CORRIGENDUM FOR NEW 1650 MTPD NPK PLANT AT FACT -CD, AMBALAMEDU ON LSTK BASIS

A. PROCESS

1. *Document No.32687-11-PS-001-SW_R0, Page 4 of 25, Clause ix Pt no.5, Scope of Work.*

6. Coo-ordination and/or Assistance for Statutory Approvals from Government / Non-Government bodies/ agencies as per prevailing acts or rules, Environment Related Approvals before commencement or during Construction if any.

The above clause sentence has been modified as.

6. All liaisoning, Coo-ordination and/or Assistance for Statutory Approvals from Government / Non-Government bodies/ agencies as per prevailing acts or rules, Environment Related Approvals before commencement or during Construction if any.

2. *Document No.32687-11-PS-001-SW_R0, Page 5 of 25, Clause ix Pt no.35, Scope of Work.*

35. Strengthening and/or Renovation of existing facilities i.e. Existing Urea Silo, Urea Bagging plant & Urea Gantry if required

The above clause sentence stands deleted.

3. *Document No.32687-11-PS-001-SW_R0, Page 6 of 25, Clause 2.0 (ii), Scope of Work.*

(ii) For DAP 18:46:0: *Rated capacity of* 75 *TPH (minimum) for* 22 *hours of operation in a day shall produce from* ***Pre Neutraliser with Pipe Reactor*** (***PN+PR)***. However the bidder shall furnish the design details of using PR alone for the production of NP 20:20:0:13.

The above clause is modified as,

(ii) For DAP 18:46:0: *Rated capacity of* 75 *TPH (minimum) for* 22 *hours of operation in a day shall produce from* ***Pre Neutraliser with Pipe Reactor*** (***PN+PR)***. However the bidder shall furnish the design details of using PR alone for the production of DAP 18:46:0

4. *Document No.32687-11-PS-001-SW_R0, Page 10 of 25, Clause 3.3, Scope of Work.*

- *Online vibration measurement system for critical equipment (Furnace fans and Dryer Fans).*

The above clause is modified as,

- *Online vibration measurement system for critical equipment as per the recommendation of process licensor shall be provided.*

5. *Document No.32687-11-PS-001-SW_R0, Page 14 of 25, Clause 5.3 Pt no.6 of Scope of Work & Document No.32687-11-PS-001-DB_R0, Page 26 of 39, Clause 8.2.1 Pt no.6 of Design Basis.*

6. Reclamation of Urea/ Filler/ Off spec. Product from the common shed to NPK plant via crusher

The above clause sentence is modified as,

6. Reclamation of Urea/ Filler/ Off spec. Product from the common shed to NPK plant as recommended by the Process Licensor.

6. *Document No.32687-11-PS-001-DB_R0, Page 27 of 39, Clause 8.2.2 (vii) of Design Basis*

*vii) De*dusting facility for the bagging plant as required. (Wet scrubbing preferred and the liquid discharge shall use in the plant comply to Zero liquid discharge)

The above clause is modified as

vii) Dedusting facility for the NPK bulk storage shall be Wet scrubbing and the liquid discharge shall use in the plant comply to Zero Liquid Discharge. Dry dedusting system can be employed for bagging plant, the reclamation of material to the plant shall be indicated.

7. *Document No.32687-11-PS-001-SW_R0, Page 15 of 25, Clause 5.5 (vi) & (vii) of Scope of Work & Document No.32687-11-PS-001-PH_R0, Page 9 of 13, Clause 10.0 pt. no.5,6 & 7 of Design Philosophy - Process.*

(vi) Minimum 15 bags per minute with 1:1 weighing & correction accuracy.

(vii) Weight Tolerance - 25 gm accuracy

The above clause is modified as,

(vi) Minimum 15 bags per minute with 1:5 weighing & correction accuracy.

(ii) Weight Tolerance +/– 50 gm accuracy

8. *Document No.32687-11-PS-001-SW_R0, Page 16 of 25, Clause 5.11 of Scope of Work & Document No.32687-11-PS-001-PH_R0, Page 11 of 13, Clause 14.0 of Design Philosophy - Process.*

5.11 Diesel Generator (DG) Set:

The DG set capacity selection should be based on meeting of the emergency requirement in case of power failure. The equipment connected on DG set is as below`

i) Emergency lighting

ii) Industrial Goods Lift.

iii) Battery Charger

iv) UPS

The above clause is modified as,

5.11 Diesel Generator (DG) Set:

The DG set capacity selection should be based on meeting of the emergency requirement in case of power failure for safe shutdown of the plant as recommended by process licensor. In addition to the above, the following electrical load should be considered for the DG set

i) Emergency lighting

ii) Industrial Goods Lift.

iii) Control System

iv) Battery Charger

v) UPS

9. *Document No.32687-11-PS-001-SW_R0, Page 16 of 25, Clause 5.12 of Scope of Work & Document No.32687-11-PS-001-PH_R0, Page 10 of 13, Clause 13.0 of Design Philosophy - Process.,*

The above clause stands deleted and modified clause is attached as annexure A1 to corrigendum.

10. *Document No.32687-11-PS-001-SW_R0, Page 19 of 25, Clause 5.23 of Scope of Work & Document No.32687-11-PS-001-DB_R0, Page 32 of 39, Clause 8.2.6 of Design Basis,*

Bidder shall follow ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers handbooks and standards. Design calculations shall include, but not necessarily be limited to, the following for each building: Heating, ventilation and air conditioning design loads in accordance with ASHRAE methods. These shall be computer-generated. Calculations shall be complete, neatly bound and indexed for submittal to the OWNER for review. VAM system shall be designed for achieving the above specified refrigeration load and installed within the proposed project boundary.

The above clause has been modified as

Bidder shall generally follow CPWD / ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers handbooks and standards. VAM system shall be designed for achieving the above specified refrigeration load and installed within the proposed project boundary. Design calculations shall include, but not necessarily be limited to, the following for each building: Heating, ventilation and air conditioning design loads in accordance with CPWD/ ASHRAE. Calculation for the same shall be submitted to the Owner for review.

11. *Document No.32687-11-PS-001-SW_R0, Page 19 of 25, Clause 5.24 of Scope of Work & Document No.32687-11-PS-001-DB_R0, Page 33 of 39, Clause 8.2.7 of Design Basis,*

The following added to the clause

Bidder shall design Wet scrubbing system for the bulk storage (Urea Silo) and raw material storage shed. *Dry de dusting system can be employed for bagging plant, the reclamation of material to the plant shall be indicated.*

12. *Document No.32687-11-PS-001-SW_R0, Page 25 of 25, Schematic Flow Diagram of Scope of Work*

The revised drawing for schematic flow diagram for Product Handling Facility & Raw material handling facility is attached as annexure A2 to corrigendum.

13. *Document No.32687-11-PS-001-DB_R0, Page 7 of 39, Clause no. 2.6 of Design Basis*

The above clause stands deleted and the specifications approved for fillers by process licensor shall be provided for Performance guarantee test run.

14. *Document No.32687-11-PS-001-DB_R0, Page 9 of 39, Clause no. 3.3 of Design Basis*

3.3 Steam

Low pressure (LP) steam will be made available at the plant battery limit.
Supply Condition:

Pressure, ATA (Absolute Technical Atmosphere)	: 8/5 ATA
Temperature	: 175/155^{O}C

The above clause is modified as,

3.3 Steam

Low pressure (LP) steam will be made available at the plant battery limit.
Supply Condition:

Pressure, kg/cm2g	: 8
Temperature	: 175 ^{O}C

15. *Document No.32687-11-PS-001-DB_R0, Page 12 of 39, Clause no. 4.4 of Design Basis*

4.4 Product shall be granular, free flowing and non-caking in storage. Product temperature shall be 45^{o}C (Max.) at the outlet of Final Product cooler (to be guaranteed).

The above clause is modified as,

4.4 Product shall be granular, free flowing and non-caking in storage. Product temperature shall be 45^{o}C max or 15^{o}C max. above ambient temperature at the outlet of Final Product cooler (to be guaranteed).

16. *Document No.32687-11-PS-001-DB_R0, Page 12 of 39, Clause no. 5.1 of Design Basis*

5.1 Liquid Ammonia

At a point one meter away from the battery limit at 13.5 Kg/cm^{2}g and (-)30^{o}C.
Subsequent transfer to plant through pipeline will be in the scope of the BIDDER.

The above clause has been modified as,

5.2 Liquid Ammonia

At a point one meter away from the tie in point at 13.5 Kg/cm^{2}g and (-)30^{o}C. Ref drawing *32687-03-AP-00001 R1 in this regard.* Subsequent transfer to plant through pipeline will be in the scope of the BIDDER.

17. *Document No.32687-11-PS-001-DB_R0, Page 12 of 39, Clause no. 5.5 of Design Basis*

5.5 RLNG as fuel
At a point one meter away from the battery limit at 5.0 Kg/cm^2 and (+)30^{o}C.

The above clause has been modified as,

5.5 RLNG as fuel
At a point one meter away from the tie in point at 10 Kg/cm^2(g) and 0 ^{o}C.

18. *Document No.32687-11-PS-001-DB_R0, Page 13 of 39, Clause no. 5.6 of Design Basis*

5.6 Raw Water
At a point one meter away from the battery limit at 6.0 Kg/cm2 and ambient temperature. Subsequent transfer to plant through pipeline will be in the scope of the BIdder

The above clause has been modified as,

5.6 Raw Water
At a point one meter away from the tie in point at 6.0 Kg/cm2 and ambient temperature. Subsequent transfer to plant through pipeline will be in the scope of the BIdder

19. *Document No.32687-11-PS-001-DB_R0, Page 23 of 39, Clause no. 8.1.8 of Design Basis*
8.1.8 The scrubbing system shall be designed considering the maximum limit for the Fluorine in phosphoric acid as 1.8 weight per cent % (max).

The above clause stands deleted

20. *Document No.32687-11-PS-001-DB_R0, Page 23 of 39, Clause no. 8.1.14 of Design Basis*
the sentence "Granulator should be provided with reversible motor"
The above sentence stands deleted.

21. *Document No.32687-11-PS-001-DB_R0, Page 27 of 39, Clause 8.2.2 (v) of Design Basis*
v) Reclamation of off spec. product from the screen house to the process plant

The above clause sentence has been modified as
v) Reclamation of off spec. product from the screen house to the process plant or to the common storage shed depending on the layout.

22. *Document No.32687-11-PS-001-DB_R0, Page 33 of 29, Pt no. ii of Clause 9.1, Design Basis*

ii Liquid Ammonia Sparger	: SS 904 L or equivalent
vii Granulator Pre-Scrubber	
Shell/Venturi	: SS 904 L for bottom wetted part and top portion CSRL
Spray Nozzle	: Hastelloy C or Equivalent
viii Tail Gas Scrubber	
Shell/Venturi	: SS 904 L for bottom wetted part and top portion CSRL
Spray Nozzle	: Hastelloy C or Equivalent

The above clause has been modified as,

ii Liquid Ammonia Sparger	: SS 316 L and flexible hoses
vii Granulator Pre-Scrubber	
Shell/Venturi	: SS 904 L
viii Tail Gas Scrubber	
Shell/Venturi	: CSRL
Spray Nozzle	: Duplex 2205

Scrubbers shall have single MOC and metallic as recommended by the Process Licensor

23. *Document No.32687-11-PS-001-DB_R0, Design Basis Additional clause added:*
Copper and copper alloys shall not be used anywhere in the project.

24. *Document No.32687-11-PS-001-PGT_R0, Page 5 of 15, Clause 1.3.2 (b) of Performance Guarantee Test*

b) Product temperature at the outlet of final product cooler shall be less than or equal to 45^{o}C.

The above clause has been modified as,

b) Product temperature shall be 45^{o}C max. or 15^{o}C max. above ambient temperature at the outlet of Final Product cooler.

25. *Document No.32687-11-PS-001-PGT_R0, Page 10 of 15, Clause 1.7.7 of Performance Guarantee Test*

The works cost shall be calculated as an average of production during Seventy-Two Hours (72) consecutive hours selected out of 5 days Guarantee test run period for production of each NP 20:20:0:13 & 18:46:0 Grade in the plant.

The above clause has been modified as,

The works cost shall be calculated as an average of production during Seventy-Two Hours (72) selected out of 5 days Guarantee test run period for production of each NP 20:20:0:13 & 18:46:0 Grade in the plant. The continous 72 hrs including the allowance of 2 hour of plant shutdown a day for cleaning purpose or an aggregate maximum of 6 hours of Plant shut down.

26. *Document No.32687-11-PS-001-PGT_R0, Page 12 of 15, Clause 2.2 of Performance Guarantee Test*

BIDDER shall endeavour to complete the sustained load test within a reasonable period after mechanical completion, but shall complete the same in any case within 90 days from mechanical completion.

The above clause has been modified as,

BIDDER shall endeavour to complete the sustained load test within a reasonable period after mechanical completion, but shall complete the same in any case within 150 days from mechanical completion without affecting overall project schedule (30 Months). Bidder can combine the PGTR for any of the product after completion of the SLT of particular grade. Then the other SLT and PGTR for the 2nd product grade should be made.

27. *Specification for Polypropylene (PP) Bags attached as Annexure A3 to this corrigendum.*

28. *General conditions and special conditions for selection of subvendors by LSTK Bidder is attached as Annexure F1 to this corrigendum.*

B. CIVIL

1. *Document No.32687-12-PS-001-DP_R0, Page 8 of 21 Design Philosophy-Civil & Structural Works, Description under the heading - 1.2 Site Grading*

"The topography levels of the plant can be referred from drawing no-32647-11-OP-001. Cutting, filling with burrowed earth, grading and levelling of plant area is in Contractor's scope of work. The grading of the area shall be done by cutting and filling with the following".

The above clause sentence has been modified as.

"The topography levels of the plant can be referred from drawing no-32687-03-AP-00001. Cutting, filling with burrowed earth, grading and levelling of plant area is in Contractor's scope of work. The grading of the area shall be done by cutting and filling with the following".

2. *Document No.32687-12-PS-001-DP_R0, Page 11 of 21 Design Philosophy-Civil & Structural Works, Description under the heading - 1.9 Sewage Disposal Scheme-1.9.1-General*

"Minimum pipe size shall be 100 mm and all pipes shall preferably be salt glazed stoneware unless abnormal soil conditions or high velocity dictates otherwise".

The above clause sentence has been modified as.

"Minimum pipe size shall be 100 mm and all pipes shall preferably be UPVC pipe Type B as per IS 13592 unless abnormal soil conditions or high velocity dictates otherwise".

3. *Document No.32687-12-PS-001-DP_R0, Page 14 of 21 Design Philosophy-Civil & Structural Works, Description under the heading - 1.14 Surface Finishing*

"The CONTRACTOR shall provide two (02) years Guarantee for all structural painting works".

The above clause sentence has been modified as.

"Painting shall be as per Specs and manufacturer's certificate shall be furnished for review. The remaining shelf life at the time of application shall be approved by Engineer in Charge".

4. *Document No.32687-12-PS-001-DP_R0, Page 19 of 21 Design Philosophy-Civil & Structural Works, Description under the heading - 3 Construction*

3.0.6 "The CONTRACTOR shall be responsible for obtaining the statutory approval from local authorities such as Inspector of Factories, Development Authorities, Municipal Corporation and other concerned authorities before starting the work".

The above clause sentence has been modified as.

"The CONTRACTOR shall do liasoning and Coordination for obtaining the statutory approval from local authorities such as Development Authorities, Municipal Corporation and other concerned authorities before starting the work".

5. *Document No.32687-12-PS-001-DB_R0, Page 11 of 44 Design Basis-Civil & Structural Works, Description under the heading – 4.1.2 Foundations Lean Concrete*

"80 mm thickness of Lean concrete mix 1:3:6 (by weight, using 40mm and down size grade crushed stone aggregate) shall be provided under all RCC foundations.".

The above clause sentence has been modified as.

"80 mm thickness of Lean concrete mix 1:4:8 (by weight, using 40mm and down size grade crushed stone aggregate) shall be provided under all RCC foundations.".

6. *Document No.32687-12-PS-001-DB_R0, Page 11 of 44 Design Basis-Civil & Structural Works, Description under the heading – 4.1.3 Hot Bitumen paint*

"All underground structures including top surfaces of foundations shall be painted with two coats of hot bitumen paint of grade 20/30 with quantity of bitumen at least 1.2 Kg/sq.m per coat.".

The above clause sentence has been deleted.

7. *Document No.32687-12-PS-001-DB_R0, Page 16 of 44 Design Basis-Civil & Structural Works, Description under the heading – 4.2 Structural Steel*

"The design of all structural steel work such as Roof trusses, Steel sheds, pipe racks, pipe bridges, tank supporting platforms, stairs, ladders, walkways, crane girders steel enclosures etc. will be carried out in accordance with allowable stress method of IS:800.".

The above clause sentence has been modified as.

"The design of all structural steel work such as Roof trusses, Steel sheds, pipe racks, pipe bridges, tank supporting platforms, stairs, ladders, walkways, crane girders steel enclosures etc. will be carried out in accordance with Limit State method of IS:800-2007."

8. *Document No.32687-12-PS-001-DB_R0, Page 31 of 44 Design Basis-Civil & Structural Works, Description under the heading – 7.1.6 Foundations*

"Concrete surfaces below GL shall be provided with 2 coats of anticorrosive bituminous coating."

The above clause sentence has been deleted.

9. *Document No.32687-12-PS-001-DP_R0, Page 15 of 21 Design Philosophy-Civil & Structural Works, Description under the heading – 1.0 Detailed Scope*

A new clause sentence has been added as

1.23 Dismantling & repair

"All dismantling and repair of existing Civil structure shall be in the scope of owner. Any repair / modification for tie in to existing Conveyor gantry or any additional modification requirement during detailed engineering shall be in Bidder's scope".

10. *The Soil Investigation report as a guide line at the proposed location of 1650 MTPD NPK plant at FACT-CD, Ambalamedu have been included as Annexure B1 in this Corrigendum*

11. *The existing Drain network available at the Proposed location of 1650MTPD NPK Plant and surrounding area have been included as Annexure B2 in this Corrigendum for reference purpose.*

C. M&PCE

1. Document No. 32687-01-PS-001-SPL
The Tender Document Special Requirements for RCC Cooling Tower (Doc No: 32687-01-PS-001-SPL) stands withdrawn. New documents, Special Requirements for FRP Cooling Tower (For OSBL), Doc No: 32687-01-PS-001-SPL2 and Special Requirements for FRP Cooling Tower (For ISBL), Doc No: 32687-01-PS-001-SPL3 are issued along with corrigendum as **ANNEXURE C1 & ANNEXURE C2** respectively.

2. Document No. 32687–01–PS–001 PH3, Design Philosophy FIREFIGHTING SYSTEM, clause 7.5.1

The term " Belt conveyors " shall read as " Belt Conveyors conveying flammable substances such as sulphur, etc."

3. Document No. 32536-01-FWN_SL-00001 Rev.0, Fire Water Network & Sleeper layout – Cochin Division (Phase 1&2)

The Tender document, Drg. No. 32536-01-FWN_SL-00001 Rev.0, Fire Water Network & Sleeper layout –Cochin Division (Phase 1&2) stands withdrawn. New document, Drg No. 32536-01-FWN_SL-00001 Rev.2, Fire Water Network & Sleeper layout –Cochin Division (Phase 1&2) is issued along with corrigendum as **ANNEXURE C3**.

4. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING (Page 12 of 18, Clause 7.1 and Page 15 of 18, Clause 7.5.2)

The weighing and correction frequency modified as 1:5

5. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING, Page 15 of 18, Clause 7.5.1

The accuracy of weighing is modified as min. ±50gms for achieving minimum 2 sigma capability for individual weighment.

6. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING

Additional requirement: If not specified, the hoppers shall be fabricated from Carbon steel plates (min. 10 mm thk.) conforming to IS 2062 or equivalent/ISO and lined with SS 304 of adequate thickness from inside (min. 3mm), not only on bottom portion but also on vertical portion for free flow of material. Hoppers for bentonite/ Clay/sand shall be fabricated from Carbon steel plates (min. 10 mm thk.) conforming to IS 2062 or equivalent/ISO.

7. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING

Additional requirement: If not specified, the MOC of bucket elevator shall be as follows.

a) For bucket elevators in ISBL, MOC as per Licensers specification shall be followed.
b) For bucket elevators handling urea in OSBL, all contact parts shall be minimum SS 304 or higher grade.
c) MOC of Bucket elevators in OSBL handling materials other than urea shall be minimum CS. Bucket tip(replaceable) shall be of hardened CS material.

8. Document No. 32687–01–PS–001 PH3 R0, Design Philosophy FIREFIGHTING SYSTEM, Clause 3.5

"Taping/s with the fire water mains shall be provided at plant battery limit (adjacent to the proposed plant location) as per requirement. The same (tie-in location/s) shall be decided during the detail engineering."

The above clause sentence is modified as

"Battery limit for the Fire water network (Tie-in points) are indicated in the drawing attached with the corrigendum as **ANNEXURE C3**, Drawing No 32536-01-FWN_SL-00001 Rev.2, Fire Water Network & Sleeper layout –Cochin Division (Phase 1&2). Residual pressure of minimum 8 kg/cm2 will be provided at battery limit."

9. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING, Page 15 of 18, Clause 7.6

"Bag Stitching machines shall be heavy duty industrial double stitching double row type with stitching speed to suit stitching up to a minimum 1,080 bags / hour. The width of each bag to be stitched shall be approx. 500 mm. The bag material shall be HDPE /PP. Machine shall be of approved make."

The above clause sentence is modified as

"Bag Stitching machines shall be heavy duty industrial double stitching single row type with stitching speed to suit stitching up to a minimum 1,080 bags / hour. The width of each bag to be stitched shall be approx. 500 mm. The bag material shall be HDPE /PP. All stitching m/c shall have spare stitching head (warehouse spare). Machine shall be of approved make"

10. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING

Additional requirement: GA Drawing with details of existing bunker outlet and height details are furnished with the corrigendum as **ANNEXURE C4**. If required, minor modification to the bunker outlet may be carried out to accommodate the duplex bagging machine.

11. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING Clause 4.0

Additional requirement: Flow diagram for raw material storage and reclamation facility, attached with the corrigendum. Requirements indicated are minimum.

12. Document No. 32687–01–PS–001 VL2 R0, SUB VENDOR LIST MATERIAL HANDLING
Following Sub Vendors are added

S. No. 5 WEIGHING-CUM-TIPPING / BAGGING MACHINE
5. Chronos Richardson India (P) Ltd., India
S. No. 6 BAG STITCHING MACHINE
2. Chronos Richardson India (P) Ltd India
3. Newlong machine co., Japan/India

13. Document No. 32687–01–PS–001 PH2 _R0, DESIGN PHILOSOPHY MATERIAL HANDLING.

Additional requirement: If ultrasonic level measurement is not feasible, depending on the type of bunker, the following level measurement methods shall be considered in the order of precedence- 1. Non-Contact Radar, 2. Guided wave radar, 3. Capacitance type level switch. However, the requirement of Level measurement for each bunker/ hopper shall be decided on case to case basis during detailed engineering as per process requirement and technical feasibility, so as to avoid excessive dependence on visual level assessment and consequent process/ product quality variation

D. PIPING DEPARTMENT

1. *Document No. 32687-03-AP-00001 R0 stands deleted and new document 32687-03-AP-00001 R1 has been uploaded as Annexure D1.*

2. *FACT CD overall plot plan uploaded for locating existing ETP with reference to proposed NP plant as Annexure D1. Also, AutoCAD file for the same have been uploaded as Annexure D2. (Since this is an AutoCAD file, it will be uploaded separately)*

E. ELECTRICAL DEPARTMENT

1. *Document No. 32687–13–PS–001 DH, Design Philosophy-Electrical, Clause No. 3.2(b). of Voltage rating of consumers*

Motors of rating above 150 kW and up to 1000Kw : 3.3kV

The above clause sentence has been modified as.

Motors of rating above 200 kW and up to 1000kW :3.3kV

2. *Document No. 32687–13–PS–001 DH, Design Philosophy-Electrical, Clause No. 3.2(c). of Voltage rating of consumers*

MV motors of rating up to and including 150 Kw :415V, 50 Hz, 3 phase, AC

The above clause sentence has been modified as

MV motors of rating up to and including 200 kW :415V, 50 Hz, 3 phase, AC

3. *Document No. 13ES905/14, Engineering Specification for Bus Trunking is Attached as Annexure E*

4. *Document No. 32687–13–PS–001 DH, Design Philosophy-Electrical, Clause No.6*

Furthermore, substation building shall contain the following facilities: -
Toilet rooms
Rest room
Office rooms
Store room

The above clause sentence has been modified as.

Furthermore, substation building shall contain the following facilities with Minimum area as given below: -
Rest Room (1No) -- 6M X 4M
Office Room (3 Nos) -- 3M X 3M
Store Room (1 No) -- 6M X 4M
Wash area with Toilet (1 No.), Bath Room (1 No.) wash basin (2 Nos) and urinals (3 Nos) – 3M X 3M

5. *Document No. 32687–13–PS–001 DH, Design Philosophy-Electrical, Clause No.1*

The minimum size of the building shall be 16mtrs x 32mtrs.The vendor shall design the layout suitably, incorporating these requirements.
The above clause sentence has been modified as.

The minimum size of the building shall be 16mtrs x 32mtrs.The vendor shall design the layout suitably, incorporating these requirements.

A PMCC with following facilities shall also be provided.

1. 63A, 3 Phase power outlet for connecting welding set.

2. 63A, 3 Phase power outlet for connecting Air Compressor

3. 32A, 3 Phase power outlet for connecting bench grinder

4. DOL Starter for conducting test run of 3 phase motors from 100HP to 200HP

5. DOL Starter for conducting test run of 3 phase motors from 20HP to100HP

6. DOL Starter for conducting test run of 3 phase motors below 20HP

7. 2 Nos. of 32A, 3 Phase power outlet as spare

ANNEXURE – A-1

FRP COOLING TOWER

ANNEXURE A1

A. FRP Cooling Tower

Cooling Tower required for the ISBL and OSBL shall be independent and suitable package type FRP Cooling Tower System shall be provided.

Cooling Tower Design should comply with below mentioned parameters

- Approach : ≤3.5^{o}C
- Supply Pressure : 3.5 kg/cm^{2}(G) minimum (Bidder to decide)
- Return Pressure : 3.0 kg/cm^{2}(G) minimum (Bidder to decide)
- Design Wet Bulb Temperature : 29ºC
- Mechanical Design Pressure : 10.5 kg/cm^{2}(G)
- Mechanical Design Temperature : 65^{o}C

	ISBL	*OSBL*
1	*Cooling Tower Cells:* *Two cells of induced draft type with RCC Sump, each cell capable of handling the maximum duty with provision for individual isolation for maintenance Job*	*Cooling Tower Cells:* *Two cells of induced draft type with RCC Sump, each cell capable of handling the 60% capacity of the maximum duty with provision for individual isolation for maintenance Job*
2	*Cooling Tower Fans:* *Two (2) nos. of cooling tower fans one for each cooling tower cell with suitable variable frequency drive (VFD) electric motor shall be provided*	*Cooling Tower Fans:* *Two (2) nos. of cooling tower fans one for each cooling tower cell with suitable variable frequency drive (VFD) electric motor shall be provided*
3	*Cooling Tower Basin / Sump:* *RCC Basin or Sump shall be provided.*	*Cooling Tower Basin / Sump:* *RCC Basin or Sump shall be provided.*
4	*Cooling Water Circulation Pumps:* *THREE (3) nos. of horizontal centrifugal type pumps, each capable of handling 50% of maximum circulation rate shall be provided.*	*Cooling Water Circulation Pumps:* *THREE (3) nos. of horizontal centrifugal type pumps, each capable of handling 60% of maximum circulation rate shall be provided.*

5	*Side stream system to be provided as per design requirement.* *Note: Chemical dosing system required for new cooling tower is under the scope of LSTK bidder. LSTK bidder shall specify the treatment requirement in detail along with the offer. One (1) chlorine gas detector to be provided.*	*Side stream system to be provided as per design requirement.* *Note: Chemical dosing system required for new cooling tower is under the scope of LSTK bidder. LSTK bidder shall specify the treatment requirement in detail along with the offer. One (1) chlorine gas detector to be provided.*
6	*For detailed scope of work refer to special requirements for FRP cooling tower vide Doc No. 32687-01-PS-001 SPL 1*	*For detailed scope of work refer to special requirements for FRP cooling tower vide Doc No. 32687-01-PS-001 SPL 1*
7	*Cooling tower blow down and Sand filter backwash water shall be routed to ETP through collection pit and pump or used in the process plant as recommended by the process licensor.*	*Cooling tower blow down and Sand filter backwash water shall be routed to ETP through collection pit and pump*

The cooling water return downstream of the system shall be provided with relief valves. The online pH & conductivity meters, cooling water supply & return header temperature, pressure transmitters, cooling tower fans & circulation pumps motor running indication shall be provided. Bidder/s to provide P&IDs of cooling tower system along with their offer.

ANNEXURE – A-2

SCHEMATIC FLOW DIAGRAMS

LEGENDS

BC–BELT CONVEYOR

FT–FIXED TRIPPER

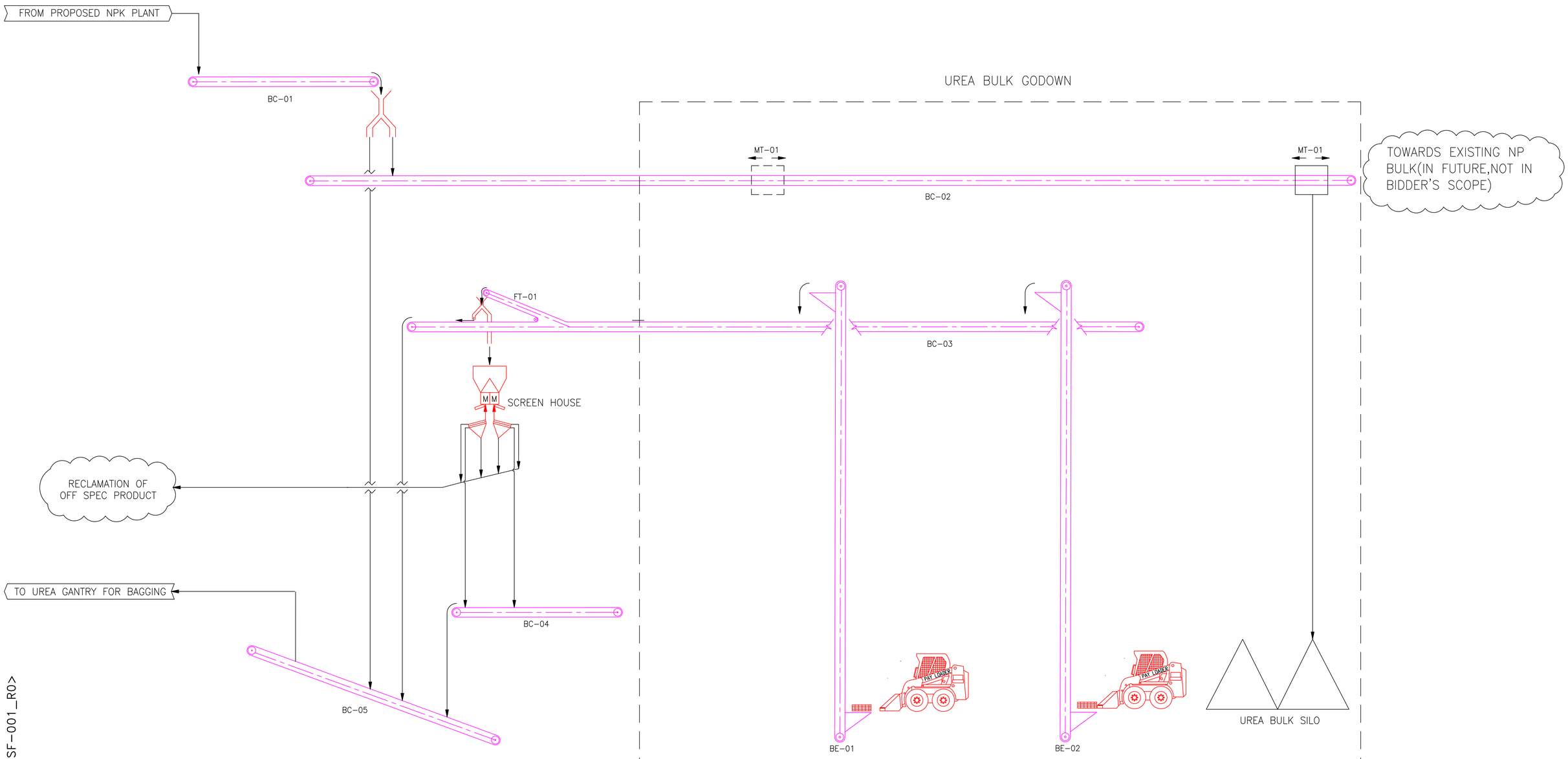
BE–BUCKET ELEVATOR

MT–MOBILE TRIPPER

BC–01–NPK PLANT TO UREA BULK GODOWN
BC–02–CONVEYOR INSIDE THE UREA SILO
BC–03–RECLAMATION CONVEYOR
BC–04,05–PRODUCT FROM SCREEN HOUSE TO BAGGING PLANT

NOTE:–

1. SCHEMATIC DIAGRAM SHOWN HERE IS INDICATIVE ONLY,BIDDER SHALL REVIEW THE SCHEME AND MODIFY (IF REQUIRED) TO MEET THE PLANT REQUIREMENT.



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A2

CLIENTS: FACT–CD

DRAWING NO.	TITLE
REFERENCE DRAWING	

NO	ZONE	PARTICULARS	REVISED	CHECKED	APPROVED	DATE
REVISION						

SCALE	NTS
DATE	17/02/2021
DRAWN	ST
CHECKED	MR
DESIGNED	MR
CHECKED	KVR
APPROVED	KVR

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LTD
UDYOGAMANDAL KERALA

FEDO

PROJECT NAME NEW 1650 MTPD NPK PLANT AT FACT–CD PROJECT No:32687

TITLE SFD OF PRODUCT HANDLING FACILITY

SHEET 1 OF 1 DRG. No. 32687–11–SF–001 REV. X X / X X / X O

OOFT004/10

LEGENDS

BC–BELT CONVEYOR

GB–GRIZZLY BAR

BE–BUCKET ELEVATOR

MT–MOVABLE TRIPPER

BC–01–OVER HEAD CENTRAL STORING CONVEYOR
BC–02–RECLEMATION CONVEYOR (ONE SIDE)
BE–01,02,03–BUCKET ELEVATORS
GB–01,02,03–GRIZZLY BARS

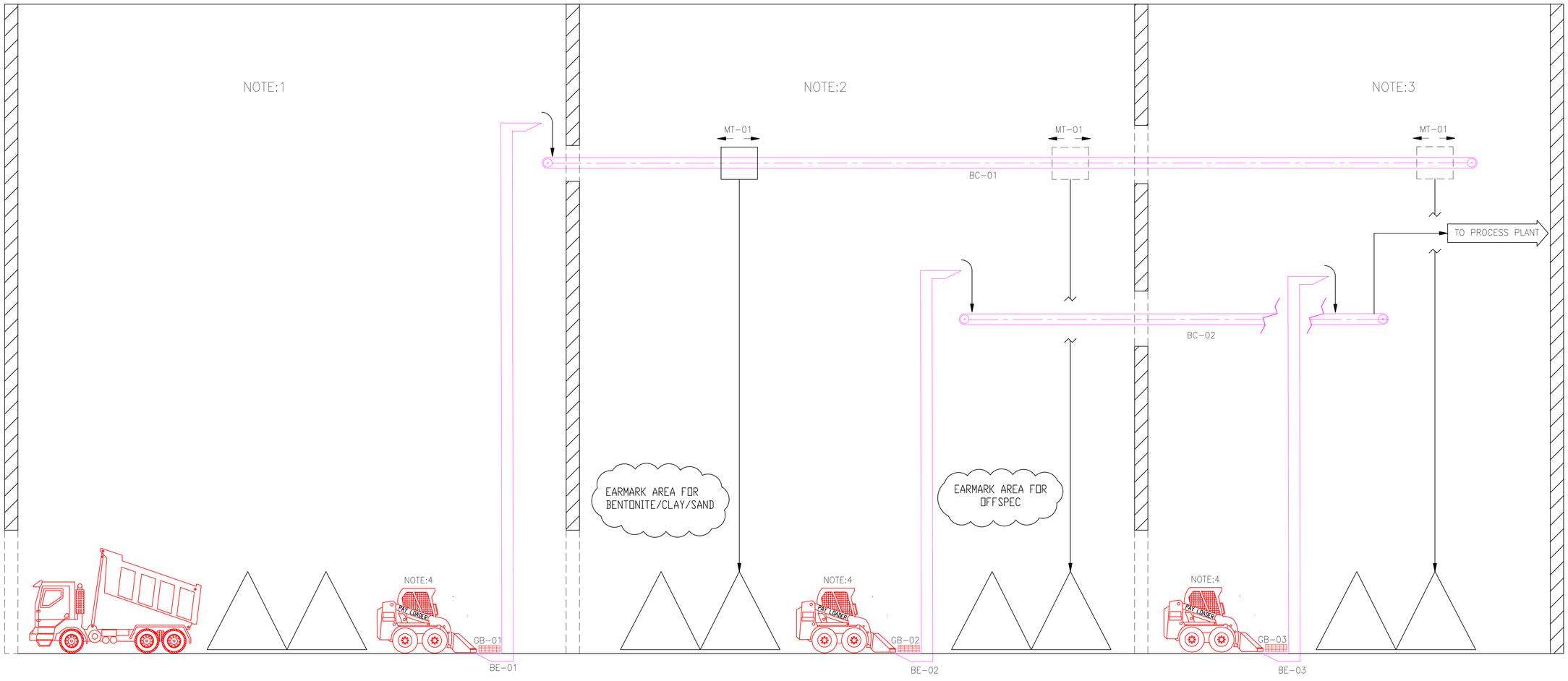
NOTES:

1:COVERED AREA FOR RAW MATERIAL DUMPING AND FEEDING TO BUCKET ELEVATOR FOR STORAGE (MINIMUM 60MT DUMPING CAPACITY).

2:COVERED AREA FOR BENTONITE/OFFSPEC/CLAY/SAND.

3:COVERED DEHUMIDIFIED AREA FOR UREA.

4:PAYLOADER & TRIPPER IN CLIENT SCOPE.



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CLIENTS: FACT–CD

DRAWING NO.	TITLE
REFERENCE DRAWING	

NO	ZONE	PARTICULARS	REVISED	CHECKED	APPROVED	DATE
REVISION						

SCALE	NTS
DATE	17/02/2021
DRAWN	ST
CHECKED	MR
DESIGNED	MR
CHECKED	KVR
APPROVED	KVR

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LTD
UDYOGAMANDAL KERALA

PROJECT NAME NEW 1650 MTPD NPK PLANT AT FACT–CD PROJECT No:32687

TITLE SFD Of RAW MATERIAL HANDLING FACILITY

X	X
X	X
X	0

SHEET 1 OF 1 DRG. No. 32687–11–SF–002 REV.

00FT004/10

ANNEXURE – A-3

PP Bag Specification

Annexure- III

SPECIFICATIONS FOR OUTSIDE LAMINATED POLYPROPYLENE (PP) BAGS

A. Inside Dimensions : 915 mm X 610 mm
   Tolerance : +30 mm, Nil on Both Width and Length
B. Capacity : 50 kgs
C. Weight of Individual Bag : 130 gms – Tolerance +/-3 %
D. Weight of a Bale (350 Bags) : 45.5 kgs. (Net wt)

   Tolerance +3%/ - 0 % (No negative tolerance)

E. Breaking strength : Widthwise : 91.8 kgf

   Widthwise (Lamination Joint) : 91.8 kgf

   Lengthwise : 91.8 kgf

   Bottom seam : 40.8 kgf

ANNEXURE – B-1

SOIL INVESTIGATION REPORT

Soil Investigation Report for the Proposed New 1650 MTPD NPK Plant at Ambalamedu for M/s. FACT-CD

December 2020

Testing agency:

GEO FOUNDATIONS & STRUCTURES PVT. LTD.
6TH FLOOR, ALPHA PLAZA,
K.P.VALLON ROAD, KADAVANTHRA,
KOCHI-682 020.
PHONE: 0484 – 2316042 / 2980092

CONTENTS

★ ★ ★ ★ ★ ★ ★

1.0 INTRODUCTION

1.1 M/s FACT Cochin Divison, Ambalamugal has awarded the work of conducting soil Investigation works at the prop. Locations of 1650 MTPD NPK Plant at FACT –CD campus at Ambalmedu to us against WO No. 4800014250 dt.13/11/2020.

1.2 The field investigation and laboratory study for subject work was carried out in November - December 2020. This report summaries the investigations and furnishes the field & Laboratory tests results with suggestions for suitable foundation at the location of each structure.

2.0SCOPE OF WORK

The scope of work at this site comprised of the following:

2.1 Mobilisation of calyx boring rig with all necessary equipment and personnel.

2.2 Boring of four boreholes at 1650 MTPD NPK Plant area and two boreholes at raw materials storage area, with rotary power drilling equipments through sand, silt, clay & rock., as instructed by Engineer – In – Charge.

2.3 Conducting Standard Penetration tests in bore-holes and collecting the representative and disturbed samples including packing and transportation to laboratory.

2.4 Drilling in rocky strata / rock with rock core barrels and collection of rock samples for testing.

2.5 Collecting water samples from the boreholes for necessary testing in the lab

2.6 To conduct the following laboratory tests on soil samples:

(a) Particle size analysis:

(i) Sieve analysis

(ii) Hydrometer analysis

(b) Index properties:

(i) Liquid limit

(ii) Plastic limit

(c) Bulk and dry density including moisture content

(d) Specific gravity

(e) Unconfined Compression test

(f) Consolidation test on non granular soils

(g) Tri axial(drained) test on cohesive soils

(h) Shear box test on non cohesive granular soils

(i) Uni axial compression test on rock samples

(j) Chemical analysis on water samples

(k) Chemical analysis on soil samples

2.7 Preparation and submitting detailed report compiling the field and laboratory test results.

3.0 FIELD INVESTIGATIONS - Borehole studies

3.1 To conduct the borehole studies at site, rotary calyx drilling rigs – engine driven - with all requisite equipment and accessories were mobilized at the work site. A team of technical personnel with skilled labours were also deputed with the rigs.

3.2 Six boreholes were bored totally at both the locations and these bores were terminated after drilling into rock and as per client's instructions. The boreholes were made as per IS: 1892 - 1979.

3.3 Standard Penetration Tests were conducted in the bore holes at regular intervals of 1.0 mtr to 1.50m as per IS: 2131-1981. In this test, the standard split spoon sampler is driven into the ground at the required depth by means of standard hammer of 63.5 kgs weight, falling from a height of 75cm. Number of blows for the first 15cm is not taken into consideration because of possible disturbances or presence of settled, suspended matters at the bottom of the bore- holes. The total number of blows for the next 30cm depth of penetration is considered as SPT 'N' values are shown in graphical representation of N value.

3.4 The samples from the Split Spoon sampler o SPT setup are collected as Representative samples. These samples so collected were carefully packed, sealed and numbered with full particulars for identification and sent to the laboratory for necessary testing.

3.5 Undisturbed soil samples were not collected during the boring works since the soil encountered is not suitable for the same.

3.6 Soil boring is done by using normal cutting tools / soil cutters fitted to the drilling rods. Once the refusal is obtained i.e SPT "N" value is greater than 100, the soil cutting tools are replaced by rockcore barrelsfittedwith either tungsten carbide bits or diamond bits. Rock Core Recovery (CR) and Rock Quality Designation (RQD) values are recorded at sitebased on the rock samples retrieved during drilling. The core samples were collected and sent to laboratory for further tests/ procedures.

3.7 The details of field tests and their location etc. are given in table 3.1

Table No.3.1

Sl No.	BH No.	Co-Ordinates		Ground Elevation
		East	North	
1.	BH-01	649642.263	1103366.100	+23.770
2.	BH-02	649656.639	1103329.710	+23.770
3.	BH-03	649670.205	1103249.063	+20.000
4.	BH-04	649710.822	1103257.995	+20.000
5.	BH-05	649636.082	1103225.111	+20.000
6.	BH-06	649696.919	1103215.539	+20.000
7.	CBR-01	649603.472	1103312.870	+23.770
8.	CBR-02	649623.205	1103192.301	+20.000
9.	CBR-03	649698.007	1103210.212	+20.000

4.0 LABORATORY INVESTIGATION

The following laboratory tests were conducted on the selected samples recovered from the test bore-holes:

a) Particle size analysis:

(i) Sieve analysis

(ii) Hydrometer analysis

b) Index properties:

(i) Liquid limit

(ii) Plastic limit

c) Bulk and dry density including moisture content

d) Specific gravity

e) Shear box test on non cohesive granular soil

f) Unconfined compressive strength

g) Uni axial compressive strength of rock

h) Chemical Analysis on soil

i) Chemical Analysis on water

All the above laboratory tests were carried out as per relevant Indian Standards.

ANNEXURE – A

1650 MTPD NPK PLANT

(BH-03, BH-04, BH-05 & BH-06)

5.0 SITE SOIL DESCRIPTION

5.1 Soil Stratification

5.1.1 The soil, in general, at the subject site is lateritic in nature which in local terminology is also called as red earth and / or murrum soils based on the composition – variations in the individual components of gravel, sand and silt & clay. The general terrain of this project area is of plain with not much of undulations.

5.1.2 **BH - 3 :** The top layer in this borehole locationconsists of 5.90m deep sandy clayey silt of medium plasticity with a layer of 1.00m silty sand of non-plastic nature sandwiched at 3.70m. The next layer is of sandy silt of non-plastic nature from 5.90m to 7.80m. Below this is a 11.20m thick silty sand layer with presence of clay towards the top of the layer. The final layer consists of 2.00m rock and the borehole is terminated at 21.0m.

5.1.3 **BH - 4 :**The first layer of the borehole consists of 3.60m of clayey sand of low plasticity. The following layer is made up of 4.20m thick clayey silt of medium plasticity with a thin layer of sandy silt at 4.70m. After this is a 2.00m thick layer of silty sand of non-plastic nature is observed, which is followed by 16.70m deep sandy silt layer with a layer of clayey silt of medium plasticity sandwiched at 15.60m. The 2.00m rock is encountered at the last layer. The borehole is terminated at 28.50m.

5.1.4 **BH-05** :This borehole consists 2.80m filled up clayey gravel with sand at the top. The following layer is of 2.00m thick clayey silt of medium plasticity. The consecutive layer comprises of 7.10m silty sand of non-plastic nature with a layer of 2.80m thick sandy silt at 6.90m. The bottommost layer is 2.00m thick rock. i.e., the termination depth in BH-05 is 13.90m.

5.1.5 **BH-06**: The borehole consists of consecutive layers of 3.70m and 1.10m thick clayey silt of medium plasticity and 3.00m and 0.60m thick silty sandy layer with presence of clay from 0.00m to 8.40m. The following layer is of alternate layers of sandy silt and silty sand, both of non-plastic nature with 3.60m and 1.80m thick layers of sandy silt and 5.00m and 0.70m thick silty sand from 8.40m to 19.50m. A 2.00m soft rock is encountered at the final layer. The borehole is terminated at 21.50m.

5.2 CROSS SECTION PROFILE& DESIGN BORELOG:

Based on the individual borelogs at the site, a cross section profile is made as given in **page No.12** which gives an idea of the changes in the strata including the rock profile variations acrossthe length and width of the site. Details of Borehole 05 is considered as the Design Borelog as it has weaker properties as compared to the soils in other borehole locations.

6 .0 DISCUSSION ON TYPE OF FOUNDATION

6.1 It is understood from the Clients that the proposed facilities at this area is an NPK Storage Plant with RCC structure of multiple floors provided in an area of about 6om x 90m to a height of 40 mtr. Such construction to the heights will surely induce more of lateral loads /moments at the ground level in addition to the vertical loads.

6.2 From the borelogs& results tables of the borehole study, itcan be observed that the soils are basically clayey and sandy soils with medium to dense in nature due to variations in N values. Rock is available at varying depths from the ground level.

6.3 The project area is in Seismic Zone III of the Map of India. In case the soils are induced to seismic loadings there can be liquefaction in the sandy natured soils below. This may cause undue settlements to the structure in case if shallow foundations are provided.
The calculations of liquefaction potential are done and provided from Page N0.69 to 79 of this report.

6.4 Hence it is found necessary that the loads coming from the structure need to be transferred to a firm stratum. Based on the soil condition and the availability of rocky strata, pile foundation shall be abetter foundation system for the proposed structure with these piles resting in the rocky strata available below.

6.5 RCC bored cast in situ piles by DMC method installed as per the relevant clauses of IS 2911 : Part 1 / Sec 2 - 2010 shall be provided as the foundation. It is suggested that piles shall be socketed into rocky strata by half times the diameter of piles (1/2 D).

6.6 Based on the variation in the profile of rocky strata, the length of piles is expected to be about 12.0 mtr to 26.5 mtr below the existing ground level in addition to the socket length. Socketing by half times the diameter of piles (1/2 D) is to ensure the end bearing component of the carrying capacity. The safe carrying capacities for different diameters of piles calculated as per relevant clauses of above said IS Code are tabulated and given below in Table **No.7.1**. A factor of safety of 2.5 is considered for calculating the safe capacities.

7.0 FOUNDATION SUGGESTIONS:

7.1 Pile Foundation Suggestions:

7.1.1 Considering the nature of loads expected at the ground level from the tall RCC structure of about 40 mtr height and the nature of soils availableat the subject site, pile foundation installed by bored cast in situ method as per the relevant clauses of IS : 2911 – Part 1 / Sec 2 – 2010 shall be a feasible foundation system. These pilefoundations of suitable diameter shall be bored through all types of soils and terminated after seating in the rock strata. This facilitates us to take the advantage of generating an end bearing component of thecarrying capacity in addition to the frictional component along the length of the pile.

7.1.2 Hence, RCC bored cast in situ piles by DMC method installed as per the relevant clauses of IS 2911 Part1/ Sec 2 - 2010 shall be provided as the foundation. The pile capacities are worked out for different diameters of piles considering the termination of 0.5 times D in rocky strata. Based on the variation in the profile of rocky strata, the length of piles is expected to be about 12.0 mtr to 26.5mtr below the existing ground level in addition to the socket length. A factor of safety of 2.5 is considered for calculating the safe capacities. The safe carrying capacities for different diameters of piles are tabulated as given below in **Table No.7.1**

Table No: 7.1

Dia. Of Pile	Safe Capacity (T)		
	Compression	Tension	Shear
60 cms	160	30	2.5
70 cms	230	35	3.5
80cms	300	42	4.0
90 cms	380	48	5.5
100 cms	470	55	6.5

7.1.3 A typical calculation of the pile capacity working out is given inPage No. 82 to 88 of this report.

7.1.4. It is also suggested that the carrying capacities of the piles given above shall be verified by conducting pile load test as per relevant clauses of IS 2911(Part-4)-2013.

7.2 Shallow Foundations Suggestions

7.2.1 In the areas where lightly loaded structures are likely to come up within the project area, shallow foundations like individual square footing / strip footing may be proposed.

7.2.2 Bearing capacity of different types of footings are worked out as per relevant clauses of Indian Standard Code of Practice IS: 6403 - 1981 for shear criterion and IS: 8009 (Part – I) – 1976 for settlement criterion. Values calculated for different sizes of footing to be placed at different depths from the existing ground level are as given in the table No 7.2. The bearing capacities were calculated from shear criterion and with corrected N value for 50mm settlement after considering the water table correction factor.

Table No: 7.2.1 (Square footing)

Size of footing (m)	Depth below EGL	Bearing capacity from shear criterion (T/M^2)	Bearing capacity from settlement criterion (T/M^2)
1.0 x 1.0	1.00m	13.5	32.0
	1.50m	16.5	31.0
	2.00m	18.0	23.0
	2.50m	20.5	11.5
	3.00m	23.5	12.0
1.50 x 1.5	1.00m	12.5	23.5
	1.50m	14.5	19.5
	2.00m	16.0	19.0
	2.50m	17.5	18.5
	3.00m	20.5	27.0
2.0 x 2.0	1.00m	12.5	19.5
	1.50m	13.5	25.5
	2.00m	15.0	27.0
	2.50m	16.5	35.5
	3.00m	19.0	26.0
2.5 x 2.5	1.00m	12.0	23.0
	1.50m	13.0	25.0
	2.00m	14.5	22.0
	2.50m	15.5	23.0
	3.00m	18.0	22.0
3.0 x 3.0	1.00m	12.0	21.5
	1.50m	13.0	21.0
	2.00m	14.0	20.0
	2.50m	15.0	23.0
	3.00m	17.5	20.5

Table No: 7.2.2 (Strip footing)

Size of footing (m)	Depth below EGL	Bearing capacity from shear criterion (T/M^2)	Bearing capacity from settlement criterion (T/M^2)
0.80	1.00m	11.0	35.0
	1.50m	13.0	40.0
	2.00m	15.5	26.5
	2.50m	17.5	12.0
	3.00m	20.0	7.0
1.00	1.00m	10.5	39.0
	1.50m	12.5	30.0
	2.00m	14.0	20.5
	2.50m	16.0	12.0
	3.00m	18.5	5.0
1.20	1.00m	10.5	45.0
	1.50m	12.0	24.0
	2.00m	13.5	15.0
	2.50m	15.0	8.0
	3.00m	17.0	14.0
1.50	1.00m	10.0	23.5
	1.50m	11.0	17.5
	2.00m	12.5	21.0
	2.50m	14.0	24.0
	3.00m	16.0	21.0
2.00	1.00m	9.50	31.0
	1.50m	10.5	25.0
	2.00m	12.0	25.0
	2.50m	13.0	27.0
	3.00m	14.5	20.0

	1.00m	9.50	22.5
	1.50m	10.5	21.0
2.50	2.00m	11.5	18.5
	2.50m	12.5	19.5
	3.00m	14.0	21.5

7.2.3 It is the general practice that the least value calculated from the shear criterion and the settlement criterion is considered as the safe bearing capacity(SBC) for the proposed size of footing placed at the suggested depth. A typical calculation of working out for the bearing capacities are given in Page No. 89 to 93.

8.0 METHOD OF COMPUTING BEARING CAPACITY FOR SHALLOW FOUNDATIONS

Bearing capacity for shallow foundation is worked out based on the Shear criteria as given in relevant clauses of IS: 6403 – 1981 RA-2016 and settlement criteria as given in IS: 8009(part-1)–1976 RA-2013. The least of these two values is considered as the Safe / Allowable Bearing Capacity value for the given foundation.

8.1 Calculation as per Shear Criteria:

$qds = 1/F \{C.Nc.Sc.dc.ic + q(Nq-1).Sq.dq.iq + 1/2.B.\Upsilon.N\gamma.S\gamma.d\gamma.i\gamma.w'\}$

where,

qds – Safe allowable bearing capacity in Kg/cm^2

C - Cohesion of the soil in Kg/cm^2

q - Overburden pressure in Kg/cm^2

B – Width of footing in cm

Υ - Unit wt. Of soil in Kg/cc

Sc, Sq& $S\gamma$ - Shape factors

dc, dq, $d\gamma$ - Depth factors

ic, iq& $i\gamma$ - inclination factors

Nc, Nq& Nγ - Bearing capacity factors depending upon the angle of internal friction of the soil.

F – Factor of safety

W' – Correction factor for water table

8.2 Calculation as per Settlement Criteria:

8.2.1 Calculation as per Settlement Criteria for Sandy Layer:-

Settlement is calculated from the graph given in Fig.No.9 of IS 8009 Part-1
From the said graph, Settlement for unit pressure of 1Kg/cm^2 for the width of foundation B is correlated.

8.2.2 Calculation as per Settlement Criteria for clayey Layer:-

Consolidation settlement, S_t is given by,

$$S_t = \frac{C_c}{1+e_0} H \log \frac{p_0 + \Delta p}{p_0}$$

C_c - Compression index

e_0 - Initial void ratio

H - Thickness of clay stratum

P_0 - Consolidation pressure

Δp - Net change in pressure

8.3 METHOD OF COMPUTING CAPACITIES FOR PILE FOUNDATIONS:

Safe capacity of RCC Bored cast-in-situ pile can be computed by using the formula given in IS: 2911 (Part-1/Sec-2)-2010:

Ultimate bearing capacity Qu of piles in Cohesion less soil:

n

$$Qu = Ap(0.5.D.\gamma.N\gamma + PD.Nq) + \sum_{I=1} k .PDi .\tan \delta . Asi$$

Where,

Ap= Cross sectional area of pile toe in cm²

D= Stem dia. in cm

γ= effective unit weight of soil at pile toe in kg /cm³

PD = effective overburden pressure in Kg / cm²

$N\gamma$ and Nq = bearing capacity factors depending upon the angle of internal friction Ø at toe

$\sum_{I=1}^{I=n}$ = Summation of N layers in which pile is installed

K = Coefficient of earth pressure

PDi = effective overburden pressure in Kg /cm² for the i^{th}layer where i varies from 1 to n.

δ= angle of wall friction between pile and soil in degree (may be taken equal to Ø)

Asi= Surface area of pile stem in cm² in the ith layer where i varies from 1 to n.

For cohesive soil:-

Safe capacity of pile = 1/F {AP.Nc.Cp + α. C.As)

Where

Ap- c/s area of pile toe in cm²

Nc- bearing capacity factor

Cp- average cohesion at pile tip in Kg/cm²

α - Reduction factor

C – average cohesion throughout the length of pile in Kg/cm²

S- Surface area of pile shaft in cm^2

F - Factor of safety.

9.0 ADDITIONAL DETAILS

9.1 Ground water table is recorded and mentioned in the borelogs of respective boreholes. It is observed that the water table varies between 4.10m to 6.40mbelow existing ground Leveland design depth of water levelis taken as 4.10m. However, the soils are considered to be saturated for the purpose of calculating bearing capacities / pile capacities, which is the general practice.

9.2 From the chemical analysis results of water and soil given in Table 8 (pg. 80) and Table 9 (pg. 81) of this report, it can be understood that the test values of all the parameters are within thepermissible limit as per IS 456:2014. Hence no additional precautions are suggested with regard to the usage of cement and / or steel reinforcement for the concrete works in this project.

9.3 Hence Ordinary Portland Cement of 53 Grade can be used for all concrete works. The grade of concrete shall be as per specifications laid down in IS: 456 – 2000. TMT Rebars of Fe 500 Grade shall be used for the concreting works of various foundations proposed at this subject site.

10.0 CONCLUDING REMARKS

10.1 RCC Bored cast in situ piles to be considered for the proposed structure. The Safe capacities for different diameter of piles taken to a depth of 12.m to 26.5m below the existing ground level and socketed by 0.5 times the diameter of piles in to the rocky strata is given below in Table No.10.1.

Table No.10.1

Dia. Of Pile	Safe Capacity		
	Compression	Tension	Shear
60 cms	160	30	2.5
70 cms	230	35	3.5
80 cms	300	42	4.0
90 cms	380	48	5.5
100 cms	470	55	6.5

10.2 It is also suggested that the carrying capacities of the piles given above shall be verified by Conducting Initial pile load test as per relevant clauses of IS 2911(Part-4)-2013.

10.3 Based on the soil conditions, in case of lightly loaded structures, shallow footing can be suggested as a suitable type of foundation. The safe bearing capacities for different sizes of footing at different depths are as given below.

Table No: 10.3.1 (Square footing)

Size of footing (m)	Depth below EGL	Safe Bearing capacity (T/M^2)
1.0 x 1.0	1.00m	13.5
	1.50m	16.5
	2.00m	18.0
	2.50m	11.5
	3.00m	12.0
1.50 x 1.5	1.00m	12.5
	1.50m	14.5
	2.00m	16.0
	2.50m	17.5
	3.00m	20.5

2.0 x 2.0	1.00m	12.5
	1.50m	13.5
	2.00m	15.0
	2.50m	16.5
	3.00m	19.0
2.5 x 2.5	1.00m	12.0
	1.50m	13.0
	2.00m	14.5
	2.50m	15.5
	3.00m	18.0
3.0 x 3.0	1.00m	12.0
	1.50m	13.0
	2.00m	14.0
	2.50m	15.0
	3.00m	17.5

Table No: 10.3.2 (Strip footing)

Size of footing (m)	Depth below EGL	Safe Bearing capacity (T/M^2)
0.80	1.00m	11.0
	1.50m	13.0
	2.00m	15.5
	2.50m	12.0
	3.00m	7.0
1.00	1.00m	10.5
	1.50m	12.0
	2.00m	14.0
	2.50m	12.0
	3.00m	5.0

1.20	1.00m	10.5
	1.50m	12.0
	2.00m	13.5
	2.50m	8.0
	3.00m	14.0
1.50	1.00m	10.0
	1.50m	11.0
	2.00m	12.5
	2.50m	14.0
	3.00m	16.0
2.00	1.00m	9.50
	1.50m	10.5
	2.00m	12.0
	2.50m	13.5
	3.00m	14.5
2.50	1.00m	9.50
	1.50m	10.5
	2.00m	11.5
	2.50m	12.5
	3.00m	14.0

10.3 The suggestions given in this report are based on the results of tests onsub-soil samples collected from the bore-holes. If in actual execution any variation is found, this office may also referred to.

For GEO FOUNDATIONS & STRUCTURES PVT LTD,

A.V.S.CHAKRAVARTI
M.Tech (Geotechnical Engg.)
MIGS, MICI
SR. GENERAL MANAGER

1650 MTPD NPK PLANT

(BH-03, BH-04, BH-05& BH-06)

GRAPHICAL REPRESENTATION OF "N" VALUES

BORELOGS

RESULT TABLES

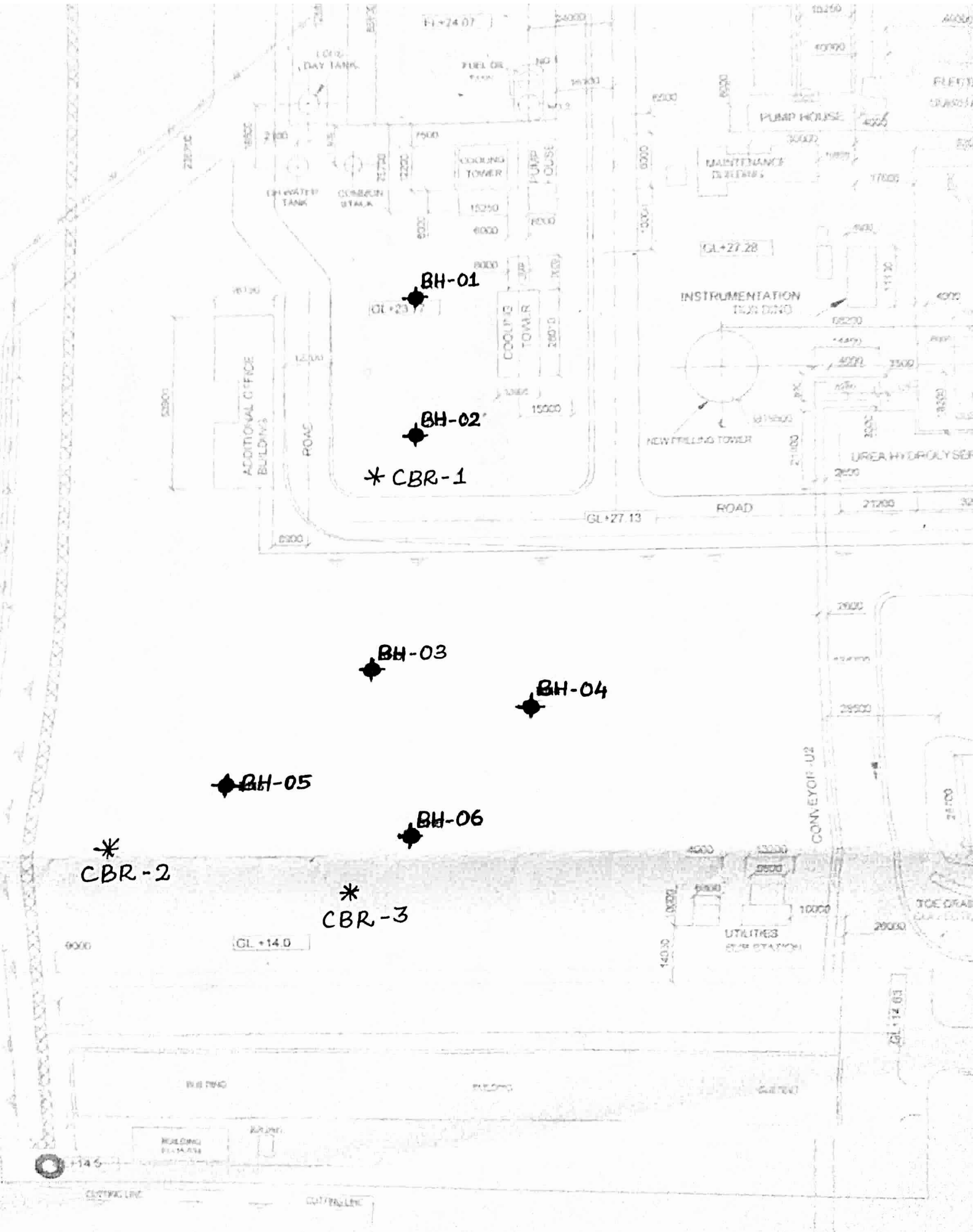
SIEVE ANALYSIS GRAPHS

SHEAR GRAPHS

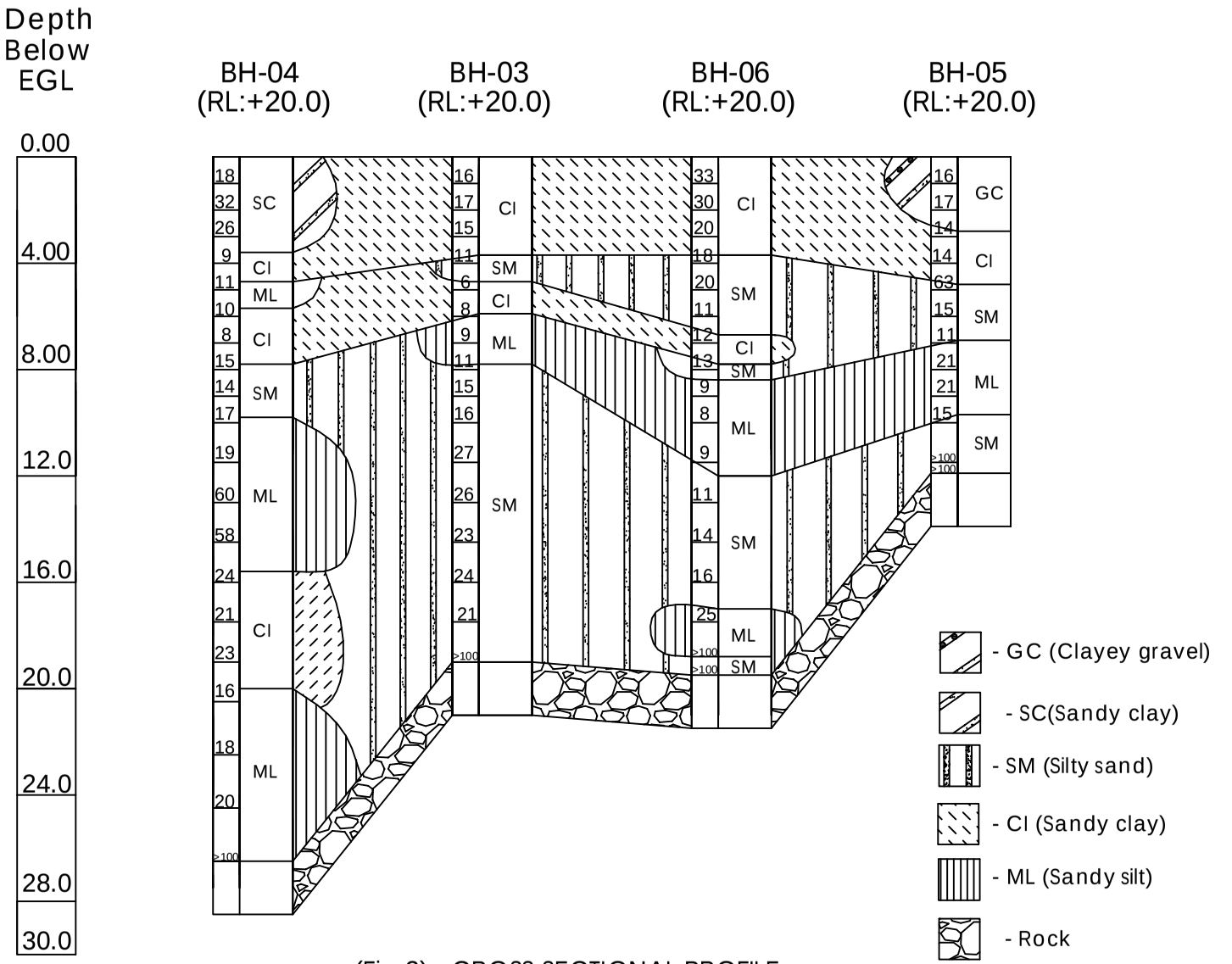
CHEMICAL ANALYSIS OF WATER & SOIL

LIQUIFACTION ANALYSIS

TYPICAL CALCULATIONS FOR DIFFERENT TYPES OF FOUNDATIONS


BH-01
BH-02
CBR-1
BH-03
BH-04
BH-05
BH-06
CBR-2
CBR-3
ROAD
GL +27.13
GL +14.0
PUMP HOUSE
INSTRUMENTATION
COOLING TOWER
ADDITIONAL OFFICE BUILDING
CONVEYOR U2
UTILITIES

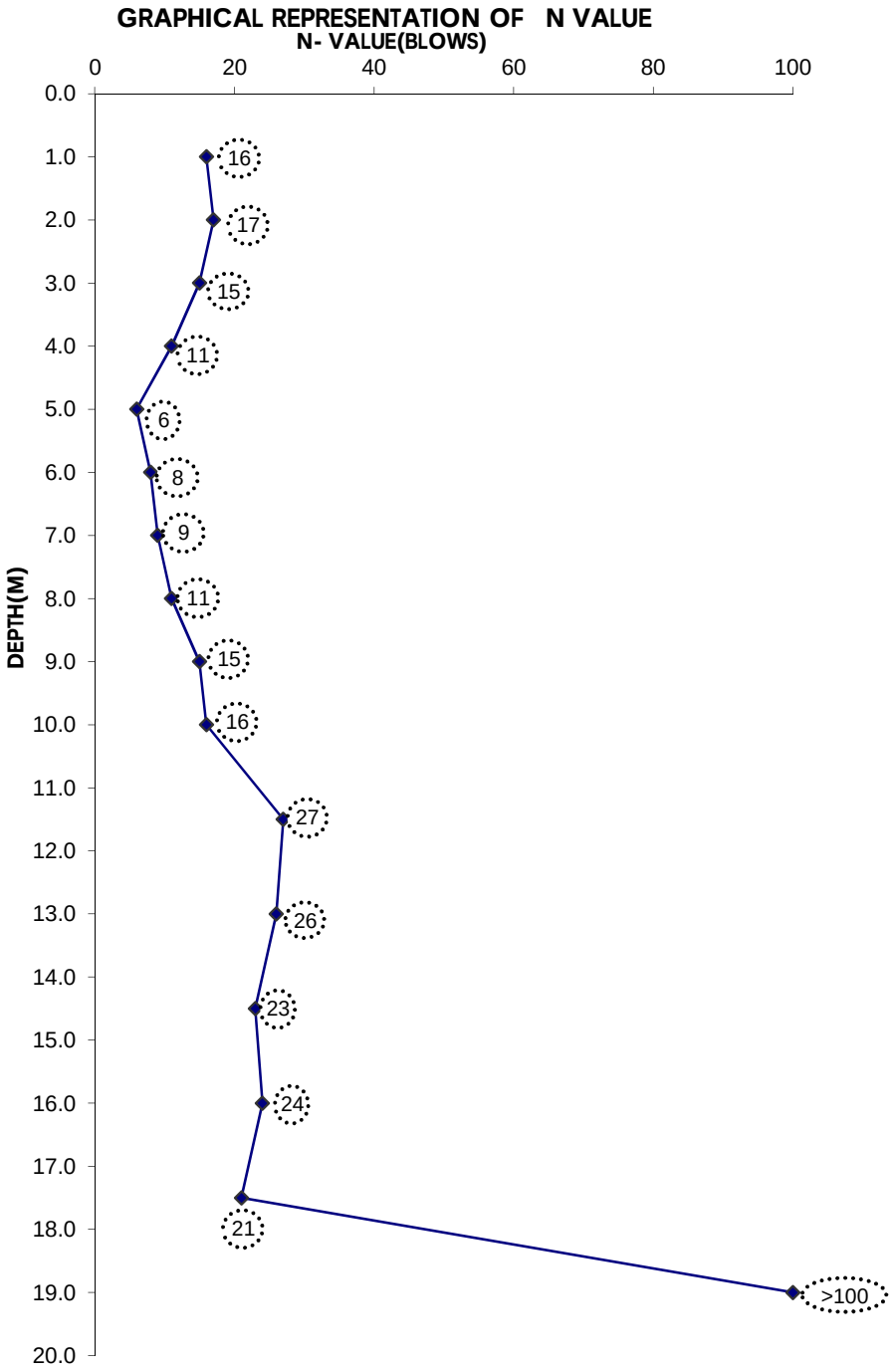
PROJECT: SOIL INVESTIGATION WORK FOR THE PROPOSED 1650 MTPD, NPK PLANT



(Fig.2) : CROSS SECTIONAL PROFILE

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-03**	Date of Boring Started	: 24.11.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 25.11.2020
		G.W.L : 5.50M		Termination Depth	: 21.0 M
					TC-5397



BORE HOLE TERMINATED AT 21.0 M

FIG.3

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-03** Type of Boring : Rotary Termination Depth : 21.0 M Reduced Level : +20.00	Boring Started : 24.11.2020 Boring Completed : 25.11.2020 Ground Water Level : 5.50 M Co-ordinates : E- 649670.205, N- 1103249.063	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT " N "	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	3.70	Sandy clayey silt (W/brown)	CI	**1.00**	1.00-1.45	8	8	8	**16**				
				2.00	2.00-2.45	2	8	9	**17**				
				3.00	3.00-3.45	4	7	8	**15**				
	1.00	Silty sand with gravel (Y/brown)	SM	**4.00**	4.00-4.45	5	6	5	**11**				
	1.20	Sandy clayey silt with presence of gravel(W/brown)	CI	**5.00**	5.00-5.45	3	2	4	**6**				
	1.90	Sandy silt with presence of clay(Br /white) Sandy silt(W/grey)	ML	**6.00**	6.00-6.45	2	4	4	**8**				
				7.00	7.00-7.45	3	5	4	**9**				
				8.00	8.00-8.45	4	5	6	**11**				
	11.2	Silty sand with presence of clay(Y/brown) Silty sand with presence of clay and gravel(Pale yellow) Silty sand(Brown) Silty sand with presence of gravel(Grey)	SM	**9.00**	9.00-9.45	5	7	8	**15**				
				10.0	10.0-10.45	6	8	8	**16**				
				11.5	11.5-11.95	11	17	10	**27**				
				13.0	13.0-13.45	9	14	12	**26**				
				14.5	14.5-14.95	4	8	15	**23**				
				16.0	16.0-16.75	6	10	14	**24**				
				17.5	17.5-17.95	4	9	12	**21**				
				19.5									
	2.00	Rock		**20.5**	19.0 to 20.0	DRILLING DONE USING DIAMOND BIT				84	45	240	
				21.5	20.0 to 21.0	DRILLING DONE USING DIAMOND BIT				40	NIL	-	

Termination Depth : 21.0m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :4

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 5.50m

Date of Boring Started : 24.11.2020
Boring completed : 25.11.2020
Termination Depth : 21.0m

Table No.: 1&2

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-03																				
16	1.00	SPT-01	Sandy clayey silt(W/brown)	CI	1	33	47	19	40						2.48					
17	2.00	SPT-02	Sandy clayey silt(W/brown)	CI					33	45	23	22								
15	3.00	SPT-03	Sandy clayey silt(W/brown)	CI	3	30	49	18	32						2.45	1.94	1.49	UCS	0.59	-
11	4.00	SPT-04	Silty sand with gravel(Y/brown)	SM	23	42	35	0	32	No Limit										
6	5.00	SPT-05	Sandy clayey silt with presence of gravel(W/brown)	CI	5	32	43	20	38	44	22	22								
8	6.00	SPT-06	Sandy silt wtih presence of clay (Br./white)	ML	0	40	54	6	44	No Limit										
9	7.00	SPT-07	Sandy silt(W/yellow)	ML	0	48	52	0	34	No Limit					2.53	1.63	1.22	DST	0.12	20
11	8.00	SPT-08	Silty sand with presence of clay (Y/brown)	SM	0	53	44	3	42	No Limit										
15	9.00	SPT-09	Silty sand with presence of clay (Y/brown)	SM					44											
16	10.0	SPT-10	Silty sand with presence of clay and gravel (Pale yellow)	SM	6	60	32	2	23	No Limit					2.56	1.70	1.38	DST	0.14	22

:24:

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 5.50m

Date of Boring Started : 24.11.2020
Boring completed : 25.11.2020
Termination Depth : 21.0m

Table No.: 1&2

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-03																				
27	11.5	SPT-11	Silty sand with presence of clay and gravel (Pale yellow)	SM					17											
26	13.0	SPT-12	Silty sand with presence of clay and gravel (Pale yellow)	SM	5	63	29	3	23	No Limit										
23	14.5	SPT-13	Silty sand(Brown)	SM	0	58	42	0	43	No Limit					2.57	1.73	1.21	DST	0.09	24
24	16.0	SPT-14	Silty sand(Brown)	SM					59											
21	17.5	SPT-15	Silty sand with presence of gravel (Grey)	SM	4	63	33	0	54	No Limit					2.55	1.71	1.11	DST	0.11	22
	19.0 to 21.0		Rock						-											

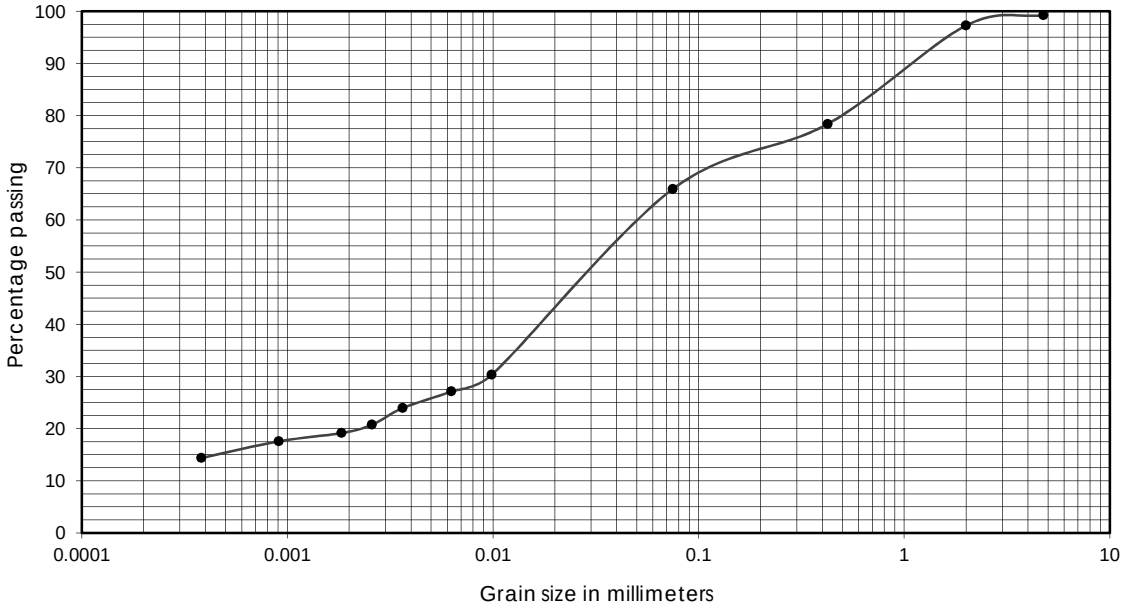
:25:

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

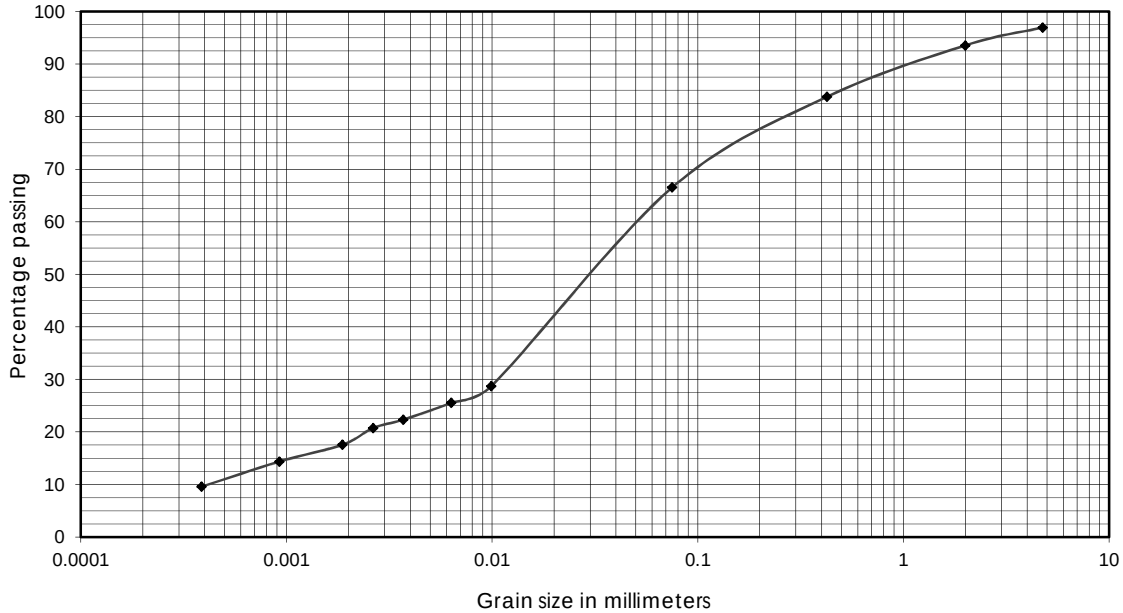
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	1.00	Cl	1	33	47	19			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-03	3.00	Cl	3	30	49	18			

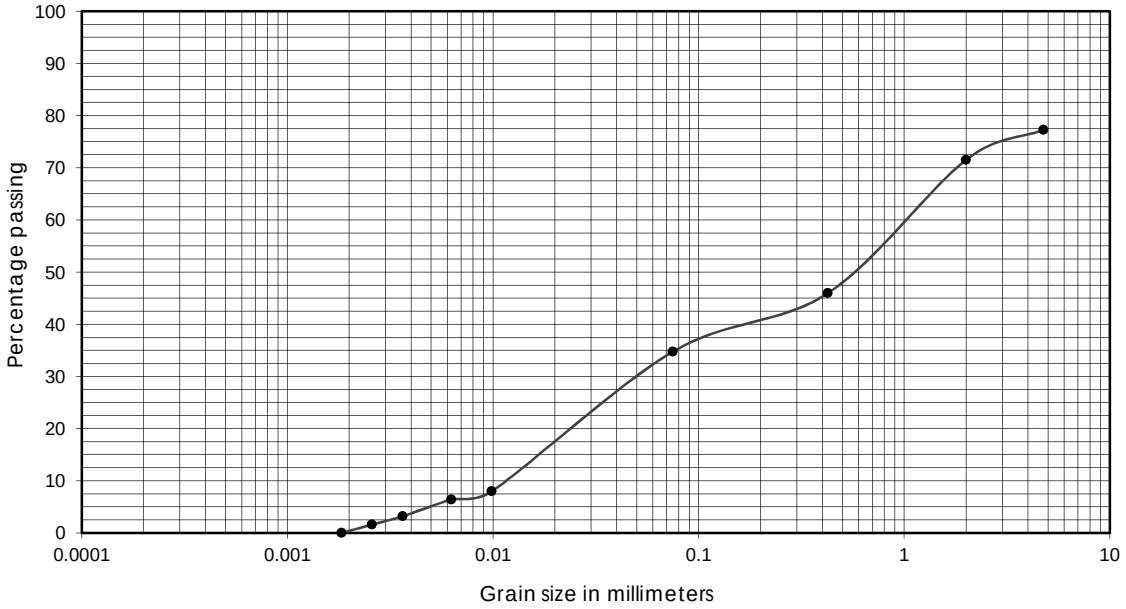
FIG.5

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

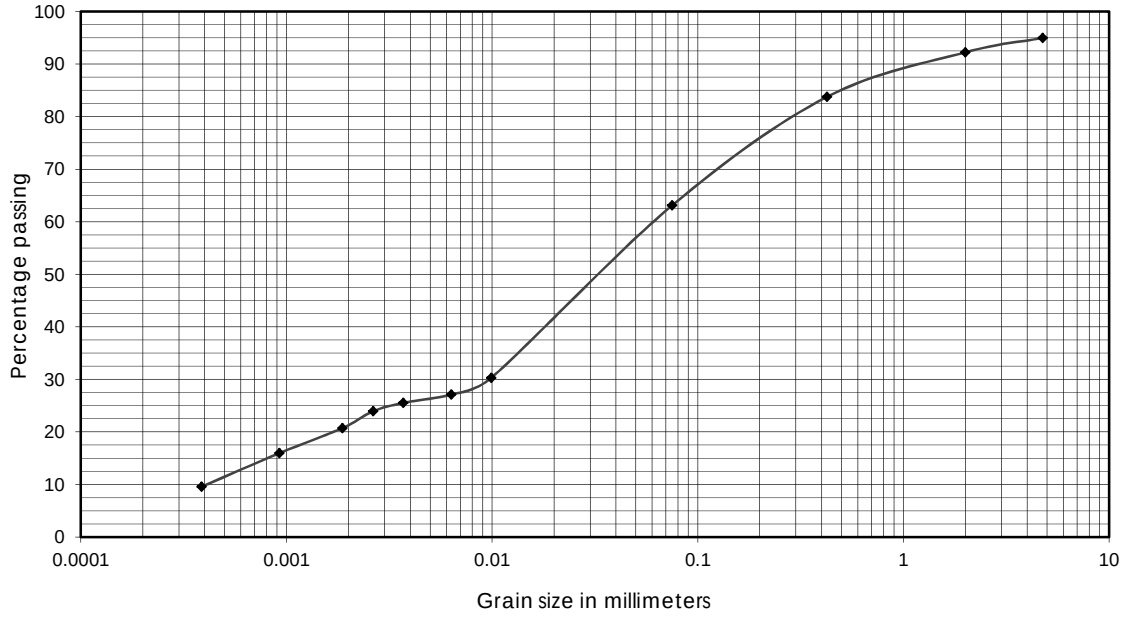
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	4.00	SM	23	42	35	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-03	5.00	CI	5	32	43	20			

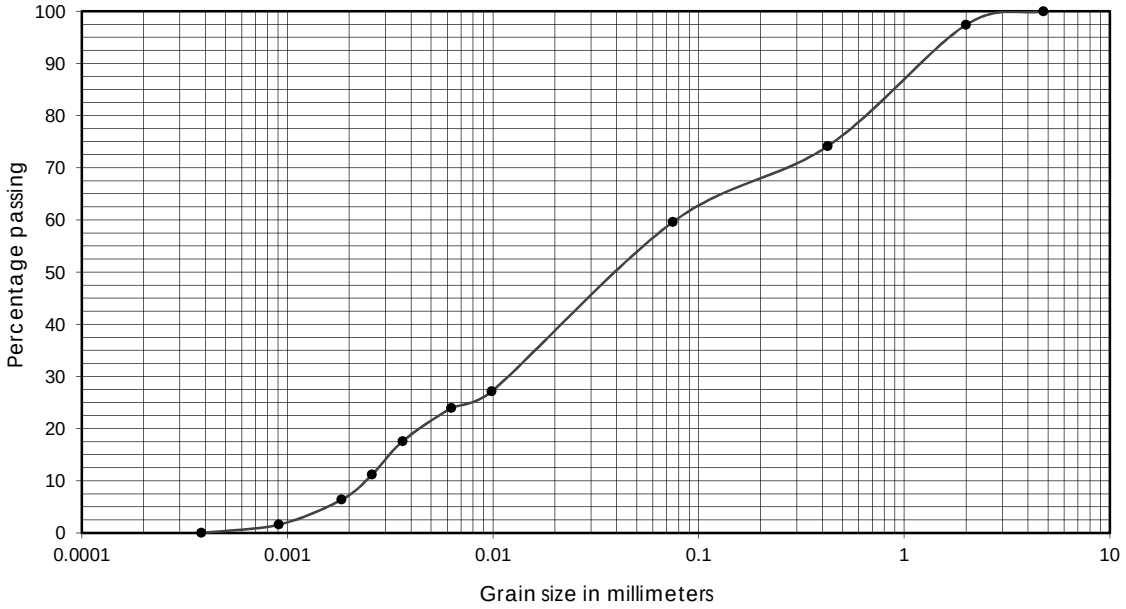
FIG.6

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

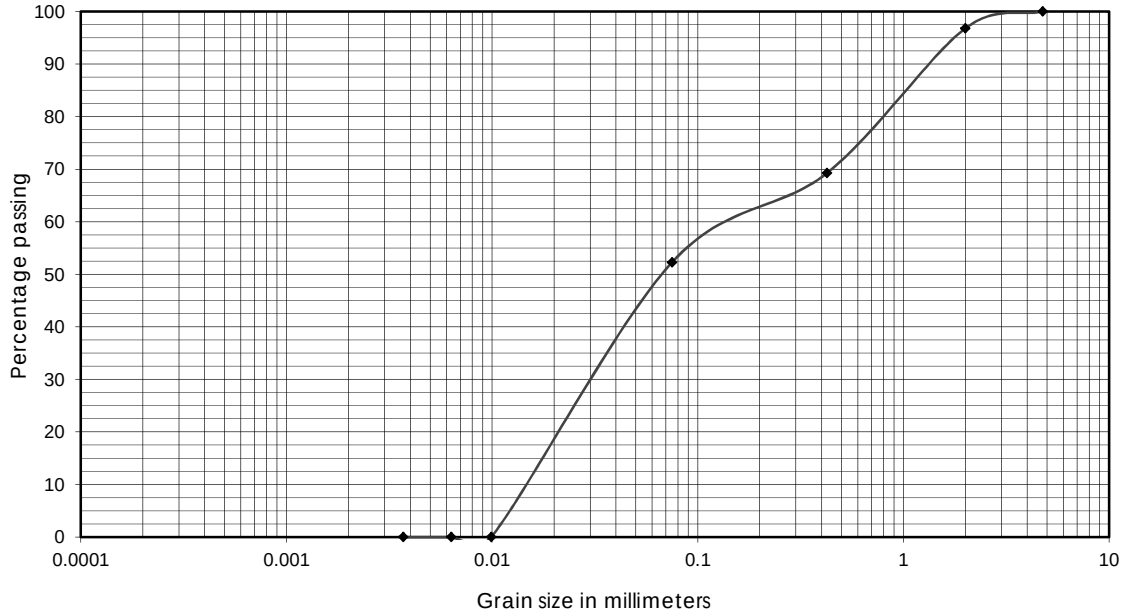
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	6.00	ML	0	40	54	6			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-03	7.00	ML	0	48	52	0			

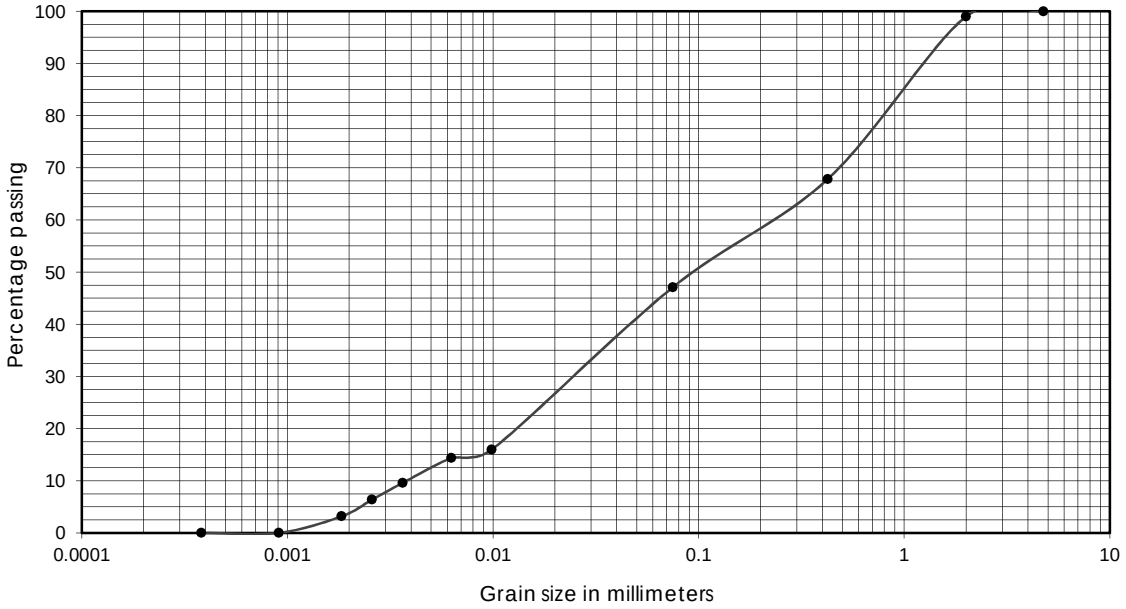
FIG.7

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

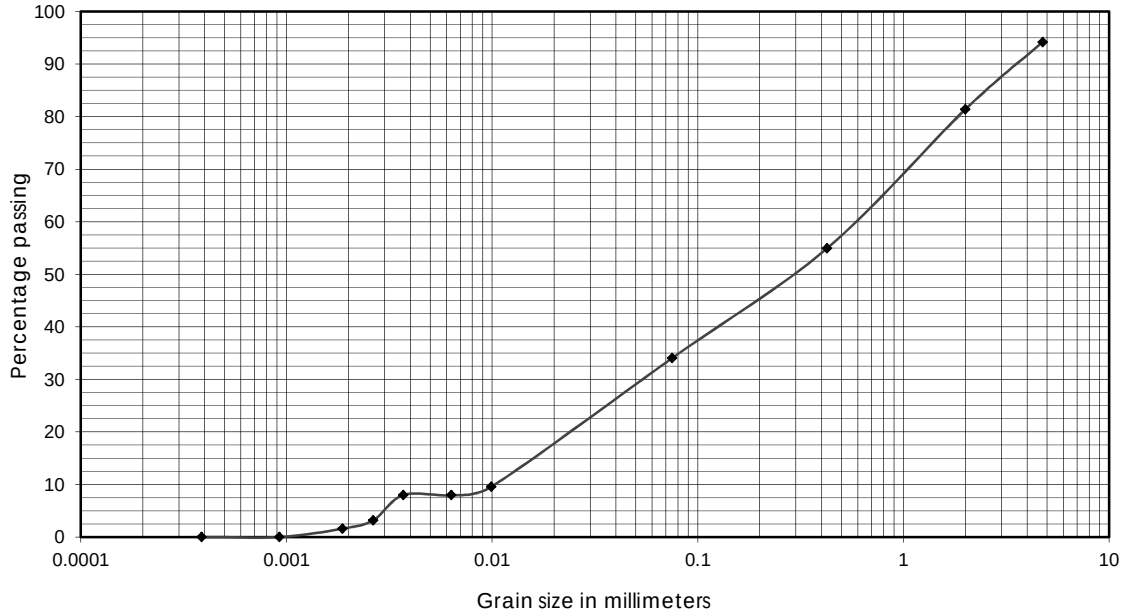
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	8.00	SM	0	53	44	3			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-03	10.00	SM	6	60	32	2			

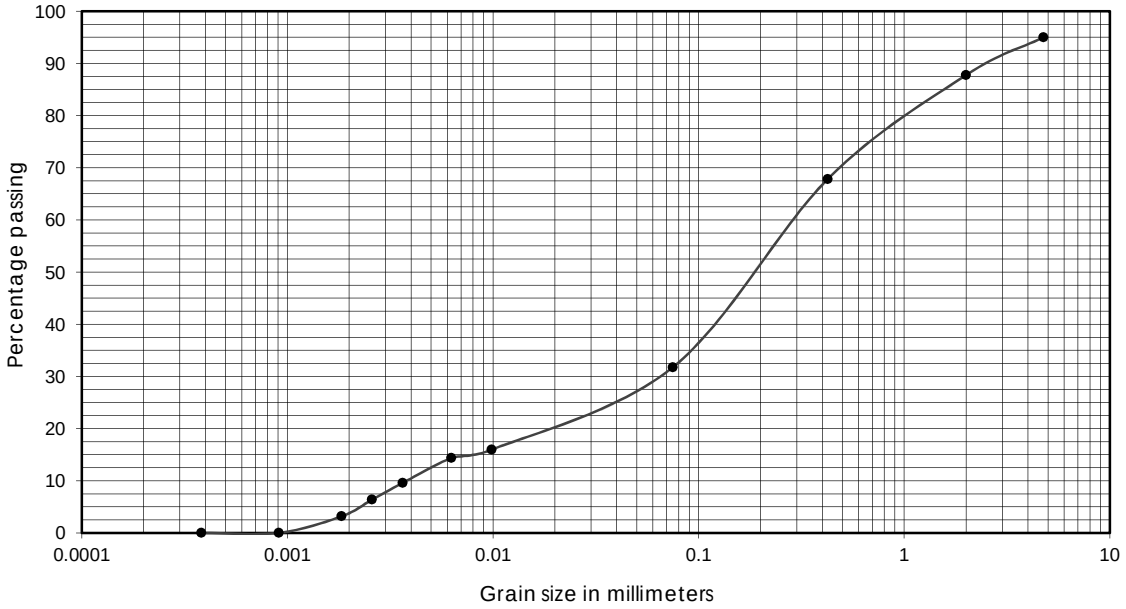
FIG.8

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

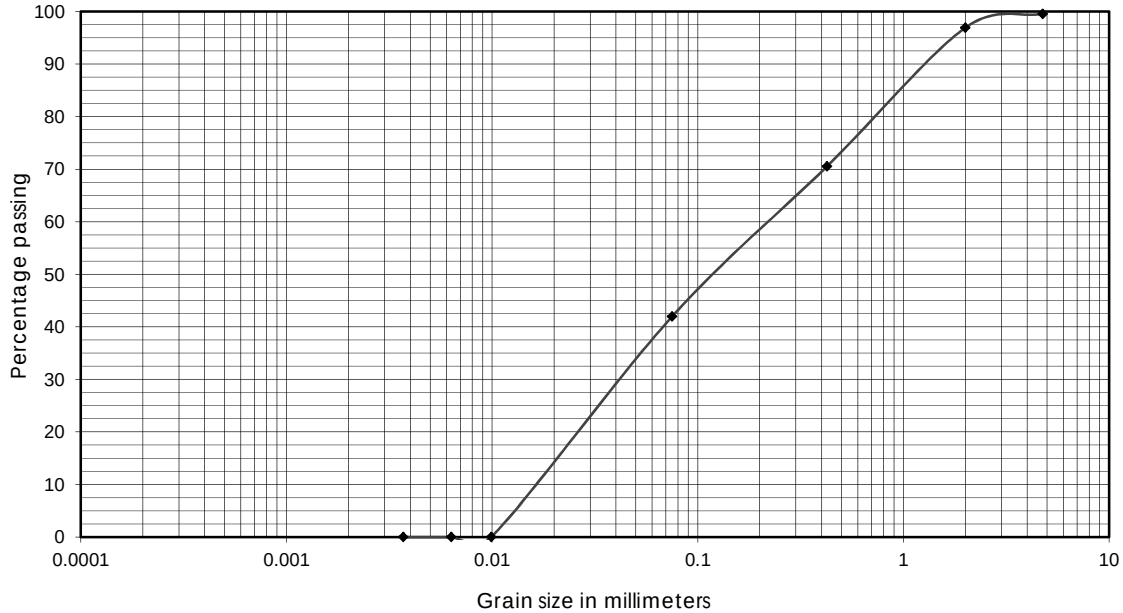
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	13.00	SM	5	63	29	3			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-03	14.50	SM	0	58	42	0			

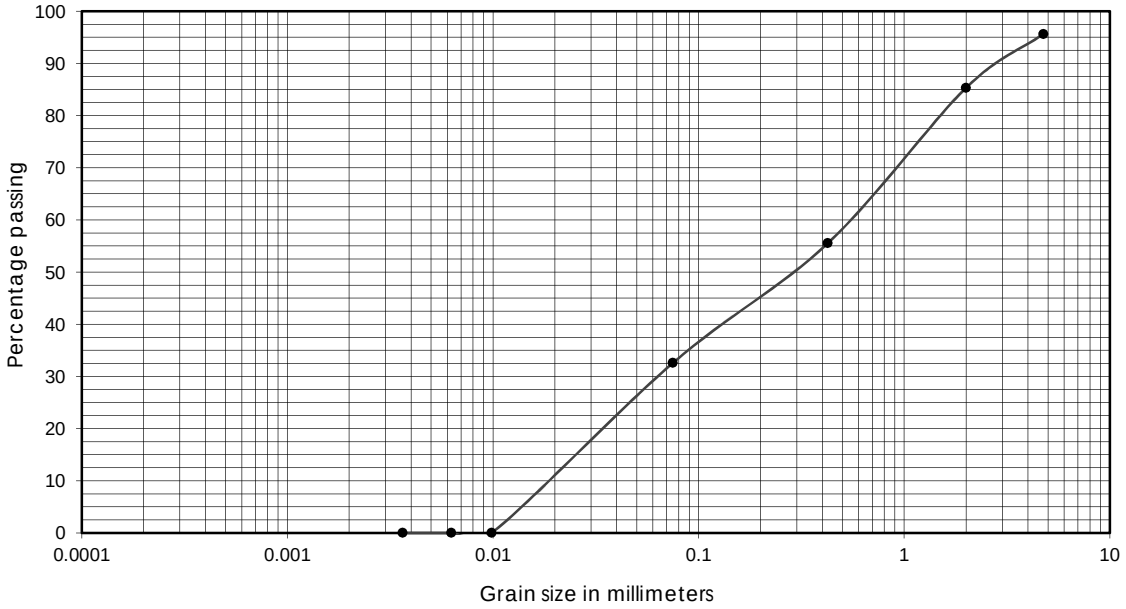
FIG.9

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

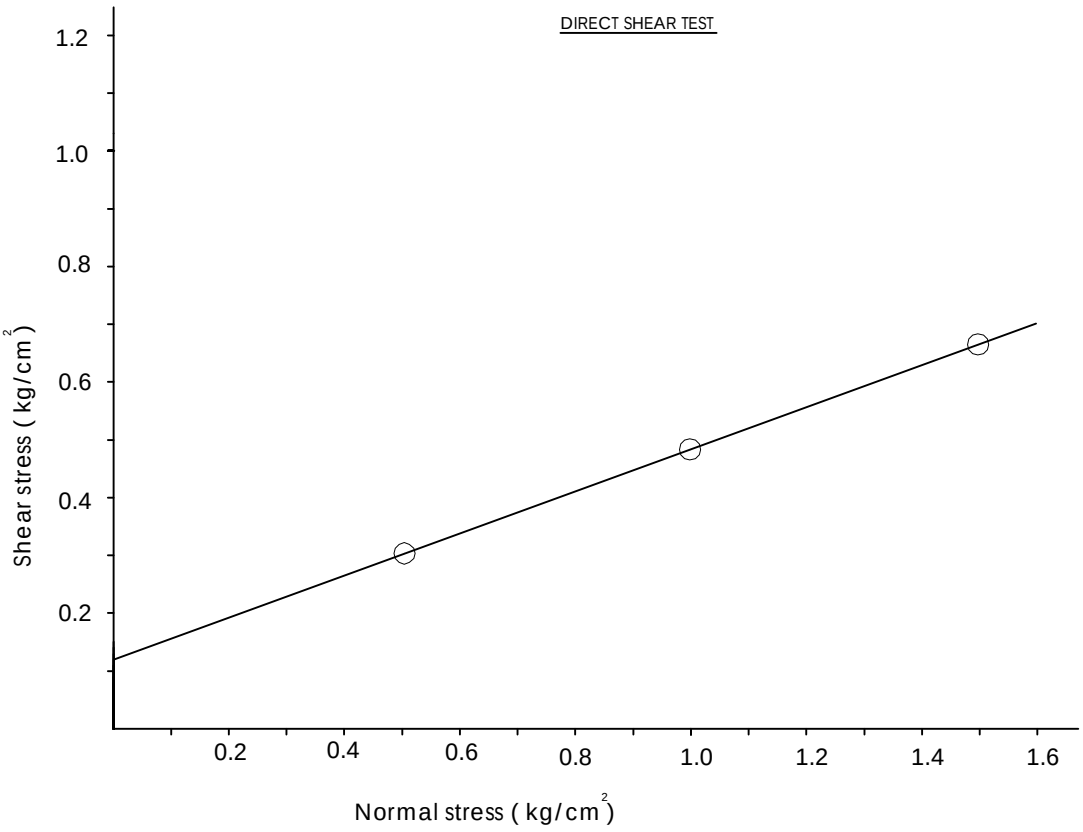
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



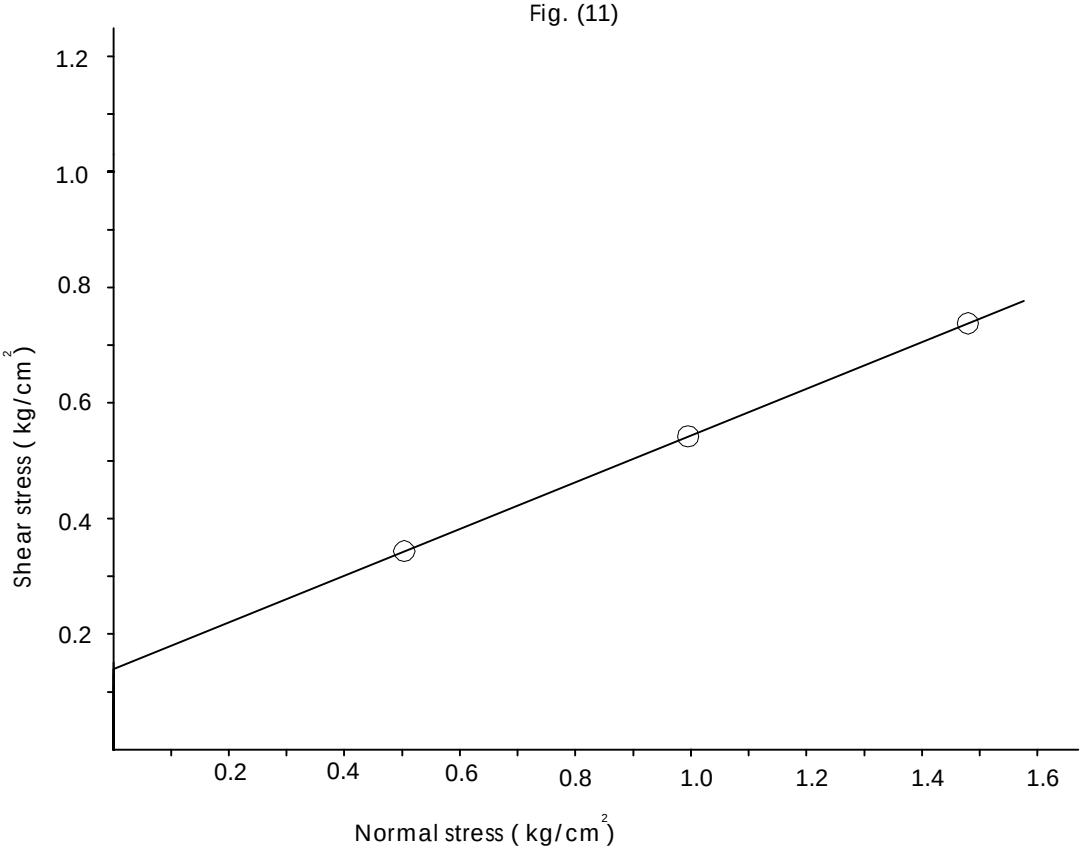
BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-03	17.50	SM	4	63	33	0			

FIG.10



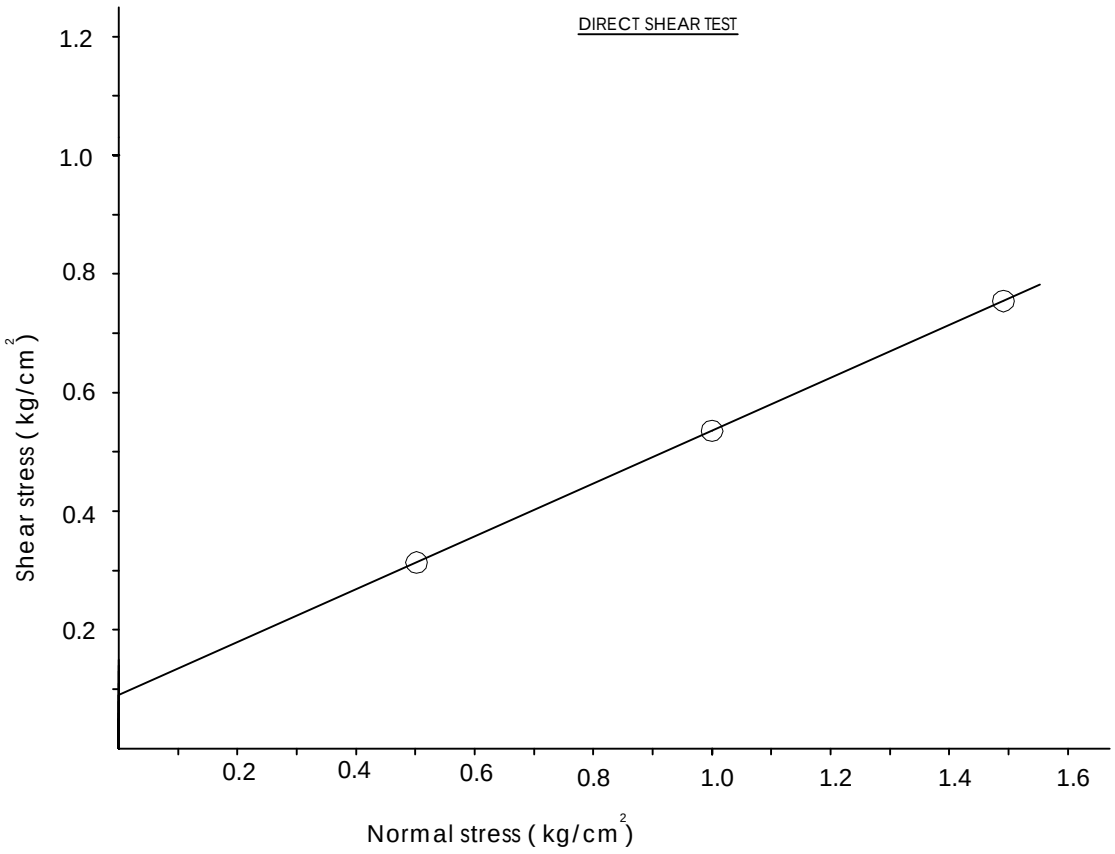
BORE HOLE NO: 03
SAMPLE NO : SPT-07
DEPTH : 7.00 M
C = 0.12 Kg/cm^2 Ø= 20°

Fig. (11)



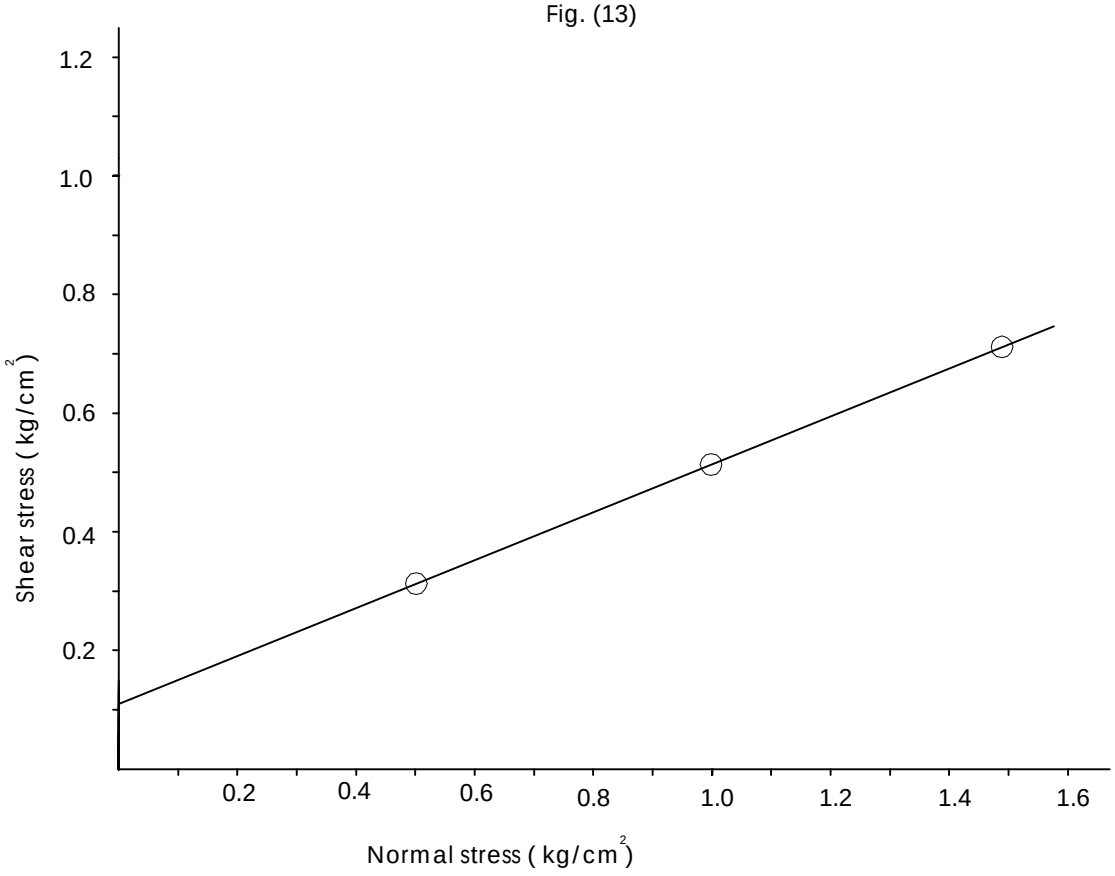
BORE HOLE NO: 03
SAMPLE NO : SPT-10
DEPTH : 10.00 M
C = 0.14 Kg/cm^2 Ø= 22°

Fig. (12)



BORE HOLE NO: 03
SAMPLE NO : SPT-13
DEPTH : 14.50 M
C = 0.09 Kg/cm^2 Ø= 24°

Fig. (13)



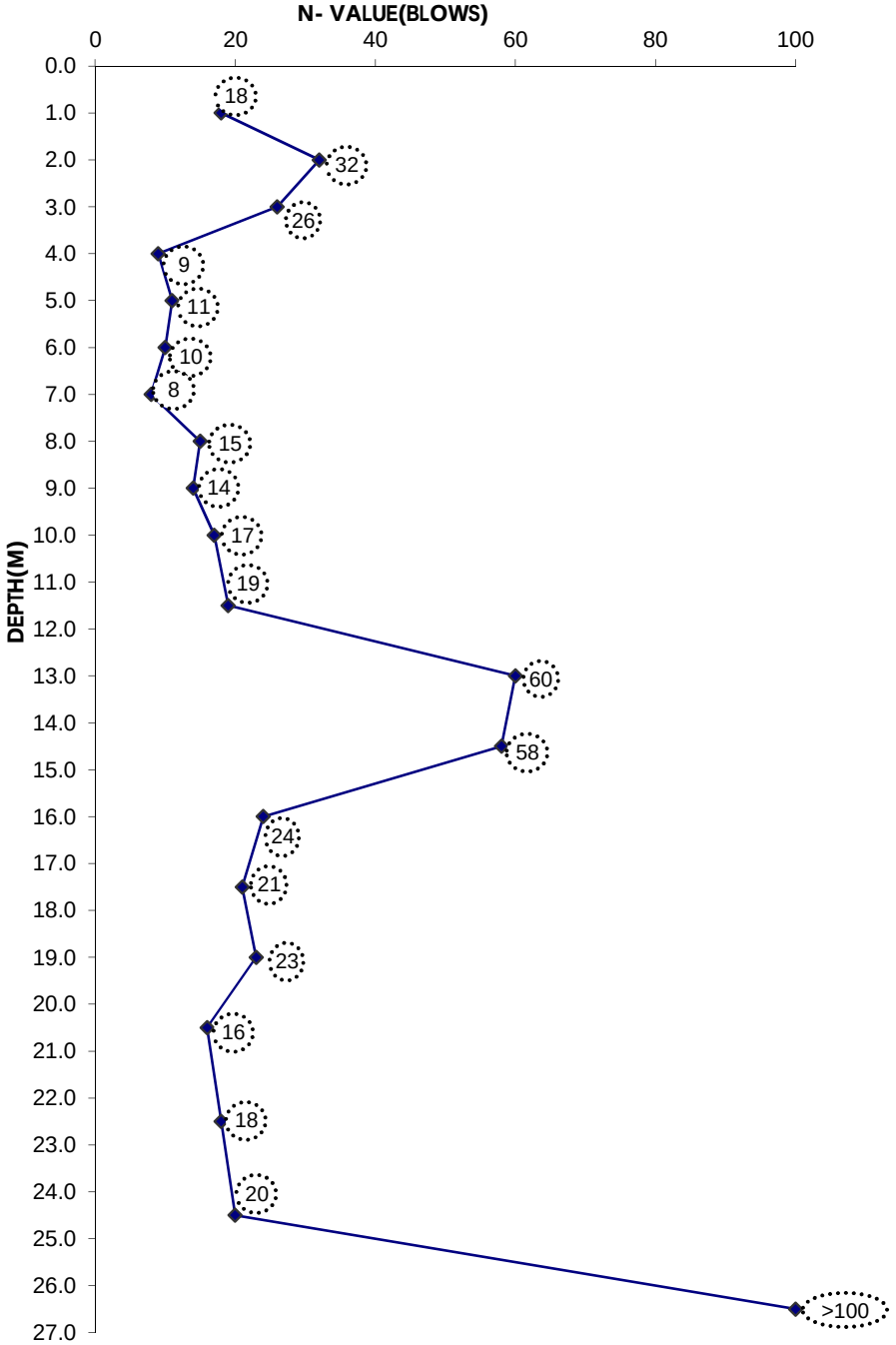
BORE HOLE NO: 03
SAMPLE NO : SPT-15
DEPTH : 17.50 M
C = 0.11 Kg/cm^2 Ø= 22°

Fig. (14)

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-04**	Date of Boring Started	: 27.11.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 28.11.2020
		G.W.L : 5.70M		Termination Depth	: 28.50M
					TC-5397

GRAPHICAL REPRESENTATION OF N VALUE



BORE HOLE TERMINATED AT 28.50 M

FIG.15

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-04** Type of Boring : Rotary Termination Depth : 28.5 M Reduced Level : +20.00	Boring Started : 27.11.2020 Boring Completed : 28.11.2020 Ground Water Level : 5.70 M Co-ordinates : E- 649710.822, N- 1103257.995	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT " N "	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	3.60	Clayey sand with gravel and clay(Red)	SC	**1.00**	1.00-1.45	6	9	9	**18**				
				2.00	2.00-2.45	9	19	13	**32**				
				3.00	3.00-3.45	8	12	14	**26**				
	1.10	Sandy clayey silt(W/red)	CI	**4.00**	4.00-4.45	3	4	5	**9**				
	1.00	Sandy silt with clay (W/yellow)	ML	**5.00**	5.00-5.45	4	5	6	**11**				
	2.10	Sandy clayey silt with presence of gravel(W/red)	CI	**6.00**	6.00-6.45	4	5	5	**10**				
				7.00	7.00-7.45	4	4	4	**8**				
	2.00	Silty sand with presence of clay(Y/red)	SM	**8.00**	8.00-8.45	7	7	8	**15**				
				9.00	9.00-9.45	6	7	7	**14**				
	5.80	Sandy silt with clay(pinkish Grey)	ML	**10.0**	10.0-10.45	7	8	9	**17**				
				11.5	11.5-11.95	3	7	12	**19**				
				13.0	13.0-13.45	9	20	40	**60**				
				14.5	14.5-14.95	10	27	31	**58**				
	4.40	Sandy clayey silt(W/brown)	CI	**16.0**	16.0-16.75	10	10	14	**24**				
				17.5	17.5-17.95	7	9	12	**21**				
				19.0	17.5-17.96	8	10	13	**23**				
	2.50	Sandy silt with clay(W/grey)	ML	**20.5**	17.5-17.97	4	7	9	**16**				
				22.5	17.5-17.98	5	8	10	**18**				

Termination Depth : 21.0m **(continued.....page 17)**

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :16

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-04** Type of Boring : Rotary Termination Depth : 28.5 M Reduced Level : +20.00	Boring Started : 27.11.2020 Boring Completed : 28.11.2020 Ground Water Level : 5.70 M Co-ordinates : E- 649710.822, N- 1103257.995	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT " N "	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	4.00	Sandy silt with clay(W/grey)	ML	**24.5**	24.5-24.95	6	9	11	**20**				
	2.00	Rock		**27.0**	26.5 to 27.5	DRILLING DONE USING DIAMOND BIT				41	NIL	-	
				28.0	27.5 to 28.5	DRILLING DONE USING DIAMOND BIT				32	NIL	-	
				29.0									

Termination Depth : 28.5m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :17

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 5.70m

Date of Boring Started : 27.11.2020
Boring completed : 28.11.2020
Termination Depth : 28.5m

Table No.: 3&4

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			IS SL (%) IS 2720(Part6): 1972	IS FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm^2	Ø (^{o})
BOREHOLE BH-04																				
18	1.00	SPT-01	Clayey sand with gravel and clay(Red)	SC	10	44	30	16	20						2.54	1.84	1.53	DST	0.15	23
32	2.00	SPT-02	Clayey sand with gravel and clay(Red)	SC					22											
26	3.00	SPT-03	Clayey sand with gravel and clay(Red)	SC	13	45	24	18	31											
9	4.00	SPT-04	Sandy clayey silt(W/red)	CI	4	33	42	21	42	48	24	24			2.47	1.78	1.25	UCS	0.35	-
11	5.00	SPT-05	Sandy silt with clay(W/yellow)	ML	0	44	42	14	32	No Limit										
10	6.00	SPT-06	Sandy clayey silt with presence of gravel(W/red)	CI	3	35	42	20	36											
8	7.00	SPT-07	Sandy clayey silt with presence of gravel(W/red)	CI					37						2.46	1.75	1.28	UCS	0.29	-
15	8.00	SPT-08	Silty sand with presence of clay(Y/red)	SM	0	55	41	4	38	No Limit										
14	9.00	SPT-09	Silty sand with presence of clay(Y/red)	SM					28						2.57	1.89	1.48	DST	0.09	31
17	10.0	SPT-10	Sandy silt with clay(Pinkish grey)	ML	1	37	49	13	34	No Limit					2.52					
19	11.5	SPT-11	Sandy silt with clay(Pinkish grey)	ML	2	39	45	14	35	No Limit										
60	13.0	SPT-12	Sandy silt with clay(Pinkish grey)	ML					34											
58	14.5	SPT-13	Sandy silt with clay(Pinkish grey)	ML	0	38	49	13	33	No Limit					2.54	1.79	1.35	DST	0.02	33

:37:

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 5.70m

Date of Boring Started : 27.11.2020
Boring completed : 28.11.2020
Termination Depth : 28.5m

Table No.: 3&4

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm^2	Ø (^{o})
BOREHOLE BH-04																				
24	16.0	SPT-14	Sandy clayey silt(W/brown)	CI	0	35	43	22	32	73	32	41								
21	17.5	SPT-15	Sandy clayey silt(W/brown)	CI					43	62	35	27								
23	19.0	SPT-16	Sandy clayey silt(W/brown)	CI	0	33	47	20	27											
16	20.5	SPT-17	Sandy silt with clay(W/grey)	ML	0	37	52	11	37	No Limit					2.55					
18	22.5	SPT-18	Sandy silt with clay(W/grey)	ML					40	No Limit					2.54	1.69	1.21	DST	0.07	27
20	24.5	SPT-19	Sandy silt with clay(W/grey)	ML	0	35	55	10	35	No Limit										
	26.5 to 28.5		Rock						-											

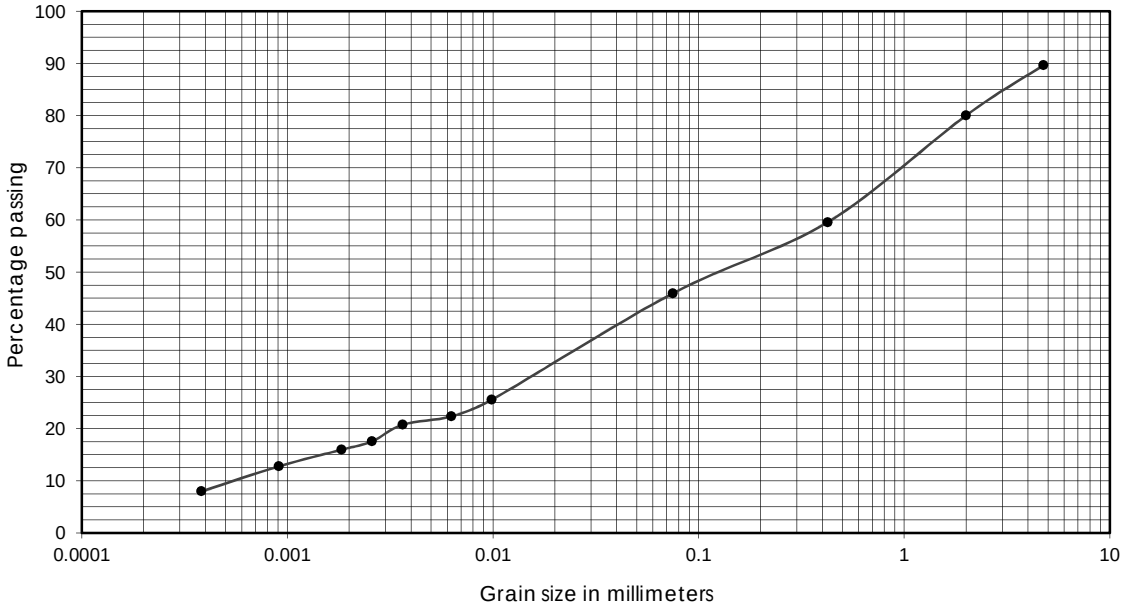
:38:

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

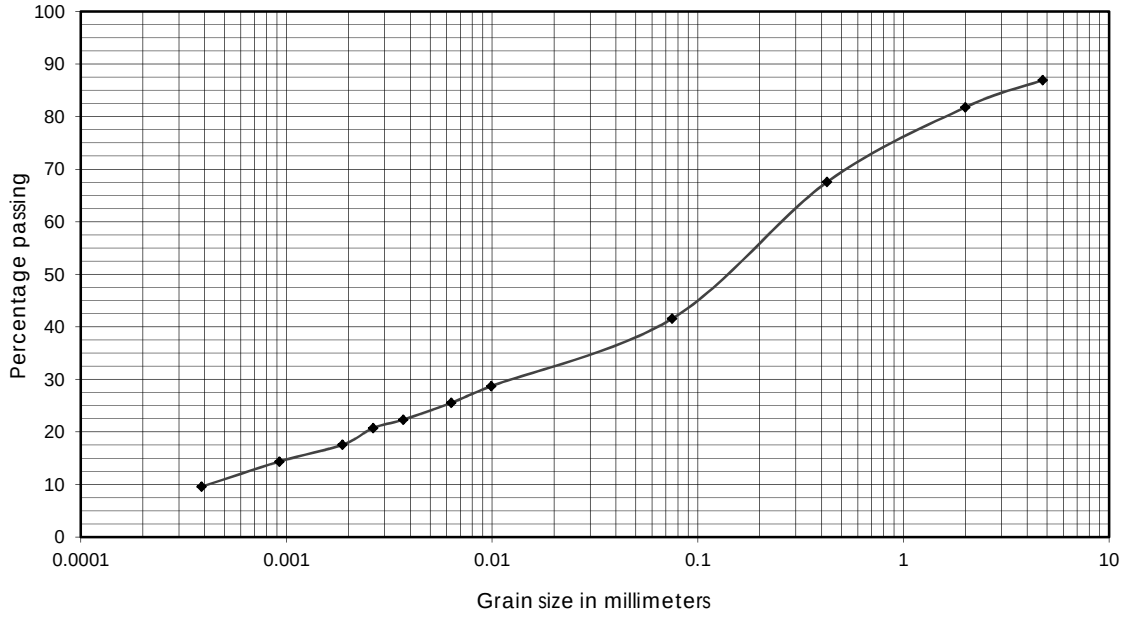
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	1.00	SC	10	44	30	16			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	3.00	SC	13	45	24	18			

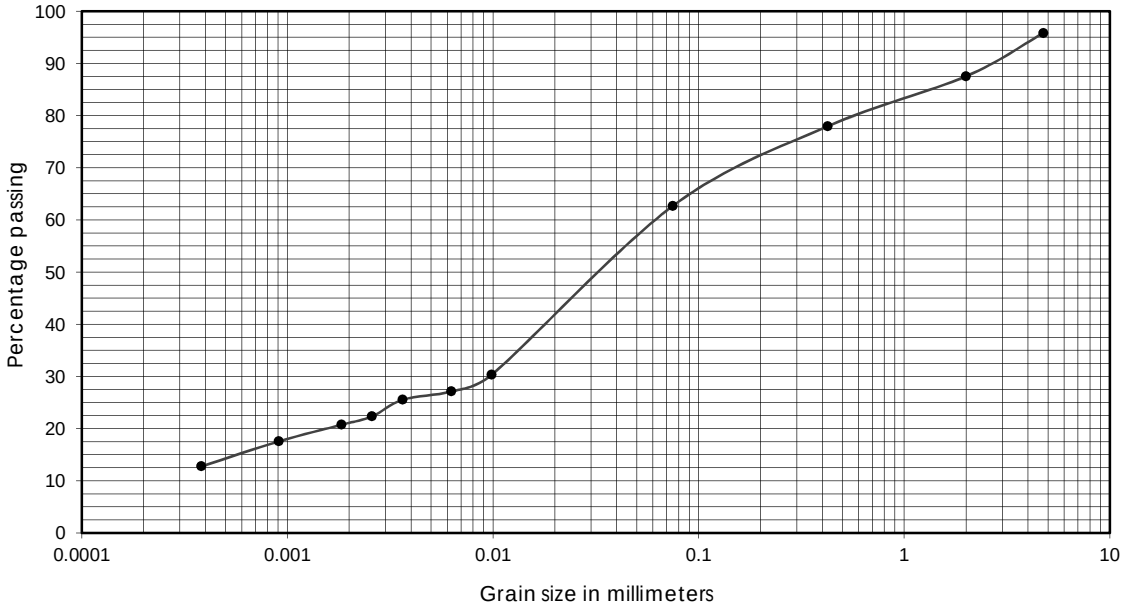
FIG.18

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

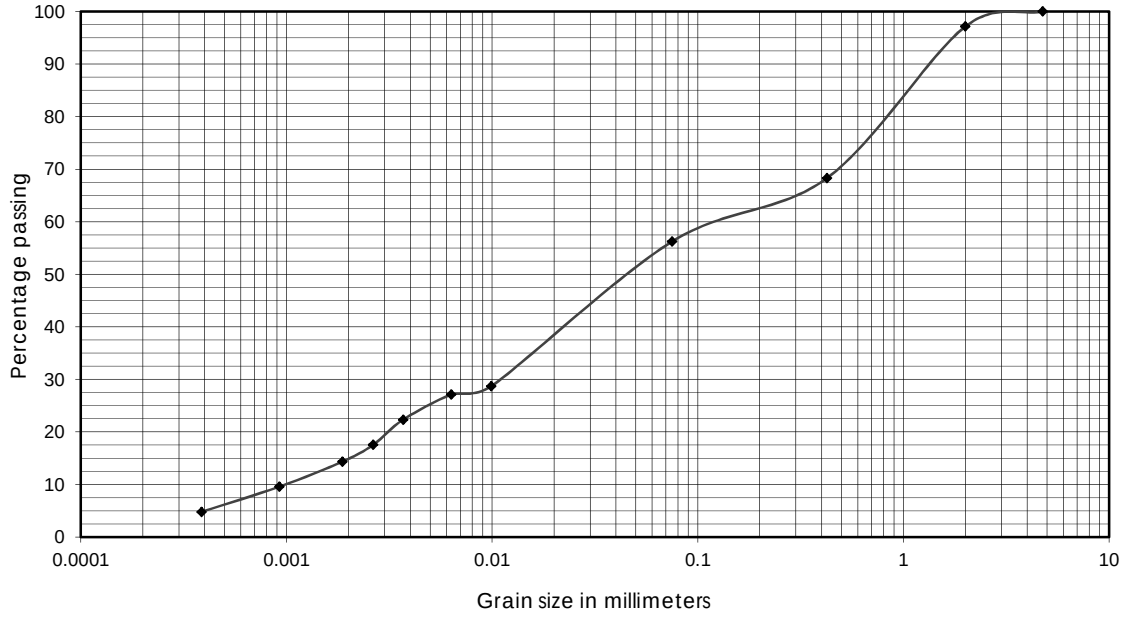
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	4.00	Cl	4	33	42	21			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	5.00	ML	0	44	42	14			

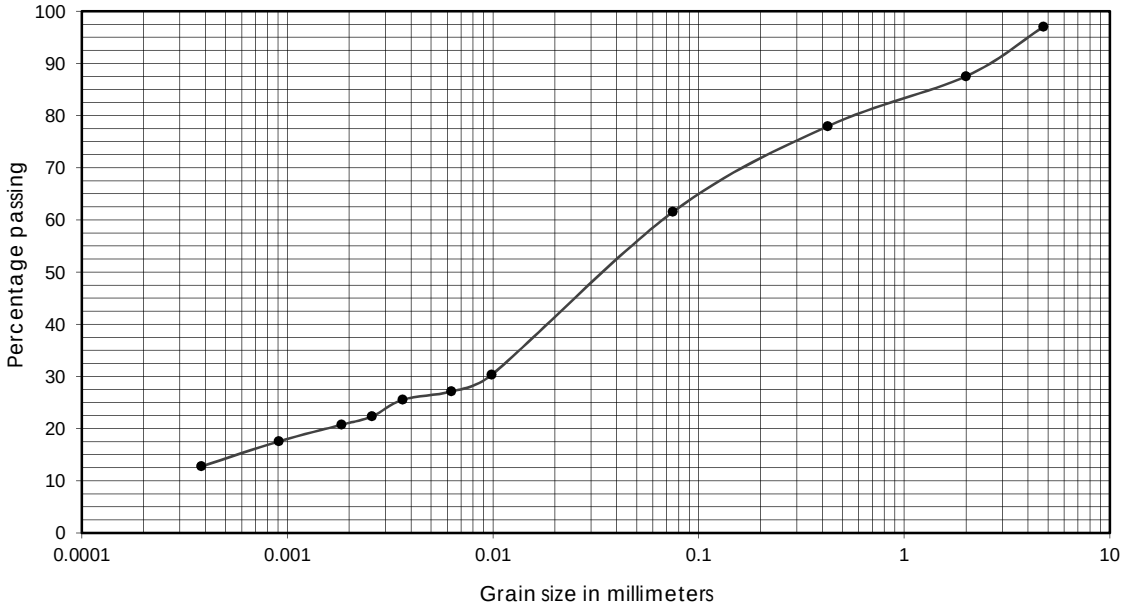
FIG.19

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

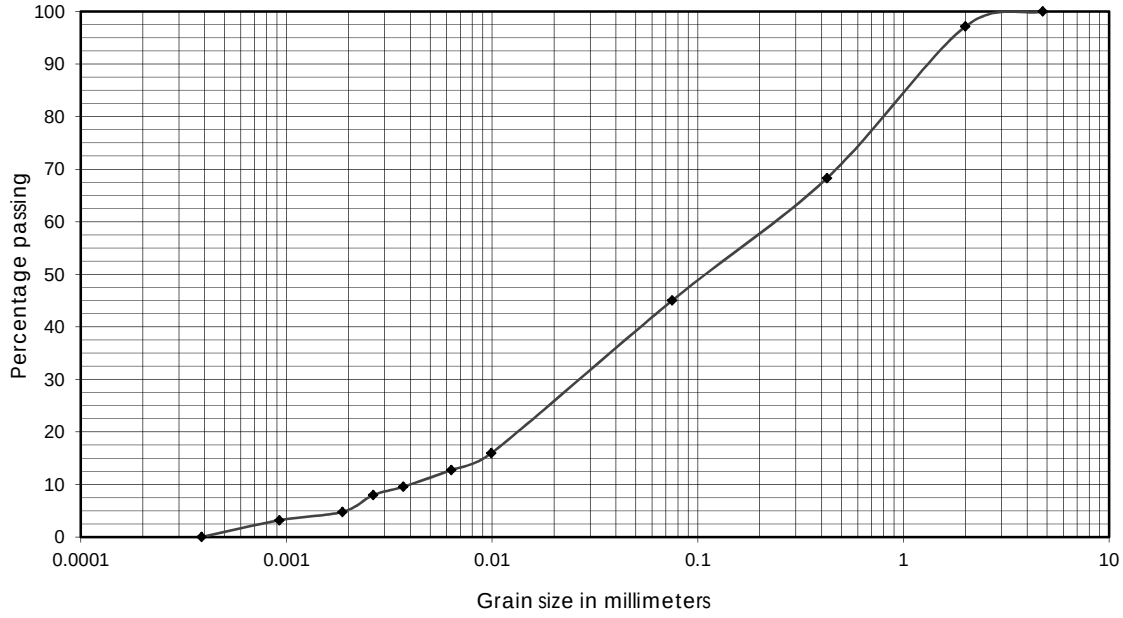
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	6.00	Cl	3	35	42	20			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	8.00	SM	0	55	41	4			

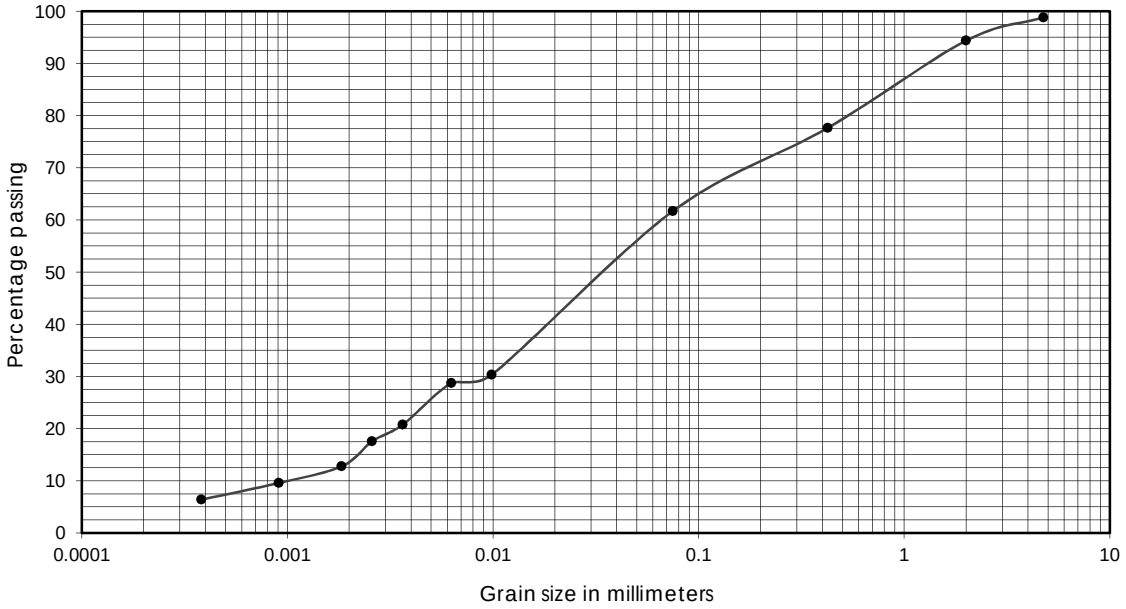
FIG.20

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

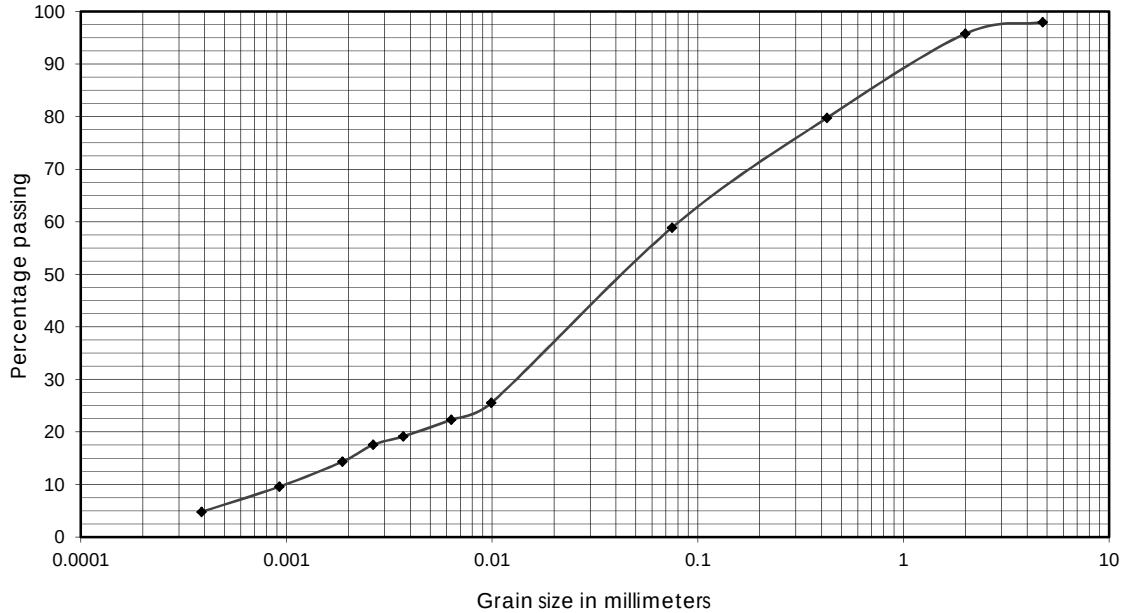
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	10.00	ML	1	37	49	13			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	11.50	ML	2	39	45	14			

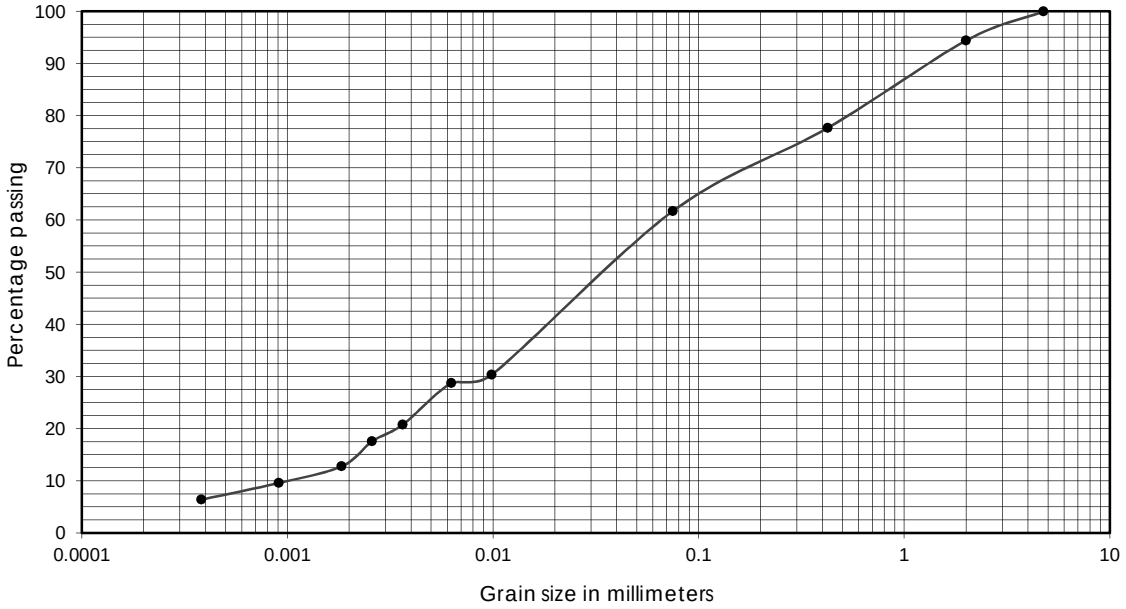
FIG.21

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

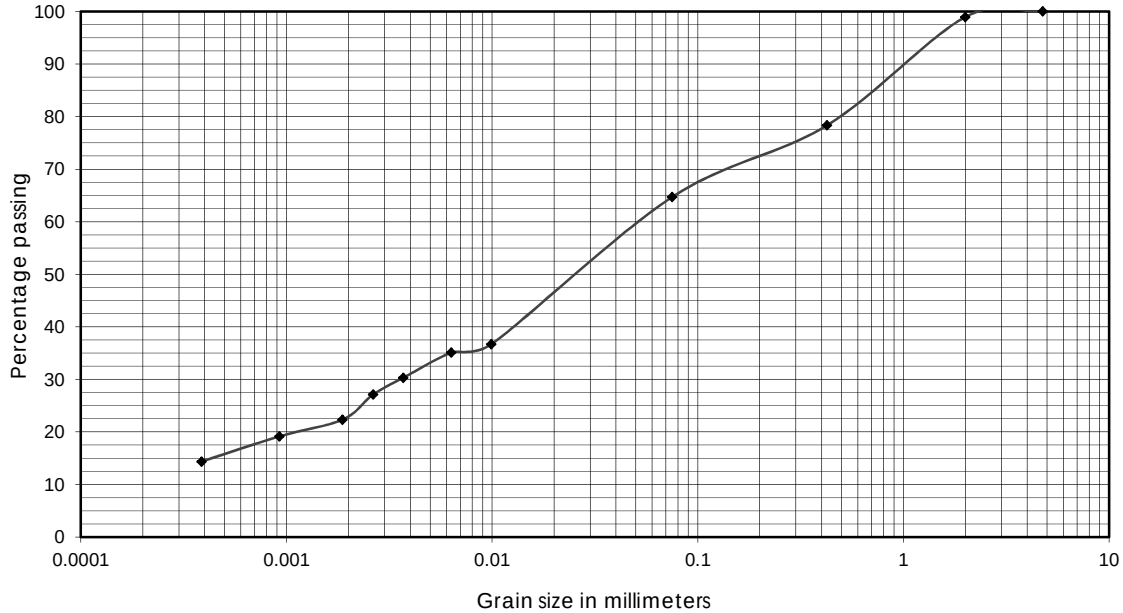
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	14.50	ML	0	38	49	13			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	16.00	CI	0	35	43	22			

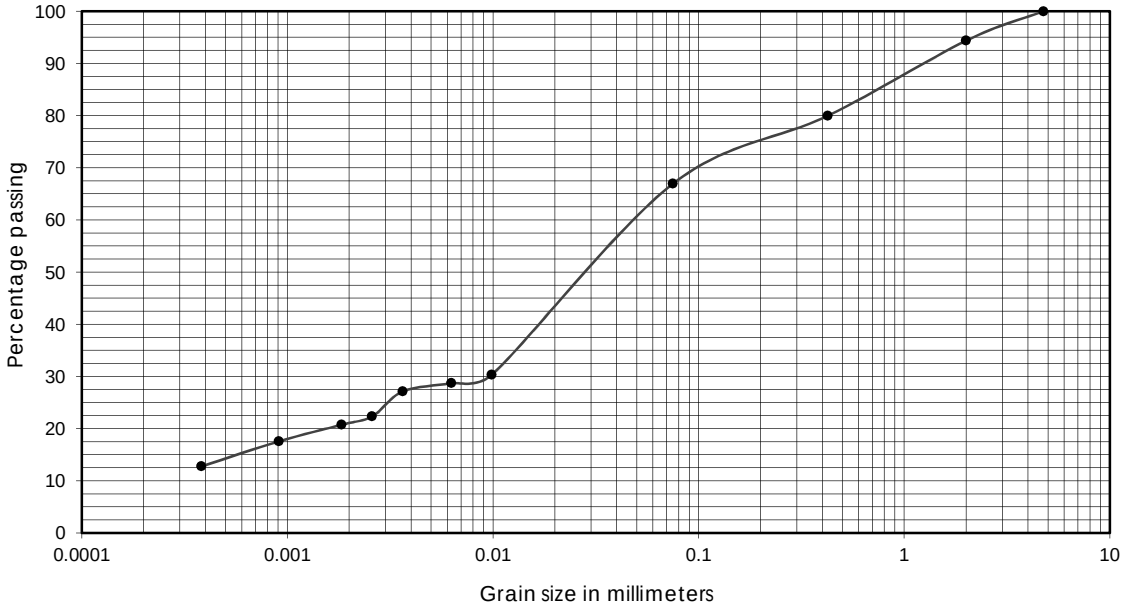
FIG.22

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

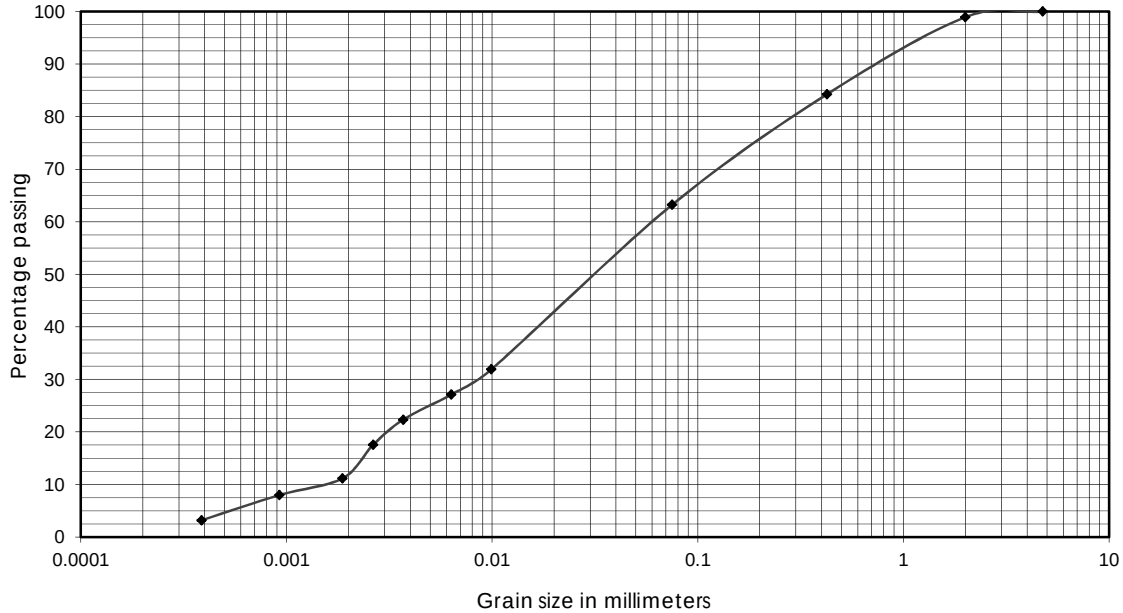
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	19.00	Cl	0	33	47	20			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-04	20.50	ML	0	37	52	11			

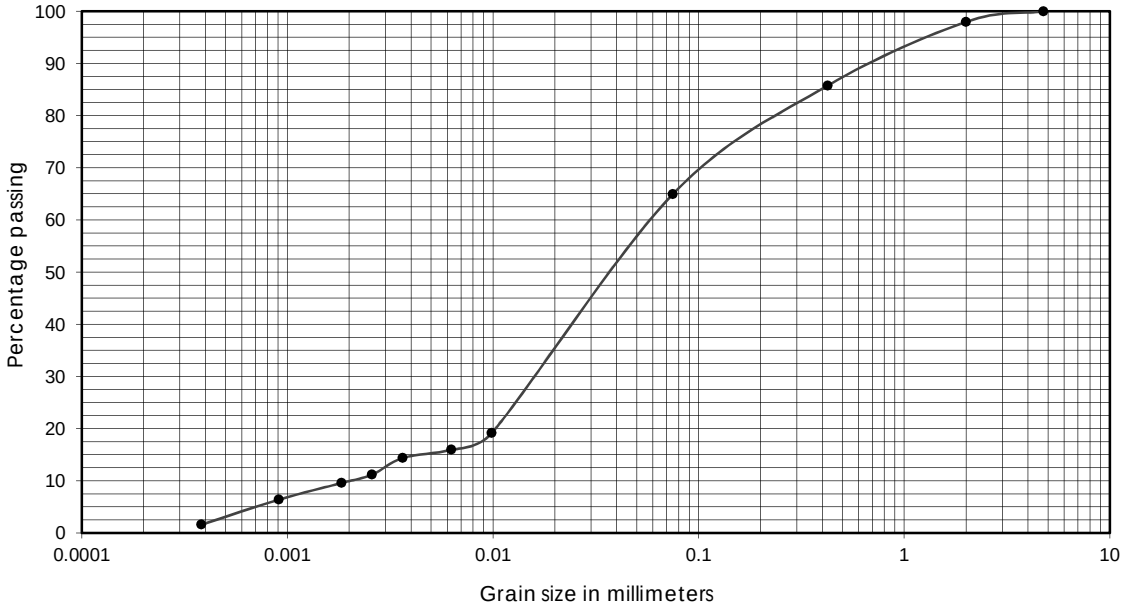
FIG.23

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

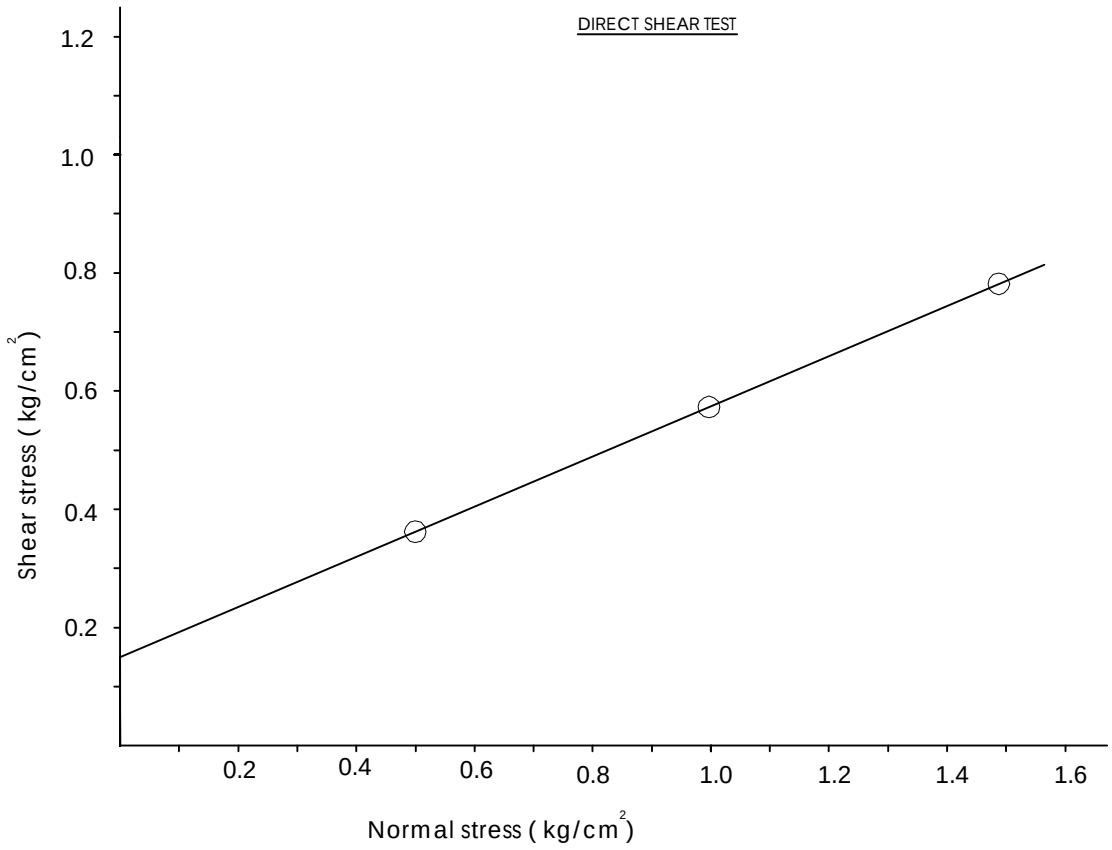
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



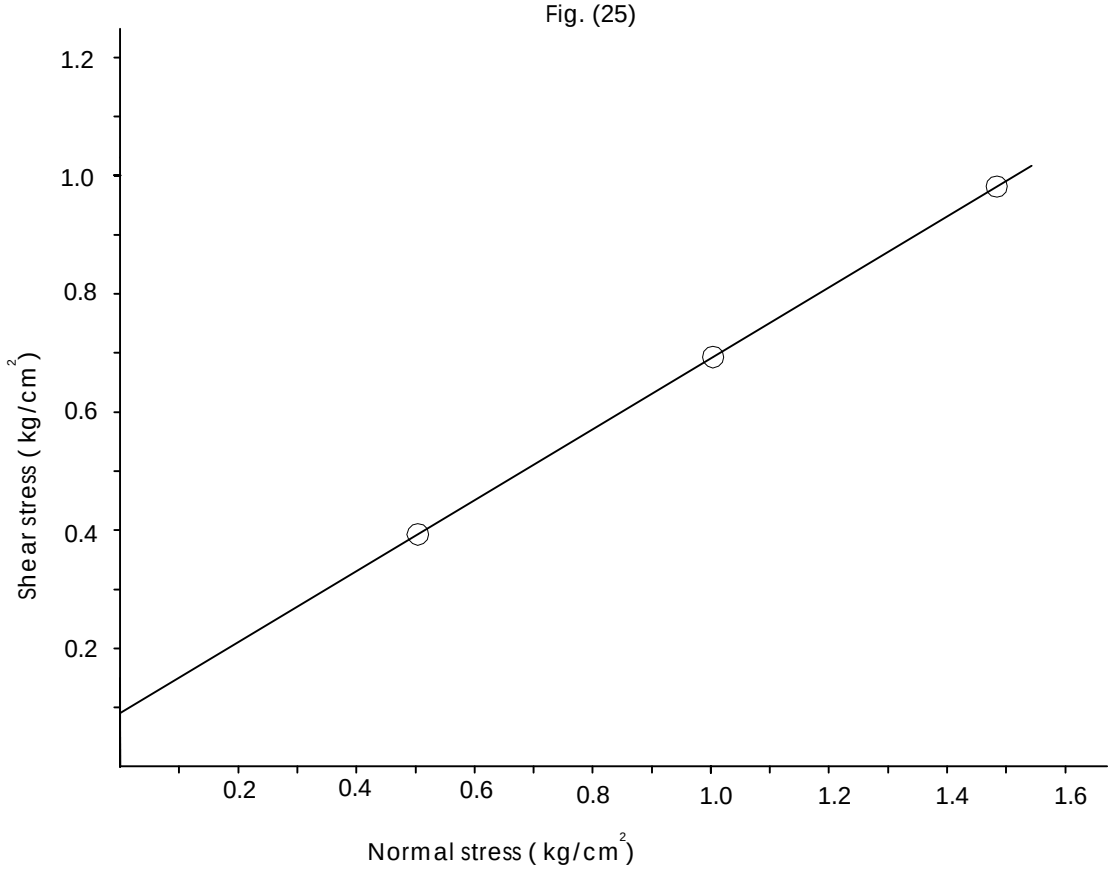
BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-04	24.50	ML	0	35	55	10			

FIG.24



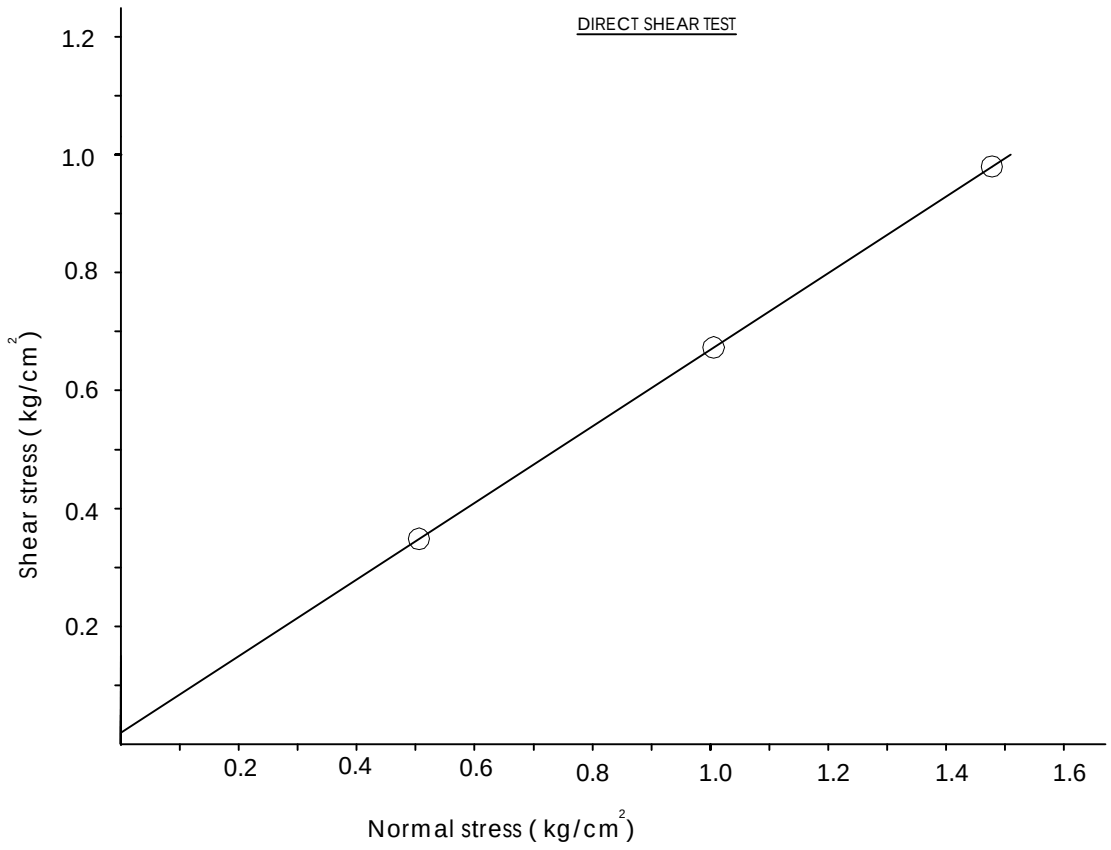
BORE HOLE NO: 04
SAMPLE NO : SPT-01
DEPTH : 1.00 M
C = 0.15 Kg/cm^2 Ø= 23°

Fig. (25)



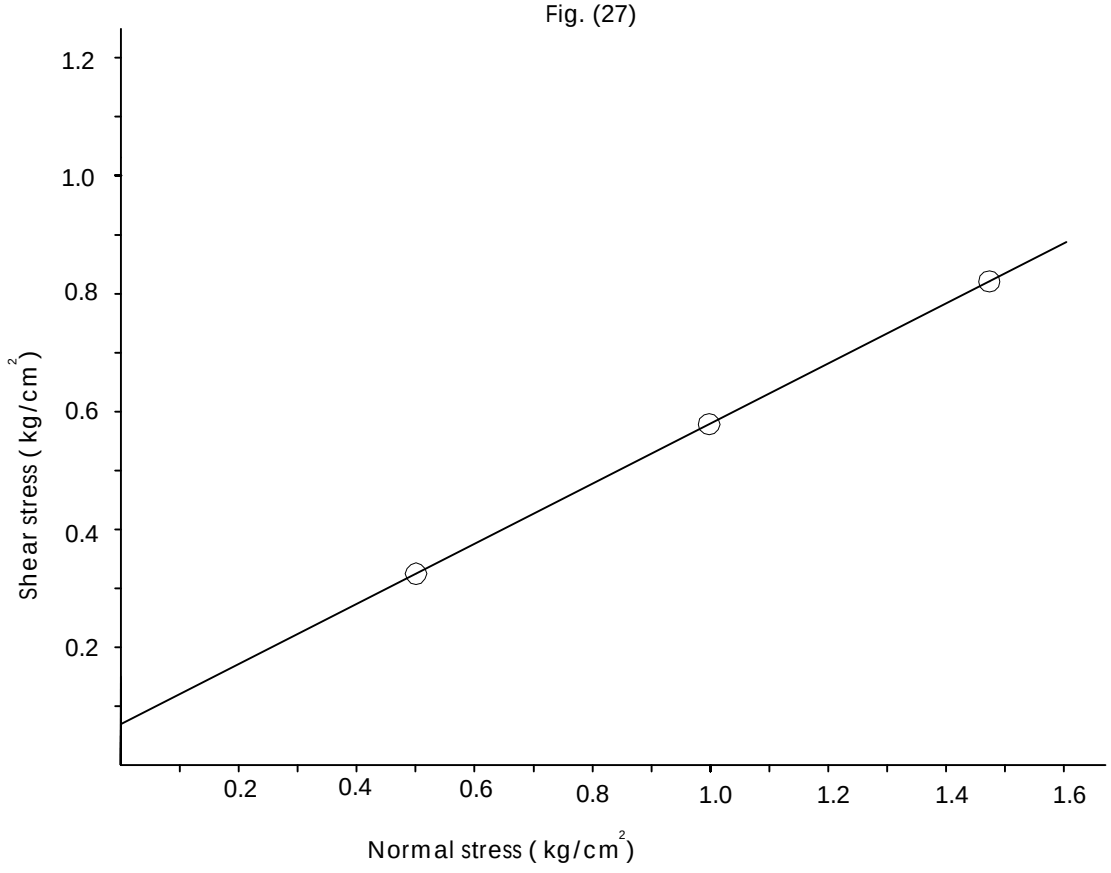
BORE HOLE NO: 04
SAMPLE NO : SPT-09
DEPTH : 9.00 M
C = 0.09 Kg/cm^2 Ø= 31°

Fig. (26)



BORE HOLE NO: 04
SAMPLE NO : SPT-13
DEPTH : 14.50 M
C = 0.02 Kg/cm^2 Ø= 33°

Fig. (27)



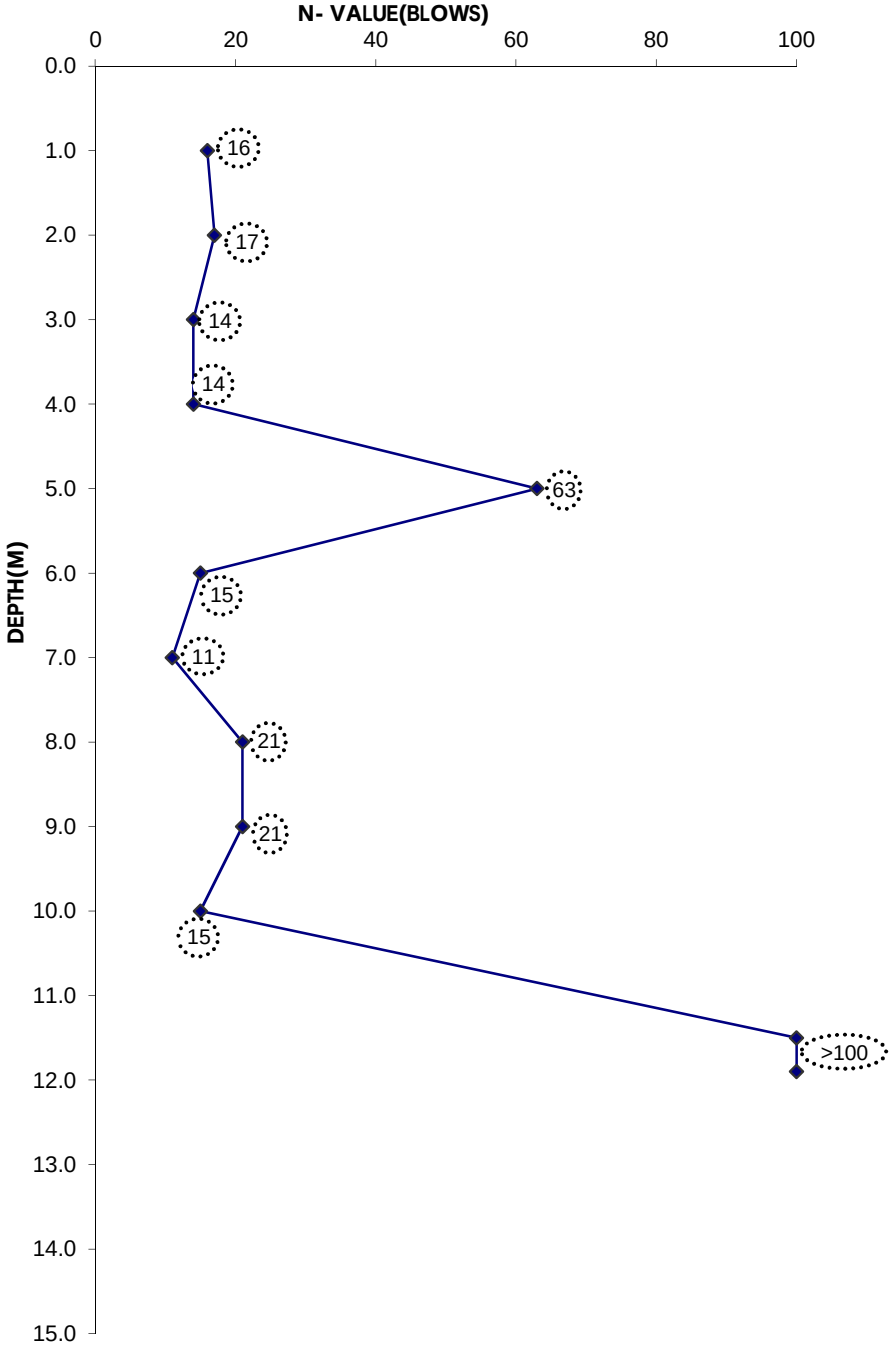
BORE HOLE NO: 04
SAMPLE NO : SPT-18
DEPTH : 22.50 M
C = 0.07 Kg/cm^2 Ø= 27°

Fig. (28)

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-05**	Date of Boring Started	: 23.11.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 24.11.2020
		G.W.L : 4.10M		Termination Depth	: 13.90M
					TC-5397

GRAPHICAL REPRESENTATION OF N VALUE



BORE HOLE TERMINATED AT 13.90 M

FIG.29

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-05** Type of Boring : Rotary Termination Depth : 13.9 M Reduced Level : +20.00	Boring Started : 23.11.2020 Boring Completed : 24.11.2020 Ground Water Level : 4.10 M Co-ordinates : E- 649636.082, N- 1103225.111	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT "N"	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	2.80	Clayey gravel with sand and silt(W/red)	GC	**1.00**	1.00-1.45	7	8	8	**16**				
				2.00	2.00-2.45	8	9	8	**17**				
				3.00	3.00-3.45	7	7	7	**14**				
	2.00	Sandy clayey silt(W/red)	CI	**4.00**	4.00-4.45	5	6	8	**14**				
				5.00	5.00-5.45	4	36	27	**63**				
	2.10	Silty sand(Red)	SM	**6.00**	6.00-6.45	4	7	8	**15**				
				7.00	7.00-7.45	3	5	6	**11**				
	2.80	Sandy silt with clay(Red)	ML	**8.00**	8.00-8.45	6	9	12	**21**				
				9.00	9.00-9.45	10	10	11	**21**				
		Sandy silt with clay(Y/brown)		**10.0**	10.0-10.45	8	7	8	**15**				
	2.20	Silty sand(Gr./yellow)	SM	**11.5**	11.5-11.95	8	100	-	**>100**				
		Silty sand(Br./yellow)		**12.0**									
	2.00	Rock		**13.0**	11.9 to 12.9	DRILLING DONE USING DIAMOND BIT				82	51	250	
				14.0	12.9 to 13.9	DRILLING DONE USING DIAMOND BIT				77	47	-	

Termination Depth : 13.9m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :30

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 4.10m

Date of Boring Started : 23.11.2020
Boring completed : 24.11.2020
Termination Depth : 13.9m

Table No.:5

TC-5397

ULR-TC539720000000184F

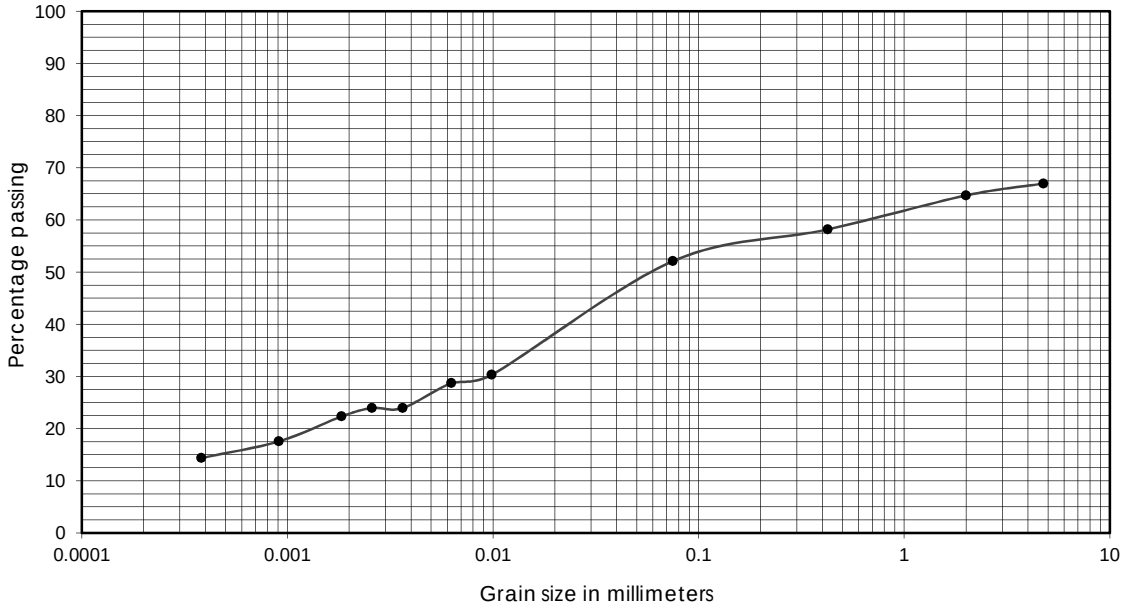
SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-05																				
16	1.00	SPT-01	Clayey gravel with sand and silt(W/red)	GC	33	15	30	22	32	55	24	21			2.54	1.78	1.35	DST	0.19	23
17	2.00	SPT-02	Clayey gravel with sand and silt(W/red)	GC					27											
14	3.00	SPT-03	Sandy clayey silt(W/red)	CI	2	34	44	20	32	43	21	22								
14	4.00	SPT-04	Sandy clayey silt(W/red)	CI					37						2.47	1.82	1.30	UCS	0.46	-
63	5.00	SPT-05	Silty sand(Red)	SM	1	83	16	0	18	No Limit										
15	6.00	SPT-06	Silty sand(Red)	SM	0	78	22	0	30	No Limit					2.60	1.87	1.44	DST	0.04	24
11	7.00	SPT-07	Sandy silt with clay(Red)	ML	0	28	64	8	49	No Limit										
21	8.00	SPT-08	Sandy silt with clay(Red)	ML					40											
21	9.00	SPT-09	Sandy silt wth clay(Y/brown)	ML	0	33	61	6	32	No Limit					2.54	1.84	1.39	DST	0.07	25
15	10.0	SPT-10	Silty sand(Gr./Yellow)	SM	0	67	33	0	24	No Limit										
>100	11.5	SPT-11	Silty sand(Br./yellow)	SM	0	63	37	0	29	No Limit					2.61	1.79	1.39	DST	0.03	36
	11.9 to 13.9		Rock						-											

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

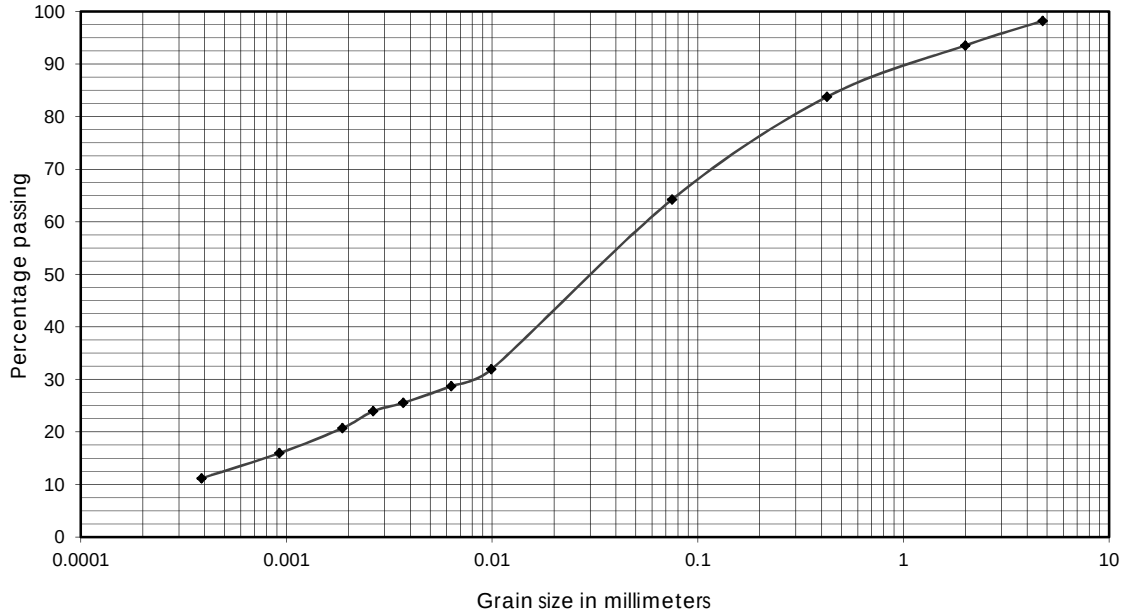
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-05	1.00	GC	33	15	30	22			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-05	3.00	CI	2	34	44	20			

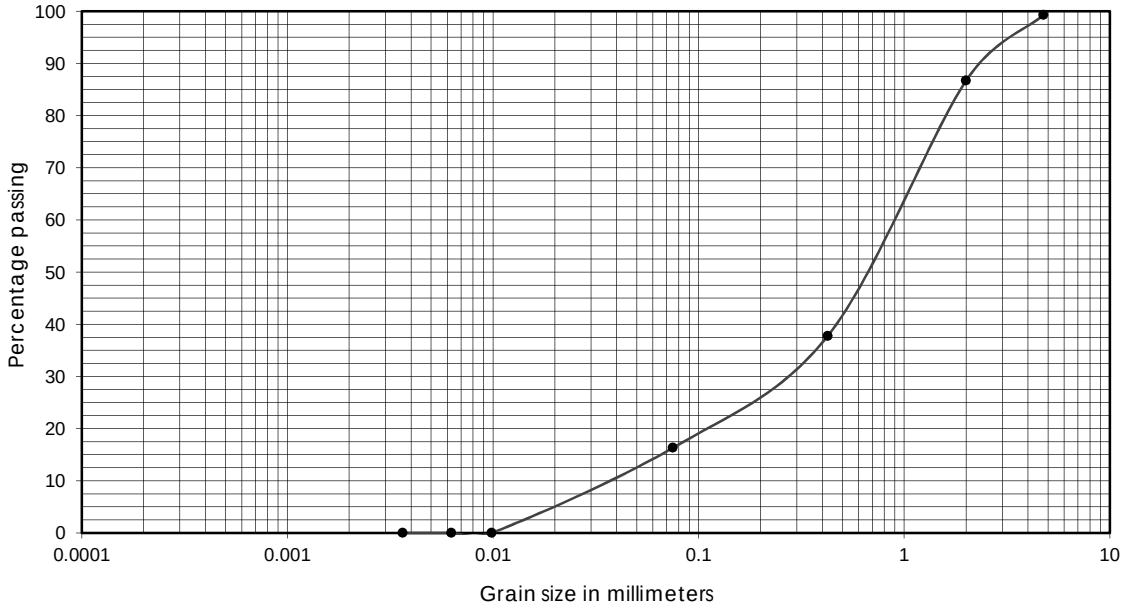
FIG.31

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

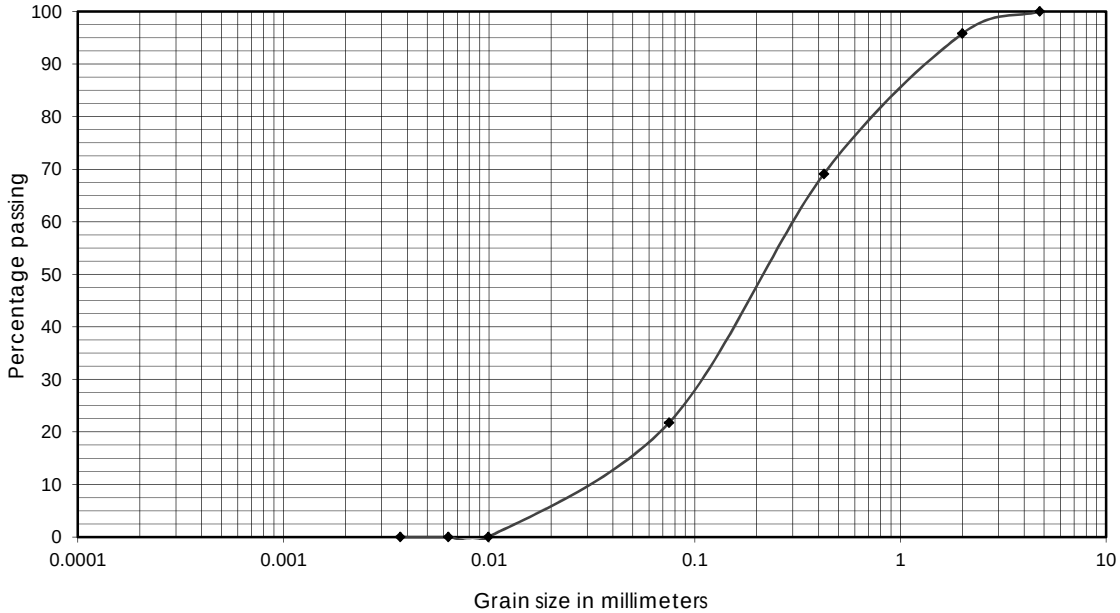
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-05	5.00	SM	1	83	16	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-05	6.00	SM	0	78	22	0			

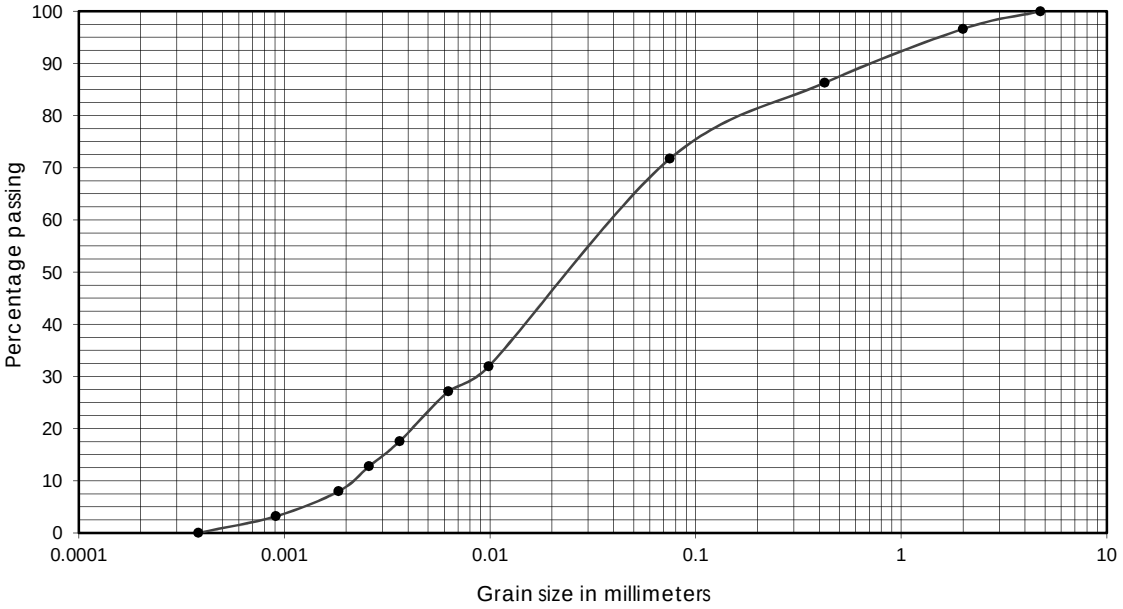
FIG.32

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

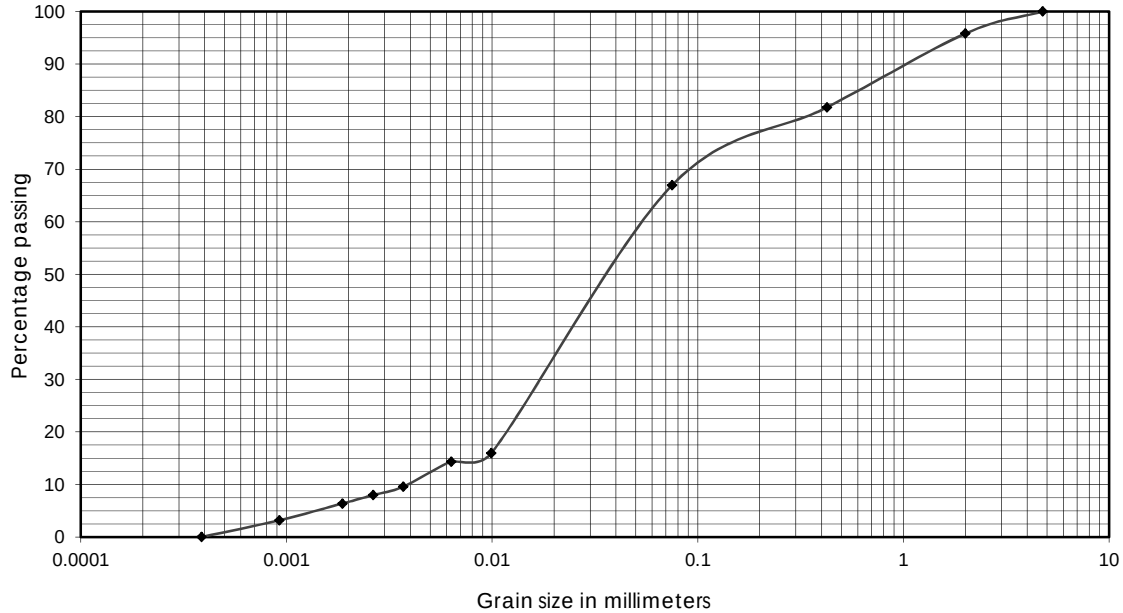
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-05	7.00	ML	0	28	64	8			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-05	9.00	ML	0	33	61	6			

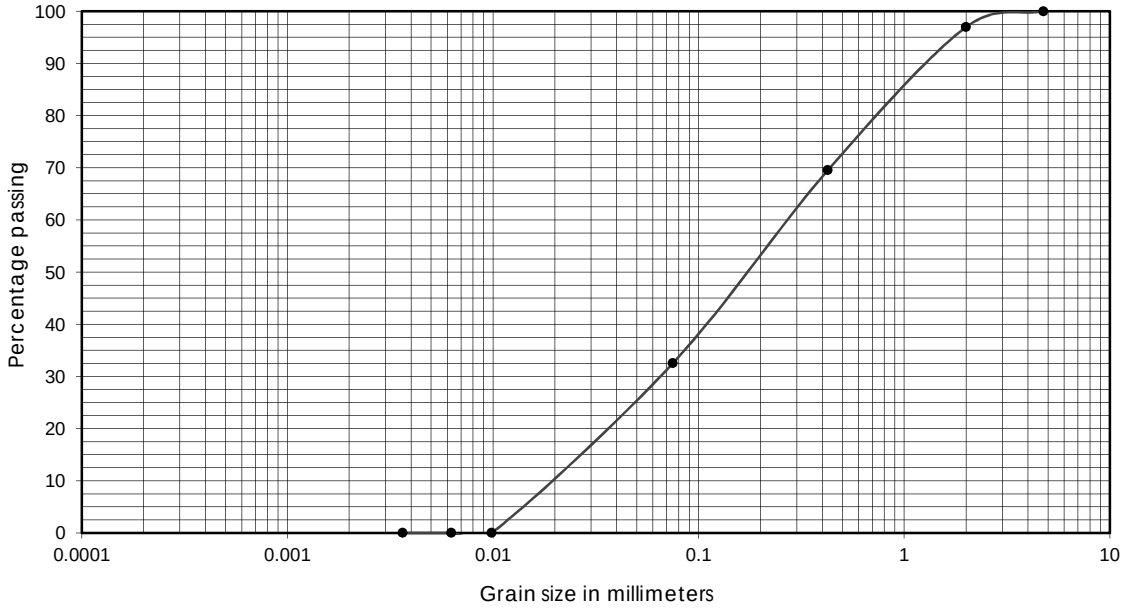
FIG.33

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

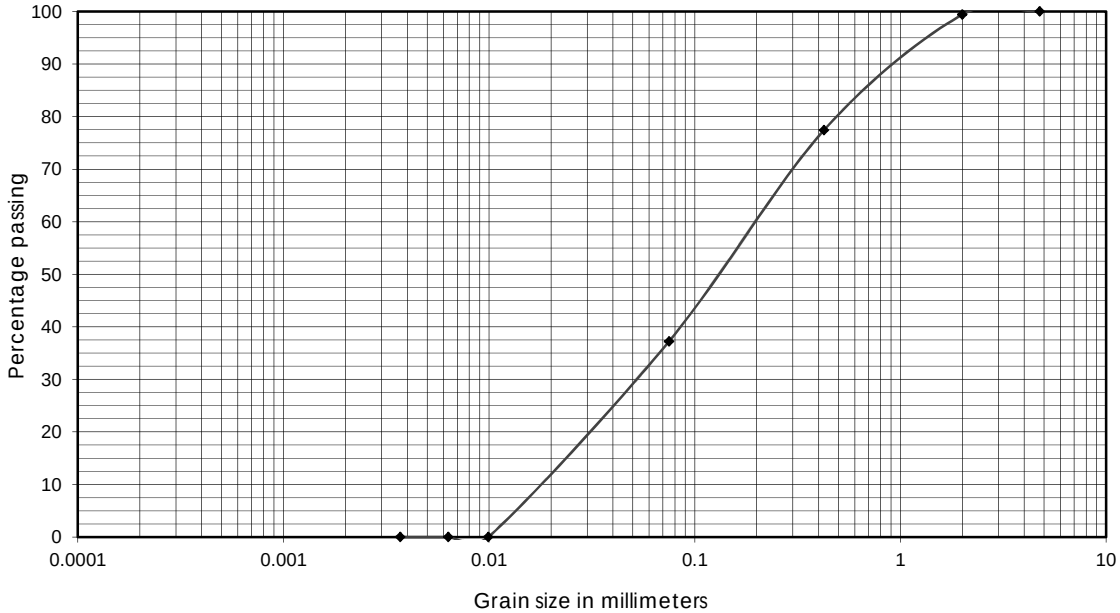
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST

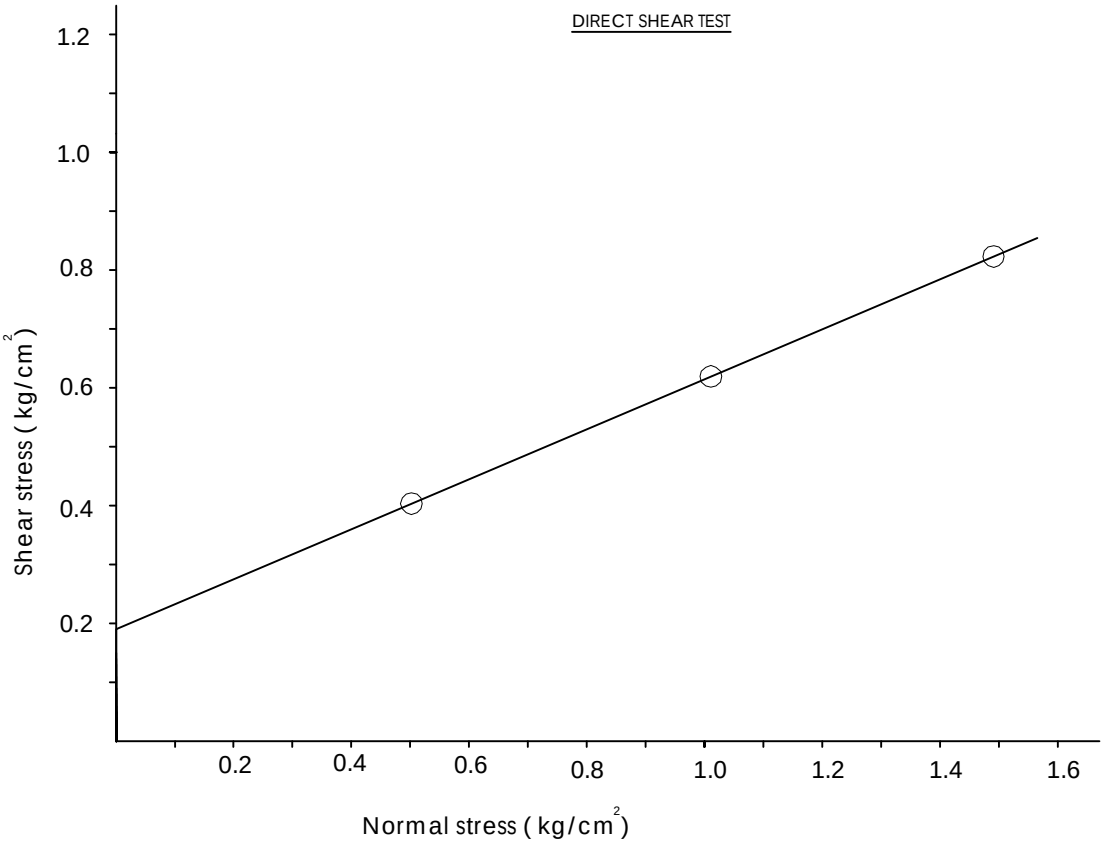


BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-05	10.00	SM	0	67	33	0			



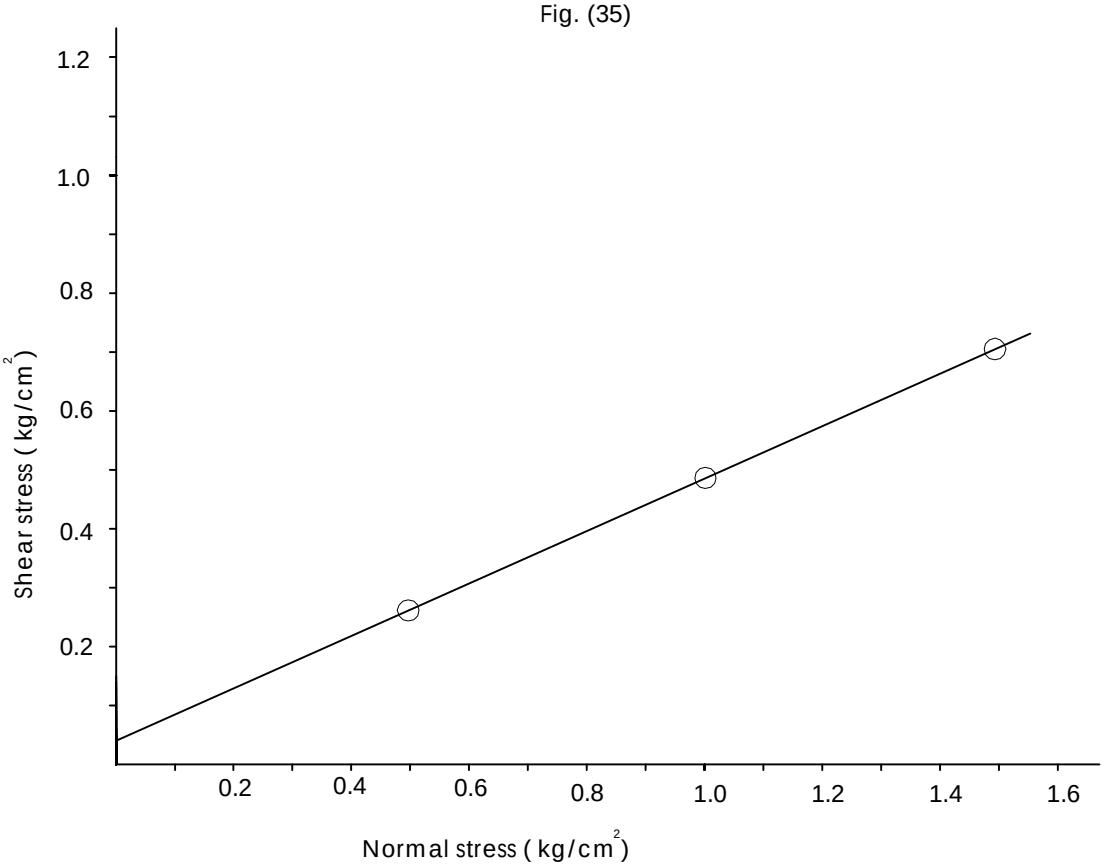
BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-05	11.50	SM	0	63	37	0			

FIG.34



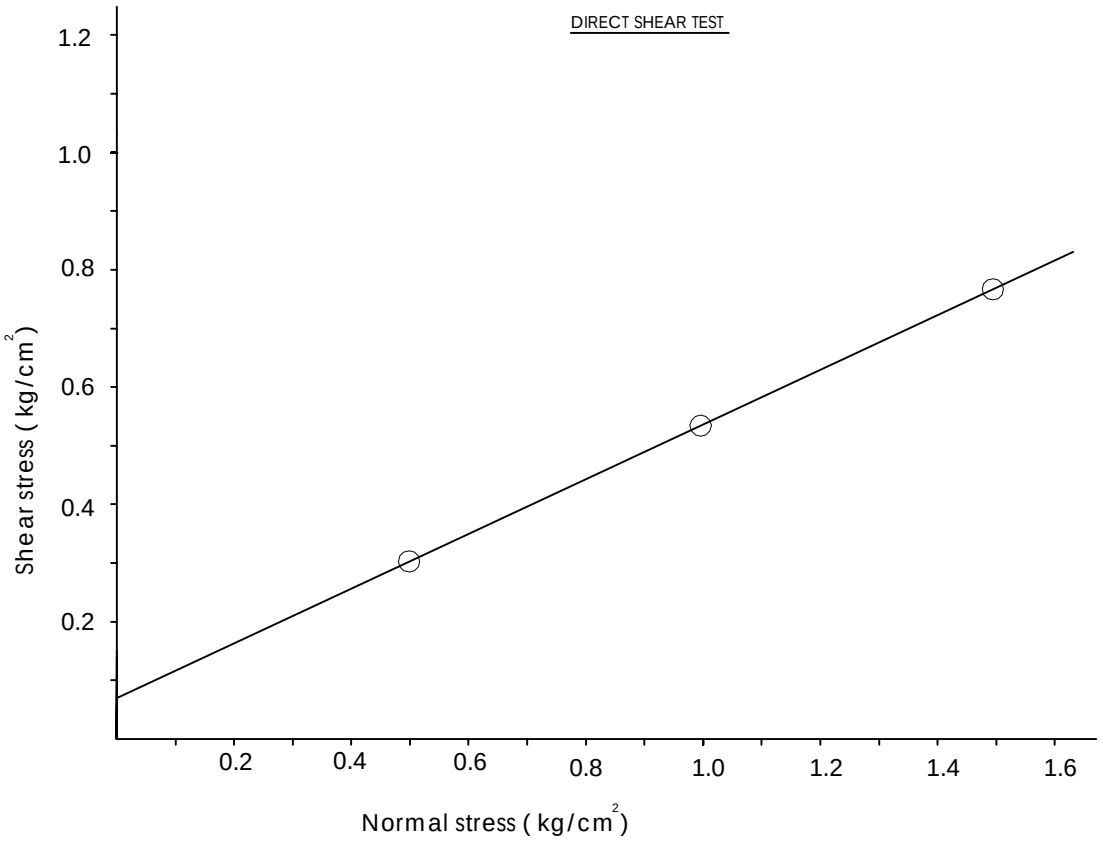
BORE HOLE NO: 05
SAMPLE NO : SPT-01
DEPTH : 1.00 M
C = 0.19 Kg/cm^2 Ø= 23°

Fig. (35)



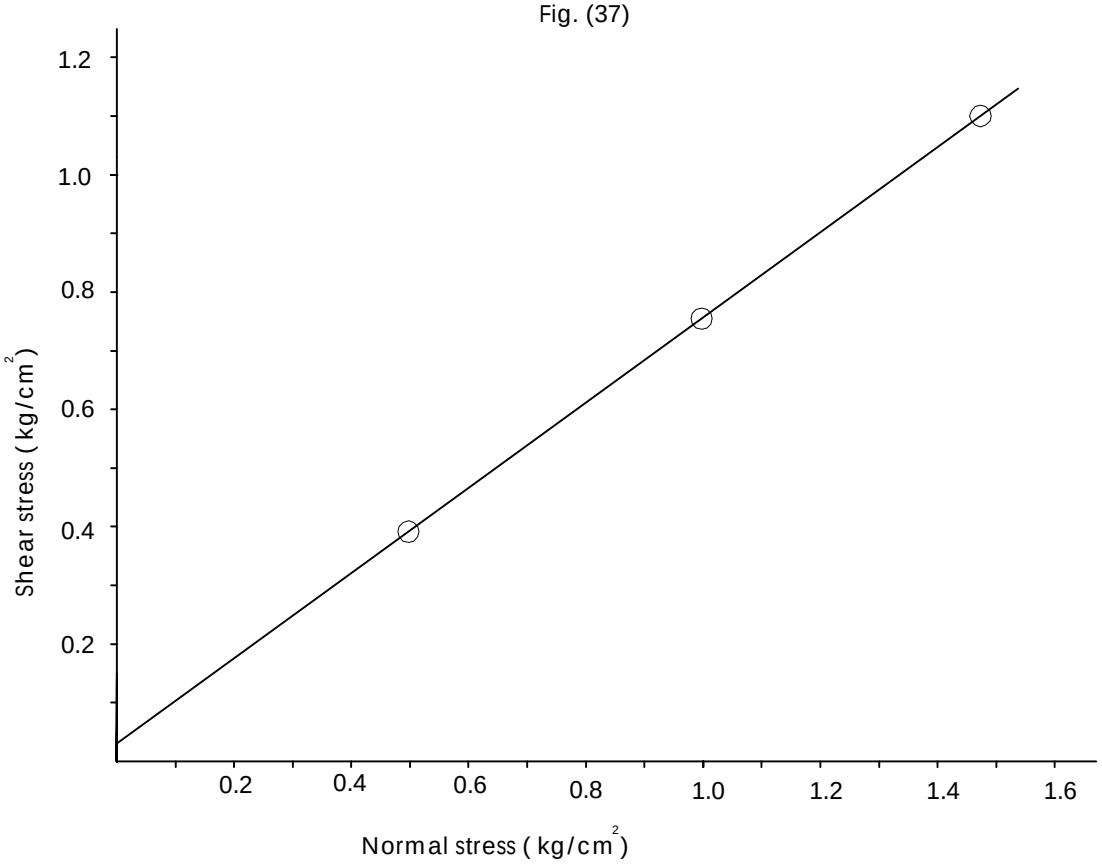
BORE HOLE NO: 05
SAMPLE NO : SPT-06
DEPTH : 6.00 M
C = 0.04 Kg/cm^2 Ø= 24°

Fig. (36)



BORE HOLE NO: 05
SAMPLE NO : SPT-09
DEPTH : 9.00 M
C = 0.07 Kg/cm^2 Ø= 25°

Fig. (37)



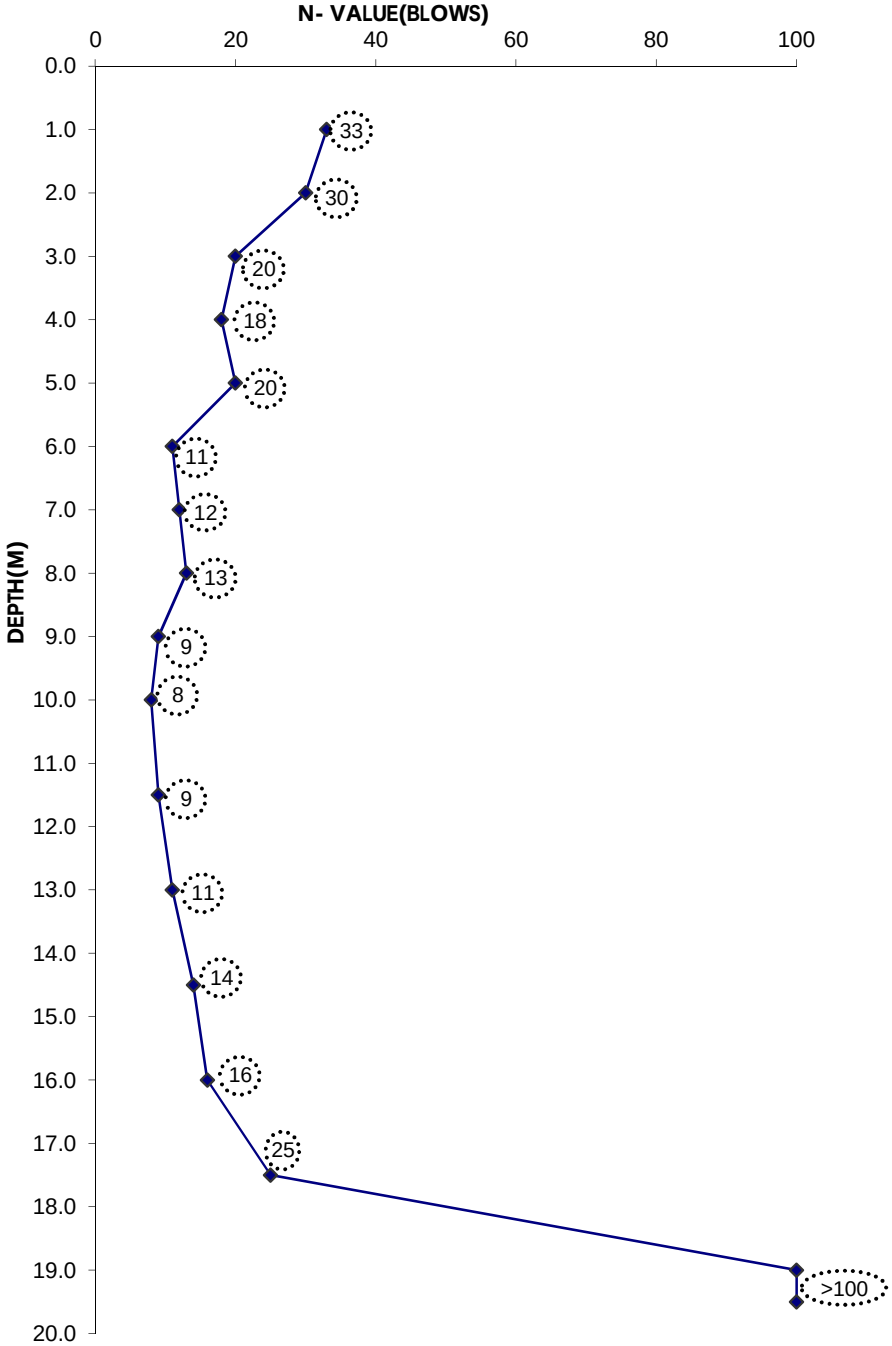
BORE HOLE NO: 05
SAMPLE NO : SPT-11
DEPTH : 11.50 M
C = 0.03 Kg/cm^2 Ø= 36°

Fig. (38)

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-06**	Date of Boring Started	: 30.11.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 01.12.2020
		G.W.L : 6.40M		Termination Depth	: 21.50M
					TC-5397

GRAPHICAL REPRESENTATION OF N VALUE



BORE HOLE TERMINATED AT 21.50 M

FIG.39

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-06** Type of Boring : Rotary Termination Depth : 21.5 M Reduced Level : +20.00	Boring Started : 30.11.2020 Boring Completed : 01.12.2020 Ground Water Level : 6.40M Co-ordinates : E-649696.919, N-1103215.539	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT "N"	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	3.70	Sandy clayey silt with presence of gravel(W/yellow)	CI	**1.00**	1.00-1.45	10	13	20	**33**				
				2.00	2.00-2.45	10	18	12	**30**				
				3.00	3.00-3.45	8	9	11	**20**				
	3.00	Silty sand with presence of clay (W/yellow)	SM	**4.00**	4.00-4.45	9	9	9	**18**				
				5.00	5.00-5.45	7	10	10	**20**				
				6.00	6.00-6.45	8	5	6	**11**				
	1.10	Sandy clayey silt(R/yellow)	CI	**7.00**	7.00-7.45	5	6	6	**12**				
				8.00	8.00-8.45	6	7	6	**13**				
	0.60	Silty sand with clay and presence ofgravel	SM	**9.00**	9.00-9.45	8	4	5	**9**				
	3.60	Sandy silt with clay(Pale brown)	ML	**10.0**	10.0-10.45	3	4	4	**8**				
				11.5	11.5-11.95	4	5	4	**9**				
				13.0	13.0-13.45	4	5	6	**11**				
	5.00	Silty sand(Yellow)	SM	**14.5**	14.5-14.95	5	6	8	**14**				
				16.0	16.0-16.75	7	8	8	**16**				
				17.5	17.5-17.95	10	11	14	**25**				
	1.80	Sandy silt(Grey)	ML	**19.0**	19.0-19.45	27	85	15	**>100**				31/45 cm penetration
	0.70	Silty sand(Grey)	SM										
	2.00	Rock		**20.0**	19.5 to 20.5	DRILLING DONE USING DIAMOND BIT				78	52	245	
				21.0	20.5 to 21.5	DRILLING DONE USING DIAMOND BIT				83	60	-	
				21.0									

Termination Depth : 21.5m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :40

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 6.40m

Date of Boring Started : 30.11.2020
Boring completed : 01.12.2020
Termination Depth : 21.5m

Table No.: 6&7

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm^2	Ø (^{o})
BOREHOLE BH-06																				
33	1.00	SPT-01	Sandy clayey silt with presence of gravel(W/yellow)	CI	6	39	38	17	19	40	22	18			2.42	1.92	1.61	UCS	1.28	-
30	2.00	SPT-02	Sandy clayey silt with presence of gravel(W/yellow)	CI					18											
20	3.00	SPT-03	Sandy clayey silt with presence of gravel(W/yellow)	CI	5	40	37	18	25											
18	4.00	SPT-04	Silty sand with presence of clay (W/yellow)	SM	2	61	31	6	23	No Limit					2.58	1.67	1.36	DST	0.07	25
20	5.00	SPT-05	Silty sand with presence of clay (W/yellow)	SM	5	60	26	9	25	No Limit										
11	6.00	SPT-06	Silty sand with presence of clay (W/yellow)	SM					23											
12	7.00	SPT-07	Sandy clayey silt (R/yellow)	CI	1	47	34	18	30	42	23	19								
13	8.00	SPT-08	Silty sand with clay and presence of gravel(R/white)	SM	3	55	31	11	24	No Limit					2.55	1.64	1.32	DST	0.13	22
9	9.00	SPT-09	Sandy silt with clay(Pale brown)	ML	0	40	50	10	36	No Limit										
8	10.0	SPT-10	Sandy silt with clay(Pale brown)	ML					41											
9	11.5	SPT-11	Sandy silt with clay(Pale brown)	ML	0	39	48	13	36	No Limit					2.50	1.66	1.22	DST	0.17	20

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

LOCATION : AMBALAMEDU

Ground Water Level : 6.40m

Date of Boring Started : 30.11.2020
Boring completed : 01.12.2020
Termination Depth : 21.5m

Table No.: 6&7

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm^2	Ø (^{o})
BOREHOLE BH-06																				
11	13.0	SPT-12	Silty sand(Yellow)	SM	2	73	25	0	33	No Limit										
14	14.5	SPT-13	Silty sand(Yellow)	SM					34											
16	16.0	SPT-14	Silty sand(Yellow)	SM	0	76	24	0	28	No Limit										
25	17.5	SPT-15	Sandy silt(Grey)	ML	0	47	53	0	42	No Limit					2.46	1.70	1.20	DST	0.05	26
>100	19.0	SPT-16	Silty sand(Grey)	SM	0	55	45	0	20	No Limit										
	19.5 to 21.5		Rock						-											

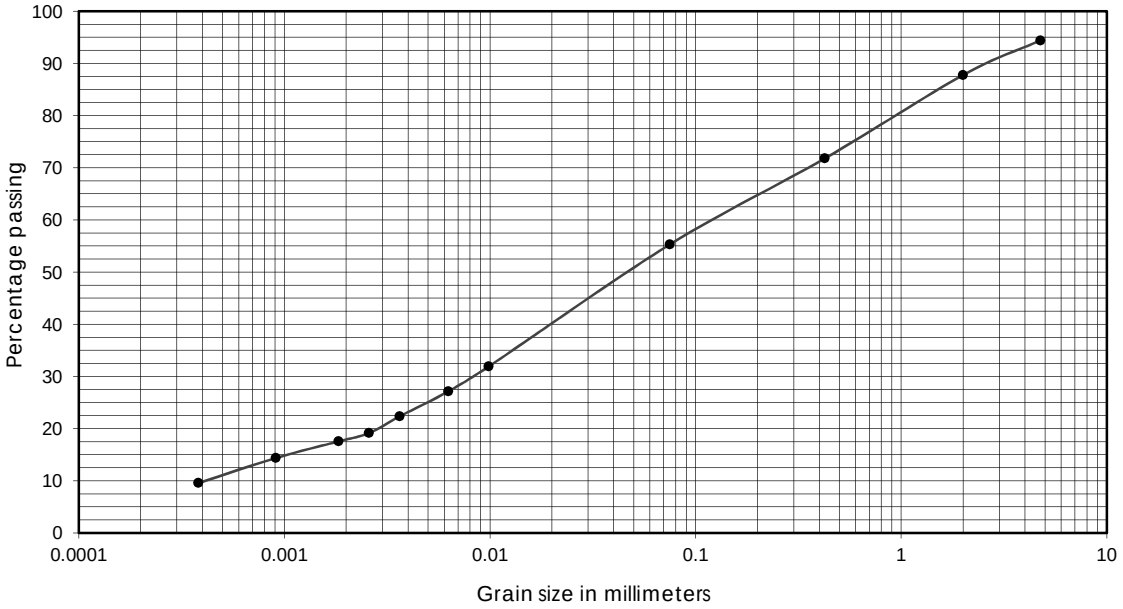
:60:

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

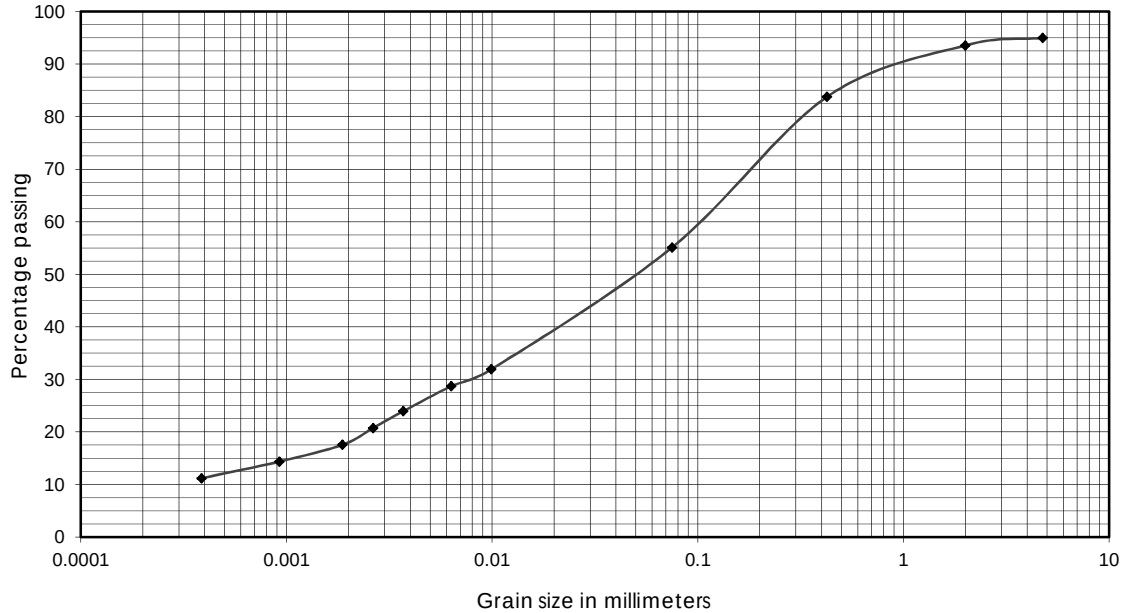
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	1.00	Cl	6	39	38	17			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	3.00	Cl	5	40	37	18			

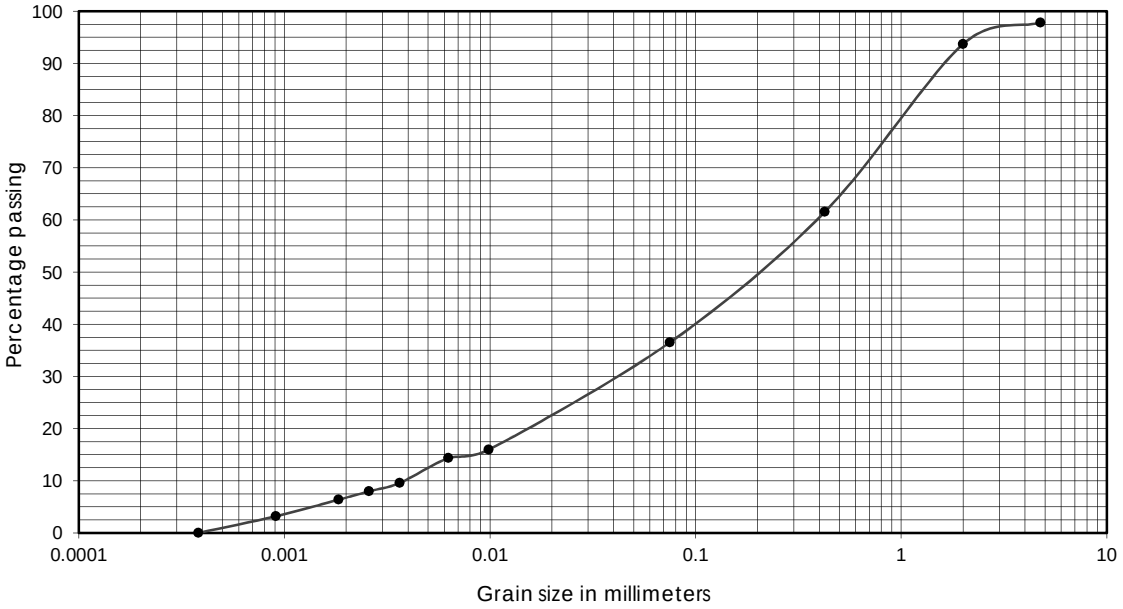
FIG.41

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

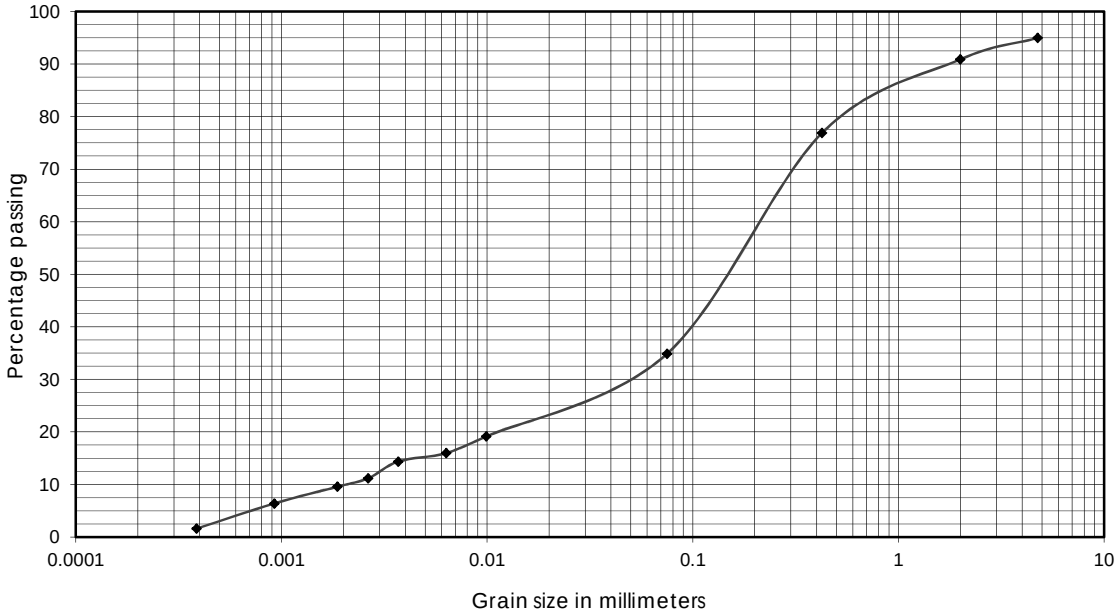
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	4.00	SM	2	61	31	6			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	5.00	SM	5	60	26	9			

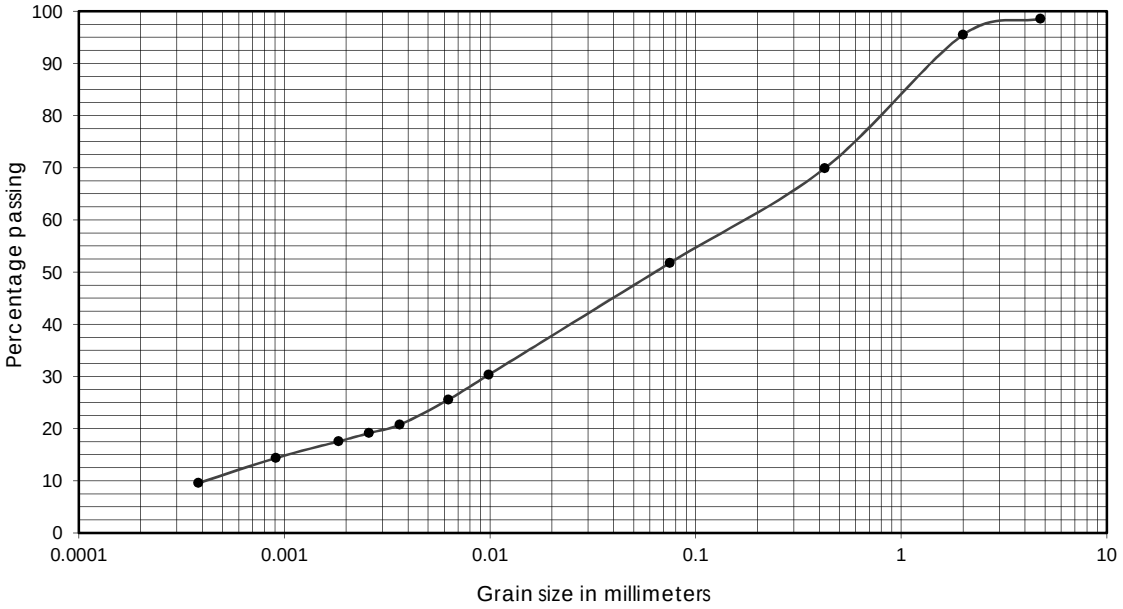
FIG.42

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

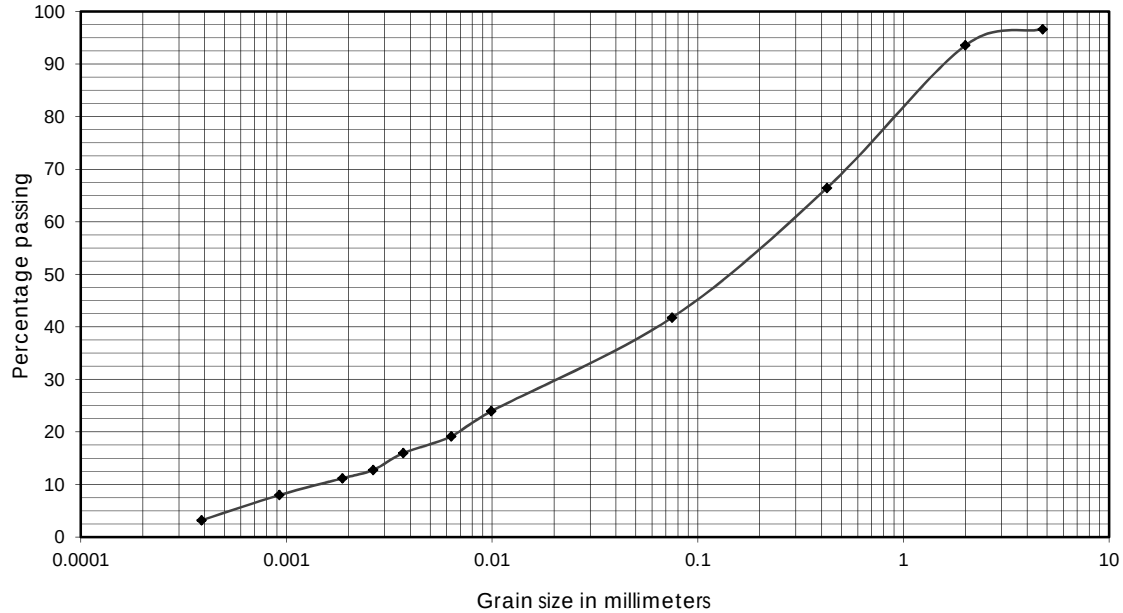
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	7.00	Cl	1	47	34	18			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	8.00	SM	3	55	31	11			

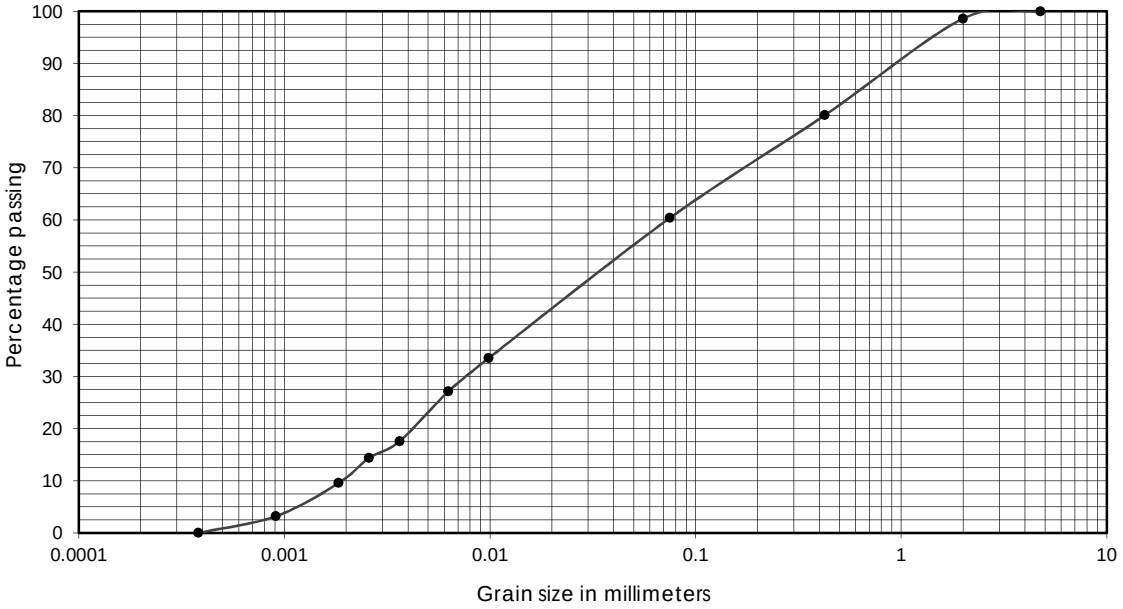
FIG.43

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

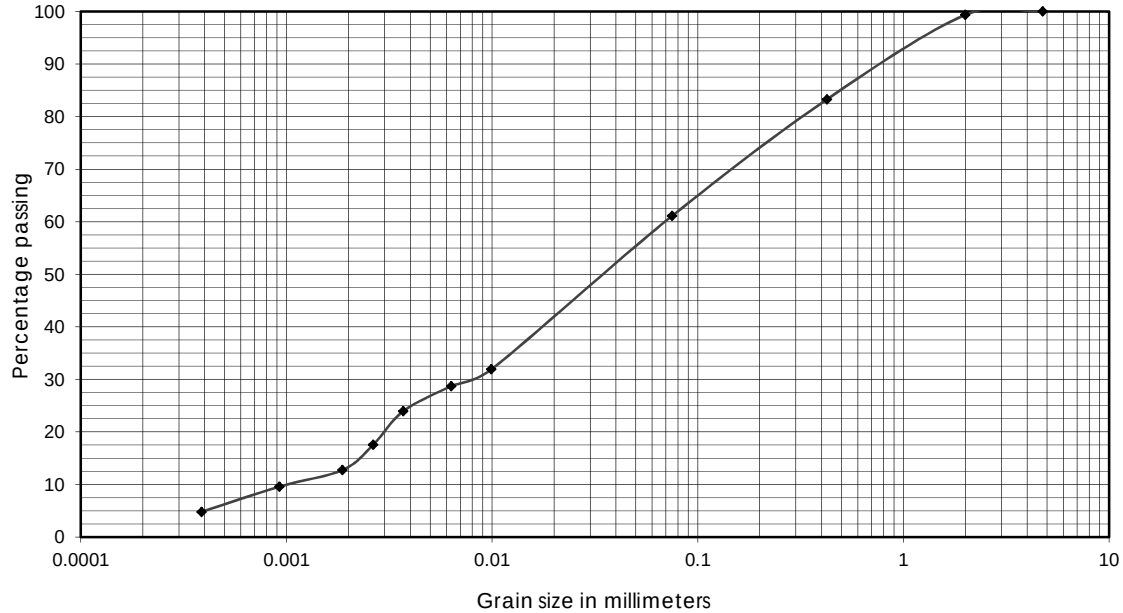
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	9.00	ML	0	40	50	10			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	11.50	ML	0	39	48	13			

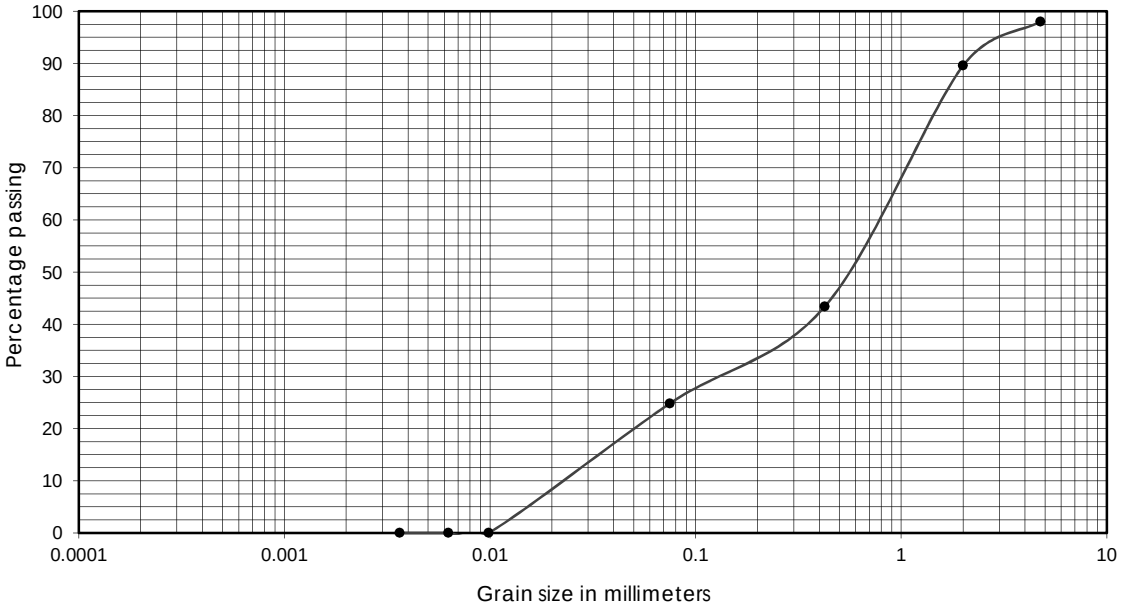
FIG.44

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

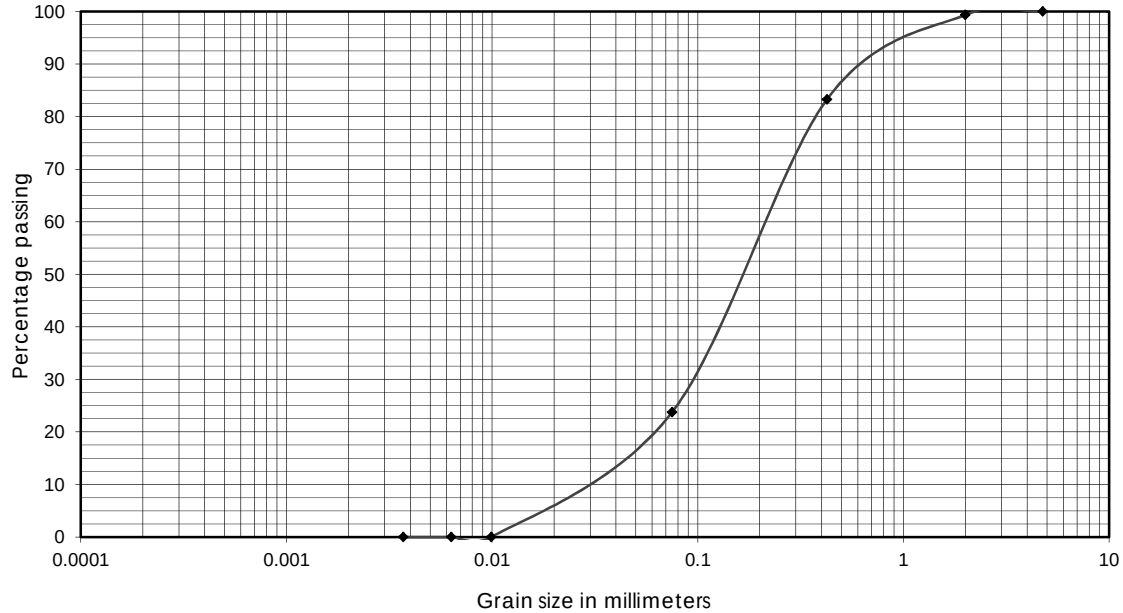
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	13.00	SM	2	73	25	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	16.00	SM	0	76	24	0			

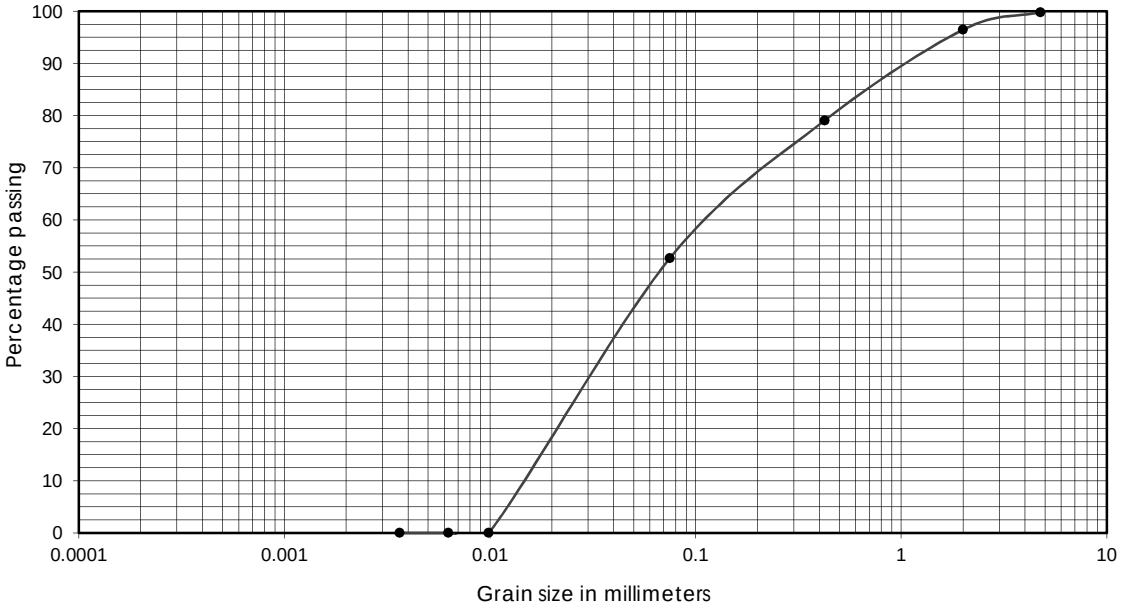
FIG.45

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

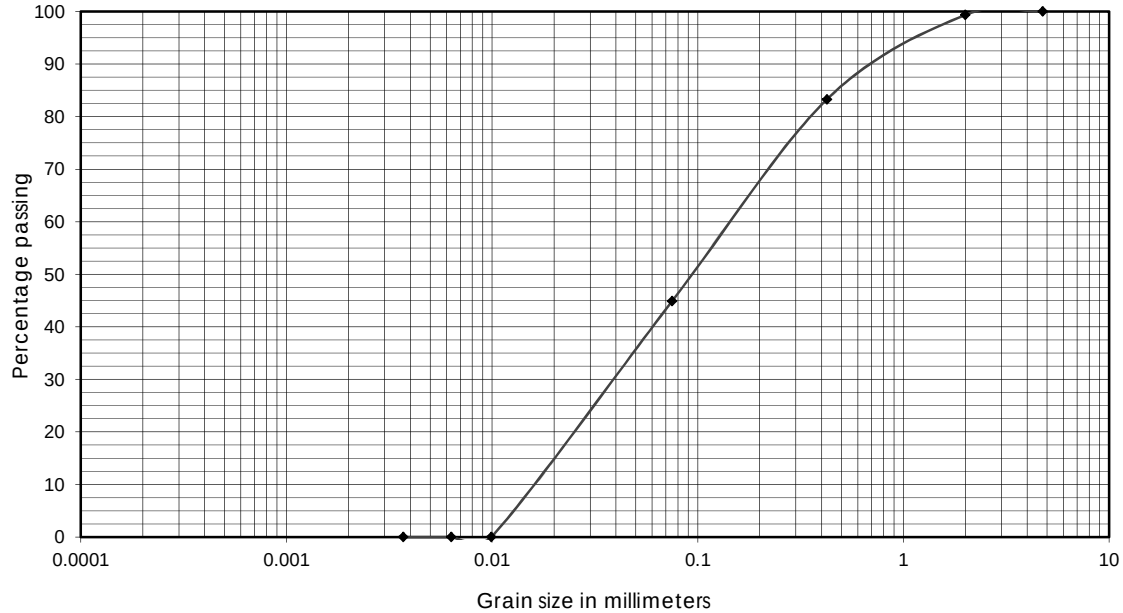
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-06	17.50	ML	0	47	53	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-06	19.00	SM	0	55	45	0			

FIG.46

DIRECT SHEAR TEST

BORE HOLE NO: 06
SAMPLE NO : SPT-04
DEPTH : 4.00 M
C = 0.07 Kg/cm^2 Ø= 25°

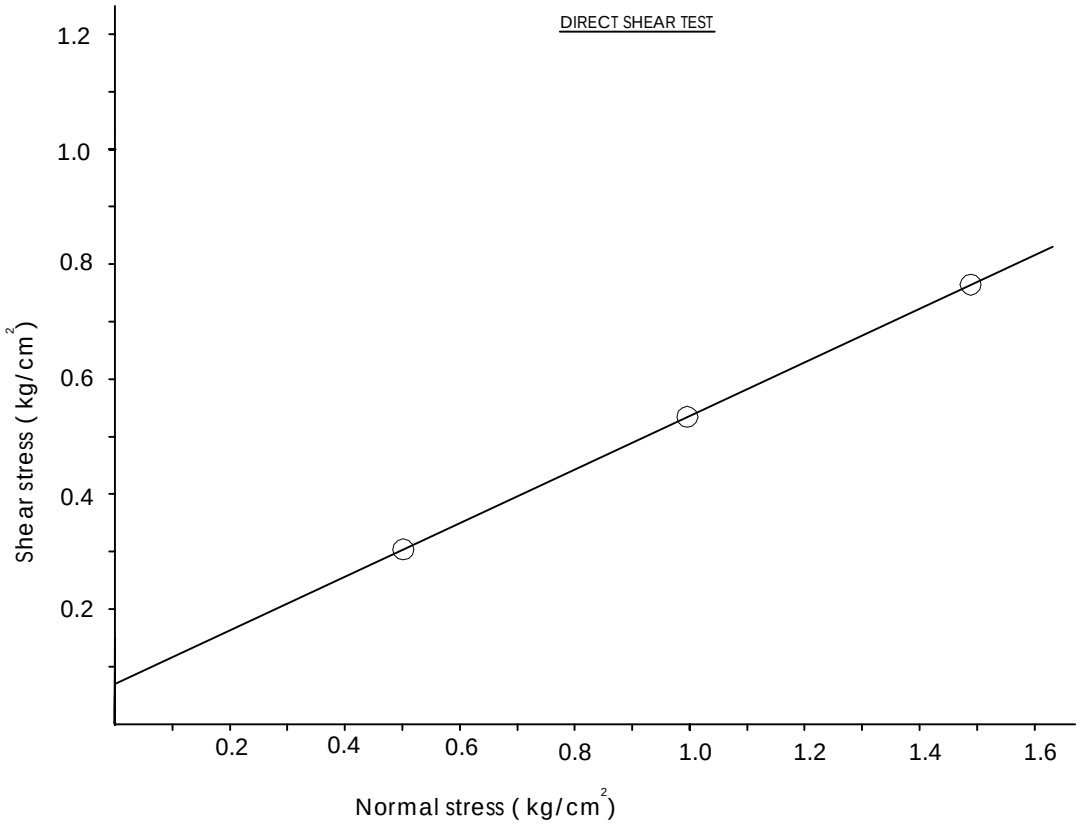


Fig. (47)

BORE HOLE NO: 06
SAMPLE NO : SPT-08
DEPTH : 8.00 M
C = 0.13 Kg/cm^2 Ø= 22°

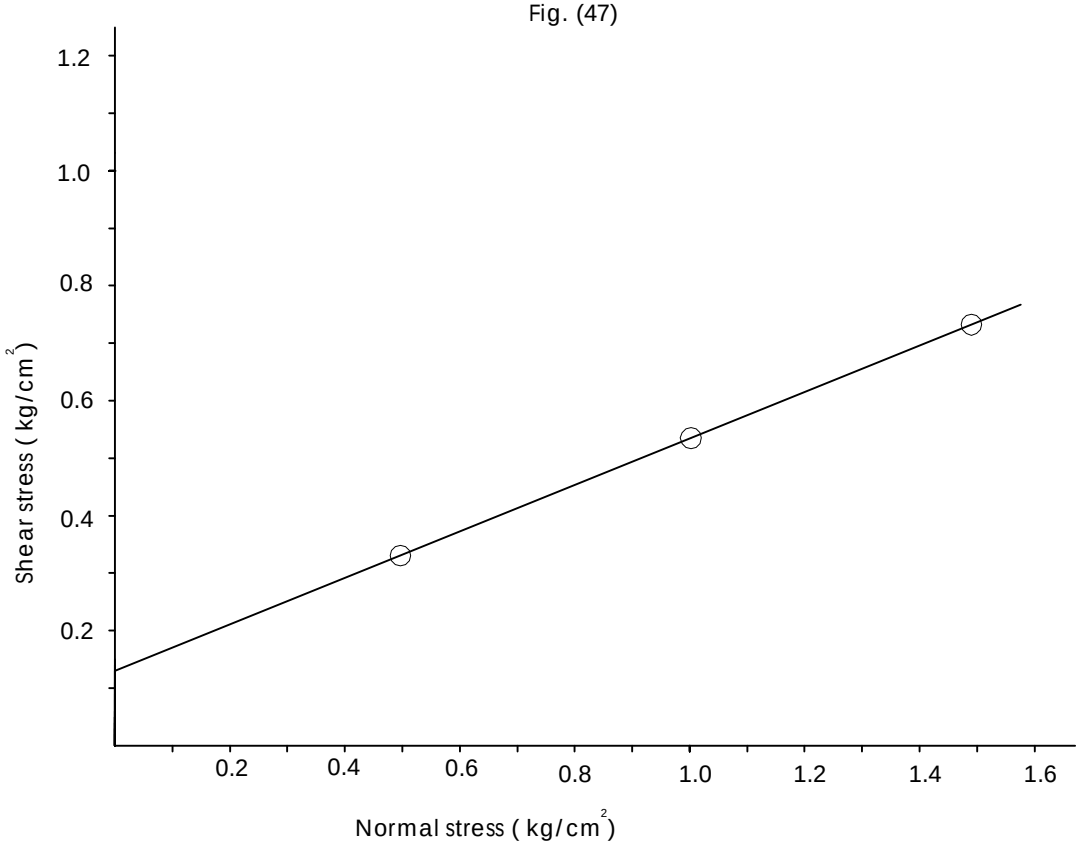
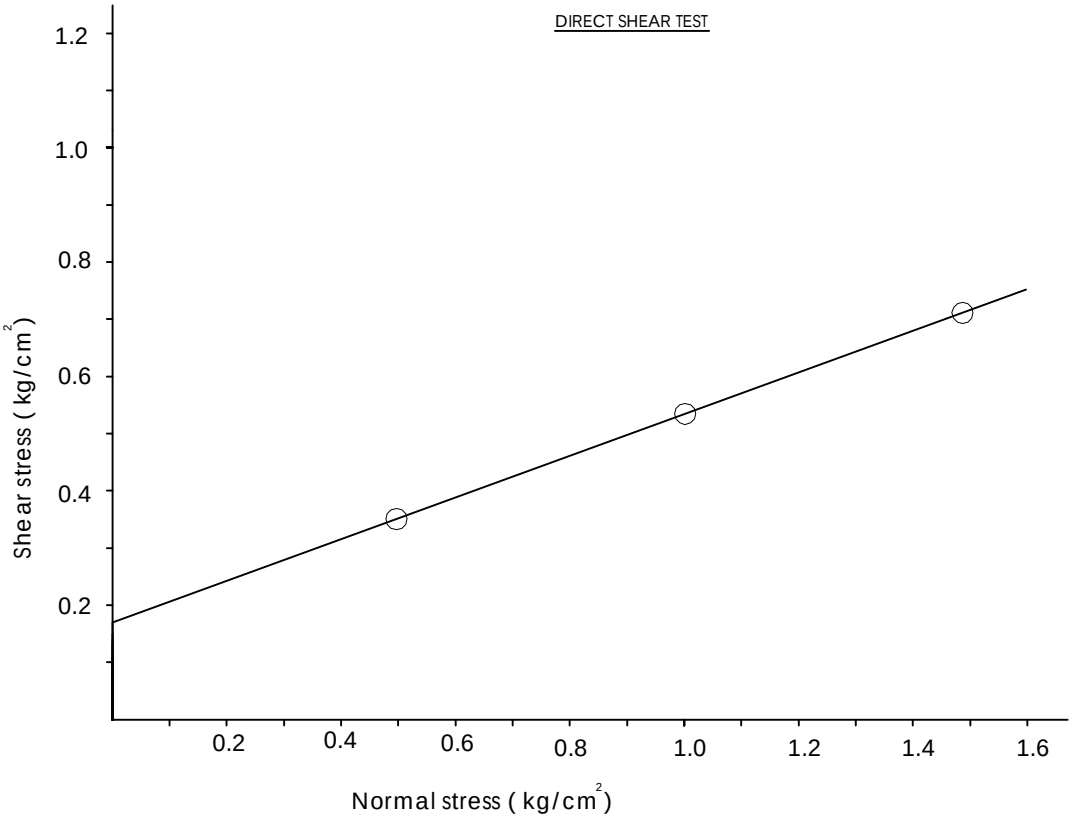
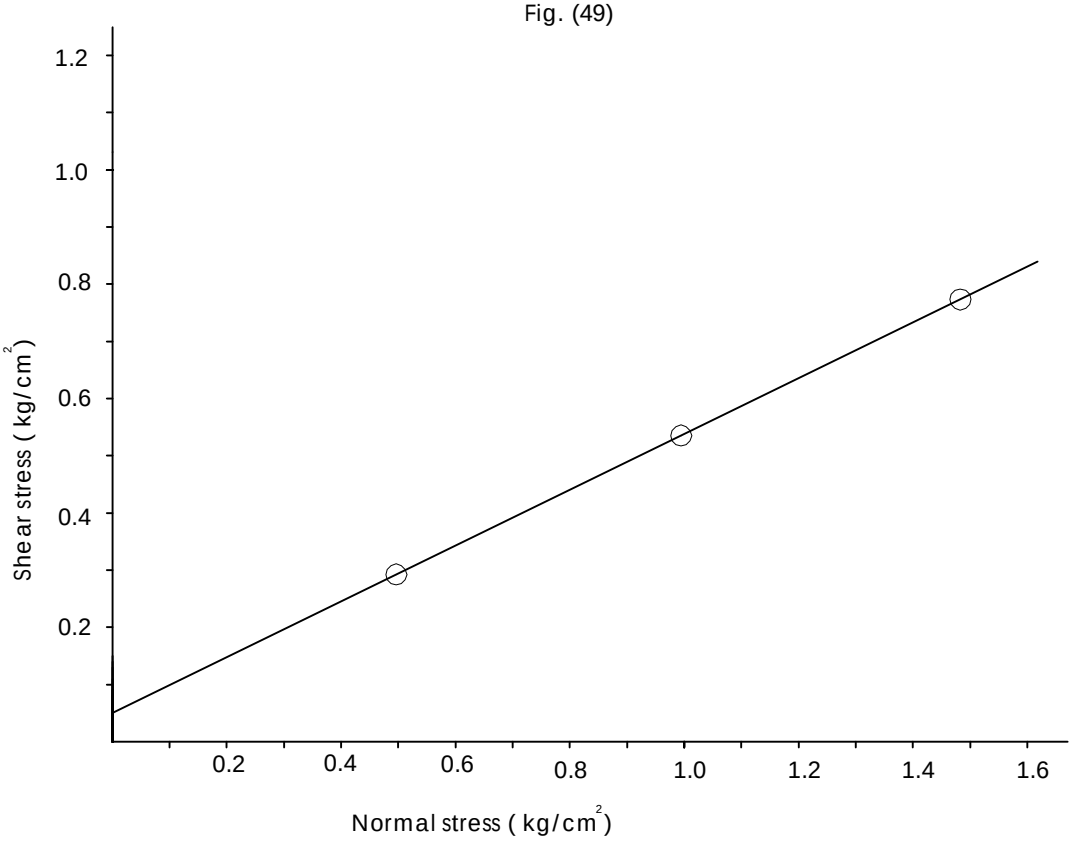


Fig. (48)



BORE HOLE NO: 06
SAMPLE NO : SPT-11
DEPTH : 11.50 M
C = 0.17 Kg/cm^2 Ø= 20°

Fig. (49)



BORE HOLE NO: 06
SAMPLE NO : SPT-15
DEPTH : 17.50 M
C = 0.05 Kg/cm^2 Ø= 26°

Fig. (50)

	NAME OF WORK: GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT	BORE HOLE NO. BH-03

LIQUEFACTION CALCULATIONS as per IS 1893:part-01:2016

$$FS = \frac{CRR}{CSR},$$

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

No. of layers	Soil Description	Depth		g_d	N_{avg}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, P_a (Pa)
		From (m)	To (m)				
Layer No.1	Sandy clayey silt	0.00	-4.00	19.40	16	37600	100658
Layer No.2	Silty sand with gravel	-4.00	-5.00	16.30	11	31500	100658
Layer No.3	Sandy clayey silt	-5.00	-6.00	19.40	6	56400	100658
Layer No.4	Sandy silt	-6.00	-8.00	16.30	9	50400	100658
Layer No.5	Silty sand	-8.00	-11.5	17.00	21	80500	100658
Layer No.6	Silty sand	-11.5	-19.0	17.20	24	136800	100658

CRR (Cyclic Resistance Ratio) Calculations

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2} - \frac{1}{200}$$

$$(N_1)_{60CS} = \alpha + \beta(N_1)_{60},$$

$$(N_1)_{60} = C_N N_{60},$$

$$C_N = \sqrt{\frac{P_a}{\sigma'_{vo}}} \le 1.7,$$

$$N_{60} = NC_{60},$$

$$C_{60} = C_{HT}C_{HW}C_{SS}C_{RL}C_{BD}.$$

***Since, SPT equipment are of specified recommendations N_{60} = N obtained**

ALPHA, α	BETA, β	Fineness Content, FC
0	1	FC ≤ 5%
$e^{(1.76-(190/FC2))}$	$0.99+(FC^{1.5}/1000)$	5% < FC < 35%
0.5	1.2	FC ≥ 35%

N1 60 CS Calculations:

Layer	N_{60}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	C_N	$(N_1)_{60}$	Fineness Content, FC (%)	ALPHA, α	BETA, β	$(N_1)_{60CS}$
Layer No.1	16	37600	100658	1.64	26.18	44	0.500	1.200	**31.91**
Layer No.2	11	31500	100658	1.70	18.70	35	0.500	1.200	**22.94**
Layer No.3	6	56400	100658	1.34	8.02	63	0.500	1.200	**10.12**
Layer No.4	9	50400	100658	1.41	12.72	56	0.500	1.200	**15.76**
Layer No.5	21	80500	100658	1.12	23.48	27	4.479	1.130	**31.02**
Layer No.6	24	136800	100658	0.86	20.59	21	3.778	1.086	**26.14**

A	B	C	D
$\frac{1}{34-(N_1)_{60CS}}+$	$\frac{(N_1)_{60CS}}{135}+$	$\frac{50}{[10\times(N_1)_{60CS}+45]^2}-$	$-\frac{1}{200}$

$CRR_{7.5}$ VALUES

A	B	C	D	$CRR_{7.5}$
0.4795	0.2364	0.0004	0.005	0.7113
0.0904	0.1699	0.0007	0.005	0.2560
0.0419	0.0750	0.0023	0.005	0.1142
0.0548	0.1168	0.0012	0.005	0.1678
0.3357	0.2298	0.0004	0.005	0.5609
0.1272	0.1936	0.0005	0.005	0.3164

K Sigma Calculations

$$K_\sigma = \left(\sigma'_{vo}/P_a\right)^{(f-1)}$$

Relative Density (%)	*f*
40 - 60	0.8 ~ 0.7
60 - 80	0.7 ~ 0.6
(f-1)	-0.3

Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	K_σ
37600	100658	1.3437
31500	100658	1.4170
56400	100658	1.1898
50400	100658	1.2306
80500	100658	1.0693
136800	100658	0.9121

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CRR (Cyclic Resistance Ratio) Calculations:

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

Layers	$CRR_{7.5}$	MSF	K_{σ}	K_{α}	CRR
Layer No.1	0.7113	0.9996	1.3437	1.0000	0.9554
Layer No.2	0.2560	0.9996	1.4170	1.0000	0.3626
Layer No.3	0.1142	0.9996	1.1898	1.0000	0.1358
Layer No.4	0.1678	0.9996	1.2306	1.0000	0.2064
Layer No.5	0.5609	0.9996	1.0693	1.0000	0.5996
Layer No.6	0.3164	0.9996	0.9121	1.0000	0.2885

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

CSR (Cyclic Stress Ratio) Calculations:

Layers	a_{max}/g	Total Vertical Overburden Pressure, σ_{vo} (Pa)	Effective Overburden Pressure, σ'_{vo} (Pa)	Stress Reduction Factor, Υ_d	CSR
Layer No.1	0.16	77600	37600	0.9694	0.2081
Layer No.2	0.16	81500	31500	0.9618	0.2588
Layer No.3	0.16	116400	56400	0.9541	0.2048
Layer No.4	0.16	130400	50400	0.9388	0.2526
Layer No.5	0.16	195500	80500	0.8670	0.2190
Layer No.6	0.16	326800	136800	0.6667	0.1656

*** peak ground acceleration (PGA) is not available, take a_{max}/g according to seismic zone factor:**

Seismic zone factor	II	III	IV	V
z	0.10	0.16	0.24	0.36

Stress Reduction Factor, Υ_d	
1-0.00765**z**	$0 < \mathbf{z} \leq 9.15$m
1.174-0.0267**z**	9.15m < **z** ≤ 23.0m

***z - depth below ground level (in metres)**

***if FOS<1, soil is assumed to be liquefy**

	Depth (m)	Factor Of Safety, FOS	Susceptibility against liquefaction
BoreHole No-03	4.00	4.59	Not Susceptible to liquefaction
	5.00	1.40	Not Susceptible to liquefaction
	6.00	0.66	Susceptible to liquefaction
	8.00	0.82	Susceptible to liquefaction
	11.5	2.74	Not Susceptible to liquefaction
	19.0	1.74	Not Susceptible to liquefaction

	NAME OF WORK: GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT	BORE HOLE NO. BH-05

LIQUEFACTION CALCULATIONS as per IS 1893:part-01:2016

$$FS = \frac{CRR}{CSR},$$

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

No. of layers	Soil Description	Depth		g_d	N_{avg}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, P_a (Pa)
		From (m)	To (m)				
Layer No.1	Clayey gravel	0.00	-3.00	17.80	17	23400	100658
Layer No.2	Sandy clayey silt	-3.00	-5.00	18.20	14	41000	100658
Layer No.3	Silty sand	-5.00	-7.00	18.70	39	60900	100658
Layer No.4	Sandy silt	-7.00	-10.0	18.40	18	84000	100658
Layer No.5	Silty sand	-10.0	-11.5	18.40	15	96600	100658
Layer No.6	Silty sand	-11.5	-11.9	17.90	100	94010	100658

CRR (Cyclic Resistance Ratio) Calculations

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2} - \frac{1}{200}$$

$$(N_1)_{60CS} = \alpha + \beta(N_1)_{60},$$

$$(N_1)_{60} = C_N N_{60},$$

$$C_N = \sqrt{\frac{P_a}{\sigma'_{vo}}} \le 1.7,$$

$$N_{60} = NC_{60},$$

$$C_{60} = C_{HT}C_{HW}C_{SS}C_{RL}C_{BD}.$$

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***Since, SPT equipment are of specified recommendations N_{60} = N obtained**

ALPHA, α	BETA, β	Fineness Content, FC
0	1	FC ≤ 5%
$e^{(1.76-(190/FC2))}$	$0.99+(FC^{1.5}/1000)$	5% < FC < 35%
0.5	1.2	FC ≥ 35%

N1 60 CS Calculations:

Layer	N_{60}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	C_N	$(N_1)_{60}$	Fineness Content, FC (%)	ALPHA, α	BETA, β	$(N_1)_{60CS}$
Layer No.1	17	23400	100658	1.70	28.90	26	4.388	1.123	**36.83**
Layer No.2	14	41000	100658	1.57	21.94	32	4.828	1.171	**30.52**
Layer No.3	39	60900	100658	1.29	50.14	19	3.434	1.073	**57.22**
Layer No.4	18	84000	100658	1.09	19.70	46	0.500	1.200	**24.14**
Layer No.5	15	96600	100658	1.02	15.31	33	4.882	1.180	**22.94**
Layer No.6	100	94010	100658	1.03	103.48	37	0.500	1.200	**124.67**

A	B	C	D
$\frac{1}{34-(N_1)_{60CS}}+$	$\frac{(N_1)_{60CS}}{135}+$	$\frac{50}{[10\times(N_1)_{60CS}+45]^2}-$	$-\frac{1}{200}$

$CRR_{7.5}$ VALUES

A	B	C	D	$CRR_{7.5}$
-0.3533	0.2728	0.0003	0.005	-0.0852
0.2870	0.2260	0.0004	0.005	0.5085
-0.0431	0.4239	0.0001	0.005	0.3760
0.1015	0.1789	0.0006	0.005	0.2759
0.0904	0.1699	0.0007	0.005	0.2561
-0.0110	0.9235	0.0000	0.005	0.9075

K Sigma Calculations

$$K_\sigma = \left(\sigma'_{vo}/P_a\right)^{(f-1)}$$

Relative Density (%)	*f*
40 - 60	0.8 ~ 0.7
60 - 80	0.7 ~ 0.6
(f-1)	-0.3

Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	K_σ
23400	100658	1.5491
41000	100658	1.3092
60900	100658	1.1627
84000	100658	1.0558
96600	100658	1.0124
94010	100658	1.0207

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CRR (Cyclic Resistance Ratio) Calculations:

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

Layers	$CRR_{7.5}$	MSF	K_{σ}	K_{α}	CRR
Layer No.1	-0.0852	0.9996	1.5491	1.0000	-0.1319
Layer No.2	0.5085	0.9996	1.3092	1.0000	0.6655
Layer No.3	0.3760	0.9996	1.1627	1.0000	0.4370
Layer No.4	0.2759	0.9996	1.0558	1.0000	0.2912
Layer No.5	0.2561	0.9996	1.0124	1.0000	0.2591
Layer No.6	0.9075	0.9996	1.0207	1.0000	0.9259

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

CSR (Cyclic Stress Ratio) Calculations:

Layers	a_{max}/g	Total Vertical Overburden Pressure, σ_{vo} (Pa)	Effective Overburden Pressure, σ'_{vo} (Pa)	Stress Reduction Factor, Υ_d	CSR
Layer No.1	0.16	53400	23400	0.9771	0.2319
Layer No.2	0.16	91000	41000	0.9618	0.2220
Layer No.3	0.16	130900	60900	0.9465	0.2116
Layer No.4	0.16	184000	84000	0.9070	0.2066
Layer No.5	0.16	211600	96600	0.8670	0.1975
Layer No.6	0.16	213010	94010	0.8563	0.2018

*** peak ground acceleration (PGA) is not available, take a_{max}/g according to seismic zone factor:**

Seismic zone factor	II	III	IV	V
z	0.10	0.16	0.24	0.36

Stress Reduction Factor, Υ_d	
1-0.00765**z**	$0 < \mathbf{z} \leq 9.15$m
1.174-0.0267**z**	9.15m < **z** ≤ 23.0m

***z - depth below ground level (in metres)**

***if FOS<1, soil is assumed to be liquefy**

	Depth (m)	Factor Of Safety, FOS	Susceptibility against liquefaction
BoreHole No-05	3.00	-0.57	Susceptible to liquefaction
	5.00	3.00	Not Susceptible to liquefaction
	7.00	2.07	Not Susceptible to liquefaction
	10.0	1.41	Not Susceptible to liquefaction
	11.5	1.31	Not Susceptible to liquefaction
	11.9	4.59	Not Susceptible to liquefaction

	NAME OF WORK: GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT	BORE HOLE NO. BH-06

LIQUEFACTION CALCULATIONS as per IS 1893:part-01:2016

$$FS = \frac{CRR}{CSR},$$

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

No. of layers	Soil Description	Depth		g_d	N_{avg}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, P_a (Pa)
		From (m)	To (m)				
Layer No.1	Sandy Clayey silt	0.00	-4.00	19.20	28	36800	100658
Layer No.2	Silty sand	-4.00	-7.00	16.70	16	46900	100658
Layer No.3	Snady clayey silt	-7.00	-8.00	17.00	12	56000	100658
Layer No.4	Silty sand	-8.00	-9.00	16.40	13	57600	100658
Layer No.5	Sandy silt	-9.00	-13.0	16.60	9	85800	100658
Layer No.6	Silty sand	-13.0	-17.5	17.00	14	122500	100658
Layer No.7	Sandy silt	-17.5	-19.0	17.00	25	133000	100658
Layer No.8	Silty sand	-19.0	-19.5	17.00	100	136500	100658

CRR (Cyclic Resistance Ratio) Calculations

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2} - \frac{1}{200}$$

$$(N_1)_{60CS} = \alpha + \beta(N_1)_{60},$$

$$(N_1)_{60} = C_N N_{60},$$

$$C_N = \sqrt{\frac{P_a}{\sigma'_{vo}}} \le 1.7,$$

$$N_{60} = NC_{60},$$

$$C_{60} = C_{HT}C_{HW}C_{SS}C_{RL}C_{BD}.$$

***Since, SPT equipment are of specified recommendations N_{60} = N obtained**

ALPHA, α	BETA, β	Fineness Content, FC
0	1	FC ≤ 5%
$e^{\wedge(1.76-(190/FC2))}$	$0.99+(FC^{1.5}/1000)$	5% < FC < 35%
0.5	1.2	FC ≥ 35%

N1 60 CS Calculations:

Layer	N_{60}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	C_N	$(N_1)_{60}$	Fineness Content, FC (%)	ALPHA, α	BETA, β	$(N_1)_{60CS}$
Layer No.1	28	36800	100658	1.65	46.31	37	0.500	1.200	**56.07**
Layer No.2	16	46900	100658	1.47	23.44	24	4.179	1.108	**30.14**
Layer No.3	12	56000	100658	1.34	16.09	52	0.500	1.200	**19.81**
Layer No.4	13	57600	100658	1.32	17.19	42	0.500	1.200	**21.12**
Layer No.5	9	85800	100658	1.08	9.75	40	0.500	1.200	**12.20**
Layer No.6	14	122500	100658	0.91	12.69	16	2.767	1.054	**16.14**
Layer No.7	25	133000	100658	0.87	21.75	53	0.500	1.200	**26.60**
Layer No.8	100	136500	100658	0.86	85.87	45	0.500	1.200	**103.55**

A	B	C	D
$\frac{1}{34-(N_1)_{60CS}}+$	$\frac{(N_1)_{60CS}}{135}+$	$\frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2}-$	$-\frac{1}{200}$

$CRR_{7.5}$ VALUES

A	B	C	D	$CRR_{7.5}$
-0.0453	0.4153	0.0001	0.005	0.3652
0.2591	0.2233	0.0004	0.005	0.4778
0.0705	0.1467	0.0008	0.005	0.2130
0.0777	0.1565	0.0008	0.005	0.2299
0.0459	0.0904	0.0018	0.005	0.1330
0.0560	0.1196	0.0012	0.005	0.1718
0.1351	0.1970	0.0005	0.005	0.3277
-0.0144	0.7670	0.0000	0.005	0.7477

K Sigma Calculations

$$K_\sigma = \left(\sigma'_{vo}/P_a\right)^{(f-1)}$$

Relative Density (%)	*f*
40 - 60	0.8 ~ 0.7
60 - 80	0.7 ~ 0.6
(f-1)	-0.3

Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	K_σ
36800	100658	1.3524
46900	100658	1.2575
56000	100658	1.1923
57600	100658	1.1823
85800	100658	1.0491
122500	100658	0.9428
133000	100658	0.9198
136500	100658	0.9127

CRR (Cyclic Resistance Ratio) Calculations:

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

Layers	$CRR_{7.5}$	MSF	K_{σ}	K_{α}	CRR
Layer No.1	0.3652	0.9996	1.3524	1.0000	0.4937
Layer No.2	0.4778	0.9996	1.2575	1.0000	0.6006
Layer No.3	0.2130	0.9996	1.1923	1.0000	0.2539
Layer No.4	0.2299	0.9996	1.1823	1.0000	0.2717
Layer No.5	0.1330	0.9996	1.0491	1.0000	0.1395
Layer No.6	0.1718	0.9996	0.9428	1.0000	0.1619
Layer No.7	0.3277	0.9996	0.9198	1.0000	0.3013
Layer No.8	0.7477	0.9996	0.9127	1.0000	0.6821

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

CSR (Cyclic Stress Ratio) Calculations:

Layers	a_{max}/g	Total Vertical Overburden Pressure, σ_{vo} (Pa)	Effective Overburden Pressure, σ'_{vo} (Pa)	Stress Reduction Factor, Υ_d	CSR
Layer No.1	0.16	76800	36800	0.9694	0.2104
Layer No.2	0.16	116900	46900	0.9465	0.2453
Layer No.3	0.16	136000	56000	0.9388	0.2371
Layer No.4	0.16	147600	57600	0.9312	0.2482
Layer No.5	0.16	215800	85800	0.8269	0.2163
Layer No.6	0.16	297500	122500	0.7068	0.1785
Layer No.7	0.16	323000	133000	0.6667	0.1684
Layer No.8	0.16	331500	136500	0.6534	0.1650

*** peak ground acceleration (PGA) is not available, take a_{max}/g according to seismic zone factor:**

Seismic zone factor	II	III	IV	V
z	0.10	0.16	0.24	0.36

Stress Reduction Factor, Υ_d	
1-0.00765**z**	$0 < \mathbf{z} \leq 9.15$m
1.174-0.0267**z**	9.15m < **z** ≤ 23.0m

***z - depth below ground level (in metres)**

***if FOS<1, soil is assumed to be liquefy**

	Depth (m)	Factor Of Safety, FOS	Susceptibility against liquefaction
BoreHole No-06	4.00	2.35	Not Susceptible to liquefaction
	7.00	2.45	Not Susceptible to liquefaction
	8.00	1.07	Not Susceptible to liquefaction
	9.00	1.09	Not Susceptible to liquefaction
	13.0	0.64	Susceptible to liquefaction
	17.5	0.91	Susceptible to liquefaction
	19.0	1.79	Not Susceptible to liquefaction
	19.5	4.13	Not Susceptible to liquefaction

NAME OF WORK: GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

Liquefaction Analysis Results

	Depth (m)		Factor Of Safety, FOS	Susceptibility against liquefaction
	To (m)	From (m)		
BoreHole No-03	0.00	4.00	4.59	Not Susceptible to liquefaction
	4.00	5.00	1.40	Not Susceptible to liquefaction
	5.00	6.00	0.66	Susceptible to liquefaction
	6.00	8.00	0.82	Susceptible to liquefaction
	8.00	11.5	2.74	Not Susceptible to liquefaction
	11.5	19.0	1.74	Not Susceptible to liquefaction

	Depth (m)		Factor Of Safety, FOS	Susceptibility against liquefaction
	To (m)	From (m)		
BoreHole No-05	0.00	3.00	-0.57	Susceptible to liquefaction
	3.00	5.00	3.00	Not Susceptible to liquefaction
	5.00	7.00	2.07	Not Susceptible to liquefaction
	7.00	9.00	1.41	Not Susceptible to liquefaction
	9.00	10.00	1.31	Not Susceptible to liquefaction
	10.00	11.50	4.59	Not Susceptible to liquefaction

If FS < 1, then the soil is assumed to liquefy as per IS 1893 (Part - 1) : 2016

NAME OF WORK: GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT

Liquefaction Analysis Results

	Depth (m)		Factor Of Safety, FOS	Susceptibility against liquefaction
	To (m)	From (m)		
BoreHole No-06	0.00	4.00	2.35	Not Susceptible to liquefaction
	4.00	7.00	2.45	Not Susceptible to liquefaction
	7.00	8.00	1.07	Not Susceptible to liquefaction
	8.00	9.00	1.09	Not Susceptible to liquefaction
	9.00	13.0	0.64	Susceptible to liquefaction
	13.0	17.5	0.91	Susceptible to liquefaction
	17.5	19.0	1.79	Not Susceptible to liquefaction
	19.0	19.5	4.13	Not Susceptible to liquefaction

If FS < 1, then the soil is assumed to liquefy as per IS 1893 (Part - 1) : 2016

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TABLE NO: 8

SOIL INVESTIGATION FOR THE NEW 1650 MTPD NPK PLANT

CHEMICAL ANALYSIS ON WATER

BH No.	Test Results			
	Chlorides (PPM)	Salinity (PPM)	Sulphates (PPM)	PH Value
BH-03	15.0	27.09	Nil	7.0
BH-04	14.0	25.29	Nil	7.0
BH-05	13.0	23.48	Nil	7.0
BH-06	14.0	25.29	Nil	7.0

Permissible Limit as per IS 456:2000

	For PCC	For RCC
Chlorides (PPM)	**2000**	**500**
Sulphates (PPM)	**400**	**400**
Ph Value	**6 to 9**	**6 to 9**

TABLE NO: 9

SOIL INVESTIGATION FOR THE NEW 1650 MTPD NPK PLANT

CHEMICAL ANALYSIS ON SOIL

BH No.	Depth below EGL (m)	Chlorides (%)	Sulphate (%)	Calcium Carbonate (%)	pH Value
BH-03	1.00	0.177	0.07	2.06	6.5
	7.00	0.650	0.14	2.20	7.0
BH-04	10.0	0.56	0.10	2.48	7.0
	20.5	0.53	0.09	3.12	6.5
BH-05	1.00	0.53	0.12	2.38	6.5
	10.0	0.63	0.18	2.83	7.0
BH-06	1.00	0.49	0.11	3.92	7.0
	11.5	0.63	0.14	3.20	6.5

TYPICAL CALCULATION FOR BORED CAST IN SITU PILES
(AS PER IS: 2911 (PART-1/SEC2)-2010)

CALCULATION FOR PILE CAPACITY IN COMPRESSION

LOCATION: NEW 165 MTPD NPK PLANT

Diameter of pile **: 100cm**

Depth of Pile **: 12.6m and ½ D socketed in to the rocky strata**

Borehole No. **: BH-05**

CALCULATION FOR END BEARING:-

End Bearing : Ap (0.5 $D\gamma N_\gamma$ + PD Nq)

Where,

Ap : Cross sectional area of pile toe in cm^2

D : stem diameter in cm

γ : Effective unit weight of soil at pile toe in Kgf/cm^3

P_D : effective overburden pressure at pile toe in Kgf/cm^2

N_γ, Nq : Bearing capacity factors depending upon the angle of Internal friction

Effective over Burden Pressure at pile tip, PD (15 to 20 times the diameter of pile)

: 18 * 100cm = 18m

: (4.80 * 0.80) + (7.10 *0.833) = 9.76 * 10^{-1} Kg/cm^2

N_γ : 109.41 (For $\Phi = 40^o$) from Table No.1 of IS 6403:1981

Nq : 135 (From fig 1. of IS 2911(part1/sec2)-1979

End Bearing : $\pi/4(100^2)$ [(0.5 * 100 * 1.20 * 10^{-3} * 109.41) + (9.76 * 10^{-1} *136)]

: **1094.10 T**

CALCULATION FOR FRICTIONAL RESISTENCE

For Cohesion less soil : $K^* P_{Di} * \tan \Phi * Asi$

K : Coefficient of Earth Pressure

P_{Di} : Effective overburden pressure in Kg/cm2 for the ith layer where I varies from 1 to n

Asi : Surface area of pile stem in cm^2

Φ : Angle of wall friction between pile and soil, in degrees.

For Cohesive soil : $\alpha * C * As$

α : Reduction Factor

C : Average cohesion through out the length of pile in Kg/cm^2

As : Surface area of pile shaft in cm^2

From 2.8m to 4.80(Cohesive Soil)

: $0.40 * 0.46 * \pi * 100 * 200$

= 11.56 T

From 4.80m to 11.5m (Cohesion less Soil)

: $1.50 * 6.63 * 10^{-1} * \pi * 100 * 670 * \tan 25$

= 97.62 T

From 11.50m to 11.9m (Cohesion less Soil)

: $1.50 * 9.76 * 10^{-1} * \pi * 100 * 40 * \tan 36$

= 13.37 T

From 11.9 m to 12.4(0.5 d in rocky strata)

: $1.50 * 9.76 * 10^{-1} * \pi * 100 * 50 * \tan 40$

= 19.3 T

Total Capacity	: End Bearing + Total Friction
	: (1094.44 + 11.56 + 97.62 + 13.37 + 19.30)
	= 1**236.29 T**
Factor of Safety	: 2.5
Safe Capacity	= Total Capacity /Factor of Safety
	= 1236.29 / 2.5
	= 494.51 T
Self weight of the pile	**:** $\pi/4 * D^2 * 2.5 * H$
	: $\pi/4 * (1)^2 * 2.5 * 12.4$
	: **24.34 T**
Net Safe Capacity	**: Safe Capacity – Self weight of the pile**
	= 494.51 – 24.34
	= 470.17 T

SAY 470 Tones

TYPICAL CALCULATION FOR BORED CAST IN SITU PILES
(AS PER IS: 2911 (PART-1/SEC2)-2010)

CALCULATION FOR PILE CAPACITY IN TENSION

LOCATION: NEW 165 MTPD NPK PLANT

Diameter of pile **: 100cm**

Depth of Pile **: 12.6m and ½ D socketed in to the rocky strata**

Borehole No. **: BH-05**

CALCULATION FOR FRICTIONAL RESISTENCE

For Cohesion less soil **: $K^* P_{Di}$ * tan Φ * Asi**

K : Coefficient of Earth Pressure

$P_{Di:}$: Effective overburden pressure in Kg/cm2 for the ith layer where I varies from 1 to n

Asi : Surface area of pile stem in cm^2

Φ : Angle of wall friction between pile and soil, in degrees.

For Cohesive soil **: $\alpha * C * As$**

α : Reduction Factor

C : Average cohesion through out the length of pile in Kg/cm^2

As : Surface area of pile shaft in cm^2

From 2.8m to 4.80(Cohesive Soil)

: 0.40 *0.46 * π * 100 * 200

= 11.56 T

From 4.80m to 11.5m (Cohesion less Soil)

: 1.50 * 6.63 * 10^{-1} * π * 100 * 670 * tan25

= 97.62 T

From 11.50m to 11.9m (Cohesion less Soil)

: $1.50 * 9.76 * 10^{-1} * \pi * 100 * 40 * \tan 36$

= 13.37 T

From 11.9 m to 12.4(0.5 d in rocky strata)

: $1.50 * 9.76 * 10^{-1} * \pi * 100 * 50 * \tan 40$

= 19.3 T

Total Frictional Resistance : (11.56 + 97.62 + 13.37 + 19.3)

= 141.85 T

Self Weight of the Pile : $\pi /4 * D^2 * H * 2.5$

: $\pi /4 * (1)^2 * 12.4 * 2.5$

= 24.34 T

Total Tension Capacity = Total frictional Resistance + Self weight of the pile

= 141.85 + 24.34

= **166.19 T**

Factor of Safety : 3.0

Safe Capacity = Total Tension Capacity / factor of safety

= 166.19/3

= 55.39 T

SAY 55 Tones

Typical Calculation for Lateral Load Capacity (As per IS 2911(Part1/sec2):2010)
(Considering Liquefaction)

LOCATION: Soil investigation work for the proposed New 1650 MTPD NPK Plant

1.0 Considerations:-

1. Grade of Concrete : M-25
2. Grade of Steel : Fe 500 D
3. Pile Diameter : 100 CM
4. Depth of liquefiable stratum, L1 : 3.0m

Calculation based on Annex– C (Cl.6.5.2) of IS 2911(Part1/Sec2):2010

Assuming the Pile as fixed head conditions,

From C-2.3.2 of Annex-C, Stiffness Factor, R1 in metres is calculated as

$$R1 = 4\sqrt{E*I/KB}$$

$$K = (k1/1.5) * (0.3/B)$$

Where,

k1 : 36×10^3 KN/m^3 (From Table No.4, Annex –C in IS: 2911(part-1/sec-2) : 2010- For stiff clay)

K : $(36 \times 10^3 / 1.5) * (0.30/1)$

: 7200

E : Youngs modulus of M25 concrete

: $5000\sqrt{fck}$ = 25000×10^3KN/m^2

I : Moment of Inertia

: $\pi \times D^4/64 = 0.049$ m^4

T : $4\sqrt{25000 \times 10^3 \times 0.049 / (7200 * 1.0)} = 3.61$ m

L1 / T = 3.0 / 3.61 = 0.83

From fig.4, Annex-C in IS: 2911(part-1/sec-2):2010

For 'L1/T' of 0.83 = Zf/T : 2.05 (For fixed head piles in sand)

Zf, Length of Fixity : 2.05 x 3.61 = 7.4005 m

Maximum deflection of Pile, Y = 5mm (As per cl. No.8.4.1 of IS 2911(Part-4): 2013

$Y = [H (e + Zf)^3 / 12 E I] 10^3$

$H = 0.005 \times 12 \times 25000 \times 10^3 \times 0.049 / (3 + 7.4005)^3$

= 65.33 KN

= 6.53 T

Say 6.50 Tons

Project: Soil Investigation work for the proposed Square Footing

Project : Soil investigation work for the New 1650 MTPD NPK Plant

Size of Footing : 1.50m x 1.50 m

Depth of Footing : 2.00 m

Bore Hole No. consider for design : BH-05

SBC from Shear Criterion(As per IS 6403-1981)

These parameters are considered for calculation:-

1	Cohesion	C	= 0.19	Kg/cm^2
2	Angle of internal friction	Φ	= 23	degree
	In case of local shear failure,	$\Phi'=\tan^{-1} 0.67 \tan\Phi$	= 15.75	
3	Bearing capacity factors , taken from Table No.1 of IS 6403-1981, Clause 5.1.1			
		Nc	= 11.86	
		Nq	= 4.16	
		$N\gamma$	= 3.12	
4	Shape factors , taken from Table No.2 of IS 6403-1981			
		Sc	= 1.30	
		Sq	= 1.20	
		$S\gamma$	= 0.80	
		$\sqrt{N\Phi} = \tan(45 + \Phi/2)$	= 1.511	
5	Depth factors as per clause 5.1.2.2 of IS 6403-1981			
		$dc = 1 + 0.2\, D\, \sqrt{N\Phi} / B$	= 1.4029	
		$dq = 1 + 0.1D\, \sqrt{N\Phi} / B$	= 1.2015	
		$d\gamma = 1 + 0.1\, D\, \sqrt{N\Phi} / B$	= 1.2015	
6	Depth of footing	D	= 200	cm
7	Width of footing	B	= 150	cm
8	Bulk weight of foundation	γ	= 0.78	gm/cc
9	Effective surcharge at base level of foundation, $q = \gamma D$		= 156	
10	Water correction factor	$w' = 0.5 (1 + z w^2) / B$	= 0.50	
11	Factor of Safety		= 3	
12	Bearing capacity,	$qd = 1/3 (C \times 10^3 \times Nc \times Sc \times dc \times ic + \gamma \times D (Nq-1) \times Sq \times dq \times iq + 0.5\, B \times \gamma \times N\gamma \times S\gamma \times d\gamma \times i\gamma \times w')$		
			= 16.2 T/M^2	

Project: Soil Investigation work for the New 1650 MTPD NPK Plant

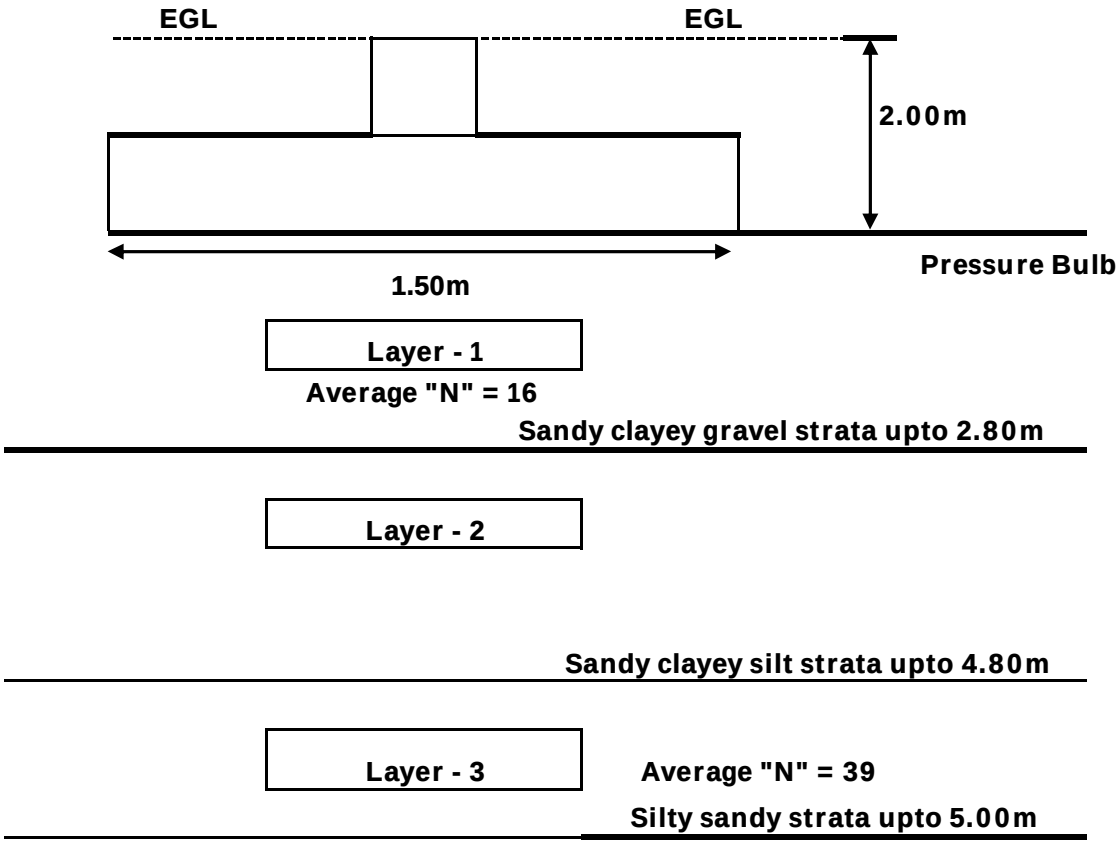
Size of Footing : 1.50 m x 1.50m

Depth of Footing : 2.00m

Bore Hole No. considered for Design : BH-05

SBC from settlement criterion(As per IS 8009(part-1)-1976)

Capacity Calculation for 50mm Settlement



The pressure bulb influences the soil upto 5.0m (2B) below the footing. It can be observed that soil strata upto 2.80m is medium sandy clayey gravel. From 2.80m to 4.80m medium sandy clayey silt is observed. Below this depth again silty sandy stratum of medium dense nature is found.

Layer - 1 (From 2.00m to 2.80m)

Average N value below the founding stratum in the zone of influence = 16

Corrected N value is calculated as [15+ ((N -15)/2] = [15 +(16-15)/2]

= 15.5

Settlement from graph in **Fig. 9** of IS 8009-Part-1 = 0.016m

For 1.50m width of square footing at an average N value of 16, settlement is 0.016m for 1 kg/cm^2

Maximum permisible settlement considered in this layer = 15mm

Bearing pressure corresponding to 15mm settlement = 9.38 t/m^2

Layer -2 (From 2.80m to 4.80m)

Assume settlement	: 30 mm
Depth of Footing	: 2.00m
Width of footing	: 1.50m
Considering pressure bulb, 2B=Ht	: 5.00m
Liquid Limit	: 43
Specific gravity	: 2.47
Dry density	: 1.30 gm/cc
Coefficient of consolidation, $Cc=0.009(W_L-10)$	: 0.297
Initial voids Ratio , $e_0 = (G/r_d)-1$	: 0.90
Overburden Pressure, P	: 3.004 T/M^2
Pressure Increment, Log (P + p)/ P	: 0.742 T/M^2
Safe Bearing Pressure, $(p*(B+Ds)^2/B^2$	: 3.59 T/M^2

Layer - 3 (From 4.80m to 5.00m)

Average N value below the founding stratum in the zone of influence = 39

Corrected N value is calculated as [15+ ((N -15)/2] = [15 +(39-15)/2]

= 27

Settlement from graph in **Fig. 9** of IS 8009-Part-1 = 0.008m

For 1.50m width of square footing at an average N value of 39, settlement is 0.008m for 1 kg/cm^2

Maximum permisible settlement considered in this layer = 5mm

Bearing pressure corresponding to 5mm settlement = 6.25 t/m^2

Hence Total Bearing pressure for 50mm settlement = 9.38 + 3.59 + 6.25

= 19.22 T/M^2, Say 19 T/M^2

The Least value from Shear / settlement Criterion is taken as the Safe Bearing Capacity

Typical Calculation for Strip Footing

Soil Investigation work for the New 1650 MTPD NPK Plant

Width of Footing : 0.80 m

Depth of Footing : 1.00m

Bore Hole No. Considered for Design : BH-5

Calculation of Bearing Capacity from Shear Criterion(As per IS 6403:1981)

1	*Cohesion*	*C*	*0.19*	*Kg/cm2*
2	*Angle of internal friction*	*Φ*	*23*	*degree*
	In case of local shear failure,	$\Phi'=\tan^{-1} 0.67 \tan\Phi$	= 15.75	
2	*Bearing capacity factors,*	*Nc*	*11.860*	
		Nq	*4.160*	
		Nγ	*3.12*	
3	*Shape factors*	*Sc*	*1*	
		Sq	*1*	
		Sγ	*1*	
		√NΦ=tan(45+Φ/2)	*1.511*	
4	*Depth factors*	*dc=1+0.2D√NΦ/B*	*1.3777*	
		dq=1+0.1D√NΦ/B	*1.1889*	
		dγ=1+0.1D√NΦ/B	*1.1889*	
6	*Depth of footing*	*D*	*100*	*cm*
7	*Width of footing*	*B*	*80*	*cm*
8	*Bulk weight of foundation*	*γ*	*0.78*	*gm/cc*
9	*Effective surcharge at base level of foundation*	*q=γD*	*78*	
10	*Depth of water table*		*-*	*cm*
11	*Water correction factor*	*w'=0.5(1+zw2)/B*	*0.50*	
12	***Safe bearing capacity***	***qds=1/3(CNc103Scdcic+γD(Nq-1)Sqdqiq+0.5BγNγSγdγiγw')***	***11.40***	***T/m²***

Calculation of bearing Capacity from settlement criterion(AS per IS 8009(Part-1)-1976

*1	*Average N value below the foooting*	*16*	
2	*Correction (if N>15) i.e. [15 + (N-15)/2]*	*15.5*	
*3	*Settlement for unit pressure from fig.9 of IS 8009(Part-1)-1976*	*0.014*	*m*

For 0.80m width of strip footing at an average corrected ' N ' value of 15.5, settlement is 0.014m for 1 kg/cm2

4	*By taking maximum permissible settlement as 50mm*	*50.00*	*mm*
5	*Bearing pressure*	*35.71*	*T/m2*

Bearing pressure for 50m settlement is 35 t/m2

Hence the least value from shear /settlement is taken as the safe Bearing capacity

i.e/ 11.0 T /m^2

ANNEXURE – B

RAW MATERIAL STORAGE GODOWN

(BH-01 & BH-02)

11.0 SOIL DESCRIPTION

11.1 Soil Stratification

11.1.1 The soil, in general, at the subject site is lateritic in nature which in local terminology is also called as red earth and / or murrum soils based on the composition – variations in the individual components of gravel, sand and silt & clay. The general terrain of this project area is of plain with not much of undulations.

11.1.2 **BH - 1 :** The top layer of this borehole is consisting of 3.20m thick gravely silty sand layer of non-plastic nature which is followed by 1.20m thick hard laterite strata. The next layer is of sandy clayey silt of high plasticity from 4.40m to 22.0m. Below this is a thin layer of silty sand of clay with 0.60m thickness. The final layer consists of 7.40m soft rock and the borehole is terminated at 30.0m.

11.1.3 **BH - 2 :**The first layer of the borehole consists of 4.00m of gravely silty sand of non-plastic nature. The following layer is identified as a 2.00m thick hard laterite which is followed by 2.80m clayey sand of low plasticity. After this is a 2.30m thick layer of clayey silt of high plasticity is encountered. The consecutive layer comprises of 20.90m thick silty sand of non-plastic nature with a layer of 7.00m thick clayey silt of high plasticity. The borehole is terminated at 34.0m after drilling 2.0 mtr in rocky strata with core barrel.

11.2 CROSS SECTION PROFILE & DESIGN BORELOG:

Based on the individual borelogs at the site, a cross section profile is made as given in page No.75 which gives an idea of the changes in the strata including the rock profile variations acrossthe length and width of the site. Details of Borehole 01 is considered as the Design Borelog as it has weaker properties as compared to the other borehole details.

12 .0 DISCUSSION ON TYPE OF FOUNDATION

12.1 It is understood from the Clients that the proposed facilities at this area is the Raw Material Storage Godown. The structure is likely to induce more of lateral loads /moments at the ground level in addition to the vertical loads.

12.2 From the borelogs & results tables of the borehole study, it can be observed that the soils are basically clayey and sandy soils with medium to dense in nature due to variations in N values. Rock is available at varying depths from the ground level.

12.3 The project area is in Seismic Zone III of the Map of India. In case the soils are induced to seismic loadings there can be liquefaction in the sandy natured soils below. This may cause undue settlements to the structure in case if shallow foundations are provided. The calculations of liquefaction potential are done and provided from Page N0.134 to 137 of this report.

12.4 Hence it is found necessary that the loads coming from the structure need to be transferred to a firm stratum. Based on the soil condition and the availability of rocky strata, pile foundation shall be a better foundation system for the proposed structure with these piles resting in the rocky strata available below.

12.5 RCC bored cast in situ piles by DMC method installed as per the relevant clauses of IS 2911 : Part 1 / Sec 2 - 2010 shall be provided as the foundation. It is suggested that piles shall be socketed into rocky strata by one time the diameter of piles (1 D). Based on the variation in the profile of rocky strata, the length of piles is expected to be about 22.6mtr to 32.0mtr below the existing ground level in addition to the socket length. This strata can be identified by conducting an SPT and socketing can be started if N value is > 100. Socketing by one time the diameter of piles (1D) is to ensure the end bearing component of the carrying capacity. The safe carrying capacities for different diameters of piles calculated as per relevant clauses of above said IS Code are tabulated and given below in Table **No.13.1**. A factor of safety of 2.5 is considered for calculating the safe capacities.

13.0 FOUNDATION SUGGESTIONS :

13.1 Pile Foundation Suggestions:

13.1.1 Considering the nature of loads expected at the ground level from the proposed structure and the nature of soils available at the subject location, pile foundation installed by bored cast in situ method as per the relevant clauses of IS : 2911 – Part 1 / Sec 2 – 2010 shall be a feasible foundation system. These pile foundations of suitable diameter shall be bored through all types of soils and terminated after seating in the rock strata. This facilitates us

to take the advantage of generating an end bearing component of the carrying capacity in addition to the frictional component along the length of the pile.

13.1.2 Hence, RCC bored cast in situ piles by DMC method installed as per the relevant clauses of IS 2911 Part1/ Sec 2 - 2010 shall be provided as the foundation. The pile capacities are worked out for different diameters of piles considering the termination of 1 times D in rocky strata. Based on the variation in the profile of rocky strata, the length of piles is expected to be about 22.60 mtr to 32.0mtr below the existing ground level in addition to the socket length. A factor of safety of 2.5 is considered for calculating the safe capacities. The safe carrying capacities for different diameters of piles are tabulated as given below in **Table No.13.1**

Table No: 13.1

Dia. Of Pile	Safe Capacity (T)		
	Compression	Tension	Shear
60 cms	160	35	5.5
70 cms	230	43	7.5
80cms	300	53	9.0
90 cms	390	64	11.0
100 cms	485	77	13.0

13.1.3. It is also suggested that the carrying capacities of the piles given above shall be verified by conducting pile load test as per relevant clauses of IS 2911(Part-4)-2013.

13.2 Shallow Foundations Suggestions

13.2.1 In the areas where lightly loaded structures are likely to come up within the project area, shallow foundations like individual square footing / strip footing may be proposed.

13.2.2 Bearing capacity of different types of footings are worked out as per relevant clauses of Indian Standard Code of Practice IS: 6403 - 1981 for shear criterion and IS: 8009 (Part – I) – 1976 for settlement criterion. Values calculated for different sizes of footing to be placed at different depths from the existing ground level are as given in the table No 13.2.1.

The bearing capacities were calculated from shear criterion and with corrected N value for 50mm settlement after considering the water table correction factor.

Table No: 13.2.1 (Square footing)

Size of footing (m)	Depth below EGL	Bearing capacity from shear criterion (T/M^2)	Bearing capacity from settlement criterion (T/M^2)
1.0 x 1.0	1.00m	9.00	40.0
	1.50m	12.0	40.0
	2.00m	15.5	40.0
	2.50m	19.5	40.0
	3.00m	24.0	35.0
1.50 x 1.5	1.00m	8.50	34.0
	1.50m	11.5	34.0
	2.00m	14.5	30.0
	2.50m	18.0	26.0
	3.00m	21.5	22.5
2.0 x 2.0	1.00m	8.50	28.5
	1.50m	11.5	24.5
	2.00m	14.5	21.0
	2.50m	17.5	18.0
	3.00m	20.5	14.5
2.5 x 2.5	1.00m	9.00	25.0
	1.50m	11.5	22.0
	2.00m	14.5	16.5
	2.50m	17.5	13.5
	3.00m	20.0	10.0

	1.00m	9.50	19.0
	1.50m	12.5	16.0
3.0 x 3.0	2.00m	14.5	13.0
	2.50m	17.0	10.0
	3.00m	20.0	7.0

Table No: 13.2.2 (Strip footing)

Size of footing (m)	Depth below EGL	Bearing capacity from shear criterion (T/M^2)	Bearing capacity from settlement criterion (T/M^2)
	1.00m	7.50	45.0
	1.50m	10.5	45.0
0.80	2.00m	14.0	45.0
	2.50m	17.5	45.0
	3.00m	22.0	45.0
	1.00m	7.50	45.0
	1.50m	10.0	45.0
1.00	2.00m	13.0	45.0
	2.50m	16.5	45.0
	3.00m	20.5	42.0
	1.00m	7.50	37.0
	1.50m	10.0	37.0
1.20	2.00m	13.0	37.0
	2.50m	16.0	33.0
	3.00m	19.5	28.0
	1.00m	7.50	34.0
	1.50m	10.0	34.0
1.50	2.00m	12.5	32.0
	2.50m	15.5	26.0
	3.00m	18.5	22.5

2.00	1.00m	8.0	29.0
	1.50m	10.0	26.5
	2.00m	12.5	23.0
	2.50m	15.0	17.5
	3.00m	18.0	14.0
2.50	1.00m	8.0	25.0
	1.50m	10.5	22.0
	2.00m	12.5	19.0
	2.50m	15.0	16.5
	3.00m	17.5	13.0

13.2.3 It is the general practice that the least value calculated from the shear criterion and the settlement criterion is considered as the safe bearing capacity(SBC) for the proposed size of footing placed at the suggested depth.

14.0 METHOD OF COMPUTING BEARING CAPACITY FOR SHALLOW FOUNDATIONS

Bearing capacity for shallow foundation is worked out based on the Shear criteria as given in relevant clauses of IS: 6403 – 1981 RA-2016 and settlement criteria as given in IS: 8009(part-1)–1976 RA-2013. The least of these two values is considered as the Safe / Allowable Bearing Capacity value for the given foundation.

14.1 Calculation as per Shear Criteria:

$qds = 1/F \{C.Nc.Sc.dc.ic + q(Nq-1).Sq.dq.iq + 1/2.B.\Upsilon.N\gamma.S\gamma.d\gamma.i\gamma.w'\}$

where,

qds – Safe allowable bearing capacity in Kg/cm^2

C - Cohesion of the soil in Kg/cm^2

q - Overburden pressure in Kg/cm^2

B – Width of footing in cm

Υ - Unit wt. Of soil in Kg/cc

Sc, Sq& Sγ - Shape factors

dc, dq, dγ - Depth factors

ic, iq& iγ - inclination factors

Nc, Nq& Nγ - Bearing capacity factors depending upon the angle of internal friction of the soil.

F – Factor of safety

W' – Correction factor for water table

14.2 Calculation as per Settlement Criteria:

14.2.1 Calculation as per Settlement Criteria for Sandy Layer:-

Settlement is calculated from the graph given in Fig.No.9 of IS 8009 Part-1
From the said graph, Settlement for unit pressure of 1Kg/cm^2 for the width of foundation B is correlated.

14.2.2 Calculation as per Settlement Criteria for clayey Layer:-

Consolidation settlement, S_t is given by,

$$S_t = \frac{C_c}{1+e_0} H \log \frac{p_0 + \Delta p}{p_0}$$

C_c - Compression index

e_0 - Initial void ratio

H - Thickness of clay stratum

P_0 - Consolidation pressure

Δp - Net change in pressure

14.3 METHOD OF COMPUTING CAPACITIES FOR PILE FOUNDATIONS:

Safe capacity of RCC Bored cast-in-situ pile can be computed by using the formula given in IS: 2911 (Part-1/Sec-2)-2010:

Ultimate bearing capacity Qu of piles in Cohesion less soil:

$$Qu = Ap(0.5.D.\gamma.N\gamma + PD.Nq) + \sum_{I=1}^{n} k .PDi .\tan \delta . Asi$$

Where,

Ap= Cross sectional area of pile toe in cm²

D= Stem dia. in cm

γ= effective unit weight of soil at pile toe in kg /cm³

PD = effective overburden pressure in Kg / cm²

Nγ and Nq = bearing capacity factors depending upon the angle of internal friction Ø at

toe

$\sum_{I=1}^{I=n}$ = Summation of N layers in which pile is installed

K = Coefficient of earth pressure

PDi = effective overburden pressure in Kg /cm² for the i^{th}layer where i varies from 1 to n.

δ= angle of wall friction between pile and soil in degree (may be taken

equal to Ø)

Asi= Surface area of pile stem in cm² in the ith layer where i varies from 1 to n.

For cohesive soil:-

Safe capacity of pile = 1/F {AP.Nc.Cp + α. C.As)

Where

Ap- c/s area of pile toe in cm²

Nc- bearing capacity factor

Cp- average cohesion at pile tip in Kg/cm²

α - Reduction factor

C – average cohesion throughout the length of pile in Kg/cm²

S- Surface area of pile shaft in cm²

F - Factor of safety.

15.0 CONCLUDING REMARKS

15.1 RCC Bored cast in situ piles to be considered for the proposed structure. The Safe capacities for different diameter of piles taken to a depth of 22.6m to 32.0m socketed by 1 times the diametr of piles in to the rocky strata is given below in Table No.15.1.

Table No.15.1

Dia. Of Pile	Safe Capacity		
	Compression	Tension	Shear
60 cms	160	35	5.5
70cms	230	43	7.5
80cms	300	53	9.0
90 cms	390	64	11.0
100 cms	485	77	13.0

15.2 It is also suggested that the carrying capacities of the piles given above shall be verified by conducting Initial pile load test as per relevant clauses of IS 2911(Part-4)-2013.

15.3 Based on the soil conditions, in case of lightly loaded structures, shallow footing can be suggested as a suitable type of foundation. The safe bearing capacities for different sizes of footing at different depths are as given below.

Table No: 15.3.1 (Square footing)

Size of footing (m)	Depth below EGL	Safe Bearing capacity (T/M^2)
1.0 x 1.0	1.00m	9.0
	1.50m	12.0
	2.00m	15.5
	2.50m	19.5
	3.00m	24.0
1.50 x 1.5	1.00m	8.50
	1.50m	11.5
	2.00m	14.5
	2.50m	18.0
	3.00m	21.5

2.0 x 2.0	1.00m	8.50
	1.50m	11.5
	2.00m	14.5
	2.50m	17.5
	3.00m	14.5
2.5 x 2.5	1.00m	9.0
	1.50m	11.5
	2.00m	14.5
	2.50m	13.5
	3.00m	10.0
3.0 x 3.0	1.00m	9.50
	1.50m	12.5
	2.00m	13.0
	2.50m	10.0
	3.00m	7.0

Table No: 15.3.2 (Strip footing)

Size of footing (m)	Depth below EGL	Safe Bearing capacity (T/M^2)
0.80	1.00m	7.50
	1.50m	10.5
	2.00m	14.0
	2.50m	17.5
	3.00m	20.0
1.00	1.00m	7.50
	1.50m	10.0
	2.00m	13.0
	2.50m	16.5
	3.00m	20.5

1.20	1.00m	7.50
	1.50m	10.0
	2.00m	13.0
	2.50m	16.0
	3.00m	19.5
1.50	1.00m	7.50
	1.50m	10.0
	2.00m	12.5
	2.50m	15.5
	3.00m	18.5
2.00	1.00m	8.0
	1.50m	10.0
	2.00m	12.5
	2.50m	15.0
	3.00m	14.0
2.50	1.00m	8.0
	1.50m	10.5
	2.00m	12.5
	2.50m	15.0
	3.00m	13.0

15.4 The suggestions given in this report are based on the results of tests on sub-soil samples collected from the bore-holes. If in actual execution any variation is found, this office may also referred to.

For GEO FOUNDATIONS & STRUCTURES PVT.LTD.

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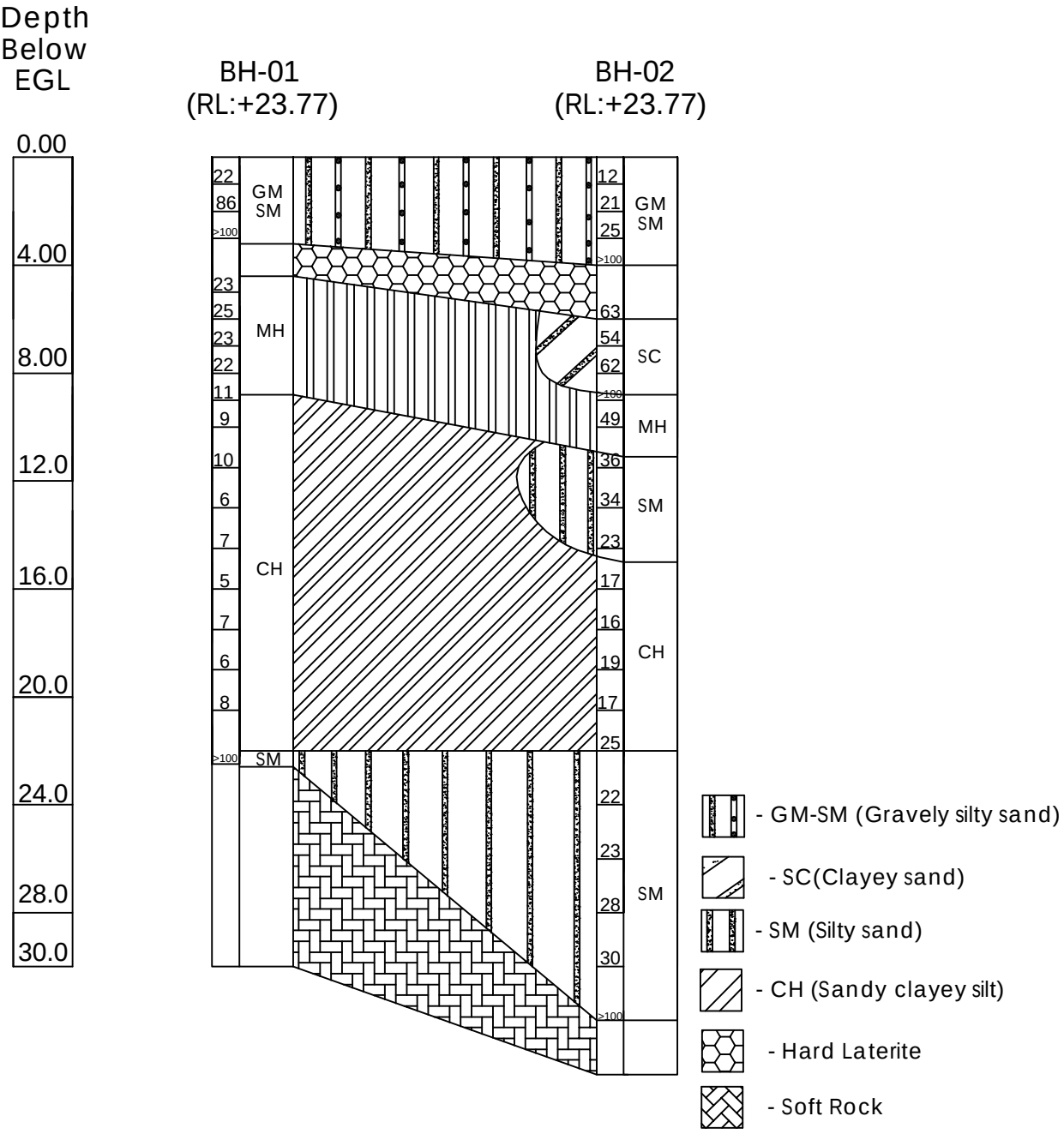
SR. GENERAL MANAGER

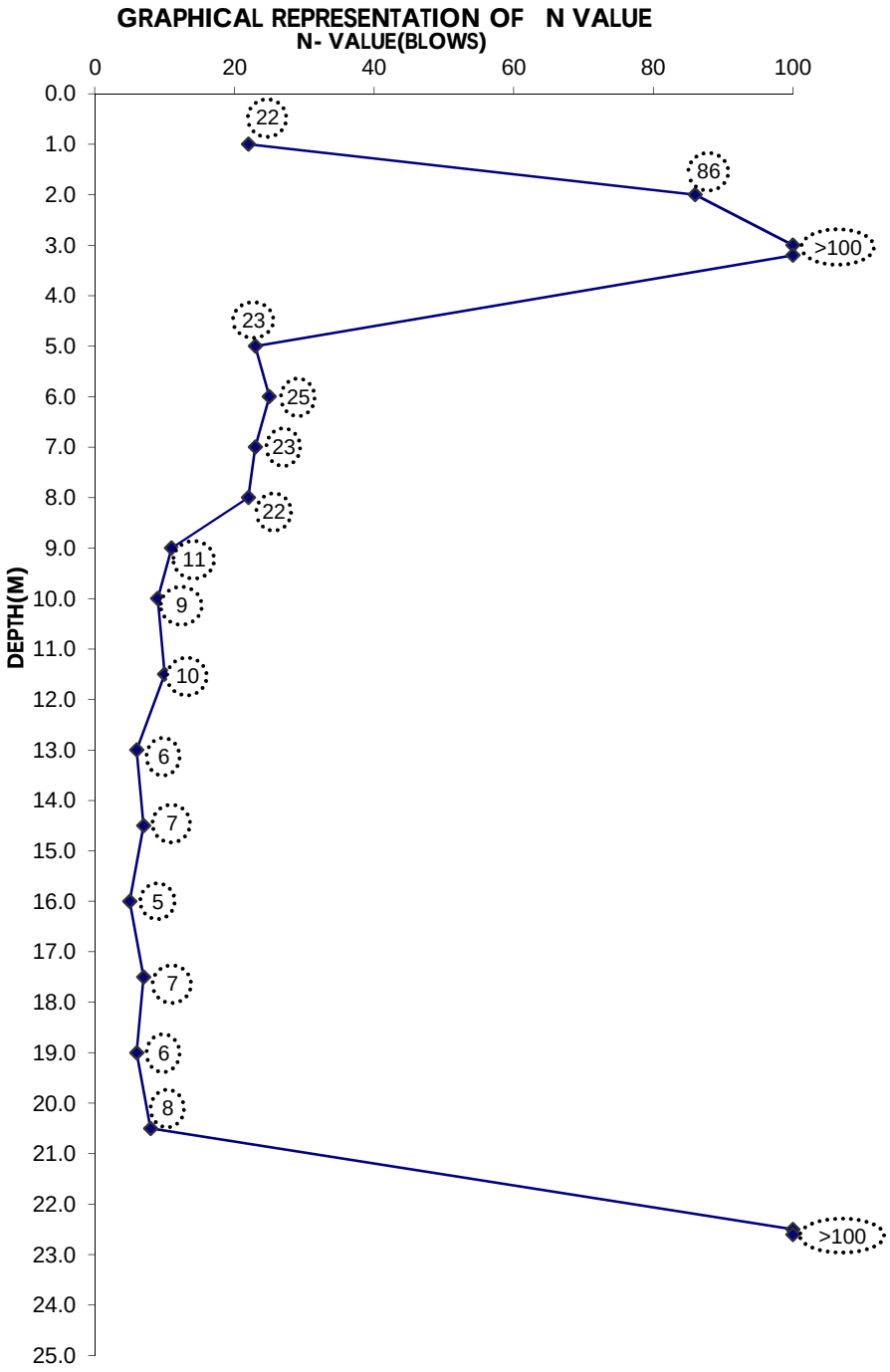
PROJECT: SOIL INVESTIGATION WORK FOR THE PROPOSED RAW MATERIAL STORAGE AREA



(Fig.51) : CROSS SECTIONAL PROFILE

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-01**	Date of Boring Started	: 02.12.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 03.12.2020
		G.W.L : 9.20M		Termination Depth	: 30.0 M
					TC-5397



BORE HOLE TERMINATED AT 30.0 M

FIG.52

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE RAW MATERIAL STORAGE TANK

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-01**	Boring Started : 02.12.2020		**TC-5397**
		Type of Boring : Rotary	Boring Completed : 03.12.2020		
		Termination Depth : 30.0 M	Ground Water Level : 9.20 M		
		Reduced Level : +23.770	Co-ordinates : E- 649642.263, N- 1103366.100		

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES	BLOWS/15cm			SPT " N "	Rock Core characteristics			REMARKS
					TEST DEPTH IN m	15cm	15cm	15cm		C.R (%)	R.Q.D (%)	UCS KG/CM^2	
	3.20	Gravely silty sand(Coffee Brown)	GM-SM	**1.00**	1.00-1.45	8	10	12	**22**				15 / 45 cm penetration
				2.00	2.00-2.45	27	40	46	**86**				
		Gravely silty sand(W/ Brown)		**3.00**	3.00-3.20	100	-	-	**>100**				
	1.20	Hard Laterite			3.20 to 4.40	DRILLING DONE BY USING DIAMOND BIT				NIL	NIL		
	4.40	Sandy clayey silt(Brownish White)	MH	**5.00**	5.00-5.45	7	12	11	**23**				
				6.00	6.00-6.45	8	11	14	**25**				
				7.00	7.00-7.45	9	11	12	**23**				
				8.00	8.00-8.45	10	11	11	**22**				
				9.00	9.00-9.45	4	4	7	**11**				
	10.2	Sandy clayey silt(Brownish White)	CH	**10.0**	10.0-10.45	4	4	5	**9**				
				11.5	11.5-11.95	3	4	6	**10**				
				13.0	13.0-13.45	2	3	3	**6**				
				14.5	14.5-14.95	3	4	3	**7**				
		Sandy clayey silt(Y/white)		**16.0**	16.0-16.75	2	2	3	**5**				
				17.5	17.5-17.95	2	3	4	**7**				
				19.0	17.5-17.96	3	3	3	**6**				

(continued ....page 54)

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :53

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE RAW MATERIAL STORAGE TANK

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-01** Type of Boring : Rotary Termination Depth : 30.0 M Reduced Level : +23.770	Boring Started : 02.12.2020 Boring Completed : 03.12.2020 Ground Water Level : 9.20 M Co-ordinates : E- 649642.263, N- 1103366.100	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES	BLOWS/15cm			SPT " N "	Rock Core characteristics			REMARKS
					TEST DEPTH IN m	15cm	15cm	15cm		C.R (%)	R.Q.D (%)	UCS KG/CM^2	
	3.00	Sandy clayey silt(Y/white)	CH	20.5	20.50-20.95	3	4	4	8				10/45 cm penetration
	0.60	Silty sand with clay(Yellow)	SM	22.5	22.50-22.60	>100	-	-	>100				
	7.40	Soft Rock		23.5 24.5 25.5 26.5 27.5 28.5 29.5	22.60 to 30.0	DRILLING DONE USING DIAMOND BIT				NIL	NIL		
				30.5									

Termination Depth : 30.0m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :54

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

LOCATION : AMBALAMEDU

Ground Water Level : 9.20m

Date of Boring Started : 02.12.2020
Boring completed : 03.12.2020
Termination Depth : 30.0m

Table No.: 10&11

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-01																				
22	1.00	SPT-1	Gravely silty sand(Coffee Brown)	GM-SM	45	39	16	0	11	No Limit					2.64					
86	2.00	SPT-2	Gravely silty sand(W/Brown)	GM-SM	34	33	3	3	27	No Limit										
>100	3.00	SPT-3	Gravely silty sand(W/Brown)	GM-SM	42	40	16	2	27	No Limit										
	3.20 to 4.40	DS-1	Hard Laterite																	
23	5.00	SPT-4	Sandy clayey silt(Brownish white)	MH	0	22	41	37	29											
25	6.00	SPT-5	Sandy clayey silt(Brownish white)	MH					28	77	36	41								
23	7.00	SPT-6	Sandy clayey silt(Brownish white)	MH	0	20	42	38	36						2.38	1.97	1.45	UCS	1.03	-
22	8.00	SPT-7	Sandy clayey silt(Brownish white)	MH					33											
11	9.00	SPT-8	Sandy clayey silt(Brownish white)	CH	0	28	43	29	36	59	26	33								
9	10.0	SPT-9	Sandy clayey silt(Brownish white)	CH	0	29	43	28	39						2.42	1.69	1.22	UCS	0.27	-
10	11.5	SPT-10	Sandy clayey silt(Brownish white)	CH					39											

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NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

LOCATION : AMBALAMEDU

Ground Water Level : 9.20m

Date of Boring Started : 02.12.2020
Boring completed : 03.12.2020
Termination Depth : 30.0m

Table No.: 10&11

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-01																				
6	13.0	SPT-11	Sandy clayey silt(Y/white)	CH	0	24	52	24	50	55	25	30								
7	14.5	SPT-12	Sandy clayey silt(Y/white)	CH					47											
5	16.0	SPT-13	Sandy clayey silt(Y/white)	CH	0	25	50	25	44						2.41	1.50	1.04	UCS	0.19	-
7	17.5	SPT-14	Sandy clayey silt(Y/white)	CH	0	28	47	25	32	57	26	31								
6	19.0	SPT-15	Sandy clayey silt(Y/white)	CH					49											
8	20.5	SPT-16	Sandy clayey silt(Y/white)	CH	0	25	49	26	38	59	26	33								
>100	22.5	SPT-17	Silty sand with clay(Yellow)	SM	2	53	34	11	24	No Limit					2.53	2.10	1.69	DST	0.09	35
	22.6 to 30.0		Rock																	

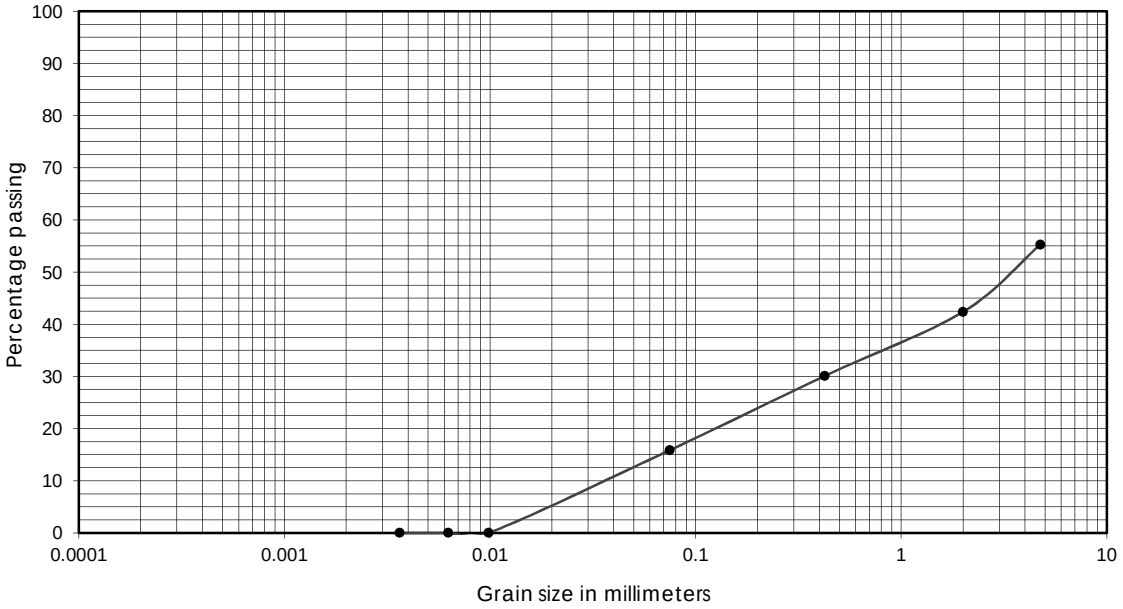
:111:

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

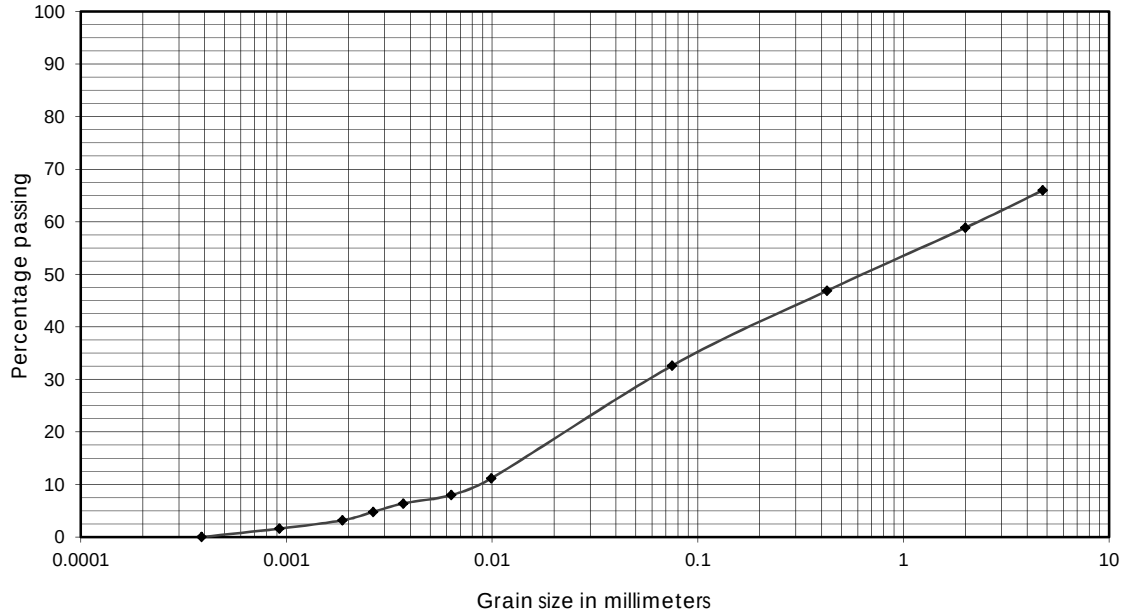
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	1.00	GM-SM	45	39	16	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	2.00	GM-SM	34	33	30	3			

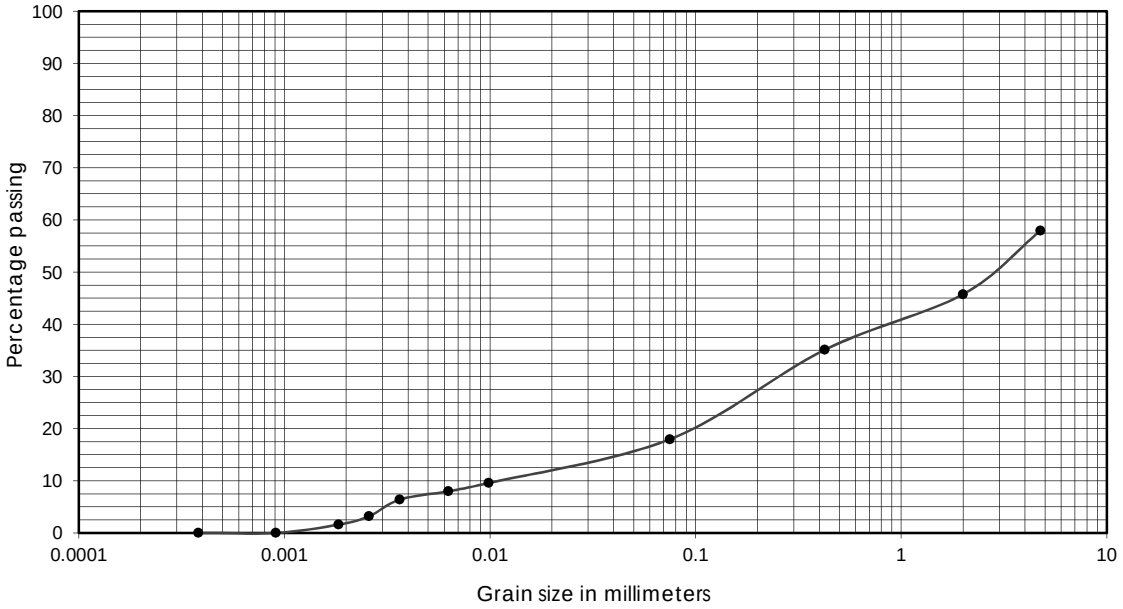
FIG.55

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

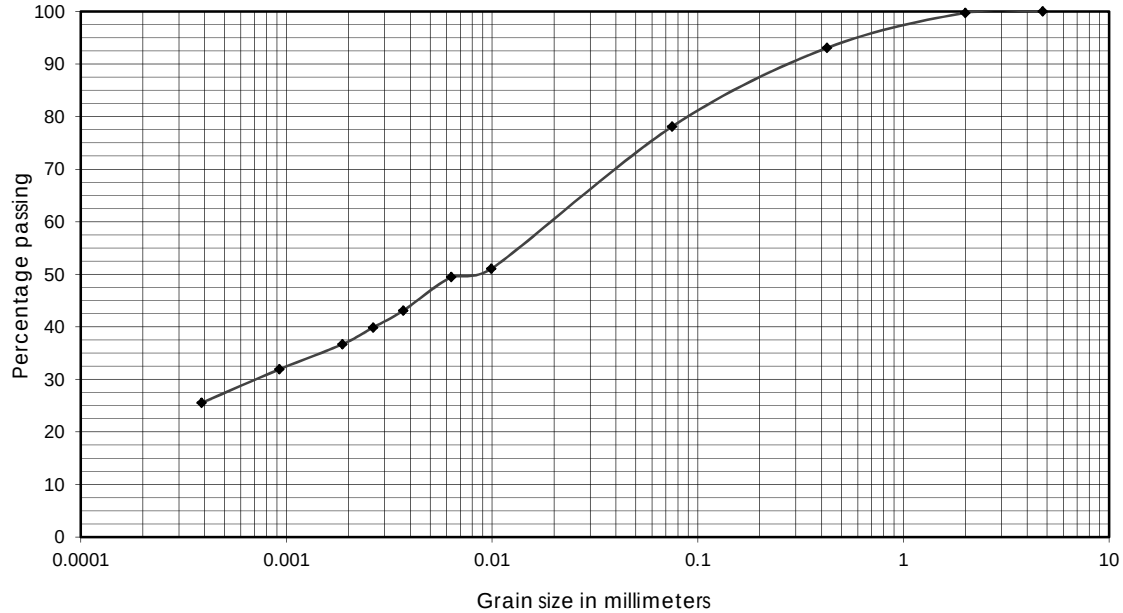
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	3.00	GM-SM	42	40	16	2			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	5.00	MH	0	22	41	37			

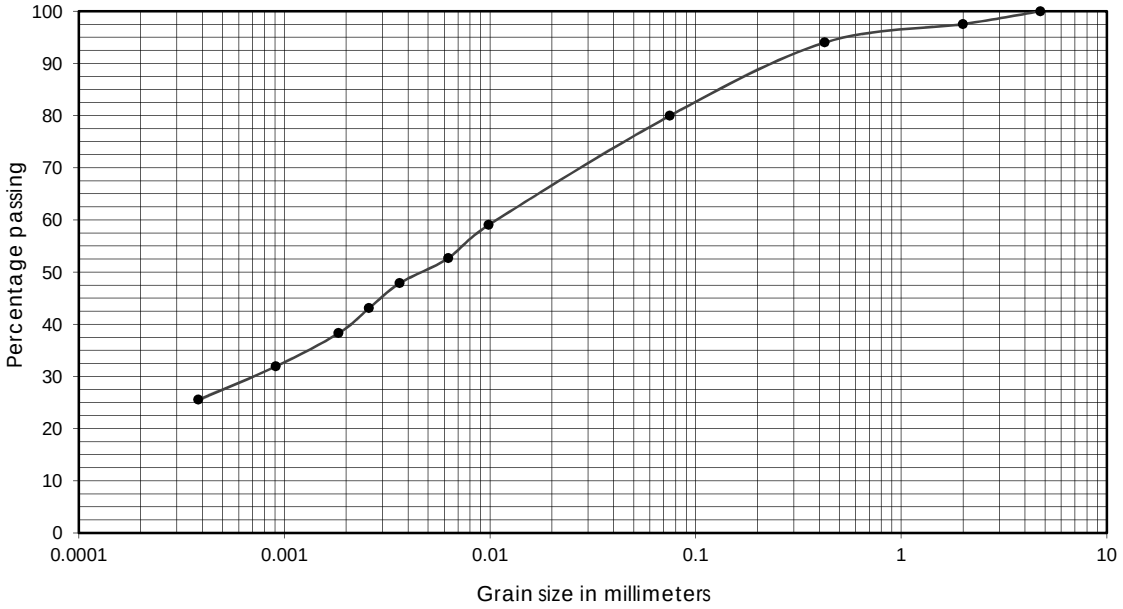
FIG.56

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

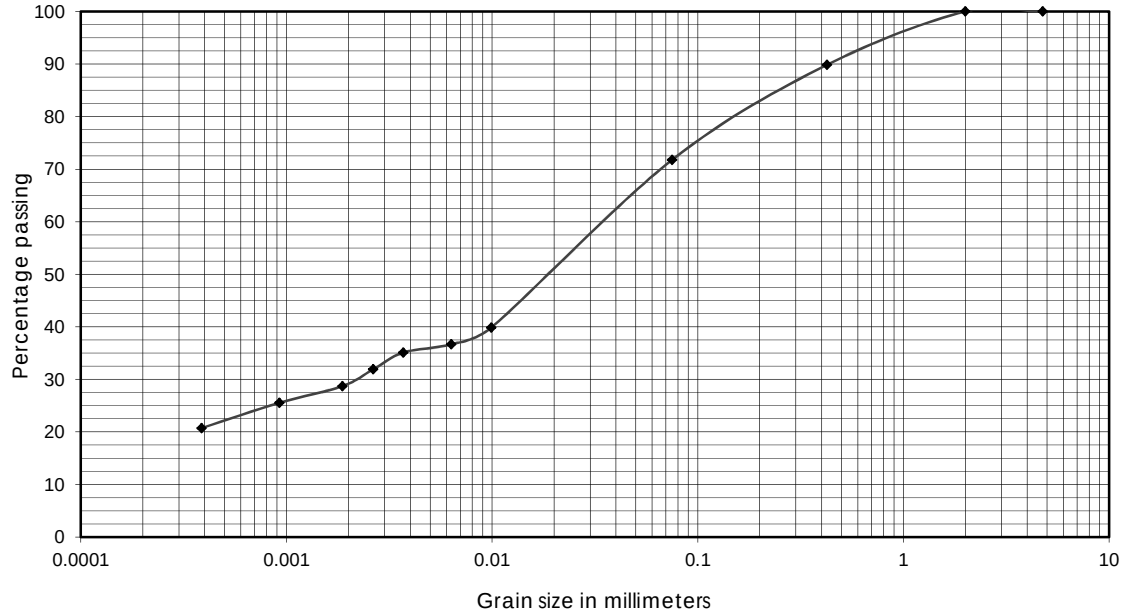
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	7.00	MH	0	20	42	38			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	9.00	CH	0	28	43	29			

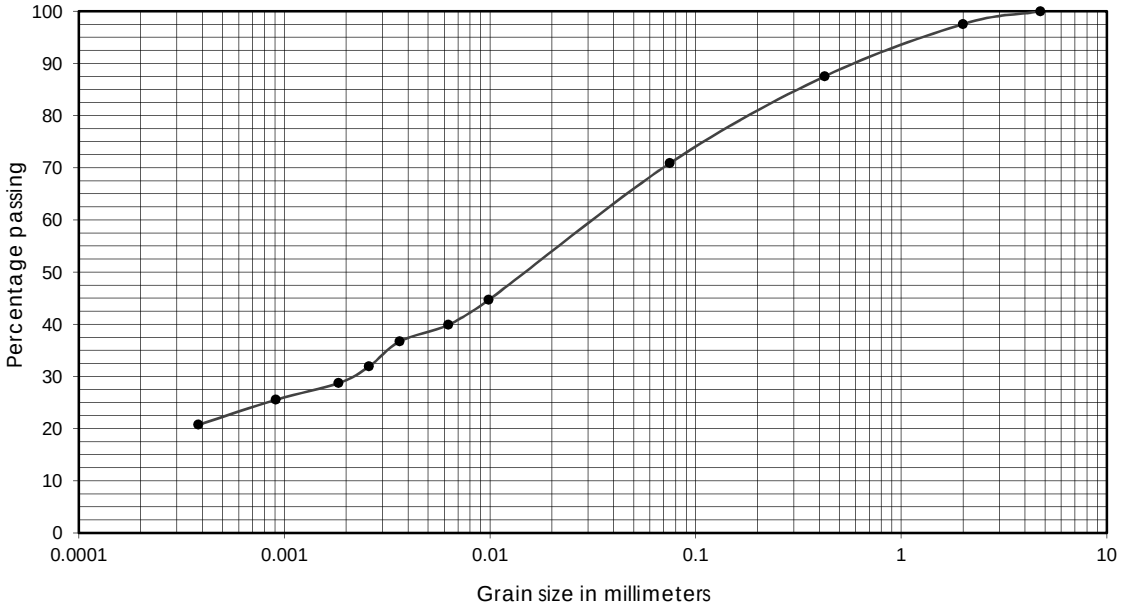
FIG.57

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

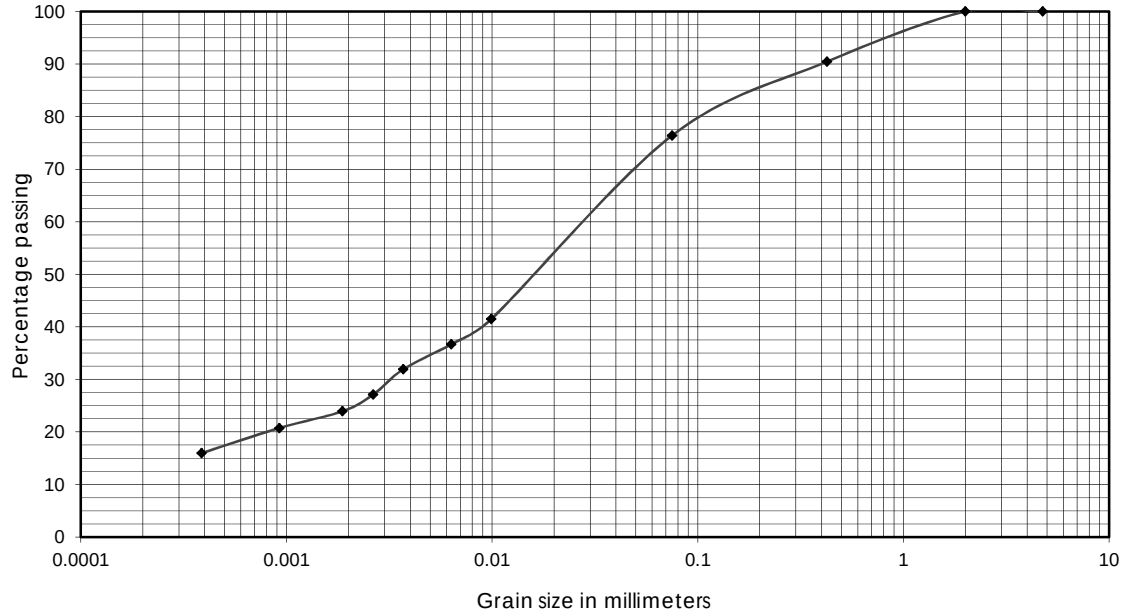
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	10.00	CH	0	29	43	28			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	13.00	CH	0	24	52	24			

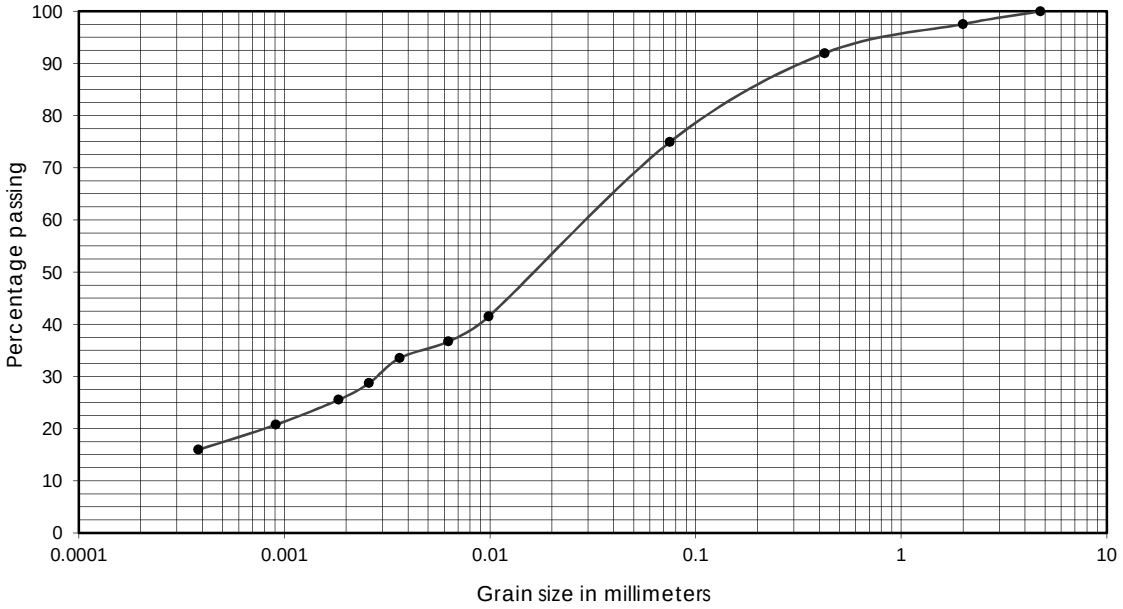
FIG.58

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

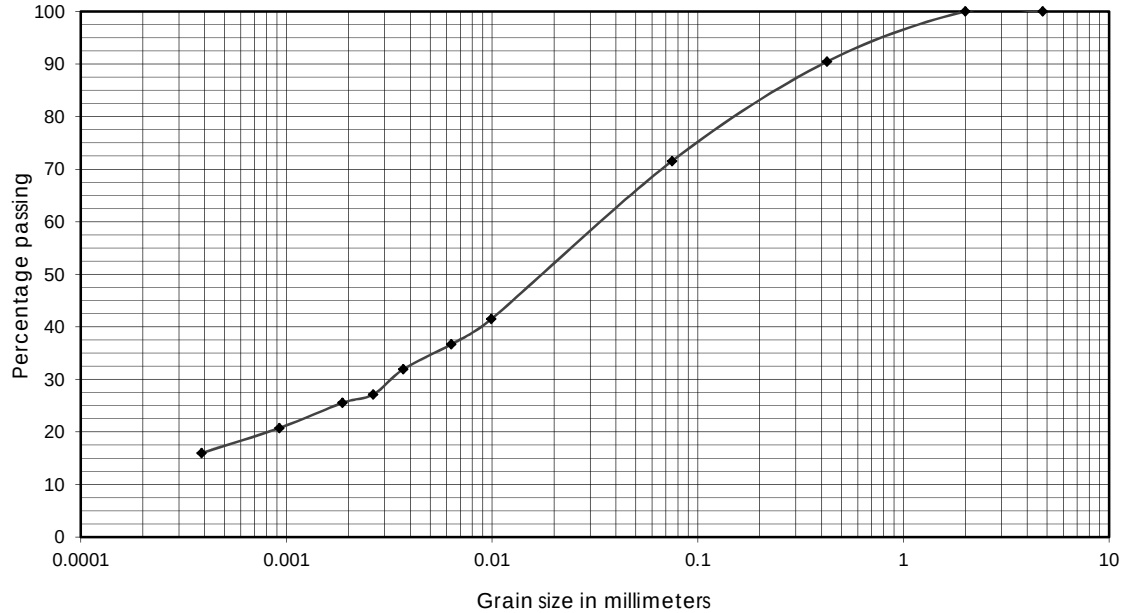
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	16.00	CH	0	25	50	25			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	17.50	CH	0	28	47	25			

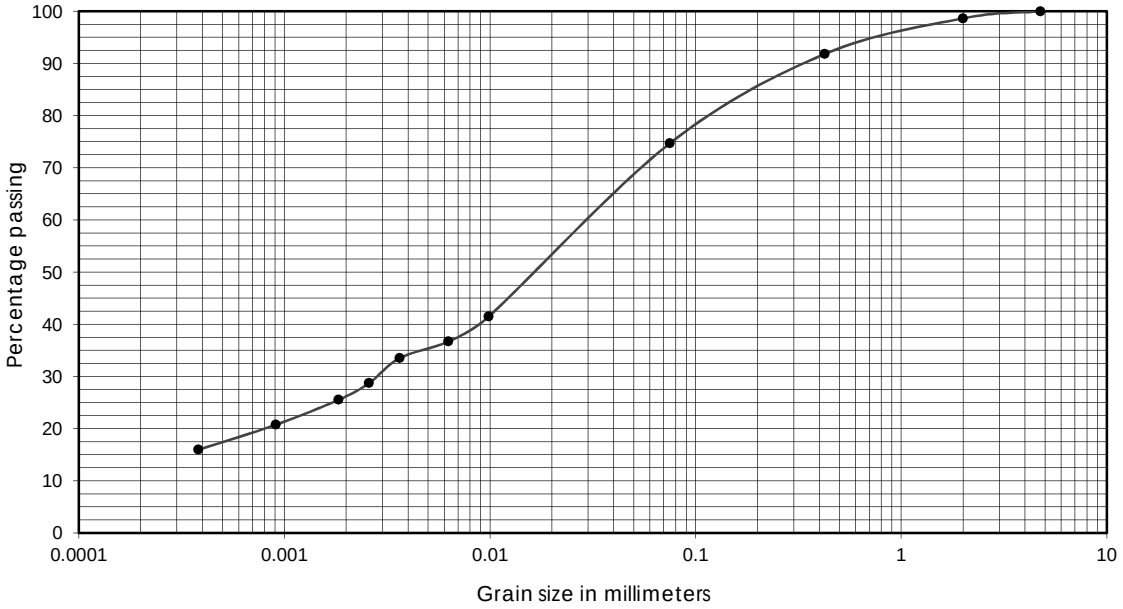
FIG.59

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

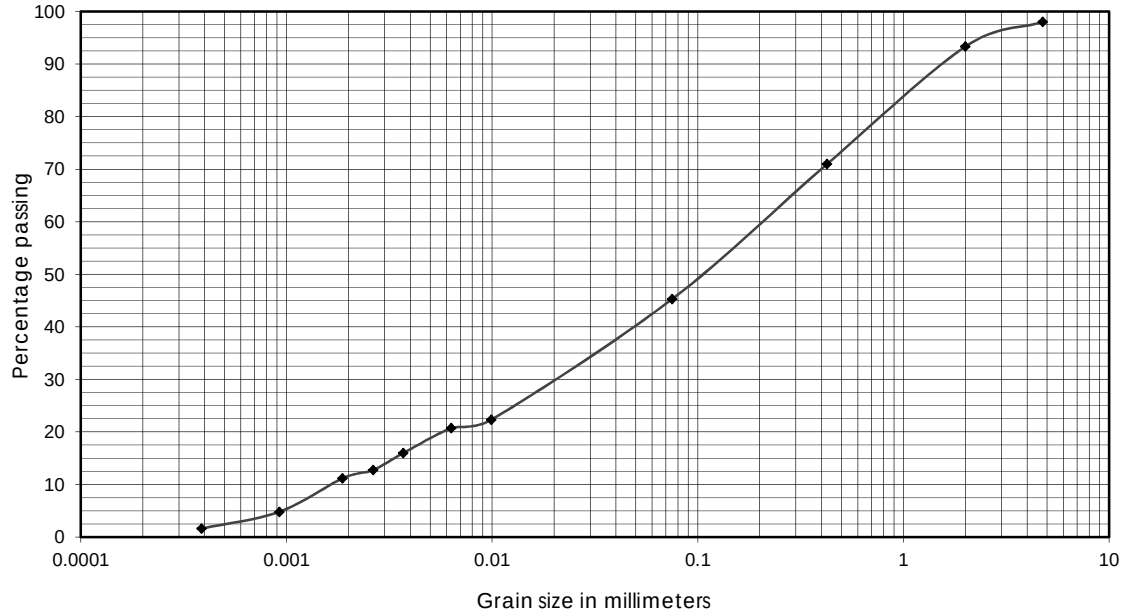
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST

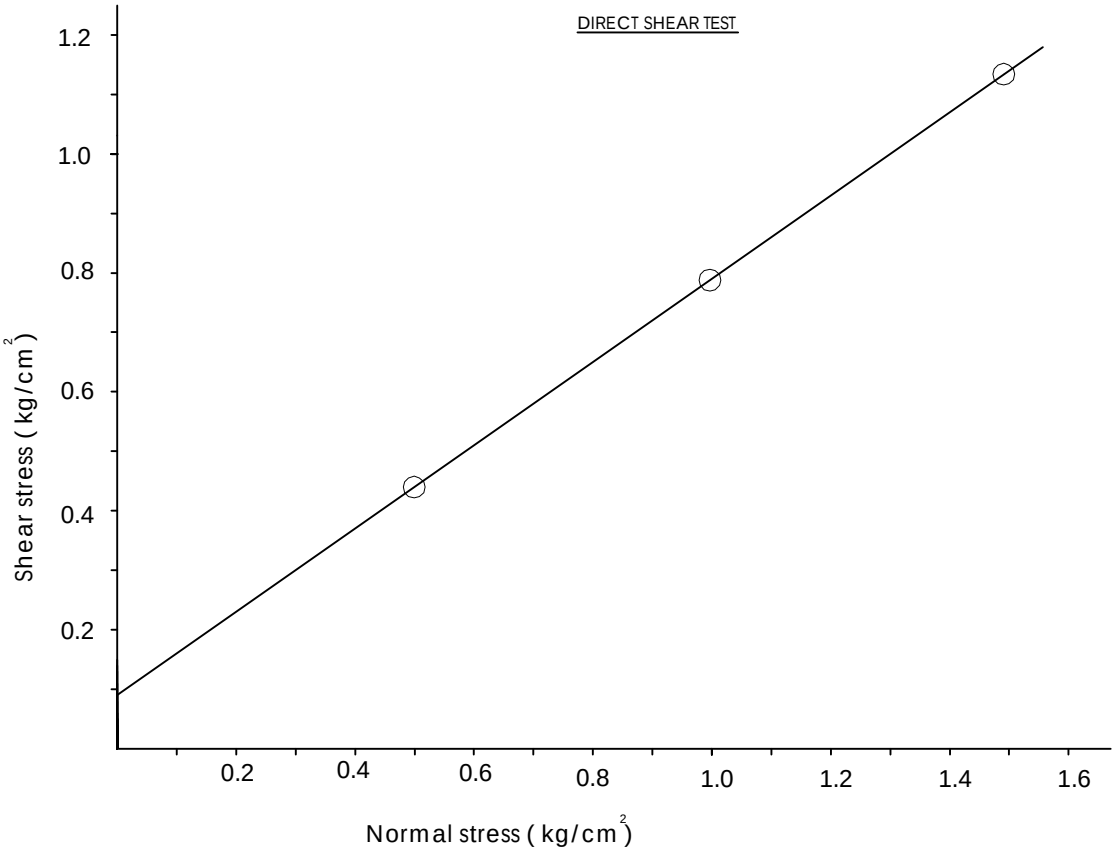


BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-01	20.50	CH	0	25	49	26			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-01	22.50	SM	2	53	34	11			

FIG.60



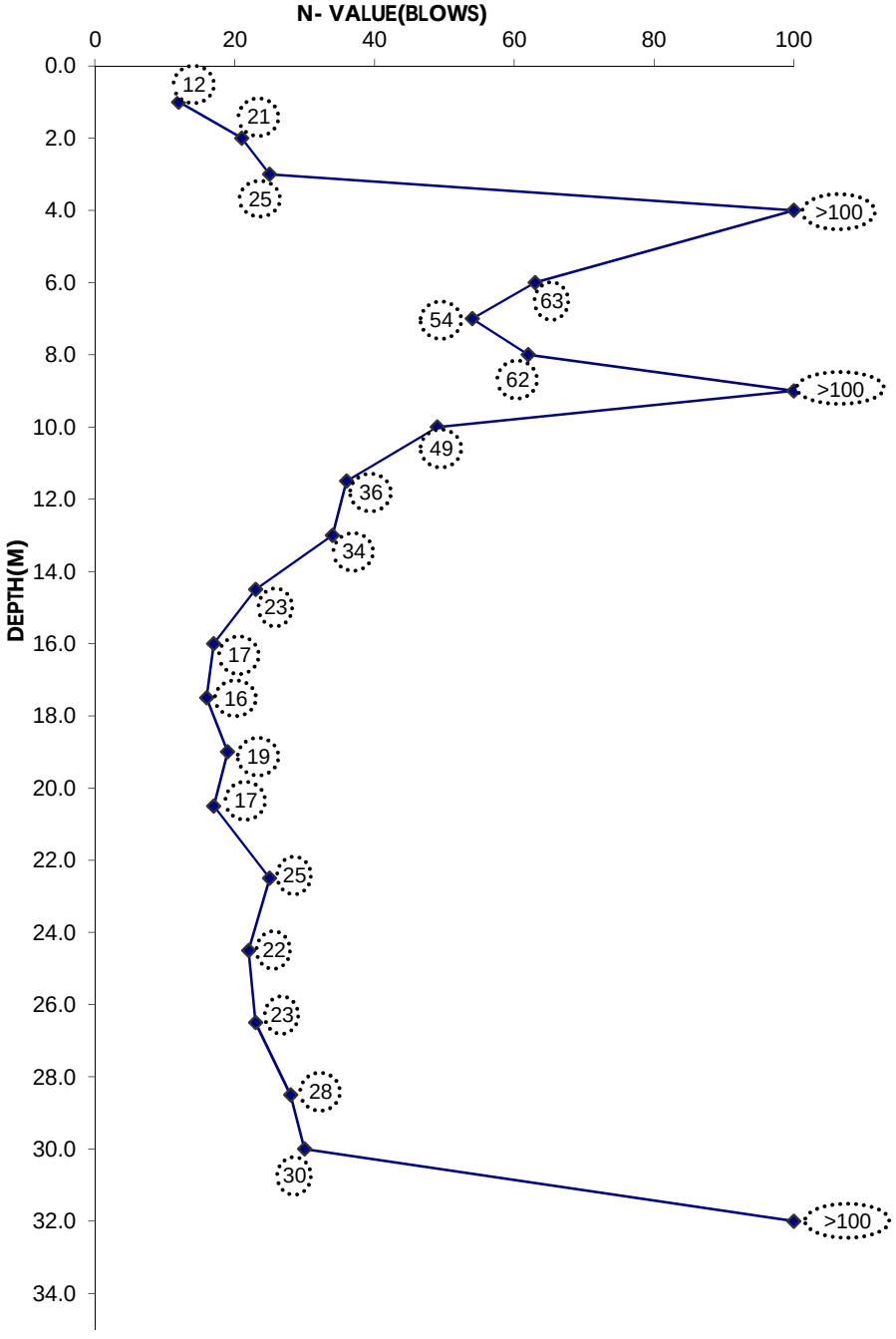
BORE HOLE NO: 01
SAMPLE NO : SPT-17
DEPTH : 22.50 M
C = 0.09 Kg/cm^2 Ø= 35°

Fig. (61)

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No	**: BH-02**	Date of Boring Started	: 03.12.2020
		Type of Boring	: Rotary	Date of Boring Completed	: 05.12.2020
		G.W.L : 9.20M		Termination Depth	: 34.0 M
					TC-5397

GRAPHICAL REPRESENTATION OF N VALUE



BORE HOLE TERMINATED AT 34.0 M

FIG.62

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE RAW MATERIAL STORAGE TANK

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-02** Type of Boring : Rotary Termination Depth : 34.0 M Reduced Level : +23.770	Boring Started : 03.12.2020 Boring Completed : 05.12.2020 Ground Water Level : 9.20 M Co-ordinates : E- 649656.639, N- 1103329.710	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES TEST DEPTH IN m	BLOWS/15cm 15cm	15cm	15cm	SPT " N "	Rock Core characteristics C.R (%)	R.Q.D (%)	UCS KG/CM^2	REMARKS
	4.00	Gravely silty sand(Br./red)	GM-SM	**1.00**	1.00-1.45	4	6	6	**12**				
				2.00	2.00-2.45	8	10	11	**21**				
				3.00	3.00-3.45	10	12	13	**25**				
				4.00		>100	-	-	**>100**				5 / 45 cm penetration
	2.00	Hard Laterite			4.00 to 6.00	DRILLING DONE BY USING DIAMOND BIT				NIL	NIL		
					6.00-6.45	24	36	27	**63**				
	2.80	Clayey sand with presence of gravel(W/brown)	SC	**7.00**	7.00-7.45	25	26	28	**54**				
				8.00	8.00-8.45	27	30	32	**62**				
				9.00	9.00-9.45	20	62	>100	**>100**				36/45 cm penetration
	2.30	Sandy clayey silt(Gr./red)	MH	**10.0**	10.0-10.45	14	20	29	**49**				
				11.5	11.5-11.95	14	16	20	**36**				
	3.90	Silty sand(Y/brown)	SM	**13.0**	13.0-13.45	13	17	17	**34**				
				14.5	14.5-14.95	12	11	12	**23**				
	4.00	Sandy clayey silt(Pinkish brown)	CH	**16.0**	16.0-16.75	4	7	10	**17**				
				17.5	17.5-17.95	5	8	8	**16**				
		Sandy clayey silt(Yellow)		**19.0**	17.5-17.96	6	9	10	**19**				

Termination Depth : 34.0m **(continued ....page 64)**

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :63

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE RAW MATERIAL STORAGE TANK

	GEO FOUNDATIONS & STRUCTURES PVT. LTD	Bore Hole No : **BH-02** Type of Boring : Rotary Termination Depth : 34.0 M Reduced Level : +23.770	Boring Started : 03.12.2020 Boring Completed : 05.12.2020 Ground Water Level : 9.20 M Co-ordinates : E- 649656.639, N- 1103329.710	**TC-5397**

LOCATION : AMBALAMEDU

SOIL PROFILE	THICKNESS OF STRATA (m)	DESCRIPTION OF STRATA	IS CLASSIFICATION	DEPTH (m)	SAMPLES	BLOWS/15cm			SPT " N "	Rock Core characteristics			REMARKS
					TEST DEPTH IN m	15cm	15cm	15cm		C.R (%)	R.Q.D (%)	UCS KG/CM^2	
	3.00	Sandy clayey silt (Yellow)	CH	**20.5**	20.50-20.93	7	9	8	**17**				
	10.0	Silty sand(Y/grey)	SM	**22.5**	22.50-22.95	10	12	13	**25**				
				24.5	24.50-24.95	10	11	11	**22**				
		Silty sand(Gr./brown)		**26.5**	26.50-26.95	9	12	11	**23**				
				28.5	28.50-28.95	8	16	12	**28**				
		Silty sand(White)		**30.0**	30.0-30.45	11	12	18	**30**				
				32.5									
	2.00	Rock		**33.5**	32.0 to 33.0	DRILLING DONE USING DIAMOND BIT				NIL	NIL		
				34.5	33.0 to 34.0	DRILLING DONE USING DIAMOND BIT				NIL	NIL		

Termination Depth : 34.0m

Note : UDS- Undisturbed Sample **SPT "N"-Standard Penetration Test "N"**

Fig :64

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

LOCATION : AMBALAMEDU

Ground Water Level : 9.20m

Date of Boring Started : 03.12.2020
Boring completed : 05.12.2020
Termination Depth : 34.0m

Table No.: 12&13

TC-5397

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				IS NMC(%) 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	IS SPG 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-02																				
12	1.00	SPT-1	Gravely silty sand(Br./red)	GM-SM	42	36	22	0	12	No Limit										
21	2.00	SPT-2	Gravely silty sand(Br./red)	GM-SM					19											
25	3.00	SPT-3	Gravely silty sand(Br./red)	GM-SM	46	35	19	0	17	No Limit					2.62					
>100	4.00 to 6.00	DS-1	Hard Laterite						21											
63	6.00	SPT-4	Clayey sand with presence of gravel (W/brown)	SC	5	46	30	19	27	44	23	21			2.53	1.81	1.43	DST	0.17	29
54	7.00	SPT-5	Clayey sand with presence of gravel (W/brown)	SC	10	45	27	18	22											
62	8.00	SPT-6	Clayey sand with presence of gravel (W/brown)	SC					21											
>100	9.00	SPT-7	Sandy clayey silt(Gr./red)	MH	0	20	42	38	26	65	34	31								
49	10.0	SPT-8	Sandy clayey silt(Gr./red)	MH					22						2.38	1.97	1.61	UCS	1.68	-
36	11.5	SPT-9	Silty sand(Y/brown)	SM	1	65	34	0	26	No Limit										
34	13.0	SPT-10	Silty sand(Y/brown)	SM					25						2.55	1.78	1.42	DST	0.06	27
23	14.5	SPT-11	Silty sand(Y/brown)	SM	2	68	30	0	24	No Limit										

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NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

TC-5397

LOCATION : AMBALAMEDU

Ground Water Level : 9.20m

Date of Boring Started : 03.12.2020
Boring completed : 05.12.2020
Termination Depth : 34.0m

Table No.: 12&13

ULR-TC539720000000184F

SPT 'N'	DEPTH (M)	SAMPLE	SOIL DESCRIPTION	I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS(%) IS 2720(Part5):1985				NMC(%) IS 2720 (Part2):1973	ATTERBERG'S LIMIT(%) IS 2720(Part-5): 1985			SL (%) IS 2720(Part6): 1972	FSI (%) IS 2720 (Part40):1977	SPG IS 2720(Part-3/sec1):1980	UNIT WEIGHT (gm/cc)		SHEAR PARAMETER- IS 2720(Part-13):1986		
					GRA - VEL (%)	SAND (%)	SILT (%)	CLAY (%)		LL	PL	PI				WET	DRY	METHOD	C kg/cm²	Ø (°)
BOREHOLE BH-02																				
17	16.0	SPT-12	Sandy clayey silt(Pinkish brown)	CH	0	29	43	28	30	63	26	37								
16	17.5	SPT-13	Sandy clayey silt(Pinkish brown)	CH					33						2.41	1.72	1.29	UCS	0.55	-
19	19.0	SPT-14	Sandy clayey silt(Yellow)	CH	0	34	39	27	27	61	25	36								
17	20.5	SPT-15	Sandy clayey silt(Yellow)	CH					30											
25	22.5	SPT-16	Silty sand(Y/grey)	SM	1	74	25	0	23	No Limit										
22	24.5	SPT-17	Silty sand(Gr./brown)	SM	0	66	34	0	34	No Limit					2.53	1.73	1.29	DST	0.06	24
23	26.5	SPT-18	Silty sand(Gr./brown))	SM					24											
28	28.5	SPT-19	Silty sand(White)	SM	1	76	23	0	17	No Limit										
30	30.0	SPT-20	Silty sand(White)	SM	0	75	25	0	21	No Limit					2.59	1.90	1.57	DST	0.05	26
	32.0 to 34.0		Rock																	

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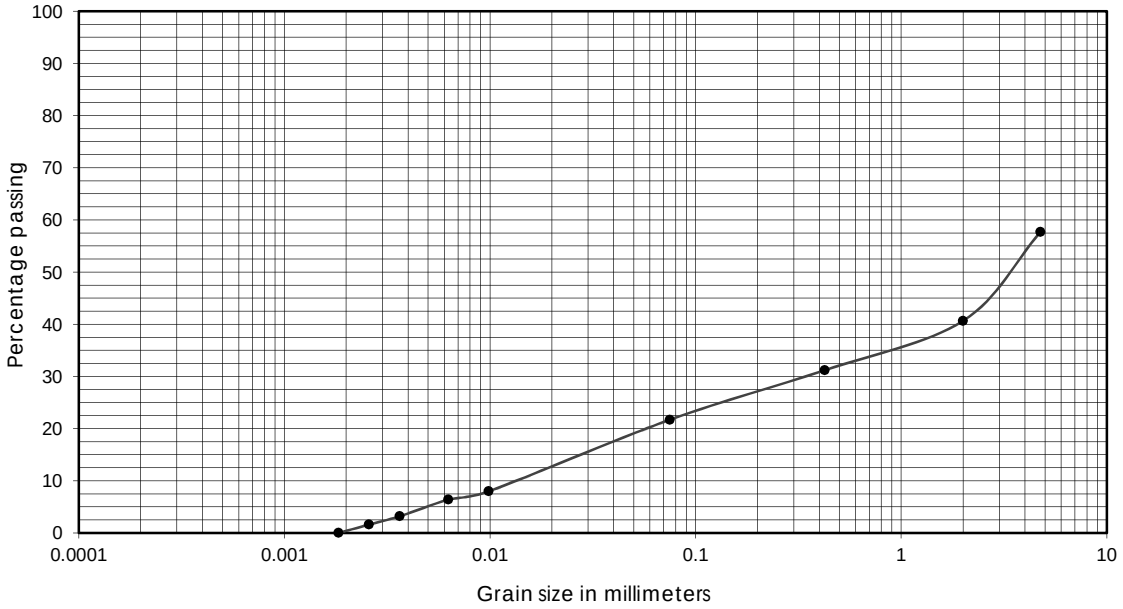
GEO FOUNDATIONS AND STRUCTURES PVT. LTD

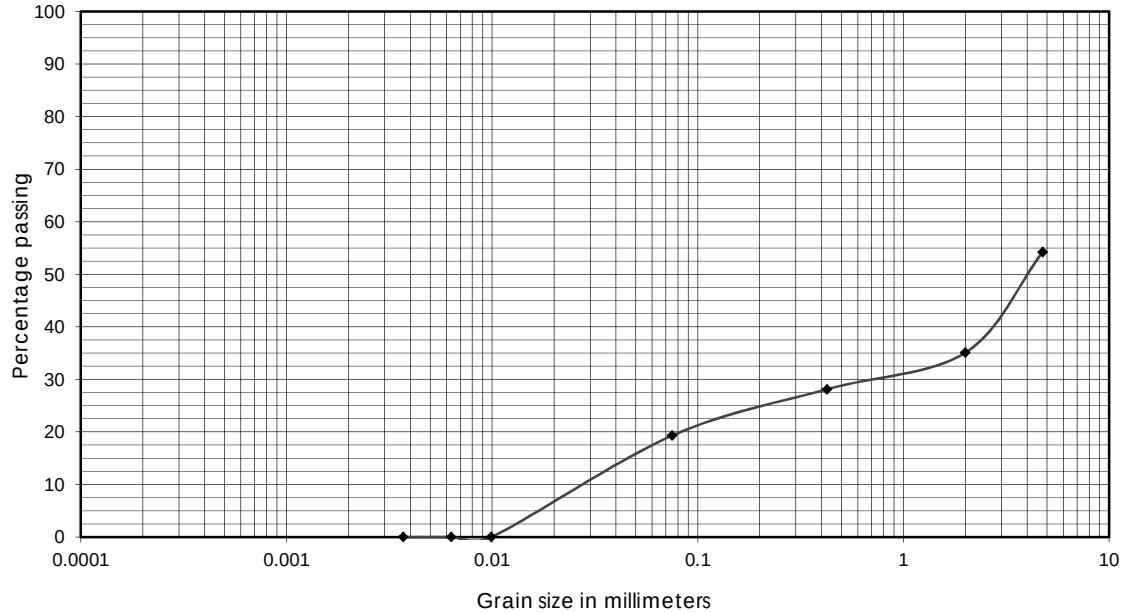
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	1.00	GM-SM	42	36	22	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	3.00	GM-SM	46	35	19	0			

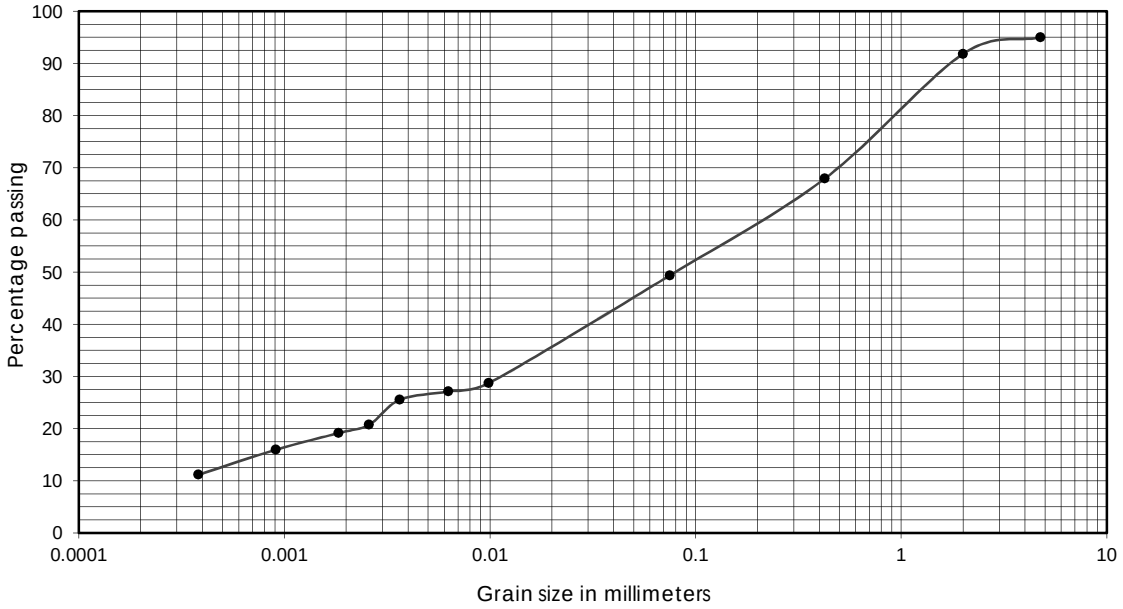
FIG.65

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

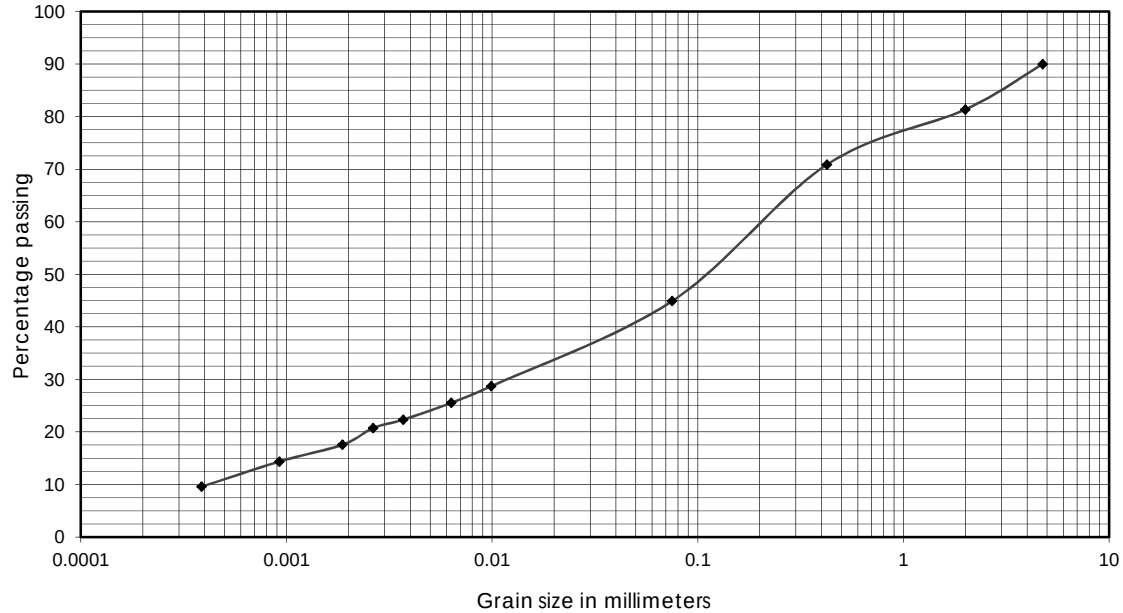
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	6.00	SC	5	46	30	19			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	7.00	SC	10	45	27	18			

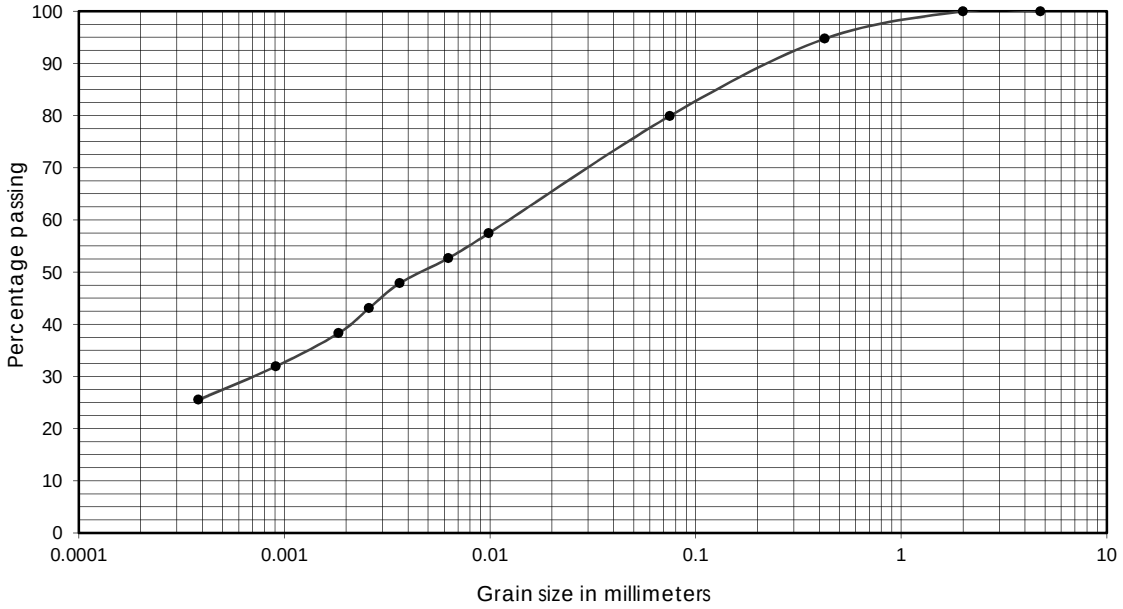
FIG.66

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

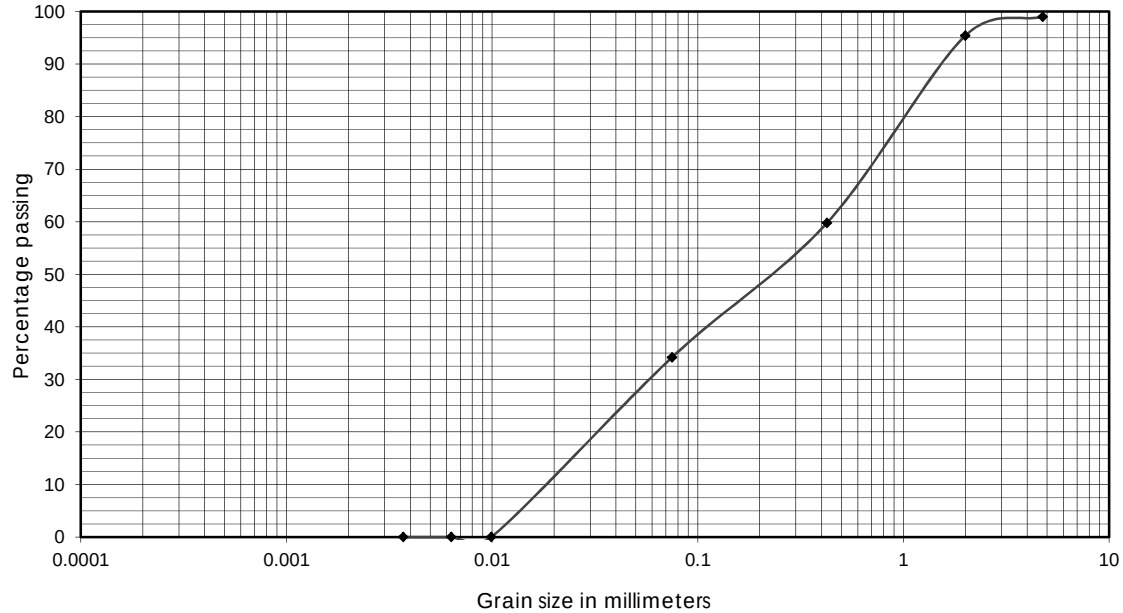
TC-5397

NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	9.00	MH	0	20	42	38			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	11.50	SM	1	65	34	0			

FIG.67

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

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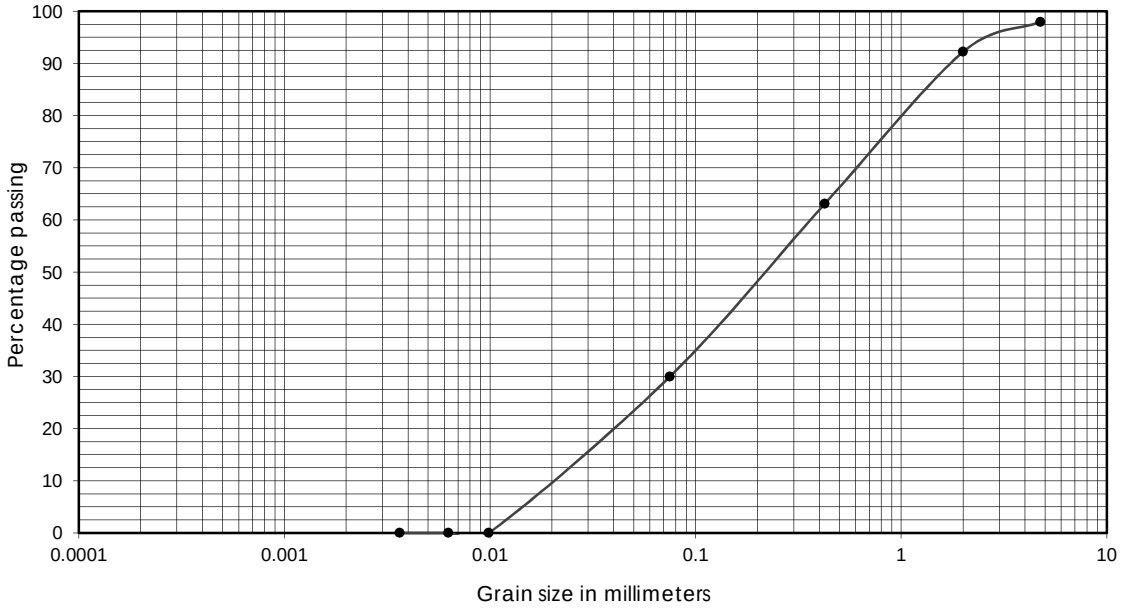
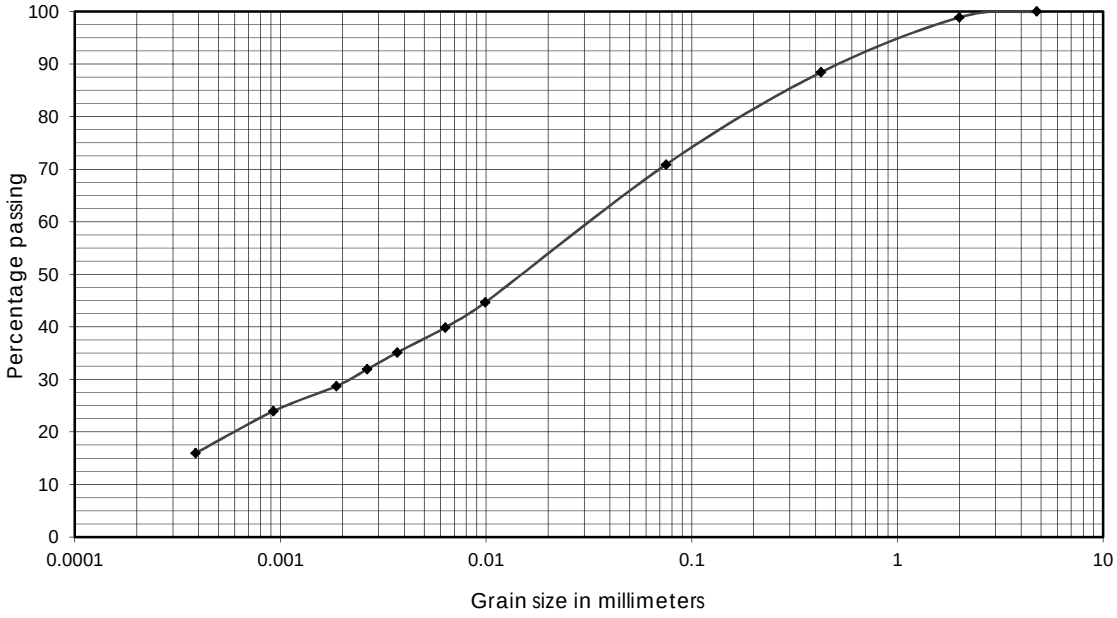
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	14.50	SM	2	68	30	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	16.00	CH	0	29	43	28			

FIG.68

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

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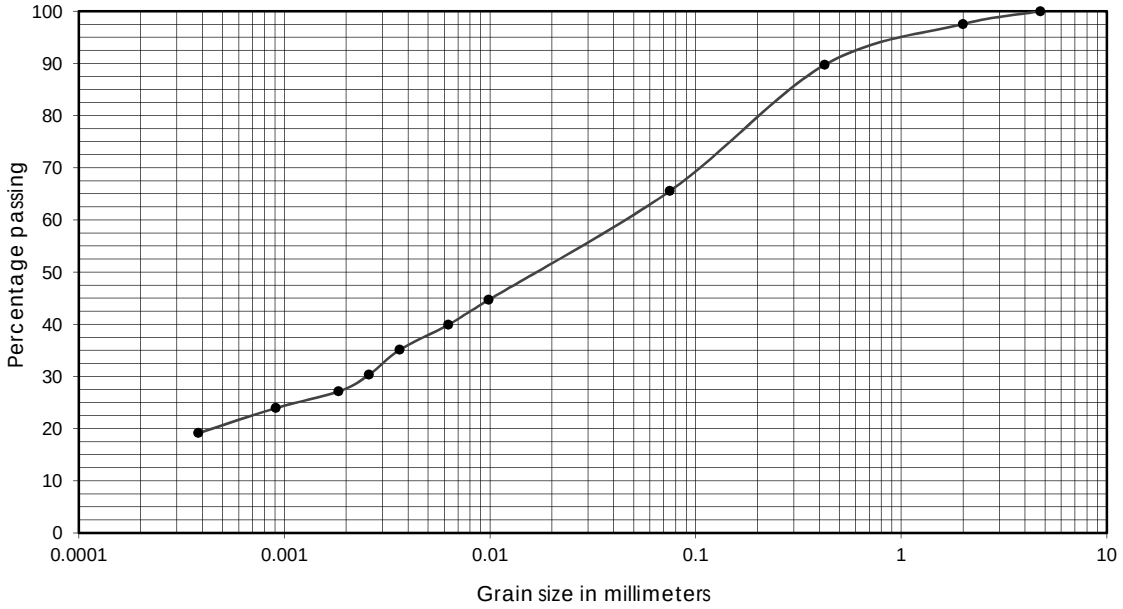
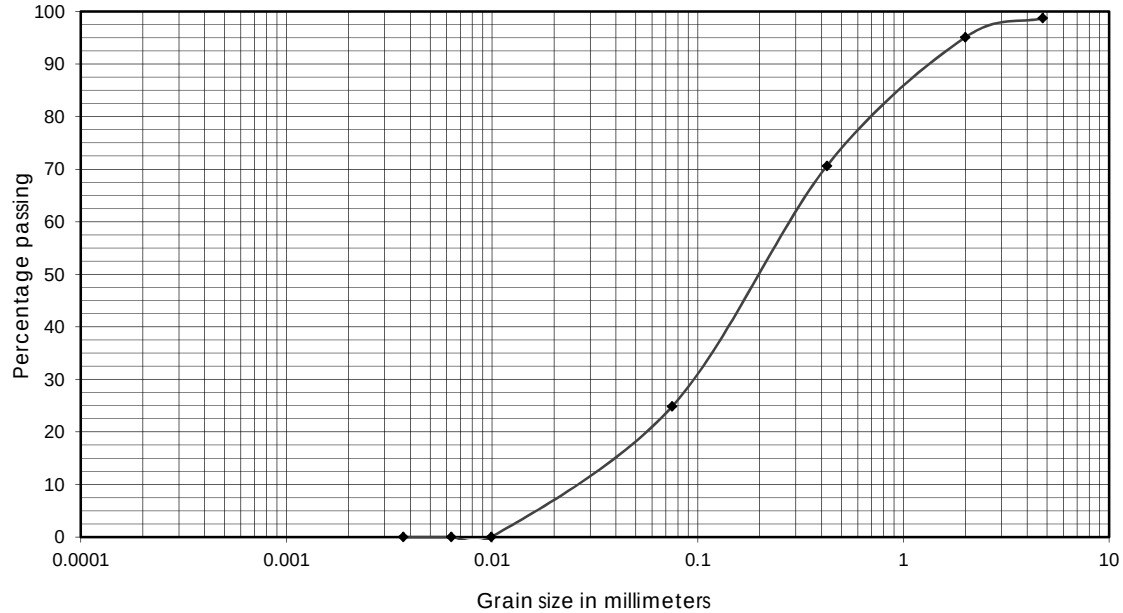
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	19.00	CH	0	34	39	27			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	22.50	SM	1	74	25	0			

FIG.69

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

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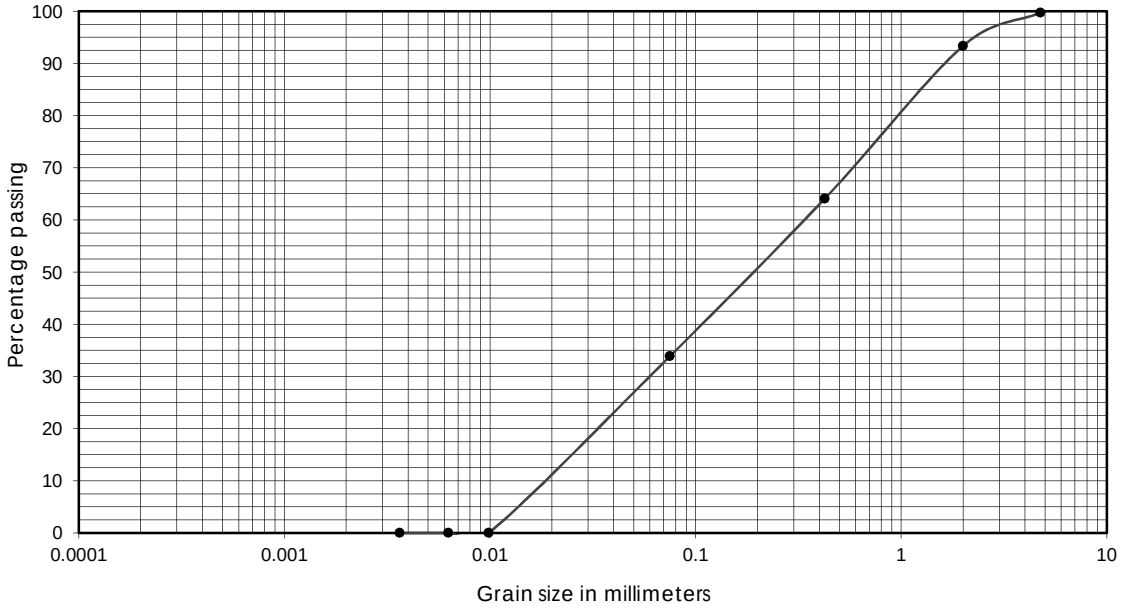
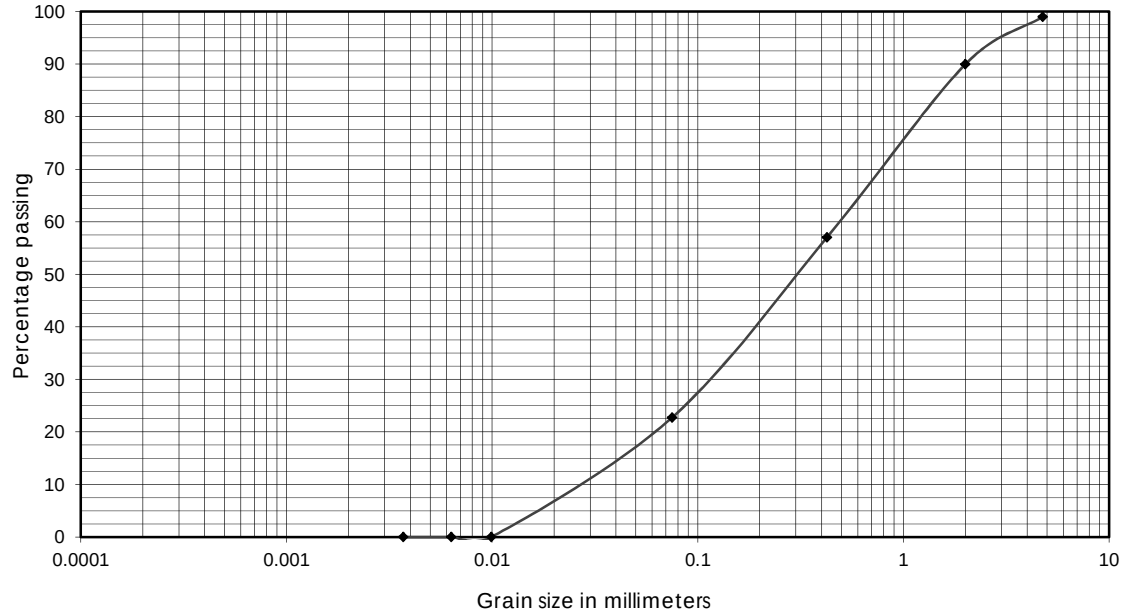
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	24.50	SM	0	66	34	0			



BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	D0
BH-02	28.50	SM	1	76	23	0			

FIG.70

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

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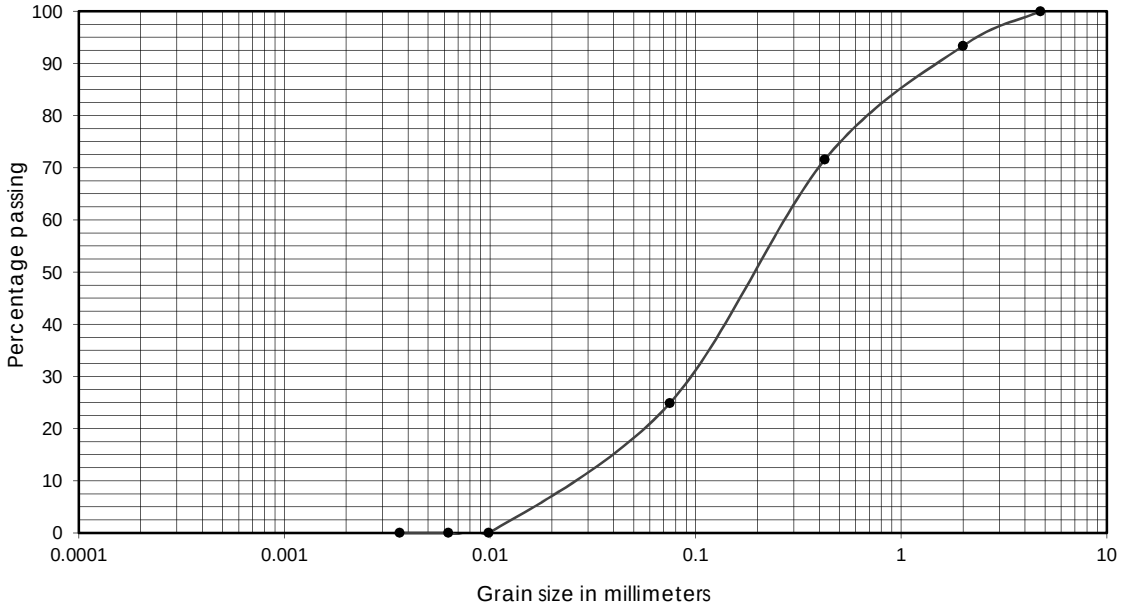
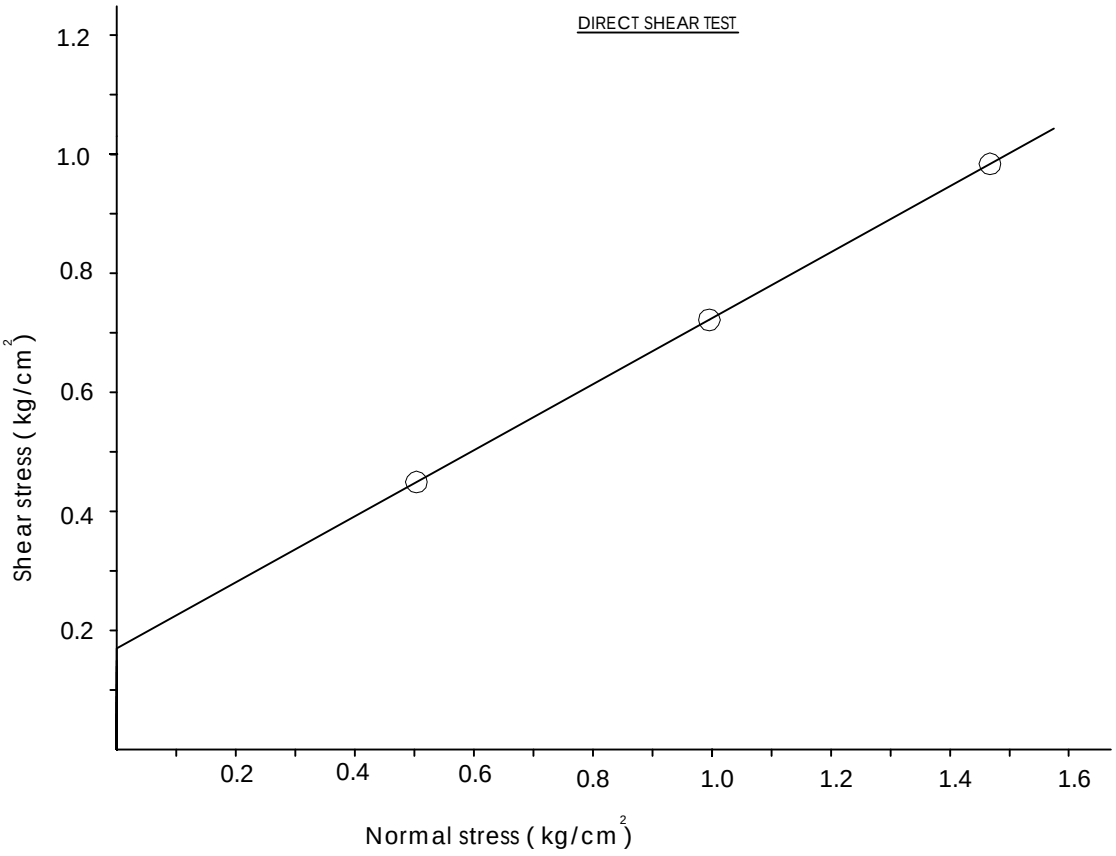
NAME OF WORK : SOIL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

GRAINSIZE ANALYSIS TEST



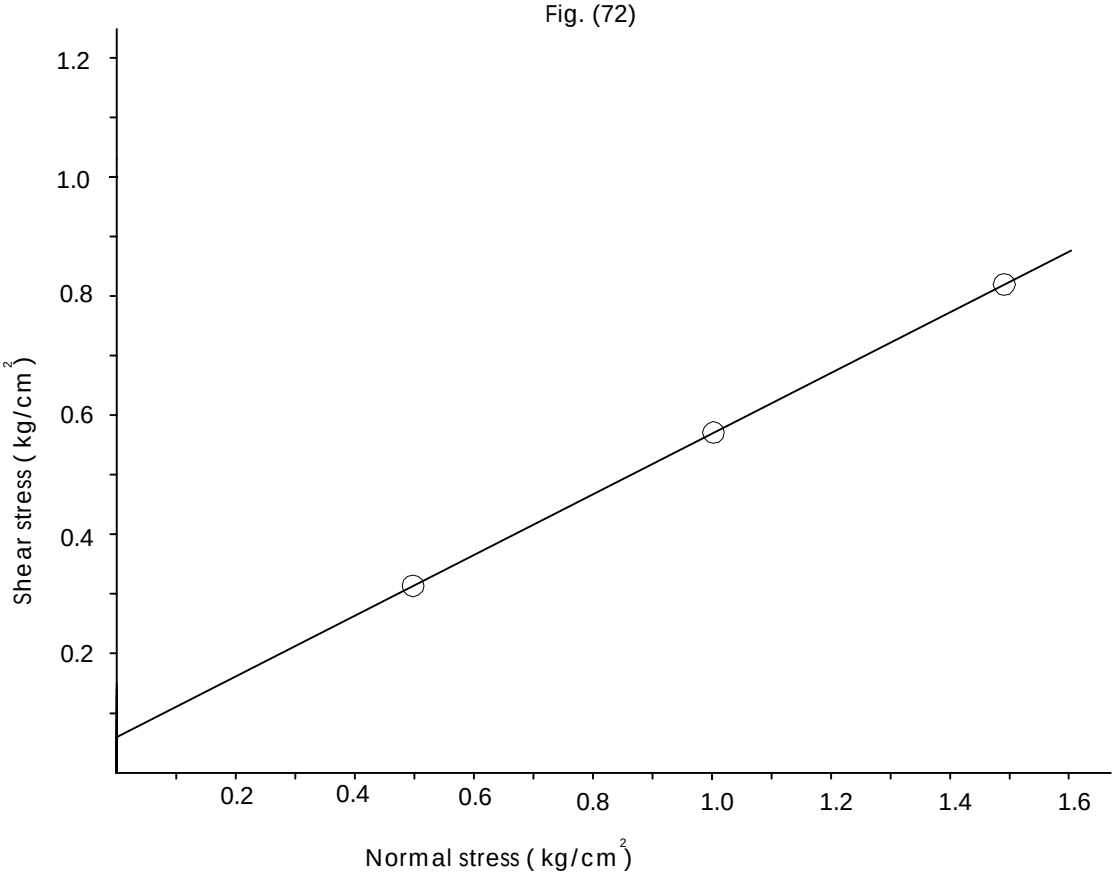
BH No.	Depth	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
BH-02	30.00	SM	0	75	25	0			

FIG.71



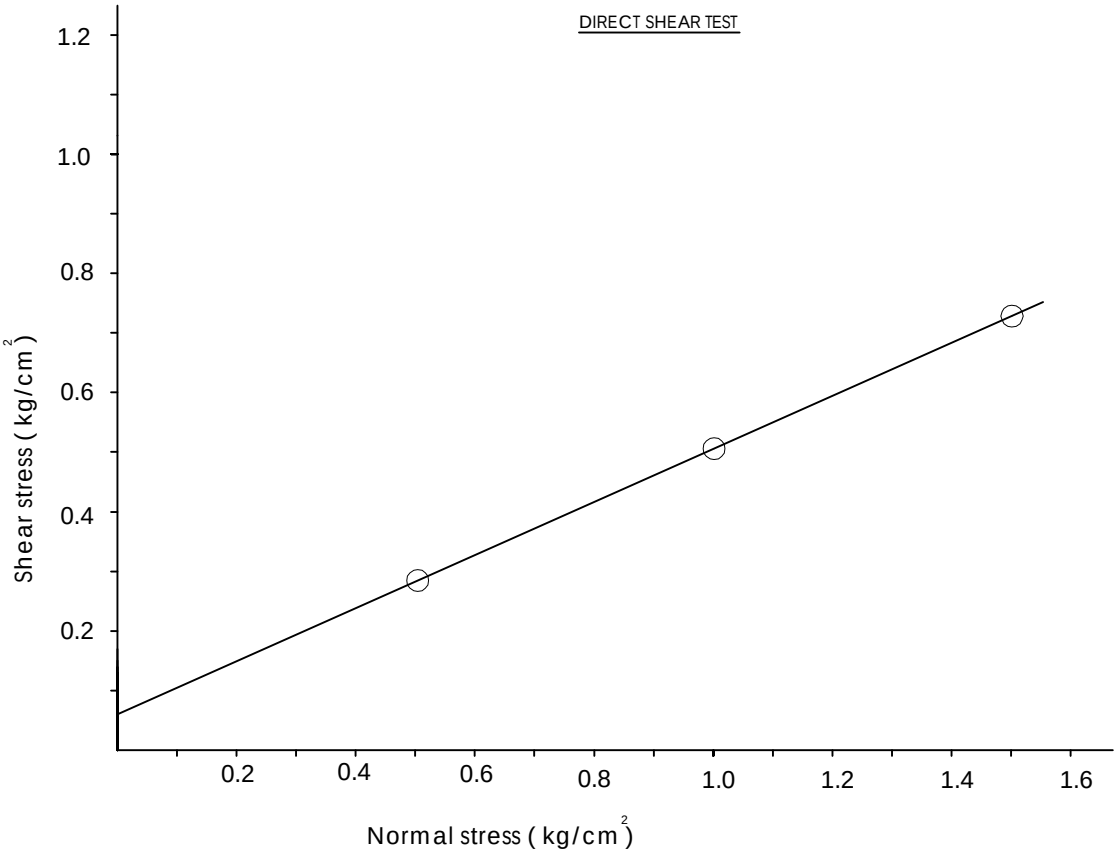
BORE HOLE NO: 02
SAMPLE NO : SPT-04
DEPTH : 6.00 M
C = 0.17 Kg/cm^2 Ø= 29°

Fig. (72)



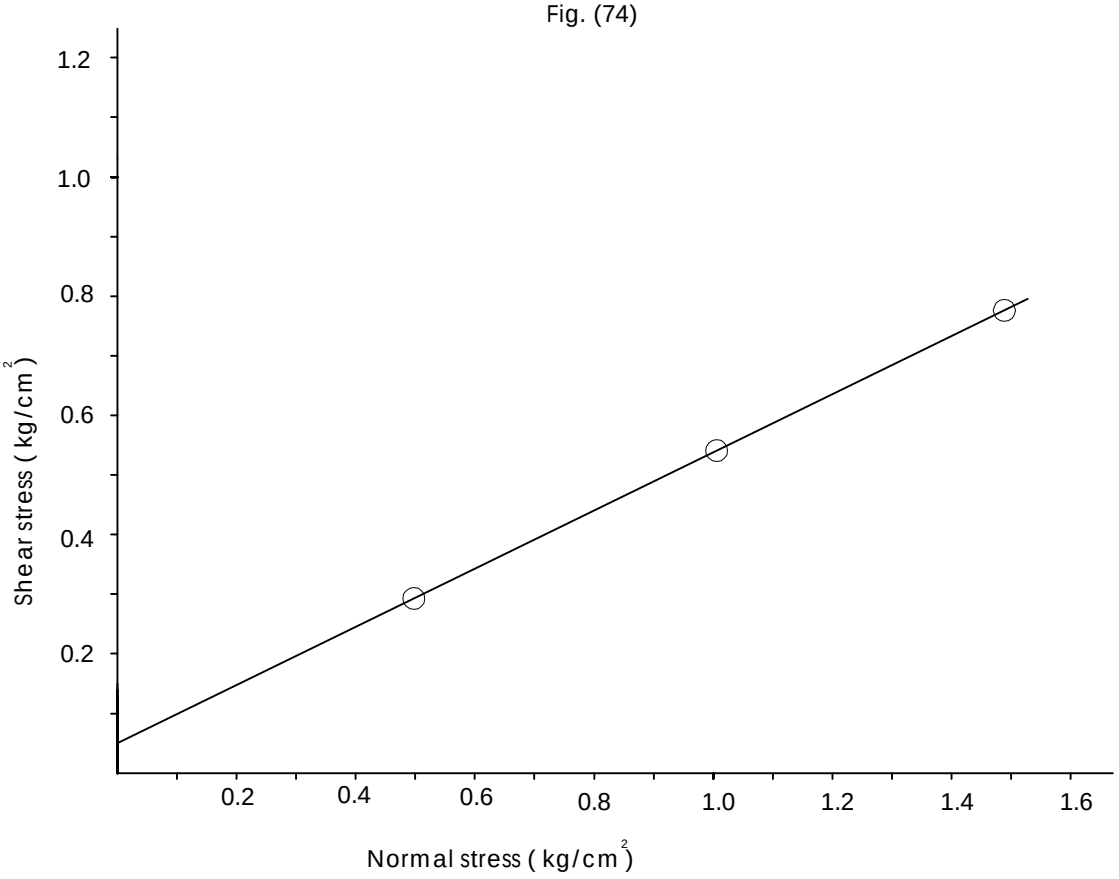
BORE HOLE NO: 02
SAMPLE NO : SPT-10
DEPTH : 13.00 M
C = 0.06 Kg/cm^2 Ø= 27°

Fig. (73)



BORE HOLE NO: 02
SAMPLE NO : SPT-17
DEPTH : 24.50 M
C = 0.06 Kg/cm^2 Ø= 24°

Fig. (74)



BORE HOLE NO: 02
SAMPLE NO : SPT-20
DEPTH : 30.00 M
C = 0.05 Kg/cm^2 Ø= 26°

Fig. (75)

	NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA	BORE HOLE NO. BH-02

LIQUEFACTION CALCULATIONS as per IS 1893:part-01:2016

$$FS = \frac{CRR}{CSR},$$

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

No. of layers	Soil Description	Depth		g_d	N_{avg}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, P_a (Pa)
		From (m)	To (m)				
Layer No.1	Gravely silty sand	0.00	-6.00	18.10	19	48600	100658
Layer No.2	Clayey sand	-6.00	-9.00	18.10	60	72900	100658
Layer No.3	Sandy clayey silt	-9.00	-11.5	19.70	75	111550	100658
Layer No.4	Silty sand	-11.5	-14.5	17.80	35	113100	100658
Layer No.5	Silty sand	-14.5	-16.0	17.80	23	124800	100659
Layer No.6	Sandy clayey silt	-16.0	-22.5	17.20	17	162000	100658
Layer No.7	Silty sand	-22.5	-28.5	17.30	23	208050	100658
Layer No.8	Silty sand	-28.5	-32.0	19.00	29	288000	100658

CRR (Cyclic Resistance Ratio) Calculations

$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

$$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2} - \frac{1}{200}$$

$$(N_1)_{60CS} = \alpha + \beta(N_1)_{60},$$

$$(N_1)_{60} = C_N N_{60},$$

$$C_N = \sqrt{\frac{P_a}{\sigma'_{vo}}} \le 1.7,$$

$$N_{60} = NC_{60},$$

$$C_{60} = C_{HT}C_{HW}C_{SS}C_{RL}C_{BD}.$$

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***Since, SPT equipment are of specified recommendations N_{60} = N obtained**

ALPHA, α	BETA, β	Fineness Content, FC
0	1	FC ≤ 5%
$e^{\wedge(1.76-(190/FC2))}$	$0.99+(FC^{1.5}/1000)$	5% < FC < 35%
0.5	1.2	FC ≥ 35%

N1 60 CS Calculations:

Layer	N_{60}	Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	C_N	$(N_1)_{60}$	Fineness Content, FC (%)	ALPHA, α	BETA, β	$(N_1)_{60CS}$
Layer No.1	19	48600	100658	1.44	27.34	14	2.205	1.042	**30.71**
Layer No.2	60	72900	100658	1.18	70.50	31	4.770	1.163	**86.74**
Layer No.3	75	111550	100658	0.95	71.24	40	0.500	1.200	**85.99**
Layer No.4	35	113100	100658	0.94	33.02	17	3.012	1.060	**38.01**
Layer No.5	23	124800	100659	0.90	20.66	30	4.706	1.154	**28.55**
Layer No.6	17	162000	100658	0.79	13.40	34	4.931	1.188	**20.85**
Layer No.7	23	208050	100658	0.70	16.00	20	3.615	1.079	**20.88**
Layer No.8	29	288000	100658	0.59	17.14	24	4.179	1.108	**23.17**

A	B	C	D
$\frac{1}{34-(N_1)_{60CS}}+$	$\frac{(N_1)_{60CS}}{135}+$	$\frac{50}{\left[10\times(N_1)_{60CS}+45\right]^2}-$	$-\frac{1}{200}$

$CRR_{7.5}$ VALUES

A	B	C	D	$CRR_{7.5}$
0.3037	0.2275	0.0004	0.005	0.5266
-0.0190	0.6425	0.0001	0.005	0.6186
-0.0192	0.6370	0.0001	0.005	0.6128
-0.2491	0.2816	0.0003	0.005	0.0278
0.1835	0.2115	0.0005	0.005	0.3904
0.0761	0.1545	0.0008	0.005	0.2263
0.0762	0.1547	0.0008	0.005	0.2267
0.0923	0.1716	0.0007	0.005	0.2596

K Sigma Calculations

$$K_\sigma = \left(\sigma'_{vo}/P_a\right)^{(f-1)}$$

Relative Density (%)	*f*
40 - 60	0.8 ~ 0.7
60 - 80	0.7 ~ 0.6
(f-1)	-0.3

Effective Overburden Pressure, σ'_{vo} (Pa)	Atmospheric Pressure, *P*a (Pa)	K_σ
48600	100658	1.2441
72900	100658	1.1016
111550	100658	0.9696
113100	100658	0.9656
124800	100659	0.9375
162000	100658	0.8670
208050	100658	0.8043
288000	100658	0.7295

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$$CRR = CRR_{7.5}(MSF)K_{\sigma}K_{\alpha},$$

CRR (Cyclic Resistance Ratio) Calculations:

Layers	$CRR_{7.5}$	MSF	K_{σ}	K_{α}	CRR
Layer No.1	0.5266	0.9996	1.2441	1.0000	0.6549
Layer No.2	0.6186	0.9996	1.1016	1.0000	0.6812
Layer No.3	0.6128	0.9996	0.9696	1.0000	0.5940
Layer No.4	0.0278	0.9996	0.9656	1.0000	0.0268
Layer No.5	0.3904	0.9996	0.9375	1.0000	0.3659
Layer No.6	0.2263	0.9996	0.8670	1.0000	0.1961
Layer No.7	0.2267	0.9996	0.8043	1.0000	0.1823
Layer No.8	0.2596	0.9996	0.7295	1.0000	0.1893

$$CSR = 0.65\left(\frac{a_{max}}{g}\right)\left(\frac{\sigma_{vo}}{\sigma'_{vo}}\right)r_d,$$

CSR (Cyclic Stress Ratio) Calculations:

Layers	a_{max}/g	Total Vertical Overburden Pressure, σ_{vo} (Pa)	Effective Overburden Pressure, σ'_{vo} (Pa)	Stress Reduction Factor, Y_d	CSR
Layer No.1	0.16	108600	48600	0.9541	0.2217
Layer No.2	0.16	162900	72900	0.9312	0.2164
Layer No.3	0.16	226550	111550	0.8670	0.1831
Layer No.4	0.16	258100	113100	0.7869	0.1867
Layer No.5	0.16	284800	124800	0.7468	0.1772
Layer No.6	0.16	387000	162000	0.5733	0.1424
Layer No.7	0.16	493050	208050	0.4131	0.1018
Layer No.8	0.16	608000	288000	0.3196	0.0702

*** peak ground acceleration (PGA) is not available, take a_{max}/g according to seismic zone factor:**

Seismic zone factor	II	III	IV	V
z	0.10	0.16	0.24	0.36

Stress Reduction Factor, Y_d	
1-0.00765**z**	$0 < z \leq 9.15$m
1.174-0.0267**z**	9.15m < **z** ≤ 23.0m

***z - depth below ground level (in metres)**

***if FOS<1, soil is assumed to be liquefy**

	Depth (m)	Factor Of Safety, FOS	Susceptibility against liquefaction
BoreHole No-02	6.00	2.95	Not Susceptible to liquefaction
	9.00	3.15	Not Susceptible to liquefaction
	11.5	3.24	Not Susceptible to liquefaction
	14.5	0.14	Not Susceptible to liquefaction
	16.0	2.06	Not Susceptible to liquefaction
	22.5	1.38	Not Susceptible to liquefaction
	28.5	1.79	Not Susceptible to liquefaction
	32.0	2.70	Not Susceptible to liquefaction

NAME OF WORK : GEOTECHNICAL INVESTIGATION WORKS IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA

Liquefaction Analysis Results

	Depth (m)		Factor Of Safety, FOS	Susceptibility against liquefaction
	To (m)	From (m)		
BoreHole No-02	0.00	6.00	2.95	Not Susceptible to liquefaction
	6.00	9.00	3.15	Not Susceptible to liquefaction
	9.00	11.5	3.24	Not Susceptible to liquefaction
	11.5	14.5	0.14	Not Susceptible to liquefaction
	14.5	16.0	2.06	Not Susceptible to liquefaction
	16.0	22.5	1.38	Not Susceptible to liquefaction
	22.5	28.5	1.79	Not Susceptible to liquefaction
	28.5	32.0	2.70	Not Susceptible to liquefaction

If FS < 1, then the soil is assumed to liquefy as per IS 1893 (Part - 1) : 2016

.

TABLE NO: 14

SOIL INVESTIGATION FOR THE PROPOSED RAW MATERIAL STORAGE AREA

CHEMICAL ANALYSIS ON WATER

BH No.	Test Results			
	Chlorides (PPM)	Salinity (PPM)	Sulphates (PPM)	PH Value
BH-01	15.0	27.09	Nil	7.0
BH-02	14.0	25.29	Nil	7.0

Permissible Limit as per IS 456:2000

	For PCC	For RCC
Chlorides (PPM)	**2000**	**500**
Sulphates (PPM)	**400**	**400**
Ph Value	**6 to 9**	**6 to 9**

TABLE NO: 15

SOIL INVESTIGATION FOR THE PROPOSED RAW MATERIAL STORAGE AREA

CHEMICAL ANALYSIS ON SOIL

BH No.	Depth below EGL (m)	Chlorides (%)	Sulphate (%)	Calcium Carbonate (%)	Calcium Carbonate (%)
BH-01	6.00	0.43	0.08	0.92	6.5
	13.0	0.31	0.03	1.59	7.0
BH-02	3.00	0.56	0.14	0.80	7.0
	24.5	0.56	0.09	1.48	7.0

ANNEXURE -03

TEST RESULTS OF LAB CBR TEST

In addition to the borehole studies done at site, the scope of works includes conducting a Lab CBR test. For this purpose, bulk sample is collected from a trial pit at the given location.

Modified Proctor Density testas per IS:2720 (Part 8) – RA 2015 and **soaked California Bearing Ratio** as per IS:2720 (Part 16) - 2016 in the laboratory on the bulk sample. The test results are compiled and given herewith in this annexure for further procedures.

Test Number	Grain size analysis(As per IS 2720 Part-4-1985)-RA-2015				Modified Proctor Test(As per IS 2720 Part-8-1985)-RA 2015		Soaked CBR (%)-As per IS 2720 (Part-16)-1987)-RA-2011
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Optimum Moisture Content (%)	Maximum Dry density (gm/cc)	
CBR-01	25	49	23	3	16.0	1.94	3.28
CBR-02	15	56	27	2	12.0	2.14	4.96
CBR-03	25	37	30	8	18.2	1.86	2.91

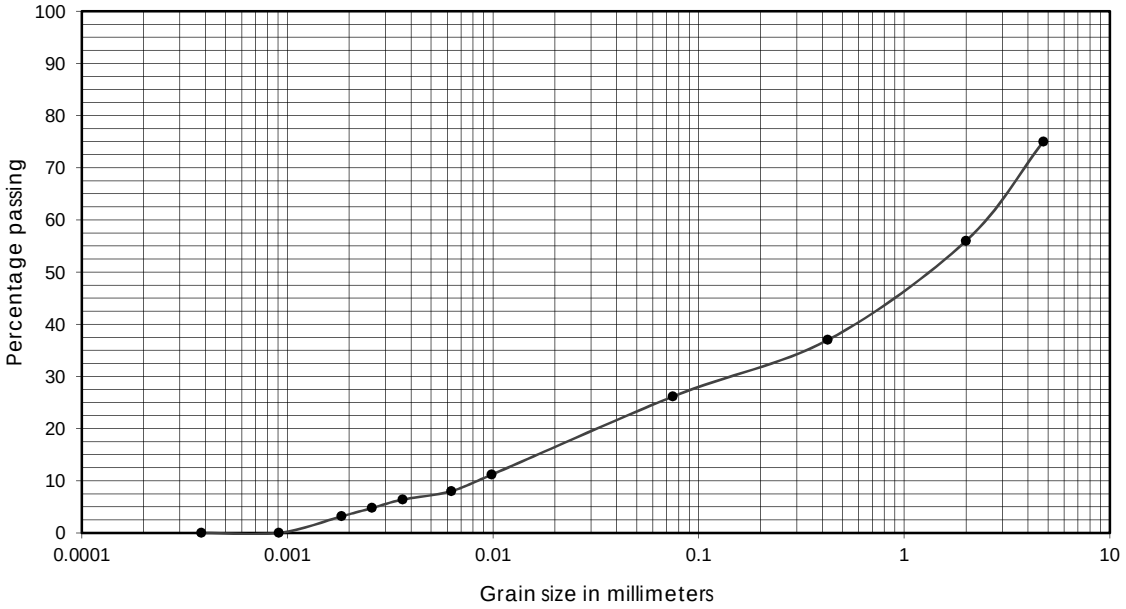
Test data is also provided herewith in subsequent pages.

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

NAME OF WORK : SOIL INVESTIGATION WORK FOR THE PROPOSED RAW MATERIAL STORAGE GODOWN

GRAINSIZE ANALYSIS TEST



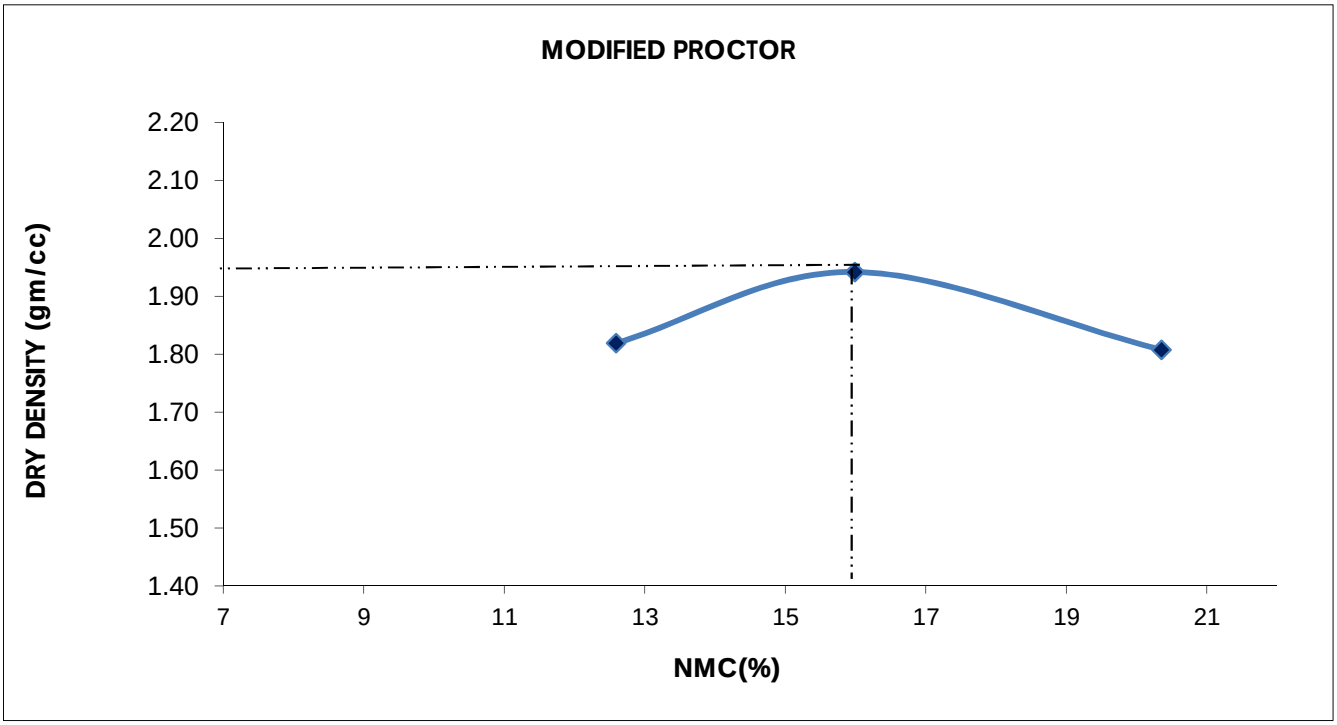
Sample	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
CBR-01	SM	25	49	23	3			

FIG.76

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

T/C-5397

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD FOR THE PROPOSED RAW MATERIAL STORAGE AREA



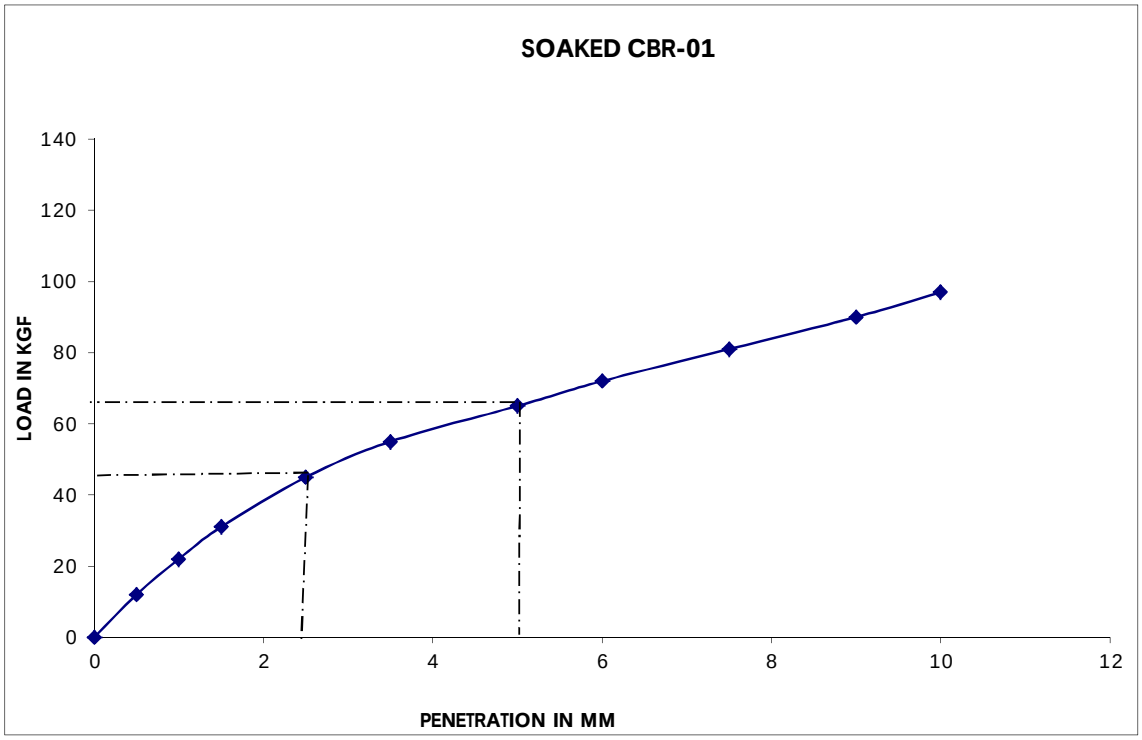
Test Results	
Bulk density	**: 2.25 gm/cc**
MDD	**: 1.94 gm/cc**
OMC	**: 16.0** %

FIG.77

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

PROJECT : SOIL INVESTIGATION WORK FOR THE PROPOSED RAW MATERIAL STORAGE GODOWN



Location	: Trial Pit-01
Type of Soil	: Silty sand with gravel and clay
Maximum Dry Density	: 1.94gm/cc
Optimum Moisture Content	: 16.00%
CBR Value	: 3.28%

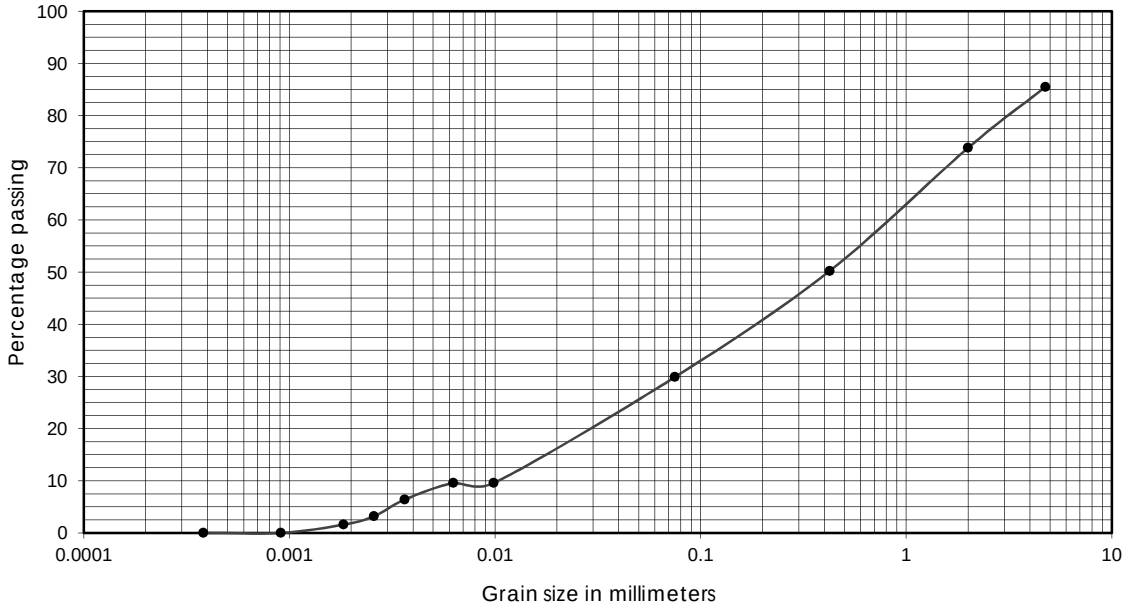
FIG.78

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

NAME OF WORK : SOIL INVESTIGATION WORK FOR THE NEW MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



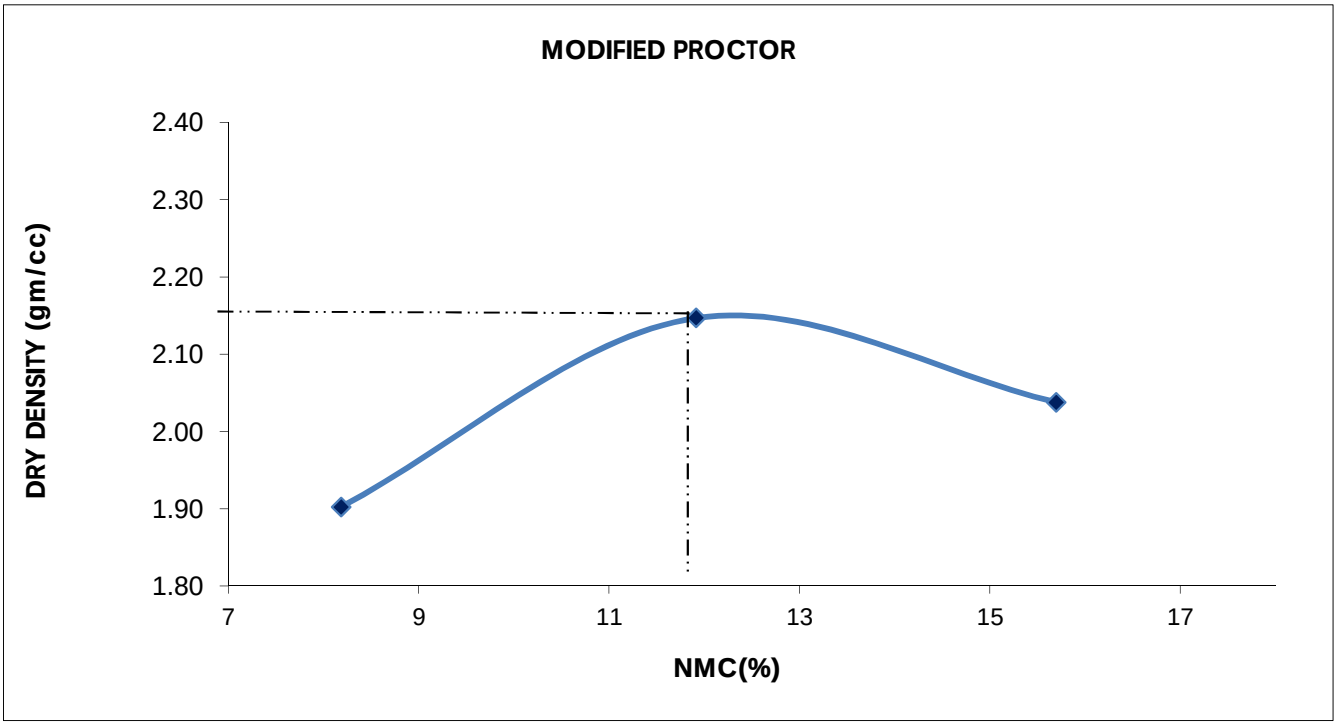
Sample	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
CBR-02	SM	15	56	27	2			

FIG.79

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

T/C-5397

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT



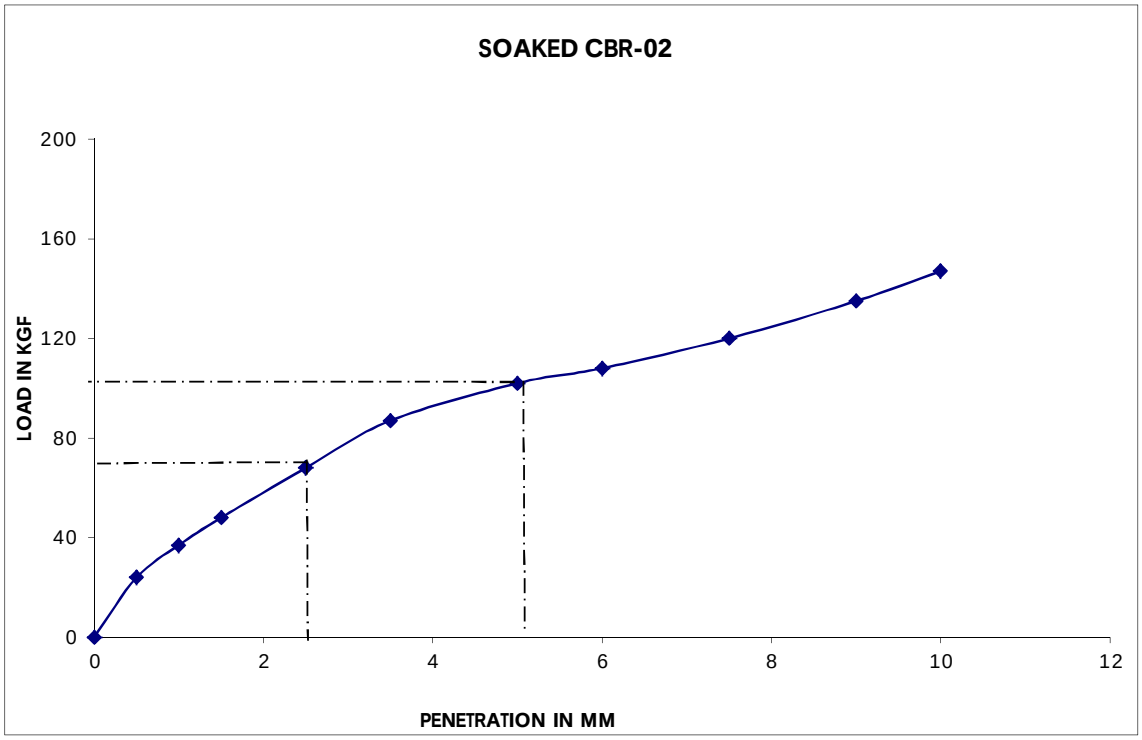
Test Results	
Bulk density	**: 2.39 gm/cc**
MDD	**: 2.14 gm/cc**
OMC	**: 12.0** %

FIG.80

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

PROJECT : SOIL INVESTIGATION WORK FOR THE NEW 1650 MTPD NPK PLANT



Location	: Trial Pit-02
Type of Soil	: Silty sand with gravel and clay
Maximum Dry Density	: 2.14gm/cc
Optimum Moisture Content	: 12.00%
CBR Value	: 4.96%

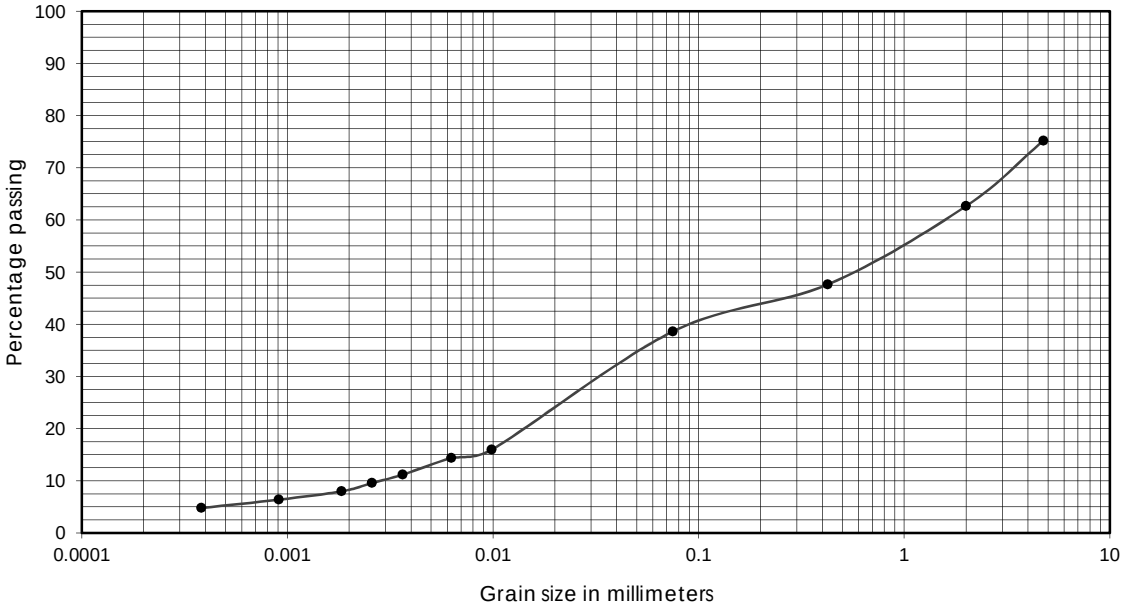
FIG.81

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

NAME OF WORK : SOIL INVESTIGATION WORK FOR THE NEW MTPD NPK PLANT

GRAINSIZE ANALYSIS TEST



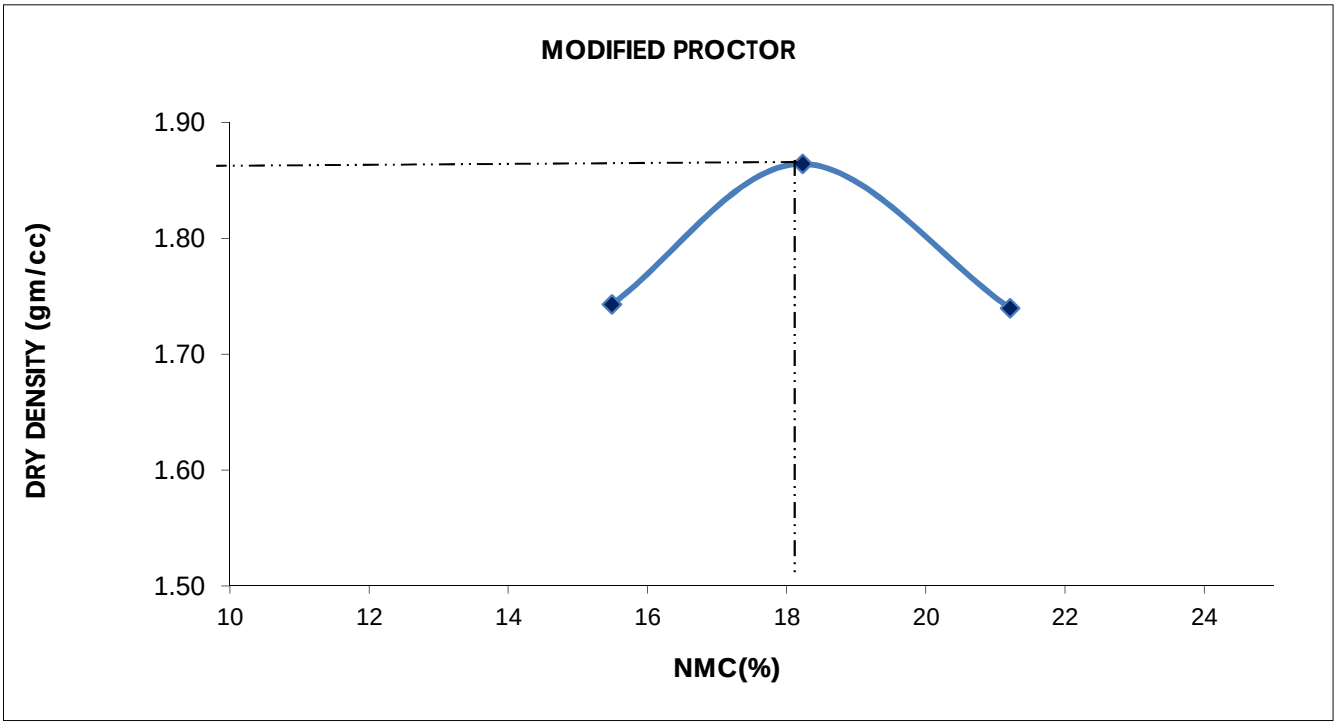
Sample	IS Class	Gravel(%)	Sand(%)	Silt(%)	Clay(%)	D60	D10	Cu
CBR-03	SM	25	37	30	8			

FIG.82

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

T/C-5397

NAME OF WORK : GEOTECHNICAL INVESTIGATION IN FACT-CD AT THE PROPOSED LOCATION OF THE NEW 1650 MTPD NPK PLANT



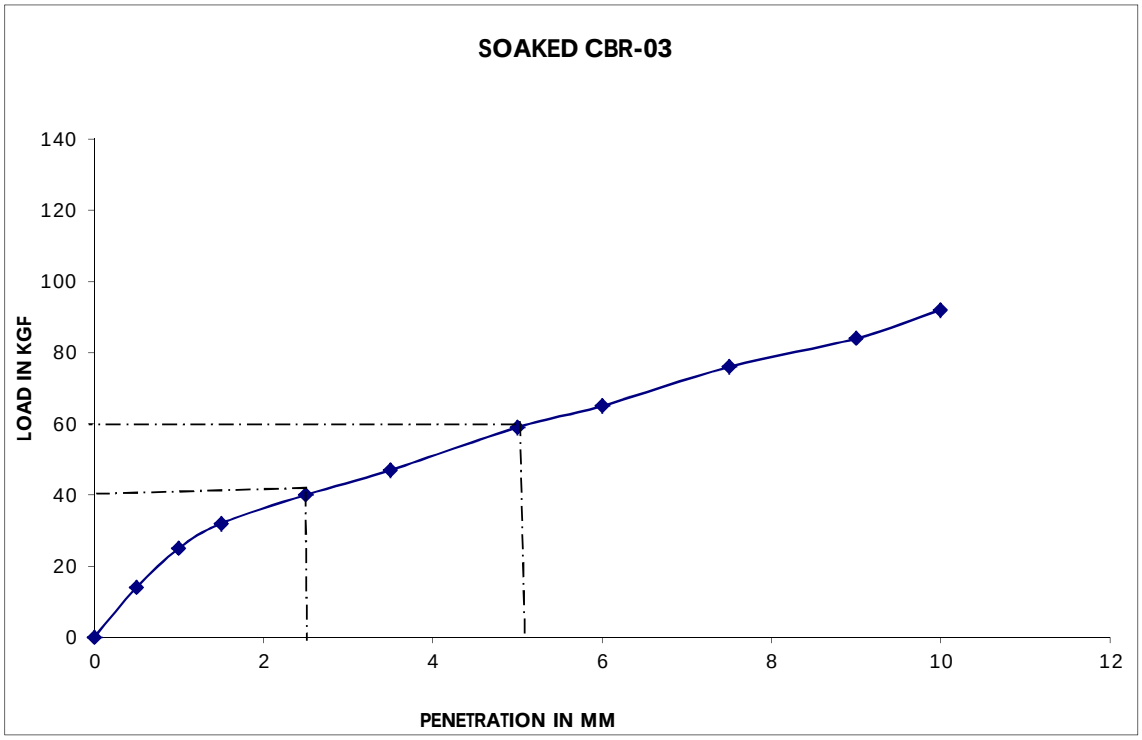
Test Results	
Bulk density	**: 2.19 gm/cc**
MDD	**: 1.86 gm/cc**
OMC	**: 18.2** %

FIG.83

GEO FOUNDATIONS AND STRUCTURES PVT. LTD

TC-5397

PROJECT : SOIL INVESTIGATION WORK FOR THE NEW 1650 MTPD NPK PLANT



Location	: Trial Pit-03
Type of Soil	: Silty sand with gravel and clay
Maximum Dry Density	: 1.86gm/cc
Optimum Moisture Content	: 18.20%
CBR Value	: 2.91%

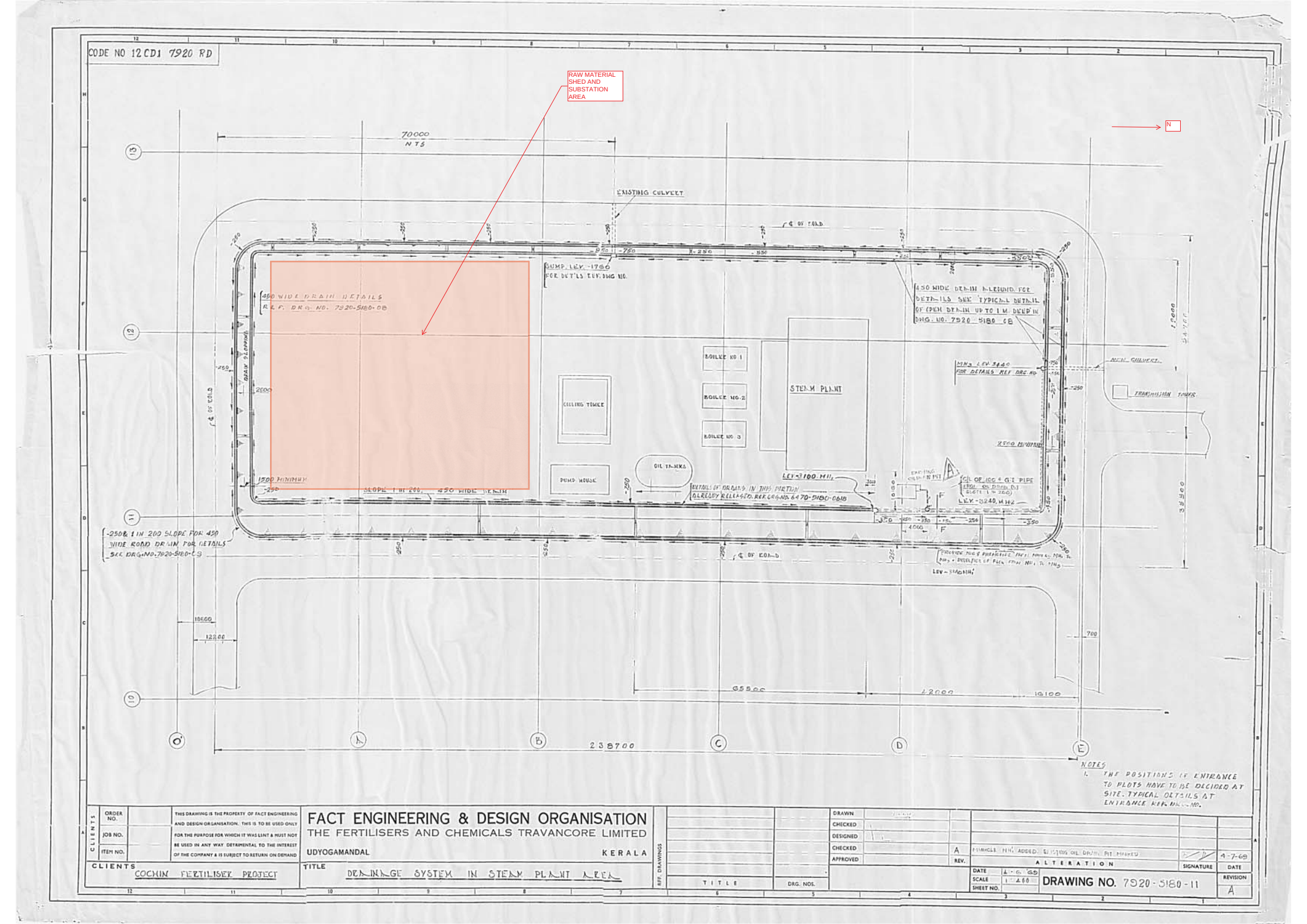
FIG.84

ANNEXURE B-2

ANNEXURE – B-2

DRAWINGS OF DRAINAGE

SYSTEM



CLIENTS

ORDER NO.	
JOB NO.	
ITEM NO.	

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CLIENTS COCHIN FERTILISER PROJECT

FACT ENGINEERING & DESIGN ORGANISATION

THE FERTILISERS AND CHEMICALS TRAVANCORE LIMITED

UDYOGAMANDAL KERALA

TITLE DRAINAGE SYSTEM IN STEAM PLANT AREA

REF. DRAWINGS

TITLE

DRG. NOS.

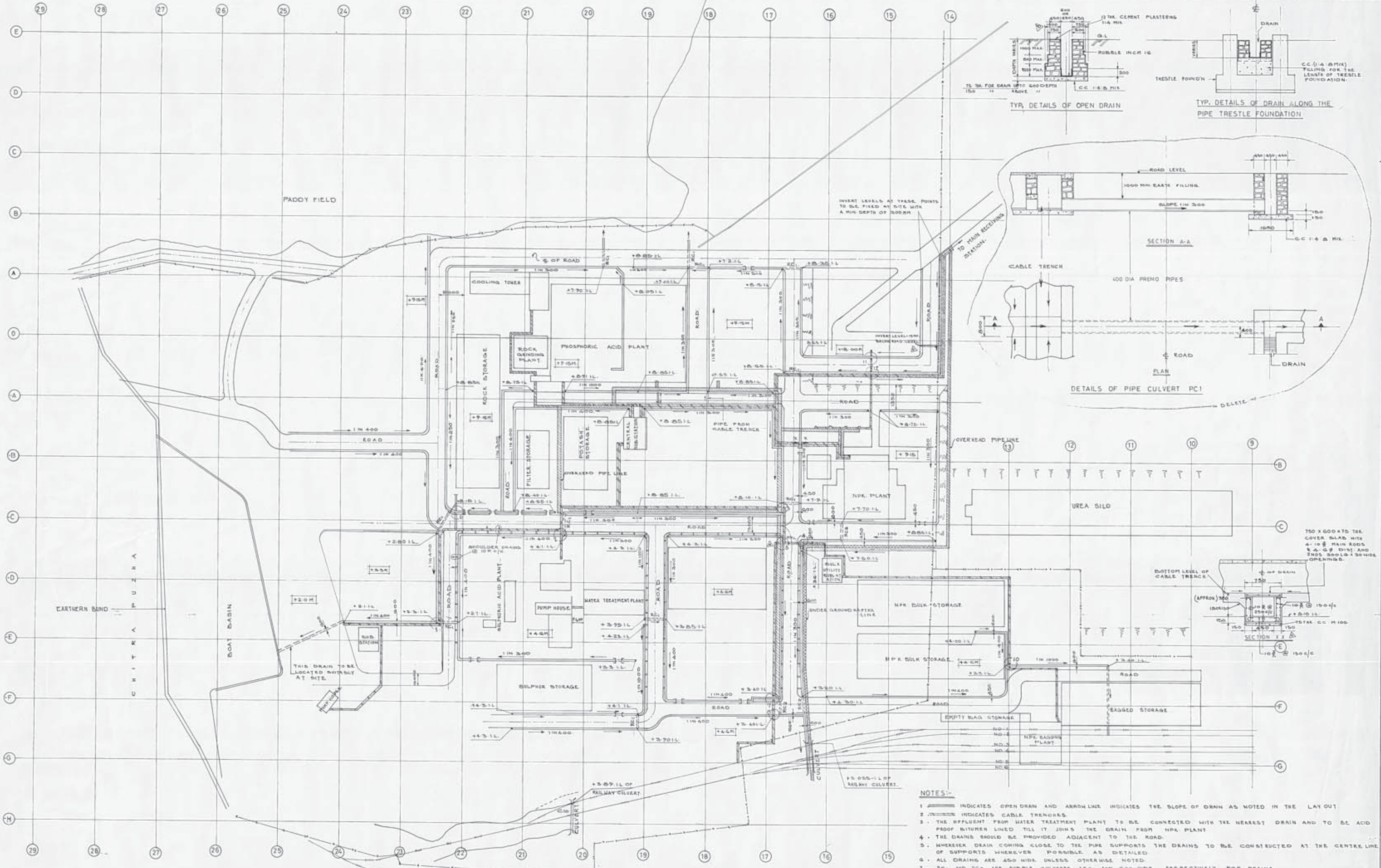
DRAWN			
CHECKED			
DESIGNED			
CHECKED			
APPROVED			

REV.	ALTERATION	SIGNATURE	DATE
A	3 NOS. MH ADDED IN STEAM OIL DRAIN PIT MARKED		4-7-68

DATE	2-6-68
SCALE	1:200
SHEET NO.	

DRAWING NO. 7920-5180-11

REVISION A



NOTES:-

1. ═══ INDICATES OPEN DRAIN AND ARROW LINE INDICATES THE SLOPE OF DRAIN AS NOTED IN THE LAY OUT
2. ═══ INDICATES CABLE TRENCHES.
3. THE EFFLUENT FROM WATER TREATMENT PLANT TO BE CONNECTED WITH THE NEAREST DRAIN AND TO BE ACID PROOF BITUMEN LINED TILL IT JOINS THE DRAIN FROM NPK PLANT
4. THE DRAINS SHOULD BE PROVIDED ADJACENT TO THE ROAD.
5. WHEREVER DRAIN COMING CLOSE TO THE PIPE SUPPORTS THE DRAINS TO BE CONSTRUCTED AT THE CENTRE LINE OF SUPPORTS WHEREVER POSSIBLE AS DETAILED
6. ALL DRAINS ARE 450 WIDE UNLESS OTHERWISE NOTED.
7. RC1 AND RC2 ARE RUBBLE CULVERTS 450 AND 600 WIDE RESPECTIVELY FOR DRAINS.
8. JUNCTIONS MARKED NO1 TO 12 ARE CABLE TRENCH CROSSINGS FOR DETAILS REF LAY OUT OF CABLE TRENCHES
9. AT JUNCTIONS MARKED 1,2,4,5 AND 7 TO 12, SUITABLE PIPES TO BE PROVIDED AT SITE TO DRAINS FROM THE NEAREST CABLE TRENCHES FOR DRAINAGE OF WATER REF LAYOUT OF CABLE TRENCHES FOR FURTHER DETAILS
10. ═╪═ INDICATES ENTRANCE TO PLANT AREA. PROVIDE 150 THK. COVER SLABS WITH 12 ϕ MAIN RODS @ 200 c/c AND 10 ϕ DISTRIBUTERS @ 250 c/c FOR DRAINS AT THIS PORTIONS

CLIENTS: COCHIN PHASE II

DRG. NO	TITLE
	DETAILS OF RC1, RC2 AND MANHOLE MH1

REFERENCE DRAWINGS

S. NO.	ZONE	PARTICULARS	INITIAL	DATE
D		CROSSING NO15 SHIFTED AND NOTE '10' ADDED		
C		ENTRANCE TO PLANT AREA ADDED & DIRECTION OF DRAINS NEAR BULK STORAGE CHANGED		
C		CROSSINGS 3,4,5 & 6 SHIFTED BY CHANGING THE ROUTE OF CABLE TRENCH		
B		DRAINS MODIFIED THIS REVISION CANCELLS ALL PREVIOUS ISSUES		
A		DETAILS OF DRAINS, CULVERTS ETC ADDED		

REVISION

SCALE:
DATE: 1-10-1982
DRAWN: MGK TRACED: [illegible]
CHECKED / DESIGNED / CHECKED / APPROVED

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LIMITED
UDYOGAMANDAL, KERALA

TITLE: COCHIN FERTILISER PROJECT PHASE II
LAY OUT OF DRAINS

SHEET OF

DRG. No. 0716-7923-5180-0002 R0

ANNEXURE – C-1

SPECIAL REQUIREMENTS FOR FRP COOLING TOWER

(OSBL)

ANNEXURE C1

Job No.	:	**32687**
Item	:	**FRP COOLING TOWER (OSBL)**
Item No.	:	**-**
Project	:	**NEW 1650 MTPD NPK PLANT AT FACT-CD AMBALAMEDU ON LSTK BASIS**
Client	:	**FACT-CD**
Location	:	**AMBALAMEDU, COCHIN**

REV.	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED
0	08.02.2021	FOR ENQUIRY	LA	SK	AAN

FACT ENGINEERING AND DESIGN ORGANISATION

FEDO

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 The cooling tower shall consist of single unit with two independent cells. Each cell shall be designed for independent handling of **60%** of the rated flow required for the complete unit. Cooling water basin shall have two partitions corresponding to each cell and these shall be interconnected with suitable piping systems. The scope of work includes complete design, fabrication, supply, erection, testing and commissioning of the FRP cooling tower.

1.2 To ensure safety of personnel at the time of working on cooling tower, necessary provisions shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments.

2.0 SCOPE OF WORK AND DELIVERABLES

Design, Supply, Installation, Commissioning and testing of FRP cooling tower and accessories, hereafter referred to as cooling tower system. Specifications of cooling tower system are given in the following sections.

2.1 MAJOR TASKS INVOLVED IN THE JOB ARE AS FOLLOWS:

2.1.1 Design, fabrication, installation and commissioning of a FRP cooling tower system along with all the specified accessories.

2.1.2 Supply, installation and commissioning of necessary motors, pumps, Fans, piping and pipe supports.

2.1.3 Supply and installation of necessary accessories like valves, pressure gauges, temperature gauges, flow meter, etc for efficient working of the cooling tower.

2.1.4 Supply and installation of chlorinator with suitable booster pump including its installation for the specific dosage of chlorine in all respects.

2.1.5 Complete design and construction of FRP tower including cold water basin, cooling tower and FRP super structure as allied systems for cooling tower system.

2.1.6 Supply, installation of the associated electrical equipments.

2.1.7 Inspection, commissioning and Performance testing of Cooling Tower as per CTI-ATC 105 standard.

2.1.8 Any other item/ work required for satisfactory and safe working of the cooling tower system.

3.0 COOLING TOWER (PACKAGED COOLING TOWER)

3.1 The cooling tower may be located at a well ventilated place at ground level. In addition there shall be ample open space all around cooling towers for free flow of air.

3.2 SPECIFICATIONS:-

Sl No	Description	Specification
1.	Type	Mechanical draft - Induced – Counter flow
2.	Construction of cooling tower	In Fibre glass Reinforced Plastic (FRP) construction in Stainless steel 304/Pultruded FRP supporting frame work with PVC fill
3.	Basin	RCC

4.	Rating and certification	To be rated for the heat rejection capacity.
5.	Range-Design	The Cooling tower shall be designed to cool the requisite quantity of water through a range of around 6 to 8 degree C against the prevailing wet bulb temperature.
6.	Design Ambient Air Wet bulb temp (Deg C)	29
7.	Wet Bulb approach-Design	The cooling tower shall be selected for a wet bulb approach of not more than 3.5 degree C.
8.	Outlet temperature:	The cold-water temperature from the cooling tower shall match the entering temperature for the requisite equipment.
9.	Heat to be rejected in the Cooling Tower (Rated)	To Suit the heat rejection capacity envisaged with sufficient margin
10	Flow rate:	The water flow rate through the cooling tower shall match the requisite equipments with sufficient margin
11	No of Cells	Two Nos.(2W+0S)
12	Capacity of Each cell	Each cell shall be designed for independent handling of 60% of the rated flow required for the complete unit.
13	Fan per cell	1 No
14	Fan Drive	Electric Motor with Variable Frequency Drive
15	Cold Water Pumps	2W+1S –CS/CI-Electric Motor Driven
16	HW inlet Temperature	Bidder to furnish
17	CW outlet temperature	Bidder to furnish
18	Cold Water Pump Type and Capacity	Horizontal-Centrifugal
19	Side Stream filter unit	1 No
20	Dosing Unit	Facilities for the chemical treatment of Cooling water shall be provided in LSTK bidder scope. Supply of chemicals for the chemical treatment of Cooling water shall be in client scope.

NOTES:-

1) **Sand filter (Side stream filter) unit shall be complete with back wash arrangements like sand filter blower (air scouring blower) (1W+1S), necessary piping etc. Sand filter to be installed at cooling water pump discharge header side and outlet of Sand filter routed back to cooling tower basin. Sand filter to be suitably designed to obtain the suspended solid value of 5 PPM at the outlet for the specified raw water characteristics.**
2) **Cooling tower blow down and Sand filter backwash water shall be routed to ETP through collection pit and pump.**
3) **Copper and Copper based Copper and Copper based materials shall not be used.**

3.3 MATERIAL AND CONSTRUCTION

3.3.1 Fibre glass Reinforced Plastic (FRP) Cooling tower in SS supporting framework

3.3.2 The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary.

3.3.3 The cooling tower shall be induced draft type, with FRP casing in rectangular shape, and with RCC basin to match the shape of the casing.

3.3.4 The supporting framework for the tower casing shall be in Stainless steel 304/ Pultruded FRP considering the overall corrosive nature of the surrounding area. Also fasteners, and all other wetted metallic parts shall be in Stainless Steel.

3.3.5 The fills shall be of PVC. Thickness of PVC fills shall not be less than 0.2 mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.

3.3.6 The water distribution shall be through fixed type spray nozzles in Poly Propylene ensuring uniform water loading and distribution of water over the fill.

3.3.7 Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material.

3.3.8 The fan shall be multi-blade axial flow type, made of FRP. The fan assembly shall be statically and dynamically balanced.

3.3.9 The fan drive shall be from a three phase induction motor, either direct or through a spiral gear work.

3.3.10 The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.

3.3.11 To ensure safety of personnel at the time of working on cooling tower a steel ladder shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments. The ladder shall be bolted to the tower at the top and grouted in masonry at the bottom end.

4.0 COOLING WATER PUMPS (2W+1S)

4.1.1 The cooling water pumps shall be of centrifugal back pull out type construction having mechanical seal and oil lubricated. The pumps shall be centrifugal type direct driven with a 3 phase, 415 + 10%volts, 50 Hz., A.C. motor. The pumps shall be suitable for continuous operation in the system.

4.1.2 Three Numbers of cold water pumps shall be supplied, (Two shall be operational and one standby) with suitable NRV at delivery lines. The pumps shall be driven by a Squirrel cage Induction motor of suitable HP to supply the rated water flow required for the cooling tower unit complete to the required head and with sufficient margin. Provision to be made to operate each pump independently or in any two pumps configuration. The motor shall be TEFC type and class ‘F’ insulation and of approved makes.

4.1.3 Cold Water pumps shall be housed in covered roofs of structural steel.

4.2 MATERIALS AND CONSTRUCTION

4.2.1 The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.

4.2.2 The impeller shall be of Cast Iron or as per manufacturer’s standard. This shall be shrouded type with machined collars. The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.

4.2.3 The shaft shall be of stainless steel or CS and shall be accurately machined. The shaft shall be

balanced to avoid vibrations at any speed within the operating range of the pump.

4.2.4 The shaft sleeve shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.

4.2.5 The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated (or oil lubricated as per standards) and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.

4.2.6 The shaft seal shall be stuffing box type, so as to allow minimum leakage compatible with the operation of the seal. The stuffing box shall be of adequate length and shall be packed with graphite asbestos or any other suitable material for the operating temperature. A drip well shall be provided beneath the seal.

4.2.7 The pump shall be directly coupled to the motor shaft through, a flexible coupling protected by a coupling guard.

4.2.8 The pump and motor shall be mounted on a common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.

5.0 COOLING TOWER BASIN

5.1 The cooling tower basin shall be of RCC construction, Actual capacity shall be designed taking into consideration water flow rate, drift and evaporation losses so as to run the cooling tower on full load without makeup water for at least 8 hrs per day. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin. The cooling tower basin with partition in between shall be such that the cold water pumps are always flooded with cooling water thereby avoiding the use of priming pumps, etc. Suitable isolation arrangements of individual basin enclosures from forebay space to be provided for maintenance purpose. Suitable piping and valve arrangements to be provided with the individual basins for filling the treated water, draining the basins during maintenance/ blowdown, and for overflow provisions.

6.0 COOLING FILL UNITS

6.1 The cooling fill unit shall be so designed that maximum duration of contact between water and air is achieved. The cooling fill shall be made of PVC and suitably arranged to give the maximum performance. The frames holding the fill in position shall be of stainless steel. The fill support shall be of Stainless steel construction. Thickness of PVC fills shall not be less than 0.2mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.

7.0 DRIFT ELIMINATORS

7.1 The drift eliminators should be of PVC material laid down as per acceptable standard and designed to operate with minimum pressure drop and maximum efficiency. This arrangement should be suitably supported on Stainless steel structure Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets.

8.0 FAN STACK/CASING

8.1 Separate fan casing is required for each cell, made of FRP with suitable diameter and shape

to provide free flow of air.

9.0 HOT WATER DISTRIBUTION AND SPRAY NOZZLES

9.1 Hot water distribution system shall be designed for a water load of 115% of the circulation rate. The internal distribution of hot water in the cooling tower shall be of pressurized closed loop with self-adjusting, non-clogging and self-cleaning type of polypropylene spray nozzles. The water distributions over the fill are to be uniform and free from dead zones, thereby attaining a better overall performance.

9.2 Material of Construction for Hot Water distribution:

- Hot Water Header pipe (inside tower): SS 304/PVC
- Hot Water Laterals / Branch Pipes: PVC
- Distribution/ Spray Nozzles: PP

10.0 FAN ASSEMBLY

10.1 Individual sets of fan assembly unit shall be provided for each cell so that the cells can be operated either individually or together. The fan assembly and drive system shall be designed for totally vibration free operation. Suitable lighting arrangements in the tower top shall also be provided.

11.0 FAN ELECTRIC MOTOR

11.1 The electric motors to drive the fan of each cell shall be of adequate capacity. Motors shall be Induction type, 3 phase, 50 cycles, 415± 10% Volts and they shall be totally enclosed and fan cooled. Start and stop controls to be provided both at the control panel and at the top of the cooling tower and shall be of manual reset type. The motors shall be provided with suitable push button operated direct On-line Starters and all required electrical accessories. The motor shall be TEFC type and class ‘F’ insulation and of approved makes. Variable frequency Drive shall be provided for the fan motor.

11.2 Motors for cooling tower fan drive shall have horse power ratings including service factor, if any, at least equal to the following percentage of rated brake horse power.

Nameplate rating, KW	% above rated BHP
18.5 and less	125
Above 18.5 & below 75	115
75 and above	110

11.3 Gear losses and transmission losses (as applicable) shall be added to fan power consumption before driver ratings are applied.

12.0 TESTS AND INSPECTION

12.1 The Cooling tower unit after complete erection and commissioning shall be field tested for performance. As far as possible the test shall be conducted at a time when the atmospheric conditions are close to the design conditions.

12.2 The test shall be conducted in accordance with “Acceptance test code for water-cooling

tower of Cooling Tower Institute CTI-ATC 105 latest revisions". Measuring gauges/instruments required for these tests shall be provided by the vendor. Provision will be made to connect the gauges/instruments at appropriate location in the pipelines.

****

ANNEXURE – C-2

SPECIAL REQUIREMENTS FOR FRP COOLING TOWER

(ISBL)

ANNEXURE C2

TECHNICAL PROCUREMENT SPECIFICATION	SPECIAL REQUIREMENTS FOR FRP COOLING TOWER (ISBL)	32687–01–PS–001 SPL2	
		Page 1 of 8	R 0

Job No.	:	**32687**
Item	:	**FRP COOLING TOWER (ISBL)**
Item No.	:	**-**
Project	:	**NEW 1650 MTPD NPK PLANT AT FACT-CD AMBALAMEDU ON LSTK BASIS**
Client	:	**FACT-CD**
Location	:	**AMBALAMEDU, COCHIN**

REV.	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED
0	08.02.2021	FOR ENQUIRY	LA	SK	AAN

FACT ENGINEERING AND DESIGN ORGANISATION

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 The cooling tower shall consist of single unit with two independent cells. Each cell shall be designed for independent handling of **100%** of the rated flow required for the complete unit. Cooling water basin shall have two partitions corresponding to each cell and these shall be interconnected with suitable piping systems. The scope of work includes complete design, fabrication, supply, erection, testing and commissioning of the FRP cooling tower.

1.2 To ensure safety of personnel at the time of working on cooling tower, necessary provisions shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments.

2.0 SCOPE OF WORK AND DELIVERABLES

Design, Supply, Installation, Commissioning and testing of FRP cooling tower and accessories, hereafter referred to as cooling tower system. Specifications of cooling tower system are given in the following sections.

2.1 MAJOR TASKS INVOLVED IN THE JOB ARE AS FOLLOWS:

2.1.1 Design, fabrication, installation and commissioning of a FRP cooling tower system along with all the specified accessories.

2.1.2 Supply, installation and commissioning of necessary motors, pumps, Fans, piping and pipe supports.

2.1.3 Supply and installation of necessary accessories like valves, pressure gauges, temperature gauges, flow meter, etc for efficient working of the cooling tower.

2.1.4 Supply and installation of chlorinator with suitable booster pump including its installation for the specific dosage of chlorine in all respects.

2.1.5 Complete design and construction of FRP tower including cold water basin, cooling tower and FRP super structure as allied systems for cooling tower system.

2.1.6 Supply, installation of the associated electrical equipments.

2.1.7 Inspection, commissioning and Performance testing of Cooling Tower as per CTI-ATC 105 standard.

2.1.8 Any other item/ work required for satisfactory and safe working of the cooling tower system.

3.0 COOLING TOWER (PACKAGED COOLING TOWER)

3.1 The cooling tower may be located at a well ventilated place at ground level. In addition there shall be ample open space all around cooling towers for free flow of air.

3.2 SPECIFICATIONS:-

Sl No	Description	Specification
1.	Type	Mechanical draft - Induced – Counter flow
2.	Construction of cooling tower	In Fibre glass Reinforced Plastic (FRP) construction in Stainless steel 304/Pultruded FRP supporting frame work with PVC fill
3.	Basin	RCC

4.	Rating and certification	To be rated for the heat rejection capacity.
5.	Range-Design	The Cooling tower shall be designed to cool the requisite quantity of water through a range of around 6 to 8 degree C against the prevailing wet bulb temperature.
6.	Design Ambient Air Wet bulb temp (Deg C)	29
7.	Wet Bulb approach-Design	The cooling tower shall be selected for a wet bulb approach of not more than 3.5 degree C.
8.	Outlet temperature:	The cold-water temperature from the cooling tower shall match the entering temperature for the requisite equipment.
9.	Heat to be rejected in the Cooling Tower (Rated)	To Suit the heat rejection capacity envisaged with sufficient margin
10	Flow rate:	The water flow rate through the cooling tower shall match the requisite equipments with sufficient margin
11	No of Cells	Two Nos.(1W+1S)
12	Capacity of Each cell	Each cell shall be designed for independent handling of 100% of the rated flow required for the complete unit.
13	Fan per cell	1 No
14	Fan Drive	Electric Motor with Variable Frequency Drive
15	Cold Water Pumps	2W+1S–CS/CI-Electric Motor Driven
16	HW inlet Temperature	Bidder to furnish
17	CW outlet temperature	Bidder to furnish
18	Cold Water Pump Type and Capacity	Horizontal-Centrifugal
19	Side Stream filter unit	1 No
20	Dosing Unit	Facilities for the chemical treatment of Cooling water shall be provided in LSTK bidder scope. Supply of chemicals for the chemical treatment of Cooling water shall be in client scope.

NOTES:-

1) **Sand filter (Side stream filter) unit shall be complete with back wash arrangements like sand filter blower (air scouring blower) (1W+1S), necessary piping etc. Sand filter to be installed at cooling water pump discharge header side and outlet of Sand filter routed back to cooling tower basin. Sand filter to be suitably designed to obtain the suspended solid value of 5 PPM at the outlet for the specified raw water characteristics.**
2) **Cooling tower blow down and Sand filter backwash water shall be routed to ETP through collection pit and pump.**
3) **Copper and Copper based materials shall <u>not</u> be used.**

3.3 MATERIAL AND CONSTRUCTION

3.3.1 Fibre glass Reinforced Plastic (FRP) Cooling tower in SS supporting framework

3.3.2 The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as

may be necessary.

3.3.3 The cooling tower shall be induced draft type, with FRP casing in rectangular shape, and with RCC basin to match the shape of the casing.

3.3.4 The supporting framework for the tower casing shall be in Stainless steel 304 / Pultruded FRP considering the overall corrosive nature of the surrounding area. Also fasteners, and all other wetted metallic parts shall be in Stainless Steel.

3.3.5 The fills shall be of PVC. Thickness of PVC fills shall not be less than 0.2 mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.

3.3.6 The water distribution shall be through fixed type spray nozzles in Poly Propylene ensuring uniform water loading and distribution of water over the fill.

3.3.7 Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material.

3.3.8 The fan shall be multi-blade axial flow type, made of FRP. The fan assembly shall be statically and dynamically balanced.

3.3.9 The fan drive shall be from a three phase induction motor, either direct or through a spiral gear work.

3.3.10 The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.

3.3.11 To ensure safety of personnel at the time of working on cooling tower a steel ladder shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments. The ladder shall be bolted to the tower at the top and grouted in masonry at the bottom end.

4.0 COOLING WATER PUMPS (2W+1S)

4.1.1 The cooling water pumps shall be of centrifugal back pull out type construction having mechanical seal and oil lubricated. The pumps shall be centrifugal type direct driven with a 3 phase, 415 + 10%volts, 50 Hz., A.C. motor. The pumps shall be suitable for continuous operation in the system.

4.1.2 Three Numbers of cold water pumps shall be supplied, (Two shall be operational and one standby) with suitable NRV at delivery lines. The pumps shall be driven by a Squirrel cage Induction motor of suitable HP to supply the rated water flow required for the cooling tower unit complete to the required head and with sufficient margin. Provision to be made to operate each pump independently or in any two pumps configuration. The motor shall be TEFC type and class ‘F’ insulation and of approved makes.

4.1.3 Cold Water pumps shall be housed in covered roofs of structural steel

4.2 MATERIALS AND CONSTRUCTION

4.2.1 The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.

4.2.2 The impeller shall be of Cast Iron or as per manufacturer’s standard. This shall be shrouded type with machined collars. The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.

4.2.3 The shaft shall be of stainless steel or CS and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.

4.2.4 The shaft sleeve shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.

4.2.5 The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated (or oil lubricated as per standards) and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.

4.2.6 The shaft seal shall be stuffing box type, so as to allow minimum leakage compatible with the operation of the seal. The stuffing box shall be of adequate length and shall be packed with graphite asbestos or any other suitable material for the operating temperature. A drip well shall be provided beneath the seal.

4.2.7 The pump shall be directly coupled to the motor shaft through, a flexible coupling protected by a coupling guard.

4.2.8 The pump and motor shall be mounted on a common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.

5.0 COOLING TOWER BASIN

5.1 The cooling tower basin shall be of RCC construction, Actual capacity shall be designed taking into consideration water flow rate, drift and evaporation losses so as to run the cooling tower on full load without makeup water for at least 8 hrs per day. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin. The cooling tower basin with partition in between shall be such that the cold water pumps are always flooded with cooling water thereby avoiding the use of priming pumps, etc. Suitable isolation arrangements of individual basin enclosures from forebay space to be provided for maintenance purpose. Suitable piping and valve arrangements to be provided with the individual basins for filling the treated water, draining the basins during maintenance/ blowdown, and for overflow provisions.

6.0 COOLING FILL UNITS

6.1 The cooling fill unit shall be so designed that maximum duration of contact between water and air is achieved. The cooling fill shall be made of PVC and suitably arranged to give the maximum performance. The frames holding the fill in position shall be of stainless steel. The fill support shall be of Stainless steel construction. Thickness of PVC fills shall not be less than 0.2mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.

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8.0 FAN STACK/CASING

8.1 Separate fan casing is required for each cell, made of FRP with suitable diameter and shape to provide free flow of air.

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9.1 Hot water distribution system shall be designed for a water load of 115% of the circulation rate. The internal distribution of hot water in the cooling tower shall be of pressurized closed loop with self-adjusting, non-clogging and self-cleaning type of polypropylene spray nozzles. The water distributions over the fill are to be uniform and free from dead zones, thereby attaining a better overall performance.

9.2 Material of Construction for Hot Water distribution:

- Hot Water Header pipe (inside tower): SS 304/PVC
- Hot Water Laterals / Branch Pipes: PVC
- Distribution/ Spray Nozzles: PP

10.0 FAN ASSEMBLY

10.1 Individual sets of fan assembly unit shall be provided for each cell so that the cells can be operated either individually or together. The fan assembly and drive system shall be designed for totally vibration free operation. Suitable lighting arrangements in the tower top shall also be provided.

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12.0 TESTS AND INSPECTION

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12.2 The test shall be conducted in accordance with “Acceptance test code for water-cooling tower of Cooling Tower Institute CTI-ATC 105 latest revisions”. Measuring gauges/instruments required for these tests shall be provided by the vendor. Provision will be made to connect the gauges/instruments at appropriate location in the pipelines.

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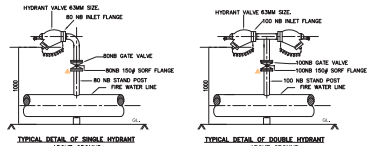
ANNEXURE – C-3

FIRE WATER NETWORK LAYOUT

ANNEXURE C3

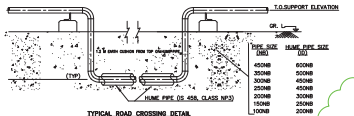
PROJECT 1ST STAGE CLOUDED IN GREEN

(Need to be completed prior to the commissioning of new 10000MT Ammonia Tank & new 1650tpd NP Plant.)

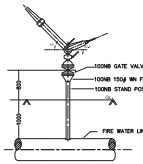


TYPICAL DETAIL OF SINGLE HYDRANT ABOVE GROUND

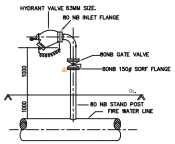
TYPICAL DETAIL OF DOUBLE HYDRANT ABOVE GROUND



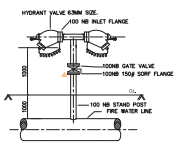
TYPICAL ROAD CROSSING DETAIL



TYPICAL DETAIL OF MONITOR UNDER GROUND



TYPICAL DETAIL OF SINGLE HYDRANT UNDER GROUND



TYPICAL DETAIL OF DOUBLE HYDRANT UNDER GROUND

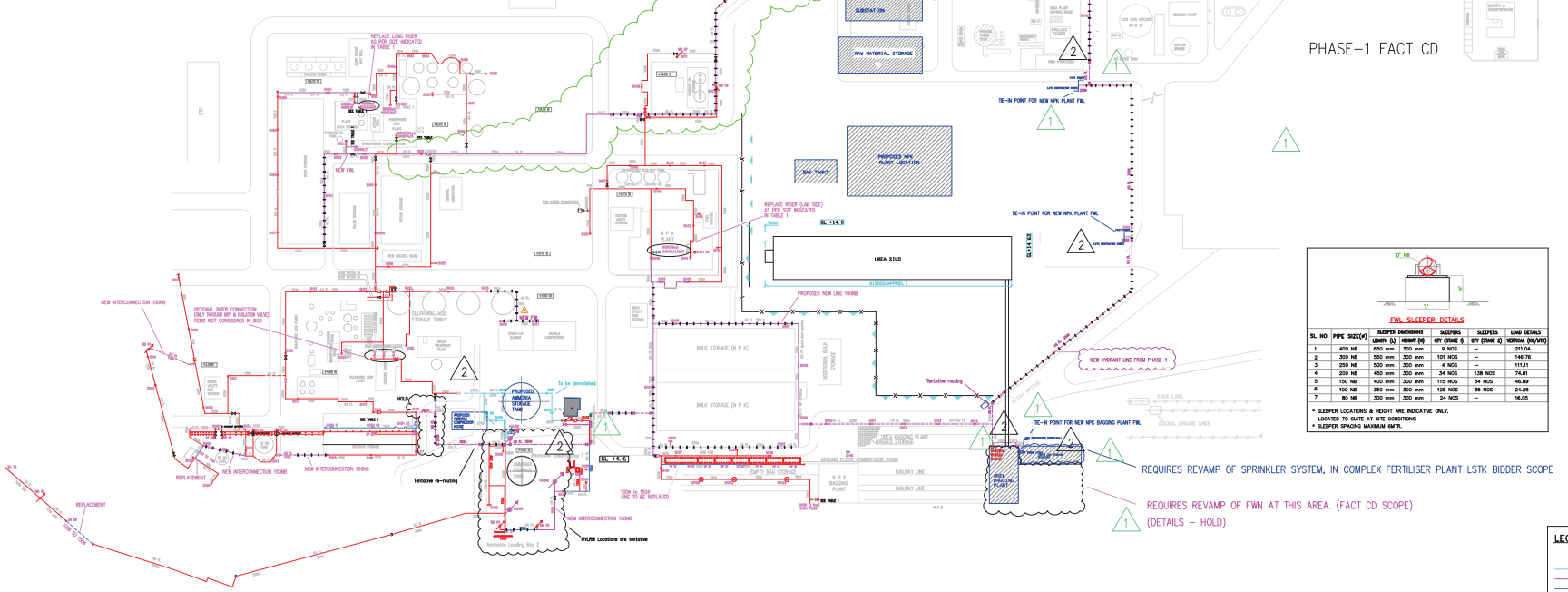


TABLE 1 (ELEVATION OF OHSM PHASE I)

AREA	FLOOR	ELEVATION	NO. OF HYDRANTS	DIA OF RISER LINE
SULPHURIC STORAGE	-	17303	3	150/100/100
ROCK GRINDING PLANT (SHORT RISER)	I	5303	1	80
	II	7803	1	100
ROCK GRINDING PLANT (LONG RISER)	II	11703	1	150
	III	15850	1	150
	IV	22200	1	150
	V	30303	1	100
	VI	35003	1	65
UREA BAGGING PLANT	I	7625	1	150
	II	15465	2	150
NPK BAGGING PLANT	II	11750	1	150
	IV	26550	1	150
NPK GRANULATION PLANT(LAB SIDE)	II	9500	2	150
	III	13500	2	100
NPK GRANULATION PLANT(NE TRANSFORMER SIDE)	II	9500	1	100
PHOSPHORIC ACID PLANT (Near transformer room)	I	8800	1	100
	II	12750	1	80
(Near storage tank)		5300	1	150
		11400	1	100
		14000	1	100
TRANSFORMER CONTROL ROOM	I	8300	1	100
	II	8900	1	100

TABLE 2 (ORIFICE DETAILS)

TAG NOS	THROAT DIA. (mm)	Line size (NB)
OP 01	14 mm	50
OP 02	14 mm	50
OP 03	20 mm	50
OP 04	19 mm	50
OP 05	15 mm	50
OP 06	21 mm	50
OP 07	43 mm	100
OP 08	42 mm	100
OP 19	27 mm	80
OP 20	27 mm	80
OP 21	27 mm	80
OP 22	27 mm	80
OP 23	27 mm	80
OP 24	27 mm	80
OP 25	27 mm	80
OP 26	27 mm	80

TABLE 3 (YFS HYDRANT/ MONITOR DETAILS)

ZONE	SINGLE HYDRANT	DOUBLE HYDRANT	WATER MONITOR	HVLR MONITOR	SURFACE HYDRANT	DELUGE HYDRANT
PHASE 2	70(70)	24(48)	7(28)	3(18)	3(3)	27(27)
PHASE 1	30(30)	7(14)	1(4)	1(6)	0	2(2)

* HVLR, Hydrant/monitors for the proposed 10000 MT Ammonia Tank and Hydrant/monitors for the proposed 1650 tpd complex fertiliser plant are not included in Table 3 (Shall be included in LSTK contractor scope)

TABLE 4 (PUMP DETAILS)

PUMP	PURPOSE	HEAD (MWC)	CAPACITY (CUM/HR)	NOS	DRIVE	RPM	MAKE & MODEL
P1, P2, P3 (EXISTING)	2W+1S	88	410	1 Each	Diesel Engine driven (250 HP)	1800	Beacon Weir (50FC 150/200
P4 (EXISTING)	JOCKEY	90	10.2	1	Electric Motor driven (15 KW)	2930	Beacon Weir (G 80/32/250

TABLE 5 (SPRINKLER DETAILS)

AREA	NO. OF SPRINKLER NOZZLES	K FACTOR LPM/(Kg/cm²)^1/2
EMPTY BAG STORAGE	134	30
SULPHUR STORAGE	61	16
AMMONIA LOADING BAY 1	68	16
AMMONIA LOADING BAY 2	67	30

FWL SLEEPER DETAILS

SL. NO.	PIPE SIZE(nd)	SLEEPER DIMENSIONS LENGTH (L)	WIDTH (W)	SLEEPERS QTY (STAGE I)	SLEEPERS QTY (STAGE 2)	LOAD DETAILS VERTICAL (KG/MTR)
1	400 NB	650 mm	300 mm	9 NOS	-	211.04
2	300 NB	550 mm	300 mm	101 NOS	-	146.76
3	250 NB	500 mm	300 mm	4 NOS	-	111.11
4	200 NB	450 mm	300 mm	34 NOS	138 NOS	74.81
5	150 NB	400 mm	300 mm	115 NOS	34 NOS	45.89
6	100 NB	350 mm	300 mm	125 NOS	38 NOS	24.28
7	80 NB	300 mm	300 mm	24 NOS	-	16.05

* SLEEPER LOCATIONS & HEIGHT ARE INDICATIVE ONLY. LOCATED TO SUITE AT SITE CONDITIONS
* SLEEPER SPACING MAXIMUM 6MTR.

PIPING : 150 NB and BELOW - API 5L Gr.B PSL1
ABOVE 150 NB - IS 3589 Gr. 410
UNDER GROUND PIPING SHALL BE PROVIDED WITH WRAPPING & COATING AT ROAD CROSSINGS HUME PIPES SHALL BE PROVIDED.

LEGEND:-

- EXISTING FW LINE TO BE DEMOLISHED FOR NEW AMMONIA TANK
- PROPOSED NEW FIRE WATER LINE
- FIRE WATER LINE TO BE REPLACED
- EXISTING FIRE WATER LINE
- SH SINGLE HYDRANTS
- WM/HVLRM WATER MONITOR
- DH DOUBLE HYDRANTS
- SFH SURFACE HYDRANTS
- OHSH OVER HEAD SINGLE HYDRANTS
- ISOLATING VALVE
- NON RETURN VALVE
- SPRINKLER LINES
- OVER HEAD OR ABOVE GROUND FWL
- UNDER GROUND FWL

DRAWING ORIGINATED FROM: 32536-01-FH-001, R8 LAYOUT OF FIRE HYDRANT SYSTEM - COCHIN DIVISION (PHASE-1 & 2)

CLIENT: FACT-CD, AMBALAMEDU

DRAWING NO.	TITLE	R.No.	ZONE	PARTICULARS	REVISED	CHECKED	APPROVED	DATE
32536-01-FH-001, R8	LAYOUT OF FIRE HYDRANT SYSTEM - COCHIN DIVISION (PHASE-1 & 2)	1		TIE IN POINT SCOPE, LINE SIZE CHANGE AT UREA BG PLNT, ADDITIONAL VALVE NEAR UREA HYDROLISER	MCK	LA	AAN	01.02.21
REFERENCE DRAWING				PROPOSED NP PLANT TIE IN POINT RELOCATION, T CONNECTION CHANGE IN AMMONIA TANK FW TIP	MCK	LA	AAN	22.01.21
				REVISION				

SCALE	N.T.S
DATE	09.07.2020
DRAWN	MAHESH
CHECKED	SK
DESIGNED	LA
CHECKED	SK
APPROVED	AAN

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LTD
UDYOGAMANDAL KERALA

FEDO

PROJECT NAME: FIRE HYDRANT SYSTEM | PROJECT NO: 3901-32536

TITLE: FIRE WATER NETWORK & SLEEPER LAYOUT - COCHIN DIVISION (PHASE-1 & 2)

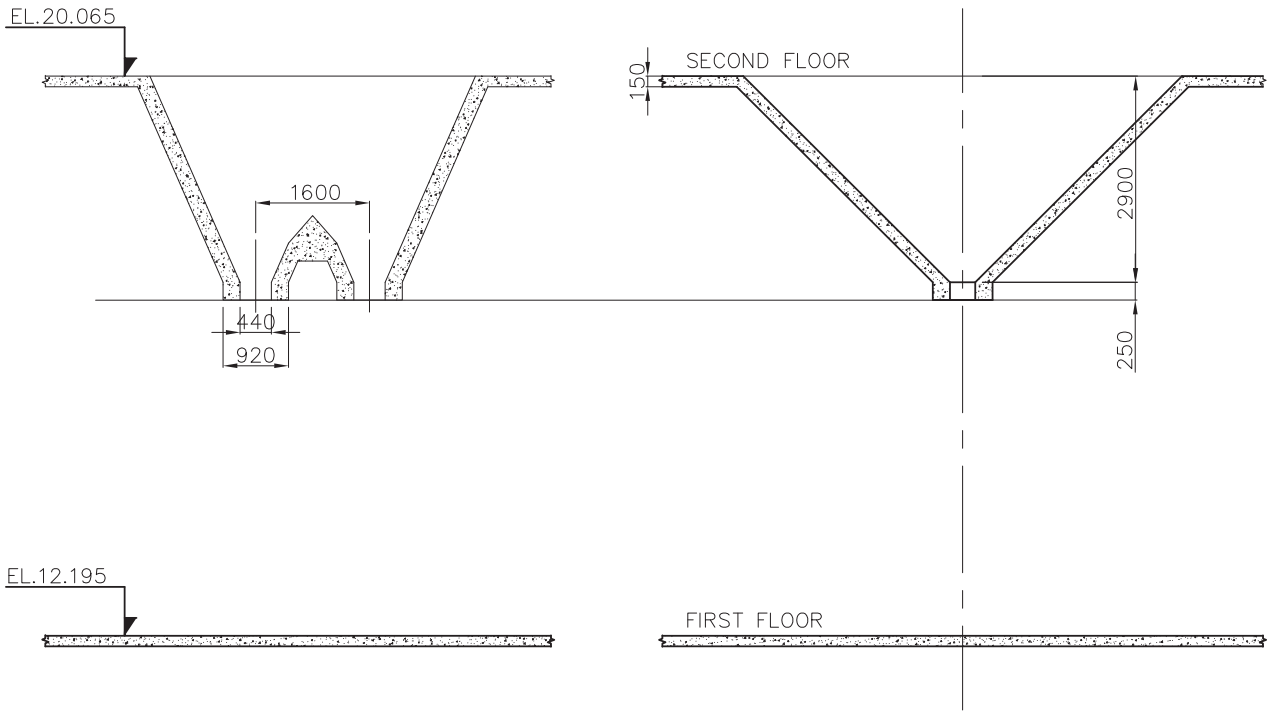
SHEET 1 OF 1 | DRG. NO. 32536-01-FWN_SL-00001 | REV. 2

00FTD04/96

ANNEXURE – C-4

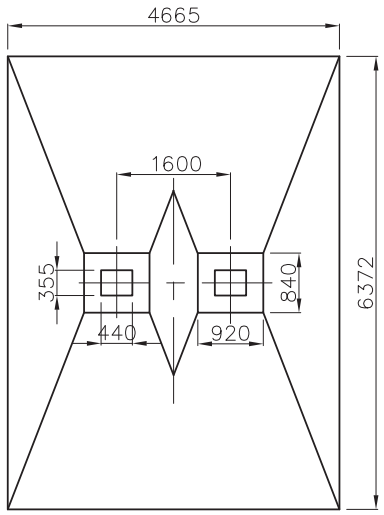
UREA BAGGING BUNKER DETAILS

ANNEXURE C4



FRONT ELEVATION

SIDE ELEVATION



PLAN

REFE.DRAWINGS:

1. 6330-5180-06-B
2. 6330-5180-03-G

NO.	DESCRIPTION	DRAWN	CHKD	APPRD.	DATE
0	TENDER PURPOSE	MCK	LA	AAN	05.02.21

SCALE: 1:100 SHEET 1 OF 1

CLIENT: FACT- CD

PROJECT NAME: NEW 1650 MTPD NPK PLANT AT FACT CD AMBALAMEDU ON LSTK BASIS

PROJECT NO: 32687

TITLE: EXISTING UREA BAGGING PLANT BUNKER

REV. 0

DRG. NO. 32687-01-GA-00001

FACT ENGINEERING & DESIGN ORGANISATION

UDYOGAMANDAL KERALA

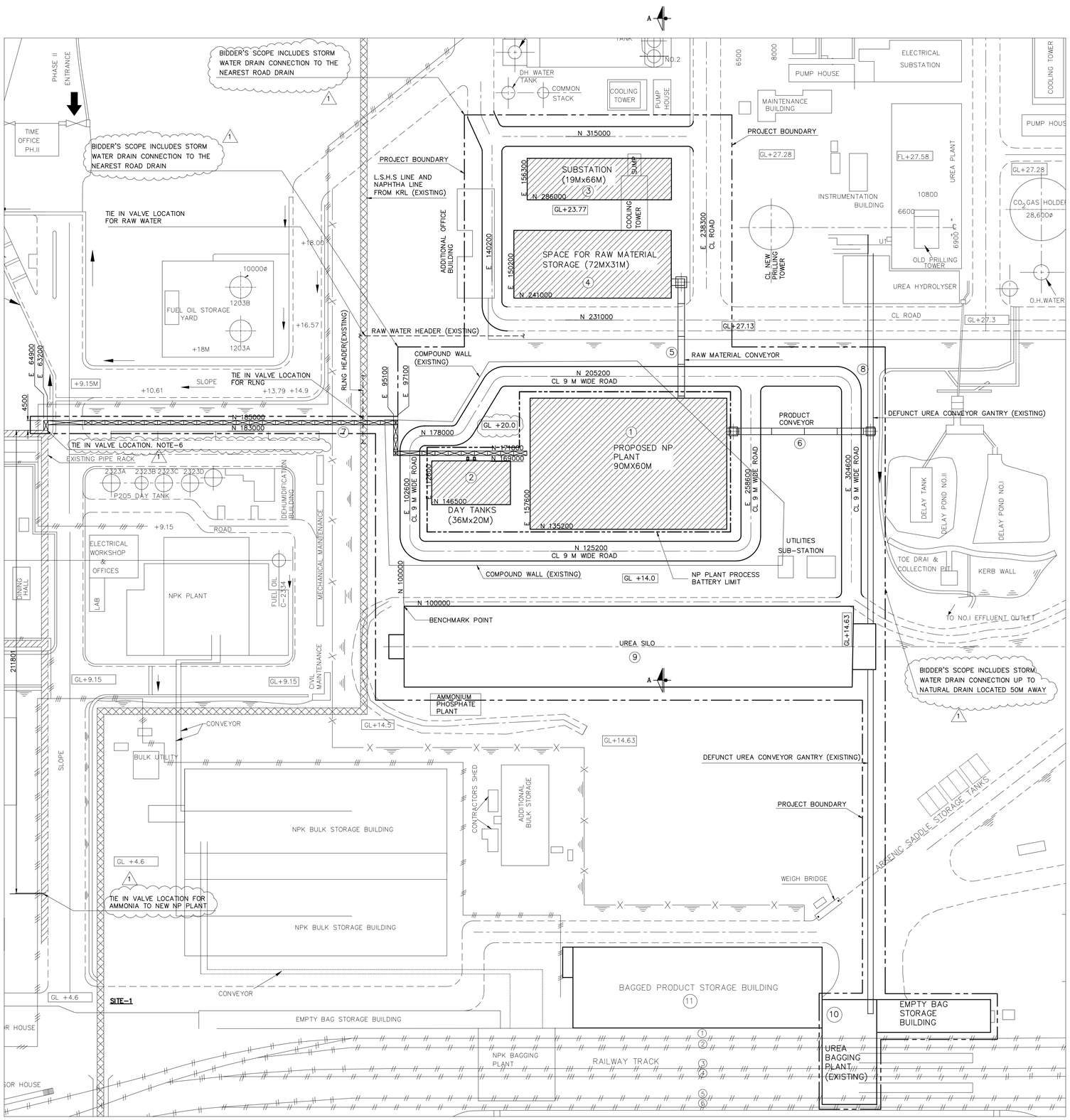
FEDO

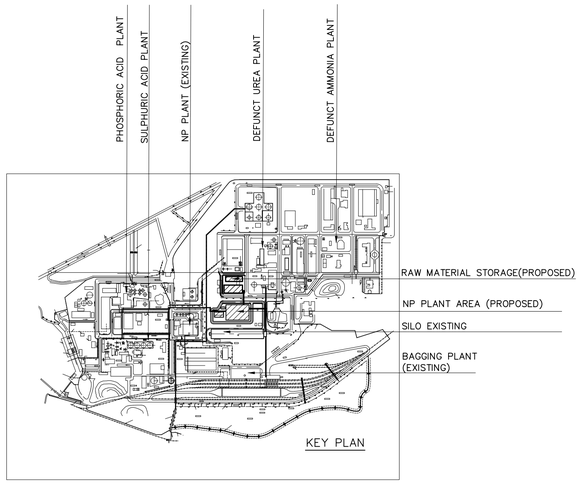
00FT007/96

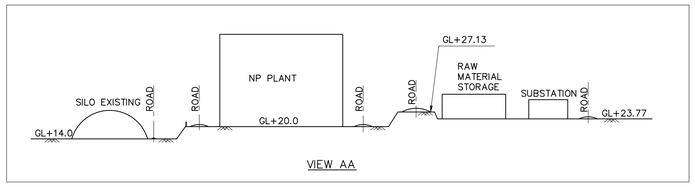
ANNEXURE – D-1

AREA PLOT PLAN & OVERALL

LAYOUT DRAWING







LIST OF UNITS

UNIT NO.	DESCRIPTION	SIZE IN METERS	REMARKS
1	PROPOSED NP PLANT AND ASSOCIATED FACILITIES	90X60	NEW
2	DAY TANKS	36X20	NEW
3	SUBSTATION	66X19	NEW
4	SPACE FOR RAW MATERIAL STORAGE	72X31	NEW
5	RAW MATERIAL CONVEYOR	–	NEW
6	PRODUCT CONVEYOR	–	NEW
7	PIPE RACK– STRUCTURE	–	NEW
8	DEFUNCT UREA CONVEYOR	–	EXISTING
9	UREA SILO	–	EXISTING
10	UREA BAGGING PLANT	–	EXISTING
11	BAGGED PRODUCT STORAGE BUILDING	–	EXISTING

LEGEND: –

AREA FOR NEW FACILITY

NEW PIPE RACK

ROAD NEW

ROAD EXISTING

PROJECT BOUNDARY

NOTES: –

1. ALL DIMENSIONS ARE IN MM.
2. ADDITIONAL OFFICE BUILDING AT WESTERN SIDE OF RAW MATERIAL GODOWN MAY BE DEMOLSHED FOR NEW LOCATION OF ROAD IF REQUIRED.
3. COORDINATE 100000 N AND 100000 E AND ELEVATION +14.0 AT BENCHMARK POINT
4. FOR FIRE WATER SCOPE REFER DRAWING 32536-01-FWN_SL-00001
5. EFFLUENT GENERATED IF ANY SHALL BE COLLECTED IN EFFLUENT PIT AND PUMPED TO EXISTING ETP.(EQUALISATION TANK).FOR ETP LOCATION REFER OVERALL PLOT PLAN.
6. TIE IN VALVE LOCATION FOR ALL PIPING EXCEPT AMMONIA, FIRE WATER, RLNG, RAW WATER AND SEWER.

FOR TENDER PURPOSE ONLY

CLIENT M/S FACT-CD

DRAWING NO.	TITLE	NO	ZONE	PARTICULARS	REVISED	CHECKED	APPROVED	DATE
	MOM WITH FURNACE FABRICA							
32324-11-OP-0001	PROPOSED NPK PLANT AT FACT CD	1		ISSUED FOR TENDER PURPOSE	TKA	JTG	KK	01-02-21
REFERENCE DRAWING		REVISION						

SCALE	1:1000
DATE	09-11-2020
DRAWN	TKA
CHECKED	
DESIGNED	KR
CHECKED	KR
APPROVED	KK

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LTD
UDYOGAMANDAL KERALA

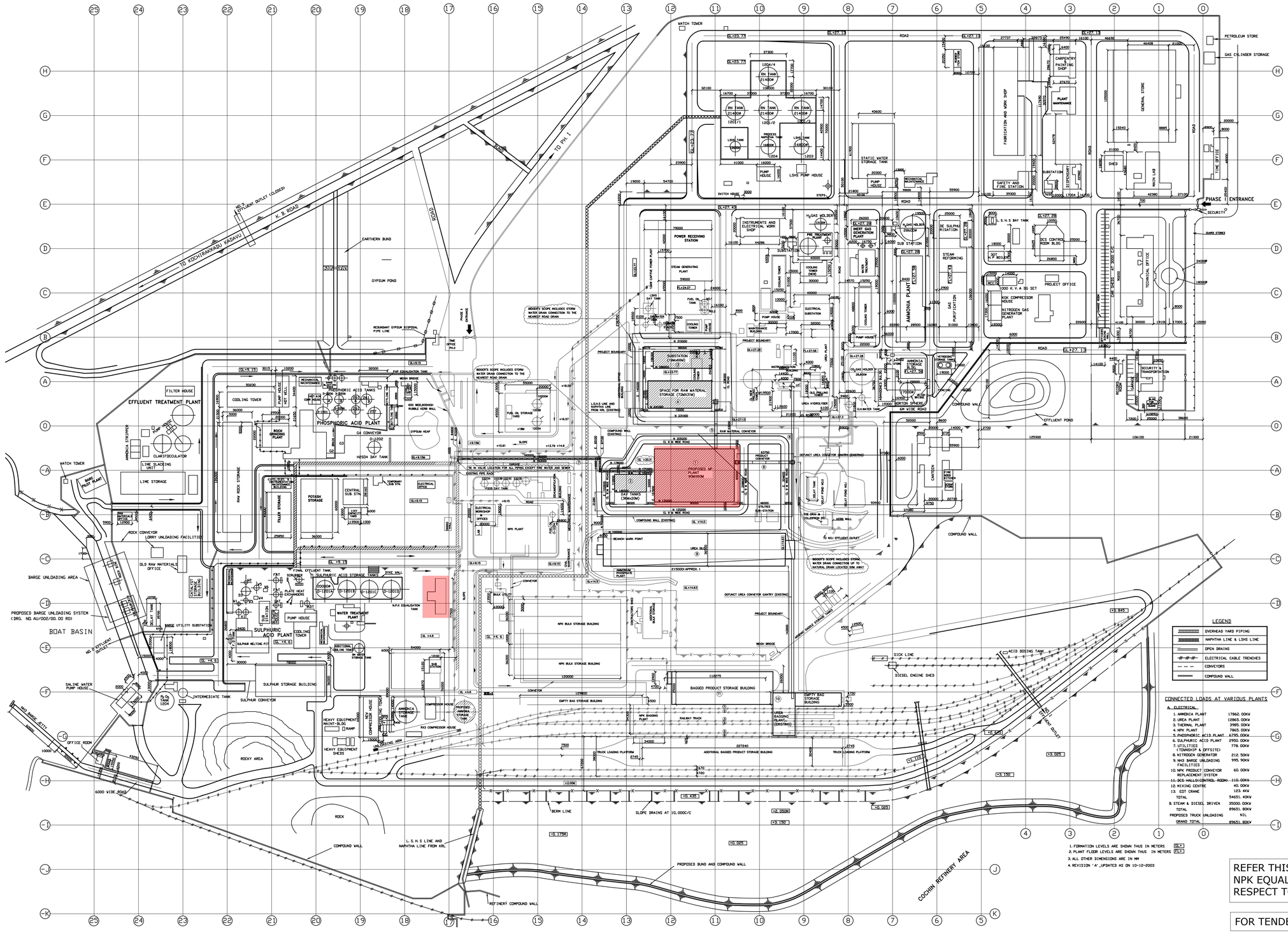
FEDO

PROJECT NAME: NEW 1650 TPD COMPLEX FERTILISER PLANT USING PIPE REACTOR TECHNOLOGY
PROJECT NO: 32687

TITLE: PLOT PLAN – 1650 TPD COMPLEX FERTILISER PLANT

SHEET 1 OF 1 | DRG. NO. 32687-03-AP-00001 | REV. 1

00FT004/97



A1

CLIENTS M/S FACT C.D

DRG.NO. TS/C/GL - 183 A | PLOT PLAN OF PHASE I AND PHASE II.

DRAWING NO. | TITLE | REFERENCE DRAWING

NO	ZONE	PARTICULARS	REVISED	CHECKED	APPROVED	DATE

REVISION

SCALE	1 : 2000
DATE	16-9-2009
DRAWN	A. Ramachandran
CHECKED	--
DESIGNED	--
CHECKED	--
APPROVED	--

FACT ENGINEERING & DESIGN ORGANISATION
THE FERTILISERS AND CHEMICALS TRAVANCORE LTD
UDYOGAMANDAL KERALA

FEDO

PROJECT NAME PROJECT No:

TITLE OVERALL PLOT PLAN – FACT CD

SHEET OF DRG. No. REV. 0

00FT004/97

ANNEXURE – E-1

BUS TRUNKING

CONTENTS

1.0.0 SCOPE

1.1.0 This specification covers the requirements for design, manufacture, testing and supply of overhead Busbar trunking system (Bus trunking) for industrial applications, comprising of busbars, metallic enclosure, insulating supports, bimetallic connections, flexible connections, adapter chambers, bus trunking termination flanges etc. to give reliable and continuous operation at the load ratings specified.

2.0.0 REFERENCES

2.1.0 The following documents shall be read in conjunction with this specification

2.1.1 **Engineering specification and Data sheet** of **General requirements for Electrics**

2.1.2 **Data sheet** of **Bus trunking**

2.1.3 **Technical particulars** of **Bus trunking**

3.0.0 STANDARDS

3.1.0 Requirements laid down in the latest revision of the following standards and other relevant standards shall be strictly adhered to:

IS: 8623 Part (II) Factory built assemblies of switchgear and control gear for voltage up to and including 1000 V AC & 1200 V DC Particular requirements for Busbar trunking system
IS: 8084 Interconnecting busbars for AC voltage above 1 KV up to and including 36 KV
IS: 11353 Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS: 5578 Guide for marking of insulated conductors.
IS: 1271 Thermal evaluation and classification of electrical insulation
IS: 10026 Insulating varnishes containing solvents
IS: 3043 Code of practice for Earthing

4.0.0 SERVICE CONDITIONS

4.1.0 The equipment shall be designed to operate satisfactorily under the service conditions and power supply conditions specified in the **Data sheet** of **General Requirements for Electrics** and **Data sheet** of **Bus trunking.**

5.0.0 CONSTRUCTIONAL REQUIREMENTS OF BUSBARS AND BUSBAR SUPPORTS

5.1.0 Bus bars shall be of uniform cross section, high conductivity, high quality extruded aluminum / copper, continuously rated for the rated current and service conditions specified in the data sheet.

5.2.0 The busbars and busbar supports shall withstand the maximum of dynamic, thermal and magnetic stresses and strains due to the maximum short circuit current corresponding to the fault level indicated in the data sheet, without any deformation, deterioration or damage.

5.3.0 Suitable provisions shall be made for the expansion of the busbars caused by temperature variation. Due consideration shall be given to proximity and skin effects and reactance while choosing the sizes of the busbars and spacing.

5.4.0 Bus trunking shall be designed in such a way that mechanical forces of the conductors shall not be transmitted on to the terminals of the equipment connected at either ends.

5.5.0 Appropriate identification markings/labels shall be provided on the busbars and tapings for distinguishing the various phases and neutral.

5.6.0 Suitable busbar supports shall be mounted on to the enclosure at specific intervals, allowing sufficient tolerance to prevent strain on to the busbars and supports.

5.7.0 Additional busbar supports for the bus bars shall be provided at all bends.

5.8.0 Busbar supports provided shall be guaranteed to withstand the stresses due to short circuits.

5.9.0 Busbar supports and insulators shall be non-hygroscopic type glass reinforced plastic material with anti tracking features to prevent flashovers. Hylam shall not be used for this purpose.

6.0.0 BUSBAR JOINTS

6.1.0 All joints of busbars shall have effective treatment for maintaining the conductivity of the joints as per relevant standards.

6.2.0 Bimetallic joints shall be made between copper and aluminum conductors for the prevention of any electrolytic corrosion.

6.3.0 Sufficient clearances shall be ensured at all joints. Also facilities for inspection of joints, bends, busbars etc. shall be provided in the bus trunking by providing removable covers.

7.0.0 ENCLOSURE

7.1.0 Material of enclosure shall be mild steel (MS) sheet.

7.2.0 Composition of material of enclosure shall be chosen to avoid any possible hysteresis effect on the bus trunking. Sheathing should not be electrically continuous to prevent heating by eddy currents.

7.3.0 Bus trunking enclosure and its terminations on the equipment shall be designed in such a way that vibrations of the transformer/ DG set / Alternator shall not be transmitted to them.

7.4.0 The entire bus trunking shall be made dust and vermin proof. Trunking installed outdoors shall be weather proof.

7.5.0 In the case of weather proof bus trunking, due consideration shall be given to the severe monsoon and high humidity of the location, while designing the enclosure. Special type of hood

(canopy) shall be provided on all exposed portions of the bus trunking for preventing any moisture getting inside.

7.6.0 Special care shall be taken while designing the joints of bus trunking system to prevent any moisture getting inside through joints.

7.7.0 The enclosure shall be coated with two coats of suitable anti-corrosive paint over two coats of primer suitable for anti-corrosive paint to give protection against action of chemical fumes present in the environment.

7.8.0 Power supply to anti condensation heaters (as required in the data sheet) shall be provided through a marshaling box.

7.9.0 Breather with silica gel shall be provided for each closed section of bus trunking.

8.0.0 TRUNKING ENDS

8.1.0 The bus trunking termination ends shall be suitable for proper and easy connection to the transformer, alternator or switchgear, as the case may be.

8.2.0 Suitable flexible connections shall be provided for all termination ends of the busbars. These shall be of bimetallic type wherever necessary. They shall be designed to carry the rated current and withstand short circuit condition.

9.0.0 BENDS

9.1.0 Bends shall be designed to provide head room clearance not less than 1.829M below the bus duct for passage.

9.2.0 Provision shall be made for additional supports at bends.

10.0.0 EARTHING

10.1.0 Earthing arrangement shall be given in accordance with IS:732 and IS: 3043.

10.2.0 Duplicate continuous earthing strips of material and size specified in the data sheet shall be provided on the entire length of the trunking. Strips shall be connected to the body of trunking by means of integral bolts, spring washers and nuts. The hardware used shall not cause any corrosion due to bimetallic action.

10.3.0 The size of the strip shall be adequate in accordance with voltage level, fault level and the jointing conditions adopted.

10.4.0 A minimum of two terminals shall be provided on the strip for external connections to earth grid.

10.5.0 If the size of strip is indicated in the data sheet both earth strips shall have the size specified.

ANNEXURE – F-1

GENERAL CONDITIONS AND SPECIAL CONDITONS

FOR SELECTION OF SUBVENDORS BY LSTK BIDDER

APPENDIX-1

GENERAL CONDITIONS TO BE FOLLOWED BY THE LSTK BIDDER FOR SELECTION OF SUB-VENDORS FOR BROUGHT OUT ITEMS BY THE LSTK BIDDER FOR NEW 1650TPD NPK PLANT AND 10000MT AMMONIA TANK AT FACT-CD

1.0 LSTK BIDDER shall necessarily procure all the brought out material/equipment forming permanent part of the unit/plant from OWNER approved sub vendor only. This shall include sub ordered items/components also. The "Approved Sub-Vendors" shall be item specific.

2.0 (i) OWNER's recommended Sub-vendor list for the items is enclosed in this section **(Appendix-4)**

(ii) Special conditions to be followed for selection of sub-vendors for brought out items by the LSTK bidder: 1650 TPD NPK Plant is enclosed in **Appendix-2**

(iii) Special conditions to be followed for selection of sub-vendors for brought out items by the LSTK bidder: 10000 MT Ammonia storage and associated facilities is enclosed in **Appendix-3**

In case of a conflict between this general conditions and special conditions, the respective clauses under special conditions shall prevail to the extent of such conflict.

3.0 (i) LSTK BIDDER may procure material from any of OWNER recommended sub vendors. However current validity of sub-vendor approval & their approved product range and the conditions imposed while according sub-vendor approval shall be verified by the LSTK BIDDER before placement of order.

LSTK BIDDER shall also verify the work load, stability and solvency status of the vendor prior to placement of order.

(ii) **Sub Vendors on OWNER holiday list shall not be considered for ordering, which need to be verified by the LSTK BIDDER prior to placement of order. LSTK BIDDER shall comply with this requirement without any time or cost implication to Owner.**

(iii) In case any sub vendor is recommended subsequent to release of this sub-vendor list, the same may also be considered by the LSTK BIDDER with prior intimation to OWNER and obtain their concurrence prior to placement of order.

(iv) LSTK BIDDER may consider additional alternate sub-vendors not included in the above list, with prior intimation of OWNER approval status, documents/credentials

to be furnished by the vendor in such cases shall solely be the responsibility of the LSTK BIDDER. Also please note the special conditions in this regard.

4.0 Compliance to procurement of material from approved sub-vendors is mandatory and shall be fully complied with. No deviation to the recommended sub-vendor list shall generally be acceptable except in certain genuine/deserving cases. Also please note the special conditions in this regard.

5.0 For items not covered in the above list, the sub-vendor list shall be approved by OWNER prior to placement of order by LSTK BIDDER. LSTK BIDDER shall list down the proposed sub suppliers/vendors for such items and submit the same for OWNER's review/approval along with necessary documents/credentials. Non acceptance of a particular proposed sub-vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication. Please refer special conditions also.

6.0 **LSTK BIDDER shall have an independent assessment of capability of all the sub-vendors for timely deliveries of material/equipment even if the sub-vendor is from the recommended list of the owner. Any delays in deliveries by vendor(s) shall not be a cause of schedule and cost implication.**

7.0 At any stage of the project, if it comes to the notice of OWNER that LSTK BIDDER has procured material/equipment, intentionally or unintentionally whatsoever, from an unapproved sub-vendor and/or items not falling in approved product range of vendor(s), then the same shall be rejected forthwith and LSTK BIDDER shall be liable to replace such material/plant/machinery within the contract price and without any time/schedule implication.

8.0 List of sub-vendors appearing anywhere else in the contract document in case of duplication of the items at two or more places (except for the sub-vendor list provided by Process Licensor, if applicable) shall not be considered by LSTK BIDDER and shall be superseded by the sub-vendor list enclosed herewith.

Sub-Vendor for any item not covered in this vendor list but appearing anywhere in the Licensor process package, Licensor vendor list shall be followed.

In case of any Mandatory/Proprietary items appearing in this vendor list as well as in the Licensor's process package, the sub-vendors as recommended by the Process Licensor shall be followed.

9.0 It is understood that should the name of sub-vendor be changed due to change in their Company or Corporate shareholding, OWNER will accept such sub-vendor under its new name with prior approval for which the requisite documentation shall be furnished by the LSTK BIDDER.

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Any such approval shall however, not release the LSTK BIDDER from any of his obligations under the CONTRACT; neither shall any such approval signify nominations or instruction to use such a sub-vendor. All approved sub-vendors are deemed to have been freely chosen by the LSTK BIDDER at his own risk

10.0 The recommended sub-vendor list for fabricated equipment (Vessels etc.) is for fabrication alone, where mechanical design of the equipment is included in LSTK BIDDER'S SCOPE, LSTK Bidder SHALL EITHER HIMSELF OR THROUGH HIS DETAILED Engineering sub LSTK Bidder be responsible for designing and obtaining approval/review of Mechanical design calculations as per codes/specifications specified elsewhere in the Bid/Contract documents from OWNER.

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Appendix-2

Sub : SPECIAL CONDITIONS TO BE FOLLOWED FOR SELECTION OF SUB VENDORS FOR BROUGHT OUT ITEMS BY LSTK BIDDER - **1650 TPD NPK Plant at FACT-CD**

The following conditions shall apply with regard to selection of sub vendors for 1650 TPD NPK plant.

1. Supply of Equipments through Process Licensor(s) or through their Approved Vendor list

The bidder shall obtain the list of such equipment(s) to be supplied through Process Licensor or through the approved OEM's / vendor list of Process Licensor as applicable along with reference of plant where such equipment supplied by these OEMs are in successful operation and submit to the owner (FACT/FEDO) for their approval.

In case of authorized dealers of the OEM, necessary authorization certificate from the OEM shall be submitted along with the bid.

2. Supply of Equipments/ Machinery from the Owner's recommended Sub-Vendor list

For equipment(s) not covered under Sl.No.1 above, the LSTK bidder should select sub-vendors primarily from the owners recommended list. However the following shall also apply:

a. Bidder is free to suggest certain new sub vendors in addition to the owner's recommended sub-vendor list as per their experience. In case certain new sub vendors are to be added by the bidder, the conditions specified in the tender document elsewhere and noted below shall be complied.

AND

b. For all critical items, the selected new sub vendor(s) should also be approved by Process Licensor even if the sub-vendor appears in the recommended sub vendor list of the owner.

3. Supply of Equipments/Machinery not covered in the Owner's recommended sub vendor list/ new sub Vendors to be added

A new sub vendor list shall be prepared by bidder for supply of Equipment(s) / Machinery not covered in OWNER's sub vendor list.

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As it is not possible by the Owner to ascertain credentials of all the added sub vendors in the new sub vendor list, the following prequalification criteria, with respect to Past Performance / Experience of the sub vendor for any Equipment / Machinery shall be applicable:

A. <u>For new Indian Sub Vendors proposed by the LSTK bidder</u>

1. The proposed sub vendor during the last 15 (fifteen) years from the date of publication of the tender, should have manufactured and supplied either by themselves or though their authorized dealers at least TWO similar Plant Equipments or Machinery for the specified duties and the same should be operating satisfactorily after commissioning for at least One Year. The LSTK Bidders should submit relevant documentary proof as follows:

   a. Copy of Purchase Orders with full technical details of the equipment or machinery supplied by the proposed sub vendor.

   b. Certificate(s) from user regarding satisfactory performance of the equipment(s) or machinery(s) after commissioning for at least One Year for the respective qualifying purchase order(s).

   <u>Notes:</u>

   i. Similar Plant Equipment or Machinery shall mean the respective Equipment / Machinery in any fertilizer / Refinery / Petrochemical / Chemical plant meant for performing the specified duty.

   ii. In case of authorized dealers of the manufacturer, necessary authorization certificate from the manufacturer shall be submitted.

AND

2. For all critical items: In addition to the above criteria, the sub Vendor should also be approved by Process Licensor.

B. <u>Applicable for new Foreign Sub Vendors proposed by the LSTK bidder:</u>

1. The proposed sub vendor during the last 15 (fifteen) years from the date of publication of the tender, should have manufactured and supplied either by themselves or though their authorized dealers at least **TWO** similar Plant Equipments or Machinery for the specified duties outside the country of origin of the sub vendor and the same should be operating satisfactorily after commissioning for at least One Year. The LSTK Bidders should submit relevant documentary proof as follows:

   a. Copy of Purchase Orders with full technical details of the equipment or machinery supplied by the proposed sub vendor.

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b. Certificate(s) from user regarding satisfactory performance of the equipment(s) or machinery(s) after commissioning for at least One Year for the respective qualifying purchase order(s).

Notes:

i. *Similar Plant Equipment or Machinery shall mean the respective Equipment / Machinery in any fertilizer / Refinery / Petrochemical / Chemical plant meant for performing the specified duty.*

ii. *In case of authorized dealers of the manufacturer, necessary authorization certificate from the manufacturer shall be submitted.*

AND

2. For all critical items: In addition to the above criteria, the sub Vendor should also be approved by Process Licensor.

However for all the above cases, it may not be mandatory by the owner to permit the LSTK bidder to add the sub-vendor(s) proposed by him even if the sub vendor(s) meets the specified criteria. The decision of the owner shall be final and binding on the LSTK bidder in all cases.

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