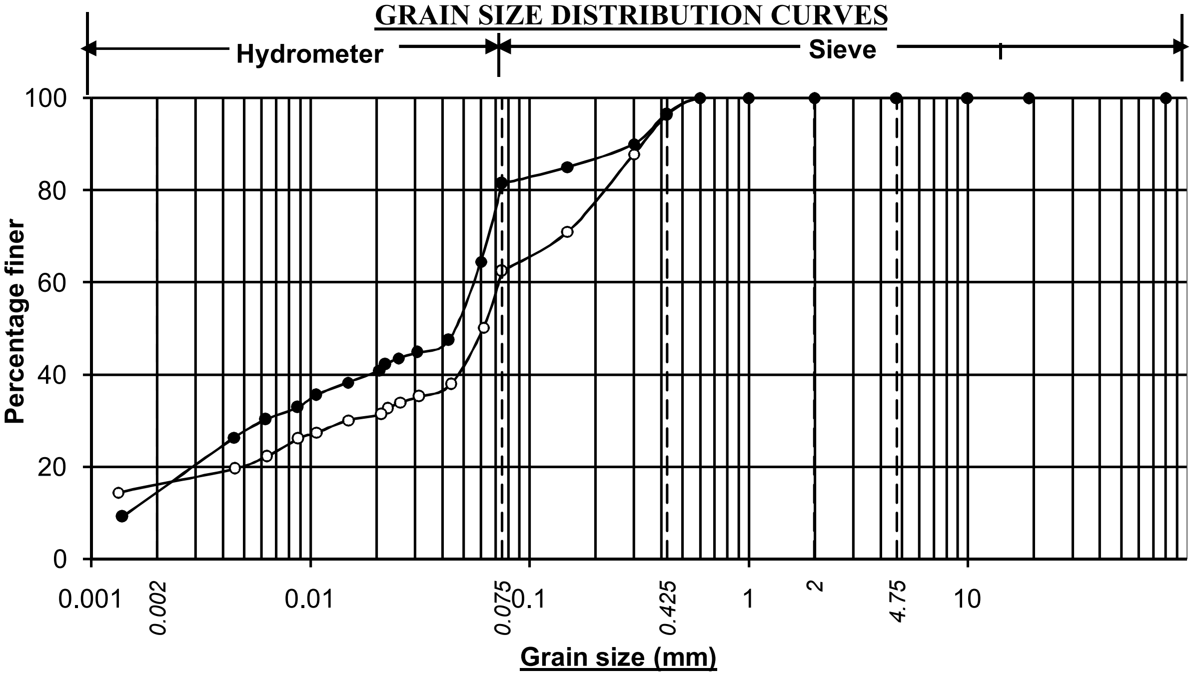


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND05,SPT-06, 9.00M	14.4	22.1	24.0	39.5	0.0	63.5		0.0

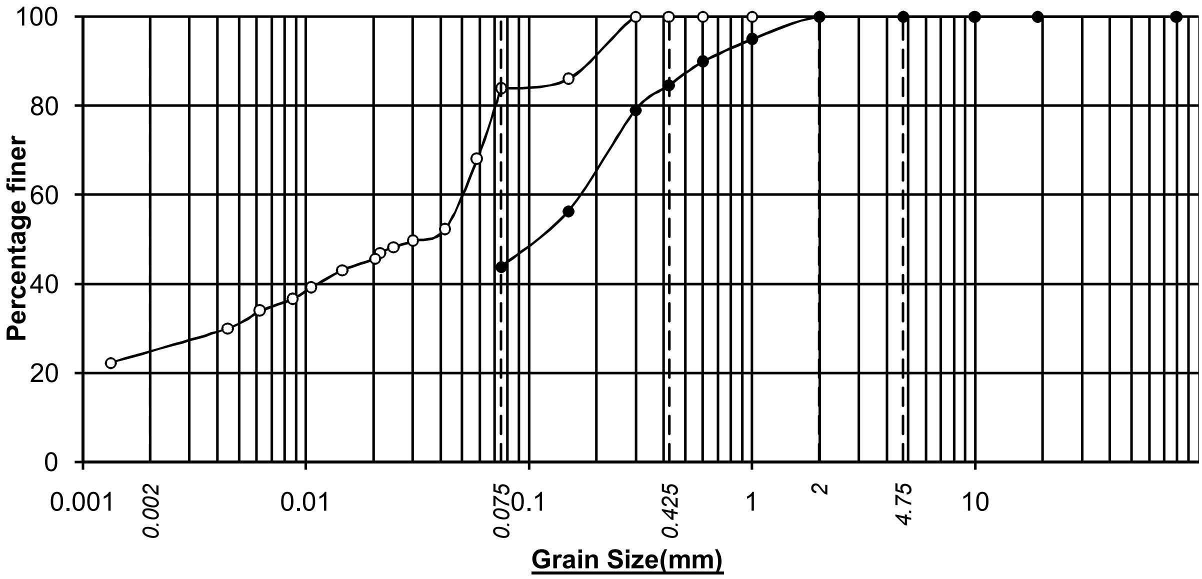
Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. **Job No. 4095**

C. E. Testing Company Pvt. Ltd.

Sheet No.:



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND06,UDS-01, 2.50M	16.1	46.4	33.8	3.7	0.0	37.5		0.0
BH-MND06,SPT-03, 4.50M	14.5	67.0	15.2	3.3	0.0	18.5		0.0



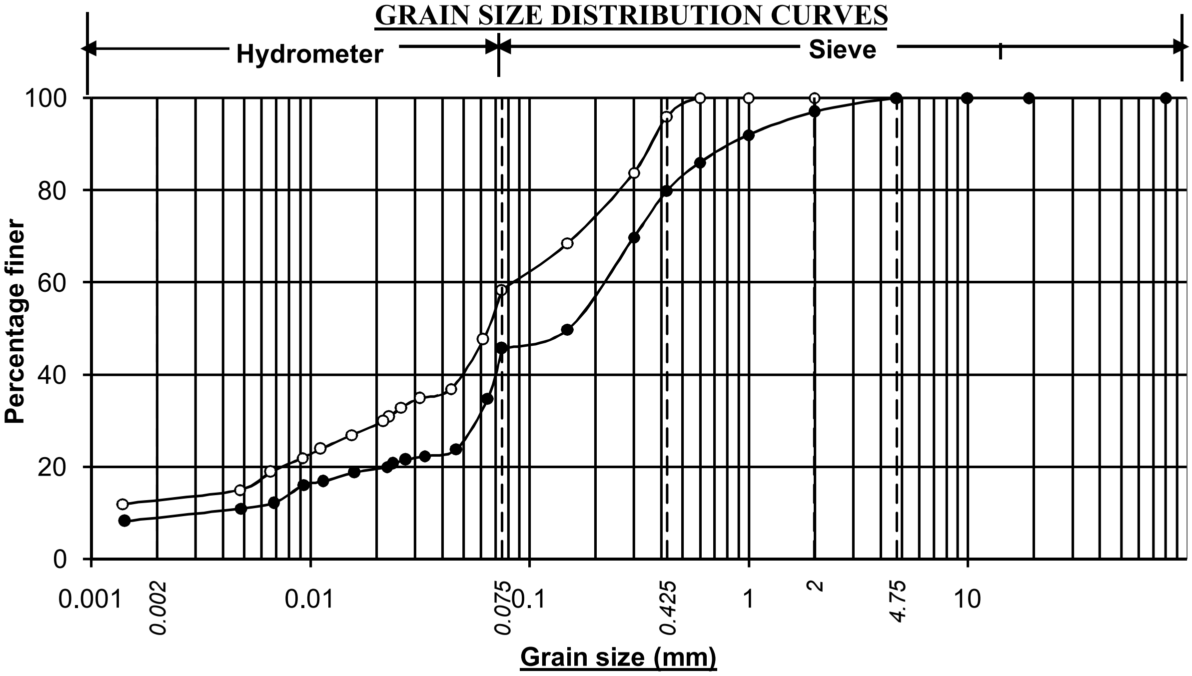
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND06,SPT-06, 9.00M	24.8	59.0	16.2	0.0	0.0	16.2		0.0
BH-MND06,SPT-07, 10.50M		43.8	40.8	15.4	0.0	56.2		0.0

Project:- Geotech. Inv. Work for 5th Stream of Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

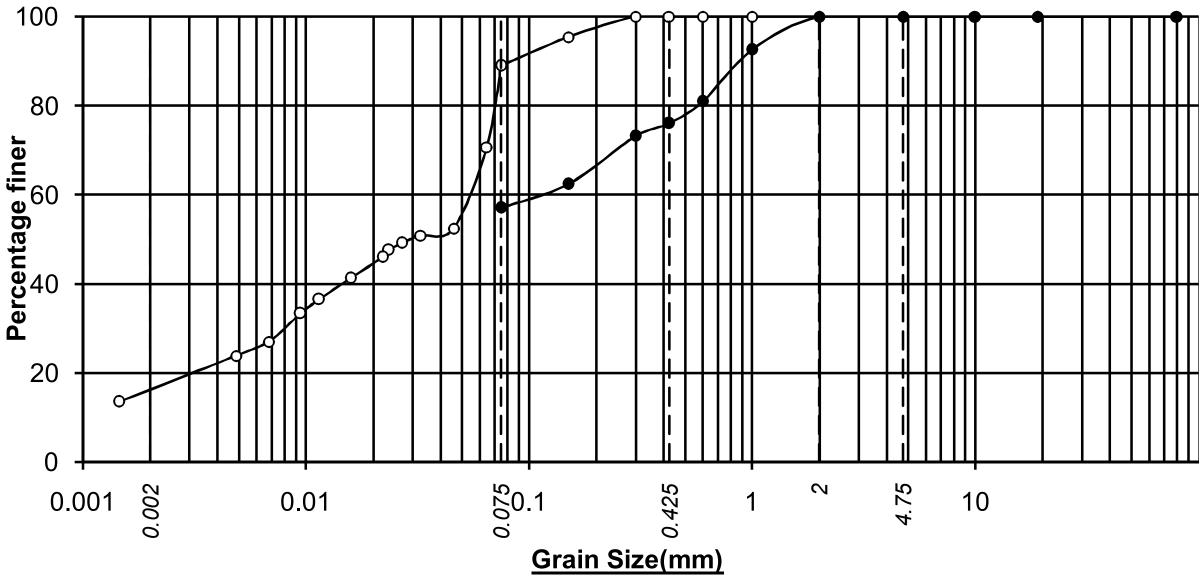
C. E. Testing Company Pvt. Ltd.

Sheet No.:

GRAIN SIZE DISTRIBUTION CURVES



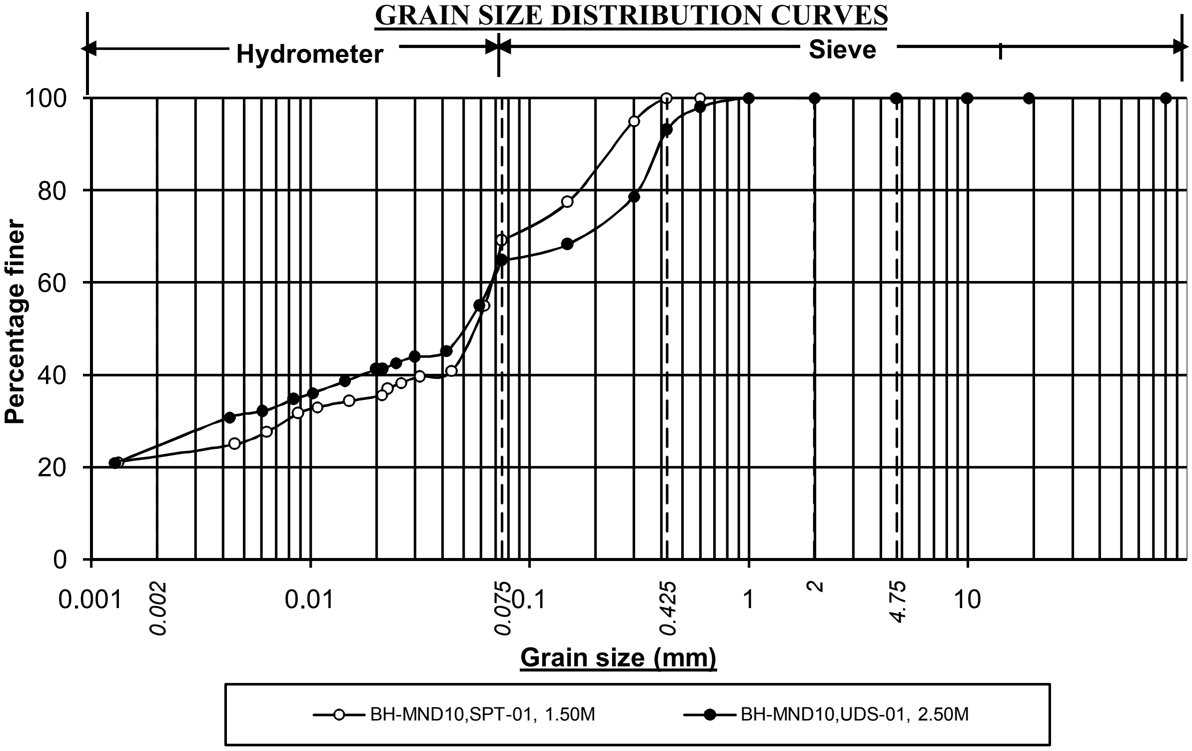
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND07,DS-02, 1.00M	12.8	45.6	37.6	4.0	0.0	41.6		0.0
BH-MND07,UDS-01, 3.00M	9.0	36.7	34.2	17.1	3.0	54.3		0.0



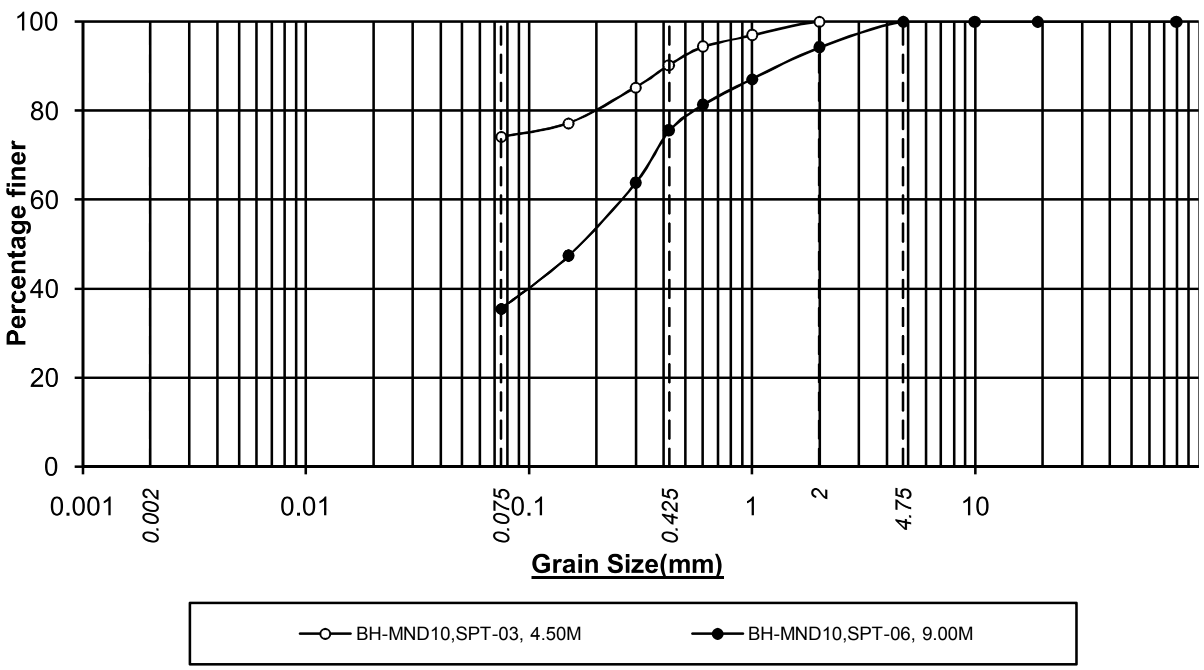
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND07,SPT-05, 8.00M	16.2	72.8	11.0	0.0	0.0	11.0		0.0
H-MND07,SPT-07, 11.00		57.1	19.0	23.9	0.0	42.9		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



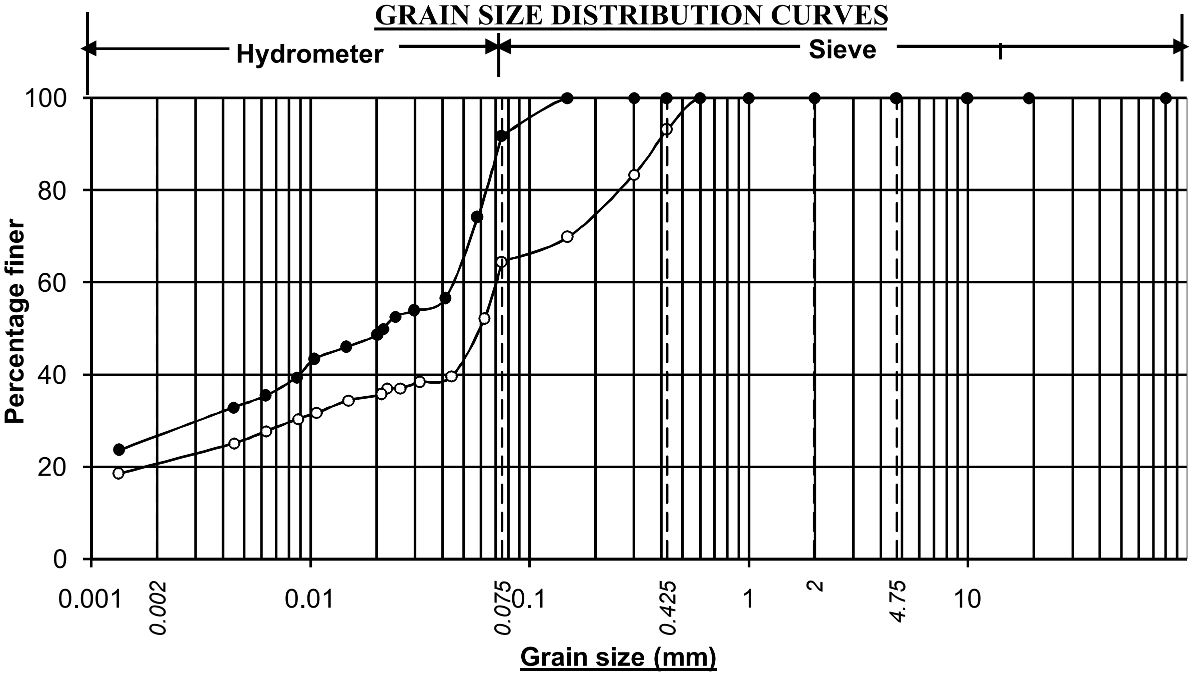
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND10,SPT-01, 1.50M	22.4	46.7	30.9	0.0	0.0	30.9		0.0
BH-MND10,UDS-01, 2.50M	24.5	40.3	28.4	6.8	0.0	35.2		0.0



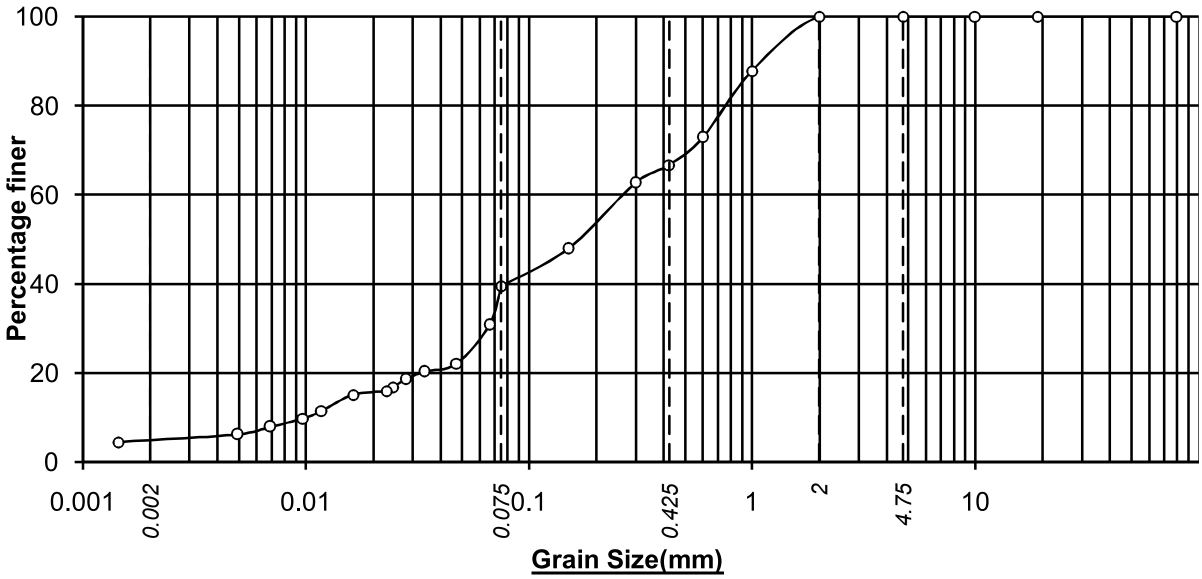
Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND10,SPT-03, 4.50M		74.1	16.1	9.8	0.0	25.9		0.0
BH-MND10,SPT-06, 9.00M		35.5	40.0	18.7	5.8	64.5		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND11,UDS-01, 2.50M	20.7	43.8	28.7	6.8	0.0	35.5		0.0
BH-MND11,SPT-04, 6.00M	26.7	65.1	8.2	0.0	0.0	8.2		0.0

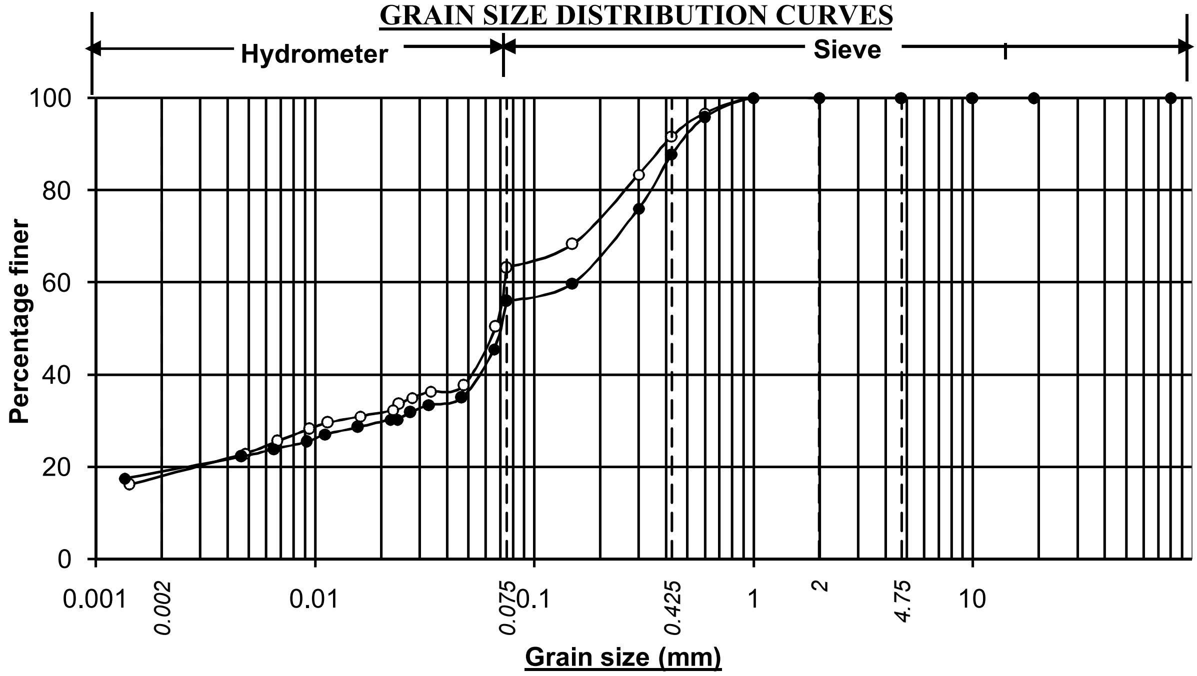


Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND11,SPT-06, 9.50M	4.9	34.6	27.2	33.3	0.0	60.5		0.0

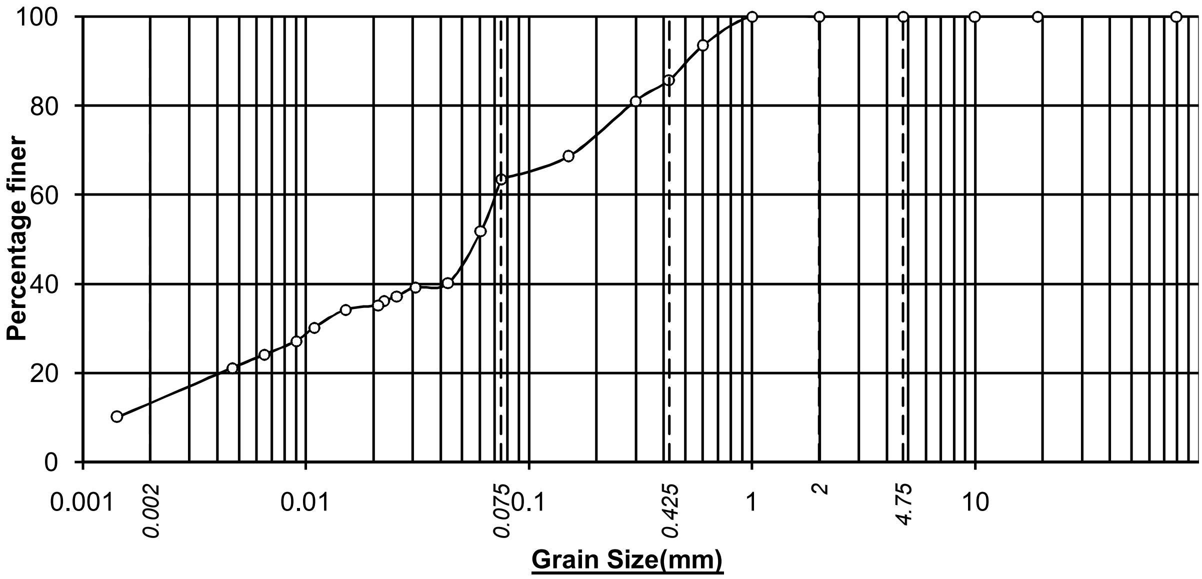
Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**

C. E. Testing Company Pvt. Ltd.

Sheet No.:

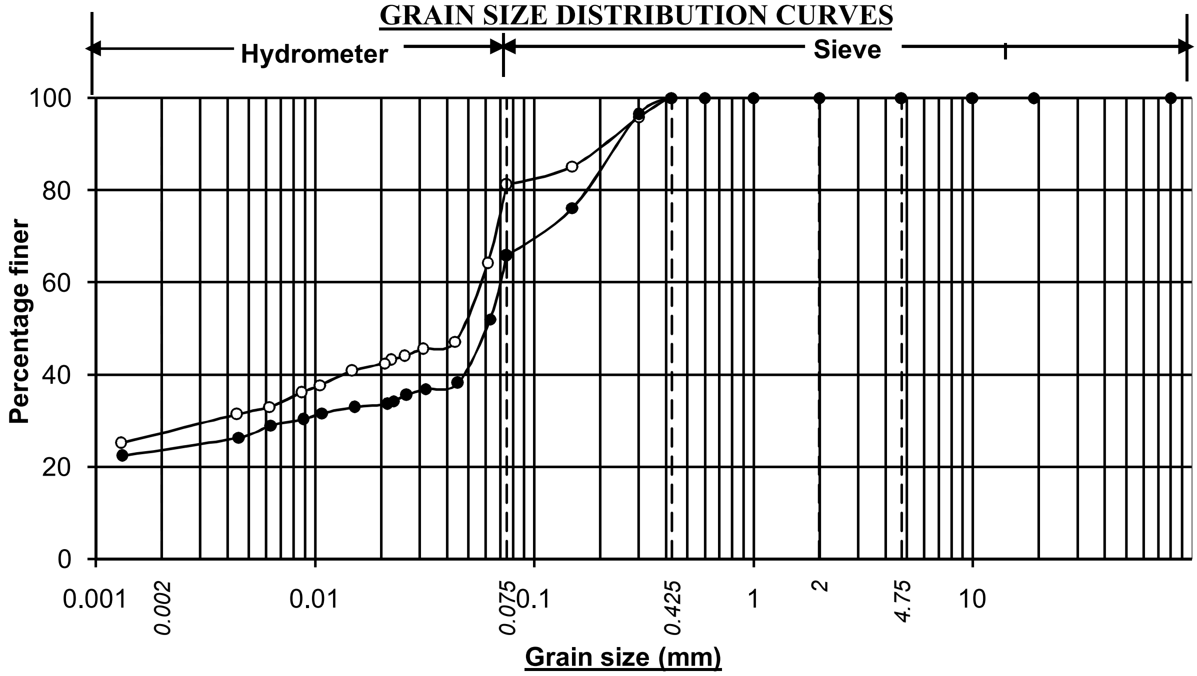


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND12,SPT-01, 1.50M	18.0	45.2	28.5	8.3	0.0	36.8		0.0
BH-MND12,UDS-01, 3.05M	19.0	37.0	31.8	12.2	0.0	44.0		0.0

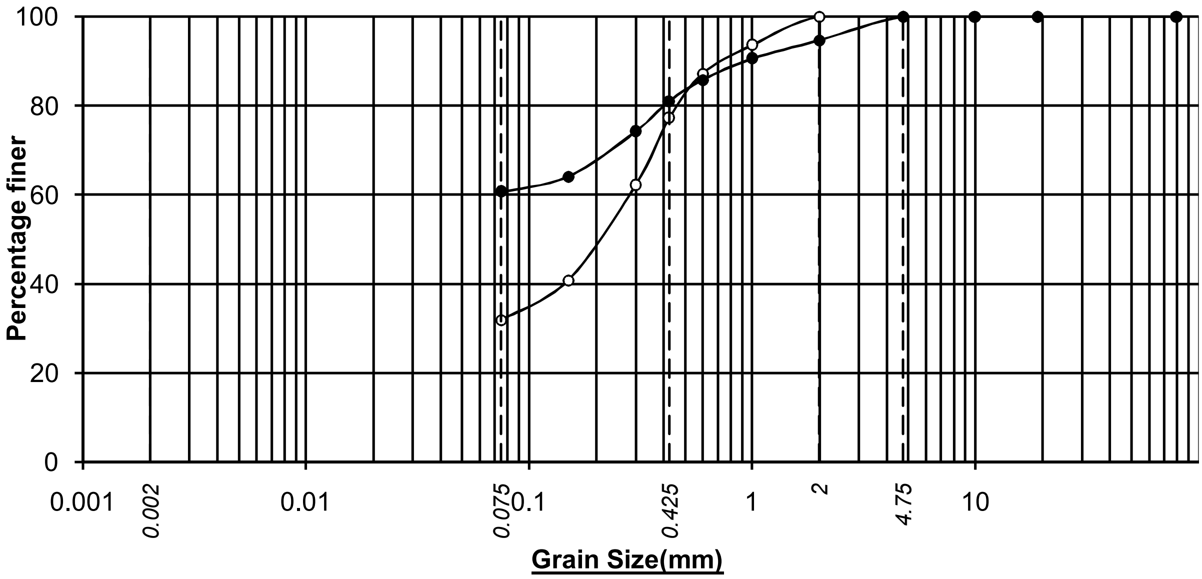


Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-0.425*	*0.425-2.00*	*2.0-4.75*	Total sand	Weighted mean dia (mm)	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Fine sand (%)**	**Medium sand (%)**	**Coarse sand (%)**			**Gravel (%)**
BH-MND12,SPT-06, 9.50M	13.2	50.3	22.2	14.3	0.0	36.5		0.0

Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha.	**Job No. 4095**	



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND13,UDS-01, 3.00M	27.4	53.8	18.8	0.0	0.0	18.8		0.0
BH-MND13,SPT-07, 11.00M	23.7	42.1	34.2	0.0	0.0	34.2		0.0



Grain size (mm)	<0.002	0.002-0.075	0.075-0.425	0.425-2.00	2.0-4.75	Total sand	Weighted mean dia (mm)	>4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)			Gravel (%)
BH-MND13,DS-08, 12.00M		31.9	45.3	22.8	0.0	68.1		0.0
BH-MND13,SPT-09, 14.00M		60.7	20.3	13.7	5.3	39.3		0.0

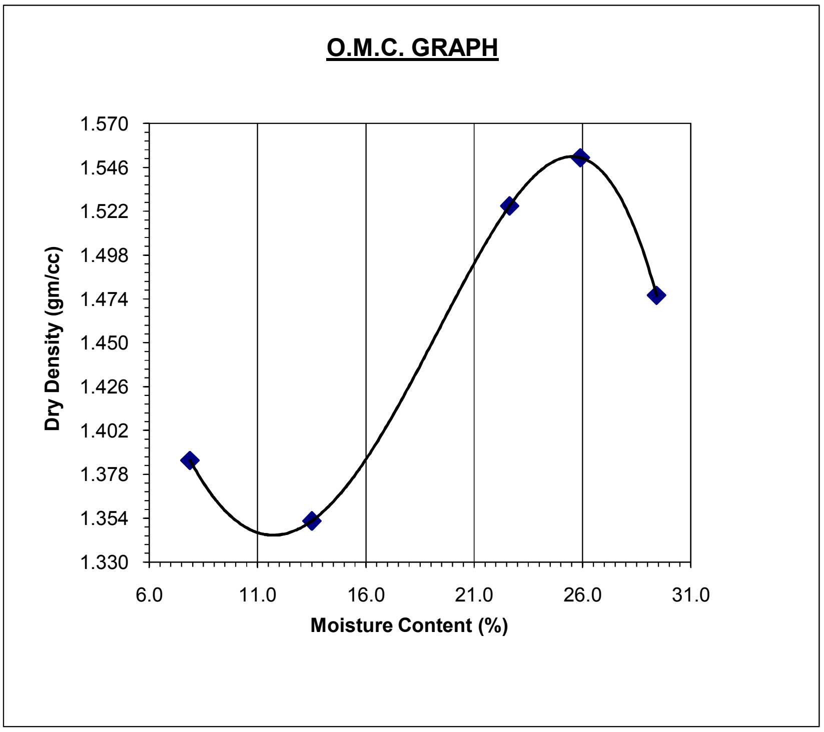
Project:- Geotech. Inv. Work for 5th Stream Alumina Refinery at Damanjodi, Odisha. | **Job No. 4095**

C.B.R. & PROCTOR TEST RESULTS.

TP04 / DS01

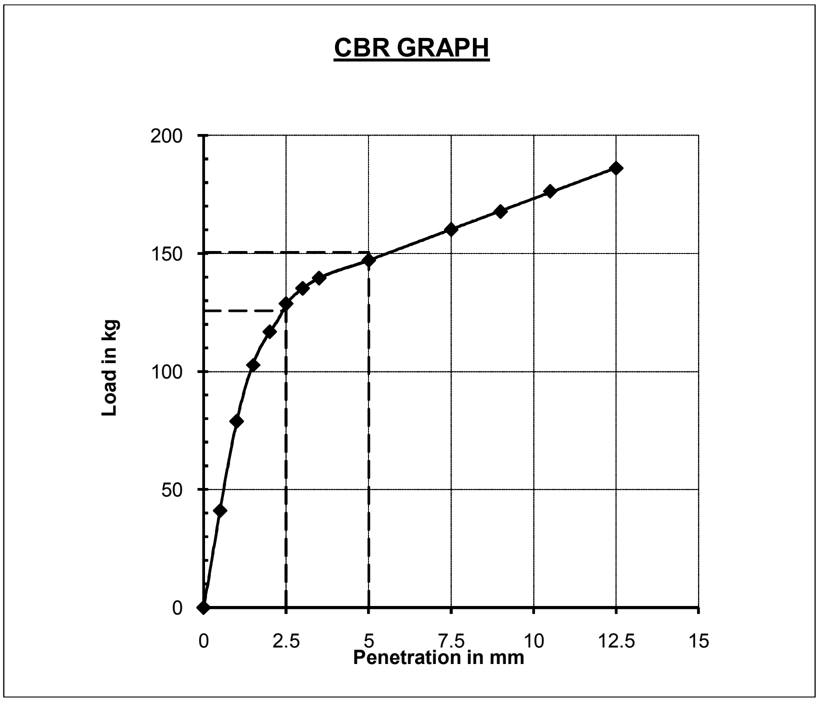
Depth = 1.00M

Maximum Dry Density : 1.552 gm/cc
Optimum Moisture Content: 25.50 %



TYPE :- SOAKED

Penetration (mm)	CBR (%)
2.5	9.18
5.0	7.33

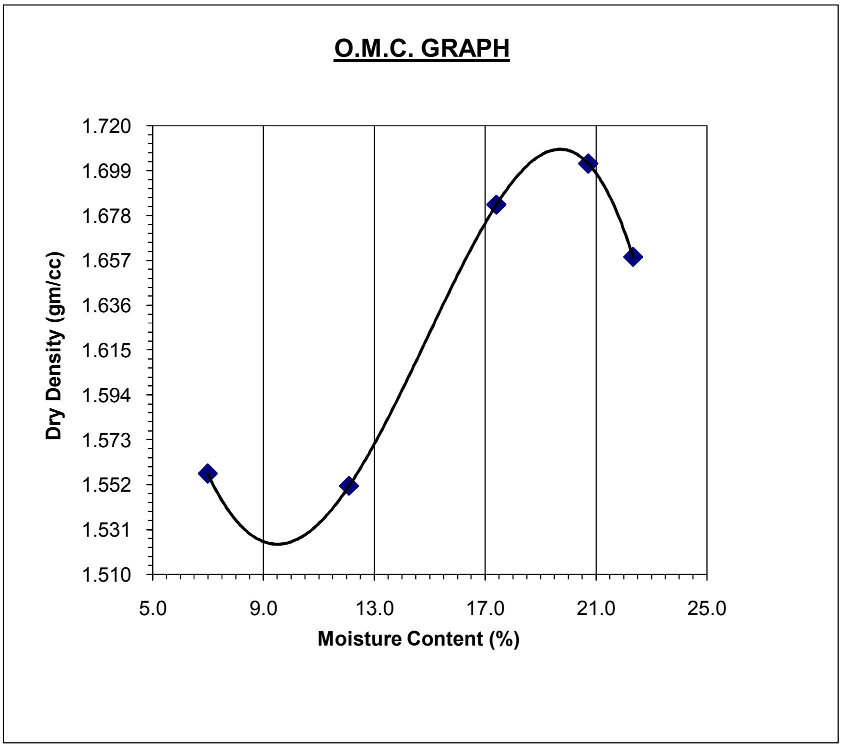


C.B.R. & PROCTOR TEST RESULTS.

TP05 / DS01

Depth = 0.50m

Maximum Dry Density : 1.709 gm/cc
Optimum Moisture Content: 19.75 %

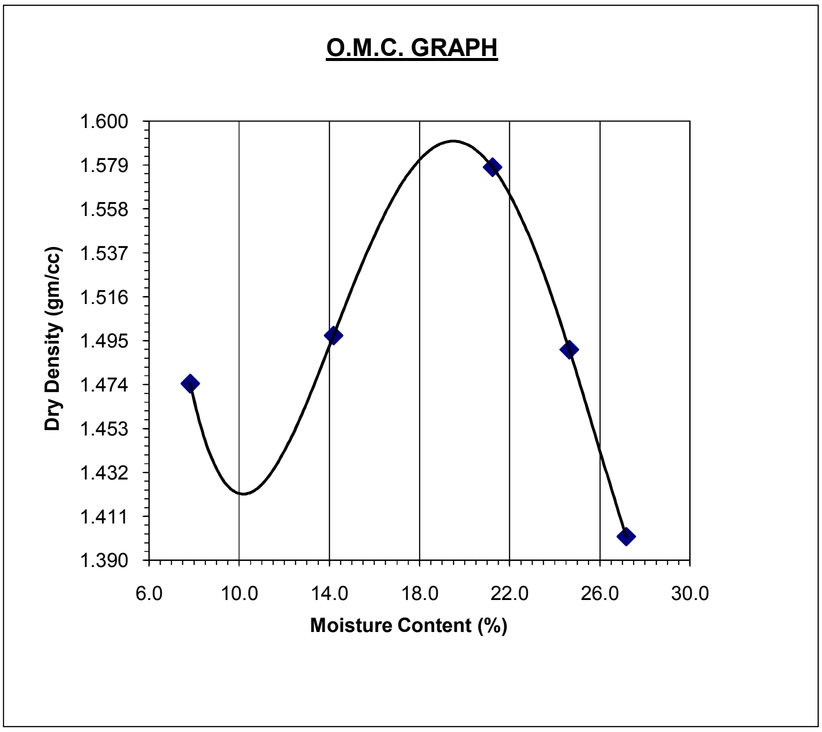


C.B.R. & PROCTOR TEST RESULTS.

TP07 / DS02

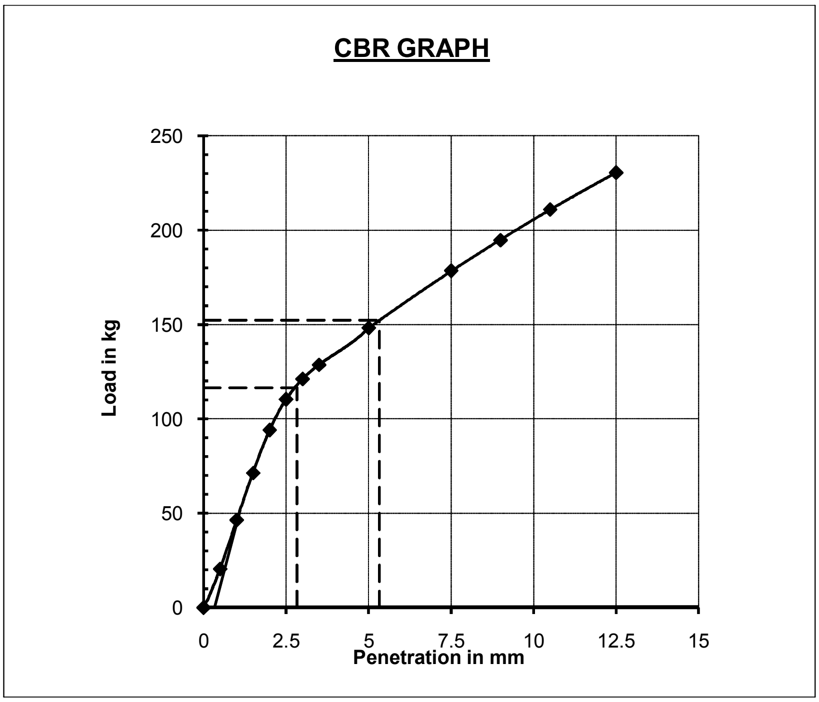
Depth = 2.00m

Maximum Dry Density : 1.590 gm/cc
Optimum Moisture Content: 19.60 %



TYPE :- SOAKED

Penetration (mm)	CBR (%)
2.5	8.51
5.0	7.42

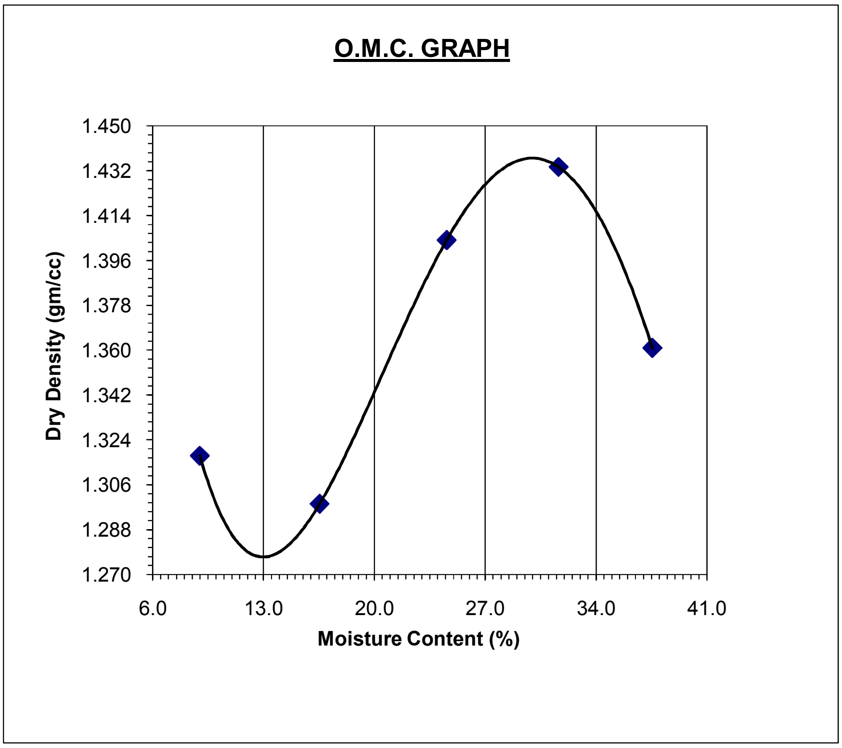


C.B.R. & PROCTOR TEST RESULTS.

TP08 / DS03

Depth = 3.00m

Maximum Dry Density : 1.437 gm/cc
Optimum Moisture Content: 30.05 %



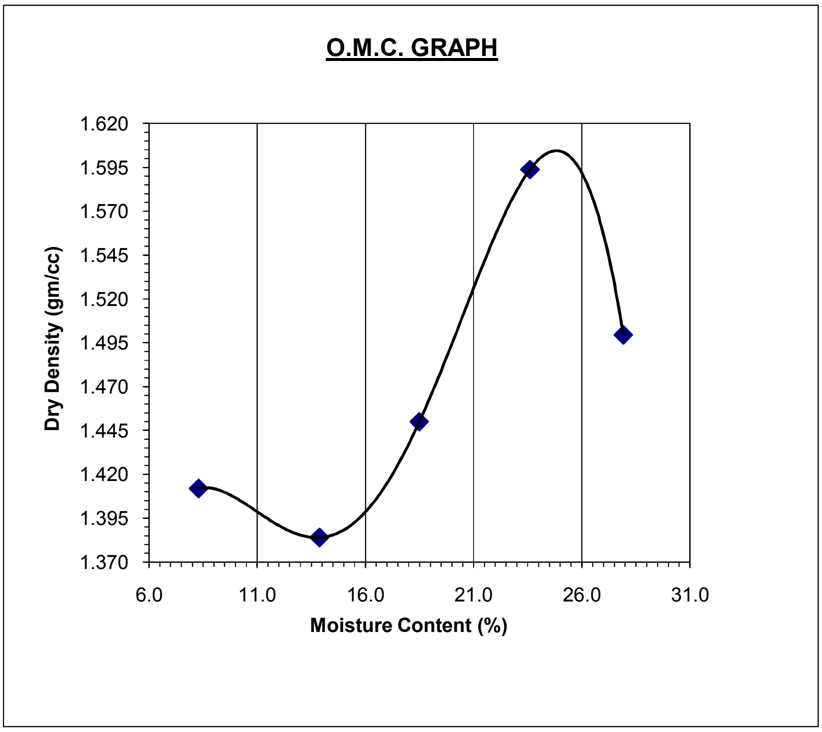
C.B.R. & PROCTOR TEST RESULTS.

TP-MND-01 / DS01

Depth = 1.00m

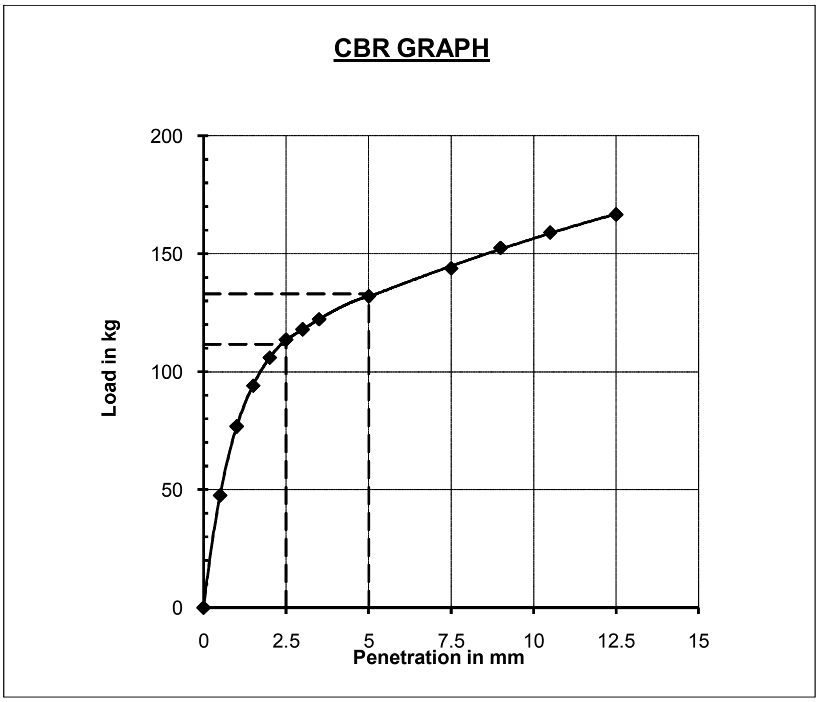
Maximum Dry Density : 1.604 gm/cc

Optimum Moisture Content: 24.90 %



TYPE :- SOAKED

Penetration (mm)	CBR (%)
2.5	8.16
5.0	6.48



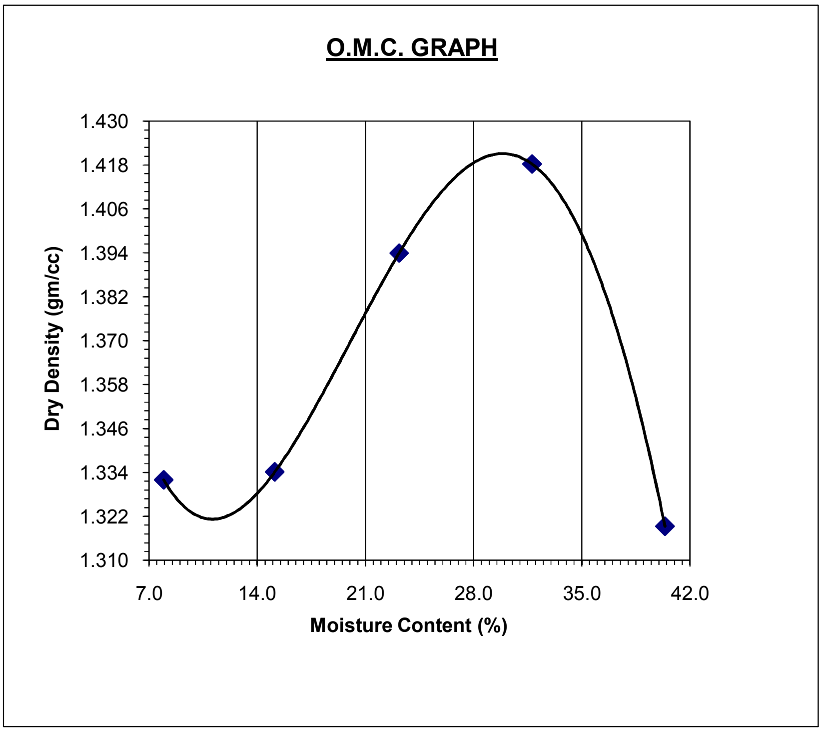
C.B.R. & PROCTOR TEST RESULTS.

CBR02 / DS01

Depth = 0.80m

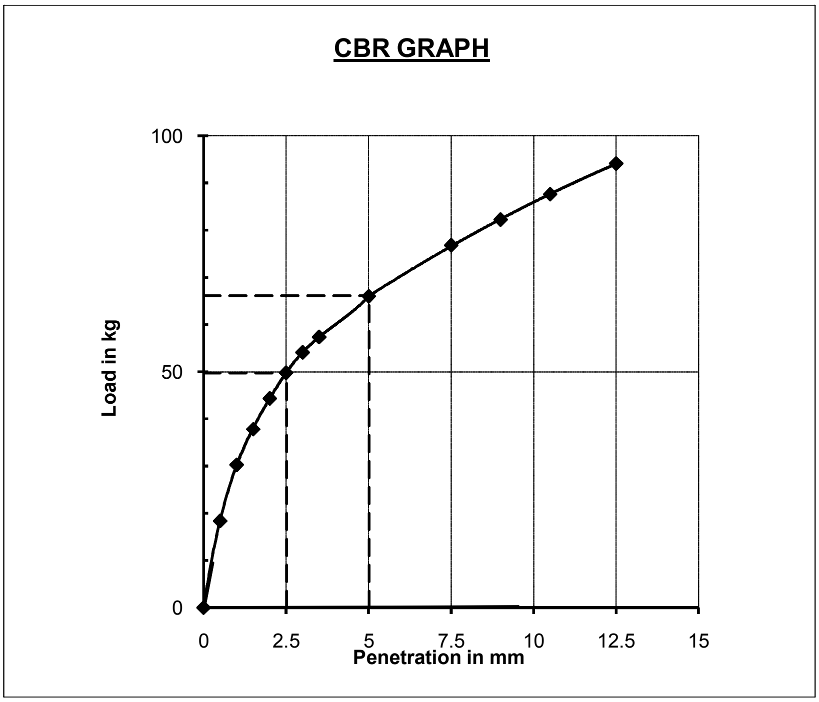
Maximum Dry Density : 1.421 gm/cc

Optimum Moisture Content: 30.10 %



TYPE :- SOAKED

Penetration (mm)	CBR (%)
2.5	3.63
5.0	3.22

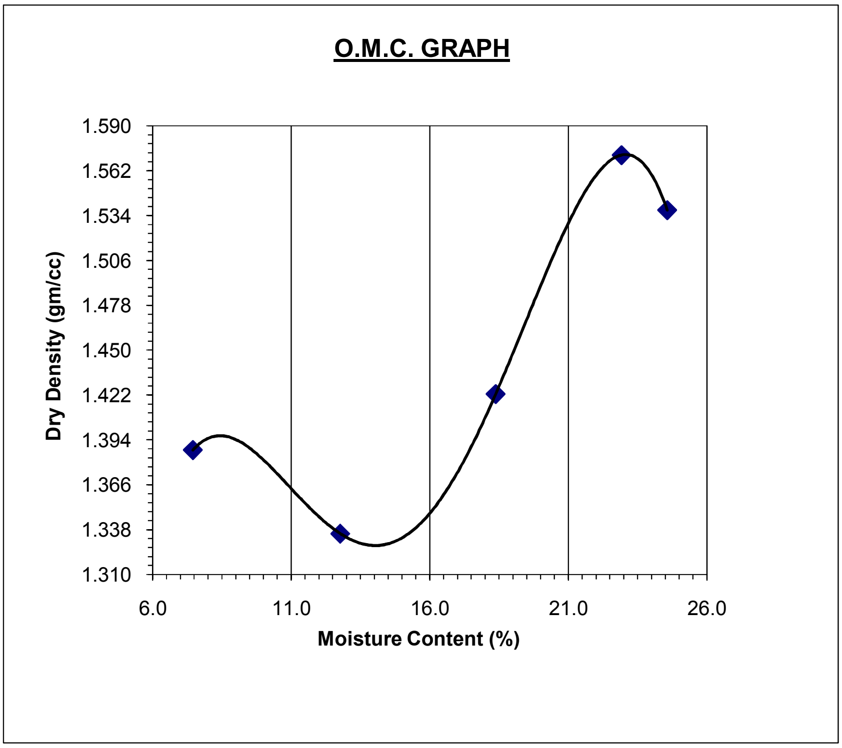


C.B.R. & PROCTOR TEST RESULTS.

CBR09 / DS01

Depth = 0.50m

Maximum Dry Density : 1.572 gm/cc
Optimum Moisture Content: 23.10 %



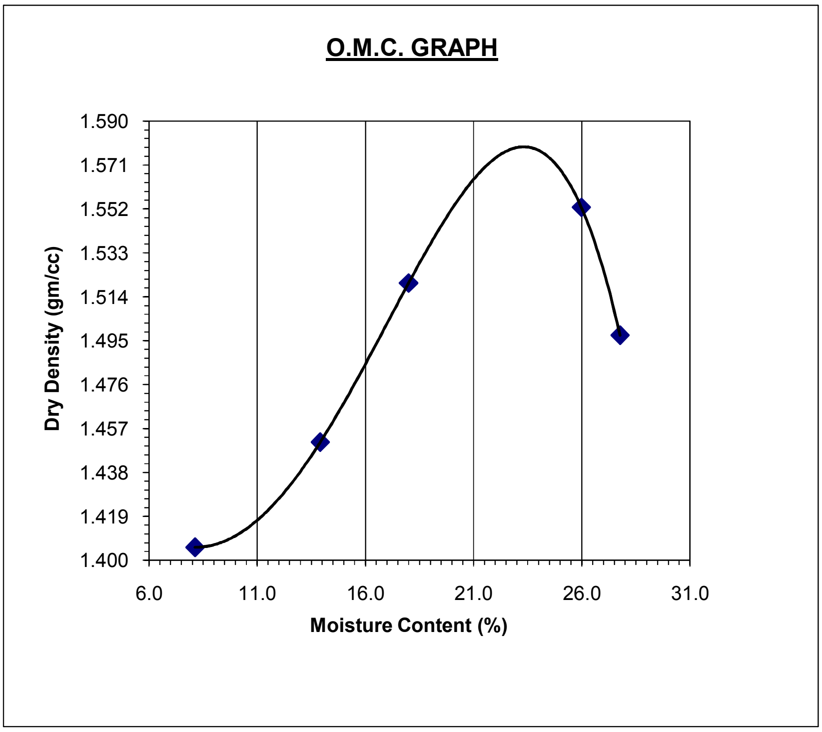
C.B.R. & PROCTOR TEST RESULTS.

CBR10 / DS01

Depth = 0.50m

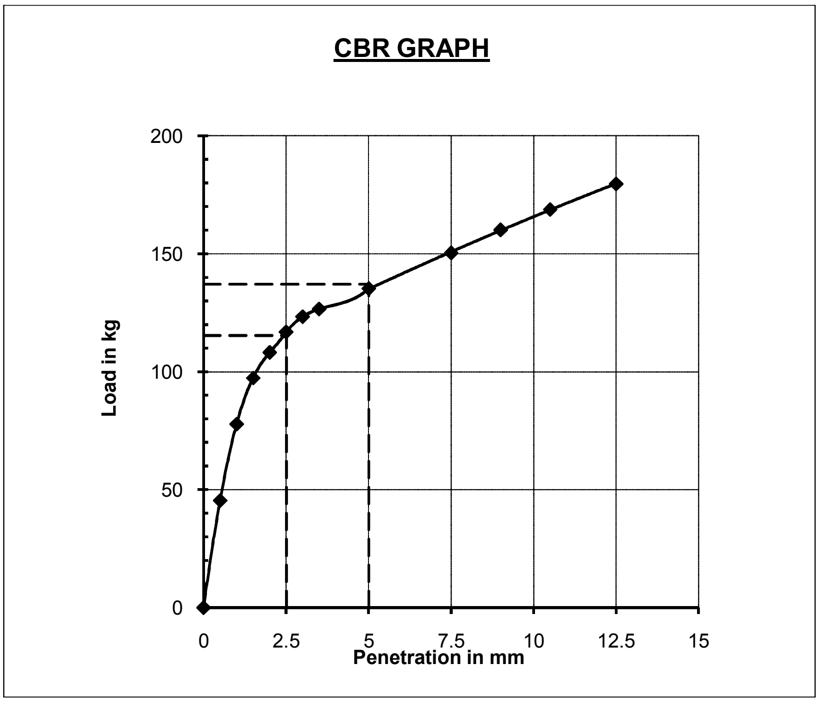
Maximum Dry Density : 1.578 gm/cc

Optimum Moisture Content: 23.40 %



TYPE :- SOAKED

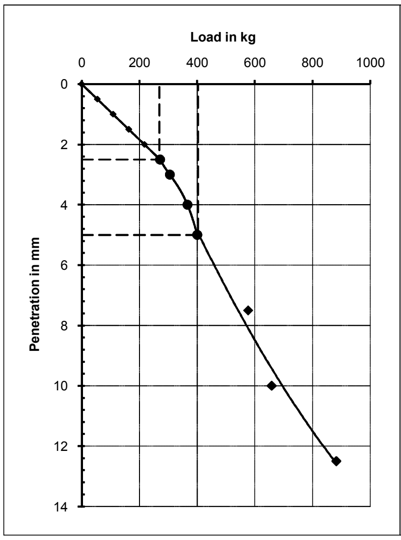
Penetration (mm)	CBR (%)
2.5	8.42
5.0	6.68

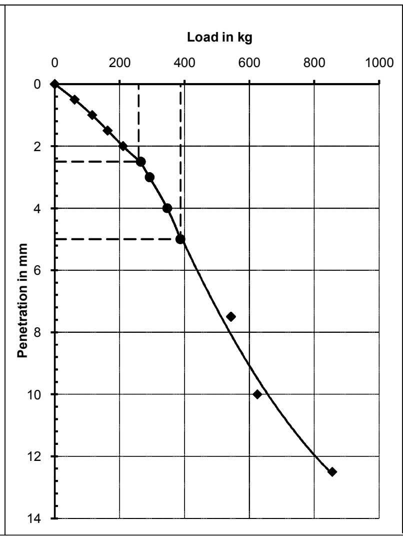


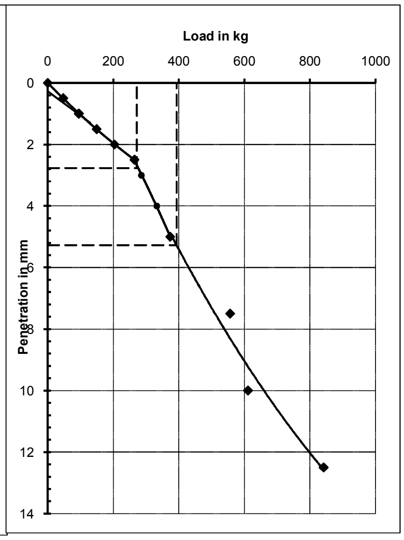
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-02 (Soaked)

Test - 1		Test - 2		Test - 3	
Penetration (mm)	CBR (%)	Penetration (mm)	CBR (%)	Penetration (mm)	CBR (%)
2.5	19.69	2.5	18.87	2.5	19.88
5.0	19.64	5.0	18.88	5.0	19.11



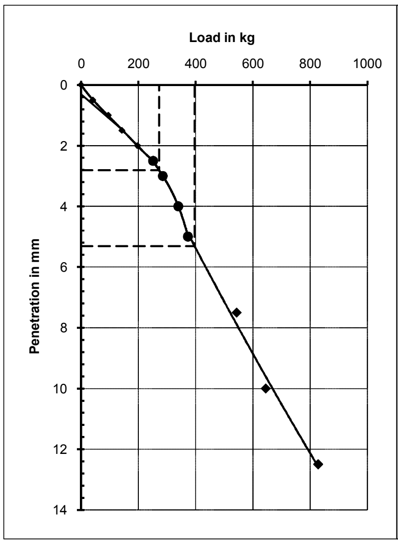


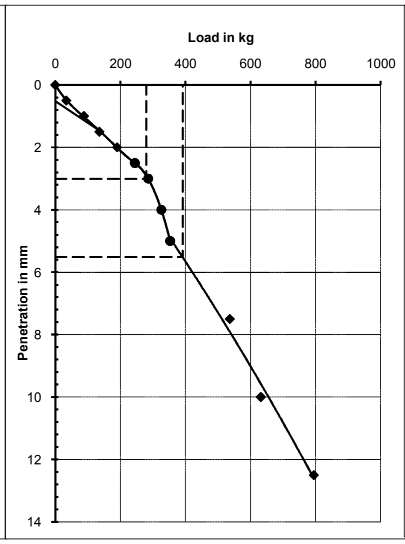


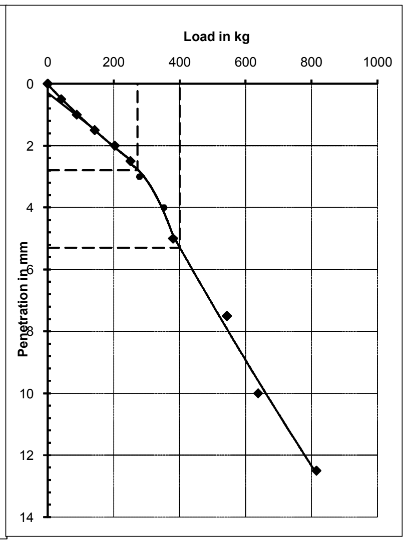
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-02 (Unsoaked)

Test - 1		Test - 2		Test - 3	
Penetration (mm)	CBR (%)	Penetration (mm)	CBR (%)	Penetration (mm)	CBR (%)
2.5	19.86	2.5	20.40	2.5	19.91
5.0	19.26	5.0	19.04	5.0	19.52



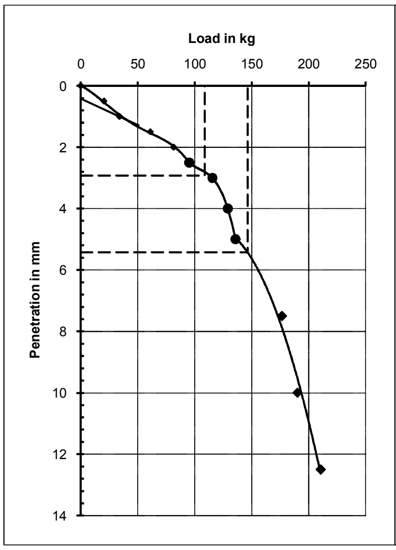


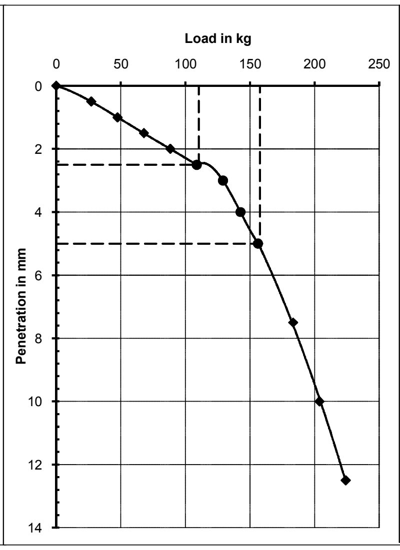


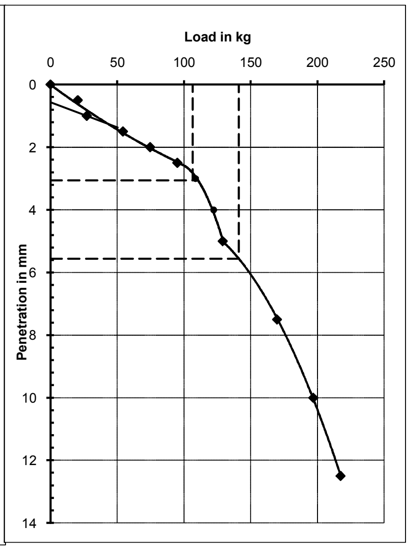
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-04 (Soaked)

Test - 1 Penetration (mm)	CBR (%)	Test - 2 Penetration (mm)	CBR (%)	Test - 3 Penetration (mm)	CBR (%)
2.5	7.95	2.5	8.05	2.5	7.78
5.0	7.12	5.0	7.67	5.0	6.87



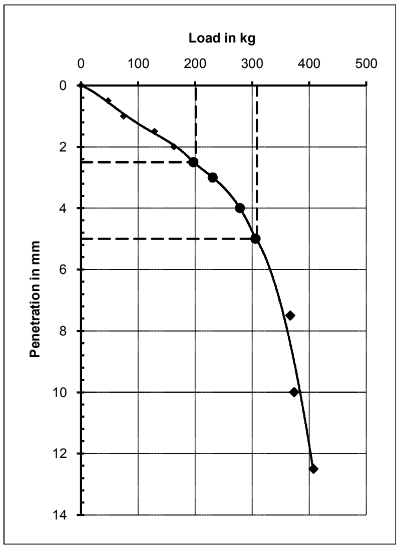


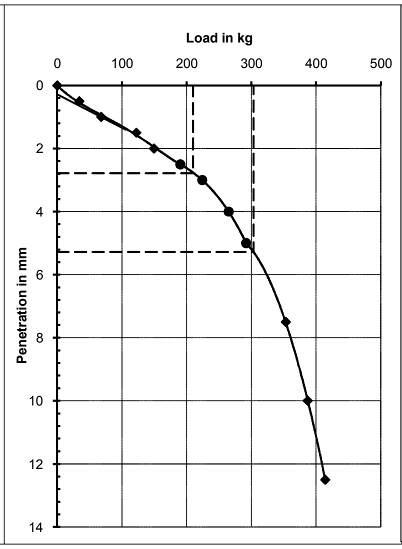


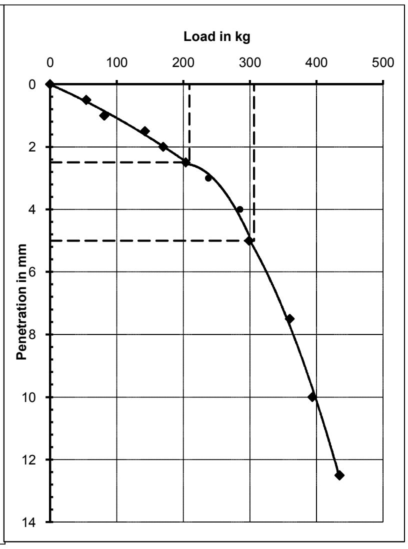
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-04 (Unsoaked)

Test - 1 Penetration (mm)	CBR (%)	Test - 2 Penetration (mm)	CBR (%)	Test - 3 Penetration (mm)	CBR (%)
2.5	14.67	2.5	15.30	2.5	15.25
5.0	15.00	5.0	14.77	5.0	14.90



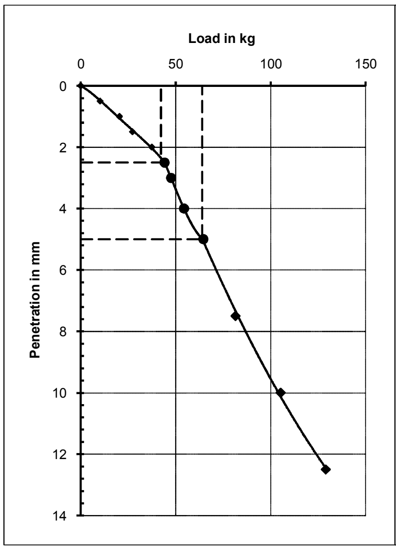


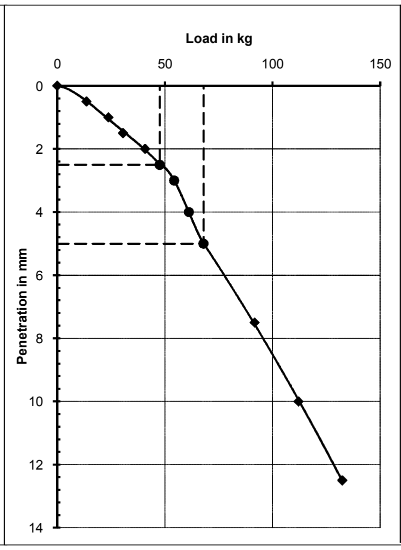


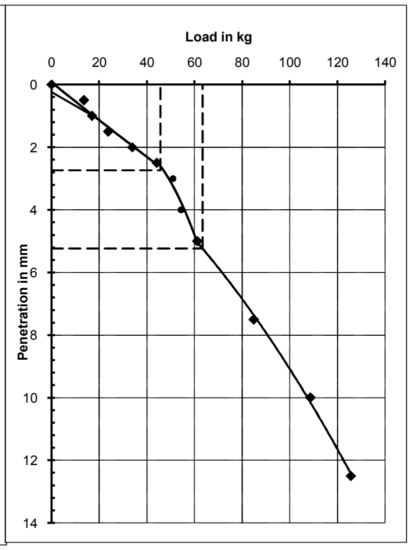
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-08 (Soaked)

Test - 1 Penetration (mm)	CBR (%)	Test - 2 Penetration (mm)	CBR (%)	Test - 3 Penetration (mm)	CBR (%)
2.5	3.08	2.5	3.48	2.5	3.33
5.0	3.11	5.0	3.31	5.0	3.08



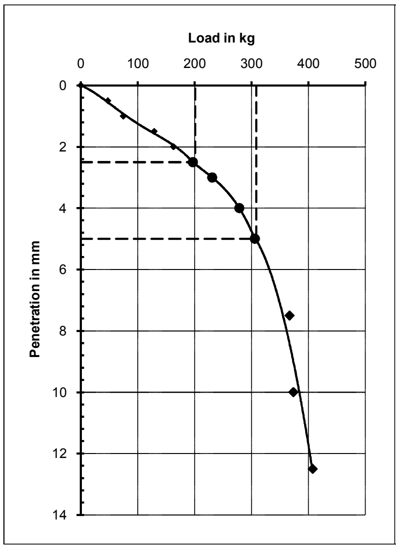


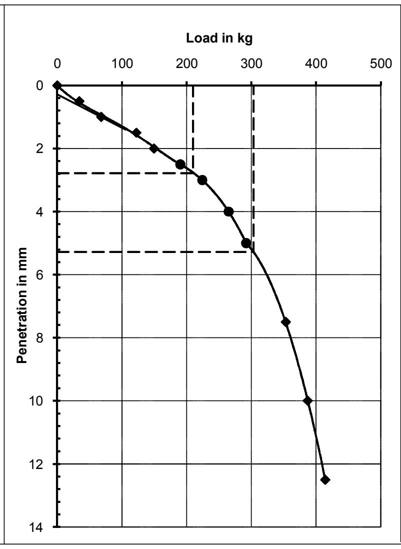


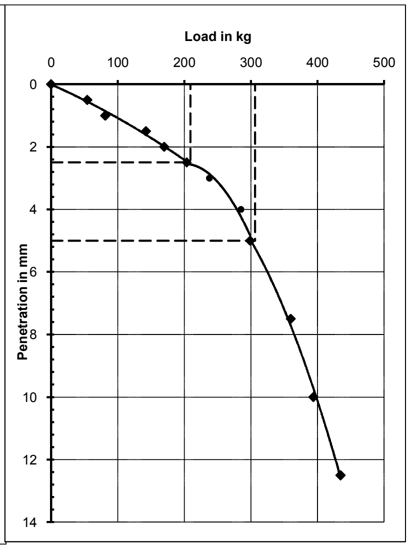
Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-04 (Unsoaked)

Test - 1 Penetration (mm)	CBR (%)	Test - 2 Penetration (mm)	CBR (%)	Test - 3 Penetration (mm)	CBR (%)
2.5	14.67	2.5	15.30	2.5	15.25
5.0	15.00	5.0	14.77	5.0	14.90







Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-09 (Soaked)

Test - 1

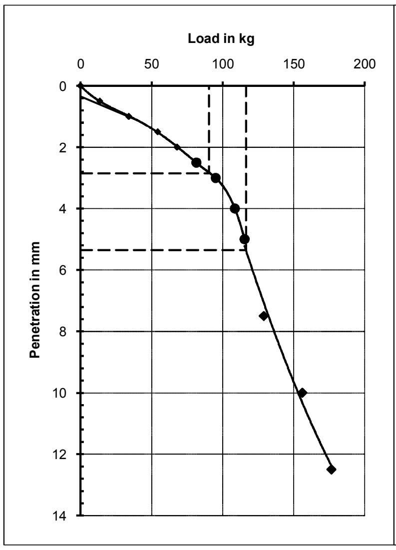
Penetration (mm)	CBR (%)
2.5	6.59
5.0	5.66

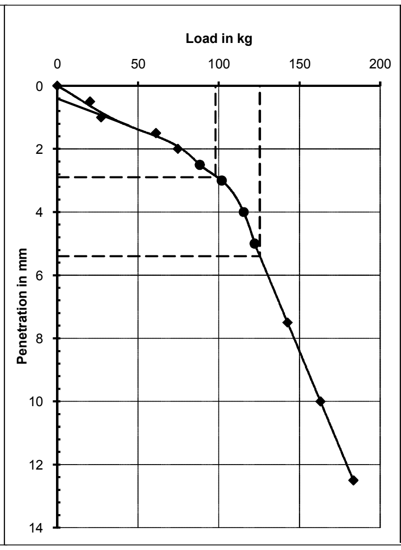
Test - 2

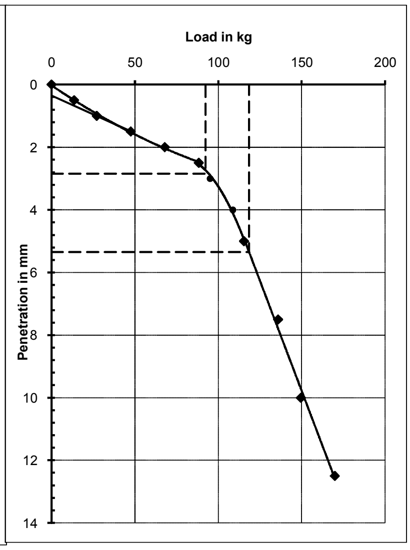
Penetration (mm)	CBR (%)
2.5	7.15
5.0	6.11

Test - 3

Penetration (mm)	CBR (%)
2.5	6.73
5.0	5.76







Load Penetration Curve of Field C.B.R. Test

Field CBR NO.-09 (Unsoaked)

Test - 1

Penetration (mm)	CBR (%)
2.5	10.78
5.0	9.55

Test - 2

Penetration (mm)	CBR (%)
2.5	11.73
5.0	10.96

Test - 3

Penetration (mm)	CBR (%)
2.5	11.24
5.0	10.63