# ]TENDER SPECIFICATION

**NO: BHE/PW/PUR/MANUT-CVL RWR /1563**

**Job:** All Civil and Architectural work for raw water reservoir & Pump House, Pipe Line from Raw water pump house PT plant etc **for Unit # 01, 02, 03 & 04 (i.e. All Four Units).**

**AT**

**4X270 MW Thermal Power Stations, Manuguru, Distt- Khammam, Telangana**

## Volume 1 E – Technical Specification and Plot Plan

**TENDER SPECIFICATIONS CONSISTS OF:**

- **Notice Inviting Tender**
- **Volume 1 A - Technical Conditions of Contract,**
- **Volume 1 B - Special conditions of Contract,**
- **Volume 1 C - General conditions of Contract**
- **Volume 1 D - Forms & Procedures**
- **Volume 1 E – Technical Specification and Plot Plan**

**Bharat Heavy Electricals Limited**
(*A Government of India Undertaking*)
Power Sector - Western Region
345-Kingsway, Nagpur-440001

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EARNEST MONEY DEPOSIT: Refer Notice Inviting Tender

LAST DATE FOR TENDER SUBMISSION: Refer Notice Inviting Tender

THESE TENDER SPECIFICATION DOCUMENTS CONTAINING VOLUME-I AND VOLUME- II ARE ISSUED TO:

M/s. ……………………………………………

…………………………………………………….

PLEASE NOTE:

THESE TENDER SPECS DOCUMENTS ARE NOT TRANSFERABLE.

For Bharat Heavy Electricals Limited

AGM (Purchase)
Place: Nagpur
Date

# 4x 270 MW BHADRADRI THERMAL POWER STATION,

**VOLUME: II B**

**SECTION – D**

## *GENERAL TECHNICAL SPECIFICATION*

**EARTHEN RAW WATER RESERVOIR**

Maharatna Company


**Bharat Heavy Electricals Limited**
**Project Engineering Management**
**PPEI Building, Power Sector,**
**Plot No. 25, Sector 16A,**
**Noida (U.P.)-201301**

# 1.00 GENERAL SPECIFICATION

1.1 **Scope**

This shall include all works involved in site clearance, setting out, dewatering and protection, excavation, sorting, transportation, embankment filling, watering and compaction to required degree and disposal of residual earth etc as per the instructions of engineer.

1.2 Supplying, providing and operating of necessary measuring and testing devices and materials including consumables if any are included in the scope of work. No separate measurement or payment for testing the work shall be made but the rates quoted for the items shall include the cost of such tests which are required during the course of execution of the wok.

1.3 All tools and tackles, equipment, machinery etc used in this work shall be of standard quality and manufactured by reputed concerns conforming to relevant IS Codes or equivalent thereof. Classification of various type of strata encountered during excavation shall be done in accordance with Clause-1.2.0. Any material used for filling/back filling should be got approved by the engineer. Any material which is of substandard quality procured and brought to site shall be rejected by the engineer-in-charge. The contractor upon such rejection by the engineer shall remove the materials from the site at his own risk and cost and no extra compensation whatsoever shall be paid on this account.

1.4 The vendor must satisfy himself of the character and volume of all work under various items and expected surface/subsurface soil profiles and surface/subsurface water table to be encountered. He must also satisfy himself about general conditions of site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry the work under this scope. No extra claim on account of any variation in surface and subsurface conditions shall be entertained at any stage.

1.5 In addition to these specifications, latest Indian Standard codes shall be used wherever applicable.

1.6 In case of conflict amongst the various provisions of specifications, the decision of the engineer-in-charge shall be final and binding on the Contractor.

**2.0 Materials**

**2.1 Material for Excavation**

For the purpose of classification of various strata met during the course of excavation the following are to be followed.

**2.1.1 Soft Rock**

It shall include rock removable in the opinion of the engineer without blasting such as lime stone, sand stone, weathered rock, hard conglomerates etc by splitting with the help of crow bars, wedges, pavement breakers, pneumatic tools, hammers or such implements.

**2.1.2 Hard Rock**

It shall include rock which requires blasting in the opinion of the engineer for excavation, but where blasting is prohibited for any reasons excavation shall be carried out by chiseling, wedging or any other method approved by the engineer. The mere fact that the Contractor resorts to blasting shall not classify the soil/soft rock under hard rock.

**2.1.3** **Soil**

All kind of soils which can be excavated by normal means such as shovels pick axe, spade etc and which do not fall under Clause-2.1.1 or 2.1.2 shall be classified under this head.

**2.1.4** The type of strata met during excavation shall be classified by the engineer-in-charge whose decision will be final and binding on the Contractor.

## 3.0 Clearance of Site

**3.1** All areas required for construction of the reservoir and three metres on upstream and downstream beyond the seat of reservoir embankment, appurtenant works and the surface of all borrow pits shall be cleared of all trees, stumps, roots, vegetation, rubbish and other objectionable materials. The material obtained will be the property of BHEL and materials pronounced useful by the engineer will be conveyed and properly stacked excluding stumps, roots etc as directed with all leads and lifts. Useless materials shall be burnt or otherwise disposed off as directed by engineer-in-charge. The cost of clearance as specified above is deemed to be included in the items of earthwork for reservoir and appurtenant works and no separate payment on account of this is admissible.

## 4.0 Setting Out

4.1 It will be the responsibility of the contractor to install substantial references marks; bench marks etc and maintain them as long as required true to the curve, level and slopes. The contractor will assume full responsibility for alignment, elevation and dimension of each and every part of works, labour, materials etc required for setting out and establishing bench marks and other reference marks at no extra cost to the owner/BHEL. The contractor shall repair and rebuild the reference points in case of any damage, intentional or otherwise at his expense.

## 5.0 Dewatering & Protection

5.1 Where water is met with in the excavation due to stream flow, seepage, springs, reservoir, rain or other reasons, the contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, coffer dams and other necessary works to keep the work area dry. The methods to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer-in-charge. Approval of the engineer-in-charge shall not relieve the contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the works.

Where cofferdams are required, these shall be constructed to adequate depths and heights, be safely designed and constructed and be made as water tight as is necessary for facilitating construction to be carried out inside them. The interior dimension of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping machinery etc inside the enclosed area.

**5.2** At the discretion of the contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area. The contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause any damage to the works, crops or any other property.

No separate payment for these operations will be made. The cost of all these operations shall be deemed to have been included in the unit rates tendered for the earthwork items under bill of quantities.

## 6.0 Earthwork Classification

6.1 Earthwork is mainly classified to its purpose as under:

i. Stripping for seat of reservoir embankment
ii. Earthwork in excavation for foundations of spillways, abutments, sumps, drains, channels, Pipe supports, R.C.C./pipe culverts, Retaining walls etc.
iii. Earthwork in embankment and bed construction: Providing and laying of embankment and bed with approved selected soil either from specified borrow areas or from compulsory excavation.

### 6.2 Stripping for seat of reservoir embankment

The entire area of embankment including a 2.5m wide strip beyond and contiguous with the area of embankment proper as shown in the drawings shall be stripped to a sufficient depth as directed to remove all unsuitable materials. The unsuitable materials shall include all debris, top soil, vegetable matter including roots, loose rock, organic silt, swamp material and other perishable or objectionable materials that are unsuitable for use in permanent construction or that might interfere with the proper bonding of the embankment with the foundation or the proper compaction of the materials in the embankment or that may be otherwise objectionable. The stripping shall be kept well in advance of other items of works to ensure that no undesirable materials will get mixed with approved embankment materials and to enable proper inspection and measurement. Materials from stripping operation shall be disposed off in such a way as not to detract from the finished appearance of the project or as directed. This material is not to be used for embankment construction under any circumstances.

### 6.3 General

6.3.1 The excavation shall include removal of all materials of whatever nature and whether wet or dry, exactly in accordance with the line, levels, grades and curves shown on the plans or as directed by the Engineer-in-charge. All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the contractor in each individual case for the method he proposes to adopt for the excavations including dimensions, side slopes, shoring, dewatering, disposal etc. This approval however shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the contractor shall be paid for the extra excavation and filling at the appropriate item of rates.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the Engineer due to contractor’s fault, the excess depth shall be filled up to the required level at the latter’s cost with ordinary cement concrete of nominal mix 1:4:8 or a richer mix as directed by the Engineer in each individual case. The contractor shall be responsible for assumptions and conclusions as to the nature of materials to be excavated and the difficulty of making and maintaining the required excavations and performing the work required as shown on the drawings and in accordance with this specification. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc shall be furnished by the contractor and installed as required and the cost thereof shall be deemed to have been included in the unit rate bid for excavation. The contractor shall be held responsible for any damage to any part of the work caused by collapse of sides of excavations. Material may be salvaged if it can be done with safety for the work and structures as approved by the Engineer-in-Charge. However no extra cost shall be claimed for material not salvaged.

Where excavation requires bracing, sheeting or shoring etc the contractor shall submit to the Engineer-in-charge drawing showing arrangement and details of proposed installation and shall not proceed until he received approval from the Engineer-in-charge and no extra shall be paid to the contractor on this account. For the purpose of excavation of earthwork the term soil shall apply to all kinds of soil containing any percentage of kankar, moorum and/or shingle etc except soft/hard rock.

6.3.2 **Blasting**

Blasting material required for excavation work included in this tender shall be arranged by the contractor from any authorised dealer of such approved material. Necessary assistance in the form of approval for procurement of the material may be given by BHEL. The contractor shall be fully responsible for entering into agreement with any authorised magazine contractor in respect of rates, regularity of supply etc.

Explosives shall be stored in the magazine building to be provided by the contractor under the special care of watchman so that in case of accidents no damage occurs to other parts of the work. Explosives, detonators and fuses shall each be separately stored. The Engineer-in-Charge or his authorised representative shall have the access to check the contractor's store of explosives and his accounts.
All rules under the Explosives Act or other local rules in force shall be fully observed.

Blasting work shall be done by employing qualified personnel and under careful supervision. Blasting shall only be carried out at certain specified times as directed by the Engineer. Proper precautions for safety of persons and property shall be taken. Where blasting is to be carried out in proximity of other structures proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing damage to adjacent structures and other property.

The contractor shall prepare a scheme of drilling holes for rock blasting for excavation upto the required depth as shown in the drawing which shall be got approved before actual blasting of rocks is carried out. Safety Codes such as IS 4081 & IS 6922 should be followed in connection with the blasting work.

The contractor shall be responsible for any accident to workmen, public or owner’s property due to blasting operations in absence of adequate protection from his end. All cost for rectification of damages shall be borne by the contractor.

6.3.2.1 **Restrictions on Blasting**

a) No blasting which may disturb or endanger the stability, safety or quality of the foundation will be permitted.
b) Blasting within 200m of main work in progress or of a permanent structure shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the foundation excavation reaches the last one meter and only small charge preferably black powder may be allowed so as not to shatter the foundation.
e) The last blast shall not be more than 0.5m in depth. Thereafter for finishing the excavation work (except in special locations only in rock where specifically indicated or ordered in writing by the Engineer-in-Charge) the use of explosives shall be discontinued and the excavation be completed by barring, wedging, chiseling or other suitable methods approved or directed by the Engineer-in-Charge and cost of such work will be deemed to have been included in the tendered rate.

6.3.3 **Sorting of Excavated Materials**

The excavated material shall be carefully sorted for use in the reservoir bed/ embankment construction as directed by the Engineer-in-Charge and shall be hauled directly to the place of use if possible. The excavated material, which is not considered fit for use in the bed/embankment shall be immediately removed and deposited at such place and in such manner as will be directed by the Engineer-in-Charge. The material found unusable should be got approved by the Engineer-in-Charge before actually disposing it off.

Material excavated shall not be placed in the embankment till the foundation for the embankment has been cleared, stripped and prepared as specified and adequate arrangements be made for watering and rolling the layers of earth fill in the bed/ embankment. This material shall be subjected to the same degree of embankment control as for the material obtained from the borrow areas.

All the excavated materials from excavation shall be selected by removing roots, grass, organic matter and other objectionable matter and be sorted out into different types of materials for use in different zones of reservoir as directed by the Engineer-in-Charge. The same shall be loaded in the vehicles proceeding directly to the place of use except such material as is required to be stock piled.

The useful material that cannot be used directly shall be heaped in separate area with reference to the nature of the material. Stockpiles shall be of as regular size as possible allowing of easy measurements. The material once heaped shall be utilised as and when where required and as directed by the Engineer-in-Charge. The cost of complete item of earthwork includes the cost of rehandling of the materials so temporarily heaped and reused.

6.3.4 **Mode of Wasting Materials**

The waste materials shall be heaped in spoil banks in regular shapes with suitable slopes as directed and properly trimmed so as to present a neat appearance or they may be wasted in other approved locations. The spoil banks shall be located in such a way that they will not interfere with the natural flow of river. No material shall be wasted where it will detract from the appearance or interfere with the accessibility of the completed structures. Excavated materials shall not be carelessly thrown over the premises but the same shall be deposited directly in permanent positions consistent with proper execution of work.

**6.3.5 Removal of Water from Foundation Excavation/drain etc.**

Wherever water is met with during excavation the contractor shall provide and maintain adequate dewatering equipment/arrangement to remove and dispose of all surface water and ground water entering the excavations and other parts of the work. The method of removal of water from foundation excavation shall be efficient and effective. Where the excavation for foundation/drain extends below water table, the portion below water table shall be dewatered in advance of excavation. The excavation shall be kept dry during sub grade preparation and continually thereafter until the construction to be provided therein is completed to the extent that no damage from hydrostatic pressure, floatation or other cause will result. Ground water level shall be maintained at least 300mm below the bottom of the excavation.

The dewatering shall be accomplished in a manner that will prevent loss of fines from the foundations, will maintain stability of the excavated slopes and bottom of structure and will result in all construction operations being performed in dry condition. The use of sufficient number of properly screened wells or other equivalent methods shall be used as approved for dewatering. The seepage along the bottom of the drains shall also be controlled which may require supplementing the dewatering systems by pipe drains leading to sumps from which water shall be pumped. Such pipe drains shall be of uniform diameter for each run and shall be provided with grout connections and returns at 15m intervals and shall be embedded in reasonably well graded gravel or like materials. During placing and compacting of the materials in the embankment and bed the water level at every point shall be maintained below the bottom of the earth fill until the compacted fill at that point has reached a height of 1.5m. The water level shall be maintained at least 1.5m below the top of the compacted fill. When the fill has been constructed to an elevation which will permit the dewatering systems to maintain water level at or below the designated elevations as determined by the Engineer-in-Charge, the pipe drains including surrounding gravel shall be filled with grout composed of water and cement or clay.

**6.3.6 Preparing and Testing of Foundations**

**6.3.6.1 Scaling, Trimming of Foundation**

After rough excavation to the required depth is completed, scaling and trimming operations for the removal of all pieces loosened during excavation or partly separated from main rock mass by seams or cracks shall be carried out to the satisfaction of the Engineer-in Charge.

**6.3.6.2 Treatment of Weak Local Spots**

All weathered or partly decomposed pieces of rock shall be removed so as not to leave on the foundation rock other than that which is an integral part of the rock mass. Areas of low bearing capacity, seams, joints, crevices, steep inclined seams, weak zones or such other defects shall be corrected by excavation of open trenches to the lines, depth and dimensions as directed by the Engineer-in-Charge. If on washing and cleaning such defects in any position of the foundation are found to be unsuitable for the foundation it shall be further excavated to the required depth and refilled with concrete as directed by the Engineer-in-Charge. The cost of such additional rock excavation and concrete so required for refilling shall be paid for under the respective items of rock excavation and concrete etc.

**6.3.6.3 Final Finished Surface of Foundation**

The finally prepared foundation shall present a rough surface in cross section to give added resistance to sliding. All polished surface shall be roughened artificially to give a good bond. The surface shall be free from steep angles and the edges of benches shall be chamfered approximately to 45° pinnacles or sharp projection shall be knocked off and prominent knobs flattened.

**6.3.6.4 Testing for Soundness**

The finally finished foundation rock shall be treated by striking with a heavy hammer and if any loose portion of foundation rock is revealed by a hollow sound it shall be excavated further without blasting till a clear ringing sound is obtained.

**6.3.6.5 Preparation of Surfaces prior to Laying**

Immediately before masonry/concreting is started the foundation shall be thoroughly cleared of all loose material including all chips, sand, dirt and the slightest film of oil or grease. This shall be done with the help of steel brooms, hammers, picks, jets of water and jets of air at high pressures and or wet sand blasting followed by thorough washing. The whole surface and joints shall be cleared of all dirt clinging to them by holding the tip of the water hose close to it. The pressure for jet of water or oil shall not be less than 15m of water and 80 psi for air. The nozzle shall be of approved design. The process is to be accomplished to thorough scrubbing with stiff wire brushes.

The washing and scrubbing shall be continued until all deleterious material clinging to the surface is removed. This is indicated by the wash water in the trenches becoming clean and free from dirt. In the final cleaning all water shall be removed by using sponge so that not the slightest pool of water remains. Cost of preparation of foundation as specified herein before shall be deemed to have been included in the tendered rates for excavation.

**7.0 Specification for Earthwork in Embankment/Bed Construction**

**7.1 General**

The item of embankment/bed construction shall include stripping of borrow areas, excavating the materials from the proposed reservoir bed/borrow areas, conveying the same and placing the same on the useful materials from compulsory excavation in specified layers forembankment and bed including watering and mixing (or drying as the case may be) and mechanical compaction to specified density at specified moisture content for each type of material and performing all operations necessary and ancillary there to.

**7.2 Borrow Areas**

**7.2.1 General**

All material required for construction of embankment, bed or backfill which are not available from the compulsory excavation (from foundations, drains, raw water reservoir area and from the available excavated stuff by other agencies etc) shall be obtained from the prescribed borrow areas. Borrow pits shall be opened at the location and to the limits as per direction of the Engineer-in-Charge. As far as practicable the borrow areas going under submergence on upstream side shall be tackled first. Tenderers are required to ascertain from BHEL site office concerned details regarding availability and lead for areas for execution of this work. The contractor is expected to have his own prospecting quarries before tendering for the works.

The depth of cut in all borrow areas will be designated by the Engineer-in-Charge and the cuts shall be made to such designated depths only. Shallow cuts will be permitted in the borrow areas if uncertified materials with uniform moisture contents are encountered. Each designated borrow area shall be fully exploited before switching over to the next designated borrow area. Haphazard exploitation of borrow pits shall not be permitted. The type of equipment used and the operations in the excavation of materials in borrow areas shall be such as will produce the required uniform mixture of materials for the embankment and bed filling. Borrow pits shall not be opened within a distance of 5 (five) times the height of embankment contiguous to heel or the toe of the embankment or 25m whichever is more. Borrow pits shall be operated so as not to impair the usefulness or mar the appearance of any part of the work or any other property. Temporary paths leading to and from respective borrow areas including temporary river and nallah crossing to the site of embankment where the materials are required to be deposited shall be constructed and maintained by the contractor at his cost.

**7.2.2 Stripping of Borrow Areas**

Before opening of a borrow area from where the material is to be obtained the area shall be cleared of all trees, stumps, bushes, etc and stripped to remove the top soil, humus, vegetable matter, organic matter, roots, rubbish and all other objectionable materials which is unsuited for the purpose for which the borrow pit is to be excavated. All such materials shall be removed to such disposal areas as directed by the Engineer-in-Charge. In no case shall the stripped material be allowed to contaminate the material going into the embankment. All trees cut shall be the property of BHEL and shall be stacked at a suitable place as directed by the Engineer-in-Charge. The rate for embankment including use of materials from borrow area includes the clearing and stripping the borrow area and disposing the waste material as directed. The cleared and stripped areas shall be maintained free from vegetable growth and adequately drained during the progress of work, without any extra cost. Excavation done for stripping borrow area shall not be paid including Government royalties if any.

**7.2.3 Borrow Area Watering**

Borrow area watering will be done wherever necessary and in the manner considered necessary by the Engineer-in-Charge of the work. The initial moisture content of material in the borrow area shall be estimated with the help of laboratory tests. The optimum moisture content for the material in the particular borrows areas shall be obtained from field laboratory. From the optimum moisture content and initial moisture content, the amount of additional water required shall be decided. The required additional moisture, so decided shall be introduced into the borrow area by watering well in advance of the excavation to ensure uniformity of moisture content. If in any location of a borrow area before or during excavation there is excessive moisture, steps shall be taken to reduce the moisture to secure the material with moisture content closest to the optimum by excavating drainage ditches, by allowing adequate time for drying or by any other means. To avoid formation of pools in the borrow areas during excavation operations, drainage ditches from borrow areas to the outlets shall be excavated wherever necessary.

**7.2.4 Stock Piling**

Stock piling shall be done at approved locations only. Before any area is used for stock piling, it shall be cleared and stripped of all vegetation and top soil as necessary to prepare the stockpile area. Stock piling of fill materials by end dumping the material down a sloping face/chute shall not be permitted if segregation of the material takes place.
Stockpiles shall be protected from being rendered less suitable for placement in the fill due to weathering effects viz. drying, over watering due to rain etc.

**7.3 Selection of Materials**

i) The borrow pit material or the material from compulsory excavation shall be got classified from the Engineer-in-Charge with regard to its suitability for filling inside the reservoir and embankment filling. The standard of material requirements shall be as per special technical requirements. The classification by the Engineer-in-Charge shall be final and binding on the contractor.

ii) The requirement of the material shall be generally as under:

All material shall be clean and free from shingle, salts, organic material, roots, boulders and any other hard materials of more than 50mm size (maximum dimension) and shall be of non-expansive/non-shrinkable type, the suitability being confirmed by laboratory tests.

**7.4 Placing of Materials**

**7.4.1 General**

The embankment/bed shall be constructed to the lines and grades as shown on the drawings. The slopes of the embankment are tentative and shall be subject to variation at any time prior to or during construction and on account of this the contractor shall not be entitled to any additional allowance above the unit prices accepted. No roots, vegetable matter, humus or other unsuitable materials shall be placed in the embankment. The contractor shall maintain the embankment in an approved manner until the final completion and acceptance of all of the work under the contract. Care shall be taken to drain all rain water falling on the rolled surface away beyond the embankment toe lines. The difference in elevation between different portion/reaches of the embankment at any cross-section above the embankment foundation shall not exceed 600mm unless specifically authorised by the Engineer-in-Charge. The embankment shall be maintained in continuous and approximately horizontal layers in the reach programmed for construction in that season. The embankment may be constructed in discontinuous portions or reaches, provided that the slopes of the bonding surface parallel to embankment axis between the previously completed portions of the embankment and materials to be placed in each zone shall not be steeper than 1:4 (vertical to horizontal). All openings or gaps through the embankment required for construction purpose shall be subject to approval and such openings or gaps if approved shall be constructed so that slope of the bonding surface between embankment in place and embankment to be placed is not steeper than 1:4 (vertical to horizontal). The suitability of each part of the foundation for placing embankment construction will be determined by the Engineer-in-Charge. The material shall be placed in layers and compacted. If the rolled surface is very uneven containing hollows and jumps, the hollows shall be filled up and surface rolled before any fresh layer is taken.

**7.4.2 Setting Out**

After the site is cleared it shall be properly set out true to lines, curves, slopes, grades and section as shown in plans or as directed by Engineer-in-Charge. Profile shall be set up without poles to mark the centre and edges of the foundation with the top levels of embankment clearly marked by paint or cut and slopes with strings and pegs at every 30m on straight portions and 10m on curves, peak marks. Longitudinal and cross section levels shall be taken recorded and checked for measurements and signed by the contractor and Engineer-in-Charge. The contractor shall provide all labour, materials such as lines, strings, pegs, nails, bamboos, stones, mortar, concrete etc required for setting out, establishing bench marks and giving profiles and other stakes. Profiles, pegs, bench marks and other marks shall be maintained without any disturbance as long as they are required. After stripping for the seat of embankment is completed and before commencing the placement of embankment all lines marking the extremities of berm, filter etc of the embankment shall be marked with reference to reference pillars. The reference pillars shall be of concrete or masonry and the information indicating chainages, levels etc shall be properly inscribed or written on them as directed by the Engineer-in-Charge. The contractor shall construct and maintain all reference pillars. No extra payment is admissible to the contractor on this account.

**7.4.3 Preparation of Foundation or preparation of Surface of Earth Work previously laid.**

**a)** No material shall be placed in any section of the embankment until the foundation for that section has been dewatered and suitably prepared and has been approved by the Engineer-in-Charge. It is necessary to ensure that the surface material of the foundation will be as compact and well bonded with the first layer of the embankment as hereinafter specified for subsequent layers of the earth fill. All portion of excavation made for test pits, cracks, local cuts, rain cuts and all other existing cavities found within the area are to be covered by earth fill which extend below the established lines of excavation for reservoir embankment foundation shall be filled with compacted earth fill materials as herein specified for earth fill in embankment and payment therefore will be made as provided for bed filling or embankment filling in which section the pits or cavities are filled.

**b) Foundation/other than rock**

The seat of the dam after it is stripped or the site over which the embankment is to be constructed shall be cleared of all loose or objectionable material before placing any layer. Soil foundations shall be scarified and loosened by means of a plough, harrow, ripper or other methods to a depth of about 150mm to 200mm to the satisfaction of the Engineer-in-Charge. Roots or other debris turned up during scarifying are removed from the entire foundation area for the fill and the clods if any are to be broken. It is then moistened to slightly above the optimum moisture (not more than 2% above the optimum moisture content) and compacted by required number of passes of the compaction equipment to the same percentage as the earth fill. The purpose of higher than optimum moisture is to ensure forcing of the soil into any unseen soft zones just below surface. The first few lifts of fill for the embankment should be carefully placed. If possible heavy rubber tyred rollers should be used for compaction because they will follow the irregular surface and not bridge over small low areas as like other types of rolling equipments. These layers of 15cm thickness must be used to ensure uniform compaction and a satisfactory intimate bond between the foundation soil and the fill materials. In already constructed slopes steps of size 300mmx150mm or otherwise as directed by Engineer-in- Charge shall be done in longitudinal direction for having good bond and homogeneousness between old and new bank, slopes etc. Contractor shall provide the necessary tools, plants and labour. The unit rate of embankment filling/bed filling item shall be inclusive of this work.

**c) Earth Work Previously Laid**

The treatment of the surface in this case before a fresh layer is placed will be the same at for the foundation other than rock. Over compacted portions of embankment formed due to constant traffic, which are likely to separate from the layers below, shall be entirely removed without any extra cost. When smooth rollers are used for compaction the surface of a compacted layer shall be scarified or roughened before fresh layer is laid on it. When sheep foot rollers are used for compaction, fresh layer may be directly laid on the previously rolled surface. Water shall be sprinkled on the previous layer unless the material in the surface is sufficiently wet. In case it contains moisture more than OMC due to rain etc it shall be raked up and allowed to dry or be worked with harrows, scarified or any other suitable equipment to reduce the moisture content to the required and then it shall be compacted before the next succeeding layer of earth fill material is placed.

**d) Rock Foundation or abutment**

The rock surface shall be thoroughly cleaned. Pockets of sand and gravel and other soil shall be removed by hand shovelling and soft erodable seams and localized decompositions be cleaned out as deep as possible. Wedging and handpicking shall remove loose rock. Finally the hand cleaned surface shall be thoroughly washed with powerful water jets to remove the fines which would have worked into the seams of the rock and obtain a clean surface. Compressed air jets shall be used as a final step in the clean-up operation.

Deep potholes or pockets shall be filled with hand compacted soil or concrete. If the rock surface in the bottom and sides of potholes is cracked, the crack should be sealed with cement grout.

Foundation rock which has very irregular surface shall be treated by laying earth fill material at a moisture content slightly above the OMC in thin layers and compacted with mechanical equipment/pneumatic hand tampers to ensure that all irregular depressions in the rock surface have been filled with soil to create an effective/complete bond.

The field laboratory shall specify the moisture content and the layer thickness. Any open crack in the rock surface shall be sealed with cement grout by suitable means. Fault zones or larger cracks shall be dug out to a depth as determined by the Engineer-in-Charge and backfilled with concrete.

**7.4.4 <u>Laying and spreading in Layers</u>**

a) Approved material free from clods and lumps larger than 50mm size shall be conveyed directly from source of excavation or from stock piles and be laid as indicated in drawings and as directed by the Engineer-in-Charge and on surface of the foundation or previously laid earth work prepared as specified. The materials shall then be spread on the embankment in uniform and continuous layers approximately horizontal unless earthwork in slope has been permitted or specified.

b) The thickness of layers will depend on the nature of materials and the type of compacting machinery. The thickness of a layer should be such that desired density after compaction shall be uniformly obtained throughout the depth. For the guidance of the contractor it may be stated that the loose thickness of the layer shall be 20cm and 15cm compacted for sheep foot roller, wheeled roller and 8cm loose and 5cm compacted by hand or pneumatic or mechanical tampers. Taking levels will find out the thickness of the compacted layers after every three (or less number if necessary) layers laid and compacted and finding out the average. The layers shall be spread in uniform width and in stages to facilitate compaction by rollers.

The work in various portions shall as far as possible be raised simultaneously. If however any part is permitted by the Engineer-in-Charge to be raised higher than the part adjacent to it, the loose uncompacted material at the junction shall be removed or watered and compacted to specified density without extra cost as directed by the Engineer-in-Charge. A minimum slope of 2:1 should be provided at such junction and vertical difference between such junction and vertical difference between such two junctions should not be more than 1m.

c) No clods or lumps more than 5cm shall be allowed and all lump and clods shall be broken up to the above size before rolling.

d) The distribution and gradation of materials to be used throughout the bed/embankment construction shall be free from lenses or pockets of materials differing substantially in texture or gradation from surrounding material. The excavation and placing operations shall be such that the materials when compacted will be so blended as to secure the best practicable degree of compaction, impermeability and stability.

e) The Engineer-in-Charge may designate the location in the earth fill where the individual loads shall be deposited. The most impervious materials shall be placed in the central upstream portion of the earth fill and the more pervious material shall be placed on either side of it so that permeability of the fill will gradually increase towards the upstream and downstream edges of the earth fill. When materials differ in dry density but have about the same permeability the material having the greater density should be placed in the outer section of the zones of the dam as the case may be.

f) Should cobbles and rock fragments of size larger than permissible be found in approved earth fill material they shall be removed by the contractor either at the site of excavation or after being transported to the earth fill but before the materials in embankment are rolled and compacted. Such cobbles and rock fragments shall be placed in the rock toe directly or wasted as approved and directed by the Engineer-in-Charge.

g) In order that proper compaction can be done up to the edges of the designed section of embankment the section shall be widened by half meter on each side i.e. on downstream and upstream side and extra material shall be deposited for this purpose at the section. The whole section will then be compacted and then dressed and brought to the required slopes. Necessary extra quantity required to be handled for this purpose shall not be paid for and is considered to be included in the rate of this item.

h) Embankment materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the embankment materials. During monsoon before stopping work on embankment for any continuous spell the top surface shall be graded and rolled with a smooth wheeled roller to facilitate run off. Prior to resuming work the top surface shall be scarified and moistened or allowed to dry as necessary and approved by the Engineer-in-Charge for resumption.

**7.4.5 Moisture Control**

a) The water content of the earth fill material prior and during compaction shall be distributed uniformly throughout each layer of the material. The difference WO-W where WO is optimum moisture content as determined by the standard Proctor compaction test expressed as percent of dry weight of soil and W is the moisture content of the embankment being compacted expressed as percent of dry weight of soil shall be as follows:

i) W-WO to be (-) 2% to (+) 2% in case of at least 90% samples collected in a week.

ii) W-WO to be (-) 3% to (+) 3% in case of the remaining 10%. The standard Proctor compaction tests shall be done time to time in the field laboratory. The materials shall be brought to the proper water content by adding necessary amount of water or allowing moisture to evaporate either at the borrow pit or on the embankment before commencing compaction of layers. When water is proposed to be sprinkled for given quantity of soil the amount of water required shall be first calculated making due allowance for natural moisture content, evaporation, base watering etc. This quantity of water shall then be thoroughly mixed with the soil by means of the disc barrows or any other suitable method before compaction. All charges for watering and mixing are included in the item of embankment including pumping, transporting, pipelines etc as necessary.

b) It may be necessary to allow the water to soak into the soil after sprinkling and mixing if necessary sufficient time to have uniform moisture throughout the layer. The contractor shall not get any extra payment for stoppage of work necessitated for allowing soaking of the soil.

c) Water content in soil to be laid to fill hollows in rock foundation and rock abutments and near sides in rock cutting will be as specified under the specification for preparation of foundation (OMC + 2 percent of dry weight of soil). The same moisture content shall be adhered to in case of filling and filling around masonry structures.

**7.4.6 Compaction**

a) Each layer after it is found to have specified moisture content uniformly distributed shall be compacted to give specified density. No fresh layer of soil shall be laid and compacted unless previous layer is approved by Engineer-in-Charge. If the water content of the material spread in layer is more or less than specified, compaction shall not be started unless the moisture content is brought to specified value.

b) Compaction of the embankment/bed shall be done by smooth wheeled power rollers (8 to 10T) or by standard sheep foot rollers or by vibratory rollers whichever is suitable. The number of passes required by a particular type of roller to attain specified density shall be decided by actual trials for different type of soils to be used and equal number of passes should be given to each layer before carrying out the field density test. The final control compaction will however be on the basis of specified densities and not in the number of passes. The contractor has to make his own arrangements for required numbers of rollers required for this work.

c) In the parts of bunds in-accessible to the specified rolling equipment such as test pits or trial pits below foundation level, irregular sides of trenches, drains and portions around and in contact with the structures where the rolling equipment will not be permitted to operate compaction shall be accomplished with either hand or mechanical tampers of approved type. Rollers will not be permitted to operate within 0.5m of concrete or masonry structures and the filling within this distance shall be tampered by hand and mechanical tampers. All materials to be tampered shall be spread in layers with thickness as specified. The moisture content of the materials and the degree of compaction shall be equal to that specified separately. Special care as directed shall be exercised to obtain a good contact and good bond with rock surfaces, surfaces of masonry or concrete.

**7.4.6.1 Field Density Tests**

The degree of compaction will be such as to give dry density as specified below. The density measurements will be conducted by the department from time to time to ascertain whether the compaction attained is as specified. For this purpose for every 300 cum of compacted earth work for every layer at least two field density tests will be taken and maximum dry density (standard Proctor test) and OMC be worked out by oven drying method or kerosene oil burning method if the correlation is found to exist with the former. As the oven drying method involve 24hours period to facilitate work preliminary control as follows shall be exercised. The wet density of compacted layer shall be equal to or above optimum wet density (OWD) and placement moisture content (tested by Kerosene oil burning method) with + 1% of the optimum moisture content. If any field density test reveals that the dry density is less than the permissible, additional rolling will have to be done without any extra cost. In the event of additional rolling being permitted if it is found that original moisture has evaporated, the layer may be broken up or scarified as directed and watered and allowed to soak before rolling to bring the moisture content to specified value. Necessary assistance for carrying out such density and moisture content tests shall be provided by the contractor free of costs to BHEL staff. The sample for density measurements will be taken from anywhere to ensure that no weak spots at locations such as junctions of sloping filter bed, embankment and turning places of compacting equipment or any doubtful area.

**7.4.6.2 Degree of Compaction**

**Criteria for Control of Compacted Reservoir Bed/Embankment**

| Type of Zone<br><br>1. | % of gravel fraction i.e. Bigger than 6mm size by dry weight of total material<br><br>2. | Minimum acceptable density<br><br>3. | Desired moisture content within<br><br>4. |
|---|---|---|---|
| Bed filling | 0 to 25 | 95% Standard proctor as per IS 2720, (Part-7) | 2% of OMC |
| Embankment filling | 0 to 25 | 95% Standard proctor as per IS 2720, (Part-7) | -do- |
| Filter Material | Sand | Dd = 85% | |
| | Gravel | Dd = 85% | |

Dd is the relative density.

**7.4.7 Settlement Allowance**

In the earth fill embankments, settlement allowance of 2% will be provided. The base width of the dam will not be increased to maintain the design slopes indicated in the drawings for the additional height as settlement allowance but the following procedure will be adopted. Settlement allowance will be calculated at various levels where the slope is to be changed and the elevations including settlement allowance will be derived, the embankment width at the designed levels remaining same. The edge of embankment at the increased elevations (including settlement) when joined with the point where the slope has changed earlier below shall give the slope to be adopted for construction.

If the embankment is raised in more than one season, provision for settlement shall be made in the last season’s construction by slight steepening of slopes near the top.

**7.4.8 Finishing and Maintenance**

The contractor shall make good at his cost all the damages caused to the constructed work either by rain floods or any reason whatsoever till he finally hand over the entirely completed contracted work. The constructed works shall continue to be maintained by the contractor at his cost irrespective of whether they are paid in running account bills (R.A. bills) or otherwise till the completed works are accepted and taken over by the Department.

**7.5 Mode of Measurement**

a) Stripping for seat of reservoir embankment

Measurement of stripping of embankment base will be measured in square meter as per the actual area stripped as per the drawing and as per the directions of Engineer-in-Charge. Stripping for borrow areas will not be measured for payment.

b) Excavation in bed, foundations, drains and channels etc.

The measurement of excavation shall be the measurement of cut as worked out from the areas of cross-section of original ground and the finally excavated line within the payable excavation lines. The cross section shall be taken at every 15m or such shorter intervals as per the directions of Engineer-in-Charge.

Where level for different soil strata cannot be precisely marked and defined, the bidder shall stack different soils of various classifications separately for measurement purposes and then dispose off as directed. The measurement of rocks when made from stacks of spoils shall be reduced by 50% for voids for payment as excavation.

Where soft rock and hard rock is mixed the measurement of the excavation shall be done as follows. The two kinds of rocks shall be stacked separately and measured in stacks. The net quantity of the two units of rocks shall be so arrived by applying deduction of 50% for looseness in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity of the excavated material, then the quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of the two types of rocks. Where stacking is not feasible the method suggested by Engineer-in-Charge should be followed.

Where soil, ordinary rock or hard rock is mixed, excavated material from hard rock and soft rock shall be stacked separately. Measurements for each shall be reduced by 50% to allow for voids and to arrive at the net quantity. The difference between the entire excavation and the quantity of hard rock and soft rock measured above shall be taken as excavation in ordinary soil.

c) Embankment Construction

i) The work shall be measured on the basis of cross section. The cross section shall be taken at an interval of 15m or at a closer distance as found necessary and as directed by the Engineer-in-Charge. The gross quantity of earthwork, rip-rap etc as the case may be will be based on these cross sections. These cross sections will indicate separately, the zones of earthen embankment, rip-rap etc for facility of arriving at the correct quantities that went into the embankment. Any extra filling due to side slips caused due to negligence of contractor or resulting due to delay in filling will not be paid for.

ii) The line demarcating the zones of cross sections shall conform to the respective typical sections except where departures from these are specially permitted by the Engineer-in-Charge.

iii) The final measurements will be recorded on cross sectional basis. These will be paid for after relevant deductions. Foundation plan with relevant cross sections of the reservoir embankment showing dimensions and levels shall be prepared by contractor and got approved from Engineer-in-Charge in token of acceptance before commencement of stripping and again after completion of the seat of reservoir embankment. The final measurement will be based on the accepted foundation plan and relevant cross sections and the completed section of the dam at the time of taking final cross section.

iv) The quantities shall be calculated by the mean area method viz.
$L/3x\ [A_1+A_2+\sqrt{(A_1A_2)}]$

d) Bed filling
Measurement of bed filling will be in cubic meter for the final compacted thickness actually carried out as per approved drawings.

## 7.6 Rate

The accepted unit rate for the items of stripping, excavation in bed/foundation/ drains/channel and filling in bed and embankment construction are deemed to include all operations including necessary testing described in the specifications herein above.

**8.0 Specifications for hand Placed Rip-Rap/Rock Toe**

**8.1 Scope**

The item shall consists of furnishing of all tools, equipments, materials and labour required for quarrying, transporting and laying the rip-rap including bedding, excavation, dressing of embankment to designed slopes and other operations necessary and ancillary thereto.

Rip-rap shall be hand placed on the slope of the reservoir embankment as marked in the drawings and as per the direction of Engineer-in-Charge. The thickness of rip-rap layer shall be measured normal to the slope of the embankment.

**8.2 Materials**

The rip-rap/rock toe material shall consist of the most durable rock fragments of approved quality selected for the purpose. The quality of individual rock fragments shall be sound, hard, dense and resistant to abrasion and shall be free from cracks, seams, shale partings, conglomerate bands and other defects that would tend to increase unduly their susceptibility to destruction by water and weathering action. The shape of the individual rock fragment shall be angular, fragments having thickness less than 50% of their maximum dimensions shall not be used as rip rap. The individual stones (for atleast 50% of the surface) laid in riprap/rock toe should weigh at least 75kg. These stones shall be evenly distributed over the paved area. No stone shall have any dimension less than 10cm.

The rubble quarries and rock stacks from compulsory excavation shall be got approved from the Engineer-in-Charge. Approval to quarry and stacks shall not mean that all rubble available from that quarry is also approved by the Engineer-in-charge and only approved quality of rubble will have to be used.

**8.3 Construction Operations**

The base slope shall first be prepared to receive the rip-rap/rock toe and the rip-rap/rock toe shall be laid on filter backing. The filter backing shall consist of 15cm graded sand layer on the earth slope and I5cm gravel or metal laid on sand layer. The thickness of rip-rap is exclusive of the thickness of filter backing of gravel or metal.

The stones in the rip-rap/rock toe shall be placed on edge with the longer dimension normal to the slope. Starting at the bottom of the slope the stones shall be laid compactly with staggered joints and so matched and interlocked that they shall be keyed together with a minimum joint space. The wedging shall be done with the largest chip practicable, each chip being well driven home with a hammer so that no chip can be removed by hand. The wedging shall be carried out simultaneously with placing in position of the larger stones and shall in no case be permitted to fall behind. Very irregular projections shall be knocked off so that the rip-rap presents a reasonably uniform surface free of loose stones. Larger rock fragments should be uniformly distributed with smaller rock fragments filling the space between the larger fragments.

Hand placed rip-rap/rock toe should preferably be laid in one course such that the layer thickness is same as the stone size. Where it is not possible to do so, the rip-rap may be laid in two layers. If two layers of stones are used, header stones extending through both layers and spaced at about 1.5m in both directions in a zigzag pattern shall be provided. Also of the two layers, the top layer shall be of larger stones and the stones in top layer should be made to interlock with the bottom layer. No loose spauls or chips should be laid on the top surface of the pitching. The chips shall not be used as a substitute for full thickness of the large stones. The surface should present reasonable uniform slope as designed with dense but rough face.

**8.4 Measurement**

The measurement shall be made for the finished work in cubic metre correct to two places of decimal as per the required thickness of rip-rap laid excluding the thickness of filter backing. No deductions for voids will be made. The measurement of rock toe shall be recorded on cross-sectional area bases. The quantities shall be calculated by mean area method viz $[A_1 + A_2 + \sqrt{A_1A_2}] x\ L/3$

8.5 **Rate**

The contract unit rate for rip-rap/rock toe shall be payment in full for carrying out the required operations including full compensation for

i) Supplying, providing and testing all materials to be incorporated the work including all royalties, fees, rents wherever necessary with all leads and lifts.
ii) Necessary excavation of embankment.
iii) All labour, tools, equipment and incidentals to complete the work as per specifications.

9.0 **Specification for Graded Filter**

9.1 **Scope**

The item of graded filter shall include furnishing all tools, equipments, materials and labour required for providing and laying approved filter materials including screening and washing the materials if necessary, watering and compaction, excavation and dressing of embankment to designed slopes and other operations necessary and ancillary thereto.

Graded filters shall be constructed underneath the rip-rap/rock toe on the upstream and downstream slopes of embankment as shown in drawing, as horizontal filters and chimney filters in the body of embankment etc as indicated in the drawings and as per the direction of Engineer-in-Charge. The thickness of sloping filter shall be measured normal to the slope of the embankment.

9.2 **Materials**

The graded filter shall consist of sand, gravel or crushed stone suitably graded to satisfy the following filter criteria.

i) The coefficient of permeability of draining material should be more than 6 times that of base material.

ii) The grain size curve of the filter should be roughly parallel to that of the base material.

iii) (D15 of filter material)/ (D15 of base material) > 5

iv) (D15 of filter material)/ (D85 of base material) < 5

Where D15 and D85 represent the sizes, at which 15% and 85% of total filter particles are finer (by weight) respectively. If more than one filter layer is required the same criteria is to be followed considering finer filter as the base material for selection of the gradation of the coarser filter.

The requirements for grading of the filter shall be established by the field laboratory on the basis of mechanical analysis of available materials. Mechanical analysis shall be performed on samples which have been compacted by the methods equivalent to compaction by rollers so that individual particles or rock are broken to their final condition in the embankment.

The sand, gravel or crushed stone/metal used as filter material should also conform to the following requirements.

**a) Sand**

The sand shall be natural sand. It shall be from hard dense and durable rock formations. The maximum percentage of materials less than 0.074mm size (passing No. 200 sieve) shall be 5% by weight and it should not contain organic materials. The maximum size of particles shall be 10mm (3/8th inch). The specific gravity of particles shall be not be less than 2.60. The sand shall be well graded and it should satisfy the filter criteria with adjoining filter and base materials. If necessary the sand may have to be washed or screened without any extra cost. The sand is to be supplied by the contractor from approved quarries and the item includes all charges of supply, providing and rehandling including collecting, screening, transporting, washing if necessary, stacking, necessary excavation, placing, watering, compaction, finishing etc with all leads and lifts.

**b) Gravel**

When gravel is to be used it shall mean natural gravel consisting of clean, hard, durable, dense rock fragments. It shall be well graded dense rock fragments. The percentage of material below 0.074mm size shall be less than 2%. The gravel should not contain any organic matter. The item include all charges of supplying, providing and rehandling, including collecting, screening, washing if necessary, transporting, stacking, necessary excavation, placing, watering, compaction, finishing etc with all leads and lifts.

**c) Crushed Stone/Metal**

The natural gravel deposits satisfying filter criteria if not available, the use of crushed stone/metal shall be permitted as filter material. The maximum size permissible shall be 75mm. Metal shall consist of broken or crushed rock having clean, hard, durable, dense rock pieces. It shall be reasonably well graded. The percentage of materials below 0.074mm size shall be less than 1%. The item include all charges of supply, providing and rehandling including breaking, screening, washing if necessary, transporting, stacking, necessary excavation, placing, watering, compaction, finishing etc with all leads and lifts etc.

## 9.3 Construction Operations

Before the first layer of filter material is placed, the embankment shall be trimmed neatly to the slope and grade as indicated on the drawings. The filter material shall be placed in layers of uniform thickness and care shall be taken to avoid segregation of coarse and fine material in each layer, formation of pockets and mixing of material from one layer with material of another layer or earth fill. If mixing of filter material with embankment material is observed, both the embankment and filter shall be removed to such depth as directed by the Engineer-in-Charge and such removal and consequent replacement with approved material shall be done by and at the expense of the contractor.

The filter material shall be deposited in layers of thickness not more than 15cm after compaction by approved type of compactors.

Thickness of filter layer could be increased to 30cm if compaction is performed by treads of Crawler type of tractors, surface vibrators, or similar equipment. Thickness of layers shall however not be more than the penetrating depths of the vibrator if compaction is performed by internal vibrator. During or immediately prior to compaction, the material in each layer shall be thoroughly wetted to desired moisture content. The relative density of the compacted material shall be 85% averagely but not less than 70% as determined by the relative density test for cohesion less free-draining soils.

$D_d = (e_{max} - e)/ (e_{max} - e_{mjn})$

Where, e = void ratio

$e_{max}$ - void ratio at loosest state

$e_{min}$ - void ratio at densest state

and void ratio = $\frac{\text{Volume of voids}}{\text{Volume of solids}}$

The relative density may also be computed using the max. and min. density as follows: -

$$Dd = Y_{dmax}(Y_d - Y_{dmjn}.) / Y_d (Y_{dmax} - Y_{dmin})$$

Where,

$Y_{dmax}$ - Maximum dry density of soil in most compacted state as obtained by the laboratory procedure

$Y_{dmin}$ - Minimum dry density of soil in loosest state as obtained by the laboratory procedure

$Y_d$ - The dry density at which the soil is to be placed or the in place dry density.

While laying slant filter it shall be seen that the level of filter zone and two strips of adjacent zone material are higher by 0.3 to 0.6m than adjoining zone. This is necessary so as to prevent contamination of filter zone from adjacent fine material zones. Traffic over the filter zone shall not be permitted, where this is unavoidable, the filter zone at that strip shall be covered with sheets etc. While starting fresh work at such location a top 10cm filter material layer will have to be removed.

In case of horizontal filter or filter in a trench, the surface of excavation/ stripping including excavation shall be cleaned of all loose material so as to prevent contamination of the filter materials. The laying of individual layers shall proceed in such a way as to preclude as far as possible the mixing of materials of one size with that of the other.

**9.4 Measurement**

The measurement shall be made for the finished work in cubic meter correct to two places of decimal as per the required thickness of filter laid. Separate measurements shall be made for sand layer and gravel or crushed stone layer.

**9.5 Rate**

The contract unit rate for graded filter shall be payment in full for carrying out the required operations including full compensation for

i) Supplying, providing and testing all materials to be incorporated in the work including all royalties, fees, rents where necessary with all leads and lifts.
ii) Necessary excavation for laying filters.
iii) All labour, tools, equipment and incidentals to complete the work as per specification.

**10.0 Specification For Turfing**

**10.1 Scope**

The slope surfaces of the embankment after satisfactory compaction be protected by covering it with approved turfing. The turf shall be of approved quality grass. The patches of grass used for turfing shall be at least 150mm thick. Prior to placing of the turf patches it shall be ensured that the roots of the grass are not cut or damaged. The blocks of sod shall be laid on slope in close contact and then tamped firmly in place so as to fill and close the joints between sods. The turfing so laid shall be kept well watered and protected till it has firm roots. The contractor at his own expense shall redo the area not showing good healthy growth of grass.

**10.2 Measurement**

The measurement shall be made for the finished work in square metre of area on slope/horizontal surface correct to two places of decimal.

**10.3 Rate**

The contract unit rate for turfing shall be the payment in full for carrying out the required operation including full compensation for:

i) Supplying and providing all materials to be incorporated in the work including all royalties, fees, rents where necessary with all leads and lifts.
ii) Necessary excavation or dressing of embankment.
iii) All labour, tools, equipment and incidental to complete the work as per specification.

**11.0 Specification for Toe Drain**

**11.1 Scope**

A toe drain at the downstream end of rip rap shall be constructed with R.C.C. and slope as per drawings and as directed by the engineer.

**12.0 Specification for Berm Drain**

A longitudinal drain along the berm shall be constructed with R.C.C. and slope as shown in the drawing and as directed by the engineering-in-charge.

**12.01 Earth Work in Embankment**

Materials to be used for embankment filling shall be of approved quality of material excavated from the bed of the proposed reservoir area. The fill material shall be clean and free from shingle, salts, organic materials, roots and excessive amount of sod, lumps, concrete or any other foreign substances and shall be of non-expansive/non-shrinkable type. Sand to be used for filter shall be clean, medium grained and free from impurities. In any case, the materials to be used for filling purpose shall have the prior written approval of the engineer.

Fill shall be placed in horizontal layers not exceeding 200mm loose thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction/density as specified. The method of compaction shall be subject to the approval of the engineer.

Filling shall be accurately finished to line, slope, cross section and grade as shown in the approved drawings. Finished surface shall be free of irregularities and depressions and shall be within ± 20mm of the specified level.

Frequency of sampling and testing including the methods for conducting the tests are as given in Table-1. The testing frequencies set forth are the desirable minimum and the engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

Following Acceptance Criteria shall be followed:

a) All individual samples collected and tested should pass without any deviation when only one set of sample is tested.

b) For re-test of any sample, two additional samples shall be collected and tested and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirements.

12.02 Sand blanket shall be laid subsequent to base preparation. The base area shall be approved before laying the blanket material. Water as found necessary shall be sprinkled before compaction. The material for sand blanket shall consist of clean, sound and well-graded coarse sand. The material shall be free from debris, wood, vegetable matter and other deleterious matter.

The gradation of filter layer shall meet the requirements as specified below:

a) $\frac{\text{D 50 of filter}}{\text{D 50 of base material}}$ = less than 25

b) $\frac{\text{D 15 of filter}}{\text{D 15 of base material}}$ = 6 to 19

c) $\frac{\text{D 85 of filter}}{\text{D 15 of filter}}$ = Greater than 5

d) $\frac{\text{D 15 of filter}}{\text{D 85 of base material}}$ = less than 5

e) The gradation curve of the filter material shall be nearly parallel to the gradation curve of the base material.

f) The filters shall not contain more than 5% by weight of material finer than 0.075mm size.

g) The sand filter layer shall be considered as the base material for aggregate/gravel filter layer.

h) The filter material shall be suitably compacted to a firm condition to achieve a minimum relative density of 70%.

i) In addition to the above, the provision for filter as given in IS: 9429 – "Code of practice for drainage system for Earth and Rock Fill dam" also shall be followed.

12.03 The slope of embankment including berms if any shall be turf sodded. Turfing shall consist of atleast 5cm thick grass turf sods of approved variety obtained from the tank beds or river margins for use in this work. After the slope has been dressed to line, the entire slope surface shall be covered with a layer of turf sod consisting of blocks of dense lining grass growth of approved species. The sod shall include a mat of roots and earth atleast 5cm thick. Sod containing an excessive amount of obnoxious weed growth shall be excluded. Sods shall be carefully handled in transportation and placing so that minimum amount of earth will be lost from the root mass. The block of sod shall be laid on the slope in close contact and then tamped firmly in place so as to fill and close the joints between blocks. The interval of time between packing and laying shall be kept to a minimum and sod shall not be permitted to dry out. Immediately after placing, the sodded slope shall be thoroughly wetted and then kept moist for three months or till such time the grass establishes itself uniformly on the surface. The watering shall be done by water tanker/sprinkler system etc so as to avoid erosion and prevent damage to sodded areas. The growth of weeds on the turfing shall be prevented by removing them and disposing off.

12.04 Rip rap shall be hand placed on the slopes of the embankment as per IS: 8237 – "Code of practice for Protection of slope for reservoir embankment".

The rock material used for rip-rap shall satisfy the following quality requirements:

a) Specific gravity shall not be less than 2.50. (As per IS: 1122)

b) Sulphate soundness - Less than 10% loss of weight after 5 (five) cycles. (As per IS: 1126)

c) Aggregate Impact value shall not exceed 16% (As per IS : 2386)

d) Water absorption shall not exceed 2.5% (As per IS: 2386)

e) In slake durability test (As per IS: 10050), the percentage retained after two ten (10) minutes cycles shall be more than 85%.

LINING MATERIAL

The proposed lining system consisting of High-density polyethylene (HDPE) membrane shall form the watertight barrier to prevent leakage and thus prevent mixing of sub soil water with sweet water in the reservoir. Bidder shall examine in detail the prevailing conditions and furnish along with the bid complete details of their offer to meet the above requirement.

The specification as outlined hereunder shall be treated as bare minimum. Bidder shall guarantee the satisfactory performance of the proposed liner system for a period of 5 years from the date of installation. The Bidder shall also provide a warranty for the proposed liner system for an additional period of 15 years (subsequent to 5 years guarantee period for successful functioning of the liner system against the intended use. The guarantee/warranty shall be provided in a manner acceptable to the Owner.

The High-density polyethylene liner shall be manufactured of polyethylene resin. The resin composition and production shall meet the intended purpose as specified above. The natural polyethylene resins without carbon black shall meet density requirement of 0.925 to 0.937g/cc and melt index less than 0.4g/10 min. The test methods shall conform to ASTM D 1505 or ASTM D 792 or equivalent for density test and ASTM D 1238, condition E or equivalent for Melt Index test.

The HDPE liner shall not be less than 6.0m in width. Carbon black shall be included in the resin to render it ultra violet resistant. The carbon black content shall be 2 to 3% as per ASTM D 1603. The surface of liner shall not have striations, roughness, pinholes or bubbles. The liner may be smooth or textured. The liner sheet thickness shall be 1.0mm with density not less than 0.90g/cc. The Melt Flow Index (Maximum) shall be 0.55g/10min. and nominal value shall be 0.2 to 0.3g/10min. The test method for Melt Flow Index shall be as per ASTM D 1238 or equivalent. The Tensile strength at break shall not be less than 26.0 Kg/cm and the strain at break shall not be less than 200%. The Tear Strength as per ASTM D 1004 or equivalent shall not be less than 10.0 kg. The puncture resistance as per ASTM D 4833 or equivalent shall not be less than 25.0 Kg.

All metal fixtures and battens/straps shall be of stainless steel. Any sealant used shall be of type as per the recommendations of the HDPE manufacturer compatible with the intended use. However, before the use Owner's approval shall be obtained.

All resins for use in geomembrane shall conform to the following requirements. Each lot shall be sampled with following tests conforming to manufacturer's specifications.

| | | |
|---|---|---|
| 1. | Density | ASTMD1505 |
| 2. | Melt Index | ASTMD1238 |
| 3. | Infrared (IR) Spectroscopy for Additives | |
| 4. | Oxidative Induction Time (OIT) | ASTM D 3895 |

All additives are to be tested and approved prior to use with the following testing performed and compared to the manufacturer's requirements:

1. Carbon Black content ASTM D 1603

2. Oxidative Induction Time ASTM D3895

Manufacturer's Quality Assurance Testing shall conform to the provisions as stipulated here. Full width samples shall be taken as token from the end of each roll. The quality control testing shall meet following frequency:

| Test Description | Method | Frequency |
|---|---|---|
| 1. Thickness | ASTM D 1593 | Every roll |
| 2. Tensile properties | ASTM D 6693 | Every 4000 sqm |
| a) Tensile strength at Break<br>b) Elongation at Break | | |
| 3. Tear Resistance | ASTM D 1004 | -Do- |
| 4. Puncture Resistance | ASTM D 4833 | -Do- |
| 5. Carbon Black Content | ASTM D 1603 | -Do- |
| 6. Dimensional Stability | ASTM D 1204 | -Do- |
| 7. Carbon Black Dispersion | ASTM D 5596 | -Do- |
| 8. Density | ASTM D 1505 | -Do- |
| 9. Melt Index | ASTM D 1238 | -Do- |
| 10. Oxidative Induction Time | ASTM D 3895 | -Do- |

Welding rod samples shall be tested at the frequency of once per 25 rolls of welding rod. Following tests shall be performed on the samples.

1. Thickness as per : ASTM D 751
2. Density as per : ASTM D 1505
3. Melt Index as per : ASTM D 1238
4. Carbon Black content as per : ASTM D 1603

Other International codes of practices, which are equivalent to the above ASTM, shall also be acceptable to the Owner subject to prior approval.

Results of all tests shall be furnished to the Owner for his review. Owner or his authorized representative reserves the right to inspect the testing facilities and witness the test as and when required.

a. The concrete tile used as protective layer over HDPE film shall be free from impurities like particles of stone, lime and other foreign materials visible to the naked eye on the surface and shall be of uniform texture. The permissible tolerance on the dimension of the tiles shall be ± 10 mm in length and width and ± 1.5mm in thickness. The exposed joints between the tiles of protective layer shall be raked out properly and the dust and loose mortar shall be brushed out. The surface shall then be wetted before pointing. The mortar shall be pressed into the raked out joints and shall be finished off flush and level with the edges of the block so as to give smooth appearance.

12.07 Geotextile filter shall be woven type and shall satisfy the following criteria:

1. Material for Geotextile filter 100% Polypropylene

| | | |
|---|---|---|
| 2. | Equivalent opening size | as required |
| 3. | Specific gravity | 0.91 |
| 4. | Weight in gms/sqm | Min 200 |
| 5. | Thickness in mm | Min 0.58 |
| 6. | Breaking strength (5cm x 20m strip) (IS: 1969 -Latest edition) | |
| | Warpway (Kg) | >220 |
| | Weftway (Kg) | >160 |
| 7. | Percentage Elongation at break<br>(IS: 1969-Latest edition)<br>Warp<br>Weft | <br><br>< 38<br>< 32 |
| 8. | Garb strength test (3" x 1" strip)<br>(ASTM-D-1682)<br>Warpway (Kg)<br>Weftway (Kg) | <br><br>>180<br>>130 |
| 9. | Percentage Elongation (Garb test) (ASTM-D1682)<br>Warpway (Kg)<br>Weftway (Kg) | <br><br><37<br><34 |
| 10. | Tear Strength (Single rip) (ASTM-D1682)<br>Warpway (Kg)<br>Weftway (Kg) | <br>>40<br>>45 |
| 11. | Water permeability (Litres/CM/Sq. Metre)<br>at 10cm Water head | <br>>10 |
| 12. | Width to be supplied | Not less than 1.75 m |

Geo-textile filter shall be with U-V (Ultra-violet) treatment suitable for a temperature range from 0 ° C to 50 ° C so that the strength and the life of the same is not affected due to exposure to ultraviolet rays. In addition to the above, geo-textile filter shall have good resistance to chemicals and to biological degradation.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

| SI. No. | Nature of Test/ Characteristics | Method of Test | No. of Samples & Frequency of Test | Remarks |
|---|---|---|---|---|
| 1. | Suitability of Fill Materials | | | |
| | a/ Grain Size Analysis | IS: 2720 (Part -IV) | One in every 2000 cum for each type and each source of fill materials subject to a minimum of two samples. | Test for soil and sand. |

| | | | | |
|---|---|---|---|---|
| | b/ Liquid limit and plastic limit | IS : 2720 (Part -V) | -------DO------ | Test for soil |
| | c/ Shrinkage Limit | IS : 2720 (Part -VI) | -------DO------ | Test for soil |
| | d/ Free Swell Index | IS : 2720 (Part -XL) | -------DO------ | Test for soil |
| | e) Chemical Analysis | IS : 2720 | | |
| | i) Organic matter | Part-XXII | One in every 5000 cum for each type and each source of fill material. | Test for sand and soil. |
| | ii) Calcium carbonate | Part-XXIII | -------DO------ | Test for sand and soil. |
| | iii) PH | Part -XXVI | -------DO------ | Test for sand and soil. |
| | iv) Total Soluble Sulphate | Part-XXVII | -------DO------ | Test for sand and soil. |
| 2. | Standard Proctor Test | IS : 2720 (Part -VII) | One in every 2000 cum for each type and each source of Fill materials. | Test on soil for determining optimum moisture content & maximum dry density etc. |
| 3. | Moisture content for fill before compaction | IS : 2720 (Part -II) | ----Do---- | Test for soil |
| 4. | Degree of Compaction of Fill. | | | |
| | a/ Dry density by core cutter method<br>or | IS : 2720 (Part - XXIX) | For area filling, one for every 1000 sqm area for each compacted layer. | Test for soil |
| | Dry density in place by sand displacement method. | IS : 2720 (Part - XXVIII) | ----Do---- | |
| | b/ Relative density (Density Index) | IS: 2720 (Part -XIV) | ----Do---- | Test for sand |
| | c/ Dry Density by proctor needle penetration. | Standard Practice | Random checks to be carried out for each compacted layer in addition to tests mentioned under IV (a) above. | Test for soil |

# TELANGANA STATE ELECTRICITY CORPORATION LIMITED (TSGENCO) 4X270MW BHADRADRI TPS

## TECHNICAL SPECIFICATIONS (EXCEPT CHIMNEY)

## CIVIL STRUCTURAL & ARCHITECTURAL WORKS

## PE-TS-411-600-C001

## SECTION C


**Bharat Heavy Electricals Limited**
**Project Engineering Management**
**PPEI Building, Power Sector,**
**Plot No. 25, Sector 16A,**
**Noida-201301**

# CONTENTS

## 1.0 GENERAL

### 1.1 SCOPE

The scope includes civil, structural and architectural works of the following areas/structures/buildings.

- Topographical Survey
- Geo-Technical Investigation
- Leveling and Grading
- Power House including AC Plant & MCC control building
- Mill and Bunker Bay including bunkers
- Foundation for TG, Mills, ESP, FD/ID/PA Fans, Boiler & Boiler auxiliary foundations, Duct supporting column foundations and miscellaneous equipments.
- Transformer Yard including transformer foundation, fire barrier wall etc.
- Chimney
- Raw water reservoir and Raw water pump house
- Clarified water cum Fire water reservoir
- ESP Control Building
- FO System including fuel oil pump house, LDO/HFO tank foundation and dyke area.
- CW System including fore-bay basin, CW-duct, CW-pump house including maintenance bay and electrical annex.
- Fire Station Building.
- Main Plant Paving
- Service Building
- Canteen Building
- Admin building and gate Complex
- Permanent Store building
- DM Plant including DM regeneration, DM plant building, DMW Storage Tank foundation and paving etc.

- CW Treatment Building
- Compressor Building
- Chlorination Building
- Pipe and Cable Rack
- ETP Sumps.
- Chemical dosing.
- Watch Towers
- Rain Water Harvesting pits
- Plant Road and drains.
- Sanitary Sewer including inspection pits, manholes and foundation for skid mounting plant.
- Civil works for Complete Plant Water System
- Weigh Bridge
- DG Building

**1.1.1** The criteria furnished in this document shall govern the design of Civil, Structural and Architectural works of buildings, structures and yard facilities related to the proposed project, indicated in Section 1.1 only.

This document covers the general description of structural framing system, applicable design codes and standards, specific design criteria, design loads and combinations, design methodology and characteristics of construction materials to be adopted for the structures indicated above.

## 1.2 SITE INFORMATION

### 1.2.1 Site Location

The plant site is located at 10 km from Manuguru town and 20 km from Manuguru railway station and nearest airport is Vijaywada which is about 220km from site.

### 1.2.2 Grade level

Finished Graded Level (FGL) for entire plant area shall be at least 1 m above HFL.
However FGL will be finalized after topographical/contour survey data considering minimum levelling and grading works.

### 1.2.3 Soil Condition and Ground Water Level & HFL

Type of foundation, depth, safe bearing capacity etc., shall be as per the approved Geotechnical report. HFL of the plot is at RL (+) 65.465 m (based on area boundary survey drawing manuguru TPP- Boundary-4000-1).

### 1.2.4 Seismic Location

The project site lies in zone III as defined in IS: 1893 (Part 1)-2002. All the structures shall be designed complying with the requirements specified in IS: 1893 (Part-1) -2002 and (Part-4) - 2005.

### 1.2.5 Wind Pressure

Wind force on structures has been considered as per the provisions of IS: 875 (Part-3) -1987. The basic wind speed of 44 m/sec at a height of 10m above the ground level and wind assumed to blow in any direction and the most unfavorable condition shall be considered for design.

### 1.2.6 Reference Level

All elevations shall be marked with reference to Finished Ground Floor elevation of Power House building as EL (±) 0.000m.

In the Boiler, ESP and Chimney Area, paving top shall be at EL(-)0.20 m and main road levels in Boiler Area shall be EL(-)0.20 m.

Transformer yard paving top shall be EL(-)0.10 m .

## 2.0 REFERENCES, CODES AND STANDARDS

Structural design shall be developed on the basis of the standard codes and documents listed below.

All designs shall generally be prepared in accordance with Bureau of Indian Standards (BIS) codes of practice unless specified elsewhere.

## 2.1 BIS CODES AND REFERENCES

The analysis, design and construction for structural and civil works shall be in accordance with the BIS codes/standards or equivalent International codes.

### 2.1.1 EARTHWORK

| | |
|---|---|
| IS: 1498 | Classification and identification of soils for General Engineering Purposes. |

**2.1.2 LOADS**

| | |
|---|---|
| IS: 875 | Code of Practice for design loads (other than earthquake) for buildings and structures (All parts) |
| IS: 1911 | Schedule of Unit Weights of building materials |
| IS: 1893 | Criteria for earthquake resistant design of structure (All parts) |

**2.1.3 FOUNDATIONS AND SOIL ENGINEERING**

| | |
|---|---|
| IS: 1080 | Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell) |
| IS: 1904 | Code of Practice for design and construction of foundations in soils (General requirements) |
| IS: 2911 | Code of Practice for design and construction of pile foundations (All parts) |
| IS: 2950 | Code of Practice for design and construction of raft foundations |
| IS: 2974 | Code of Practice for design and construction of machine foundations (All parts) |
| IS: 8009 | Code of Practice for calculation of settlement of foundations (All parts) |
| IS: 9556 | Code of Practice for design and construction of diaphragm walls |
| IS: 11089 | Code of Practice for design and construction of ring foundation |
| IS: 13301 | Guidelines for vibration isolation for machine foundations. |

**2.1.4 REINFORCED CEMENT CONCRETE**

| | |
|---|---|
| IS: 383 | Specification for Coarse and fine aggregate from natural sources for concrete |

| | |
|---|---|
| IS: 432 | Specification for Mild steel and Medium tensile steel bars |
| IS: 455 | Specification for Portland Slag Cement |
| IS: 456 | Code of Practice for plain and reinforced concrete |
| IS: 458 | Specification for pre cast concrete pipes |
| IS: 1443 | Code of practice for laying and finishing of cement concrete flooring tiles |
| IS: 1566 | Specification for Hard drawn wire fabric for concrete reinforcement. |
| IS: 1786 | Specification for high strength deformed steel bars and wires for concrete reinforcement. |
| IS: 1834 | Hot applied sealing compounds for joints in concrete |
| IS: 2502 | Code of Practice for bending and fixing of bars for concrete reinforcement |
| IS: 3370 | Code of Practice for concrete structures for storage of liquids (All parts) |
| IS: 3414 | Code of Practice for design and installation of joints in buildings |
| IS: 3935 | Code of Practice for composite construction |
| IS: 4326 | Code of Practice for earthquake resistant design and construction of buildings. |
| IS: 4948 | Welded steel wire fabrics for general use |
| IS: 4995 | Criteria for design of reinforced concrete bins for storage of granular and powdery materials (All parts) |
| IS: 5525 | Recommendation for detailing of reinforcement in reinforced concrete works |
| IS: 8112 | Specification for 43 grade Ordinary Portland cement |
| IS: 12269 | Specification for 53 grade Ordinary Portland cement |

| | |
|---|---|
| IS:11384 | Code of Practice for composite construction in structural steel and concrete |
| IS:11682 | Criteria for design of RCC staging for Overhead water tanks |
| IS:13920 | Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces. |
| BS: 8007 | British Standard Code of practice for design of concrete structures for retaining aqueous liquid. |

**2.1.5 STRUCTURAL STEEL**

| | |
|---|---|
| IS: 800-1984 | Code of Practice for general construction in steel |
| IS: 806 | Code of Practice for use of steel tubes in general building construction |
| IS: 808 | Dimensions for hot rolled steel beam, column channel and angle section |
| IS: 813 | Scheme of symbols for welding |
| IS: 816 | Code of Practice for use of metal arc welding for general construction in mild steel |
| IS: 919 | Recommendations for limits and fits for engineering. |
| IS: 1024 | Code of Practice for use of welding in bridges and structures subjected to Dynamic loading |
| IS: 1161 | Steel tubes for structural purposes |
| IS: 1239 | Mild steel tubes, tubular and other wrought steel fittings (all parts) |
| IS: 1363 | Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) [All parts] |
| IS: 1364 | Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts] |
| IS: 1365 | Slotted counter sunk head screws (dia range 1.6 to 20 mm). |
| IS: 1730 | Dimensions for steel plate, sheet and strip for |

| | |
|---|---|
| | structural and general engineering purpose. |
| IS: 2016 | Plain Washers |
| IS: 2062 | Structural steel (fusion welding quality) |
| IS: 3502 | Specification for steel chequered plates |
| IS: 3589 | Seamless or electrically welded steel pipes for water, gas and sewage. |
| IS: 3613 | Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels. |
| IS: 4000 | Code of Practice for High strength bolts in steel structures |
| IS: 4759 | Hot dip zinc coatings on structural steel and other allied products |
| IS: 4923 | Hollow Steel sections for structural use |
| IS: 7215 | Tolerances for fabrication of steel structures |
| IS: 7280 | Base-wire electrodes for sub-merged arc welding of structural steels |
| IS: 8500 | Structural steel - micro alloyed (medium and high strength qualities). |
| IS: 8640 | Recommendations for dimensional parameters for industrial building |
| IS: 9178 | Criteria for design of steel bins for storage of bulk material (Al parts). |
| IS: 12843 | Tolerances for erection of steel structures |

**2.1.6 MASONRY**

| | |
|---|---|
| IS: 1077 | Specification for Common Burnt Clay Building Bricks . |
| IS: 1905 | Code of Practice for structural use of unreinforced masonry |
| IS: 2185 | Specification for Concrete Masonry units (All parts) |
| IS: 2212 | Code of Practice for brickwork |

| | |
|---|---|
| IS: 2185 | Concrete Masonry units (All parts - Hollow & Solid concrete blocks) |
| IS: 4860 | Specification for Acid Resistant Bricks |
| IS: 12894 | Specification for Pulverized Fuel Ash (Fly Ash) Lime Bricks |

**2.1.7 DOORS, WINDOWS AND VENTILATORS**

| | |
|---|---|
| IS: 1038 | Steel doors, windows and ventilators |
| IS: 1361 | Steel windows for industrial buildings |
| IS: 1948 | Aluminium doors windows and ventilators |
| IS: 1949 | Aluminium windows for industrial building |
| IS: 2835 | Transparent sheet glass for glazing and framing purposes |
| IS: 3103 | Code of practice for Industrial ventilation. |
| IS: 3548 | Code of practice for glazing in buildings |
| IS: 3614 | Specification for Fire check doors. |
| IS: 4351 | Specification for Steel door frames. |
| IS: 6248 | Metal rolling shutters and rolling grills. |

**2.1.8 ROOF AND FLOORING**

| | |
|---|---|
| IS: 809 | Rubber flooring materials for general purposes |
| IS: 1195 | Bitumen mastic for flooring |
| IS: 1237 | Cement concrete flooring tiles |

**2.1.9 WATER PROOFING**

| | |
|---|---|
| IS: 1322 | Bitumen felts for waterproofing and damp proofing |
| IS: 1346 | Code of practice for waterproofing of roofs with bitumen felts |
| IS: 3067 | Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings. |

**2.1.10 WATER SUPPLY, DRAINAGE AND SEWERAGE**

| | |
|---|---|
| IS: 1172 | Code of basic requirements for water supply, drainage and sanitation |
| IS: 1742 | Code of practice for building drainage |
| IS: 2065 | Code of practice for water supply in buildings |
| IS: 5329 | Code of practice for sanitary pipe work above ground for buildings |
| IS: 12251 | Code of practice for Drainage of Building Basement |

**2.1.11 MISCELLANEOUS**

| | |
|---|---|
| SP-6 | Handbook for Structural Engineers (all parts) |
| SP-7 | National Building Code of India |
| SP-16 | Design Aids for reinforced concrete to IS: 456-1978 |
| SP-20 | Handbook on masonry design and construction |
| SP-22 | Explanatory handbook on codes on earthquake engineering (IS 1893-1975 and IS: 4326-1976) |
| SP-24 | Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete (IS: 456 -1978) |
| SP-25 | Handbook on causes and prevention of cracks in buildings |
| SP-32 | Handbook on functional requirements of industrial buildings |
| SP-34 | Handbook of concrete reinforcement and detailing (SCIP) |
| SP-35 | Handbook on Water Supply and Drainage |
| SP-38 | Handbook on Typified designs for structures with Steel roof trusses (With & without cranes) |
| SP-40 | Handbook on Structures with Steel Portal frames (without cranes) |

| | |
|---|---|
| SP-47 | Handbook on Structures with Steel Lattice Portal frames (without cranes) |
| SP-64 | Explanatory handbook on IS Code of Practice for Deisgn loads (other than earthquake) for buildings and structures (Part 3 – wind load IS 875 – Part 3 – 1987) |
| IRC: 15 | Code of Practice for construction of concrete roads |
| IRC: 19 | Standard specification and Code of Practice for Water Bound Macadem |
| IRC: 36 | Recommended Practice for the Construction of Earth Embankments for Road Works |
| IRC: 37 | Guidelines for the design of flexible pavements |
| IRC: 101 | Guidelines for design of continuously reinforced Concrete pavement with elastic joints |
| IRC: SP - 042 | Guidelines on Road drainage |

## 3.0 LOADS AND LOAD COMBINATIONS

All structures will be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static and dynamic) and other piping loads, wind loads, seismic loads, temperature loads and any other loading condition which can occur during the design life of the facility.

## 3.1 DEAD LOADS (DL)

Dead loads consist of the weights of the structure complete with floors, roof, finishes, fixtures, partitions, wall panels, etc.

**3.1.1** The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

| **Materials** | **Unit weight** |
|---|---|
| Plain cement concrete | 24 $kN/m^3$ |
| Reinforced cement concrete | 25 $kN/m^3$ |
| Structural steel | 78.5 $kN/m^3$ |
| Brick work | 19 $kN/m^3$ |
| Cement plaster | 21 $kN/m^3$ |
| Floor Finish | 24 $kN/m^3$ |
| Coal | 12 $kN/m^3$ |
| Fly Ash | 16 $kN/m^3$ |
| Bottom Ash | 16 $kN/m^3$ |

:

**3.1.2** Following will be considered for evaluation of dead loads:

- Load of RCC slab wherever concrete floors are provided
- Floor finish of 40/50 mm laid over RCC Slab
- Other area flooring will consist of removable electro forged grating/ chequered plate.
- Beams & Columns as per actual size
- Wall cladding loads.
- Self-weight of supporting structure/facilities

## 3.2 IMPOSED LOADS (IL)

The loads considered as imposed loads are live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hangers (not exceeding 2.5 kN/$m^2$), erection loads, operation / maintenance loads and loads produced by personnel, movable equipment and other items placed on the structure, but not permanently attached to it. Imposed loads for design at various floors in different areas will generally be considered as given below.

Imposed/Live loads will consist of uniform live loads and equipment live loads. Uniform live loads are assumed unit loads which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, equipment, or parts which may be moved over or placed on floors during maintenance operations. These uniform live loads will not be considered on floor areas which will be permanently covered with equipment. In the absence of equipment load, the predefined LL to be considered for whole area for the design of foundation, column & mainframe beams. The floor beams may be designed for the equipment load.

Equipment live loads are calculated based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance or to be temporarily placed on or moved over floor during installation. Floors and supporting members, which are subject to heavy equipment loads, will be designed on the basis of the weight of the equipment or specifically defined loads and the erection loads wherever required. Each member in the floor which may carry these loads will be designed for the heaviest piece or pieces of equipment arranged in the most critical position. These loads will also be compared with the superimposed loads given below. Higher of the two will be adopted for analysis and design.

**Steam Piping Load:** The loads superimposed on structure by piping hangers and at the restraint points will be considered. However, pipe dynamic forces at hanger location / restraint points will not be considered to act simultaneously, in that direction with seismic forces.

**POWER HOUSE BUILDING**

| S. NO. | AREA | LOAD ( KN/$m^2$) |
|---|---|---|
| 1. | GROUND FLOOR | |
| | Unloading Bay | 30 KN/$m^2$ |
| | Other areas | 15 KN/$m^2$ |
| 2. | Mezzanine Floor | 15 KN/$m^2$ plus hung loads |
| 3. | Operating Floor | |
| | TG Lay-down Area | 30 KN/$m^2$ plus hung loads or actual load furnished by equipment supplier whichever is higher |

| | | |
|---|---|---|
| | Rotor removable Area | 30 KN/m$^2$plus hung loads or actual load furnished by equipment supplier whichever is higher. Rotor removal area beams shall also be checked for half the rotor load at the center of the beam |
| | Other areas | 15 KN/m$^2$ plus hung loads |
| 4. | Heavy equipments | As per actual loading |

**Control building**

| S. NO. | AREA | LOAD ( KN/m$^2$) |
|---|---|---|
| 1. | Control room floor | 10 KN/m$^2$plus hung loads |
| 2. | Switch gear floor | 15 KN/m$^2$ plus hung loads |
| 3. | Cable spreader floor | 7.5 KN/m$^2$ plus hung loads |

**Mill Building**

| S. NO. | AREA | LOAD ( KN/m$^2$) |
|---|---|---|
| 1. | Ground Floor | 25 KN/m$^2$ |
| 2. | Feeder , tripper floor | 15 KN/m$^2$ + hung loads + 0.5(dust load) |

**Auxiliary Buildings**

| S. NO. | AREA | LOAD ( kN/m$^2$) |
|---|---|---|
| 1. | Ground Floor | 10 KN/m$^2$ |
| 2. | Cable Spreader Floor | 7.5 KN/m$^2$ |
| 3. | Pump House Operating Floor | 15 KN/m$^2$ |
| 4. | Switchgear room | 15 KN/m$^2$ |
| 5. | Non-operational area | As per IS:875(part 2) |
| 6. | MCC room | 15 KN/m$^2$ |
| 7. | Battery room | 10 KN/m$^2$ |
| 8. | Air washer room , A/C plant | 10 KN/m$^2$ |
| 9. | AHU room | 10 KN/m$^2$ |
| 10. | All other Floors/grating /stair | 5 KN/m$^2$ |

**Non Plant Buildings**

| S. NO. | AREA | LOAD ( $KN/m^2$) |
|---|---|---|
| 1. | Floors with equipment | 10 $KN/m^2$ |
| 2. | All other floors | 5 $KN/m^2$ |

**Underground Structures/Trenches/pits**

Minimum surcharge shall be 15 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

**Covers for Trenches / Channels**

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel, or one 0.75 central point, whichever is critical, shall considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards

**Roads**

Design of roads shall be in accordance with Indian Road Congress standard IRC-37.

**Road Culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches**

Road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

**GENERAL**

| S. NO. | AREA | LOAD ( $KN/m^2$) |
|---|---|---|
| 1. | Stairs, Landings and Balconies | 5.0 $KN/m^2$ |
| 2. | Toilets | 2.0 $KN/m^2$ |
| 3. | Chequered plates, grating floors etc | 5.0 $KN/m^2$ |
| 4. | RCC Floors (General) | 5.0 $KN/m^2$ |
| 5. | Flat Roofs (Accessible) | 1.5 $KN/m^2$ |
| 6. | Flat Roofs (Non- Accessible) | 0.75 $KN/m^2$ |
| 7. | Inclined Roofs | As per IS: 875 (Part-2) |
| 8. | Walkways (General) | 5.0 $KN/m^2$ |
| 9. | Walkways of Conveyor Galleries | 5.0 $KN/m^2$ |

**3.3 WIND LOAD**

Wind loading will be in accordance with Indian Standard Code IS:875 (Part 3) for a basic wind speed of 44 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k1) shall be considered as 1.07 for all structures

**3.4 SEISMIC LOADS**

The lateral forces will be established in accordance with the recommendations of IS:1893-1984 of Indian Code of practice. The site falls in Zone- III as identified in the map in IS:1893-2002. Analysis and design of structures shall be carried out accordingly taking into consideration the factors related to soil characteristics and importance of the structure together with the basic seismic co-efficient as per provision of Indian code.

Importance factor and response reduction factor shall be taken as per IS:1893(part I & IV).

Response spectrum method shall be used for seismic analysis as per IS : 1893 .

**3.5 EARTH PRESSURE LOADS**

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and underground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

**3.6 TEMPERATURE LOADS**

The effect of temperature loads shall be considered for design of structural frames. For temperature loading calculation the temperature variation shall be considered as 2/3rd of the difference in the mean of the daily maximum ambient temperature during the hottest month of the year (0C) and mean of the daily minimum ambient temperature during the coldest month of the year (0C). The structure shall be designed to withstand stresses due to 50% of the total temperature variation. Expansion and contraction due to changes of temperature of materials of structure

shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

Mean Daily minimum ambient temperature during coldest month of the year = 11.5° C

Mean Daily maximum ambient temperature during hottest month of the year = 45.1° C

### 3.7 EQUIPMENT LOAD

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

## 3.8 CRANE, MONORAIL AND ELEVATOR LOADS

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor data. All lifting beams, monorails shall have design loads increased for impact factor. Vertical impact force and surge force in lateral and longitudinal direction shall be taken as per following.

### 3.8.1 Crane loads

i) For vertical force, an impact factor of 25% of the maximum crane wheel load.

ii) A lateral crane surge of 10% of the weight of the trolley plus the lifted load applied at the top of each rail..

iii) A longitudinal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in the longitudinal direction.

### 3.8.2 Monorail loads

i) Impact factor of 10% of lifted load hoist for rail and support design

ii) Impact factor of 25% of the lifted load for electrical hoist for rail and support design

### 3.8.3 Elevator loads

i) 100% of the lifted load plus the equipment weight for the elevator support beams.

**3.9 Load Combinations**

While designing consideration shall be given to the following load combinations :

i) DL + LL
ii) DL + LL + PL + Equip (+/-) TL
iii) DL + LL + PL + Equip + Cb + CtLA(+/-) CS (+/-) TL
iv) DL + LL + PL + Equip + Cb + CtLB(+/-)CS (+/-) TL
v) 0.9DL(+/-)EL (for DL only) (+/-) TL
vi) 0.9DL (+/-) WL1 (+/-) TL
vii) 0.9DL (+/-)WL2 (+/-)TL
viii)DL +* LL + PL + Equip + Cb + Ct(+/-) EL (+/-)TL(* Appropriate portion of LL which is considered for working out EL shall only be taken)
ix) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL1(+/-)TL
x) DL + LL + PL + Equip + Cb + CtL1(+/-) (CS1+WL2) (+/-)TL

Where the above loads are :

DL = Dead load of structures, floors, walls etc.
LL = General live load on floors
PL = Pipe Load
Equip = Equipment loads
Cb = Crane Bridge
Ct = Crane trolley positioned at middle of bridge
CtLA = Crane trolley + Load near one row
CtLB = Crane trolley + Load near other row
CtL1 = Crane trolley + Half load lifted at centre of bridge
CS = Crane surge for full load
CS1 = Crane surge for half load lifted
WL1 = Wind load from left to right
WL2 = Wind load from right to left
EL = Earthquake load
TL = Temperature load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in wind permissible stresses will be permitted.Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

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## 3.10 LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES

Following loading conditions shall be considered in addition to the loading from superstructure for the design of sub structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.
Only liquid pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).
Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with ground water table up to the finished grade level. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being emptied for maintenance.
Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

## 3.11 SPECIAL STRUCTURES

The following densities shall be considered for design of coal bunkers:

a) For volume calculations : 8.0 kN/cum
b) For Structural design : 12.0 kN/cum

Coal bunker shall be designed as per criteria specified in IS:9178 (Part I&II)

## 4.0 DESIGN METHODOLOGY

Wind and seismic forces shall not be considered to act simultaneously.
For the design of main plant structures during seismic condition, the Deaerator Feed

Water Tank shall be considered full up to operating level. However, for other load combinations, Deaerator Feed Water Tank in flooded condition shall be considered.

`Lifted Load' of crane shall not be considered during seismic condition.
For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level..

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.
For calculation of seismic load, equipment load shall be considered as Dead Load.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

**4.1 REINFORCED CONCRETE STRUCTURES**

**4.1.1 GENERAL**

Reinforced concrete structures will be moment resisting frames along both longitudinal & transverse directions. The suspended slab will be considered as continuous over secondary beam and will not form part of the framing system. RCC structures/members will be designed as per the provisions of IS: 456 using limit state method, unless use of working stress method is specifically mentioned elsewhere in this document.

Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456.

Mix design concrete will be used for all areas other than lean concrete work and plain cement concrete work where nominal/volume mix may be permitted.

Water retaining RCC Structures will be designed in accordance to IS: 3370 (Code of practice for concrete structures for the storage of liquids) by Working Stress Method.

The grade of concrete for various structures shall be as follows;

- Mass concrete filling M7.5
- PCC below T G Foundations, Fan foundations

and all vibratory foundations / Screed concrete M10

- PCC below Paving(general) incl plinth protection M10
- RCC in grade slabs M25
- Boiler area paving M20
- RCC for Super Structure works in structural Steel buildings / Trench slab and wall M25
- RCC in foundations/ Water retaining Structures M25
- RCC for Super Structure works in RCC building M25
- RCC for T G raft, Mill, BFP & fan foundations M30
- Precast RCC Trench Covers M25
- Encasement of Base plate/Steel columns/ Wall beams M20
- RCC for TG top deck and columns M35
- Drain/cable trench M25

Minimum cement content, maximum water cement ratio and minimum grade of concrete shall be considered as per IS: 456-2000 for structures not mentioned above.

Minimum cover to reinforcement shall be as per Table 16 of IS: 456-2000 for mild exposure condition. Minimum fire rating of 2 hours shall be considered where fire hazard is expected and accordingly minimum cover shall be increased if required to meet the requirements as per Table 16A of IS:456-2000.

**MATERIALS**

**Cement:** Ordinary Portland cement (Grade 53) of approved manufacturer conforming to IS: 12269 and Ordinary Portland Cement (Grade 43) conforming to IS 8112 will preferably be used. However other types of cement such as Portland slag cement conforming to IS: 455 & Portland pozzolana cement confirming to IS: 1489 may also be used except for in TG Foundation top deck and sub-structures including foundation raft, major machine foundation like PA/FD/ID FANS, MILLS,BFP etc where OPC grade 53/43 shall necessarily be used.

**Reinforcing Steel:** Reinforcing steel will be TMT bars of grade Fe-500 conforming to IS: 1786.

**Aggregates:** Coarse aggregate for concrete will be chemically inert, hard, strong

durable against weathering, of limited porosity, and free from deleterious materials. It will be properly graded. Coarse aggregates will be either crushed gravel or stone. Aggregates will meet the requirement of IS: 383.

**Admixtures:** Plasticizers-cum-retarder type admixture will generally be added to concrete for promoting workability in addition to retard setting time for mass concreting work.

**Water:** Water used for cement concrete, mortar, plaster, grout curing, washing of coarse aggregates, soaking of bricks etc. will be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure.

The following minimum thickness of the structural elements shall be followed:

- Suspended floor / slab / walkways / canopy slabs, etc 125 mm
- Ground floor slab (non-suspended) 150 mm
- Water Retaining slabs / walls 200 mm
- Cable / pipe trenches / underground pits / Launder walls and base slab 125 mm
- All footings (including raft foundations) 300 mm
- Parapets 125 mm
- Sunshades at edge 75 mm
- Pre cast louvers / fins 50 mm
- Pre cast trench cover slabs / floor slabs / louvers 75 mm
- Paving 100 mm
- Basement walls and base slab 200 mm
- Silo / bin walls 200 mm
- Underground reservoir
- Below ground water table 200 mm
- Above ground water table 150 mm

Minimum heights for pedestals for steel columns shall be as follows:

i) Top of pedestals for building structures will be kept at a lower level so that column base plate together with gussets and stiffeners remain below finished floor level

(FFL). The column bases as well as column section shall be encased in concrete above FFL as per following:

a) Open area : 300mm above paved level
b) Covered area : 150mm above FFL

ii) Stairs and ladder pedestal will be kept 200mm above the FFL

iii) Pedestals to steel columns for equipment structures:

a) Equipment in open area : as required (minimum 300 mm)
b) Equipment in covered area : as required (minimum 150 mm)
c) Structures and equipment : as per vendors data supplied by vendor subject to min as specified above

**4.1.2 FOUNDATION AND UNDERGROUND STRUCTURES**

**4.1.2.1** Foundation for all main plant structure i.e. Power House Building, Boiler, ESP, Mill and Bunker Bay, Transformer Foundations, Air compressor, and other auxiliary buildings shall be decided based on loading arrangement, load intensity and soil strata. Design of foundation at various levels shall be dependent upon the safe bearing capacity at that level and on the basis of recommendation furnished in the Geotechnical Investigation report.

Foundations will be designed for the most critical combinations of forces and moments, resulting from all possible combinations of the various loading from the structural system. No major foundations will rest on filled up ground. The effect of water table will be considered and the foundation will be checked for overturning for minimum and maximum vertical loads. The foundation sections will be sized and reinforced adequately for bending moments and shear stresses.

**4.1.2.2** All foundations including machine/equipment foundations will be of RCC block/frame foundations as the case may be. All foundations will be designed in accordance with relevant parts of IS: 2974 and IS: 456 by limit state method. Raft foundation will be designed as per IS: 2950.

**4.1.2.3** For design of Foundations and underground structures including trenches etc., ground water level shall be considered up to the finished grade level.

**4.1.2.4** **Stability** : The following minimum safety factors for stability checks of foundations shall be used:

1. Overturning 1.4
2. Sliding 1.4
3. Uplift
   a) Normal loading 1.4

b) Hydrostatic forces 1..2

Where dead load provides restoring forces, only 0.9 times dead load shall be considered. Imposed loads shall not be considered as the restoring force.

**4.1.2.5 Minimum cover to Foundation Bolts**

Minimum distance from the centerline of foundation/anchor bolt to the edge of pedestal shall be maximum of the following:

Clear distance from the edge of base plate/base frames to the outer edge of the pedestal shall be minimum 50mm.
Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm.
Clear distance from the edge of sleeve of anchor plate to the edge of pedestal shall be 75mm.

**4.1.2.6 Permissible settlement of Foundation**

For open foundations, the permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 8009. However, total settlement will be restricted to the following.

a) Foundations for main power house columns, Boiler, Mills, bunker, TP's : 25mm
b) Foundation for other structures including ESP with Isolated/strip footing of width up to 6.0M : 40mm
c) Foundation for other structures with Footings greater than 6.0M (raft) : 75 mm

**4.1.2.7 Levelling and grading:** Each layer of filling shall be watered and thoroughly compacted with proper moisture content and such equipment's as may

be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

**4.1.2.8 Backfilling:** Backfilling around foundation and bottom of pipes, thrust blocks etc shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.

**4.1.3 TANK FOUNDATIONS**

The Storage tanks/Day tanks will be resting on hydraulically compacted clear river sand, in layers of 500 mm maximum thickness, topped with 150 thk PCC. PCC layer will be topped with 50 thk. Anti-corrosive asphalt layer, which in turn is topped with 50 thk. Premix carpet. The entire sand fill along with toppings will be confined within a RCC ring beam of appropriate design.

**4.1.4 MACHINE FOUNDATIONS**

This section outlines the design philosophy and construction aspects of foundations for the following equipments;

- ✓ ID/FD/PA/SEAL AIR Fan Foundations & TG Foundation
- ✓ Boiler Feed pump foundations,
- ✓ Bowl Mill foundations and
- ✓ Miscellaneous Machine foundations.

**4.1.4.1** For the foundations of TG & Fans (ID, FD, PA & Seal Air etc.), Boiler feed pump, Bowl Mill, detailed static and dynamic analysis will be performed. The static analysis will include operating conditions load cases and abnormal loads like, maximum unbalance and seismic forces. Unbalanced loads for normal operating condition as given by machine manufacturers or as specified in IS: 2974 whichever is more conservative shall be used. Vibration isolation system shall not be provided in any of rotating foundation except for ID fan foundation

**4.1.4.2** The dynamic analysis will consist of free vibration analysis and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024 and/or VDI 2056 or as required by the machine manufacturer will be satisfied. RCC design will be done by working stress method for all machine foundations as per IS: 2974. Minimum reinforcement will be governed by the requirements specified in IS: 2974 as well as IS: 456.

**4.1.4.3** All block foundation supporting rotating equipments and resting on soil will be designed using the elastic half space theory and/or Barkan's method. The mass of the RCC block will not be less than 2.5 times the mass of the machine. Dynamic analysis will be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer will be satisfied. Minimum reinforcement will be governed by the requirements specified in IS: 2974 and IS: 456.

**4.1.4.4** The analysis and design of machine foundations will be carried out to ensure the following.

- Compliance with the manufacturer's requirements.
- No resonance phenomenon of a disturbing nature to machine operation should exist at the normal running speed.
- Calculations to be performed for dynamic as well as static cases for reinforced concrete block type pedestals.

**4.1.4.5** Bowl mills shall be supported on conventional block type R.C.C foundations. All machine foundation shall be separated from adjoining building / foundations. Isolation joints shall be given all round to isolate the machine foundation from the grade slab..

**4.1.4.6** **Foundation Sizing:** The outline plan dimensions of foundations as given by the machine supplier will be adopted. The height of foundation will be selected after taking into consideration soil strata and operating level of the machine. The eccentricity of common CG of machine and foundation with respect to the centroid of base area should not exceed 5% of the corresponding base dimensions of foundation.

**4.1.4.7** For other types of machines, most suitable type of foundations will be provided. For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary.
Foundation for pumps, and minor rotating equipment etc., are usually in the form of solid block foundations, resting on the ground or on a floor of the building.

At such machine supports, floor may be thickened and extra reinforcement provided. Rubber or neoprene pads under some of these machines to reduce transmission of vibrations to the supporting floor shall be provided if required.

### 4.1.5 LIQUID RETAINING STRUCTURES

RCC water retaining structure like storage tanks, reservoirs, etc., shall be leak proof and designed as un-cracked section with limiting steel stresses in accordance with IS: 3370 ([Part I to IV) by working stress method.

Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width to 0.1mm and limiting steel stresses as per IS: 3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS:3370 (part 1 to IV) by working stress method.

All water retaining/ storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement. Pressure relieving devices may be used and 50% release in water uplift pressure through pressure release valves may be considered in design.PRV shall not be used for clarified water tank. In all liquid structures, PVC water bars shall be provided at each construction/ expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

Screed layer of concrete grade M10 and of minimum 100 mm thickness shall be provided below all water retaining structures.

All underground water retaining/conveying system structures shall have platiciser cum waterproofing cement additives conforming to IS:9103. In addition, limits on permeability as given in IS:2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

**4.1.6**

**Raw Water Reservoir:** The capacity of raw water reservoir shall be for 7 days with minimum capacity of 6.00 Lakhs cu.m. Shape, size and detail of the same shall be as per approved drawings. The reservoir shall be provided with a free board as per requirements of IS: 10635, but in no case, the same shall not be less than 1000 mm. The reservoir shall have two compartments with separate inlet and outlet arrangement. The reservoir embankment shall be made in earthwork with side slopes 1V : 2H (minimum). The reservoir embankment shall be designed and constructed as an earthen dyke founded on natural ground with proper foundation. The entire area, top soil shall be increased to the required level as per actual conditions to totally removal of all vegetation, organic
matters, roots, soft spots etc. Required slush removal sump, provision for deep sump shall be provided in the pumping suction to ensure the pumping head. Also, a suitable spillway arrangement shall be provided to take care of any heavy storm event. The bund shall have adequate width on top to form the road for vehicle movement with minimum width as 4.0 m. bituminous road shall be constructed as per IRC.On the down

stream slope of the embankment, turfing shall be provided with a provision of Toe drain. The bund with impervious geo-membrane (LDPE 500 micron thick) layer on water contain face including base. 150 mm thick sand blanket is recommended below the geo-membrane bottom as a cushion. The reservoir shall be provided with 50 mm thick precast concrete tiles of M20 grade concrete over LDPE film / sand planked lining. The protective layer over LDPE shall be provided over entire bed and side slopes. Material to be used for bund construction shall be as per IS: 1498. Top layer of reservoir basin sub grade shall be compacted to at least 95% of Standard Proctor density by vibro compaction equipment or by any other suitable equipment

**4.2 STEEL STRUCTURES**

**4.2.1 MATERIALS**

**Structural Steel:** Structural steel will be straight sound, free from twists, cracks, flow, laminations and all other defects. Structural steel shall confirm to IS:2062 for rolled members or plates. Structural steel shall conform to Grade A of IS 2062 for rolled steel members or plates up to 20mm thickness. For plates from 20mm to 40mm thickness steel conforming to Grade BR (killed and rolling normalized) of IS 2062. For plates above 40mm thickness steel conforming to Grade BR (killed and furnace normalised) of IS 2062.

**Material:** Structural steel shapes, plates, and appurtenances for general use will conform to Indian Standards IS: 800 with minimum yield strength of 250 MPa. Connection bolts will confirm to relevant IS codes.

**Steel Grating:** All indoor gratings shall be electro forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 6 mm. All gratings shall be hot dip galvanized @ 610 gm/sqm.

**Guard rail /Handrail:** For powerhouse building upto operating floor + half landing, main stair & lobby shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of approved design to meet the functional requirement as well as very good aesthetic appearance. For any other RCC stairs of non-plant buildings 20mm square MS bar post with suitable MS flat and anodized aluminium handrails are to be provided. For any other floor of power house building, plant & non plant buildings unless otherwise indicated in the specification the post and handrails of stairs, railing, etc will be 32mm nominal bore GI pipes of medium grade conforming to IS: 1161 / IS 1239.

**Chequered Plate:** Chequered plate shall conform to IS: 3502 and shall be minimum 6 mm thickness over plane. Steel for chequered plates shall conform to Grade 'A' of IS: 2062.

**Stainless Steel:** Stainless steel liner in the Coal Bunkers will be 3.15 mm thick & of grade AISI – 304, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces, Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. while coal bunker will be made of MS plate.

### 4.2.2 FRAMING

All steel framed structures shall be either "rigid frame" or "simple space frames" or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. Most of the plants' steel buildings shall be designed as simple space frame structures.

The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. Suitable shear connectors shall be welded to the top of the top flange of all secondary beams to ensure the lateral support.. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level.

Columns shall be designed to support the load combination which produces the maximum stress ratio. Exterior columns shall be designed to resist wind moments between braced elevations as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing work points.

**4.2.3 CONNECTIONS**

Shop connections will be by welding, preferably by submerged arc welding. Field connections for light members such as purlins, girt and inaccessible beams, will be done by MS bolts with nuts. All other connections will be designed with welding / high strength friction grips bolts, as necessary.

IS: 816 and IS: 9595 shall be followed for welding of structures.
Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section will be as follows:

Full shear capacity for box section.

80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.

All welds will be continuous. The minimum size of fillet weld will be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections

and 80% of section strength for built up section or rolled section with cover plates.

Design shear force should be more than actual shear.

Moment connections between beam and column will be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns will be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.
Following connections will be provided during erection :

1.) Welded Connection

- Connection of secondary beam to main beam
- Connection of bracing to column
- Connection of bracing to longitudinal tie beam
- Connection of longitudinal tie beam to column
- Connection of spandrel beam to column
- Connection of other secondary structures

2.) HSFG Connection (Grade 8.8 bolts)

- Splicing of column/transverse frame beam/ longitudinal tie beam
- Connection of Crane Girder to column
- Connection between crane girders
- Other major connections

3.) Bearing Type Connection (HT bolts Grade 8.8)

- All removable type connections
- M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc

**4.2.4 DESIGN**

The design of steel structures will be done by linear elastic method as per the provision of IS: 800-1984. Individual members of the frames will be designed for load combinations for moment, axial force, shear force and torsion. Wind and seismic loads will not be considered to act simultaneously in transverse or longitudinal direction as per IS 1893-2002. The gable end columns of Power House building will be designed for wind and axial loads considering base as fixed and restraints provided by wind girder at operating floor and roof levels. The secondary beams will be designed as simply supported beams between the main beams of frames. The secondary beams supporting various RCC slabs without cut outs/openings will be designed as composite beam with channel type shear connectors and will be designed as per the provisions in IS: 11384 for composite construction.

All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings / moment connections shall be used to assure stability of structures. Structure shall be designed such that the surface of all parts shall be accessible for inspection, cleaning, painting and maintenance.

Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced / braced suitably if required.

Base plate shall be fixed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided for escape of air. All anchor bolts for fixing steel columns to foundation shall be embedded in foundation during concreting itself..

### 4.2.5 PERMISSIBLE DEFLECTIONS

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members, dynamic effects shall not be considered unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

#### 4.2.5.1 Vertical Deflection

| | |
|---|---|
| For beams supporting dynamic equipment | Span / 500 |
| For beams supporting floors / masonry | Span / 325 |
| For beams supporting pipes (pipe racks) | Span / 400 |
| Purlins and side runners supporting sheets | Span / 250 |

| | |
|---|---|
| For grating and chequered plates | Span / 250 subject to a maximum of 6 mm |

For crane gantries or any member subjected to dynamic loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

| | |
|---|---|
| For manually operated cranes & monorails | Span / 500 |
| For electric overhead cranes. | |
| Upto 50 t capacity | Span / 750 |
| Over 50 t capacity | Span / 1000 |

**4.2.5.2 Horizontal Deflection**

The permissible horizontal deflections shall be as given below unless specified otherwise.

| | |
|---|---|
| Single storey building | Height / 325 |
| Pipe rack columns | Height / 200 |
| Open structures | Height / 200 |
| Crane gantry girder due to surge | Span/2000 limited to maximum of 15mm |
| Building main columns at crane raillevel due to action of crane surge load only | Height/2500 limited to 10 mm |
| Open gantry columns at crane rail level due to action of crane surge load only | Height/4000 limited to 10 mm |

Provisions of IS: 800-1984 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

**4.2.6 MINIMUM THICKNESS & SIZES OF ELEMENTS**

**4.2.6.1 Minimum Thickness**

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

| | |
|---|---|
| a) Trusses, purlins, girts and bracing | 6 mm |
| b) Columns and beams | 8 mm |
| c) Gussets | 8 mm |
| d) Stiffeners | 8 mm |
| e) Base plates | 10 mm & above |
| f) Chequered plates | 6 mm o/p & above |
| g) Grating Flats | 3 mm for secondary bars and 6 mm for main / edge bars |
| h) Minimum thickness of structural members other than gratings and chequered plates directly exposed to weather and inaccessible for painting and maintenance | 8 mm |

**4.2.6.2 Minimum Sizes:** The flange width of purlins for those supporting roof sheeting and wall cladding shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at at least 50mm. The depth of beams for platform of all structures shall not be less than 125 mm.

### 4.2.7 SLENDERNESS RATIO

The Slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800.

### 4.2.8 PAINTING

All structural steel should be painted with 2 coats of zinc phosphate primer and finished with Synthetic enamel paint of approved make and colour.

All steel structure shall receive two primer coats and two finish coats of painting. First coat of primer shall be given after fabrication, before dispatch to site for erection, after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of erected structures. Two finish coats shall be applied after the second primer coat.

Steel surface which is to be painted shall be cleaned of dust and grease and heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS 05-5900. Primer paint shall be inorganic Zinc phosphate of approved brand. Dry film thickness of each primer coat shall be 25 microns minimum.

Providing and applying two coats of synthetic enamel paint with minimum 50 micron total dry film thickness (DFT) of approved make and shade to achieve an even shade over steel sections already having primer coats and keeping overall DFT with primer not less than 110 microns.

### 4.2.9 REQUIREMENTS FOR SPECIFIC STRUCTURES

#### 4.2.9.1 Coal bunkers

Design of the bunkers shall be as per IS: 9178. Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality. Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers..

Stainless steel liner in the coal Bunkers will be 4.0 mm thick & of grade SS: 409M, Finish Grade 2B (Cold Rolled, Annealed & Pickled and Skin passed) will be provided on the inner faces of entire inclined portion of Hoppers and mouth of the Hoppers, without allowing any projections in coal flow path. The suitable electrodes' classification as per AWS will be as followed for welding of stainless steel to stainless steel & for welding of stainless steel to mild steel.

The coal pressure distribution in the bunker walls and hopper will be calculated as per the guideline laid in IS: 9178.

### 4.3 DESIGN PHILOSPHY

#### 4.3.1 POWER HOUSE STRUCTURE (TURBO GENERATOR / DEAERATOR BAY)

The Main Power House structure will be moment resisting frame in the transverse direction and will have fixed base. The structure will be braced in longitudinal direction. In the longitudinal direction, the structure will be continuous for the total length of one unit of the power house. Adopting twin columns between the two units of Power house buildings, expansion gap shall be provided.

Columns inside TG bay (auxiliary structures around TG) will be fixed at base and have shear connection with beams supporting R.C.C floor at operating floor level & mezzanine floor level. Beams in transverse direction will have connection with TG bay main columns.

**Analysis of Main Frame of the Main Power House**: The structural steel main frame will be analyzed as space frame with fixed base. The frame will be subjected to dead load, live load, crane load, equipment load, wind load and seismic load. Structural analysis will be carried out for the different load combinations as specified elsewhere. For the main frame subjected to seismic load, the analysis will be carried out using the response spectrum method using at least five modes of vibration as per IS: 1893-2002.
The structural steel main frame in the longitudinal direction will be analyzed and designed as braced structure with all the applied external forces resisted through axial tension or compression.
Individual members of the frames shall be designed for various load combinations for moment, axial force, shear force and torsion. The gable end columns shall be designed for wind and axial loads considering base as fixed and restraints provided by the wind girder at operating floor and roof girder levels. The secondary beams shall be designed as simply supported beams between the main beams of frames.

**4.3.2 Electrical Bay**

The electrical bay will consist of areas for the cable spreader, switchgear floor, Control Room floor and MCC Floor. It will be supported on structural steel frame work with moment connection in transverse direction and bracings in longitudinal direction.

**4.3.3 PIPE AND CABLE RACKS AND PIPE PEDESTALS**

Pipe and Cable racks will be latticed steel structure on RCC foundations decided on the basis of Geotechnical Investigation Report. At road crossings the minimum height clearance will be 8 m.

The racks shall generally be designed as braced in the transverse direction below the bottom most rack level and rigid above the level since bracing will interfere with pipe / cables. Longitudinal direction they are braced generally in the centre of an expansion unit. Expansion joint shall be provided whenever there is a change in direction and where length of the rack exceeds 150 meters. Access ladder shall be provided at suitable locations. Where so specified 600 mm wide chequered plate platform will be provided in the cable rack portion for maintenance purpose.

**4.3.4 MILL AND BUNKER BAY**

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker. The structure shall be designed to have a Moment connection at the base of the frame.

**4.4 DRAINAGE AND SEWERAGE**

**4.4.1 SURFACE DRAINAGE**

All the paved and unpaved areas will be adequately drained. The paved areas will be sloped towards the nearest drains with a slope of 1 in 100. The surface drainage from uncontaminated areas will be connected to the nearest storm water drains through rectangular drains. Contaminated area surface drainage will be connected through a separate network. Run off coefficient for paved and unpaved areas will be taken as 0.9 and 0.6 respectively.

**4.4.2 STORM WATER DRAINAGE SYSTEM**

A network of open rectangular or pipe drain will be constructed for efficient discharge of storm water. The drains shall be constructed of RCC. Minimum clear width of the drains shall be 300mm and minimum depth of drain shall be 300mm. NP3 class pipe culverts will be provided under road and railway crossings.

For pipe drains, concrete pipes of class NP2 will be used. However, for road and rail crossing, concrete pipes of class NP3 will be used. Manholes will be provided at 30m intervals along the length, at connection points and at every change of alignment, gradient or diameter of pipeline. Hume pipe of 150mm diameter shall be provided below each road at every 50m and of 600mm diameter at every 300mm and also at all turnings for maintenance purpose. The runoff collected by the above drains will be suitably discharged at a suitable location at plant boundary.

The plant storm water drainage will be designed taking into account the finished grade levels of the plant and invert levels of existing drains(if any), area drainage pattern within and outside plant area, intensity of rainfall @50mm/hr considering heaviest fall in 24 hrs(As per climatological table furnished by customer). The slope shall not be milder than 1 in 1000 and maximum velocity in open drain shall be limited to 1.8 m/s. However a self-cleansing velocity of 0.6m/s shall be ensured.

Drains inside the building will have minimum 40mm thick grating covers. In areas where heavy equipment loads would be coming, pre-cast RCC covers will be provided in place of steel grating.

Open RCC rectangular section shall be provided for all drains.. In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness without perforations and designed for the vehicular loading will be provided.

In the buildings suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting etc. will be provided for each floor with suitable floor drains. Water from roof surface shall be removed by a system of Roof Drain Heads, rainwater down comers and necessary fixtures. The roof of power house shall be provided with a slope of 1

in 100 in one direction in A-B bay and sloping towards A - row.

Garland drains of minimum 300 mm wide shall be provided all around the buildings to lead away roof drainage to the plant drainage system. Plinth protection shall be provided between the building wall and drains with appropriate slope.

Minimum earth cover of 450mm shall be provided over drainage pipes in paved areas.

### 4.4.3 PLANT EFFLUENT DRAINAGE (OILY WASTE/PROCESS WASTE DRAINAGE)

The oily / process waste shall be collected and drained through a separate sewer system consisting of cast iron pipes in the paved area and concrete pipe class NP2 in other area. Manholes shall be provided at junctions of pipes.

The minimum dia of pipe shall be 150 mm for C.I pipe and 300 mm for concrete pipes. The pipes shall be adequately sloped and shall carry the flow to Neutralising pit / oil water separator / guard pond of effluent treatment plant as the case may be.

### 4.4.4 SEWAGE DISPOSAL

All buildings with toilets shall be connected to the sewage treatment plant with a proper sewage disposal network.
Pipe connecting toilet facilities to manholes shall be pipes of,cast iron in paved area whereas in other area hume pipes shall be provided, of minimum size 100 mm dia. Pipes connecting various manholes in the power block area shall be having a minimum dia of 150 mm.
Sewers shall have such slope as to ensure effective discharge. Manholes shall be provided along the sewers at 30 m intervals, at junctions and at changes of gradient or alignment.

### 4.4.5 BUILDINGS - WATER SUPPLY SYSTEM

Roof water tanks of adequate capacity, depending on the number of users for 12 hours requirement will be provided on the roof of buildings as required. Polyethylene water storage tank conforming to IS: 12701 will be used. The tanks will be complete with fittings including float valve, stop cock etc.
Galvanized MS pipe of medium class conforming to IS: 1239 will be used for internal piping works for potable water supply.

## 4.5 CABLE TRENCHES

The slab and walls of cable trenches shall be constructed using concrete grade M25 and pre-cast removable RCC cover (with lifting arrangement) will be constructed using concrete grade M25. Each precast removable RCC cover shall not weigh more than 75 kg and shall be provided with lifting hooks. Proper drainage of trenches shall be provided.

The cable trench walls will be designed for the following loads:

1. Triangular earth pressure + Uniform surcharge pressure of 20 kN/m$^2$.
2. Cable trench covers will be designed for self-weight of top slab and concentrated load of 200 Kg at center of span on each panel.
3. Cable trench crossing the road/rails will be designed for class AA loading of IRC/relevant IS code and should be checked for transformer loading. Lifting hooks will be provided in the pre-cast covers.
4. Cable trenches will be blocked at the ends if required with RCC walls.

Trenches located inside the building will be covered with removable chequered plate covers.

Where the cable trench connects to a building, R.C.C duct banks with PVC / HDPE conduits for running cables will be provided. There conduits shall be sealed with fire resistant sealing compound after cables are laid to prevent ingress of water into the building and to avoid spreading of fire.

## 4.6 PAVING / GRADE SLAB

RCC Grade Slab / Boiler area paving : Minimum 150 mm thick (with minimum reinforcement of 8 dia (HYSD) @ 300 c/c both ways top & bottom) over an underbed as specified herein will be provided for areas mentioned below. Underbed will consist of preparation and consolidation of sub-grade to the required level, laying of stone soling of 230mm compacted thickness with 63mm and down aggregate with interstices filled with selected sand followed by 75mm thick M10 PCC

Area between main plant building and ESP, ID, FD fan will be provided with paving. This paving will have regular configuration with boundaries of the block extending minimum 2 m from the outermost face of the equipment/structures.

1. For Ground floor of all buildings - Grade slab shall be provided
2. Two meter wide corridor along the entire width of TG & Deaerator bay at both the gable ends - Paving shall be provided
3. Complete Transformer yard area between A-row of main power house and

fencing of transformer yard – Paving shall be provided.

## 4.7 ROAD & DRAIN

The main road to the Power Plant shall originate from the main approach road. The main road shall be 12M wide(carriage way width 10M) with 1M wide shoulder on either side to accommodate large trucks movement .The 10M wide road shall be provided upto service building from the main gate.

Other roads may be of double lane of 7.5M wide (carriage way width) and single lane of 3.75M wide with 1M wide shoulder on either side for both, depending on the location.

Branch roads may be of single lane and 3.75 meter wide with 1meter wide berm on either side.

The minimum recommended road section is as follows :

Sub-base : Sub base shall consist of stones of 150 mm maximum size in two layers compacted to a thickness of 230 mm.

Base : Base shall have a thickness of 225 mm consisting of 3 layers of 75 mm each (compacted thickness).

Topping : The bituminous surfacing shall consist of wearing course of premix carpet 20 mm thick (with seal coat on top) over binder course of 55 mm thick Bituminous Macadam.

Initially only water bound macadam surface shall be constructed and after completion of bitumen topping shall be carried out .

All roads should designed in accordance with IRC 37-2001.

**DRAINAGE**

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads except patrol road where drains will be only one side.
Inside surface of the drain will have smooth neat cement finish over with screed

concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec..

**4.8 FENCING**

**4.8.1** Minimum 2.4m high fencing above toe wall shall be provided around transformer yard. Other areas where fencing is necessary it shall comprise of PVC coated galvanised chain linked fencing of minimum 8 gauge (including PVC coating ) with barbed wire for remaining height shall be provided for areas as per safety requirements.

**4.8.2** Access in fencing wherever required shall be with steel gates

**4.9 Plinth Protection**

All buildings will be provided with 1000 mm wide and 75mm thick reinforced cement concrete M25 paving all around on the outside. The plinth protection will be laid over prepared sub-grade and base formed with 100 mm thick compacted sand bed with broken bricks, or rubble laid to a thickness of 75 mm. RCC drains by the side of plinth protection for catering the storm water from roofs and adjacent area will be provided.

**4.10 Grouting/Encasement**

Grout shall be flow able, and no shrinkable kind. Grouting shall be done with Conbextra GPX-2 of `Fosroc' or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips

**4.11 Damp Proofing**

Damp proof course in a thickness of 40mm and consisting of cement concrete 1:1.5:3 with minimum of 2% admixture of approved water proofing compound shall be provided at plinth level for masonry walls in super structure.

**4.9 Watch Tower**

Watch tower shall be provided at the change of alignment of boundary wall and the inter distance of 500 mtr (approx.).

**5.0 BRIEF DESCRIPTION OF STRUCTURES IN POWER PLANT**

**5.1 POWER HOUSE BUILDING**

Main power house framing is of structural steel. Columns and framing beams are of built-up section. Main power house comprises of Turbo Generator bay and Electrical bay.

**Turbo-Generator Bay:** Roof in turbo-generator bay (A-B bay) will be with cast-in-situ RCC slab laid over metal decking sheet as a permanent shuttering.

**Other Areas:** Casting of RCC roof slab will be done with the provision of removable shuttering.

**Flooring:** The floor slab will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned elsewhere. The minimum thickness of RCC slabs will be 150mm. Floor finish of 40mm thickness will be provided over the RCC slab. Type of floor finish will be as per the functional requirements of different areas and facilities. Floor finish that will preferably be adopted for important areas will be as per Finish schedule described elsewhere. TG bay will have RCC floors at finished floor levels (FFL) at EL+8.500 and EL +13.500.

For Fire barrier wall, RCC fire barrier wall shall be provided for the transformer in front of power house. Brick partition walls will be 115mm thick. Bricks shall be burnt clay bricks or fly ash bricks of class designation 7.5 conforming to IS 12894 having 75 kg/Sqcm compressive strength shall be used for brick work. Metal cladding shall be of prefabricated, prepainted and insulated metal sheet of Luxalon or equivalent.

**5.2** Roofing : The gradient for the roof of Turbine bay will be provided either in steel structure or by use of screed concrete of M10 grade. Water proofing treatment for roof shall be provided as per Clause 6.11.

Rain water down comers shall be GI pipes conforming to IS: 1239 for Power house building. Rain water down take pipes shall be provided one per bay near each column location on both A and C row for Power House building.

## 5.3 MILL AND BUNKER BAY STRUCTURE

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed coal into the coal bunker

Mills are to be located on the ground floor. Mill foundations are to be designed as a dynamic block.

Mill maintenance platform is provided with chequered plate or gratings over steel framing with hand rails all-round. Feeder floor shall be of RCC supported on structural steel framework.

Tripper floor is provided immediately above the bunker. Tripper roof shall be of RCC supported on structural steel frame work. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair or ladder shall be provided from tripper floor to roof in each unit.

## 5.4 ESP CONTROL ROOM

This shall be a steel framed structure. The building houses cable vault, toilet, staircase, switch gear rooms, control rooms and AHU room. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC regulations.

## 5.5 TRANSFORMER YARD

Transformer yard will be provided with foundations for transformers & other equipment, cable trenches and fencing. The transformer yard will be provided with the chain link PVC coated galvanized chain link fencing of minimum 8 gauge supported by steel posts. Gravel will be filled in transformer oil and water collecting pits. The transformer yard area will be provided with RCC paving. Fire barrier wall will be provided between the adjacent transformers and fire wall will be provided in the adjacent buildings on the wall facing the transformers as per TAC requirements.

Transformer yard pit will be leveled to proper slopes for drainage towards sump. Sump will be connected to the nearest drainage system after passing through oil water separator.

The total transformer area shall be paved with 150 mm thick RCC paving over 230 mm thick rubble soling.

## 5.6 MISCELLANEOUS BUILDINGS/STRUCTURES

| SL.No. | Building Name | Description |
|---|---|---|
| 1. | Service Building | RCC structure with brick cladding. Total area of 4000 sqm (approx) |
| 2. | Clarified water pump house | RCC sump with structural steel framework above FFL only superstructure with brick cladding with RCC roof over deck sheeting. |
| 3. | CW pump house | RCC sump with structural steel framework, superstructure with brick cladding and RCC floor slabs and roof |
| 4. | CW Treatment | Steel Shed |
| 5. | ESP Control room | Steel structure frame with brick cladding RCC floor slabs and roof. |
| 6. | Compressor house | Steel Building |
| 7. | Chemical Lab | RCC structure with brick cladding. |
| 9. | Fuel oil Pressurizing pump house | RCC structure with brick cladding. |
| 11. | Administrative building | RCC structure with brick cladding. G+1 Structure of total area 2500 sqm. |
| 12 | Canteen | RCC structure with brick cladding. One floor of 40m x 18m (excluding corridor and portico). The main dining area shall have the arrangement to seat minimum 150 people at one time. In addition |

| | | |
|---|---|---|
| | | there shall be a separate executive dining area to accommodate about minimum 25 executive and separate dining area for women for 25 nos. |
| 13 | Fire Water Tank Foundations | RCC ring wall. |
| 14 | Fuel Oil Storage Tank Foundations | RCC ring wall. |
| 15 | Pipe and Cable Trestles | Structural Steel super structure with RCC foundation. |
| 16. | Raw water pump house | Steel Structure |
| 17. | Fire station | G+1 RCC structure with brick cladding.20m x 15m x 4.0m (ht) of each floor.<br>Additional 2 Nos fire tender parking area |
| 18 | Permanent Store Building | RCC columns with brick cladding and steel truss roof. Area 30m x 15m-15 No.s |
| 19 | CW Treatment Building | Steel shed with side open |
| 20 | Security Building | RCC structure with brick cladding of 300 sqm floor area |
| 21 | Parking sheds | Parking sheds shall be provided as mentioned below apart from bus parking for 3No. |

**Parking Requirement**

| Sl. No. | Location | Car parking ( No.s) | Two Wheeler Parking ( No.s) |
|---|---|---|---|
| 1 | Administrative Building | 5 | 50 |
| 2 | Service Building | 20 | 200 |
| 3 | Canteen | 10 | 100 |
| 4 | Chemical lab | -- | 10 |

| | | | |
|---|---|---|---|
| 5 | Security Building | 2 | 20 |
| 6 | Permanent store building | -- | 50 |
| 7 | CW pump house | -- | 10 |
| 8 | Ash Pump House area | 2 | 20 |
| 9 | Coal Handling area | 2 | 20 |

## 6.0 GENERAL REQUIREMENT OF BUILDINGS

The design and construction of buildings, structures etc. shall take in to account the functional requirements for operation and maintenance of all equipment and its users. The following details indicted will generally apply for all buildings and structures.

### 6.1 ARCHITECTURAL CONCEPTS AND DETAILS

Architectural scheme components viz shape, form, colour, and basic materials for interior and exterior architecture, will generally conform to that described herein and match with local practice and surroundings.

### 6.2 ROOF ACCESS

For roofs more than 8m above grade or if major equipments are placed over the roof, shall have access from a proper staircase. Minimum 1000 mm wide access path with tiles shall be provided to approach equipment on roof. For other roofs cage ladder or staircase as appropriate shall be provided.

### 6.3 PLATFORMS AND WALKWAYS

6.3.1 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms located close to each other shall be connected with walkways.

6.3.2 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off.

6.3.3 Continuous walkway with hand rails shall be provided along the crane girder level in the TG building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

### 6.4 STAIRS & LADDERS

#### 6.4.1 STEEL STAIRS

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of 35.7 degree. However, in case of space restriction, minimum 250 mm wide treads of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm and successive landing shall not be more than 5 m.

**6.4.2 STEEL LADDERS**

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5 Degree.
Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum).
Ladders shall be provided with a safety cage wherever required starting at 2.5 m above the lower landing level.

**6.4.3 RCC STAIRS**

All stairs shall have riser of minimum 150 to 180 mm and a minimum tread of 250 mm. However, for administration building riser shall be limited to 150 mm tread width of 300 mm. Minimum width of stairs shall be 1200 mm generally. No staircase shall have more than 15 risers in one flight. Aluminium angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs.

**6.5 VERTICAL HEAD ROOM**

All accessible areas will be provided with a minimum clear headroom as follows, unless otherwise specified.

1. Finished floor to ceiling (Buildings) : 3000 mm
2. Doors, walkways, platforms : 2100 mm
3. False ceiling to office areas/stairs : 2400 mm
4. Cat walkways above false ceiling : 1000 mm
5. Safety cage for cage ladders : 2500 mm
6. Access for forklift trucks : 2800 mm
7. Roads / railway crossings : 8000 mm
8. Cable and pipe racks (except road/rail crossing) : 3000 mm

**6.6 GUARD RAIL / HAND RAILS**

Guard rail will be a two-rail system with the top rail 1000 mm above the walkway/platform/floor surface and the intermediate rail 500 mm below the top rail. Guard rail post spacing will be proportioned to the length of the protected horizontal opening, but will not exceed 1500mm centre-to-centre of posts.

**6.7 EDGE PROTECTION**

Wherever possible around floor openings an RCC Kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with edge angles e.g. alround the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of manholes supporting covers and supporting edges of pre-cast covers etc.

**6.8 ANCHOR BOLTS AND INSERT PLATES**

Anchor bolts shall be designed for tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

Insert plats shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

**6.9 EXPANSION / CONSTRUCTION JOINTS**

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. At other joints these shall be 150 mm wide. Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

## 6.10 BRICK MASONRY

Brick works

a. Internal and external : 230 mm thick fly ash brick wall with 1:6 Cement-Sand mortar. All Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.

b. Half brick thick wall : 1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.

**c.** One third brick wall : 1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.

## 6.11 WATER PROOFING

**Roof Waterproofing**

Roof water proofing treatment shall be as follows :

i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR of BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK

- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –
ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

iii) For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

a) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.

b) APP membrane shall conform to Conforms to: UEAtc,ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.

c) Technical Data

- Chemical Base APP modified Bituminous Polyester
- Thickness 4mm
- Unit weight 4.40 kg/m2(According to UEAtc)

d) Mechanical / Physical Properties

- Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
- Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
- Resistance to water pressure - No leakage - (According to DIN52123)
- Carrier (Polyster) weight- 180 g/m2
- Softening Point - 145 oC - (According to ASTM D36)
- Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
- Tear resistance (L/T) N-170/180- -(According to UEATc)
- Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
- Heat Resistance- No Flow at 100oC-
- Resistance to Aging after 2000 hrs (Weather –O- Meter)- No Delamination- (According to ASTM D4799)

e) Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.

f) Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.

g) All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

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**Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.**

**6.12 Rolling Shutters**: Rolling shutters as per IS:6248 with suitable operating arrangement (manual, mechanical and /or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanized steel lath section of 18swg tested mild steel strips at 75mm rolling centers, locked with galvanized malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3 mm thick galvanized steel plate and security riveted with stiffening angles.

## 7.0 FINISHES

### 7.1 Plastering

a. Exterior & rough side of interior brick wall :

   20mm thick minimum sand faced plaster in two layers with 1:4 cement sand mortar of 12mm thick first layer and 1:3 cement sand mortar with 8mm second layer. Where external finish will require rich plastering for special finish plaster shall be of 1:4/1:3.

b. Interior wall : 12 mm thick with 1:4 cement- sand mortar:

c. Ceiling : 6 mm thick with 1:3 cement- sand mortar shall be provided to all exposed ceilings

**7.2 DOORS, WINDOWS AND VENTILATORS**

a) Generally hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.

b) Solid core factory made wooden flush doors in hard wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/electrical depending on the size of opening.

d) Special areas like control rooms and other special areas shall be provided with minimum 15 micron pre-coated i.e. colour anodised aluminium glazed partitions with air lock facilities having two sets of doors preferably double door system.

e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside.

g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.

h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

In Powerhouse building, full glazed windows of sliding type ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. For an operating floor of Power House, structural glazing may be considered as an important façade element.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided. The window area shall be so decided so as to allow adequate natural ventilation and light.

*Note: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval before execution.*

**7.3 GLAZING**

a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.

b) 4 mm thick ground glass shall be provided for toilets.

c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.

d) All glazing shall be in aluminium frame having 15-micron colour anodised.

e) 6mm thick Wired / laminated glass shall be used for windows / ventilators at higher level for safety.

f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

**7.4 ACID ALKALI RESISTANT LINING**

**7.4.1** 25mm thick acid and alkali proof tiles will be laid over acid and alkali proof epoxy mortar under bed shall be provided for Battery room, battery charger room, degasser area, chemical house floor etc. Similar tiles over chemical resistant silica based epoxy mortar shall be used as dadoing above floor level. Ceiling will be painted with chemical resistant epoxy paint.

**7.5 FLOORING & FLOOR FINISHES**

**7.5.1** The floor slabs will be designed as cast-in-situ RCC slabs with removable shuttering unless mentioned otherwise. The nominal thickness of RCC slabs will be 150 mm.

**7.5.2** The nominal total thickness of floor finish will be 40/50 mm i.e. underbed & topping. The floor will be laid on already laid and matured concrete base.

**7.5.3** The finished floor level of toilet areas shall be kept 12 mm below as that of the surrounding area. Toilet area slabs will be made water tight by suitable water proofing treatment.

**7.5.4** Floor finishes will be as per Finish schedule of this specification

**7.5.5** Skirting in general will be 150 mm high. Dado in toilets, will be upto 2.1m. height from finished floor level. Skirting and Dado will match with the floor finish.

## 7.6 FALSE CEILING

Aluminium pre-painted/Powder coated false ceiling, either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining.

## 7.7 SCHEDULE OF FINISHES

### 7.7.1 INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING

| BUILDING/ AREA | FLOORING/SKIRTING/ DADO | WALL | CEILING |
|---|---|---|---|
| T.G. Hall Area | Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite finished walkways. | Granite tiles/10mm thick high polished decorated coloured background 1st quality digital series dual charged glazed tiles of size not less than 18"x12" shall be provided for inner faces of all four sides walls of operating floor TG hall and columns (by encasing structural steel columns along A-row and both gable ends with brick masonry for 3.0mts height above operating floor) up to bottom of window lintel level or 1.80mts height from operating floor level whichever is high and balance portion of brick wall shall be painted with two coats of plastic emulsion paint over primer and white cement putty. A row and gable end shall have double skin metal cladding system above brick masonry wall. Synthetic enamel paint up to 1.50mts | T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium panel pattern false ceiling for false ceiling areas |

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| | | height and acrylic emulsion paint for balance height for all other floors of STG building. | |
| Switchgear Room, MCC Room, | Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness shall be 50mm.<br>pattern. | Synthetic enamel paint upto 1.50mts height from floor level and balance portion with plastic emulsion paint over primer and white cement putty. | Acrylic Distemper |
| 2 Control Rooms, Control Equipment Room, Computer Rooms, etc. Other than Main Control Room. | Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles similar to 'MARBONITE','FERRASTONE' of " BOSS Profile Ltd", "RESTILE",ENDURA" of H&R jonson (India) Pvt. Ltd,"Kajaria" profile Ltd",of minimum size minimum 600 mm x 600 mm x 9~10 mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles and under bed. | Vitrified tiles dadoing up to false ceiling level in UCB control room and annexure room shall be provided. Front portion of the UCB control room facade above glass panelling a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. Columns, bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern upto the false ceiling level. | Gypsum board plaster false ceiling for control room and annexure rooms. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. |

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| 3 All office areas, Conference Room and other important areas. | 10/11 mm thick non-skid fully vitrified dual charged tiles of minimum size 600 mm x 600 mm similar to ‘MARBONITE’,FERRASTONE’ of “ BOSS Profile Ltd”, “RESTILE”,ENDURA” of H&R jonson (India) Pvt. Ltd,”Kajaria” profile Ltd”, (overall 40 mm thick) laid in pattern with different colour of tiles. | Acrylic emulsion paint over white cement putty. | Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling with necessary lighting arrangements for illumination shall be provided. |
| 4 Access floor where required | Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant floor panels finished with antistatic vinyl flooring and matching skirting | | |
| 5 Stairs & Lobby | Kota stone/equivalent slab in general. | Coloured 6mm thick(min) ceramic tiles up to 1.50mts height and Acrylic emulsion Paint over white cement putty for balance height. | Acrylic Distemper Paint |
| Main Stair & Landing | Aranga White marble slab//makarana pink / Jaishalmir Yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner. | Acrylic emulsion paint over white cement putty. | Acrylic emulsion paint over white cement putty. |
| Lift lobby | Aranga White marble slab/makarana pink / Jaishalmir yellow and Baroda green combination 25 mm thick (min.) with larger possible | Granite slab cladding | Aluminium plank panelled pattern false ceiling. |

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| | size to be approved by the owner. | | |
| 6 Battery Room & Battery Charger Room, UPS Room | Minimum 20 mm thick acid and alkali resistant vitrified tiles “ENDURA” Or similar set in and jointed with epoxy mortar (overall 40 mm thick) | 20mm thick acid resistant tiles over bitumen primer up to 1.20mts height | Acid/Alkali resistant epoxy paint for balance height. |
| 7 Chemical Feed Station | Minimum 20 mm thick acid and alkali resistant vitrified tiles “ENDURA” or similar Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 40 mm thick) . | 20mm thick acid resistant tiles over bitumen primer up to 1.20mts height. | Acid/Alkali resistant epoxy paint for balance height. |
| 8 AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas | 50 mm thick heavy-duty cement concrete floor with metallic hardener. | Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement | Acrylic Distemper Paint |
| 9 Toilet and other wet areas | Minimum 10 mm thick non-skid vitrified tile of make ‘MARBONITE’,FERRASTONE’ of “ BOSS Profile Ltd”, “RESTILE”,ENDURA” of H&R jonson (India) Pvt. Ltd,”Kajaria” profile Ltd”,of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be full height starting from finish floor level. | 1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty. | Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required. |
| 10 Oil Spillage area | Non-skid self-leveling epoxy over IPS (overall 40 mm thick) | Epoxy paint. | Epoxy paint. |
| 11 Electrical Switchgear Room, MCC Room, etc | Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty IPS flooring. Overall thickness | Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for | Acrylic Distemper |

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| | shall be 40mm. | balance height over white cement putty. | |
| 12<br>All other general areas except operating floor | Overall 50 mm thick heavy-duty concrete floor (IPS) with metallic hardener or 40mm thick steelcrete tiles finish. | Synthetic enamel paint up to 1.50mts height and acrylic emulsion paint for balance height over white cement putty. | Acrylic Distemper |

### 7.7.2 Interior Finish Schedule For Auxiliary Plant Buildings

| | | | |
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| 1 Mill Building | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting | Metal cladding | Synthetic enamel paint |
| 2 ESP Control Building | 10 mm thick non-skid fully vitrified tiles of make “MARBONITE”,”FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS. | Acrylic emulsion paint over white cement putty for control room and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height for Other areas | Pre-coated aluminium panelled (600mmx600mm size) ceiling “Luxalon” or “INTERARCH” in air-conditioned areas. Acrylic Distemper paint in other areas. |
| 3 Chemical House | Minimum 20 mm thick acid and alkali resistant vitrified tile “ENDURA” or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with | 20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height | Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint. |

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| | metallic hardener. | in acid & alkali prone area and rest with Acrylic emulsion paint paint | |
| 4 Raw Water Pump House & Electrical Building | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting | Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height | Acrylic Distemper |
| 5 HFO & LDO Forwarding Pump House | Self-levelling epoxy floor paint on oily areas and heavy duty IPS flooring with hardener in balance areas. | -Do- | Acrylic Distemper Paint |
| 6 CW, ACW Pump House | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting | -Do- | -Do- |
| 7 CW, ACW Pump House | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting | -Do- | -Do- |
| | | | |
| 8 Misc. Pump Houses/ Fire Water Pump House/ Clarified water pump house | -Do- | -Do- | -Do- |
| 9 DM plant | | | |
| a) Plant area | Minimum 20 mm thick acid and alkali resistant Vitrified tile of “ENDURA” or similar set in and jointed with epoxy mortar (overall 40mm thick). | 20mm thick acid resistant tiles over bitumen primer up to 1.20mts height and Acid/Alkali resistant epoxy paint for balance height in acid & alkali | Chemical resistant paint for acid & alkali resistant area. |

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| | | prone area and rest with Acrylic emulsion paint | |
| b) MCC Room | 50 mm thick heavy duty cement concrete floor with metallic hardener or flexible electric insulated PVC synthetic sheet finish and matching skirting. | Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height | Acrylic Distemper Paint |
| c) Control room and offices | 10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room and offices. | Acrylic emulsion paint over white cement putty. | Gypsum Board / Clacium Silicate Board or tiles false ceiling with insulation on top. |
| d) Laboratories | Minimum 20 mm thick acid and alkali resistant tile set in and jointed with epoxy mortar (overall 40mm thick) along with 2100mm high dado of same tile. | Acid / Alkali resistant paint in acid & alkali prone area. | Acid / Alkali resistant paint in acid & alkali prone area. |
| e) Toilet | 10 mm thick non-skid fully vitrified tiles of make “MARBONITE”FERRASTONE” of minimum size 400 mm x 400 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be full height. | 1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty. | Acrylic Distemper Paint |
| 10 CW Chlorination Building | Minimum 20 mm thick acid and alkali resistant vitrified tile “ENDURA” or minimum 37mm thick Acid /Alkali resistant brick, set in | Chemical resistant paint in acid & alkali prone area and | Chemical resistant paint for acid & alkali resistant area |

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| | and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener. | rest with Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint over white cement putty for balance height | and other areas with Acrylic Distemper paint. |
| 11 CW Chemical Treatment Building | -Do- | -Do- | |
| 12 Condensate Transfer Pump House | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting | Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint for balance height | Acrylic Distemper |

### 7.7.3 Interior Finish Schedule For Non Plant Buildings

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| 1 Service building/Administrative building | | | |
| a) Entrry cum reception lounge, VIP lounge, Main meeting/ conference room | Suitable and approved combination shed of marble slab and strips shall be used | Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface prepared with white cement putty. | Aluminium panelled (600x600mm size) acoustic false ceiling with glass wool insulation on top similar to LUXALON of Hunter Douglas or “INTERARCH” having approved colour with stove enamel finish, integrated |

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| | | | with light fixtures, HVAC grills and other ceiling mounted accessories, complete in all respect with metal suspension system, trims, profiles etc. |
| b) Other floors/ office area etc. | 10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,”FERRASTONE”,”Kajaria” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with matching shirting of same make | - Do - | Gypsum board or Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification |
| c) For staircase and Corridors | Steps – risers & tread, stair skirting, corridor floor should be combination of Aranga white marble and Abu green marble. Wall cladding of Elevator Lobby shall be of polished granite slab of light grey shed or colour as approved by the owner. | Two coats of Acrylic Emulsion paint of approved colour shall be applied over a coat of approved primer on the masonry surface | Acrylic Distemper paint colour super white. |

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| | | prepared with white cement putty. | |
| d) Toilet & pantry | Minimum 10 mm thick non-skid vitrified tile, of minimum size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado shall be 100 mm higher than lintel level starting from finish floor level. | 1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty. | False ceiling shall be perforated aluminium stove enamel finished panels of size 600x600mm |
| e) AHU room, store Generator room, Electrical room, Etc: | 50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting. | Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height | Acrylic Distemper paint |
| 2 Canteen Building | | | |
| a) Kitchen, Dining hall etc. | 10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,FERRASTONE” | 1st quality coloured | Acrylic Distemper |

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| | of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic tiles. Dado shall be full height for Kitchen and 1500mm. high for other areas. All counter for Kitchen and service areas shall have Polished Granite slab over RCC slab or Kadapa stone | glazed tiles of minimum 6/7 mm thickness up to 1.20mts height and balance height with Acrylic emulsion paint over primer and white cement putty | paint over white cement putty. Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification |
| b) Other areas | Kota stone/equivalent flooring and skirting | Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height | Acrylic Distemper paint |
| c) Toilet & wash areas | 10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,”FERRASTONE” of minimum size 400 mm x 400 mm over IPS floor (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level. | 1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level | Acrylic Distemper paint |

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| | | starting from finish floor level. And balance portion with Acrylic emulsion paint over white cement putty. | |
| 3 Permanent Store & Inflammable Store Building | 50 mm thick heavy-duty cement concrete floor with metallic hardener and matching skirting. For office areas & AC stores vitrified tiles shall be used. | Acrylic emulsion paint with white cement putty for office & AC store areas and Synthetic enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height for other areas | Acrylic Distemper paint over white cement putty. Offices and Airconditioned areas shall have Acoustic precoated aluminium alloy panelled ceiling (600x600mm panels) stove enamelled on both sides on pre coated aluminium grid system false ceiling of approved make as per specification |
| 4 Main Gate Complex | Overall 40 mm thick Kota stone/equivalent slab flooring | Acrylic emulsion paint over white cement putty | Acrylic emulsion paint over white cement putty |
| 5 Weigh Bridge | 10/11 mm thick non-skid fully vitrified tiles | Synthetic | Acrylic |

| | | | |
|---|---|---|---|
| Control room | of make “MARBONITE”,”FERRASTONE” of size 600 mm x 600 mm (overall 40 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims | enamel paint up to 1.50mts height and Acrylic emulsion paint with white cement putty for balance height | Distemper paint |
| 7 Fire Station | | | |
| a) Office area, Toilet, Stores, Training room, Kitchen / Dining area, Dormitory, | "10/11 mm thick non-skid fully vitrified tiles of make “MARBONITE”,FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for office, dormitory area with 150 high matching skirting with 5 mm thick glazed ceramic tile dado of approved make topped with 50 mm wide matching ceramic trims 2200mm. High." | Acrylic emulsion pain | Acrylic emulsion paint |
| b) Fire tender parking area and equipment store | 50mm thick heavy duty IPS flooring with metallic hardener with matching skirting. or Paving with 65/70 mm thick pressed interlocking precast blocks | Cement paint and for equipment store Acrylic Distemper all be used | Parking area cement paint and for equipment store Acrylic Distemper shall be used. |
| 8 Watch Tower | IPS flooring with Cement Skirting | Acrylic Distemper, Epoxy paint over exposed steel structure. | Acrylic Distemper, Epoxy paint over exposed steel structure. |
| 9 Car & Scooter parking shed and Cycle parking shed | Mimimum 50mm thick coloured and polished interlocking concrete tiles with pattern as approved by the owner, set on sand bed over PCC underbed. Parking near Administrative block shall have vitrified tiles suitable for parking. | | Polycarbonate roof sheeting over RCC framed structure. |

## 7.7.4 EXTERIOR AND GENERAL FINISH SCHEDULE

**Cladding for Power house:**

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3). The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester XRW (as per AS/NZS – 2728: 1997 category 3) coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub-girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) ‘Z’ shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool insulation (Rockloyd-300) of density 48KG/M3 conforming to IS:8183 shall be provided and fixed to the inner sheet and between the two sheets as per the specification. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Approved make: LLOYD Insulations (India) Ltd, Tata Blue Scope Steel, CRIL, Metecno or similar approved.

## 7.8 The epoxy systems

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components, Comp A and B : 1:2.5 by weight Over the primed surface, epoxy modified cementitious self _levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A :Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30ºC approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 270 C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF or similar approved.

**7.9** **Anti corrosive paint**: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

| | | |
|---|---|---|
| **7.10** | False Ceiling : | Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system |
| | Approved make: | LUXALON by Hunter Dauglas, LLOYD, Armstrong, INTERARCH or similar approved. |
| | | In other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used. |
| | Approved make: | Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX, Aerolite or similar approved. |

**7.11** For T.G. Hall (operating floor) Granite / Kota stone/equivalent flooring finish will be as follows:

Minimum 18~20 mm thick polished Granite/ Kota stone/equivalent slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of + 5 mm in dimensions and + 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

**7.12** For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and

Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

| | |
|---|---|
| Approved Make : | ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. or similar approved. |
| Paints : | ICI, ASIAN Paints, Berger or similar approved |

**7.13** All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

| | |
|---|---|
| Approved Make : | Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved. |

**7.14** For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.

# TELANGANA STATE ELECTRICITY CORPORATION LIMITED (TSGENCO)
# 4X270MW BHADRADRI TPS

## TECHNICAL SPECIFICATIONS
## (EXCEPT CHIMNEY)

## CIVIL STRUCTURAL & ARCHITECTURAL WORKS

## PE-TS-411-600-C001
## SECTION D
## TECHNICAL SPECIFICATION(S)

**Bharat Heavy Electricals Limited**
**Project Engineering Management**
**Power Sector, PPEI BUILDING**
**SECTOR 16A, NOIDA-201301**

# INTRODUCTION

Bhadradri TPS(4X270MW) is being set up by Telengana State Power Generation CorporationLimited (TSGENCO) at Bhadradri in Manuguru District. .

The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

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# SECTION - D

## SUB-SECTION – D1

# EARTHWORK IN EXCAVATION AND BACKFILLING

# C0NTENT

# TECHNICAL SPECIFICATION

## FOR

## EARTHWORK IN EXCAVATION AND BACKFILLING

**1.00.00 SCOPE**

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

**1.01.00 Work To Be Provided By The Contractor**

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

**1.02.00 Work to be provided by others**

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

**2.00.00 Codes and Standards**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS: 1200 Method of measurement of building and civil engineering works, Part-I: Earthwork

IS: 2720 Method of test for soils (Relevent parts)

IS: 3764 Excavation work - Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Indian Standard Code of Practice for earthwork on Canals

IS: 6922 Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

**2.01.00 Conformity with Designs**

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

**2.02.00 Materials**

**2.02.01 General**

All materials required for the work shall be of the best commercial variety and approved by the engineer.

**2.02.02 Material for Excavation**

For the purpose of identifying the various strata encountered during the course of excavation, the following classifications are to be followed.

**a) Soil**

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

**b) Soft Rock**

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

**c) Hard Rock**

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

**However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.**

**2.02.03 Material for Filling**

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well-graded sand from approved quarries free from harmful and deleterious materials.

**2.03.00 Quality Control**

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

| Sl. No. | Activity | Check |
|---|---|---|
| 1 | Lines, levels & grades | a) By periodic surveys<br>b) By establishing markers, boards etc |
| 2 | Back filling | (a) On quality of fill material<br>(b) On moisture content of back fill<br>(c) On degree of compaction achieved |

**3.00.00 EXECUTION**

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

**3.01.00 Setting out**

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibilities of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

**3.02.00 Clearing and Grubbing etc**

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

**3.03.00 Excavation for Foundations and Trenches**

**3.03.01 General**

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion, which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

**Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

**3.03.02 Excavation in All Type of Soil and in Soft Rock**

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where detoriation of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

**3.03.03 Excavation in Hard Rock**

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

**3.03.04 Blasting**

**a) General**

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

## b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

**c) Storage of Explosives**

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes, which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

**d) Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

**e) Use of Explosives**

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short-circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

**f) Restrictions in Blasting**

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.

b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.

c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.

d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock

e) The last blast shall not be more than 0.50 m in depth.

f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and chiselling shall complete excavation or any other suitable method as approved by the engineer.

**3.03.05 Disposal**

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

**3.03.06 Disposal of Surplus Materials**

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

**3.03.07 Protection**

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

**3.03.08 Dewatering**

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

**3.03.09 Timber Shoring**

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

**a) Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide (min.) and 40mm thick (min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber, which cannot be withdrawn and is lost or buried.

**b) Open Timbering**

In case of open timbering, vertical board of 250mm wide (min.) and 40mm thick (min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

**3.03.10 Treatment of Slips**

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

**3.04.00 Backfilling**

**3.04.01 General**

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

**3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures**

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer (loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

**3.04.03 Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

**3.04.04 Filling in Trenches for Water Pipes and Drains**

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

**3.04.05 Filling in Disposal Area**

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content, which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction, which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

**3.05.00 Approaches and Fencing**

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

**3.06.00 Lighting**

Full-scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

**4.00.00 TESTING AND ACCEPTANCE CRITERIA**

**4.01.00 Excavation**

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

**4.02.00 Backfilling**

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

**5.00.00 RATES AND MEASUREMENTS**

**5.01.00 Rates**

a) The item of work in the schedule of quantities describes the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earthwork shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

**5.02.00 Measurements**

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS: 1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earthwork in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earthwork in excavation shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of the excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

## 6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

### 6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

### 6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

# TELANGANA STATE POWER GENERATION CORPORATION LIMITED (TSGENCO)

## 4X270 MW BHADRADRI TPS

## GEOTECHNICAL INVESTIGATION REPORT- CHP/ AHP AREA

**DOCUMENT NO. PE-DC-411-602-C001**

**VOLUME - 9**

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BHEL

Maharatna Company

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
NOIDA-201301

NAGADI

# NAGADI CONSULTANTS PRIVATE LIMITED


**REGISTERED OFFICE :**

*Bangalore :*

1016, Dr. Rajkumar Road, 4th Block,
Rajajinagar, Bangalore - 560 010
Tel : 080 - 23156076 Fax : 080 - 23303007
E-mail : bangalore@nagadi.co.in

**REGIONAL OFFICE :**

*New Delhi* :

106/1D Kishangarh, Vasant Kunj
New Delhi - 110 070
Tel : 011 - 26891980 Fax : 011 - 26897403
E-mail : delhi@nagadi.co.in

*Chennai :*

61C, East Coast Road, Thruvanmiyur
Chennai - 600 041
Tel : 044 - 2447870 Fax : 044 - 24488957
E-mail : chennai@nagadi.co.in

*Secunderabad :*

60, Manovikasnagar, Opp. NIMH,
Secunderabad - 500 009
Tel : 040 - 2775 446 Fax : 040 - 27751194
e-mail : secunderabad@nagadi.co.in

**Website : nagadi.co.in**


# GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED (4 X 270 MW) BHADRADRI THERMAL POWER PROJECT

## VOLUME - 9
## FOR CHP/ AHP AREA

Customer :

**Telengana State Power Generation Corporation (TS GENCO)**

EPC Contractor :

**Bharat Heavy Electricals Limited (BHEL)**

Job No. : **G(H) 1658(9)**

Date : 01.10.15

**GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED (4 X 270 MW) BHADRADRI THERMAL POWER PROJECT TELENGANA**

# VOLUME - 9
# FOR CHP/ AHPAREA

# GEOTECHNICAL INVESTIGATION REPORT FOR (4 X 270 MW) BHADRADRI THERMAL POWER PROJECT TELENGANA

## PREAMBLE

Telengana State Power Generation Corporation (TS GENCO) has proposed to install 4 x 270 MW Bhadradri Thermal Power Project in Manuguru, District Khammam, Telangana State and the job was awarded to M/s Bharat Heavy Electrical Limited. To design the foundation system of Plant structures/ buildings, a detailed geotechnical investigation was required to be conducted. M/s Bharat Heavy Electrical Limited, in turn awarded the job to M/s Nagadi Consultants Pvt. Ltd. To obtain adequate information regarding the subsoil/rock conditions, for the design of the substructures for the proposed structures of the Power Plant, a detailed geotechnical investigation programme has been undertaken at the site of the proposed plant for which a geotechnical investigation report has been prepared.

The scope of work comprises of sinking 56 nos. boreholes. The scope also included 7 nos. plate load tests, 1 no. cyclic plate load test, 3 nos. dynamic cone penetration tests and 4 nos. pressure meter tests.

This geotechnical investigation report has been prepared in 12 Volumes which are as follows:

| | |
|---|---|
| Volume - 1 | Geotechnical investigation report for Chimney Area |
| Volume - 2 | Geotechnical investigation report for ESP Area |
| Volume - 3 | Geotechnical investigation report for Mill and Boiler Area |
| Volume - 4 | Geotechnical investigation report for Power House and Transformer Yard Area |
| Volume - 5 | Geotechnical investigation report for ID Fan Area |
| Volume - 6 | Geotechnical investigation report for Switchyard Area |
| Volume - 7 | Geotechnical investigation report for Cooling Tower Area |
| Volume - 8 | Geotechnical investigation report for BOP Area |
| Volume - 9 | Geotechnical investigation report for CHP/ AHP Area |
| Volume - 10 | Geotechnical investigation report for Electrical Resistivity Area |
| Volume - 11 | Geotechnical investigation report for Permeability and CBR Test Area |
| Volume - 12 | Geotechnical investigation report for PMT & CHST Tests |

**This is Volume - 9 of the report pertaining to the CHP/ AHP Area**

## GEOTECHNICAL INVESTIGATION REPORT FOR POWER HOUSE AND TRANSFORMER YARD AREA (4 X 270 MW) BHADRADRI THERMAL POWER PROJECT TELENGANA

### *1.0 INTRODUCTION*

1.1 This volume - 9 of Geotechnical investigation report pertains to the investigations carried out for CHP/ AHP Area of the Thermal Power Project.

### *2.0 PROJECT DETAILS*

#### 2.1 Site Location

2.1.1 The site of the proposed Thermal Power Plant is located near Ramanujavaram Village adjacent to Burgampadu Etunagaram Road.

2.1.2 The site is located at a distance of about 20 km from Manuguru Railway Station.

#### 2.2 Site Topography

2.2.1 The site had earlier been used for agriculture and at the time of commencement of the investigations, standing crops were observed in some portions of the site. A few nallahs were observed to be passing through the site which apparently were used to provide irrigation water to the fields for crop cultivation/agriculture.

2.2.2 The Godavari river was observed to flow in a North-South direction to the east of the site at a distance of about 2km from the main plant area.

#### 2.3 Geology of the Site

2.3.1 The geology of the site has been assessed based on the published detailed geological studies carried out by Geological Survey of India (GSI).

2.3.2 The rocks encountered at the site belong to the Gondwana Supergroup of an older Triassic age. More specifically, the rocks belong to the Kamthi formation which primarily consists of red and grey argillaceous sandstones, conglomerates and shales. These are overlain by the Maleri formation to the North.

2.3.3 The Kamthi formation extends along the Wardha -Godavaru valley which includes areas in Maharashtra and Telengana.

2.3.4 The rock encountered at the present site is shale in a weathered condition. The rock is generally reddish brown in colour with occasional grey and white colours also encountered. The bedding planes of the shale rock encountered at the present site are generally horizontal.

**2.4 Seismic Zone**

2.4.1 The present site is located in the Seismic Zone III which is the zone of medium seismicity, as per the seismic zoning map of India given in BIS code IS:1893 (Part1)-2002.

## *3.0* OBJECT OF GEOTECHNICAL INVESTIGATION

3.1 For designing the foundation system of the proposed structures, the following data are required :

a) Type of foundation

b) Depth below the ground level at which the foundation system is to be laid.

c) Allowable bearing pressure at the foundation level.

3.2 To determine the above factors, the following information shall be required:

a) The subsoil profile indicating thickness of the various soil/rock strata, to a depth within the influence zone below the foundations

b) Engineering properties of the soil/rock strata at various levels

c) Physical characteristics of the soil/rock strata

d) Variation of strength of soil/rock strata with depth

3.3 For evaluating the above parameters, field investigations and laboratory investigations on the soil/rock samples collected during the field investigations, have been carried out.

3.4 The results from these investigations have been analysed to provide the recommendations for the design of foundations.

## *4.0* SCOPE OF WORK

4.1 The scope of work comprises of sinking 56 nos. boreholes down to a maximum depth of 30m below the existing ground level, conducting 3 nos. dynamic cone penetration tests down to depth of refusal/ rock strata, conducting 1 no. cyclic plate load test, 7 nos. plate load tests and 4 nos. pressuremeter tests.

## *5.0 FIELD INVESTIGATIONS*

5.1.1 Field investigations had commenced from 6th January 2015 and have been completed on 15th July 2015.

5.1.2 A geotechnical investigation layout showing test locations is attached in the report as reference in fig. 1.

**5.2 Boreholes**

5.2.1 All the boreholes had been conducted down to the stipulated depths.

5.2.2 All the boreholes of 150mm diameter had been progressed by Augering down to the refusal depths i.e. depths at which the boreholes could not be progressed by this method.

5.2.3 Drilling in rock/ refusal strata had been carried out in all the boreholes, to get adequate information regarding the rock strata encountered.

5.2.4 Drilling in rock / refusal strata had been carried out beyond the depths of refusal strata down to a maximum depth of 30m below the existing ground level, by rotary drilling machine using bits of Nx size.

5.2.5 The entire investigation carried out is presented in Twelve (12) Volumes as listed below:

| | |
|---|---|
| Volume - 1 | Geotechnical investigation report for Chimney Area |
| Volume - 2 | Geotechnical investigation report for ESP Area |
| Volume - 3 | Geotechnical investigation report for Mill And Boiler Area |
| Volume - 4 | Geotechnical investigation report for Power House and Transformer Yard Area |
| Volume - 5 | Geotechnical investigation report for ID Fan Area |
| Volume - 6 | Geotechnical investigation report for Switchyard Area |
| Volume - 7 | Geotechnical investigation report for Cooling Tower Area |
| Volume - 8 | Geotechnical investigation report for BOP Area |
| Volume - 9 | Geotechnical investigation report for CHP/ AHP Area |
| Volume - 10 | Geotechnical investigation report for Electrical Resistivity Tests |
| Volume - 11 | Geotechnical investigation report for Permeability and CBR Tests |
| Volume - 12 | Geotechnical investigation report for PMT & CHST Tests |

This report is Volume - 9, which presents field and laboratory test results of Boreholes, IBH-1 to IBH-56, conducted down to a maximum depth of 30m below the existing ground level, conducting dynamic cone penetration tests (DCPT),I DCPT-1, IDCPT-2 and IDCPT-4, conducting Plate load test (IPLT), IPLT-1, IPLT-3, IPLT-4,IPLT-5, IPLT-6 and IPLT-7, conducting cyclic plate load test, (ICPLT), ICPLT-1 and conducting pressuremeter tests, (IPMT), IPMT-1,IPMT-2, IPMT-3 and IPMT-4.

5.2.6 The entire CHP/ AHP Area has been divided in Six groups which are as follows :

a) Group - 1 : IBH - 1, 8, 13, 15, 18, 29, 53, 55

b) Group - 2 : IBH - 9, 14, 17, 22, 49, 50

c) Group - 3 : IBH - 16, 19, 47, 51

d) Group - 4 : IBH - 3, 7, 7, 10, 11, 12, 20, 24, 25, 54, 56

e) Group - 6 : IBH - 23, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 48

5.2.7 Termination depths and depth at which the refusal/ rock strata had been encountered in different boreholes are being given hereunder.

| IBH No. | Termination Depth (m) below EGL | Top of the Rock below EGL (m) | Existing Ground Level (m) | Boreholes Coordinates (m) | |
|---|---|---|---|---|---|
| | | | | North | East |
| 1 | 25 | 6.5 | R.L.(+)69.25 | 1993168 | 472190 |
| 2 | 20 | 9.5 | R.L.(+)68.35 | 1993352 | 472192 |
| 3 | 30 | 5 | R.L.(+)75.40 | 1992764 | 472309 |
| 4 | 30 | 5 | R.L.(+)75.50 | 1992766 | 472340 |
| 5 | 20 | 9.5 | R.L.(+)68.85 | 1993375 | 472058 |
| 6 | 20 | 9.5 | R.L.(+)67.95 | 1993413 | 472084 |
| 7 | 20 | 5 | R.L.(+)74.09 | 1992816 | 472306 |
| 8 | 15 | 6.5 | R.L.(+)69.50 | 1993134 | 472226 |
| 9 | 17 | 8 | R.L.(+)69.40 | 1993264 | 472055 |
| 10 | 17 | 5 | R.L.(+)73.70 | 1992764 | 472168 |
| 11 | 17 | 5 | R.L.(+)72.30 | 1992904 | 472168 |
| 12 | 17 | 5 | R.L.(+)71.05 | 1993000 | 472168 |
| 13 | 17 | 8 | R.L.(+)70.50 | 1993072 | 472168 |
| 14 | 17 | 8 | R.L.(+)69.35 | 1993388 | 471943 |
| 15 | 17 | 5 | R.L.(+)70.70 | 1993276 | 472167 |
| 16 | 17 | 5 | R.L.(+)69.40 | 1993175 | 472107 |
| 17 | 20 | 6.5 | R.L.(+)69.75 | 1993188 | 472044 |
| 18 | 25 | 5 | R.L.(+)69.80 | 1993120 | 472191 |

| IBH No. | Termination Depth (m) below EGL | Top of the Rock below EGL (m) | Existing Ground Level (m) | Boreholes Coordinates (m) | |
|---|---|---|---|---|---|
| | | | | North | East |
| 19 | 25 | 6.5 | R.L.(+)70.22 | 1993135 | 471956 |
| 20 | 15 | 5 | R.L.(+)74.64 | 1992811 | 472494 |
| 21 | 15 | 14 | R.L.(+)66.41 | 1993523 | 472460 |
| 22 | 25 | 9.5 | R.L.(+)69.46 | 1993325 | 471956 |
| 23 | 20 | 17 | R.L.(+)65.96 | 1992983 | 472819 |
| 24 | 13 | 5 | R.L.(+)71.88 | 1992839 | 472593 |
| 25 | 13 | 3 | R.L.(+)68.88 | 1993093 | 472460 |
| 26 | 13 | 6.5 | R.L.(+)67.95 | 1993255 | 472375 |
| 27 | 10 | 6.5 | R.L.(+)67.40 | 1993075 | 472649 |
| 28 | 13 | 8 | R.L.(+)69.10 | 1992897 | 472704 |
| 29 | 13 | 3 | R.L.(+)67.48 | 1993149 | 472571 |
| 30 | 13 | 8 | R.L.(+)67.25 | 1993311 | 472485 |
| 31 | 17 | N.E. | R.L.(+)65.25 | 1993062 | 472903 |
| 32 | 30 | 17 | R.L.(+)64.30 | 1993054 | 472887 |
| 33 | 30 | 17 | R.L.(+)66.45 | 1993405 | 472664 |
| 34 | 30 | 17 | R.L.(+)66.10 | 1993265 | 472740 |
| 35 | 30 | 17 | R.L.(+)66.20 | 1993125 | 472812 |
| 36 | 30 | 15 | R.L.(+)64.78 | 1993039 | 472860 |
| 37 | 30 | 14 | R.L.(+)66.13 | 1993008 | 472802 |
| 38 | 15 | N.E. | R.L.(+)66.25 | 1993204 | 472698 |
| 39 | 20 | 17 | R.L.(+)66.35 | 1993303 | 472645 |
| 40 | 20 | 14 | R.L.(+)66.35 | 1993414 | 472586 |
| 41 | 30 | 11 | R.L.(+)66.70 | 1993515 | 472512 |
| 42 | 30 | 15.5 | R.L.(+)62.20 | 1993563 | 472527 |
| 43 | 23 | 11 | R.L.(+)65.20 | 1993475 | 472398 |
| 44 | 23 | 11 | R.L.(+)66.40 | 1993417 | 472290 |

| IBH No. | Termination Depth (m) below EGL | Top of the Rock below EGL (m) | Existing Ground Level (m) | Boreholes Coordinates (m) | |
|---|---|---|---|---|---|
| | | | | North | East |
| 45 | 20 | 9.5 | R.L.(+)68.15 | 1993413 | 472193 |
| 46 | 30 | 8 | R.L.(+)68.05 | 1993413 | 471993 |
| 47 | 20 | 5 | R.L.(+)68.50 | 1993072 | 472054 |
| 48 | 10 | N.E. | R.L.(+)70.81 | 1993285 | 472542 |
| 49 | 30 | 8 | R.L.(+)67.00 | 1993177 | 471993 |
| 50 | 30 | 8 | R.L.(+)69.94 | 1993271 | 471993 |
| 51 | 30 | 5 | R.L.(+)69.57 | 1993076 | 471993 |
| 52 | 25 | 8 | R.L.(+)67.50 | 1993312 | 472279 |
| 53 | 10 | 4 | R.L.(+)68.45 | 1993192 | 472366 |
| 54 | 10 | 3 | R.L.(+)71.94 | 1992985 | 472473 |
| 55 | 10 | 4 | R.L.(+)67.36 | 1993237 | 472454 |
| 56 | 10 | 3 | R.L.(+)69.20 | 1993030 | 472562 |

N.E. : not encountered

EGL : Existing Ground level

5.2.8 In the soil strata, Standard Penetration Tests (SPT) had been conducted at specified intervals. Disturbed soil samples recovered from split spoon samplers had been retained for identification purposes.

5.2.9 Undisturbed soil samples had been recovered at specified intervals, by thin walled tube samplers conforming to IS : 2132. These tubes had an area ratio of less then 10%.

5.2.10 The diameter of undisturbed soil samples was 100mm and the length was 450mm.

5.2.11 The ends of sample tubes had been sealed by wax to prevent loss / ingress of moisture. Disturbed soil samples had been enclosed in polythene bags.

5.2.12 In the rock strata, the rock core samples, where recovered from the boreholes had been preserved in the core boxes with proper marking on each sample and the borelogs had been maintained appropriately.

5.2.13 Soil / rock samples had been transported to the laboratory for testing purposes.

5.2.14 Ground water table had not been encountered in any of the boreholes.

## 5.3 Dynamic Cone Penetration Test

5.3.1 The stipulated scope of work consists of conducting dynamic cone penetration tests with circulation of bentonite slurry at seven locations.

5.3.2 Dynamic cone penetration tests (IDCPT1, IDCPT2, and IDCPT4) had been conducted down to the refusal strata below the existing ground level.

5.3.3 The reduced level and the coordinates of dynamic cone penetration tests are as follows

| IDCPT No. | Existing Ground Level (m) | DCPT Coordinates (m) | |
|---|---|---|---|
| | | North | East |
| 1 | R.L.(+)68.35 | 1993414 | 472014 |
| 2 | R.L.(+)70.50 | 1993088 | 471990 |
| 4 | R.L.(+)66.40 | 1993489 | 472547 |

EGL : Existing Ground level

5.3.4 This test involved driving into the soil of a steel cone having a diameter of 65mm and an apex angle of 60 degrees attached to rods of lesser diameter with arrangement for the drilling mud to flow through the cone, by giving blows from a 65 kg hammer falling freely through a height of 75 cm. The drilling mud is forced under pressure through the pipe and cone. The mud solution coming out of the cone rises above along the drill rod eliminating thereby the frictional resistance offered by the soil for penetration. The number of blows required for every 30cm penetration had been recorded. Such a continuous record had been maintained down to the termination depth of the test.

## 5.4 Plate Load Tests & Cyclic Plate Load Test

5.4.1 All Plate Load Tests (PLT) had been conducted at 3m depth below the existing ground level at different locations on a plate of size 60 x 60cm.

5.4.2 The reduced level and the coordinates of plate load tests are as follows :

| PLT No. | Existing Ground Level (m) | PLT Coordinates (m) | |
|---|---|---|---|
| | | North | East |
| 1 | R.L.(+)70.10 | 1993026 | 472496 |
| 2 | R.L.(+)74.33 | 1992795 | 472281 |
| 3 | R.L.(+)69.55 | 1993140 | 472191 |
| 4 | R.L.(+)68.75 | 1993377 | 472024 |

| PLT No. | Existing Ground Level (m) | PLT Coordinates (m) | |
|---|---|---|---|
| | | North | East |
| 5 | R.L.(+)69.68 | 1993187 | 472071 |
| 6 | R.L.(+)69.42 | 1993255 | 472045 |
| 7 | R.L.(+)65.58 | 1992986 | 472846 |

5.4.3 Cyclic Plate Load Test (ICPLT1)had been conducted at 3m depth below the existing ground level on a plate of size 60 x 60cm.

5.4.4 The reduced level and the coordinates of the cyclic plate load test is as follows :

| ICPLT No. | Exisitng Ground level(m) | Boreholes Coordinates (m) | |
|---|---|---|---|
| | | North | East |
| 1 | R.L.(+)64.60 | 1993533 | 472533 |

5.4.5 All the tests have been conducted under saturated conditions on the strata consisting of sandy clayey silt with gravel.

5.4.6 The test pit had been excavated down to the required depth while ensuring that the plan size at the bottom of the test pits had been a minimum of 3m x 3m i.e. five times the width of the test plate.

5.4.7 The loading platforms had been erected using wooden sleepers with sand bags placed on these platforms to provide reactions of adequate magnitude.

5.4.8 A hydraulic jack had been positioned above the centre of the test plate to apply the controlled reaction loading from the loading platform onto the test plate.

5.4.9 For recording the settlements of the test plate, dial gauges had been positioned at the corners of the test plate and fixed on datum bars which rested on the soil surface at sufficiently large distances from the edge of the test plate.

5.4.10 After the arrangement of the above set up, the initial readings of the dial gauges had been noted and the first increment of the static load had been applied. This load had been maintained constant for a period till no further settlement occurred or the rate of settlement became negligible. The readings of the dial gauges had been noted down.

5.4.11 In the case of cyclic plate load tests, the load for that stage had then been removed completely in appropriate decrements of load with the dial gauge readings recorded after each decrement of load had been removed and the dial gauge readings had stabilised.

5.4.12 The next higher stage load had then been applied with the dial gauge readings recorded after the readings had stabilised.

5.4.13 In the case of cyclic plate load tests, the next higher stage load had then been applied in appropriate increments of load with the dial gauge readings recorded after each increment of load had been applied and the dial gauge readings had stabilised. The load for that stage had then been removed completely in appropriate decrements of load with the dial gauge readings recorded after each decrement of load had been removed and the dial gauge readings had stabilised.

5.4.14 The above procedure had been continued till either the maximum specified settlement of 40mm had been reached or the ultimate loading intensity had been reached.

**5.5 Pressuremeter Tests**

5.5.1 The pressuremeter tests had been carried out at different depths in different boreholes to obtain the pressure vs volume expansion behaviour (i.e. stress vs strain behaviour) of the soil/rock strata and thereon the in-situ stress strain modulus (i.e. Menard modulus) of the soil/rock strata.

5.5.2 The pressuremeter tests had been conducted using a Menard Pressuremeter test apparatus manufactured by M/s AIMIL Ltd. of 80 bar capacity using an NX size probe.

5.5.3 This test involves the installation of the probe at the required depth in the borehole in which the test is to be conducted and thereafter application of gas/water pressure in increments to inflate the probe in-situ and measurement of the consequent radial volume deformation of the soil/rock in the walls of the borehole at that depth. The required control and measurements of the gas pressure applied and the radial volume deformation is carried out using a control panel installed at the ground surface.

5.5.4 The coordinates and the reduced levels of the existing ground level of the locations at which the Pressurement tests have been conducted are being given hereunder.

| PMT No. | Existing Ground Levels (m) | PMT Coordinates (m) | |
|---|---|---|---|
| | | North | East |
| PMT-1 | R.L.(+)68.05 | 1993146 | 472499 |
| PMT-2 | R.L.(+)65.62 | 1993338 | 472706 |
| PMT-3 | R.L.(+)65.50 | 1993069 | 472867 |
| PMT-4 | R.L.(+)69.26 | 1993184 | 472170 |

EGL : Existing Ground level

5.5.5 The Pressuremeter tests had been conducted at the specified depths of 2, 4, 6, 8, 10, 12, 15, 18, 21 & 25m at each test location.

## *6.0* LABORATORY INVESTIGATIONS

### 6.1 Tests on Soil and Rock Samples from Boreholes

6.1.1 The soil samples brought to the laboratory had been subjected to various tests to determine the following properties :

a) Type and gradation of soil

b) Atterberg limits

c) Density and water content

d) Shear strength parameters

e) Free swell index

f) Swell Pressure

g) Consolidation Test

6.1.2 As the rock cores, where recovered, are in a very soft and friable state, tests to determine the physical and engineering properties of the rock cores could not be satisfactorily carried out.

## 7.0 RESULTS & ANALYSIS

### 7.1 Presentation of Results

7.1.1 As specified, the results of the borehole investigations and of the laboratory investigations conducted on the soil samples collected from the boreholes, have been presented in the form of tables.

7.1.2 The tables indicate the following:

a) Standard penetration test values at various depths

b) Soil description identifying the type of soil

c) Grain size analysis indicating composition of subsoil

d) Atterberg Limits

e) Natural density and water content

f) Triaxial test results

g) Swell test results

## 7.2 Soil/Rock Profile

7.2.1 A perusal of the data presented in the tables indicates the presence of the following two soil/rock strata at the site :

a) Stratum - I : Silty clay with occasional gravel

b) Stratum - II : Yellowish brown to reddish brown weathered shale

7.2.2 The minimum, maximum and average depths down to which the Stratum-I (i.e. Soil Strata) has been encountered are as follows :

| Structure | Borehole Nos. (IBH) | Depth (m) of Soil Strata below EGL | | |
|---|---|---|---|---|
| | | Minimum | Maximum | Average |
| Group - 1 | 1, 8, 13, 15, 18, 29, 53, 55 | 3 | 8 | 5.50 |
| Group - 2 | 9, 14, 17, 22, 49, 50 | 6.5 | 9.5 | 8.0 |
| Group -3 | 16, 19, 47, 51 | 5 | 6.5 | 5.75 |
| Group - 4 | 3, 4, 7, 10 11, 12, 20, 24, 25, 54, 56 | 3 | 5 | 4 |
| Group - 5 | 2, 5, 6, 21, 26, 27, 28, 30, 41, 42, 43, 44, 45, 46, 52 | 8 | 14 | 11 |
| Group - 6 | 23, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 48 | 14 | 17 | 15.5 |

## 7.3 Soil Composition

7.3.1 The grain size distributions of the soil samples at various depths have been presented in the form of grain size analysis curves.

7.3.2 The variations in the grain size distributions at different levels are being given hereunder

| Depth(m) | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
|---|---|---|---|---|
| 1 | 0 - 16 | 5 - 58 | 20 - 47 | 18 - 60 |

| Depth(m) | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
|---|---|---|---|---|
| 3 | 0 - 31 | 4 - 44 | 14 - 48 | 11 - 50 |
| 5 | 0 - 19 | 3 - 62 | 17 - 50 | 17 - 63 |
| 8 | 0 - 14 | 4 - 43 | 26 - 45 | 24 - 60 |
| 11 | 0 - 4 | 4 - 30 | 34 - 42 | 35 - 56 |

The above results indicate that :

a) The soil generally comprises of grain size fractions from clay to silt to sand as well as gravel.

b) Large variations are observed in the percentages of each grain size fraction (i.e. clay, silt, sand and gravel) thus indicating a very heterogenous grain size distribution of the soil throughout the site.

c) The percentage of clay has been observed to increase with depth.

### 7.4 Natural Density and Water Content

7.4.1 The variations in the natural bulk densities, water contents and dry densities of the subsoil at different depths are as given here under.

| Depth (m) | Bulk Density ($g/cm^3$) | Water Content (%) | Dry Density ($g/cm^3$) |
|---|---|---|---|
| 2 | 1.65 - 2.28 | 6.1 - 33.3 | 1.40 - 2.14 |
| 4 | 1.48 - 2.10 | 9.5 - 36.7 | 1.26 - 1.76 |
| 6.5 | 1.64 - 2.35 | 6.6 - 34.5 | 1.28 - 2.01 |
| 9.5 | 1.85 - 2.20 | 14.6 - 28.9 | 1.45 - 1.76 |

The above results indicate the following :

a) The subsoil is generally stiff / very stiff to hard silty clay down to the depths of the refusal strata.

b) Large variations are observed in the in-situ dry densities of the soil throughout the area of the site thus indicating significant heterogeneity in the in-situ density state of the soil.

**7.5 Atterberg Limits**

7.5.1 The Atterberg limits indicate that the soil is predominantly medium to high plastic with occasional layers of low plastic soils in between.

7.5.2 In the medium plastic to high plastic soil where encountered, the liquid limit varies from about 35% to 92% while the plastic limit varies from about 20% to about 42% with the Plasticity index varying from about 12 to 54.

**7.6 Standard Penetration Tests Values (N-values)**

7.6.1 The observed Standard Penetration Test values (N-values) vary between 6 and 97 in soil strata and generally in excess of 100 in case of rock strata.

7.6.2 These test results indicate that the silty clay subsoil is generally stiff / very stiff to hard down to the depths of the refusal strata.

**7.7 Rock Conditions**

7.7.1 The rock strata consists of Shale in a highly to moderately weathered condition down to the maximum depth investigated i.e. 30m below the existing ground level.

7.7.2 The colour of the shale varies from reddish to greyish.

7.7.3 Core recoveries in weathered Shale strata is generally nil. However, at some depths in some of the boreholes core recovery of upto 88% has been recorded.

7.7.4 RQD values in the weathered Shale strata is generally nil.

**7.8 Compiled Soil And Rock Profile**

7.8.1 An overview of the results of the geotechnical investigations and their analysis has been presented in the form of compiled soil and rock profile.

7.8.2 The above figures show the various strata encountered and their thicknesses in each of the boreholes and also gives the soil / rock composition and the observed N-values at various depths as also the core recoveries and RQD in the rock strata.

**7.9 Free Swell Index Tests**

7.9.1 As significant percentages of clay have been observed in the subsoil in all the boreholes, free swell index tests have been conducted on selected soil samples at different depths and different boreholes to assess the swelling characteristics of the subsoil.

7.9.2 The results of the free swell index tests show that the subsoil has shown free swelling index varying between about 25% to 145%.

## 7.10 Swell Pressure Tests

7.10.1 Swell pressure tests have been conducted on selected soil samples at different depths and different boreholes to assess the level of swelling pressures generated in the subsoil.

7.10.2 The results of the swell pressure tests show that the subsoil shows swell pressures varying between about 0.21 kg/cm$^2$ to over 1.46 kg/cm$^2$.

## 7.11 Consolidation Tests

7.11.1 Consolidation tests have been conducted on undisturbed soil samples from various depths from different boreholes to determine the consolidation properties of the soil. The consolidation properties of the clayey soil are needed for determining the probable settlements of foundations resting on this type of soil.

7.11.2 The results of these tests have been presented in the form of plots of void ratio 'e' versus normal axial stress 'p' in sheet nos.

7.11.3 The coefficient of compressibility '$a_v$' is then determined as the slope of the straight line portion of the above plot.

7.11.4 The void ratio 'e', coefficient of compressibility '$a_v$' and coefficient of volume compressibility '$m_v$' as determined for the tests conducted are given in the table below:

| IBH No. | Depth (m) | $e_0$ | $a_v$ (cm$^2$/kg) | $m_v$ (cm$^2$/kg) |
|---|---|---|---|---|
| 13 | 6.5 | 0.465 | 0.02 | 0.0136 |
| 29 | 4 | 0.444 | 0.016 | 0.011 |
| 17 | 4 | 0.461 | 0.018 | 0.013 |
| 49 | 2.4 | 0.429 | 0.024 | 0.0167 |
| 50 | 4 | 0.548 | 0.042 | 0.0271 |
| 16 | 4 | 0.446 | 0.024 | 0.0165 |
| 51 | 4 | 0.468 | 0.018 | 0.0122 |
| 27 | 4 | 0.490 | 0.024 | 0.0161 |
| 42 | 4 | 0.451 | 0.018 | 0.0124 |
| 41 | 4 | 0.424 | 0.023 | 0.0161 |
| 45 | 6.5 | 0.470 | 0.015 | 0.0102 |
| 32 | 2 | 0.461 | 0.019 | 0.0123 |

| IBH No. | Depth (m) | $e_0$ | $a_v$ ($cm^2/kg$) | $m_v$ ($cm^2/kg$) |
|---|---|---|---|---|
| 33 | 4 | 0.421 | 0.021 | 0.0147 |
| 40 | 4 | 0.469 | 0.037 | 0.0251 |

7.11.5 The results of the consolidation tests are considered for determining the settlement of shallow foundations.

## 7.12 Chemical Analysis

7.12.1 The results of the chemical analysis conducted on soil samples collected from the boreholes for determining the presence of any harmful salts which can have adverse effects on construction are as follows :

| Borehole No./ Depth (m) | pH value | Chloride Content (ppm) | Sulphate Content (ppm) $SO_4$ | Carbonate Content (ppm) | Nitrate Content (ppm) | Sulphate Content (ppm) $SO_3$ | Organic matter (ppm) | Alkali metals (ppm) |
|---|---|---|---|---|---|---|---|---|
| 2/ 2m | 6.5 | 57 | 64 | 27 | 6 | 38 | 54 | 52 |
| 16/ 6.5 | 6.5 | 38 | 64 | 27 | 6 | 38 | 54 | 52 |
| 23/ 6.5 | 7 | 24 | 69 | 24 | 7 | 44 | 62 | 55 |
| 34/ 2m | 6.5 | 62 | 79 | 35 | 10 | 40 | 80 | 62 |
| 35/ 5m | 6.5 | 53 | 74 | 32 | 8 | 49 | 39 | 70 |
| 41/ 5m | 6.5 | 38 | 65 | 28 | 6 | 46 | 72 | 60 |
| 44/ 6.5 | 7 | 41 | 64 | 29 | 6 | 40 | 66 | 52 |
| 52/ 6.5m | 6.5 | 36 | 60 | 26 | 7 | 40 | 63 | 56 |

## 7.13 Dynamic Cone Penetration Tests

7.13.1 The results of these tests have been presented in the form of plots of number of blows per 30cm penetration vs depth.

7.13.2 These results which primarily indicate the variation in the hardness/stiffness with depth of the subsoil show close conformity with the standard penetration test values (N-values) and also show that there is no significant variation in the hardness/stiffness conditions of the subsoil at the locations of these tests in reference to those observed at nearby borehole locations.

### 7.14 Plate Load Tests

7.14.1 The result of these tests have been presented in the form of loading intensity vs settlement curves.

7.14.2 The final loading intensity and the corresponding settlement along with the locations of the plate load tests are given below :

| IPLTNo. | Loading Intensity ($kg/cm^2$) | Corresponding Settlement (mm) |
|---|---|---|
| 1 | 8 | 17.05 |
| 3 | 4 | Load not sustained |
| 4 | 3 | Load not sustained |
| 5 | 8 | 22.08 |
| 6 | 3 | Load not sustained |
| 7 | 4 | Load not sustained |

7.14.3 Large variations have been observed in the load settlement behaviour of the soil strata at different locations.

7.14.4 The safe bearing capacity as determined from the plate load tests vary between $10t/m^2$ and $25t/m^2$ .

7.14.5 The modulus of subgrade reaction (K-value) can be obtained as dividing net safe bearing capacity by corresponding settlement.

7.14.6 These results clearly indicate the significant heterogeneity in the behaviour of the subsoil. The same should be and has been taken into account in arriving at the recommendations for shallow foundations resting on soil strata.

### 7.15 Cyclic Plate Load Test

7.15.1 Cyclic Plate Load Test, ICPLT1 has been conducted at the location as shown in the layout plan, at a depth of 3m below the existing ground level under saturated conditions.

7.15.2 The results of this test have been presented in the form of loading intensity vs settlement curves.

7.15.3 The final loading intensity and the corresponding settlement for the cyclic plate load test is given below :

| ICPLT No. | Loading Intensity (kg/cm²) | Corresponding Settlement (mm) |
|---|---|---|
| 1 | 4 | Continuing settlement |

7.15.4 The coefficient of elastic uniform compression '$C_u$' is determined as the slope of the loading intensity vs elastic settlement plot given in report. The elastic settlement is taken as the difference in the measured settlements of the plate under the given loading intensity and after removal of the given loading intensity respectively.

7.15.5 The coefficients of elastic uniform compression '$C_u$' for foundation areas greater than $10m^2$ size obtained from the Cyclic Plate Load Tests are :

| CPLT No. | Coeff. of Elastic Uniform Compression ($kg/cm^3$) | |
|---|---|---|
| | $C_u$ | $C_{u10}$ |
| 1 | 6.8 | 1.3 |

7.15.6 The above results indicate the large variations in the dynamic characteristics of the soil at different locations within the site.

**7.16 Pressuremeter Tests**

7.16.1 The results of the pressuremeter tests have been presented in the form of pressure vs volume plots for each of the tests conducted in sheet nos. **120 to 159.**

7.16.2 The Menard modulus is determined using the following formula :

$$E_m = 2.66 \cdot \left( V_c + V_b + \frac{V_1 + V_2}{2} \right) \cdot \left( \frac{P_2 - P_1}{V_2 - V_1} \right)$$

Where $V_c$ = initial volume of the measuring cell of the probe = $650cm^3$

$V_b$ = volume expansion required of the measuring cell of the probe to make contact with walls of the borehole

$V_1$ = volume at start of straight portion of the pressure vs volume plot

$V_2$ = volume at end of straight portion of the pressure vs volume plot

$P_1$ = pressure at start of straight portion of the pressure vs volume plot

$P_2$ = pressure at end of straight portion of the pressure vs volume plot

7.16.3 The straight portions of the respective plots for the various tests conducted have been clearly marked by dashed lines.

7.16.4 The Menard modulus determined in the various tests conducted are shown in the respective plots and are also presented in the form of tables given in Annexure-A of this report.

7.16.5 The Young's Modulus 'E' of the soil / rock strata is determined using the following formula.

$$E = \frac{E_m}{\alpha}$$

Where $\alpha$ = rheological factor

= 0.67 (for clayey soils)

= 1/3 ≈ 0.33 (for extremely fractured rock)

**8.0 DESIGN CRITERIA**

8.1 The parameters required for the design of the foundation system for the proposed structures are:

a) Type of foundation to be adopted

b) Depth at which the foundations have to be laid

c) Allowable bearing pressure on the soil/rock at the foundation level

8.2 On the basis of the analysis of the results of the investigations, the required design parameters have been arrived at as given in the following sections.

8.2.1 The type of foundation depends upon the following :

a) Subsoil/rock conditions

b) Type of structure

c) Configuration of loading points

d) Loading intensities on the foundations

8.2.2 The proposed structures are of CHP and AHP Area. Considering this, medium heavy to heavy loads can be anticipated on the foundations.

8.2.3 The results of the investigations have indicated that the rock strata in the form of weathered Shale has been encountered at depths varying between about 3m and 17m below the existing ground level.

8.2.4 Hence, the proposed structures can be supported on open foundations resting on the soil/ rock strata, depending upon the requirement.

## 9.0 RECOMMENDATIONS

9.1 Considering the subsoil/rock conditions and the proposed structures at CHP/ AHP Area, shallow / open foundations, can be adopted.

9.2 Ground water table had not been encountered in any of the boreholes.

9.3 The recommended net safe bearing capacity values for different widths of foundations at various depths are presented below.

| Structure | BH No. | FGL. R.L.(+) m | Founding Strata | Depth (m) of Foundation below FGL | Net Safe Bearing Capacity ($t/m^2$) | | |
|---|---|---|---|---|---|---|---|
| | | | | | $B \leq 3m$ | $3<B<6m$ | $B \geq 6m$ |
| Ash Slurry PH-1, Slurry Sump & Seal Water Tank, HT Switchgear Cum Control Room near Chimney for Unit 1 & 2, Vacuum cum Compressor House-2, FAE Tower 6,7 & 8, Bottom Ash Hopper-3, Pipe & Cable Rack (Stretch from FAE Tower-6 to FAE Tower-8) | 16, 19, 47 & 51 | 69.00 | Soil | 2 | 30 | 25 | 30 |
| | | | Soil | 3 | 35 | 30 | 34 |
| | | | Rock | 4.5 | 45 | 45 | 45 |
| Ash Slurry PH-2, Slurry Sump & Seal Water Tank, AHP MCC-A near TP-5, BCN 6 A/B, TP-3, DS PUMP HOUSE - II, TP – 4, TP – 5, CHP MCC-4 near Bunker Area, Tunnel 10, BCN 5 A/B, Pent House-II, Dozer Shed, BCN-8 & Stacker Reclaimer-1, MCC-4 near Bunker Area | 2, 5, 6, 45, 43, 44, 46, 28, 30 | 67.00 | Soil | 4 | 20 | 15 | 19 |
| | | | Soil | 5 | 25 | 20 | 25 |
| | | | Soil | 6 | 35 | 30 | 38 |
| | | | Soil | 7 | 40 | 35 | 40 |
| | | | Rock | 8 | 45 | 45 | 45 |

| Structure | BH No. | FGL. R.L.(+) m | Founding Strata | Depth (m) of Foundation below FGL | Net Safe Bearing Capacity ($t/m^2$) | | |
|---|---|---|---|---|---|---|---|
| | | | | | B≤3m | 3<B<6m | B≥6m |
| Ash Water Pump House / Ash Water Tank, Chemical House & Parshall Flume, Clarifier & Sludge Pit, Pipe & Cable Rack (Stretch from ASPH-1 to Silo) | 1, 8, 18, 13, 15 | 69.00 | 2.5 | Soil | 20 | 18 | 23 |
| | | | 3.5 | Soil | 25 | 20 | 25 |
| Vacuum cum Compressor House-1, Bottom Ash Hopper-1, FAE Tower-1,2,3,4 & 5, BCN-7A/B, Pipe & Cable Rack (Stretch from FAE Tower-1 to FAE Tower-6) | 9, 22, 49,50 | 69.00 | Soil | 3 | 20 | 15 | 19 |
| | | | Soil | 4 | 25 | 20 | 25 |
| | | | Soil | 5 | 30 | 25 | 30 |
| | | | Soil | 6 | 35 | 30 | 38 |
| | | | Rock | 7 | 45 | 45 | 45 |
| Silo Utility Building & Ash Conditioner Water Tank, Fly Ash Silo, AHP MCC-B near Chimney for Unit 3 & 4, conveyor 9 & stacker reclaimer-2 FDN | 11, 7, 12, 24, 25 | 67.00 | Soil | 1 | 35 | 40 | 40 |
| | | | Rock | 2 | 45 | 45 | 45 |
| Wagon Tippler Complex | 31 & 32 | 67.00 | Rock | 20.5 | 45 | 45 | 45 |
| | | | Rock | 21.5 | 45 | 45 | 45 |
| | | | Rock | 22.5 | 45 | 45 | 45 |
| Track Hopper (371 M), Maintenance bay and tunnel 1 a/b | 33, 34, 35 | 67.00 | Soil | 9 | 30 | 22 | 28 |
| | | | Soil | 12 | 33 | 25 | 30 |
| | | | Soil | 13 | 35 | 30 | 38 |
| Transfer point - 1 (under ground) & tunnel 2 a/b | 36 | 67.00 | Soil | 14.5 | 40 | 35 | 40 |
| | | | Soil | 16.5 | 40 | 35 | 40 |
| | | | Rock | 18.5 | 45 | 45 | 45 |
| | | | Rock | 19.5 | 45 | 45 | 45 |
| | | | Rock | 20.5 | 45 | 45 | 45 |

| Structure | BH No. | FGL. R.L.(+) m | Founding Strata | Depth (m) of Foundation below FGL | Net Safe Bearing Capacity (t/m$^2$) | | |
|---|---|---|---|---|---|---|---|
| | | | | | B≤3m | 3<B<6m | B≥6m |
| Transfer point - 2 (under ground) & tunnel 3 a/b | 37 | 67.00 | Soil | 4 | 20 | 14 | 18 |
| | | | Soil | 13 | 35 | 30 | 38 |
| | | | Rock | 22.5 | 45 | 45 | 45 |
| | | | Rock | 23.5 | 45 | 45 | 45 |
| | | | Rock | 24.5 | 45 | 45 | 45 |
| Pent House I, BCN-3 A/B, BCN 4 A/B, CHP MCC-1&2 Near TP-2, DS Pump House-1, Coal Settling Pond, MCC-3 Near WT, Crusher House, Wagon Tippler Control Room, Loco Shed | 38, 39, 40, 23, 31, 32, 36 | 67.00 | Soil | 5 | 25 | 18 | 20 |
| | | | Soil | 6 | 27 | 20 | 23 |
| | | | Soil | 9 | 30 | 22 | 28 |
| Emergency reclaim hopper-A | 26 | 67.00 | Rock | 12 | 45 | 45 | 45 |
| | | | Rock | 13 | 45 | 45 | 45 |
| | | | Rock | 14 | 45 | 45 | 45 |
| Coal Stock Pile - 1, 2, 3 & 4 | 53, 54, 55, 56, 27, 48 | 69.00 | Soil | 0.5 | 12 | 10 | 12 |
| | | | Soil | 1 | 13 | 11 | 14 |
| | | | Soil | 2 | 17 | 14 | 18 |

F.G.L. : Finished Ground Level

***Remarks / Notes***

*a)* *In case any loose pockets are observed at the proposed founding level, the same shall be excavated out and filled up with PCC upto the founding level.*

*b)* *Foundations resting in rock strata shall be embedded 0.3m into the rock strata.*

9.4 The soil at site down to about 2m depth below the natural ground level is generally high swelling soil. This soil shall not be used for filling and backfilling purposes. However, below 2m depth, low to medium swelling soil available at site, on confirmation by conducting suitable laboratory tests, can be used for filling/ backfilling purposes.

9.5 The modulus of subgrade reaction (K-value) can be obtained as dividing net safe bearing capacity by corresponding settlement.

9.6 Chemical tests were carried out on a few soil samples so as to detect the pH value, Sulphate and Chloride contents. The values are on the safe side as they are well within the acceptable limits. Accordingly, either Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement can be used for the purpose.

## *10.0* Appendices

10.1.1 The typical calculation of allowable bearing pressure has been shown in Appendix - A of this report.

10.1.2 A list of IS Codes referred for providing the recommendations and that which might be required to implement the same is also enclosed in this report in Appendix - B.

## 10.2 Special Note

If any loose pockets and/or soil strata are observed at the proposed foundation level, the same shall be removed and filled with lean concrete. Foundations can subsequently be placed over such a prepared surface.

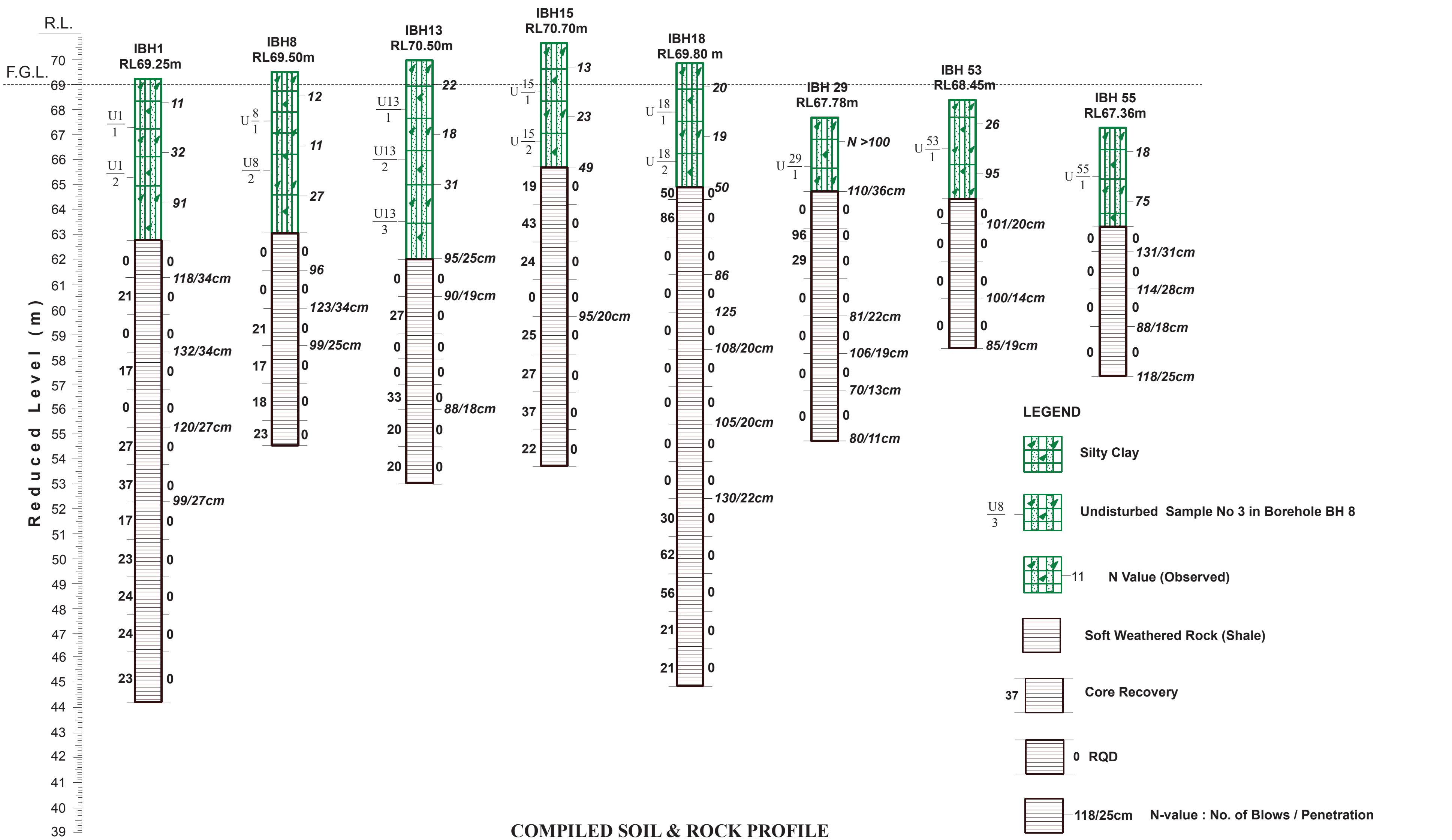
## 11.0 LIMITATIONS

This Geotechnical investigation has been carried out at locations in the site chosen by the client so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations.

*Dr. N. Santosh Rao*

*Technical Director*

*For **Nagadi Consultants Pvt. Ltd.,***




**COMPILED SOIL & ROCK PROFILE**

*Coal Handling Plant /Ash Handling Plant Area*

| | | |
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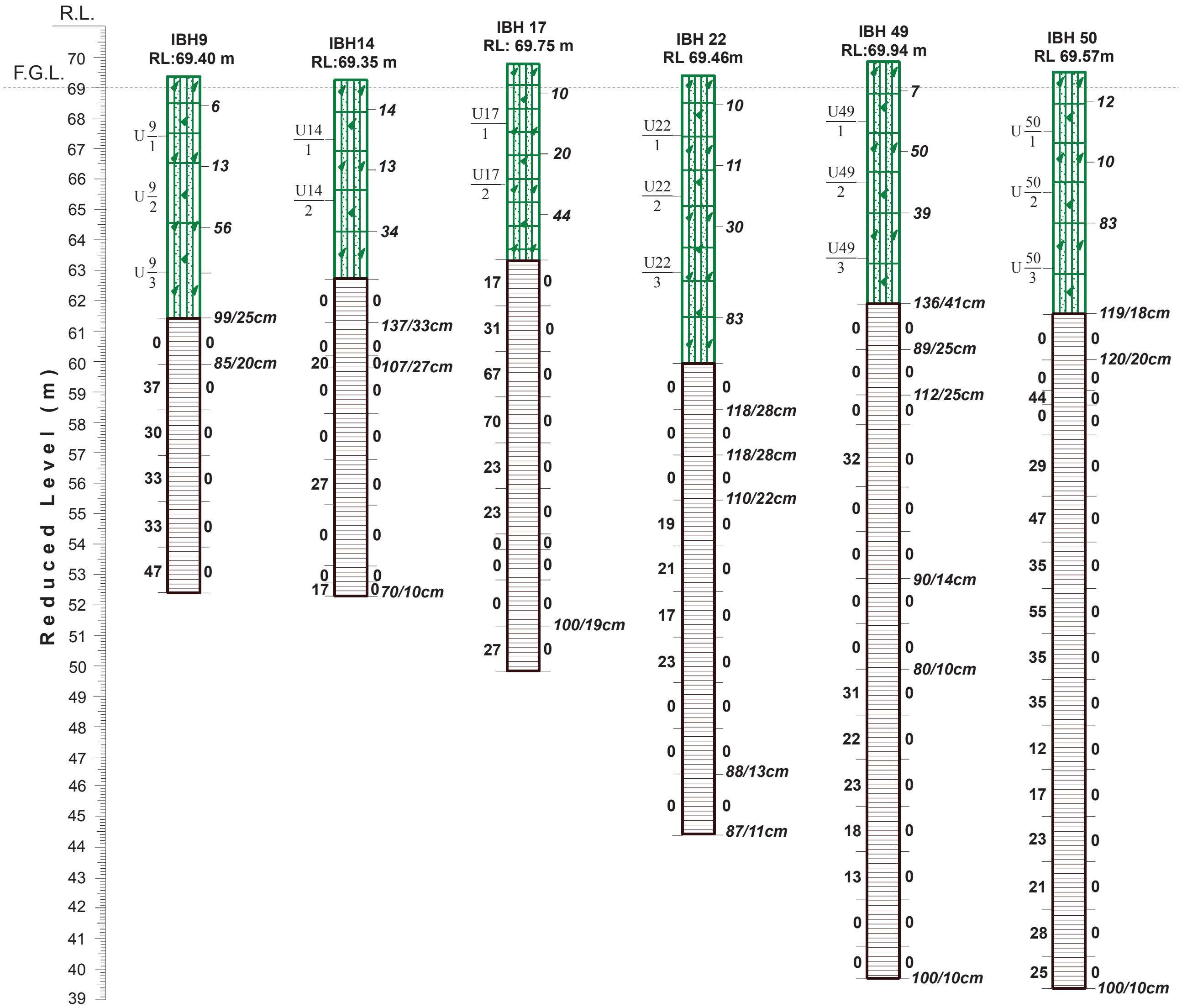


**LEGEND**

Silty Clay

U 49/1 Undisturbed Sample No 1 in Borehole BH 49

19 N Value (Observed)

Soft Weathered Rock (Shale)

50 Core Recovery

0 RQD

137/33cm N-value : No. of Blows / Penetration

## COMPILED SOIL & ROCK PROFILE

*Coal Handling Plant /Ash Handling Plant Area*

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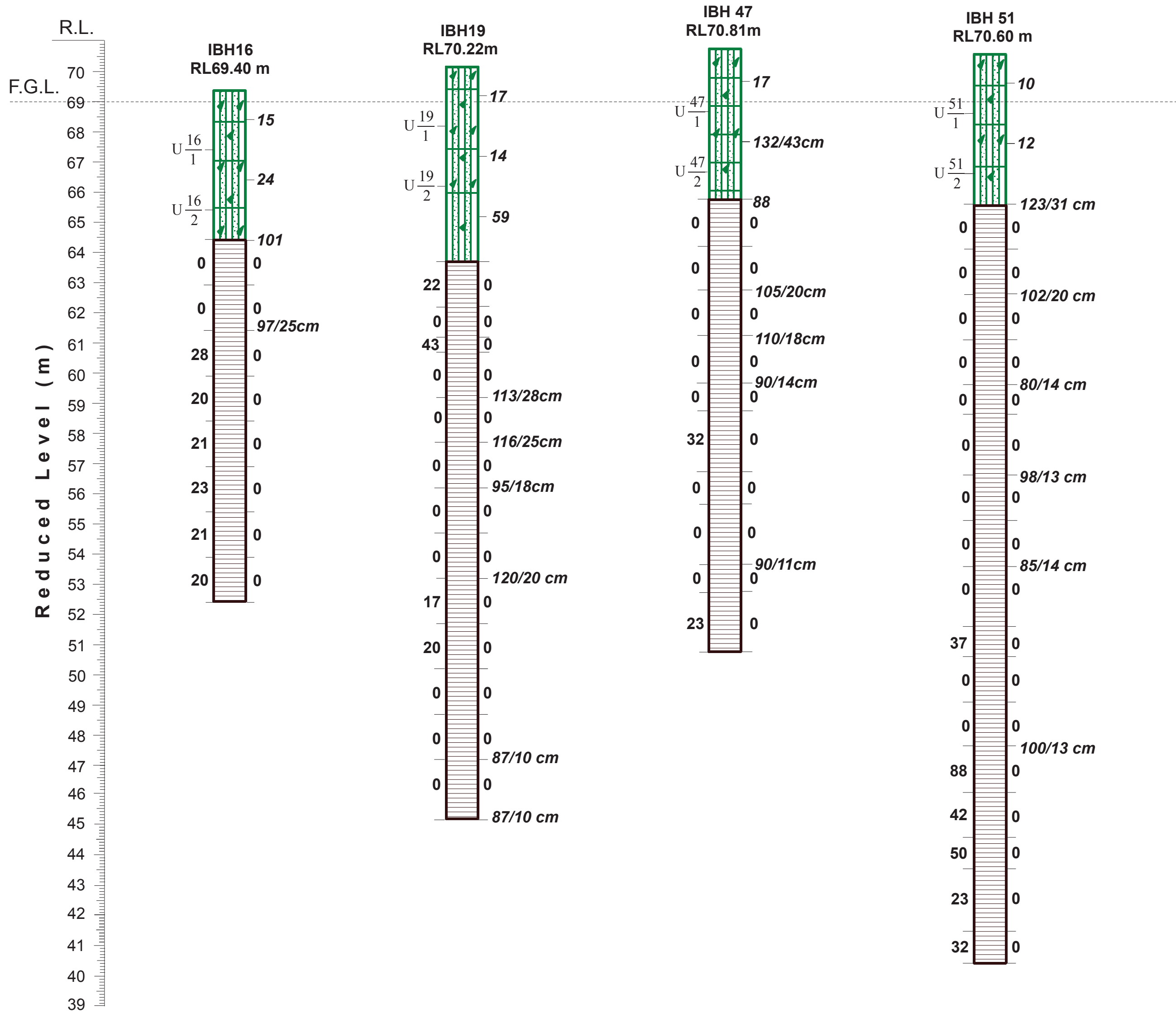
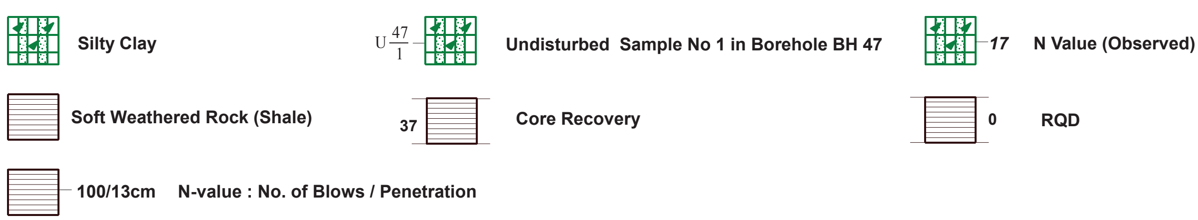



LEGEND




**COMPILED SOIL & ROCK PROFILE**

*Coal Handling Plant /Ash Handling Plant Area*

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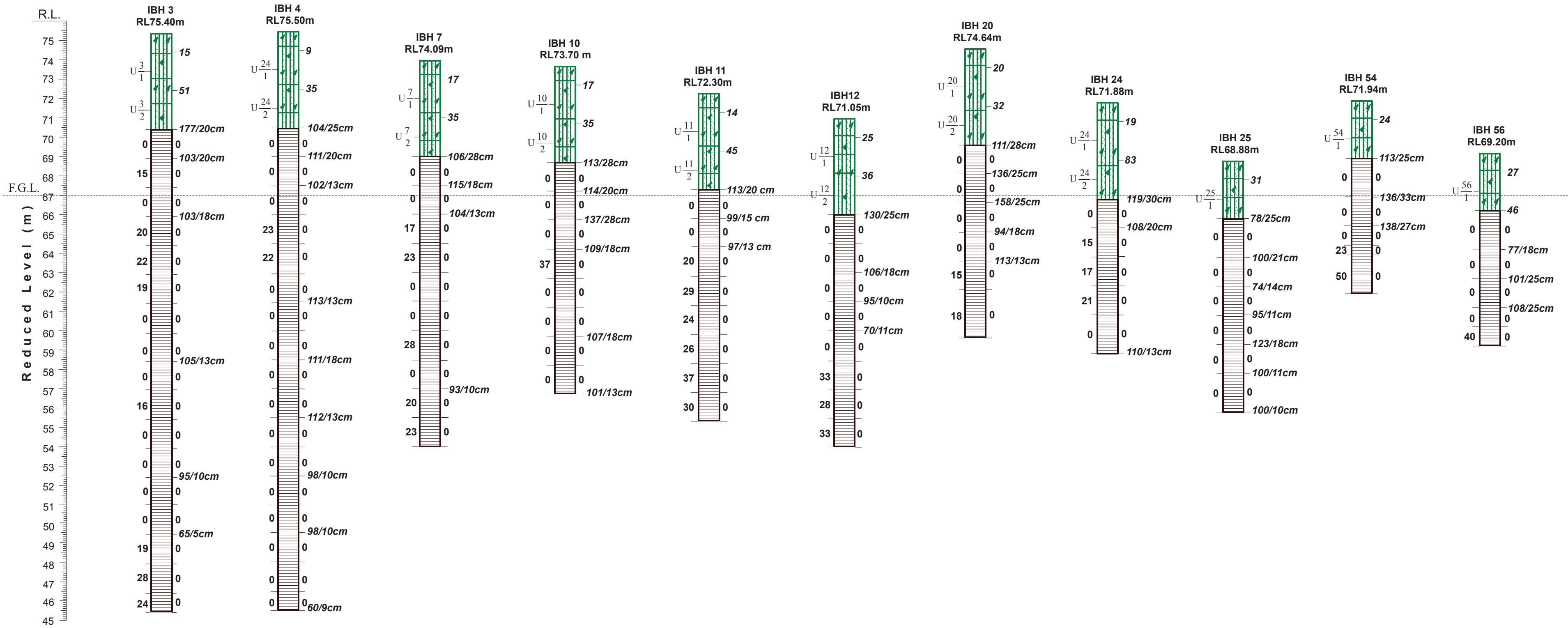


LEGEND

| | |
|---|---|
| Clayey Silty Sand | Undisturbed Sample No 3 in Borehole BH 7 |
| 15 | N Value (Observed) |
| Soft Weathered Rock (Shale) | |
| 37 | Core Recovery |
| 0 | RQD |
| 130/25cm | N-value : No. of Blows / Penetration |

**COMPILED SOIL & ROCK PROFILE**

*Coal Handling Plant /Ash Handling Plant Area*

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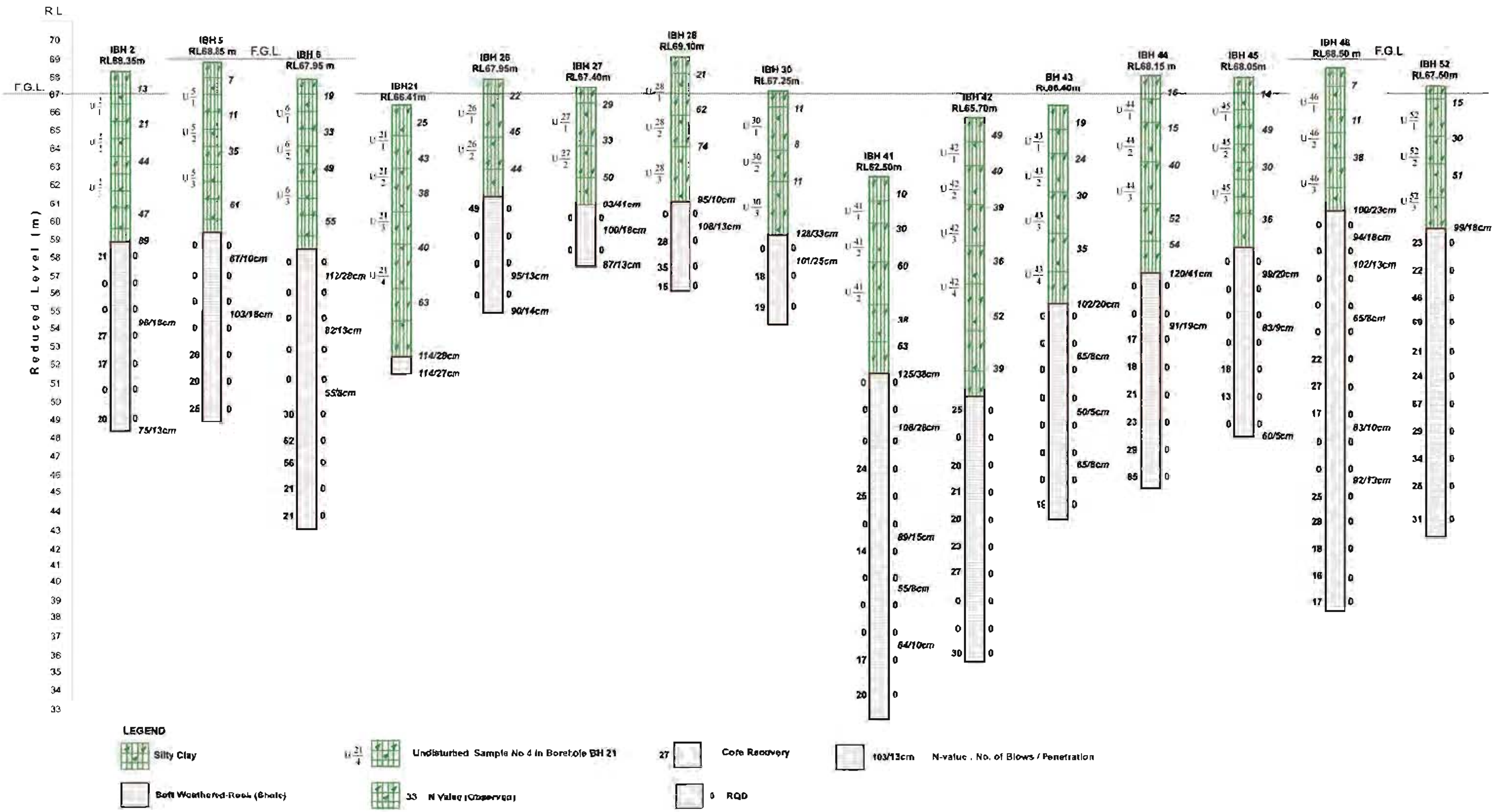


**COMPILED SOIL & ROCK PROFILE**

*Coal Handling Plant /Ash Handling Plant Area*

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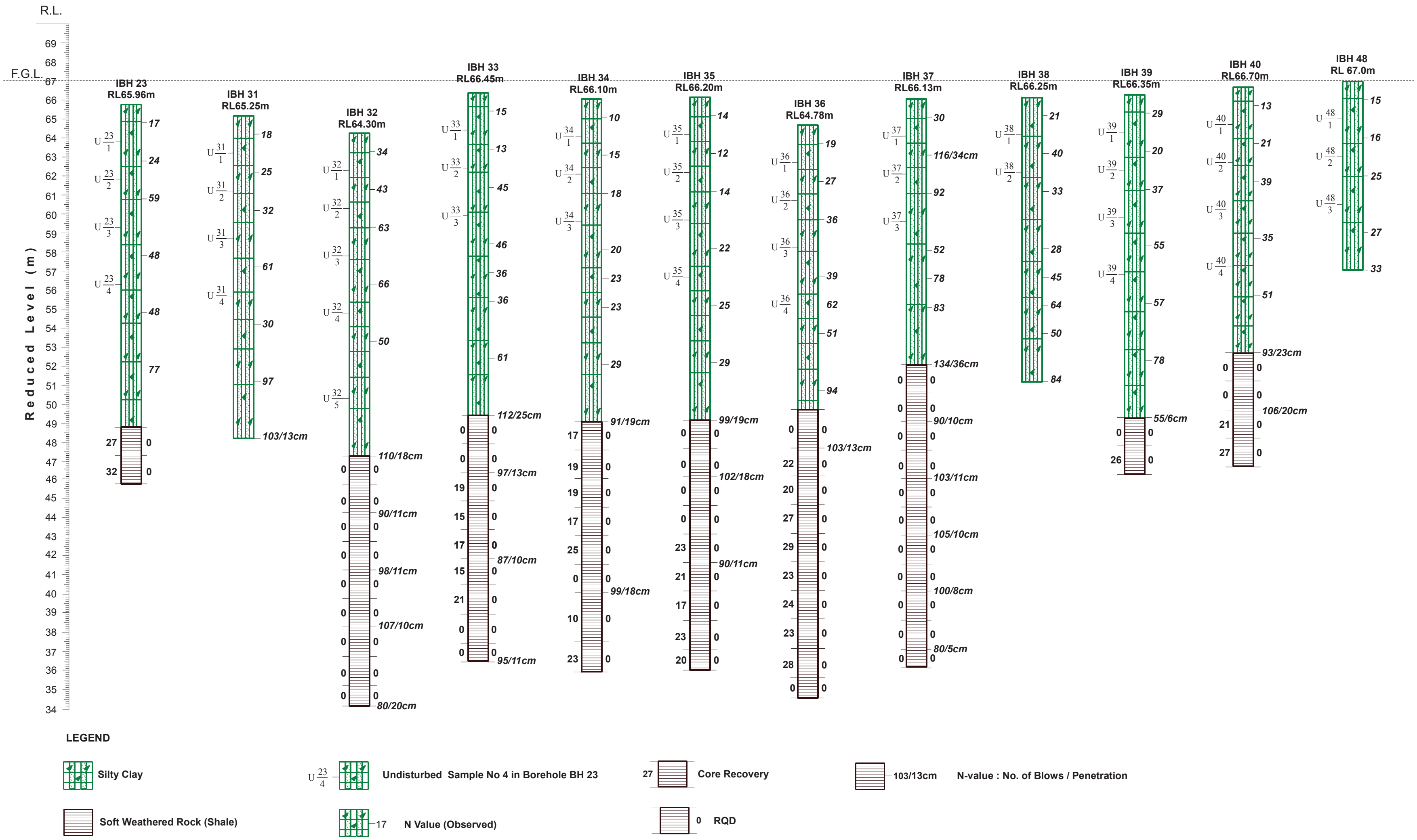

COMPILED SOIL & ROCK PROFILE

*Coal Handling Plant /Ash Handling Plant Area*

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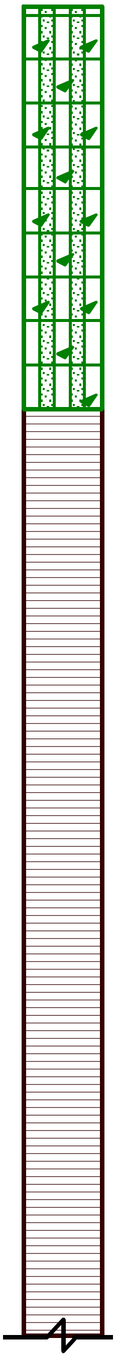
Sheet. No. : **29 of 271**

## CHP/ AHP AREA (GROUP - 1)

**Reference Boreholes IBH – 1, 8, 13, 15, 18, 29, 53, 55**

F.G.L. = R.L. (+) 69.00m



2m — **Silty Clay**
Expansive Soil

3.7m — **Silty Clay**

**Strength Parameters : cohesion '$c_u$' = 20 t/m$^2$, 'f' = 0°**

**Consolidation Parameters : '$m_v$' = 0.0012 m$^2$/t**

10m — **Highly Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 300,000 t/m$^2$, Poisson's ratio 'ṁ = 0.33**

11.7m — **Moderately Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 500,000 t/m$^2$, Poisson's ratio 'ṁ = 0.33**

*Fig. 2a : Design Profile*

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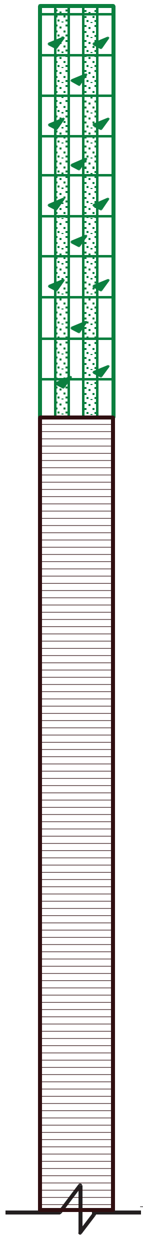
Job No. : **G(H) 1658(9)**

# CHP/ AHP AREA (GROUP - 2)

**Reference Boreholes IBH9, 14, 17, 22, 49 & 50**

F.G.L. = R.L. (+) 69.00m



| | | |
|---|---|---|
| 2m | **Silty Clay**<br>Expansive Soil | |
| 2m | **Silty Clay** | **Strength Parameters : cohesion '$c_u$' = 11 t/m$^2$, 'f' = 0°**<br>**Consolidation Parameters : '$m_v$' = 0.0014 m$^2$/t** |
| 3.7m | **Silty Clay** | **Strength Parameters : cohesion '$c_u$' = 18 t/m$^2$, 'f' = 0°**<br>**Consolidation Parameters : '$m_v$' = 0.0015 m$^2$/t** |
| 11m | **Highly Weathered Rock (Shale)** | **Elastic Parameters : elastic modulus 'E' = 300,000 t/m$^2$, Poisson's ratio 'm' = 0.33** |
| 18.8m | **Moderately Weathered Rock (Shale)** | **Elastic Parameters : elastic modulus 'E' = 500,000 t/m$^2$, Poisson's ratio 'm' = 0.33** |

***Fig. 2b : Design Profile***

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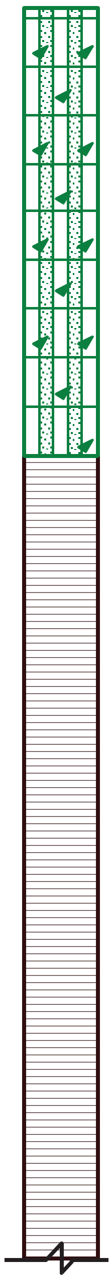
## CHP/ AHP AREA (GROUP - 3)

### Reference Boreholes IBH – 16, 19, 47 & 51

F.G.L. = R.L. (+) 69.00m



2m

**Silty Clay**
Expansive Soil

2.2m

**Silty Clay**

**Strength Parameters : cohesion '$c_u$' = 15 t/m$^2$, 'f' = 0°**

**Consolidation Parameters : '$m_v$' = 0.0014 m$^2$/t**

15m

**Highly Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 300,000 t/m$^2$, Poisson's ratio 'ṁ = 0.33**

10.8m

**Moderately Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 500,000 t/m$^2$, Poisson's ratio 'ṁ = 0.33**

*Fig. 2c : Design Profile*

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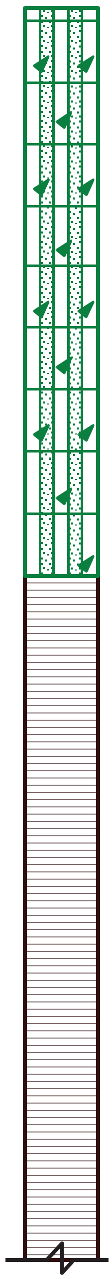
Job No. : **G(H) 1658(9)**

## CHP/ AHP AREA (GROUP - 5)

**Reference Boreholes IBH – 2, 5, 6, 21, 26 27, 28, 30, 41, 42, 43, 44, 45, 46, 52**

F.G.L. = R.L. (+) 67.00m



2m

**Silty Clay**
Expansive Soil

5.7m

**Silty Clay**

**Strength Parameters : cohesion '$c_u$' = 18 t/m$^2$, 'f' = 0°**

**Consolidation Parameters : '$m_v$' = 0.0017 m$^2$/t**

22.3m

**Highly Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 300,000 t/m$^2$, Poisson's ratio 'm' = 0.33**

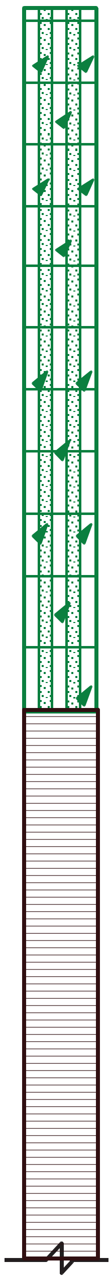
*Fig. 2d : Design Profile*

Project : **Geotechnical Investigation for (4x270MW) Bhadradri Thermal Power Plant Project, Manuguru, Khammam District, Telangana**

## CHP/ AHP AREA (GROUP - 6)

**Reference Boreholes IBH – 23, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, & 48**

F.G.L. = R.L. (+) 67.00m



2m

**Silty Clay**
Expansive Soil

13.7m

**Silty Clay**

**Strength Parameters : cohesion '$c_u$' = 15 t/m$^2$, 'f' = 0°**

**Consolidation Parameters : '$m_v$' = 0.0010 m$^2$/t**

14.3m

**Highly Weathered Rock (Shale)**

**Elastic Parameters : elastic modulus 'E' = 300,000 t/m$^2$, Poisson's ratio 'm' = 0.33**

*Fig. 2e : Design Profile*

Project : **Geotechnical Investigation for (4x270MW) Bhadradri Thermal Power Plant Project, Manuguru, Khammam District, Telangana**

# ANALYSIS FOR SAFE BEARING CAPACITY

## *A.1 METHODOLOGY*

A.1.1 The safe bearing capacities for foundations resting on both soil strata as well as weathered rock strata are determined based on the lower of the values determined from the shear failure criterion and the settlement criterion.

A.1.2 As the soil strata generally consists of Silty Clay, to calculate the safe bearing capacity from the shear failure criterion, the undrained shear strength parameters of cohesion '$c_u$' and angle of shearing resistance '$\phi_u$' are considered. For the weathered rock strata, to calculate the safe bearing capacity from the shear failure criterion, the weathered rock strata is considered as very dense sand and accordingly the appropriate value of the angle of shearing resistance '$\phi$' is adopted.

A.1.3 For the Silty Clay soil strata, the safe bearing capacity from the settlement criterion is calculated based on the consolidation properties of the clayey soil namely the coefficient of volume compressibility '$m_v$'.

A.1.4 For the weathered rock strata, to calculate the safe bearing capacity from the settlement criterion, the calculation of settlement of foundations can be carried out by use of elastic theory considering the weathered rock mass as an elastic half space with certain elastic modulus E and Poisson's ratio '$\mu$'.

A.1.5 The settlement of foundations resting on an elastic space are generally determined by the equation given by Timoshenko & Goodier. The influence factors considered in the equation given by Timoshenko & Goodier, are determined by equations given by Steinbrenner.

## *A.2 DATA*

### A.2.1 Depth of Foundation

Foundations can be placed at different levels at locations of the boreholes as given in the recommendations above.


Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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**A.2.2 Soil Properties**

The soil properties considered for the calculations of the safe bearing capacities are shown in the respective design profiles adopted for each of the groups.

**A.2.3 Weathered Rock Properties**

The typical minimum value of the elastic modulus of the weathered rock encountered at the present site which is Shale is around 300,000t/m$^2$ as given in the book titled Foundation Design by J.E. Bowles.

The Poisson's ratio '$\mu$' is typically in the range of about 0.3 to 0.4 for weathered Shale and considering the rock conditions encountered at the present site, the Poisson's ratio is taken as $\mu = 0.33$.

**A.2.4 Allowable Settlement**

The allowable settlement of foundations resting on Silty Clay soil strata is considered as 25mm only. This is because at higher total settlements, the differential settlements can become significant owing to the varying nature of soil as well as varying depth to rock (i.e. varying thickness of soil below the foundations).

The allowable settlement of foundations resting on weathered rock strata is considered as 12mm as per the provisions given in BIS codes IS:12070-1987 & IS:13063-1991.

**A.2.5 Design Profile**

The design profiles considered for each of the units, are shown in the figs. 2a to 2e.

***A.3 CALCULATION OF SAFE BEARING CAPACITY IN SILTY CLAY SOIL FROM SHEAR CRITERION***

A.3.1 The ultimate bearing capacity of the foundation is determined using the following equation as given in BIS code IS:6403-1981.

$$q_d = c_u \cdot N_c \cdot s_c \cdot d_c \cdot i_c$$

Where $c_u$ = undrained cohesion of the Silty Clay soil

| | | | | |
|---|---|---|---|---|
| $N_c$ | = | bearing capacity factor | = | 5.14 (for $\phi_u = 0$) |
| $s_c$ | = | shape factor | = | 1 (for Strip footing) |
| $d_c$ | = | depth factor | = | $1 + 0.2\ D_f/B$ |
| $i_c$ | = | inclination factor | = | 1 (for inclination $\alpha = 0^o$) |
| $D_f$ | = | depth of foundation | | |
| B | = | width of foundation | | |

A.3.2 Considering a factor of safety of 2.5, the safe bearing capacities for foundations resting at different depths at the locations of boreholes of Group - 1 to Group - 3 are given below.

| Structure | BH No. | FGL. R.L.(+) m | Founding Strata | Depth (m) of Foundation below FGL | Net Safe Bearing Capacity ($t/m^2$) | | |
|---|---|---|---|---|---|---|---|
| | | | | | B≤3m | 3<B<6m | B≥6m |
| Ash Slurry PH-1, Slurry Sump & Seal Water Tank, HT Switchgear Cum Control Room near Chimney for Unit 1 & 2, Vacuum cum Compressor House-2, FAE Tower 6,7 & 8, Bottom Ash Hopper-3, Pipe & Cable Rack (Stretch from FAE Tower-6 to FAE Tower-8) | 16, 19, 47 & 51 | 69.00 | Soil | 2 | 35 | 33 | 33 |
| | | | Soil | 3 | 37 | 35 | 34 |
| Ash Slurry PH-2, Slurry Sump & Seal Water Tank, AHP MCC-A near TP-5, BCN 6 A/B, TP-3, DS PUMP HOUSE - II, TP – 4, TP – 5, CHP MCC-4 near Bunker Area, Tunnel 10, BCN 5 A/B, Pent House-II, Dozer Shed, BCN-8 & Stacker Reclaimer-1, MCC-4 near Bunker Area | 2, 5, 6, 45, 43, 44, 46, 28, 30 | 67.00 | Soil | 4 | 47 | 43 | 42 |
| | | | Soil | 5 | 49 | 44 | 43 |
| | | | Soil | 6 | 52 | 46 | 44 |
| | | | Soil | 7 | 54 | 47 | 46 |
| Ash Water Pump House / Ash Water Tank, Chemical House & Parshall Flume, Clarifier & Sludge Pit, Pipe & Cable Rack (Stretch from ASPH-1 to Silo) | 1, 8, 18, 13, 15 | 69.00 | Soil | 3 | 48 | 45 | 45 |

| Structure | BH No. | FGL. R.L.(+) m | Founding Strata | Depth (m) of Foundation below FGL | Net Safe Bearing Capacity (t/m²) | | |
|---|---|---|---|---|---|---|---|
| | | | | | B≤3m | 3<B<6m | B≥6m |
| Vacuum cum Compressor House-1, Bottom Ash Hopper-1, FAE Tower-1,2,3,4 & 5, BCN-7A/B, Pipe & Cable Rack (Stretch from FAE Tower-1 to FAE Tower-6) | 9, 22, 49,50 | 69.00 | Soil | 3 | 27 | 25 | 25 |
| | | | Soil | 4 | 47 | 43 | 42 |
| | | | Soil | 5 | 49 | 44 | 43 |
| | | | Soil | 6 | 52 | 46 | 44 |
| Track Hopper (371 M), Maintenance bay and tunnel 1 a/b | 33, 34, 35 | 67.00 | Soil | 11 | 53 | 44 | 42 |
| | | | Soil | 12 | 55 | 46 | 43 |
| | | | Soil | 13 | 58 | 47 | 44 |
| Transfer point - 1 (under ground) & tunnel 2 a/b | 36 | 67.00 | Soil | 14.5 | 60 | 49 | 46 |
| | | | Soil | 16.5 | 65 | 51 | 48 |
| Transfer point - 2 (under ground) & tunnel 3 a/b | 37 | 67.00 | Soil | 4 | 39 | 36 | 35 |
| | | | | 13 | 58 | 44 | 44 |
| Pent House I, BCN-3 A/B, BCN 4 A/B, CHP MCC-1&2 Near TP-2, DS Pump House-1, Coal Settling Pond, MCC-3 Near WT, Crusher House, Wagon Tippler Control Room, Loco Shed | 38, 39, 40, 23, 31, 32, 36 | 67.00 | Soil | 5 | 41 | 37 | 36 |
| | | | Soil | 6 | 43 | 38 | 37 |
| | | | Soil | 7 | 45 | 39 | 38 |
| | | | Soil | 12 | 56 | 46 | 43 |

F.G.L. : Finished Ground Level

### *A.4 CALCULATION OF SAFE BEARING CAPACITY IN SILTY CLAY SOIL FROM SETTLEMENT CRITERION*

A.4.1 The safe bearing capacity of foundations resting on Silty Clay soil strata is determined using the consolidation properties of the clayey soil as given below

$$q_s = \frac{s}{\Delta p \cdot m_v \cdot H}$$

Where $\Delta p$ = increase in pressure at the middle of the soil layer due to the bearing pressure on the foundation

$m_v$ = coefficient of volume compressibility

H = thickness of the compressible soil layer

A.4.2 The increase in pressure $\Delta p$ at the middle of the soil layer is determined by the simplified method of determining the stress distribution below the foundation by considering a two dimensional spread of load in the soil at an angle of 1H : 2V.

A.4.3 For example, for a width of foundation 'B' of 3m and thickness of compressible soil layer below the foundation 'H' of 2m, the increase in pressure $\Delta p$ at the middle of the soil layer will be $0.75 t/m^2$ for a unit pressure on the foundation 'p' of $1 t/m^2$.

Considering a coefficient of volume compressibility '$m_v$' of 0.0010 $m^2/t$, the safe bearing capacity on the foundation works out to be $17 t/m^2$.

A.4.4 Further, foundation widths greater than 6m are typically considered as raft foundations and the settlements of such foundations are lower on account of the rigidity of the foundation and hence, the calculated settlements have to be reduced by use of a reduction factor for rigidity of 0.8 as given in the relevant provisions of BIS code IS:8009(Part1) - 1976.

## *A.5 CALCULATION OF SAFE BEARING CAPACITY IN WEATHERED ROCK FROM SHEAR CRITERION*

A.5.1 The ultimate bearing capacity of the foundation is determined using the following equation as given in BIS code IS:6403-1981.

$$q_d = q \cdot \left(N_q - 1\right) \cdot s_q \cdot d_q \cdot i_q + \frac{1}{2} \gamma \cdot B \cdot N_\gamma \cdot s_\gamma \cdot d_\gamma \cdot i_\gamma \cdot W'$$

Where q = effective surcharge at the foundation level

$N_q$, $N_\gamma$ = bearing capacity factors

$s_q$, $s_\gamma$ = shape factors

$d_q$, $d_\gamma$ = depth factors

$i_q$, $i_\gamma$ = inclination factors

$\gamma$ = unit weight of soil/weathered rock = $2 t/m^3$

B = width of foundation

W' = water table correction factor

A.5.2 Considering the weathered rock as dense sand, the angle of shearing resistance '$\phi$' can be taken as $40^o$.

A.5.3 Accordingly, the bearing capacity factors for general shear failure conditions will be :

$N_q$ = 64.20

$N_\gamma$ = 109.41

A.5.4 As the foundation is not subjected to any inclined loads, the inclination factors will be equal to1.

A.5.5 As the foundations can either be continuous strip or square in shape, the shape factors corresponding to the continuous strip are adopted as they are generally lower.

$s_q$ = $s_\gamma$ = 1.0

A.5.6 Considering the depth of foundation as an average of about 6m, and the width of foundation as 6m, the depth factors work out to be :

$d_{q,}\, d_\gamma$ = 1.21

A.5.7 Although ground water table has not been encountered, to be on the safer side, the water table correction factor is considered as W' = 0.5.

A.5.8 The effective surcharge at the foundation level calculated by considering the unit weight of the soil = $2t/m^3$, works out to be = $12t/m^2$.

A.5.9 Accordingly, the ultimate bearing capacity works out to be :

$q_d$ = 984 $t/m^2$

A.5.10 Applying a factor of safety of 2.5, the safe bearing capacity from shear criterion works out to be :

$q_s$ = 393 $t/m^2$

***A.6 CALCULATION OF SAFE BEARING CAPACITY IN WEATHERED ROCK FROM SETTLEMENT CRITERION***

A.6.1 The settlement of foundations resting on weathered rock strata is calculated based on the equation given by Timoshenko & Goodier as given below :

$$s = q \cdot B \cdot \frac{1-\mu^2}{E}\left(I_1 + \frac{1-2\mu}{1-\mu} I_2\right) \cdot I_F$$

The above equation simplified by Steinbrenner is given below :

$$s = q \cdot B' \cdot \frac{1-\mu^2}{E} \cdot m \cdot I_s \cdot I_F$$

Where q = loading intensity on the foundation

B' = Least lateral dimension of the contributing loaded area

m = factor which is 4 at footing centre

$I_s$ = influence factor for loaded area

$I_F$ = influence factor for depth of foundation The calculation of settlement of foundation is done considering the following data:

q = bearing pressure on foundation

= 45t/m$^2$

E = 3,00,000 t/m$^2$

μ = 0.33

The influence factors '$I_s$' & '$I_F$' are determined considering the thickness of compressible weathered rock strata, the depth of foundation and the widths of foundations.

Considering the depth of foundation of 7m and width of foundation of 6m and thickness of highly weathered rock strata of 4m, the influence factors are determined to be :

$I_s$ = 0.2386

$I_F$ = 0.6382

Accordingly, the settlement of foundation works out to be :

s = 0.24mm

As the proposed foundation will be a rigid foundation, the above calculated settlement has to be reduced by use of a reduction factor for rigidity of 0.8 as given in the relevant provisions of BIS code IS:8009(Part1) - 1976.

Accordingly, the final calculated settlement of the foundation works out to be :

*s* = *0.8 x 0.24 ≈ 0.2mm*

As the above calculated settlements of the foundation are less than the allowable settlement of 12mm, the net safe bearing capacity of 45 t/m$^2$ can be safely adopted for the foundations resting on weathered rock strata.

## LIST OF IS CODES

**Field Investigation**

| | | |
|---|---|---|
| 1. | IS : 1892 - 1979 : | Code of practice for sub surface investigations for foundations |
| 2. | IS : 2131 - 1981 : | Method of Standard Penetration Tests for soils (First revision) |
| 3. | IS : 2132 - 1986 : | Code of practice for thin walled tube sampling of soils (Second revision) |
| 4. | IS : 11315 - 1985 (Part 11) : | Method for the quantitative descriptions of discontinuities in rock masses |
| 5. | IS : 11315 - 1995 (Part 12) : | Quantitative description of discontinuities in rock mass methods. |

**Laboratory Tests**

| | | |
|---|---|---|
| 1. | IS : 2720 - 1983 (Part 1) : | Methods of test for soils: Preparation of dry soil samples for various tests (Second revision) |
| 2. | IS : 2720 - 1980 (Part 2) : | Method of test for soils: Determination of water content (Second revision) Amendment 1 |
| 3. | IS : 2720 - 1980 (Part 3/sec 1) : | Method of Test for Soils : Determination of Specific Gravity : Fine Grained Soils. (First Revision) |
| 4. | IS : 2720 - 1980 (Part 3/Sec 2) : | Method of test for soils : Determination of Specific Gravity : Fine, Medium & Coarse grained soils. (First revision). |
| 5. | IS : 2720 - 1985 (Part 4) : | Method of test for soils : Grain size analysis (Second revision) |
| 6. | IS : 2720 - 1985 (Part 5) : | Method of test for soils : Determination of liquid and plastic limit (Second revision) |
| 7. | IS : 2720 (Part 10) - 1973 : | Method of test for soils : Determination of shear strength parameters using Triaxial apparatus |

8. IS: 4078 - 1980 : Code of practice for indexing and storage of drill cores (First Revision)
9. IS: 5529 (Part1) - 1985 : Code of practice for in-situ permeability tests.

10. IS : 9143 : 1976 : Method for the determination of unconfined compressive strength of rock materials.
11. IS : 13030 : 1991 : Method of test for laboratory determination of water content, porosity, density and related properties of rock material.

**Foundation Construction**

1. IS : 1904 - 1986 : Code of practice for design and construction of foundation in soils: General requirements (Third revision)
2. IS : 1904 - 1986 : Code of practice for design and construction of foundation in soils: General requirements (Third revision)
3. IS : 6403 - 1981 : Code of practice for determination of bearing capacity of shallow foundations : First revision (Amendment 1)
4. IS : 8009 - 1976 (Part 1) : Code of practice for calculation of settlements of foundations : Shallow foundations subject to symmetrical static vertical loads (Amendment 2)
5. IS: 12070 - 1987 : Code of practice for design and construction of shallow foundations on rocks
6. IS : 13063 : 1991 : Code of practice for structural safety of buildings on shallow foundations on Rocks

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 1** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.25m | Term. Depth (m): 25.0 |
| | B.H. Coord. : 1993168N, 472190E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 5, 6)<br>11 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 3.0 | | | SPT | (20, 20, 12)<br>32 | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Greyish Red Sandy Clay Silt with Gravels |
| 5.0 | | | SPT | (7, 16, 35)<br>51 | | | Greyish Red Sandy Clay Silt with Gravels |
| 6.0 | | 45 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | | 50 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | 55 | SPT | 118/34 cm | 21 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.5 | 65 | SPT | 132/34 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 12.5 | 13.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | 90 | SPT | 120/27 cm | 19 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.5 | 16.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 80 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 17.0 | 18.5 | 85 | SPT | 99/27 cm | 17 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 140 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 85 | | | 24 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 120 | | | 24 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.0 | 25.0 | 180 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 2** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.35 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993352N, 472192E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Yellowish Brown Clay Silt |
| 1.0 | | | SPT | (3, 5, 8) 13 | | | Brown Clay Silt |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (7,10,11) 21 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (13, 17, 27) 44 | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (10, 19, 28) 47 | | | Red Clay Silt |
| 9.0 | | | | | | | Red Clay Silt |
| 9.5 | | | SPT | (19, 39, 50) 89 | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | 130 | SPT | 98/18 cm | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 145 | | | 37 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 17.0 | 18.0 | - | | | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |
| 18.0 | 19.0 | - | | | 40 | 0 | Red Moderately Weathered Rock (Shale) |
| 19.0 | 20.0 | - | | | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |
| 20.0 | | - | SPT | 75/13 cm | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |

# Field Borelog

| Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 3 |
|---|---|---|
| Location: CHP/AHP Area | Red. Lev. (m): 75.40 m | Term. Depth (m): 30 |
| B.H. Coord. : 1992764N, 472309E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | ( 3, 6, 9 ) 15 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | ( 11, 21, 30) 51 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | 25 | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | 177/20 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 45 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | - | SPT | 103/20 cm | 15 | 0 | Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.0 | 55 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 85 | SPT | 103/18 cm | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 70 | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 75 | | | 19 | 0 | Whitish Red Moderately Weathered Rock (Shale) |
| 14.0 | 16.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 135 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.0 | - | SPT | 105/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 20.0 | 145 | | | 16 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 22.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 22.0 | 23.0 | 160 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 25.0 | - | SPT | 95/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 25.0 | 26.0 | 185 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 26.0 | 27.5 | - | SPT | 65/5 cm | 19 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | 110 | | | 28 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | 65 | | | 24 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 4** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 75.50 m | Term. Depth (m): 30 |
| | B.H. Coord. :1992766N 472340E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | ( 3, 5, 8 ) 9 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | ( 8, 14, 21) 35 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | 104/25 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 45 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | - | SPT | 111/20 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | 35 | SPT | 102/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 90 | | | 23 | 0 | Whitish /Greyish Red Moderately Weathered Rock (Shale) |
| 11.0 | 13.0 | - | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |
| 13.0 | 14.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 16.0 | - | SPT | 113/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 150 | | | 0 | 0 | Whitish Red Highly Weathered Rock (Shale) |
| 17.0 | 19.0 | - | SPT | 111/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 22.0 | - | SPT | 112/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 22.0 | 23.0 | 150 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 25.0 | - | SPT | 98/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 25.0 | 26.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 26.0 | 27.0 | - | SPT | 98/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 27.0 | 28.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 29.0 | 30.0 | 85 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 30.0 | | - | SPT | 60/9 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 5** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.85m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993375N, 472058E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 3, 4) 7 | | | Yellowish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 3.0 | | | SPT | (2, 4, 7) 11 | | | Brownish Yellow Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brownish Yellow Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Brownish Yellow Sandy Clay Silt with Gravels |
| 5.0 | | | SPT | (8, 14, 21) 35 | | | Brownish Yellow Sandy Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.0 | | | | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (16, 27, 34) 61 | | | Brown Clay Silt with Gravels |
| 9.0 | | | | | | | Brown Clay Silt with Gravels |
| 9.5 | 10.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | 65 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 14.0 | - | SPT | 67/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | - | SPT | 103/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 17.0 | 90 | | | 26 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | - | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | - | | | 25 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 6** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.95 m | Term. Depth (m): 25 |
| | B.H. Coord. : 1993413N, 472084E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 8, 11) 19 | | | Yellowish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (6, 13, 20) 33 | | | Brownish Yellow Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brownish Yellow Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (14, 21, 28) 49 | | | Brownish Yellow Sandy Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.0 | | | | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (12, 24, 31) 55 | | | Brown Clay Silt with Gravels |
| 9.0 | | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 13.0 | - | SPT | 112/28cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 165 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | - | SPT | 82/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 16.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.5 | 155 | | | 0 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.5 | 19.0 | 155 | SPT | 55/8 cm | 30 | 0 | Red Moderately Weathered Rock (Shale) |
| 19.0 | 20.5 | 130 | | | 62 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.5 | 22.0 | 217 | | | 56 | 0 | Red Moderately Weathered Rock (Shale) |
| 22.0 | 23.5 | 150 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.5 | 25.0 | 155 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |

# Field Borelog

| | | | |
|---|---|---|---|
| Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | | **B.H.No. : 7** |
| Location: CHP/AHP Area | Red. Lev. (m): 74.09 m | | Term. Depth (m): 20 |
| B.H. Coord. : 1992816N, 472306E | | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brownish Yellow Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 6, 11) 17 | | | Brownish Yellow Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (9,15, 20) 35 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | 20 | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | 106/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 50 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.0 | 55 | SPT | 115/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.0 | 8.0 | 65 | | | 0 | 0 | Whitish /Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | 60 | SPT | 104/13 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | 65 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 14.0 | 115 | | | 0 | 0 | Whitish Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | - | | | 28 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.0 | 16.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 125 | SPT | 93/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.5 | 65 | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 70 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |

# Field Borelog

| | | |
|---|---|---|
| Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No. : 8 |
| Location: CHP/AHP Area | Red. Lev. (m): 69.50 m | Term. Depth (m): 15 |
| B.H. Coord. : 1993134N, 472226E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 4, 8) 12 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 4, 7) 11 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Reddish Brown Clay Silt with Gravels |
| 4.5 | | 30 | | | | | Brownish Red Clay Silt |
| 5.0 | | - | SPT | (7, 11, 16) 27 | | | Greyish Red Clay Silt |
| 6.0 | | 50 | | | | | Red Clay Silt |
| 6.5 | 7.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 55 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | - | SPT | (13, 31, 65) 96 | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 123/34 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 75 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.5 | 80 | SPT | 99/25 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 85 | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.0 | 40 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.0 | | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No. : 9** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.40 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993264N, 472055E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Silty Clay with Gravels |
| 1.0 | | | SPT | (2, 2, 4) 6 | | | Brown Silty Clay with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Silty Clay with Gravels |
| 3.0 | | | SPT | (2, 5, 8) 13 | | | Brown Silty Clay with Gravels |
| 4.0 | | | UDS | | | | Brown Silty Clay with Gravels |
| 4.5 | | | | | | | Yellowish / Whitish /Brownish Red Silty Clay with Gravels |
| 5.0 | | | SPT | (11, 27, 29) 56 | | | Brownish Red Clay Silt with Gravels |
| 6.0 | | | | | | | Red Clay Silt |
| 6.5 | 7.5 | - | UDS | | | | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 65 | | | | | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 99/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 90 | SPT | 85/20 cm | 37 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 110 | | | 30 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 120 | | | 33 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 105 | | | 33 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 110 | | | 47 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 10 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 73.70 m | Term. Depth (m):17 |
| | B.H. Coord. : 1992764N, 472168E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brownish Yellow Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 6, 11) 17 | | | Brownish Yellow Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (7, 14, 21) 35 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | 113/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.0 | - | SPT | 114/20 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.0 | 8.0 | 80 | | | 0 | 0 | Whitish /Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 137/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 75 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | - | SPT | 109/18 cm | 37 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | 85 | | | 0 | 0 | Whitish Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 145 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 16.0 | - | SPT | 107/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 155 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | | - | | 101/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

# Field Borelog

| Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 11 |
|---|---|---|
| Location:CHP/AHP Area | Red. Lev. (m): 72.30 m | Term. Depth (m): 17 |
| B.H. Coord. : 1992904N, 472168E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 6, 8) 14 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (10, 21, 24) 45 | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 4.0 | | | UDS | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 5.0 | 6.0 | - | SPT | 113/20 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | SPT | 99/15 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | 80 | SPT | 97/13 cm | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | 75 | | | 29 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 80 | | | 24 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 85 | | | 26 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 75 | | | 37 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 80 | | | 30 | 0 | Whitish Grey Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 12 |
|---|---|---|---|
| | Location:CHP/AHP Area | Red. Lev. (m): 71.05 m | Term. Depth (m): 17 |
| | B.H. Coord. :1993000N, 472168E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 9, 16) 25 | | | Yellowish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Reddish Clay Silt |
| 3.0 | | | SPT | (7, 11, 25) 36 | | | Brown Red Clay Silt with Gravels |
| 3.5 | | | | | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.5 | - | SPT | 130/25cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 106/18cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 95/10cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | SPT | 70/11cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 90 | | | 33 | 0 | Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 100 | | | 28 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 110 | | | 33 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 13** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.50 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993072N 472168E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt |
| 1.0 | | | SPT | (4, 7, 15) 22 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (5, 7, 11) 18 | | | Yellowish / Whitish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Yellowish / Whitish Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (9, 13, 18) 31 | | | Yellowish / Whitish Brown Clay Silt with Gravels |
| 6.0 | | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 95/25cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 75 | SPT | 90/19cm | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 75 | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 80 | SPT | 88/18cm | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 75 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 14** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.35 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993388N, 471943E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clayey Silt with Gravels |
| 1.0 | | | SPT | (3, 5, 9) 14 | | | Dark Brown Clayey Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clayey Silt with Gravels |
| 3.0 | | | SPT | (3, 6, 7) 13 | | | Brown Clayey Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clayey Silt with Gravels |
| 4.5 | | | | | | | Brown Clayey Silt |
| 5.0 | | | SPT | (8, 14, 20) 34 | | | Brown Clayey Silt |
| 6.0 | | | | | | | Brown Sandy Clayey Silt |
| 6.5 | | | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | | | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 137/33 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 80 | | | 20 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | - | SPT | 107/27 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 12.0 | 12.5 | 100 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.5 | 14.0 | - | | | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 14.0 | 16.5 | - | | | - | 0 | Red Highly Weathered Rock (Shale) |
| 16.5 | 17.0 | - | | | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | | - | SPT | 70/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 15** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.70 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993276N 472167E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brownish Grey Clay Silt |
| 1.0 | | | SPT | (2, 5, 8) 13 | | | Dark Brownish Grey Clay Silt |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (7, 11, 12) 23 | | | Brown Clay Silt with Gravels |
| 3.5 | | 25 | UDS | | | | Greyish Red Clay Silt |
| 4.0 | | - | | | | | Greyish Red Clay Silt |
| 4.5 | | 40 | | | | | Brownish Red Clay Silt |
| 5.0 | 6.5 | 55 | SPT | (10, 16, 33) 49 | 19 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 6.5 | 8.0 | 65 | | | 43 | 0 | Grey Sand Stone |
| 8.0 | 9.5 | 70 | | | 24 | 0 | Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 11.0 | 12.5 | 65 | SPT | 95/20cm | 25 | 0 | Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 80 | | | 27 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 75 | | | 37 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | - | | | 22 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 16** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.40 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993175N 472107E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 6, 9) 15 | | | Dark Brown Clay Silt with Gravel |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravel |
| 3.0 | | | SPT | (6, 11, 13) 24 | | | Whitish Red Highly Weathered Rock (Shale) |
| 4.0 | | | UDS | | | | Greyish Red Highly Weathered Rock (Shale) |
| 4.5 | | | | | | | Reddish Brown Clay Silt |
| 5.0 | 6.0 | - | SPT | (17, 44, 57) 101 | 0 | 0 | Greyish / Reddish Brown Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Greyish / Reddish Brown Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | | | 0 | 0 | Reddish Brown Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 70 | | | 0 | 0 | Reddish Brown Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | 80 | SPT | 103/20cm | 28 | 0 | Brownish White Sand Stone with Shale |
| 9.5 | 11.0 | 90 | | | 20 | 0 | Reddish Pink Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | 100 | | | 21 | 0 | Brownish White Moderately Weathered Rock (Shale) |
| 12.0 | 14.0 | 110 | | | 23 | 0 | Brownish White Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 115 | | | 21 | 0 | Brownish White Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 150 | | | 20 | 0 | Brownish Pink Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 17** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.75 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993188N 472044E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 4, 6) 10 | | | Brown Clay Silt with Gravel |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravel |
| 3.0 | | | SPT | (5, 8, 12) 20 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 5.0 | | | SPT | (12, 21, 23) 44 | | | Red Clay Silt with Gravels |
| 6.0 | | | | | | | Brownish Red Sandy Clay Silt |
| 6.5 | 8.0 | 50 | UDS | | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.5 | 45 | | | 31 | 0 | Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | 50 | | | 67 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 50 | | | 70 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 60 | | | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 65 | | | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | - | | | - | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 17.0 | 18.5 | - | SPT | 100/19cm | - | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 18.5 | 20.0 | 85 | | | 27 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 18** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.80 m | Term. Depth (m): 25 |
| | B.H. Coord. : 1993120N, 472191E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 10, 10) 20 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Dark Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (16, 9, 10) 19 | | | Yellowish Brown Clay Silt with Gravels |
| 4.0 | 5.0 | | UDS | | | | Yellowish Brown Stand Stone |
| 5.0 | 5.5 | 30 | SPT | (12, 20, 30) 50 | 50 | 0 | Brownish Grey Stand Stone |
| 5.5 | 7.0 | 60 | | | 0 | 0 | Brownish Grey Stand Stone |
| 7.0 | 8.5 | 63 | | | 0 | 0 | Brownish Grey Stand Stone |
| 8.5 | 9.0 | 70 | SPT | (31, 39, 47) 86 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 10.0 | 95 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | - | SPT | (30, 52, 73/8cm) 125 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 11.5 | 95 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.5 | 13.0 | 90 | SPT | 108/20cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.5 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.5 | 16.0 | 95 | SPT | 105/20cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.5 | 19.0 | 155 | SPT | 130/28cm | 30 | 0 | Red Moderately Weathered Rock (Shale) |
| 19.0 | 20.5 | 130 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.5 | 22.0 | 217 | | | 56 | 0 | Red Moderately Weathered Rock (Shale) |
| 22.0 | 23.5 | 150 | | | 39 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.5 | 25.0 | 155 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 19** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.22 m | Term. Depth (m): 25 |
| | B.H. Coord. : 1993135N, 471956E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 7, 10) 17 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 6, 8) 14 | | | Yellowish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Greyish Brown Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | (14, 23, 36) 59 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | 40 | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.5 | 70 | | | 43 | 0 | Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | SPT | 113/28 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 12.0 | 12.5 | 90 | SPT | 116/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.5 | 13.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | - | SPT | 95/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 17.0 | 180 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.5 | - | SPT | 120/20 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | - | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 21.5 | 23.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 25.0 | - | SPT | 87/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 25.0 | | - | SPT | 87/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 20** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 74.64 m | Term. Depth (m):15 |
| | B.H. Coord. : 1992811N, 472494E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt |
| 1.0 | | | SPT | (4, 7, 13) 20 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt |
| 3.0 | | | SPT | (9, 14, 18) 32 | | | Red Clay Silt |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | | SPT | 113/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 50 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.0 | - | SPT | 136/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.0 | 8.0 | 55 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 158/25 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 65 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | - | SPT | 94/18 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | 70 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 11.0 | 12.5 | 65 | SPT | 113/13 cm | 15 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 12.5 | 15.0 | 90 | | | 18 | 0 | Greyish Red Moderately Weathered Rock (Shale) |


Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 21** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.41 m | Term. Depth (m): 15 |
| | B.H. Coord. : 1993523N, 472460 E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 9, 16) 25 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (12, 19, 24) 43 | | | Yellowish Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (10, 16, 22) 38 | | | Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.5 | | | | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (11, 17, 23) 40 | | | Brown Clay Silt with Gravels |
| 9.0 | | | | | | | Brown Clay Silt with Gravels |
| 9.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 10.5 | | | | | | | Brown Clay Silt with Gravels |
| 11.0 | | | SPT | (15, 25, 38) 63 | | | Brown Clay Silt with Gravels |
| 12.0 | | | | | | | Brown Clay Silt with Gravels |
| 13.0 | | | | | | | Brown Clay Silt with Gravels |
| 14.0 | 15.0 | - | SPT | 114/28 cm | | | Red Highly Weathered Rock (Shale) |
| 15.0 | | - | SPT | 114/27 cm | | | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No. : 22** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.46 m | Term. Depth (m): 25 |
| | B.H. Coord. : 1993325 N, 471956 E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Sandy Clay Silt |
| 1.0 | | | SPT | (2, 4, 6) 10 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (2, 4, 7) 11 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (8, 11, 19) 30 | | | Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.5 | | | | | | | Brownish Red Clay Silt with Gravels |
| 8.0 | | | SPT | (13, 31, 52) 83 | | | Red Clay Silt with Gravels |
| 9.0 | | | | | | | Red Clay Silt with Gravels |
| 9.5 | | | UDS | | | | Red Clay Silt with Gravels |
| 10.5 | | | | | | | Red Clay Silt with Gravels |
| 11.0 | 12.5 | - | SPT | 118/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.5 | 14.0 | - | SPT | 118/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | - | SPT | 110/22 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.5 | 17.0 | 60 | | | 19 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | 80 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 90 | | | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 23.0 | 95 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.0 | 25.0 | - | SPT | 88/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 25.0 | | - | SPT | 87/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 23** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 65.96 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1992983N, 472819E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 7, 10) 17 | | | Yellowish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Reddish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (7, 10, 14) 24 | | | Reddish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Reddish Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Reddish Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (15, 25, 34) 59 | | | Reddish Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Reddish Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Reddish Brown Clay Silt with |
| 7.5 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (11, 20, 28) 48 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | UDS | | | | Brown Clay Silt |
| 11.0 | | | SPT | (11, 19, 29) 48 | | | Red Clay Silt |
| 12.0 | | | | | | | Red Clay Silt |
| 13.0 | | | | | | | Red Clay Silt |
| 14.0 | | | SPT | (27, 32, 45) 77 | | | Red Clay Silt |
| 15.0 | | | | | | | Red Clay Silt |
| 15.5 | 17.0 | 100 | | | 36 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | 115 | | | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 110 | | | 32 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 24** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 71.88 m | Term. Depth (m): 13 |
| | B.H. Coord. :1992839N, 472593E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Reddish Brown Clay Silt |
| 1.0 | | | SPT | (5, 8, 11)<br>19 | | | Reddish Brown Clay Silt |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (17, 40, 53)<br>83 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | 119/30 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 55 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | 65 | SPT | 108/20 cm | 15 | 0 | Brownish Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.5 | 60 | | | 17 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | 70 | | | 21 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | | - | SPT | 110/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

# Field Borelog

| | | | |
|---|---|---|---|
| Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | | **B.H.No. : 25** |
| Location: CHP/AHP Area | Red. Lev. (m): 68.88 m | | Term. Depth (m): 13 |
| B.H. Coord. : 1993093N, 472460E | | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Red Clay Silt with Gravels |
| 1.0 | | | SPT | (6, 13, 18) 31 | | | Red Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 2.5 | | | | | | | Red Clay Silt with Gravels |
| 3.0 | 3.5 | - | SPT | 78/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 3.5 | 4.0 | 40 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.0 | 4.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.5 | 5.0 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.0 | - | SPT | 100/21 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 75 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | SPT | 74/14 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 95/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 123/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | SPT | 100/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | 100 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | | - | SPT | 100/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

# Field Borelog

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 26 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.95 m | Term. Depth (m): 13 |
| | B.H. Coord. : 1993255N, 472375E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Red Clay Silt with Gravels |
| 1.0 | | | SPT | (7, 9, 13) 22 | | | Red Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (11, 18, 27) 45 | | | Red Clay Silt with Gravels |
| 3.5 | | 30 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.0 | | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.5 | | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | | - | SPT | (15, 18, 26) 44 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | 90 | | | 49 | 0 | Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 100 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | N > 100 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | SPT | 95/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | | - | SPT | 90/14 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 27** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.40 m | Term. Depth (m): 10 |
| | B.H. Coord. : 19930781N, 472649E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (7, 11, 18) 29 | | | Reddish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 10, 23) 33 | | | Red Clay Silt with Gravels |
| 3.5 | | | | | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | | | SPT | (10, 17, 33) 48 | | | Red Clay Silt with Gravels |
| 6.0 | | 60 | | | | | Red Clay Silt with Gravels |
| 6.5 | 7.0 | - | SPT | 93/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.0 | 8.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 100/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | | - | SPT | 87/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 28 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.10 m | Term. Depth (m): 13 |
| | B.H. Coord. : 1992897N, 472704E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 8, 13) 21 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 3.0 | | | SPT | (14, 25, 37) 62 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | | | SPT | (16, 29, 45) 74 | | | Red Clay Silt with Gravels |
| 6.0 | | | | | | | Red Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Greyish Red Clay Silt with Gravels |
| 7.0 | | | | | | | Red Sandy Clay Silt |
| 8.0 | 9.0 | - | SPT | 95/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 55 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 50 | SPT | 108/13 cm | 28 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 55 | | | 35 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 12.5 | 13.0 | 25 | | | 15 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 13.0 | | - | | | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658 (9)

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 29** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.48 m | Term. Depth (m): 13 |
| | B.H. Coord. : 1993149N, 472521E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 9, 11) 20 | | | Brownish Red Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Reddish Brown Clay Silt with Gravels |
| 3.0 | 3.5 | | SPT | 100/36 cm | | | Red Highly Weathered Rock (Shale) |
| 3.5 | 4.0 | 30 | | | | | Red Highly Weathered Rock (Shale) |
| 4.0 | 4.5 | - | UDS | | | | Red Highly Weathered Rock (Shale) |
| 4.5 | 5.0 | 60 | | | 96 | 0 | Red Moderately Weathered Rock (Shale) |
| 5.0 | 6.5 | 70 | | | 29 | 0 | Red Moderately Weathered Rock (Shale) |
| 6.5 | 7.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.0 | 8.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 81/22 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 106/19cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 13.0 | - | SPT | 70/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | | - | SPT | 80/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 30** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.25 m | Term. Depth (m):13 |
| | B.H. Coord. : 1993311N, 472485E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 5,6) 11 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brownish Red Clay Silt with Gravels |
| 3.0 | 3.5 | | SPT | (2, 2, 6) 8 | | | Red Clay Silt with Gravels |
| 3.5 | 4.0 | | | | 0 | 0 | Red Clay Silt with Gravels |
| 4.0 | 4.5 | | UDS | | 0 | 0 | Red Clay Silt with Gravels |
| 4.5 | 5.0 | | | | 0 | 0 | Red Clay Silt with Gravels |
| 5.0 | 6.0 | | SPT | (2, 4, 7) 11 | 0 | 0 | Red Clay Silt with Gravels |
| 6.0 | 6.5 | | | | 0 | 0 | Red Clay Silt with Gravels |
| 6.5 | 7.5 | - | UDS | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 37 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 128/33cm | 0 | 0 | Yellowish Grey Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 50 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 11.0 | 65 | SPT | 101/25 cm | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 13.0 | - | | | 19 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 31 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 65.25 m | Term. Depth (m): 17 |
| | B.H. Coord. : 1993062N, 472903E | | Water Table (m): Nil |

| Drill Run (m) From | To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 7, 11) 18 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (6, 11, 14) 25 | | | Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (9, 12, 20) 32 | | | Brown Clay Silt |
| 6.0 | | | | | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt |
| 7.0 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (12, 25, 36) 61 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | UDS | | | | Brown Clay Silt |
| 10.5 | | | | | | | Brown Clay Silt |
| 11.0 | | | SPT | (10, 16, 14) 30 | | | Brown Clay Silt |
| 13.0 | | | | | | | Brown Clay Silt |
| 14.0 | | | SPT | (23, 41, 56) 97 | | | Brown Clay Silt |
| 16.0 | 17.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | | - | SPT | 103/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 32** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 64.30 m | Term. Depth (m): 30 |
| | B.H. Coord. :1993054N, 472887E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt |
| 1.0 | | | SPT | (9, 14, 20) 34 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (13, 19, 24) 43 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt |
| 5.0 | | | SPT | (14, 26, 37) 63 | | | Brown Clay Silt |
| 6.0 | | | | | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (16, 29, 37) 66 | | | Brown Clay Silt with Gravels |
| 9.0 | | | | | | | Brown Sandy Clay Silt |
| 9.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 10.0 | | | | | | | Brown Clay Silt with Gravels |
| 10.5 | | | | | | | Brown Clay Silt with Gravels |
| 11.0 | | | SPT | (13, 19, 31) 50 | | | Greyish Brown Clay Silt |
| 12.0 | | | | | | | Brown Clay Silt |
| 13.0 | | | | | | | Brown Clay Silt |
| 14.0 | | | UDS | | | | Brown Clay Silt |
| 15.0 | | | | | | | Brown Clay Silt |
| 16.0 | | | | | | | Brown Clay Silt |
| 17.0 | 18.0 | - | SPT | 110/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 19.0 | 120 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 120 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 21.0 | - | SPT | 90/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 21.0 | 22.0 | 120 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No. : 32** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 64.30 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993054N, 472887E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 22.0 | 23.0 | 130 | SPT | 98/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 26.0 | - | SPT | 107/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 26.0 | 29.0 | - | SPT | 80/5 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 29.0 | 30.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 33 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.45 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993405N, 472664E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt |
| 1.0 | | | SPT | (4, 6, 9) 15 | | | Dark Brown Clay Silt |
| 2.0 | | | UDS | | | | Brown Clay Silt |
| 3.0 | | | SPT | (5, 8, 15) 13 | | | Brown Clay Silt |
| 4.0 | | | UDS | | | | Brown Clay Silt |
| 5.0 | | | SPT | (10, 20, 25) 45 | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt |
| 8.0 | | | SPT | (7, 18, 28) 46 | | | Brown Clay Silt |
| 9.5 | | | SPT | (9, 14, 22) 36 | | | Brown Clay Silt |
| 11.0 | | | SPT | (11, 14, 22) 36 | | | Brown Clay Silt with Gravels |
| 13.0 | | | | | | | Brown Clay Silt with Gravels |
| 14.0 | | | SPT | (13, 21, 40) 61 | | | Brown Clay Silt with Gravels |
| 16.0 | | | | | | | Brown Clay Silt with Gravels |
| 17.0 | 19.0 | - | SPT | 112/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 145 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 21.5 | 70 | SPT | 97/13 cm | 19 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 80 | | | 15 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 23.0 | 24.5 | 75 | | | 17 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 85 | | | 15 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.5 | 65 | | | 21 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 29.0 | 30.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 30.0 | | - | SPT | 95/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658 (9)

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 34 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.10 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993265N, 472740E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 4, 6) 10 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Dark Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 6, 9) 15 | | | Dark Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brownish Red Clay Silt |
| 4.5 | | | | | | | Reddish Brown Clay Silt |
| 5.0 | | | SPT | (4, 7, 11) 18 | | | Reddish Brown Clay Silt |
| 6.0 | | | | | | | Reddish Brown Clay Silt |
| 6.5 | | | UDS | | | | Reddish Brown Clay Silt |
| 7.5 | | | | | | | Reddish Brown Clay Silt |
| 8.0 | | | SPT | (5, 7, 13) 20 | | | Reddish Brown Clay Silt |
| 9.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 9.5 | | | SPT | (5, 9, 14) 23 | | | Brown Sandy Clay Silt with Gravels |
| 11.0 | | | SPT | (6, 10, 13) 23 | | | Brown Sandy Clay Silt with Gravels |
| 12.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 13.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 14.0 | | | SPT | (6, 10, 19) 29 | | | Brown Sandy Clay Silt with Gravels |
| 17.0 | 18.5 | 88 | SPT | 91/19 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 100 | | | 19 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 110 | | | 19 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 125 | | | 17 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 23.0 | 24.5 | 120 | | | 25 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 24.5 | 25.0 | - | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 34 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.10 | Term. Depth (m): 30 |
| | B.H. Coord. : : 1993265N, 472740E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 25.0 | 26.0 | 125 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 26.0 | 28.5 | - | SPT | 99/18 cm | 10 | 0 | Red Moderately Weathered Rock (Shale) |
| 28.5 | 30.0 | - | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 30.0 | | | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 35** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.20 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993126N, 472812E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 6, 8) 14 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Dark Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 5, 7) 12 | | | Brown Clay Silt |
| 4.0 | | | UDS | | | | Brown Clay Silt |
| 4.5 | | | | | | | Brown Clay Silt |
| 5.0 | | | SPT | (2, 5, 9) 14 | | | Brown Clay Silt |
| 6.0 | | | | | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt |
| 7.5 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (4, 9, 13) 22 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | UDS | | | | Brown Clay Silt |
| 10.0 | | | | | | | Brown Clay Silt |
| 10.5 | | | | | | | Brown Clay Silt |
| 11.0 | | | SPT | (5, 10, 15) 25 | | | Brown Sandy Clay Silt |
| 12.0 | | | | | | | Brown Sandy Clay Silt |
| 13.0 | | | | | | | Brown Sandy Clay Silt |
| 14.0 | | | SPT | (5, 10, 19) 29 | | | Brown Clay Silt with Gravels |
| 15.0 | | | | | | | Brown Clay Silt with Gravels |
| 16.0 | | | | | | | Brown Clay Silt with Gravels |
| 17.0 | 18.0 | 180 | SPT | 99/ 19 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 19.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 35** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.20 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993126N, 472812E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 19.0 | 22.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 22.0 | 23.0 | 110 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 24.5 | 115 | SPT | 90/11 cm | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 115 | | | 21 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.5 | 120 | | | 17 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | 80 | | | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | | | | 20 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 36** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 64.78 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993303N, 472645 E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 8, 11) 19 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 10, 17) 27 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | | | | Brown Clay Silt |
| 6.0 | | | | (8, 14, 22) 36 | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt |
| 7.0 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (9, 16, 23) 39 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | SPT | (15, 26, 36) 62 | | | Brown Clay Silt |
| 10.0 | | | | | | | Brown Clay Silt |
| 11.0 | | | SPT | (12, 22, 29) 51 | | | Brown Clay Silt |
| 13.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 14.0 | | | SPT | (23, 41, 56) 97 | | | Brown Sandy Clay Silt with Gravels |
| 16.0 | 17.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.5 | 95 | SPT | 103/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.5 | 20.0 | 85 | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 90 | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 80 | | | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.0 | 24.5 | 75 | | | 29 | 0 | Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 85 | | | 23 | 0 | Red Moderately Weathered Rock |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 36** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 64.78 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993303N, 472645 E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 26.0 | 27.5 | 80 | | | 24 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | 85 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | - | | | 28 | 0 | Red Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 37 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.13 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993008N, 472802E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (11, 12, 18) 30 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brownish Red Clay Silt with Gravels |
| 3.0 | | | SPT | 116/34 cm | | | Red Clay Silt with Gravels |
| 3.5 | | | | | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | | | SPT | (16, 37, 55) 92 | | | Red Clay Silt with Gravels |
| 6.0 | | | | | | | Red Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Red Clay Silt with Gravels |
| 7.0 | | | | | | | Red Clay Silt with Gravels |
| 8.0 | | | SPT | (13, 19, 33) 52 | | | Red Clay Silt with Gravels |
| 9.0 | | | | | | | Red Clay Silt with Gravels |
| 9.5 | | | SPT | (22, 33, 45) 78 | | | Red Clay Silt with Gravels |
| 10.5 | | | | | | | Red Clay Silt with Gravels |
| 11.0 | | | SPT | (24, 35, 48) 83 | | | Red Clay Silt with Gravels |
| 14.0 | 16.0 | - | SPT | 107/20 cm | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 130 | | | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 17.0 | 18.0 | 130 | SPT | 90/10 cm | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 18.0 | 19.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 23.0 | - | SPT | 103/11 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 26.0 | - | SPT | 105/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 26.0 | 29.0 | - | SPT | 100/ 8 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 29.0 | 30.0 | - | SPT | 80/ 5 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 38** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.25 m | Term. Depth (m): 15 |
| | B.H. Coord. : 1993204N, 472698E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (6, 9, 12) 21 | | | Yellowish Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (7, 15, 25) 40 | | | Brown Clay Silt |
| 3.5 | | | | | | | Brown Clay Silt |
| 4.0 | | | UDS | | | | Brown Clay Silt |
| 4.5 | | | | | | | Brown Clay Silt |
| 5.0 | | | SPT | (8, 15, 20) 33 | | | Brown Clay Silt |
| 6.0 | | | | | | | Brown Clay Silt |
| 6.5 | | | UDS | | | | Brown Clay Silt |
| 7.5 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (9, 12, 16) 28 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | SPT | (9, 17, 28) 45 | | | Brown Clay Silt |
| 10.0 | | | | | | | Brown Clay Silt |
| 11.0 | | | SPT | (16, 30, 34) 64 | | | Brown Clay Silt |
| 12.5 | | | SPT | (11, 17, 33) 50 | | | Brown Clay Silt |
| 15.0 | | | SPT | (25, 37, 47) 84 | | | Brown Clay Silt |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 39** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.35 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993034N, 472645E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (7, 13, 16)<br>29 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (5, 8, 12)<br>20 | | | Yellowish Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (7, 12. 25)<br>37 | | | Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.5 | | | | | | | Brown Clay Silt |
| 8.0 | | | SPT | (14, 22, 33)<br>55 | | | Brown Clay Silt |
| 9.0 | | | | | | | Brown Clay Silt |
| 9.5 | | | UDS | | | | Brown Clay Silt |
| 10.0 | | | | | | | Brown Clay Silt |
| 11.0 | | | SPT | (15, 24, 33)<br>57 | | | Brown Clay Silt |
| 12.0 | | | | | | | Brown Clay Silt |
| 13.0 | | | | | | | Brown Clay Silt |
| 14.0 | | | SPT | (15, 28, 50)<br>78 | | | Brown Clay Silt |
| 17.0 | 18.0 | - | SPT | 55/6 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 18.5 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.5 | 20.0 | - | | | 26 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 40** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.70 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993414N, 472586E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 5, 8) 13 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (5, 8, 13) 21 | | | Greyish Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Greyish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Greyish Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Greyish Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (7, 12, 25) 39 | | | Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.5 | | | | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (10, 14, 21) 35 | | | Greyish Brown Clay Silt |
| 9.0 | | | | | | | Greyish Brown Clay Silt |
| 9.5 | | | UDS | | | | Greyish Brown Clay Silt |
| 10.0 | | | | | | | Greyish Brown Clay Silt |
| 11.0 | | | SPT | (9, 21, 30) 51 | | | Greyish Brown Clay Silt |
| 12.0 | | | | | | | Greyish Brown Clay Silt |
| 13.0 | | | | | | | Greyish Brown Clay Silt |
| 14.0 | | | SPT | 93/23 cm | | | Greyish Brown Clay Silt |
| 16.0 | | | | | | | Greyish Brown Clay Silt |
| 17.0 | 18.5 | 90 | SPT | 106/20 cm | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 85 | | | 27 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 41** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 62.50 m | Term. Depth (m): 30 |
| | B.H. Coord. :1993515N, 472512 E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 4, 6) 10 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 3.0 | | | SPT | (8, 13, 17) 30 | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 5.0 | | | SPT | (10, 23, 37) 60 | | | Brown Sandy Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 7.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 8.0 | | | SPT | (6, 16, 22) 38 | | | Brown Sandy Clay Silt with Gravels |
| 9.5 | | | SPT | (19, 28, 40) 63 | | | Brownish Red Sandy Clay Silt with Gravels |
| 10.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 11.0 | 13.0 | 95 | SPT | 125/38 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | 125 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | 70 | SPT | 108/28 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.5 | 17.0 | 65 | | | 24 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 17.0 | 19.0 | - | | | 25 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 19.0 | 20.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 21.5 | - | SPT | 89/15 cm | 14 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | - | | | 0 | 0 | Reddish Grey Highly Weathered Rock (Shale) |
| 23.0 | 26.0 | - | SPT | 55/8cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 26.0 | 27.5 | 65 | SPT | 84/10cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.5 | 30.0 | 140 | | | 20 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No. : 42** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 65.70 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993563N, 472527 E | | Water Table (m): Nil |

| Drill Run (m) From | To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (17, 23, 26) 49 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 3.0 | | | SPT | (9, 17, 23) 40 | | | Yellowish Brown Sandy Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 5.0 | | | SPT | (5, 16, 23) 39 | | | Brown Sandy Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 7.5 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 8.0 | | | SPT | (10, 15, 21) 38 | | | Brown Sandy Clay Silt with Gravels |
| 9.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 9.5 | | | UDS | | | | Brownish Red Sandy Clay Silt with Gravels |
| 10.5 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 11.0 | | | SPT | (12, 23, 29) 52 | | | Reddish Clay Silt with Gravels |
| 13.0 | | | | | | | Brownish Red Clay Silt with Gravels |
| 14.0 | 15.5 | 115 | SPT | (10, 17, 22) 39 | | | Brownish Red Clay Silt with Gravels |
| 15.5 | 17.0 | - | | | 25 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.0 | 105 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 18.0 | 18.5 | 110 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.5 | 20.0 | 120 | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | | | | 21 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 42** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 65.70 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993563N, 472527 E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 21.5 | 23.0 | 125 | | | 20 | 0 | Red Moderately Weathered Rock (Shale) |
| 23.0 | 24.5 | 135 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 140 | | | 27 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |
| 26.0 | 27.0 | - | | | 0 | 0 | Reddish Grey Higly Weathered Rock (Shale) |
| 27.0 | 28.0 | - | | | 0 | 0 | Reddish Grey Higly Weathered Rock (Shale) |
| 28.0 | 29.0 | 245 | | | 0 | 0 | Reddish Grey Higly Weathered Rock (Shale) |
| 29.0 | 30.0 | 60 | SPT | 55/5 cm | 30 | 0 | Reddish Grey Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 43 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 66.40 m | Term. Depth (m): 23 |
| | B.H. Coord. : 1993475N, 472398 E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Sandy Clay |
| 1.0 | | | SPT | (5, 7, 12) 19 | | | Brown Sandy Clay Silt |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (6, 11, 13) 24 | | | Yellowish Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (6, 12, 18) 30 | | | Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 7.0 | | | | | | | Brown Clay Silt with Gravels |
| 8.0 | | | SPT | (10, 14, 21) 35 | | | Brown Clay Silt with Gravels |
| 9.0 | | | | | | | Brown Clay Silt with Gravels |
| 9.5 | | | UDS | | | | Brown Clay Silt with Gravels |
| 10.5 | | | | | | | Brown Clay Silt with Gravels |
| 11.0 | 13.0 | - | SPT | 102/20 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 17.0 | 135 | SPT | 65/8 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 20.0 | - | SPT | 50/5 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 21.0 | - | SPT | 65/8 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 21.0 | 23.0 | - | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 44** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.15 m | Term. Depth (m): 23 |
| | B.H. Coord. : 1993417N, 472290 E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (6, 6, 10) 16 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (4, 6, 9) 15 | | | Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Brownish Red Sandy Clay |
| 4.0 | | | UDS | | | | Brownish Red Sandy Clay |
| 4.5 | | | | | | | Brownish Red Sandy Clay |
| 5.0 | | | SPT | (8, 16, 24) 40 | | | Brownish Red Sandy Clay |
| 6.0 | | | | | | | Brownish Red Sandy Clay |
| 6.5 | | | UDS | | | | Brownish Red Sandy Clay |
| 7.5 | | | | | | | Brownish Red Sandy Clay |
| 8.0 | | - | SPT | (8, 21, 31) 52 | | | Greyish Red Highly Weathered Rock (Shale) |
| 9.5 | | - | SPT | (18, 22, 27) 54 | | | Greyish Red Highly Weathered Rock (Shale) |
| 11.0 | | 80 | SPT | 120/41 cm | | | Red Highly Weathered Rock (Shale) |
| 12.5 | | - | | | | | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | 140 | SPT | 91/19 cm | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 120 | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | 100 | | | 21 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 140 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 120 | | | 29 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 100 | | | 65 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 45** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.05 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993413N 472193E | | Water Table (m): Nil |

| Drill Run (m) From | To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 6, 8) 14 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (11, 21, 28) 49 | | | Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (7, 12, 18) 30 | | | Yellowish Brown Clay Silt with Gravels |
| 6.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 7.5 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 8.0 | | | SPT | (10, 15, 21) 36 | | | Brown Sandy Clay Silt with Gravels |
| 9.0 | | - | | | 0 | 0 | Reddish Brown Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | 75 | UDS | | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | - | | | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 11.0 | 13.0 | 70 | SPT | 99/20cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | 170 | SPT | 83/9cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 17.0 | 95 | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | - | | | 13 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 19.0 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | | | SPT | 60 | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 46** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.50 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993413 N, 471993 E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 3, 4) 7 | | | Dark Brown Clay Silt with Gravel |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravel |
| 3.0 | | | SPT | (2, 4, 7) 11 | | | Brown Clay Silt with Gravel |
| 4.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravel |
| 4.5 | | | | | | | Brown Clay Silt with Gravel |
| 5.0 | | | SPT | (8, 14, 24) 38 | | | Red Clay Silt |
| 6.0 | | | | | | | Red Clay Silt |
| 6.5 | | | UDS | | | | Red Clay Silt |
| 7.0 | | | | | | | Red Clay Silt |
| 8.0 | 9.0 | | SPT | 100/23 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | | SPT | 94/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | 11.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | | SPT | 102/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 13.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 13.0 | 14.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.5 | | SPT | 65/8 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.5 | 17.0 | | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | | | | 27 | 0 | Red Moderately Weathered Rock (Shale) |
| 18.5 | 19.0 | | | | 17 | 0 | Red Moderately Weathered Rock (Shale) |
| 19.0 | 20.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 46 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.50 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993188N 472044E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 20.0 | 21.0 | - | SPT | 83/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 21.0 | 22.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 22.0 | 23.0 | 170 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 23.0 | 24.5 | - | SPT | 92/13 cm | 25 | 0 | Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 65 | | | 28 | 0 | Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.5 | 70 | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | 75 | | | 16 | 0 | Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | 65 | | | 17 | 0 | Red Moderately Weathered Rock (Shale) |

| Field Borelog | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | B.H.No.: 47 |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.81 m | Term. Depth (m): 20 |
| | B.H. Coord. : 1993072N 472054E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 5, 12) 17 | | | Brown Clay Silt with Gravel |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravel |
| 3.0 | | | SPT | (15, 29, 88) 98 | | | Greyish / Whitish Brown Clay Silt with Gravels |
| 3.5 | | | | | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | | | | | | Red Clay Silt with Gravels |
| 5.0 | 6.0 | - | SPT | (20, 28, 60) 88 | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 65 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 103/20cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 110/18cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | 90 | SPT | 90/14cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 14.0 | 120 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | 80 | | | 32 | 0 | Red Moderately Weathered Rock (Shale) |
| 15.0 | 16.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 90 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.0 | - | SPT | 90/11cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 20.0 | 100 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 48** |
|---|---|---|---|
| | Location:CHP/AHP Area | Red. Lev. (m): 67.00 m | Term. Depth (m): 10 |
| | B.H. Coord. : 1993285N, 472542E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 5, 10)<br>12 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with gravels |
| 3.0 | | | SPT | (5, 6, 10)<br>16 | | | Brownish Red Clay Silt with Gravels |
| 3.5 | | | | | | | Brownish Red Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brownish Red Sandy Clay Silt with Gravels |
| 4.5 | | | | | | | Greyish Red Sandy Clay Silt |
| 5.0 | | | SPT | (7, 11,14)<br>25 | | | Greyish Red Sandy Clay Silt |
| 6.0 | | | | | | | Brownish Red Sandy Clay Silt |
| 6.5 | | | UDS | | | | Red Sandy Clay Silt |
| 7.5 | | | | | | | Red Sandy Clay Silt |
| 8.0 | | | SPT | (7, 10, 17)<br>27 | | | Red Sandy Clay Silt |
| 9.0 | | | | | | | Red Sandy Clay Silt |
| 10.0 | | | SPT | (9, 13, 20)<br>33 | | | Red Sandy Clay Silt |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 49** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.94 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993177N, 471993E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 3, 4) 7 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (18, 24, 26) 50 | | | Whitish Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brownish White Clay Silt |
| 5.0 | | | SPT | (7, 14, 25) 39 | | | Brownish White Sandy Clay Silt |
| 6.0 | | | | | | | Brown Sandy Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Brown Sandy Clay Silt with Gravels |
| 7.5 | | | | | | | Brownish Red Clay Silt |
| 8.0 | 9.0 | - | SPT | 136/41 cm | 0 | 0 | Brownish White Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 60 | | | 0 | 0 | Brownish Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 89/25 cm | 0 | 0 | Brownish White Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 60 | | | 0 | 0 | Whitish Brown Highly Weathered Rock (Shale) |
| 11.0 | 12.0 | - | SPT | 112/25 cm | 0 | 0 | Brownish / Greyish White Highly Weathered Rock (Shale) |
| 12.0 | 14.0 | - | | | 32 | 0 | Whitish Brown Moderately Weathered Rock (Shale) |
| 14.0 | 15.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 17.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 18.0 | - | SPT | 90/14 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 18.0 | 19.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 120 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 20.0 | 21.5 | 130 | SPT | 88/10 cm | 31 | 0 | Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 140 | | | 22 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 49** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.94 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993177N, 471993E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 23.0 | 24.5 | 140 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 150 | | | 18 | 0 | Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.5 | 150 | | | 13 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | 140 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 29.0 | 30.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 30.0 | | - | SPT | 100/10 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 50** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.57 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993271N, 471993E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (3, 5, 7) 12 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Reddish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (3, 4, 6) 10 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 4.5 | | | | | | | Brown Silty Clay with Gravels |
| 5.0 | 6.0 | | SPT | (19, 33, 50) 83 | | | Brown Silty Clay with Gravels |
| 6.0 | 6.5 | | | | | | Brown Silty Clay with Gravels |
| 6.5 | 7.5 | | UDS | | | | Red Silty Clay with Gravels |
| 7.5 | 8.0 | | | | | | Brownish Red Silty Clay with Gravels |
| 8.0 | 9.0 | - | SPT | 119/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | SPT | 120/20 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 70 | | | 44 | 0 | Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 12.0 | 14.0 | 120 | | | 29 | 0 | Yellowish /Whitish Grey Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 120 | | | 47 | 0 | Yellowish /Whitish Grey Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 120 | | | 35 | 0 | Yellowish /Whitish Grey Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | 130 | | | 55 | 0 | Yellowish /Whitish Grey Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 130 | | | 35 | 0 | Yellowish /Whitish Grey Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 140 | | | 35 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 140 | | | 12 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 50** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.57 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993271N, 471993E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 23.0 | 24.5 | 140 | | | 17 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 150 | | | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.5 | - | | | 21 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 27.5 | 29.0 | - | | | 28 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | - | | | 25 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 51** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.60 m | Term. Depth (m): 30 |
| | B.H. Coord. : 1993076N 471993E | | Water Table (m): Nil |

| Drill Run (m) From | Drill Run (m) To | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (2, 4, 6) 10 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Yellowish Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (3, 6, 6) 12 | | | Red Clay Silt |
| 4.0 | | | UDS | | | | Red Clay Silt with Gravels |
| 4.5 | | 40 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.0 | - | SPT | 123 | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 65 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 102/20 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 9.5 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.5 | 11.0 | 70 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 11.0 | 14.0 | - | SPT | 80/14 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 14.0 | 15.0 | 90 | SPT | 98/13 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 15.0 | 16.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 16.0 | 17.0 | 105 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 17.0 | 19.0 | - | SPT | 85/14 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 19.0 | 20.0 | 120 | | | 37 | 0 | Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 21.0 | 23.0 | - | | | 0 | 0 | Red Highly Weathered Rock |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 51** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 70.60 m | Term. Depth (m): 30 |
| | B.H. Coord. :1993076N 471993E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 23.0 | 24.5 | 130 | | | 88 | 0 | Red Moderately Weathered Rock (Shale) |
| 24.5 | 26.0 | 120 | | | 42 | 0 | Red Moderately Weathered Rock (Shale) |
| 26.0 | 27.0 | 130 | | | 50 | 0 | Red Moderately Weathered Rock (Shale) |
| 27.0 | 29.0 | 140 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 29.0 | 30.0 | - | | | 32 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 52** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.50 m | Term. Depth (m): 25 |
| | B.H. Coord. : 1993312N, 472279E | | Water Table (m): Nil |

| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (4, 5, 10) 15 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | | | SPT | (6, 9, 21) 30 | | | Brown Clay Silt with Gravels |
| 4.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 5.0 | | | SPT | (10, 15, 26) 41 | | | Brown Clay Silt with Gravels |
| 6.5 | | | UDS | | | | Red Sandy Clay Silt |
| 8.0 | 9.5 | 60 | SPT | 89/18 cm | 23 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 9.5 | 11.0 | 105 | | | 22 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 11.0 | 12.5 | 85 | | | 46 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 12.5 | 14.0 | 75 | | | 69 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 14.0 | 15.5 | 110 | | | 21 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 15.5 | 17.0 | 120 | | | 24 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 17.0 | 18.5 | 120 | | | 34 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 18.5 | 20.0 | 125 | | | 29 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 20.0 | 21.5 | 120 | | | 34 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 21.5 | 23.0 | 120 | | | 25 | 0 | Greyish Red Moderately Weathered Rock (Shale) |
| 23.0 | 25.0 | 150 | | | 31 | 0 | Greyish Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No. : 53** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 68.45 m | Term. Depth (m): 10 |
| | B.H. Coord. : 1993192N, 472366E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (7, 10, 16) 26 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Red Clay Silt with gravels |
| 3.0 | | | SPT | (30, 30, 65) 95 | | | Brownish Red Clay Silt with Gravels |
| 4.0 | 4.5 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.5 | 5.0 | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.5 | 70 | SPT | (101/20cm) | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.5 | 8.0 | 80 | | | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 8.0 | 9.5 | - | SPT | (100/14cm) | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.5 | 10.0 | - | SPT | (85/19cm) | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 54** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 71.94 m | Term. Depth (m): 10 |
| | B.H. Coord. : 1992985N, 472473E | | Water Table (m): Nil |

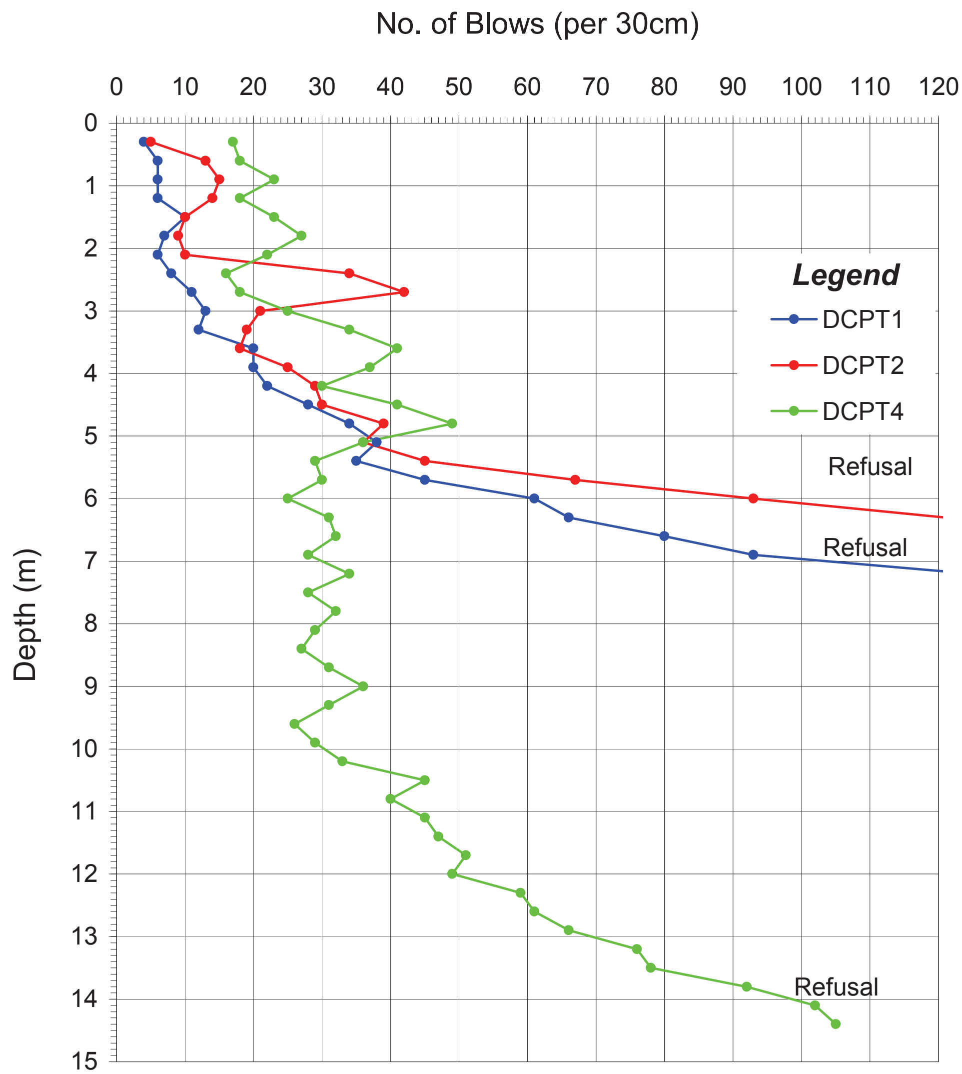
| **Drill Run (m)** | | **Drilling Time (min)** | **Sample Type** | **N-Value** | **Core Recovery (%)** | **RQD (%)** | **Strata Description** |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Yellowish Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (8, 11, 13) 24 | | | Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brown Clay Silt with Gravels |
| 3.0 | 3.5 | | SPT | 113/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 3.5 | 4.0 | 30 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.0 | 4.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.5 | 5.0 | 50 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.0 | - | SPT | 136/33 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | SPT | 138/27 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 70 | | | 23 | 0 | Red Moderately Weathered Rock (Shale) |
| 8.0 | 9.0 | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 10.0 | - | | | 50 | 0 | Red Moderately Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 55** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 67.36 m | Term. Depth (m): 10 |
| | B.H. Coord. : 1993237N, 472454E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| From | To | | | | | | |
| 0.0 | | | | | | | Dark Brown Clay Silt with Gravels |
| 1.0 | | | SPT | (5, 8, 10) 18 | | | Dark Brown Clay Silt with Gravels |
| 2.0 | | | UDS | | | | Brownish Red Clay Silt with Gravels |
| 3.0 | | | SPT | (30, 40, 35) 75 | | | Red Clay Silt with Gravels |
| 4.0 | | | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | | | SPT | 131/31 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 6.0 | | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | | | SPT | 114/28 cm | 0 | 0 | Greyish Red Highly Weathered Rock (Shale) |
| 7.5 | | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | | | SPT | 88/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | | | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 10.0 | | | SPT | 118/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |

| **Field Borelog** | Project: 4 x 270MW Thermal Power Plant at Manuguru, Telangana | | **B.H.No.: 56** |
|---|---|---|---|
| | Location: CHP/AHP Area | Red. Lev. (m): 69.20 m | Term. Depth (m): 10 |
| | B.H. Coord. : 1993030N, 472562E | | Water Table (m): Nil |

| Drill Run (m) | | Drilling Time (min) | Sample Type | N-Value | Core Recovery (%) | RQD (%) | Strata Description |
|---|---|---|---|---|---|---|---|
| **From** | **To** | | | | | | |
| 0.0 | | | | | | | Red Clay Silt |
| 1.0 | | | SPT | (8, 12, 15) 27 | | | Red Clay Silt |
| 2.0 | | | UDS | | | | Red Clay Silt |
| 3.0 | 3.5 | | SPT | (15, 28, 38) 46 | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 3.5 | 4.0 | 20 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.0 | 4.5 | - | UDS | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 4.5 | 5.0 | 30 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 5.0 | 6.0 | - | SPT | 77/18 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.0 | 6.5 | 60 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 6.5 | 7.5 | - | SPT | 101/25cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 7.5 | 8.0 | 80 | | | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 8.0 | 9.0 | - | SPT | 108/25 cm | 0 | 0 | Red Highly Weathered Rock (Shale) |
| 9.0 | 10.0 | 100 | | | 40 | 0 | Red Moderately Weathered Rock (Shale) |
| 10.0 | | - | | | 0 | 0 | Red Highly Weathered Rock (Shale) |




**Dynamic Cone Penetration Test Curves**


NAGADI

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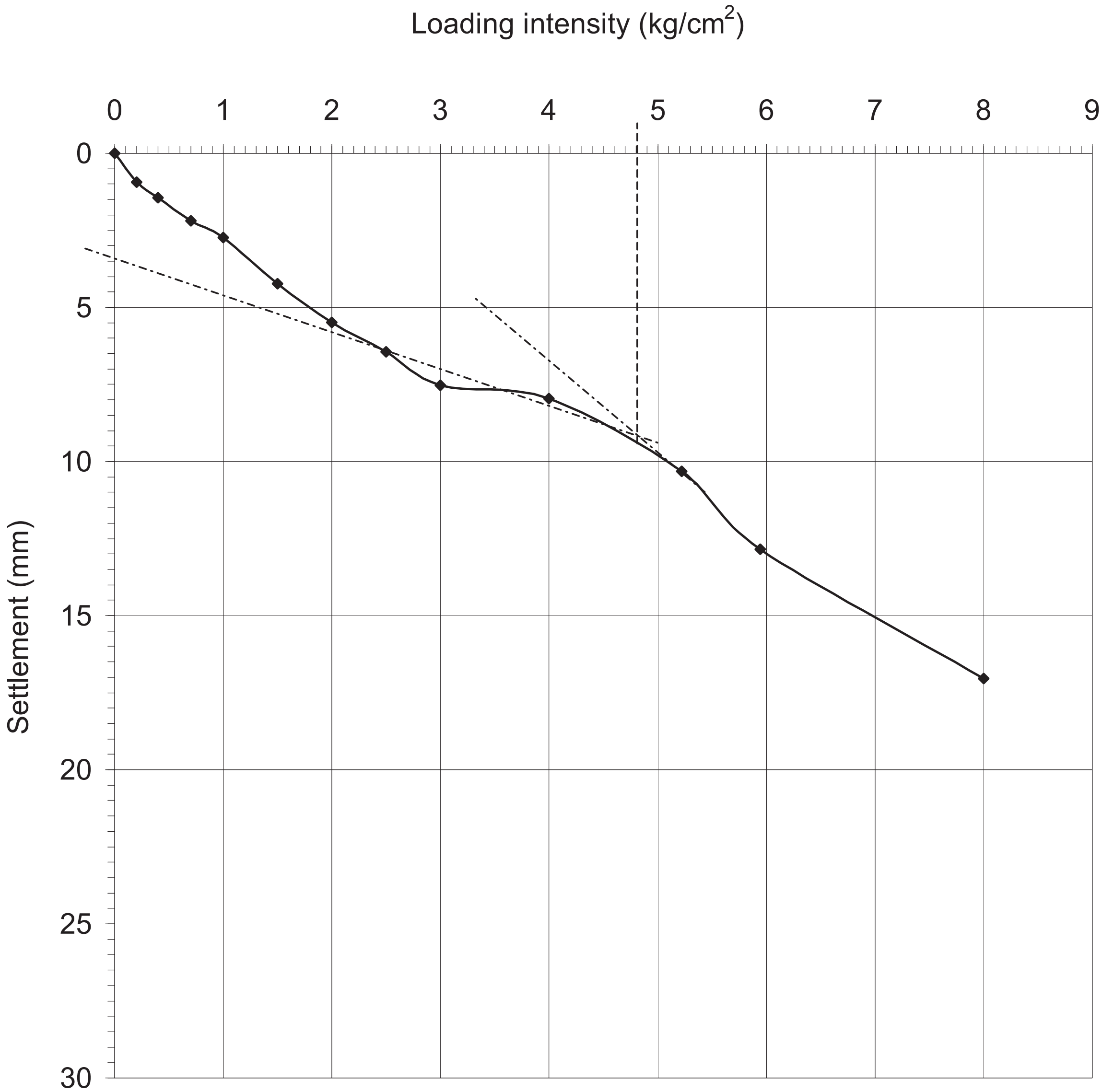
GEOTECHNICAL CONSULTANTS

| | | | |
|---|---|---|---|
| **Delhi** | : 011 (T) 26891980 | (F) 26897403 | delhi@nagadi.co.in |
| **Bangalore** | : 080 (T) 23156076 | (F) 23303007 | bangalore@nagadi.co.in |
| **Chennai** | : 044 (T) 24487870 | (F) 24488957 | chennai@nagadi.co.in |
| **Secunderabad** | : 040 (T) 27754446 | (F) 27751194 | secunderabad@nagadi.co.in |


Job No. : G(H) 1658(9)

*ltimate Bearing Capacity = 48 t/m $^2$*
*Safe Bearing Capacity = 48 / 2.5 = 19 t/m $^2$*

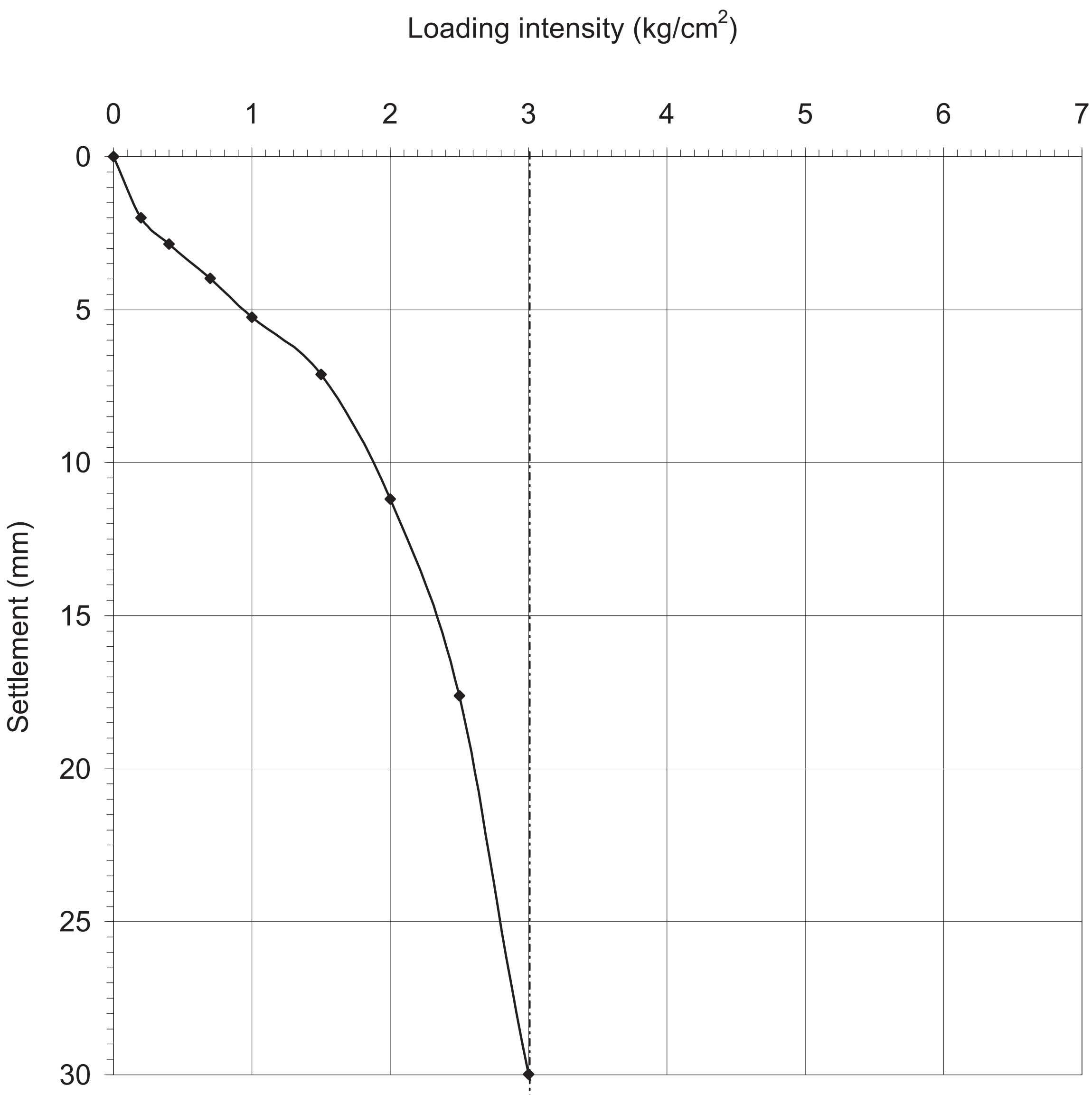



| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 8kg/cm $^2$ |
| Corresponding settlement | = | 17.05mm |
| Test condition | = | Saturated |

**Plate Load Test - IPLT1**

*ltimate Bearing Capacity  =  30 t/m$^2$*

*Safe Bearing Capacity  =  30 / 2.5  =  12t/m$^2$*



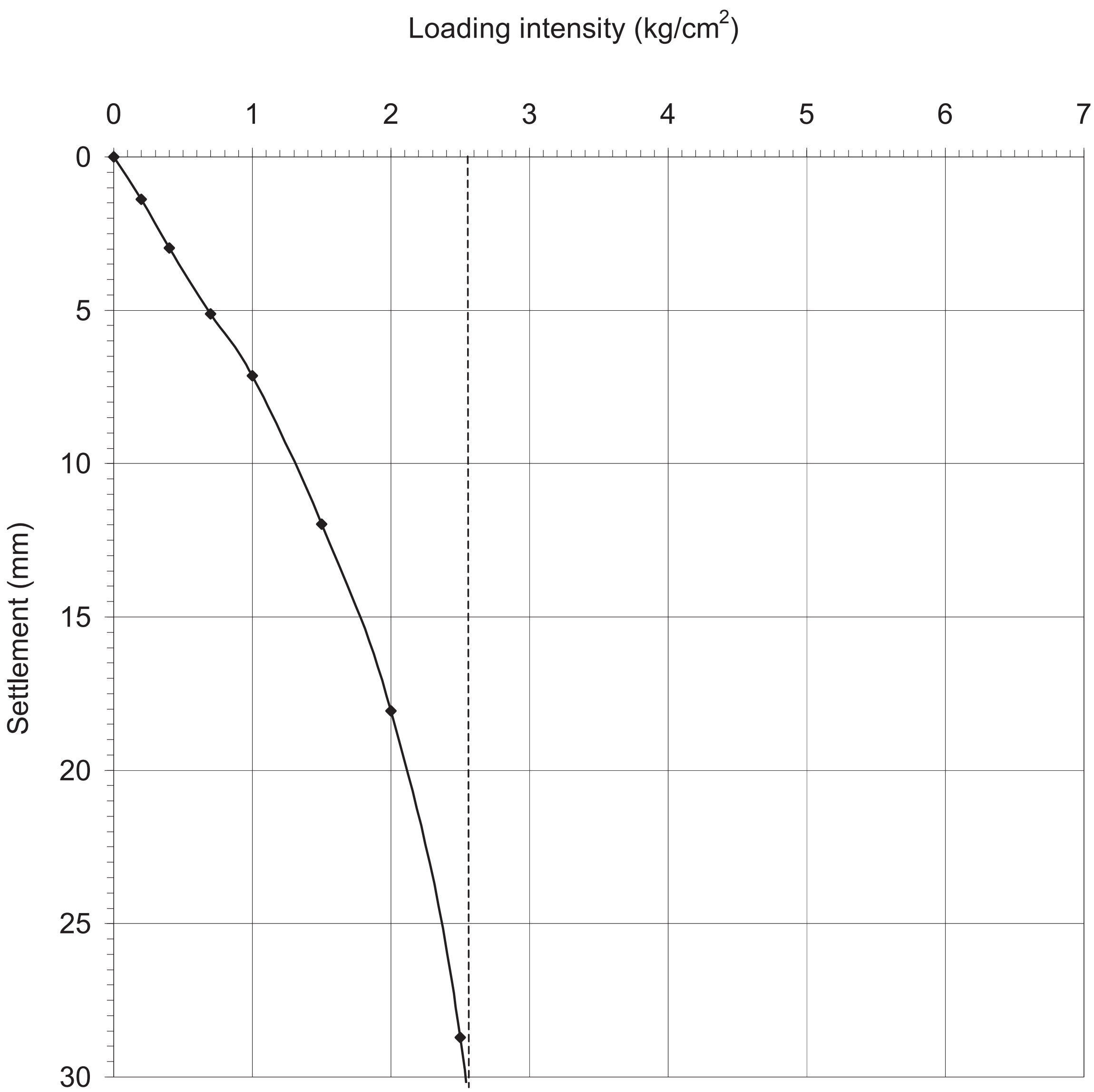

| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 4kg/cm$^2$ |
| Corresponding settlement | = | Load not |

sustained

**Plate Load Test - IPLT3**

*ltimate Bearing Capacity = 25 t/$m^2$*

*Safe Bearing Capacity = 25 / 2.5 = 10t/$m^2$*

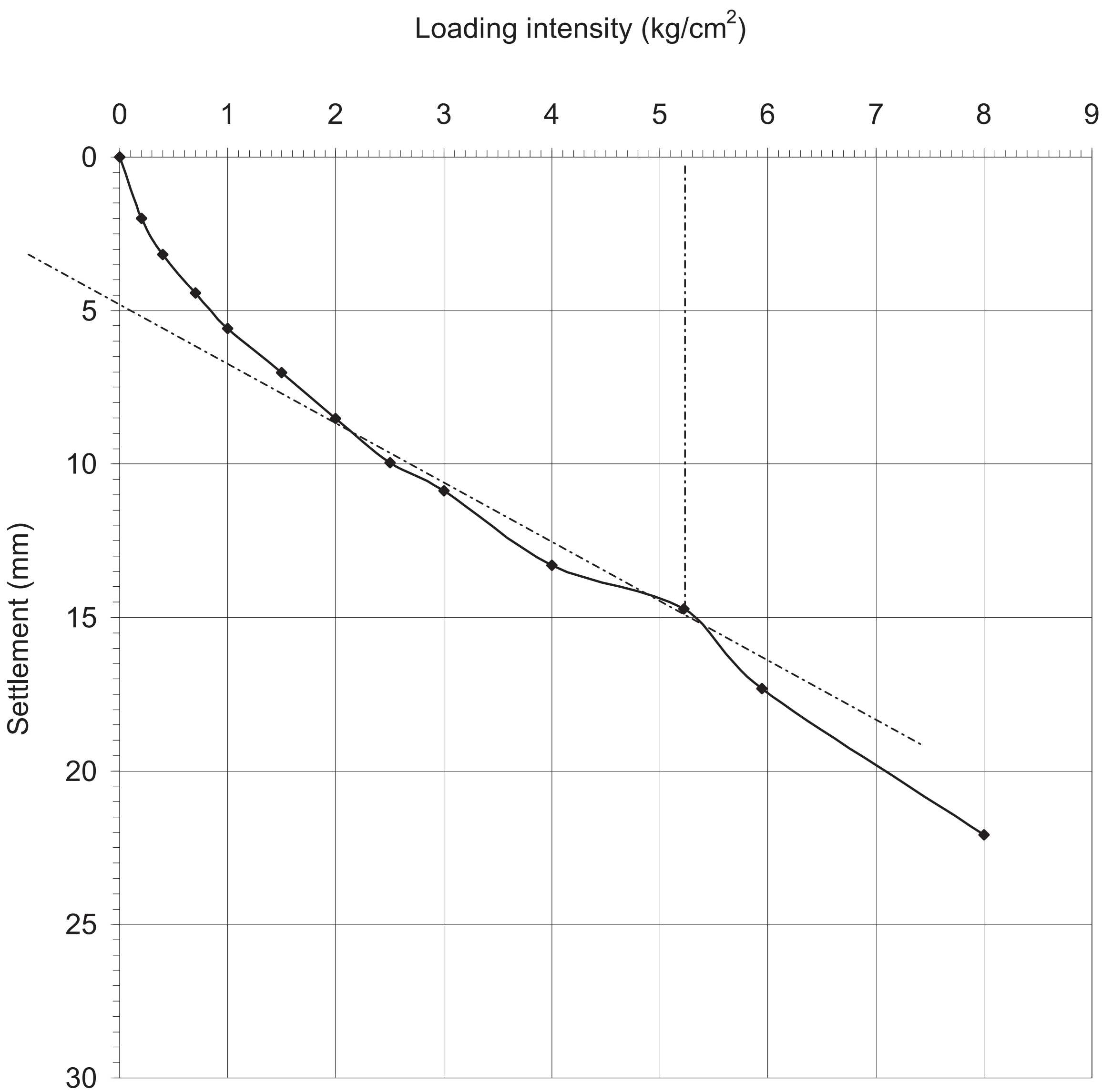



| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 3kg/$cm^2$ |
| Corresponding settlement | = | Load not sustained |
| Test condition | = | Saturated |

**Plate Load Test - IPLT4**

ltimate Bearing Capacity = 52 t/$m^2$

Safe Bearing Capacity = 52 / 2.5 = 21t/$m^2$

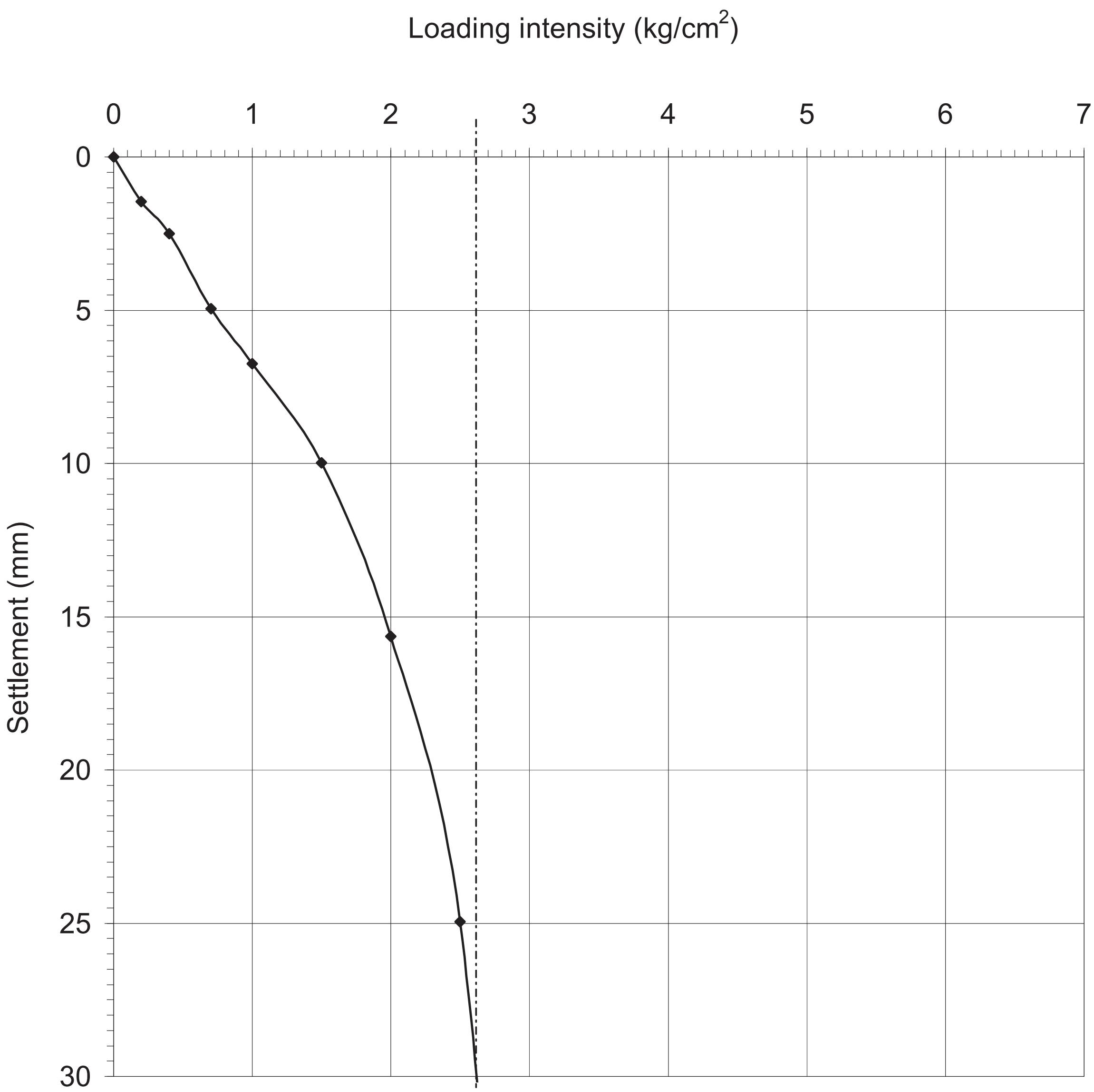



| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 8kg/$cm^2$ |
| Corresponding settlement | = | 22.08mm |
| Test condition | = | Saturated |

**Plate Load Test - IPLT5**

*ltimate Bearing Capacity = 26 t/m²*

*Safe Bearing Capacity = 26 / 2.5 = 10t/m²*

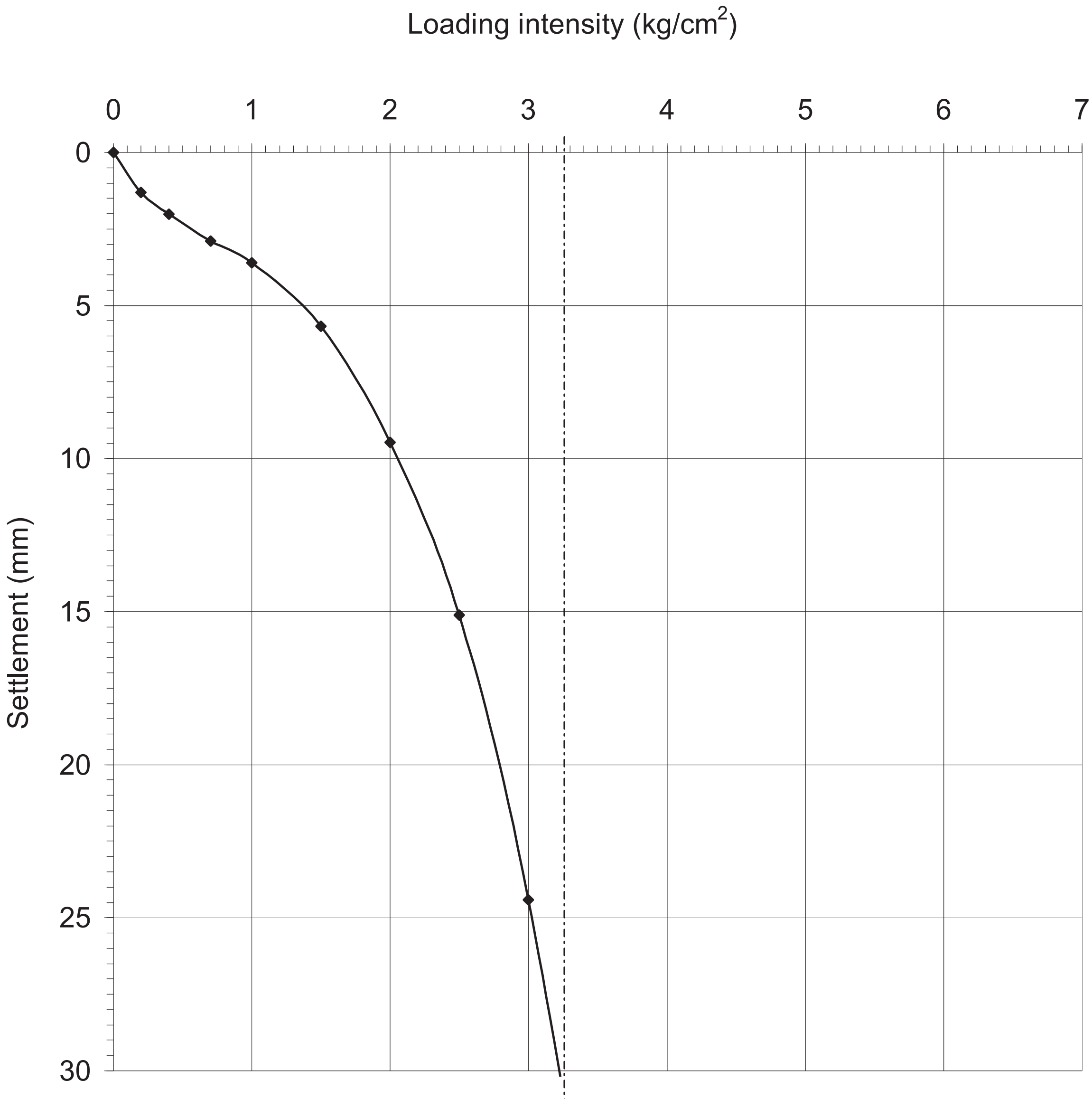



| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 3kg/cm² |
| Corresponding settlement | = | Load not sustained |
| Test condition | = | Saturated |

**Plate Load Test - IPLT6**

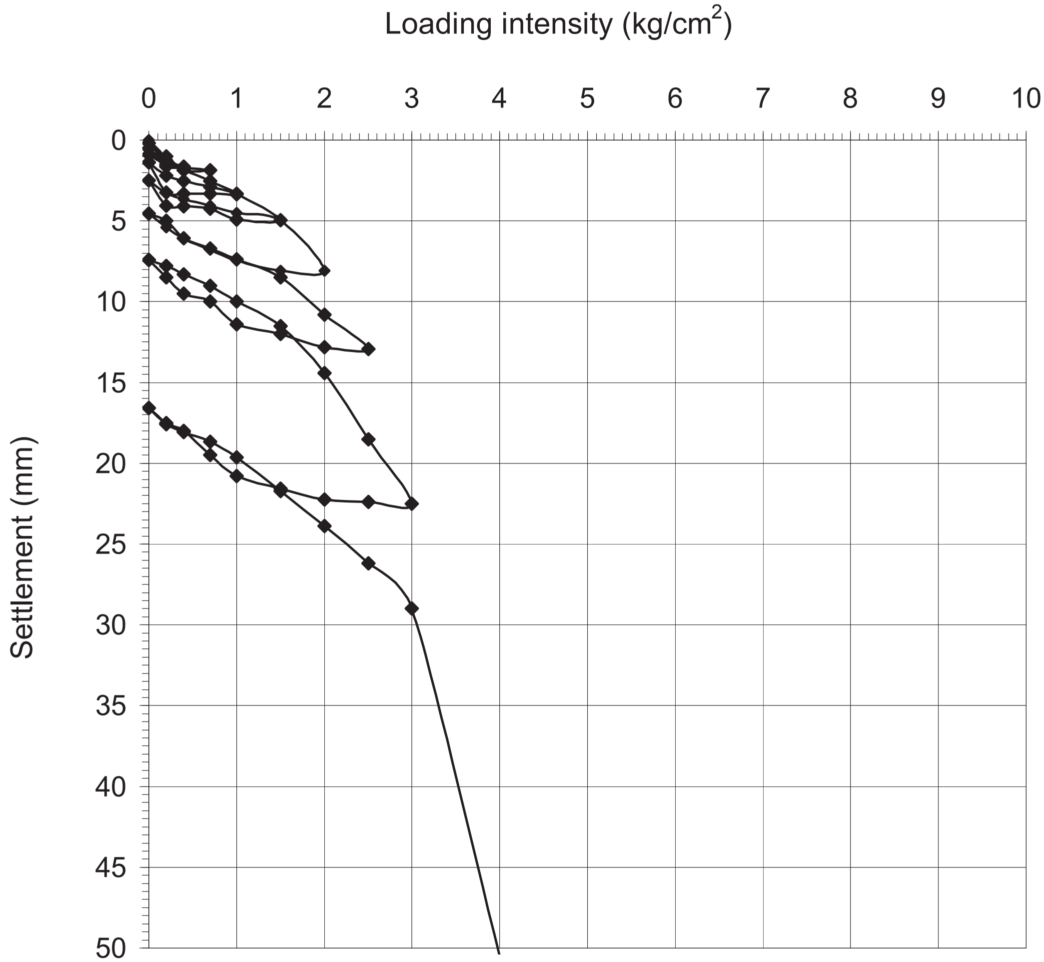
*ltimate Bearing Capacity = 32 t/m²*

*Safe Bearing Capacity = 32 / 2.5 = 13t/m²*



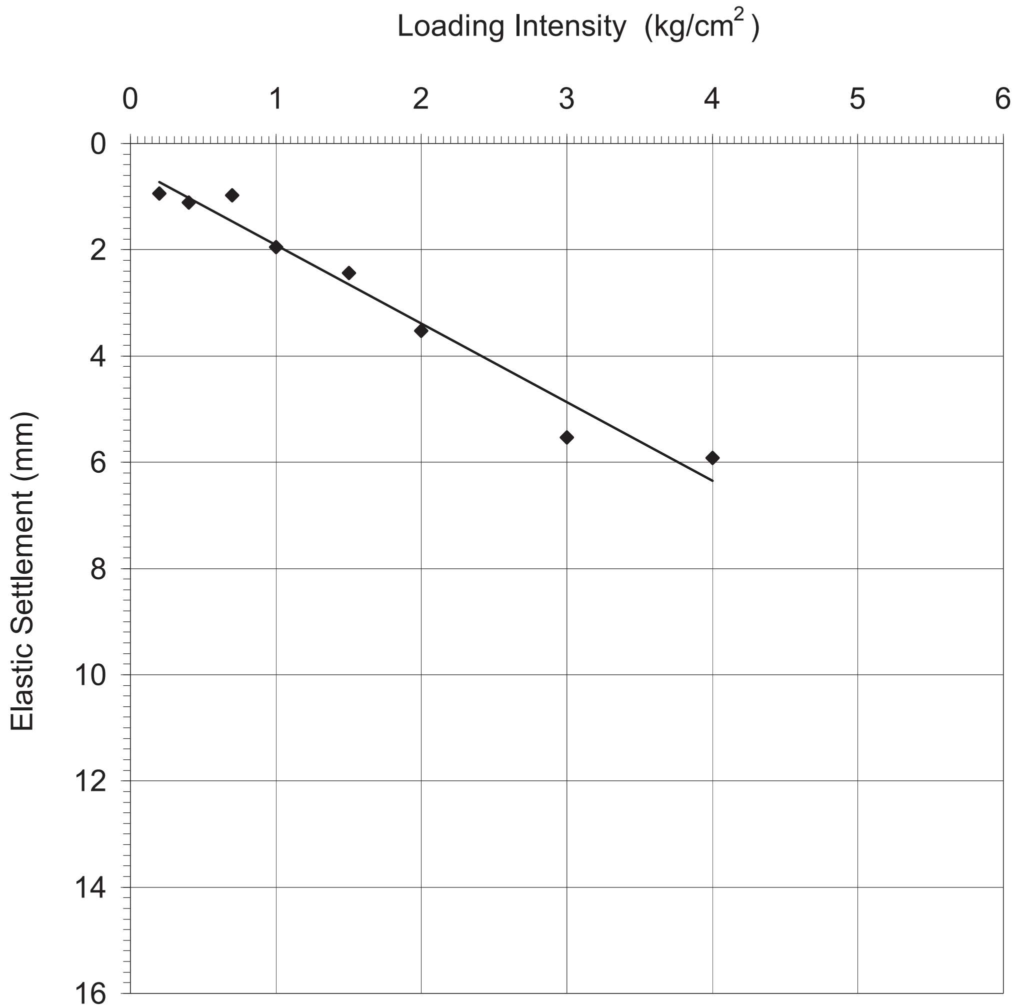

| | | |
|---|---|---|
| Size of plate | = | 60 x 60 cm |
| Depth of test | = | 3m |
| Final loading intensity | = | 4kg/cm² |
| Corresponding settlement | = | Load not |
| sustained | | |

**Plate Load Test - IPLT7**




Size of plate = 60 x 60 cm
Depth of test = 3m
Final loading intensity = 4 kg/cm$^2$
Corresponding settlement = Continuing settlement
Pit condition = Saturated

**Cyclic Plate Load Test - ICPLT1**




*Coefficient of Elastic Uniform Compression*

$C_u$ = 6.8 $kg/cm^3$

$C_{u10}$ = 1.3 $kg/cm^3$

**Cyclic Plate Load Test- ICPLT1**

Annexure - A

Results of Pressuremeter Test IPMT-1

| Depth (m) | Young's Modulus 'E' (kg/cm$^2$) |
|---|---|
| 2 | 81 |
| 4 | 425 |
| 6 | 133 |
| 8 | 199 |
| 10 | 1363 |
| 12 | 4545 |
| 15 | 3821 |
| 18 | 7042 |
| 21 | 4724 |
| 25 | 7167 |

**Results of Pressuremeter Test IPMT-2**

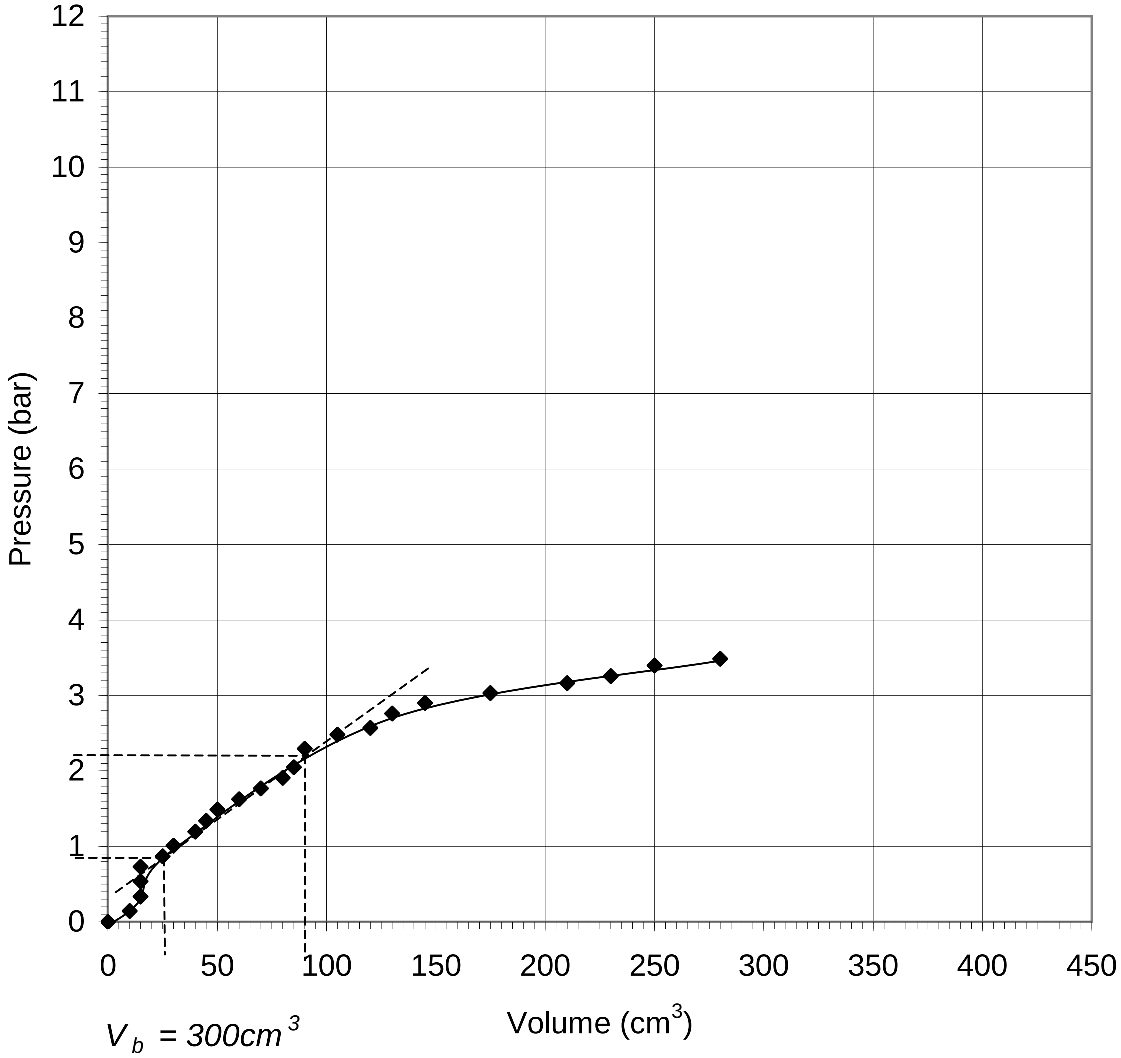
| Depth (m) | Young's Modulus 'E' (kg/cm$^2$) |
|---|---|
| 2 | 373 |
| 4 | 258 |
| 6 | 233 |
| 8 | 560 |
| 10 | 390 |
| 12 | 481 |
| 15 | 2348 |
| 18 | 2218 |
| 21 | 3709 |
| 25 | 5400 |

**Results of Pressuremeter Test IPMT-3**

| Depth (m) | Young's Modulus 'E' ($kg/cm^2$) |
|---|---|
| 2 | 118 |
| 4 | 227 |
| 6 | 218 |
| 8 | 285 |
| 10 | 430 |
| 12 | 2306 |
| 15 | 2564 |
| 18 | 2203 |
| 21 | 3939 |
| 25 | 7894 |

Results of Pressuremeter Test IPMT-4

| Depth (m) | Young's Modulus 'E' ($kg/cm^2$) |
|---|---|
| 2 | 70 |
| 4 | 90 |
| 6 | 175 |
| 8 | 1712 |
| 10 | 1500 |
| 12 | 2670 |
| 15 | 3215 |
| 18 | 5436 |
| 21 | 7324 |
| 25 | 5879 |

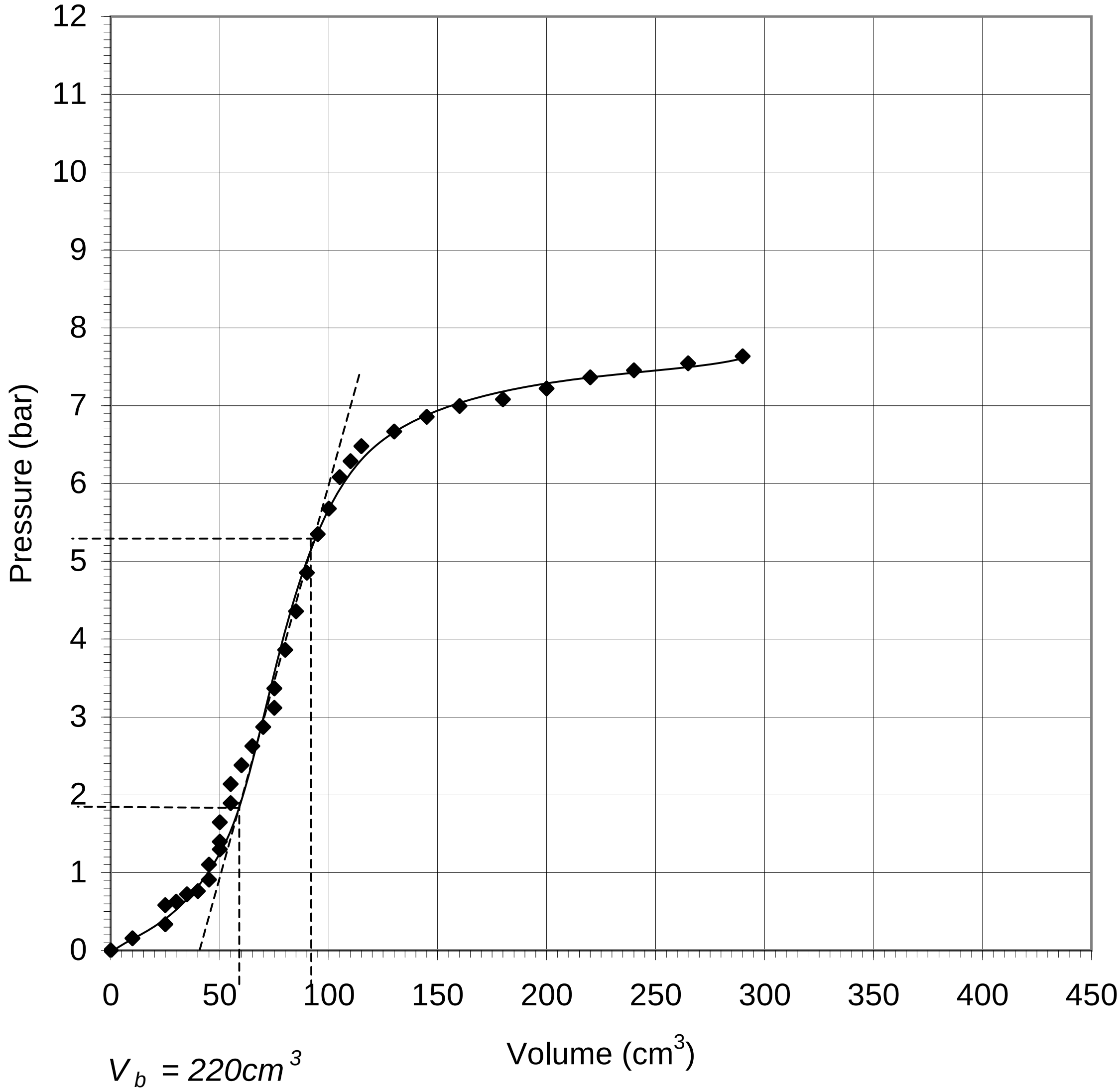



$V_b = 300cm^3$

***Pressuremeter Modulus $E_m$ = 54kg/cm$^2$***

## Pressuremeter Test Curve - 1

Location : IPMT1
Depth (m) : 2m

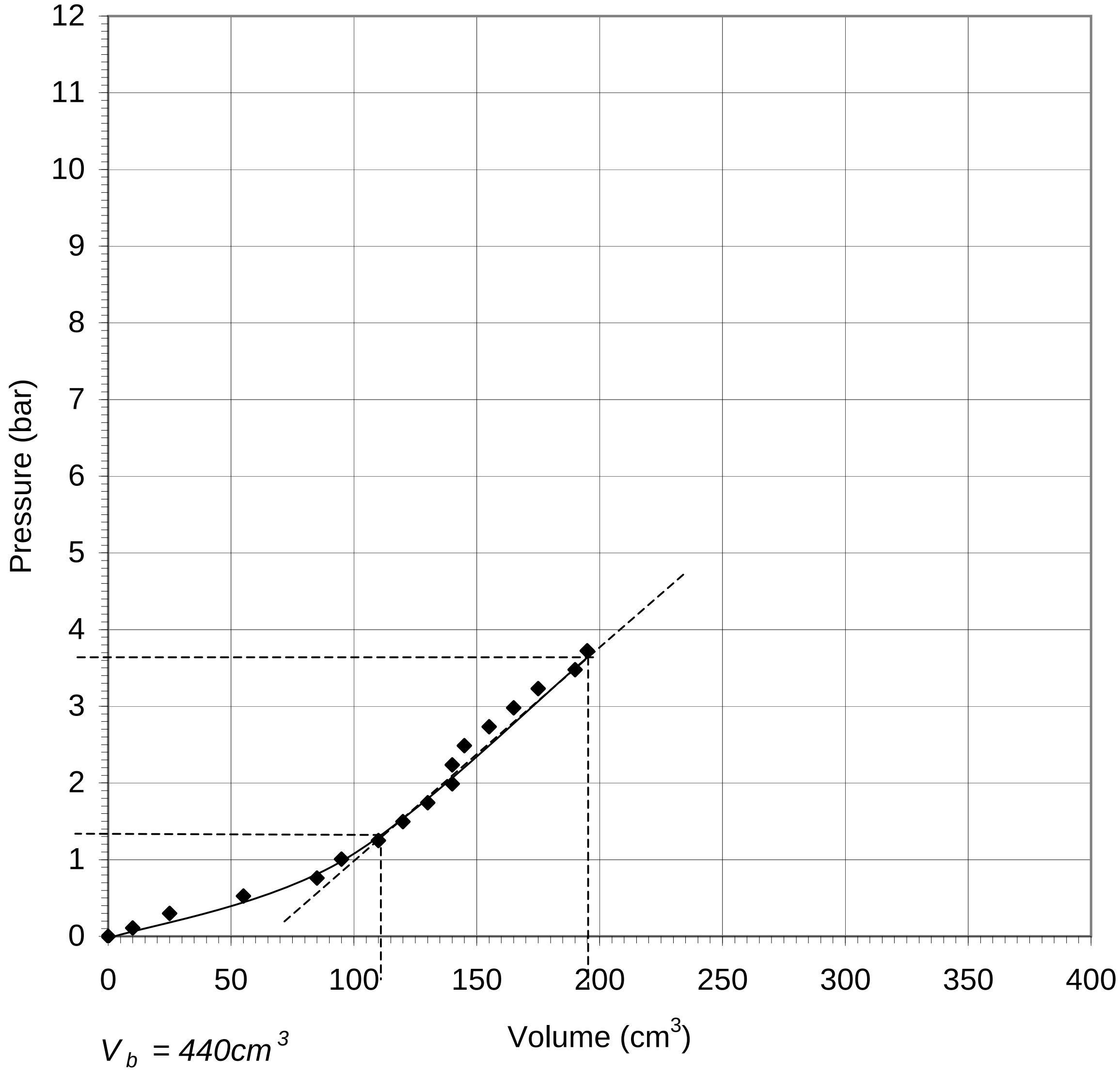



$V_b$ = 220cm$^3$

***Pressuremeter Modulus $E_m$ = 285kg/cm$^2$***

**Pressuremeter Test Curve - 2**

Location : IPMT1
Depth (m) : 4m

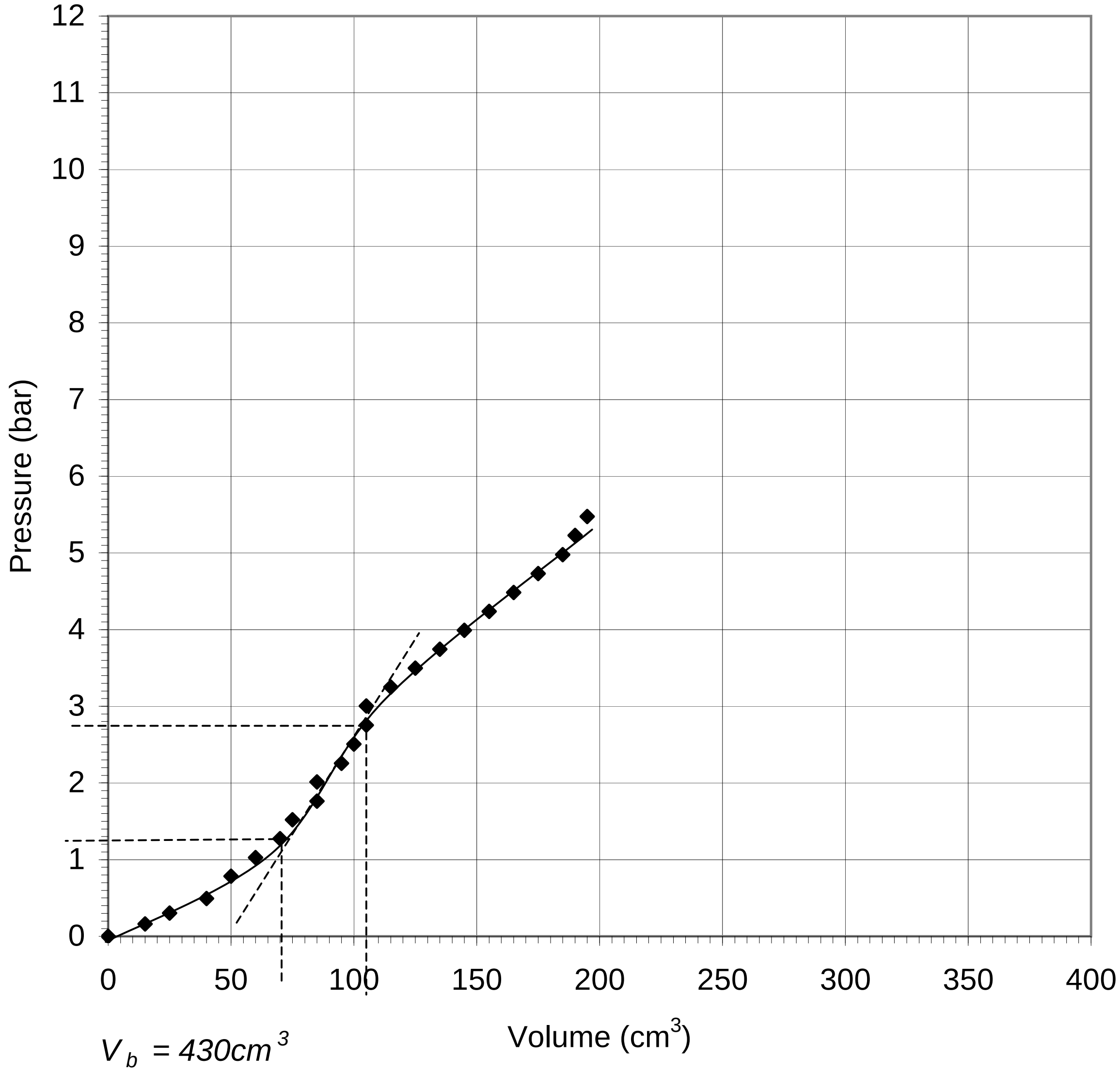



*$V_b$ = 440cm$^3$*

***Pressuremeter Modulus $E_m$ = 89kg/cm$^2$***

**Pressuremeter Test Curve - 3**

Location : IPMT1
Depth (m) : 6m

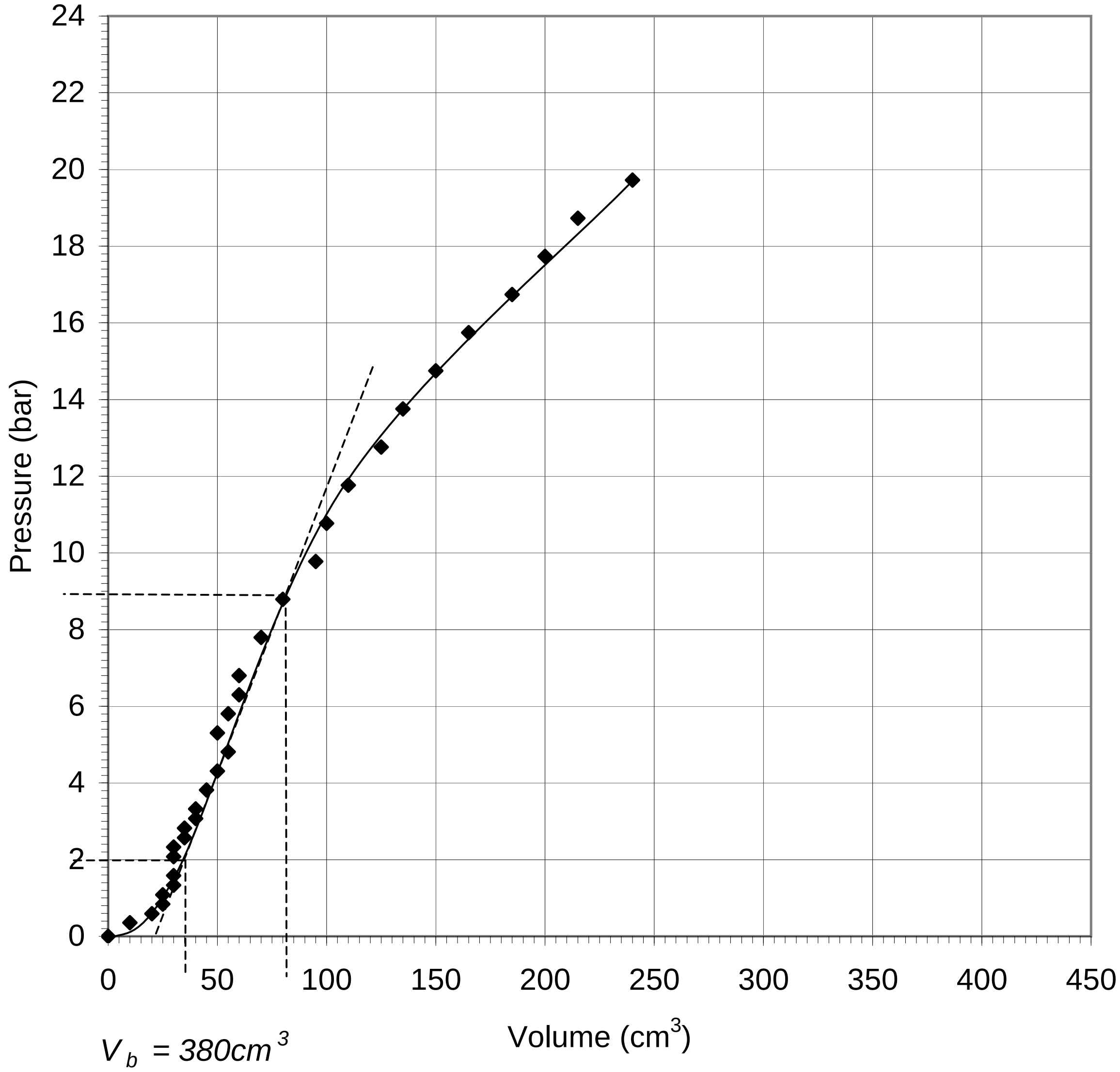



$V_b = 430cm^3$

***Pressuremeter Modulus $E_m$ = 133kg/cm$^2$***

## Pressuremeter Test Curve - 4

Location : IPMT1
Depth (m) : 8m

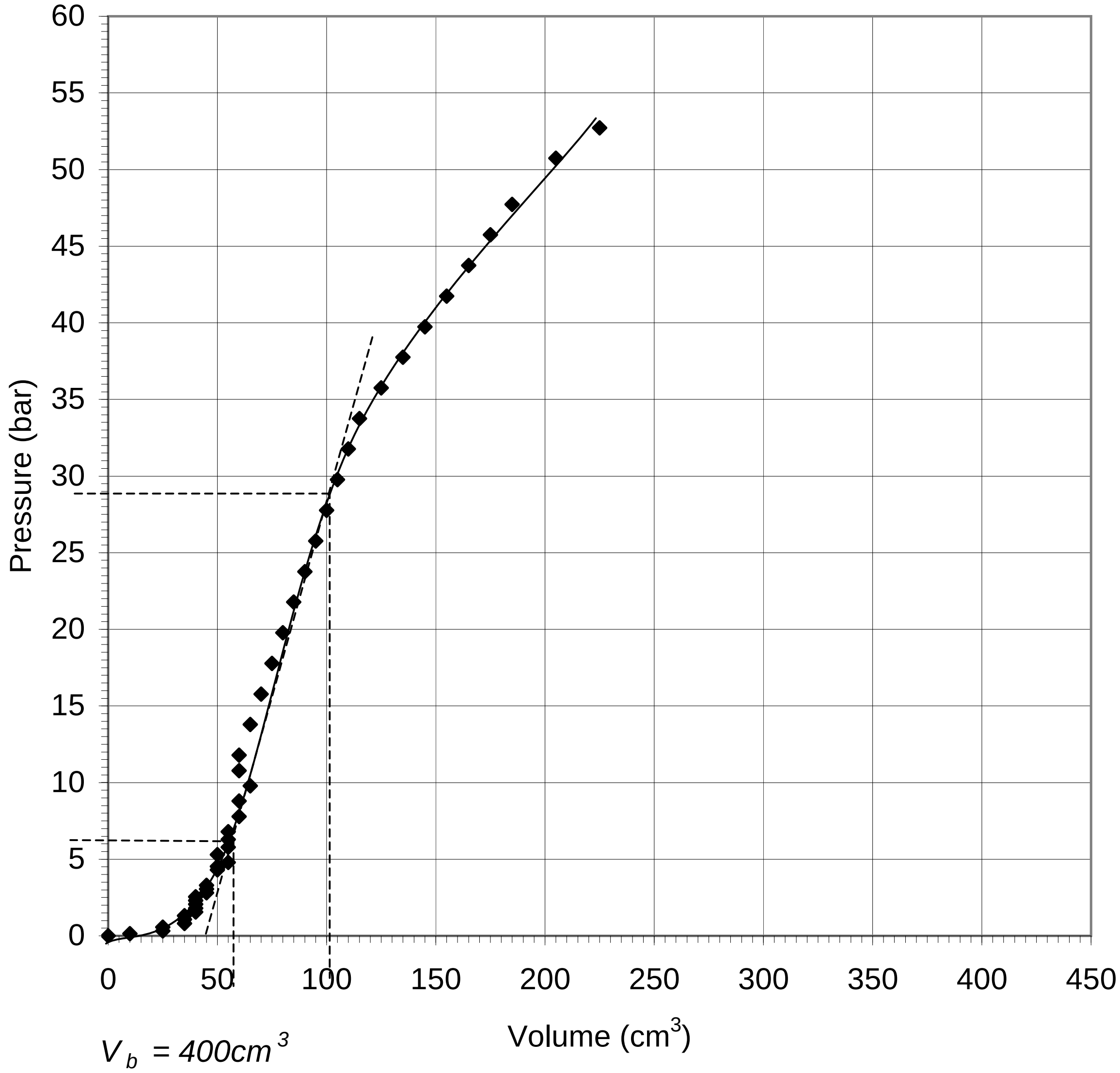



$V_b$ = 380cm$^3$

***Pressuremeter Modulus $E_m$ = 450kg/cm$^2$***

## Pressuremeter Test Curve - 5

Location : IPMT1
Depth (m) : 10m

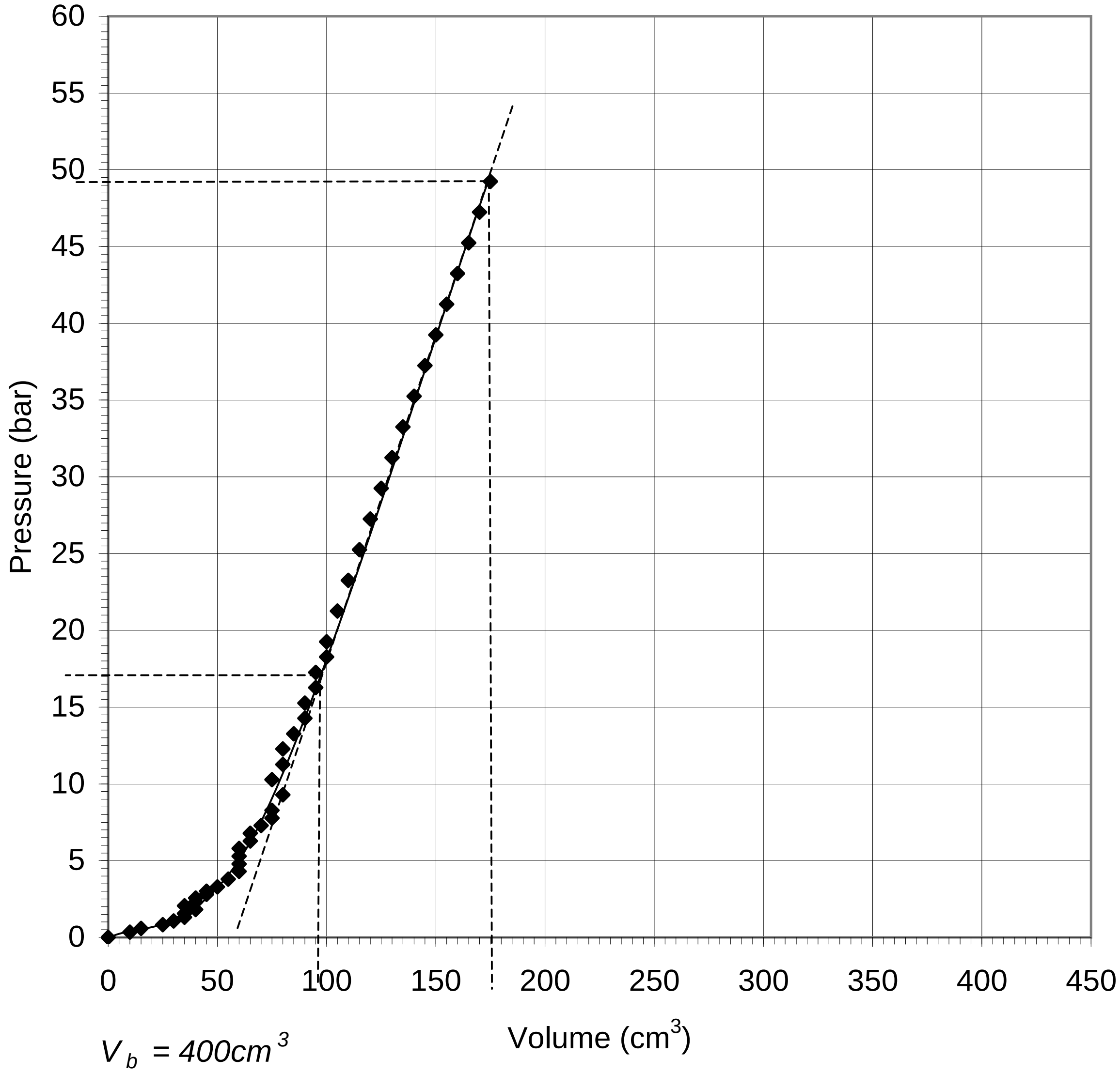



$V_b = 400cm^3$

***Pressuremeter Modulus $E_m$ = 1500kg/cm$^2$***

**Pressuremeter Test Curve - 6**

Location : IPMT1
Depth (m) : 12m

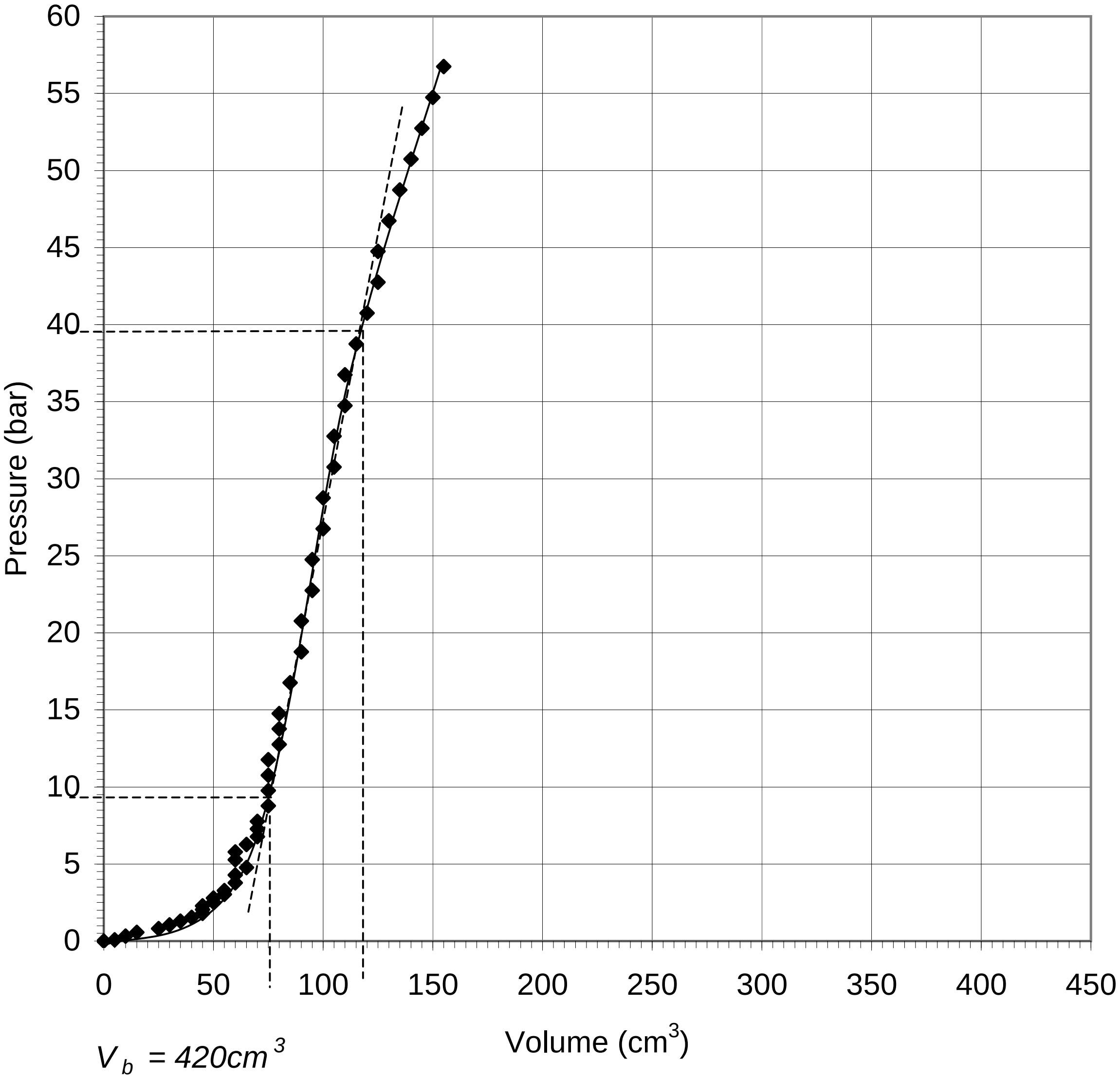



$V_b = 400cm^3$

***Pressuremeter Modulus $E_m$ = 1261kg/cm$^2$***

## Pressuremeter Test Curve - 7

Location : IPMT1
Depth (m) : 15m

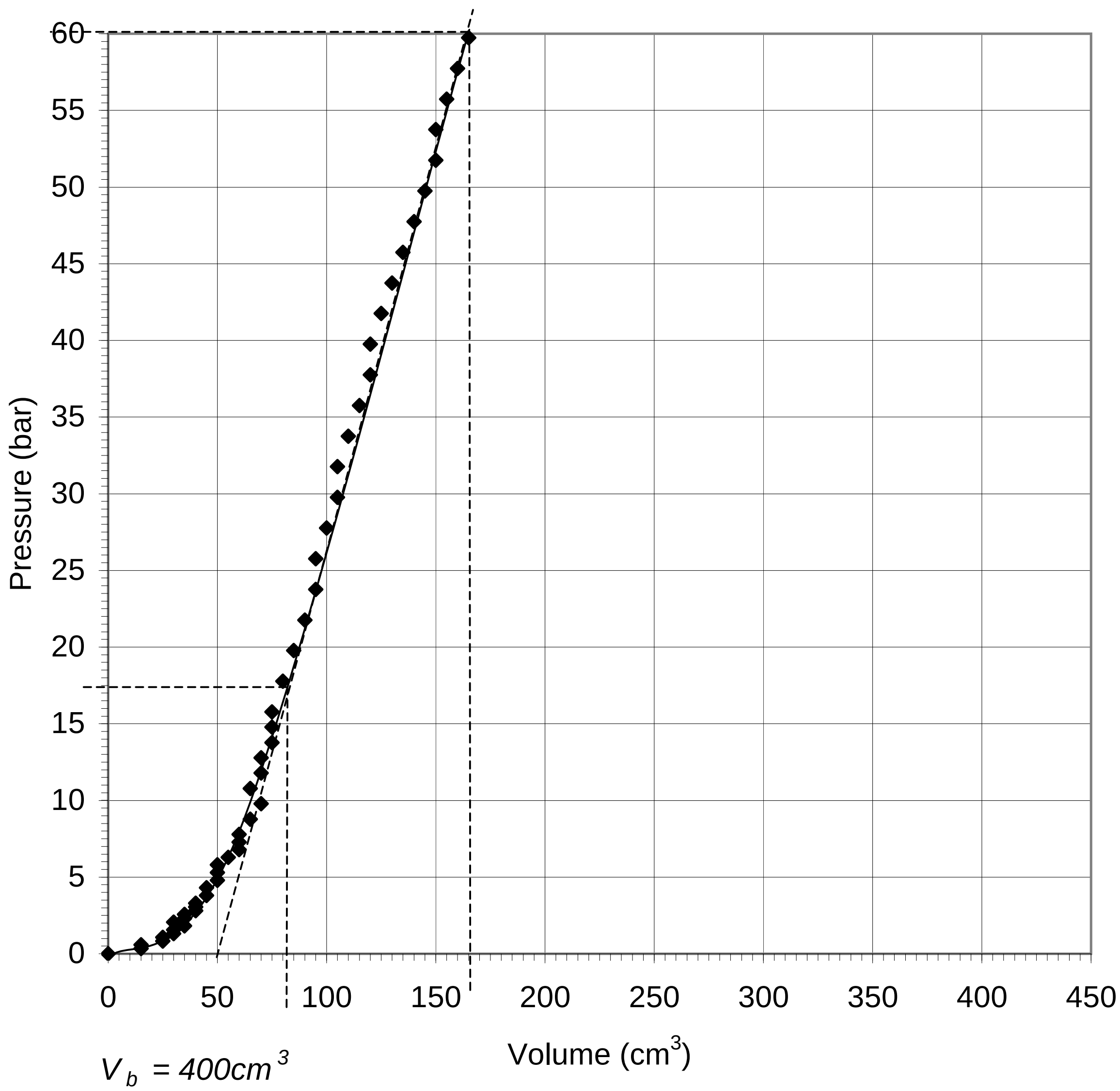



*$V_b$ = 420cm$^3$*

***Pressuremeter Modulus $E_m$ = 2324kg/cm$^2$***

**Pressuremeter Test Curve - 8**

Location : IPMT1
Depth (m) : 18m

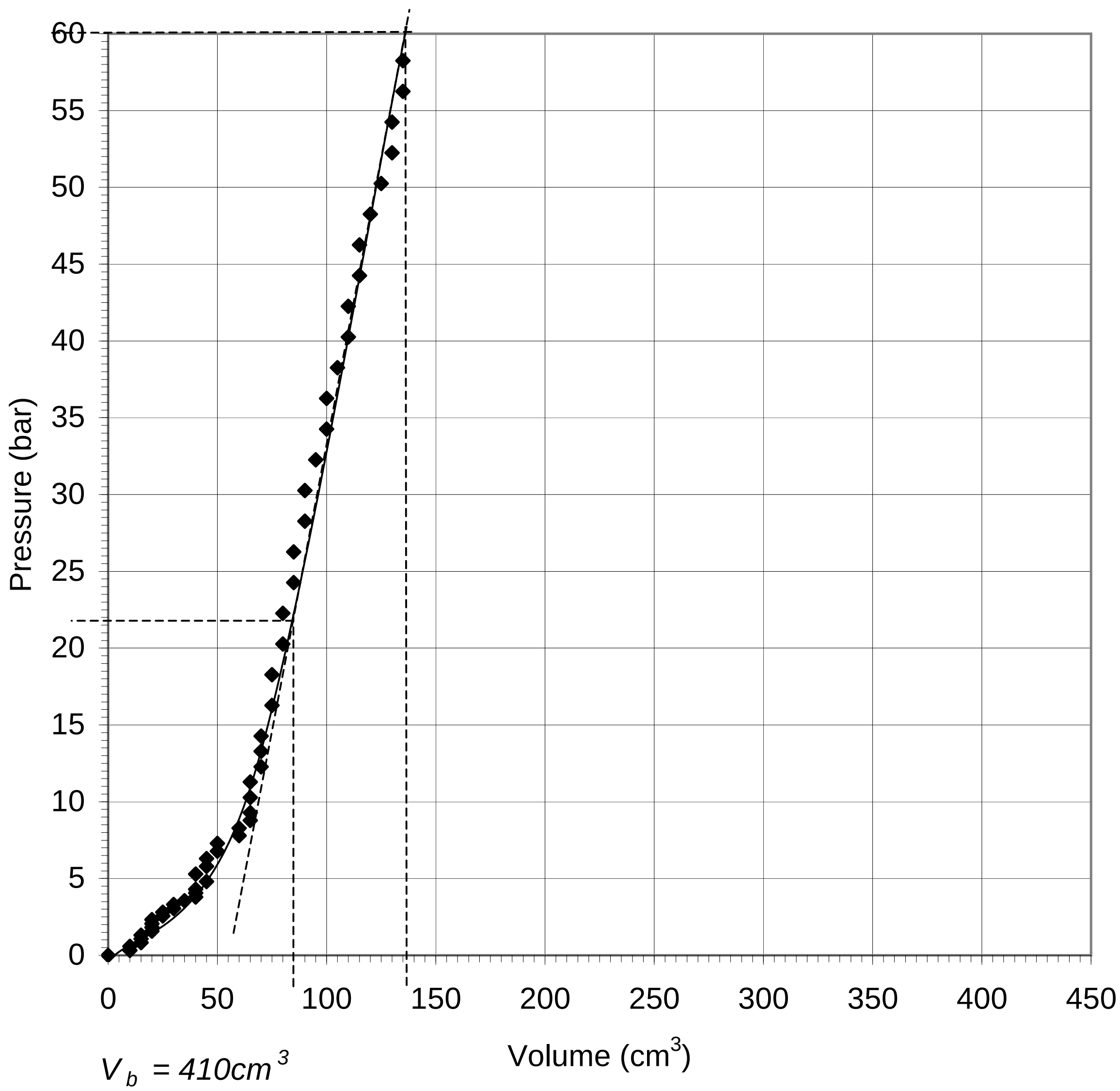



*$V_b$ = 400cm$^3$*

***Pressuremeter Modulus $E_m$ = 1559kg/cm$^2$***

**Pressuremeter Test Curve - 9**

Location : IPMT1
Depth (m) : 21m

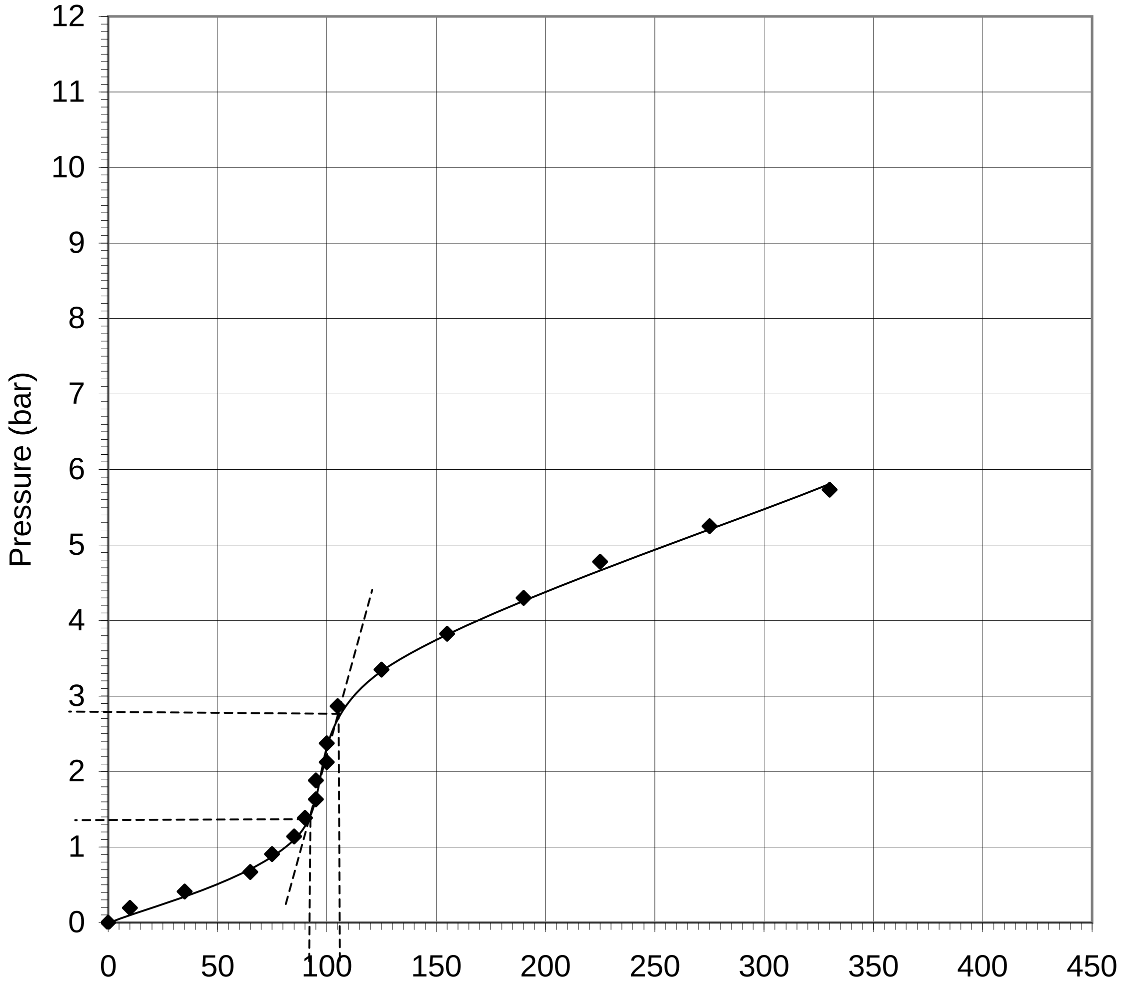



*$V_b$ = 410cm$^3$*

***Pressuremeter Modulus $E_m$ = 2365kg/cm$^2$***

**Pressuremeter Test Curve - 10**

Location : IPMT1
Depth (m) : 25m

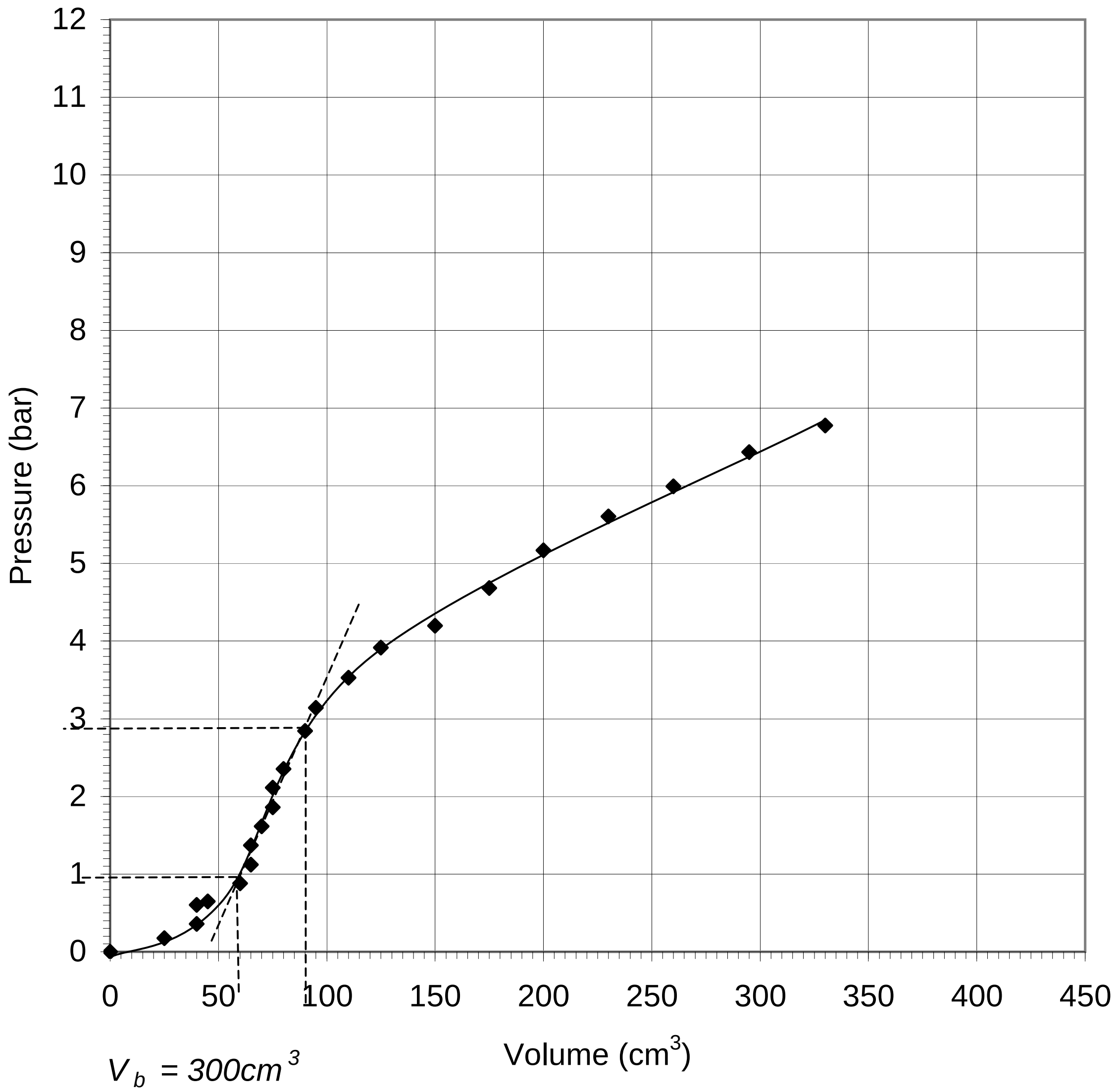



$V_b$ = 260cm$^3$

***Pressuremeter Modulus $E_m$ = 250kg/cm$^2$***

## Pressuremeter Test Curve - 11

Location : IPMT2
Depth (m) : 2m

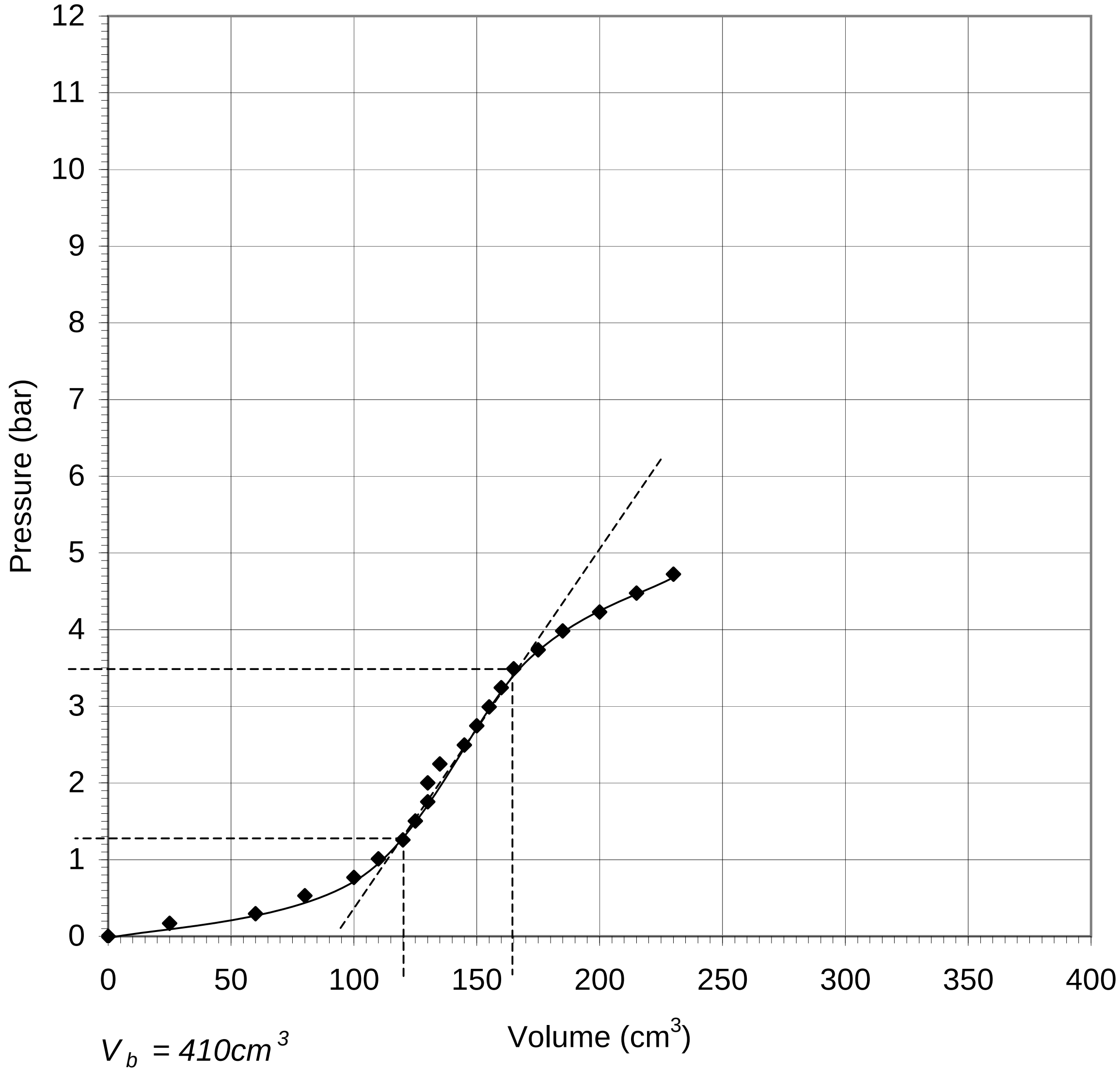



$V_b$ = 300cm$^3$

***Pressuremeter Modulus $E_m$ = 173kg/cm$^2$***

**Pressuremeter Test Curve - 12**

Location : IPMT2
Depth (m) : 4m

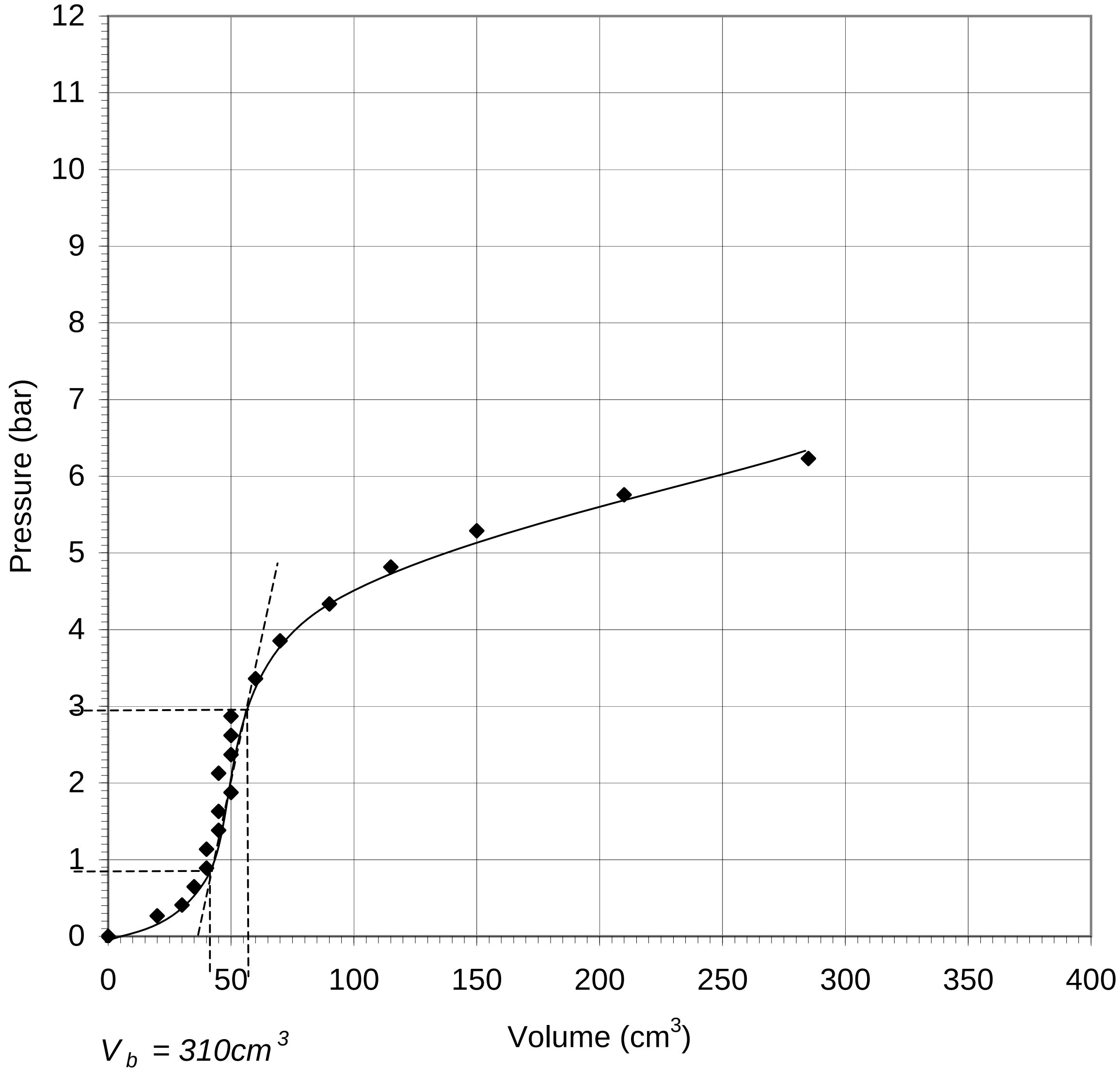



*$V_b$ = 410cm$^3$*

***Pressuremeter Modulus $E_m$ = 156kg/cm$^2$***

**Pressuremeter Test Curve - 13**

Location : IPMT2
Depth (m) : 6m

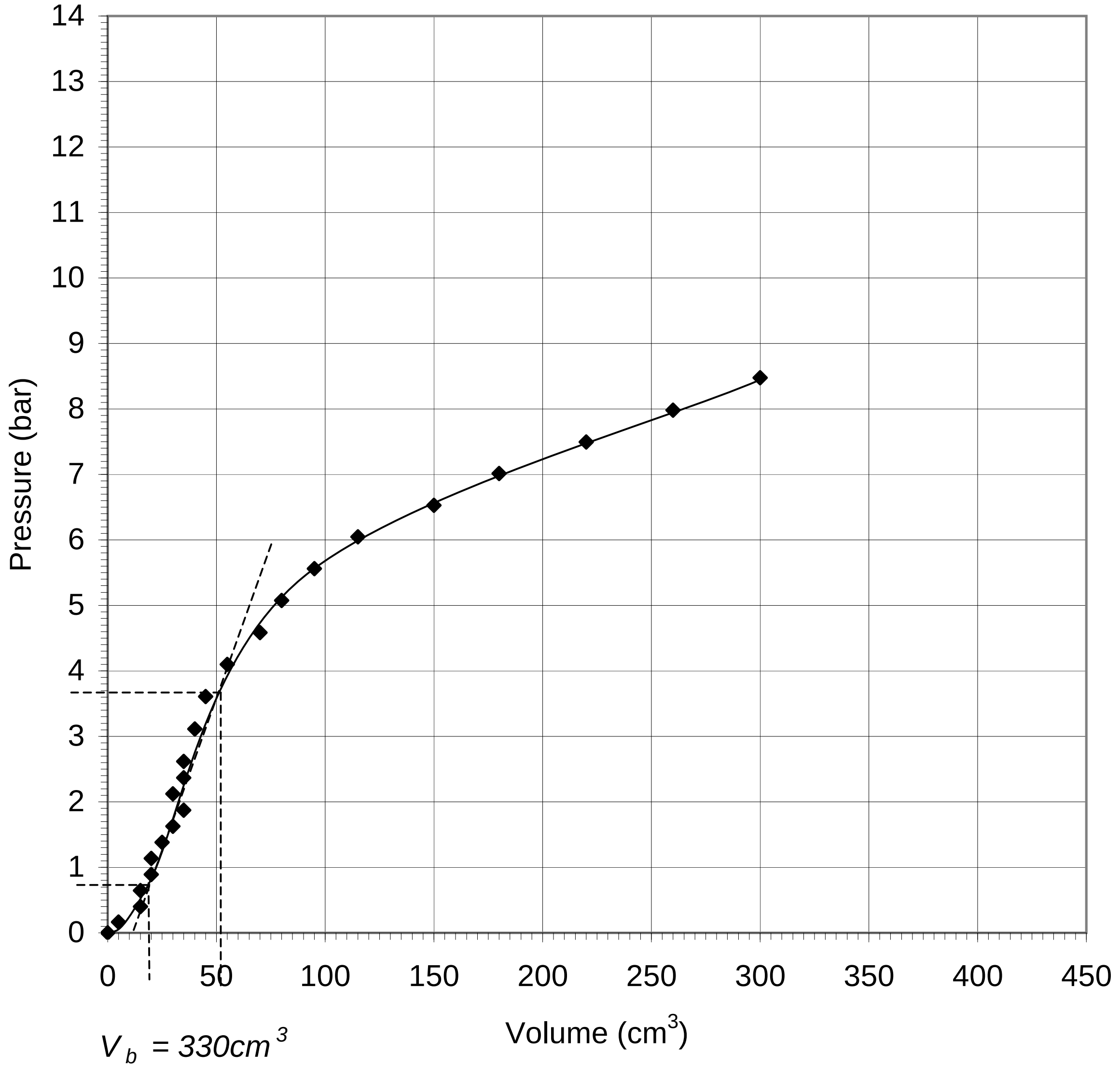



$V_b = 310cm^3$

***Pressuremeter Modulus $E_m$ = 375kg/cm$^2$***

**Pressuremeter Test Curve - 14**

Location : IPMT2
Depth (m) : 8m

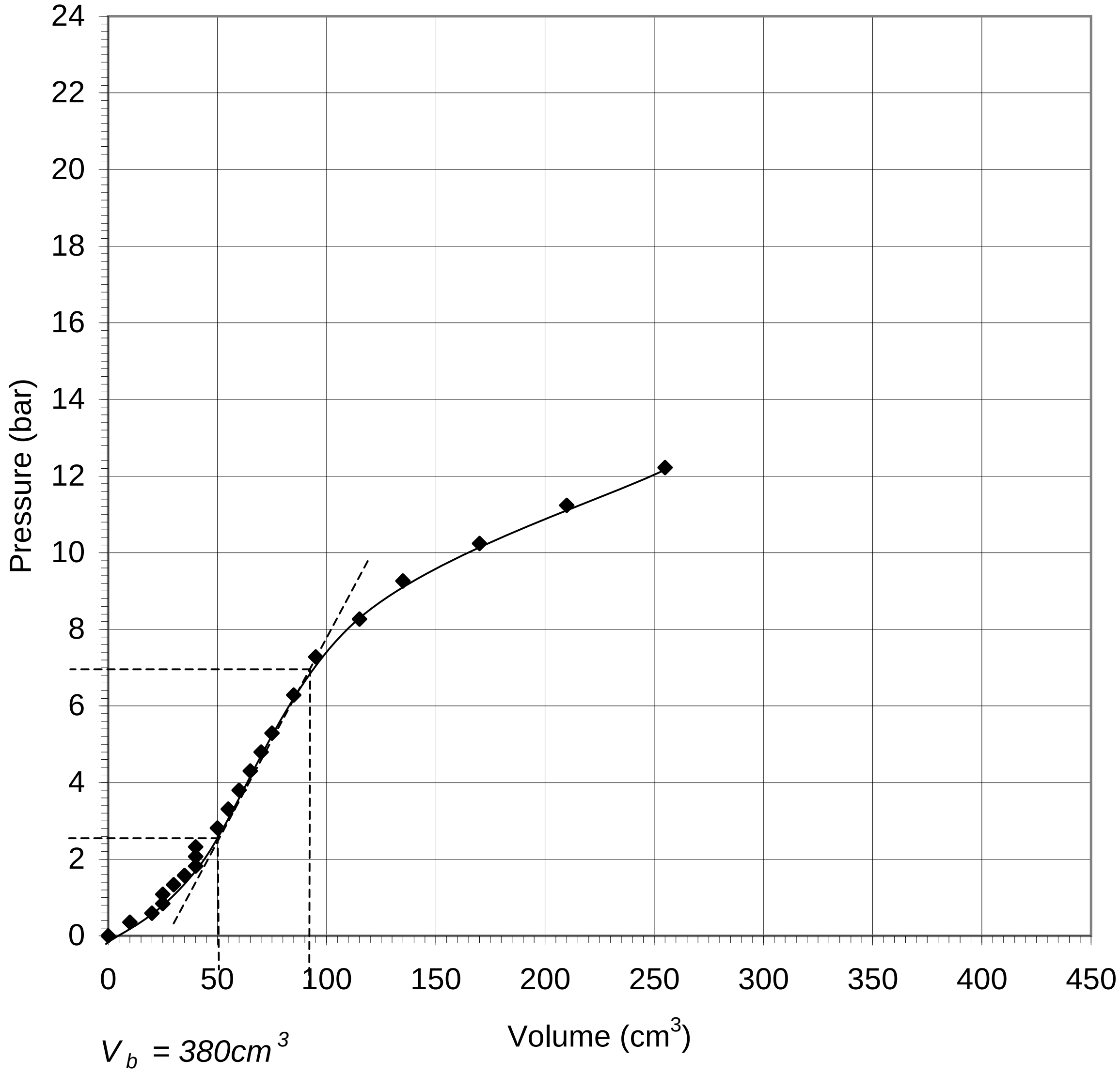



*$V_b$ = 330cm$^3$*

***Pressuremeter Modulus $E_m$ = 261kg/cm$^2$***

**Pressuremeter Test Curve - 15**

Location : IPMT2
Depth (m) : 10m

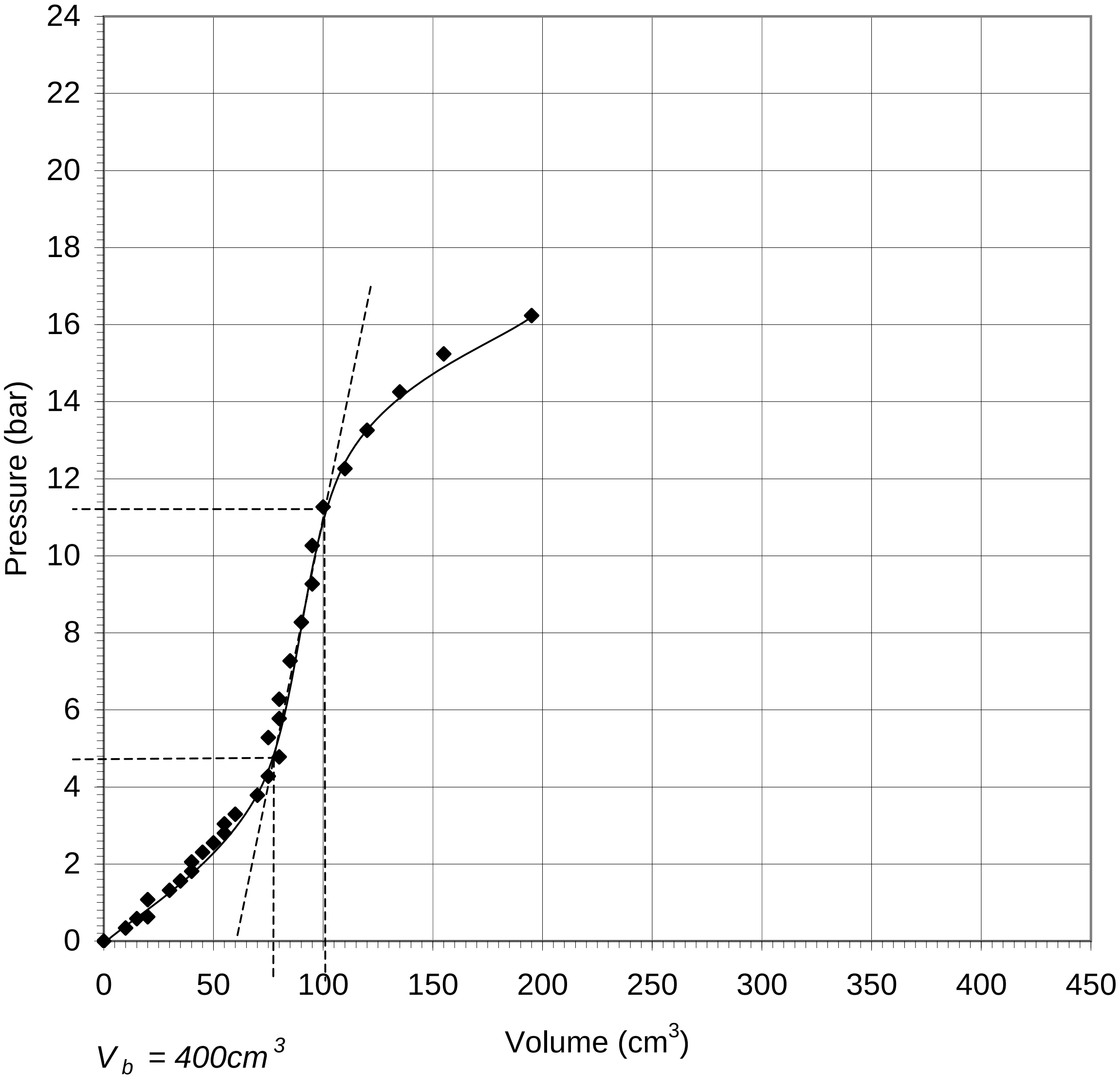



$V_b$ = 380cm$^3$

***Pressuremeter Modulus*** $E_m$ ***= 322kg/cm***$^2$

## Pressuremeter Test Curve - 16

Location : IPMT2
Depth (m) : 12m

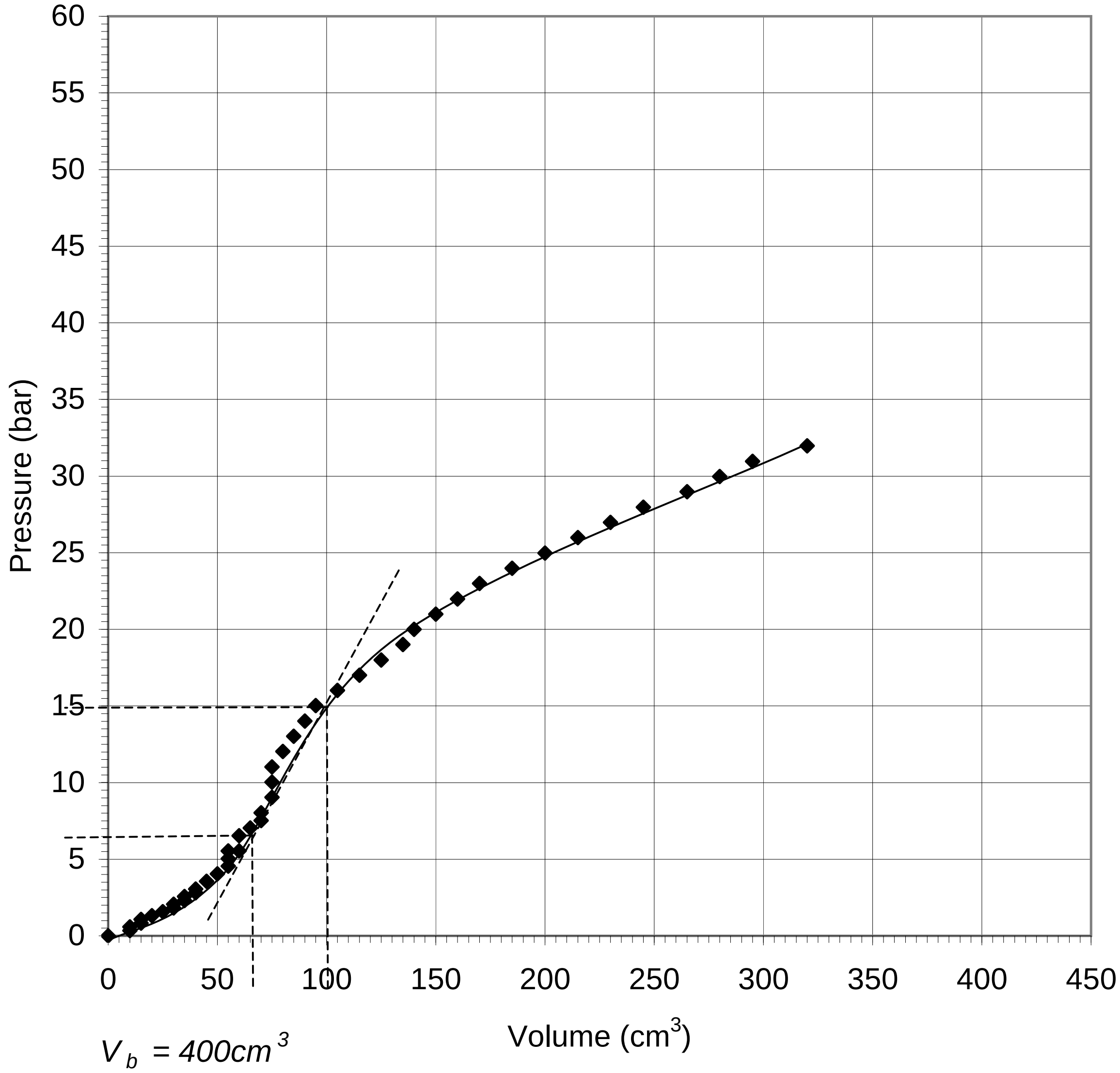



*$V_b$ = 400cm³*

***Pressuremeter Modulus $E_m$ = 775kg/cm²***

## Pressuremeter Test Curve - 17

Location : IPMT2
Depth (m) : 15m

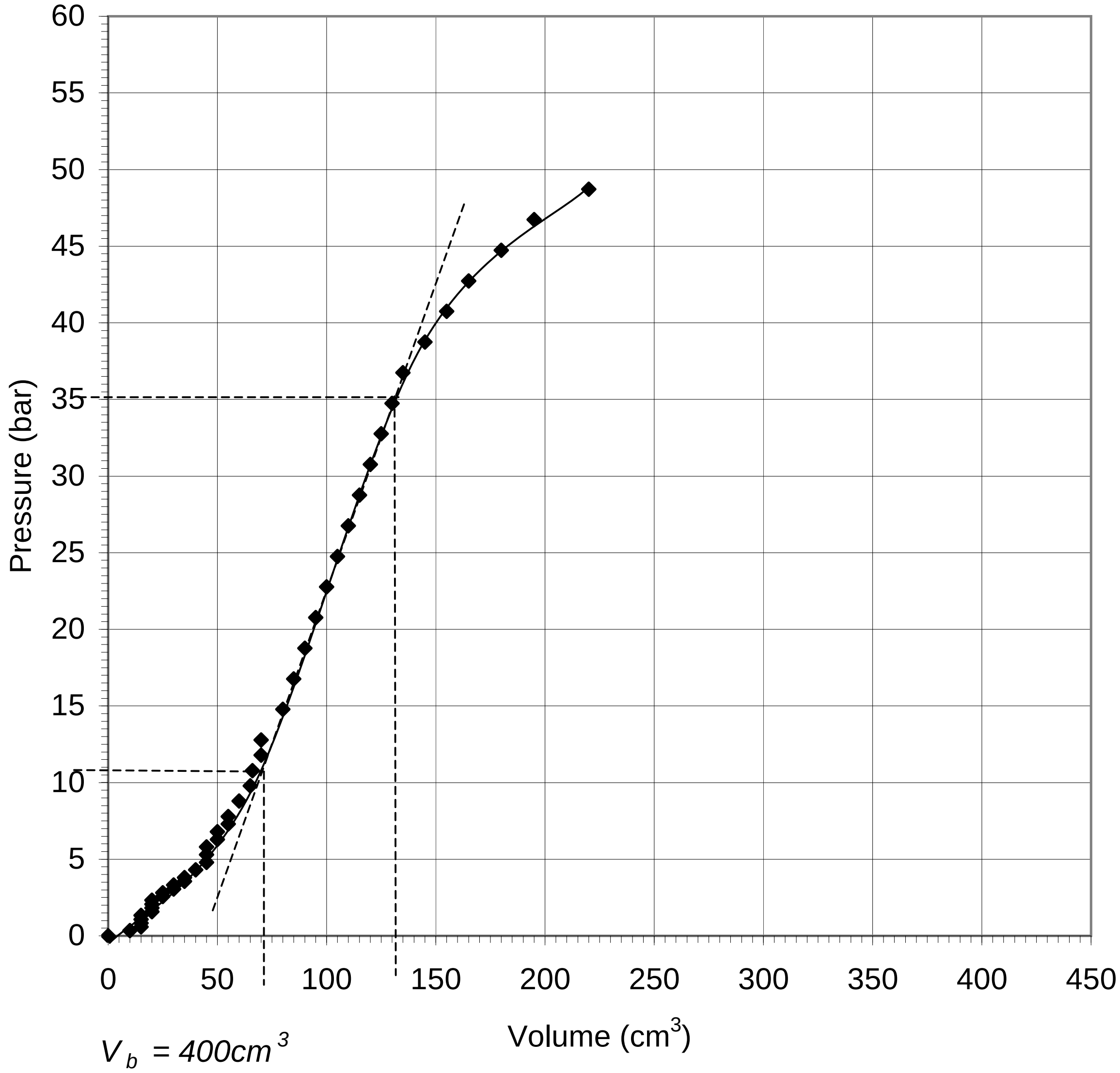



$V_b$ = 400cm$^3$

***Pressuremeter Modulus $E_m$ = 732kg/cm$^2$***

**Pressuremeter Test Curve - 18**

Location : IPMT2
Depth (m) : 18m

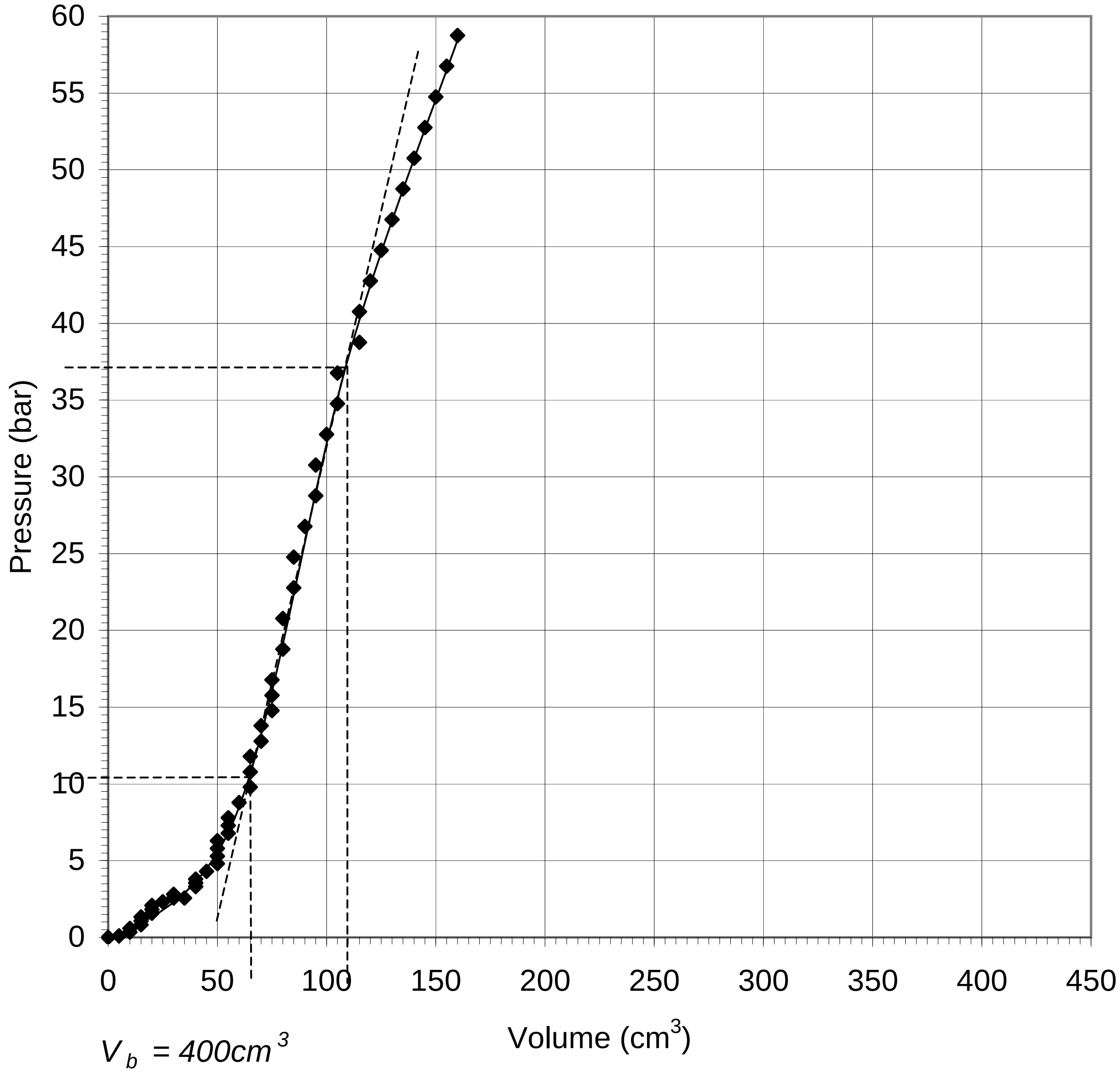



*$V_b$ = 400cm$^3$*

***Pressuremeter Modulus $E_m$ = 1224kg/cm$^2$***

**Pressuremeter Test Curve - 19**

Location : IPMT2
Depth (m) : 21m

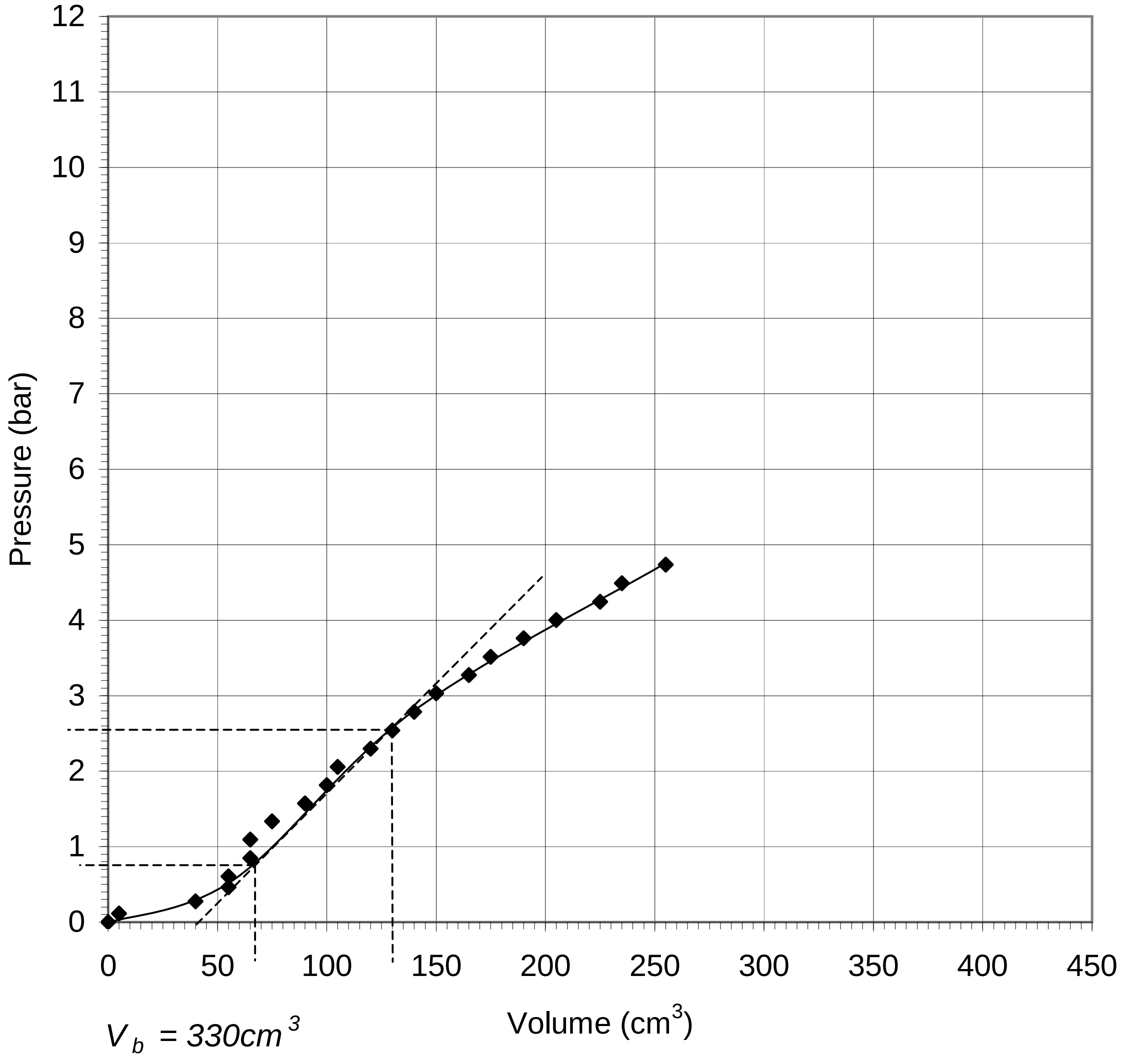



$V_b$ = 400cm$^3$

***Pressuremeter Modulus $E_m$ = 1782kg/cm$^2$***

**Pressuremeter Test Curve - 20**

Location : IPMT2
Depth (m) : 25m

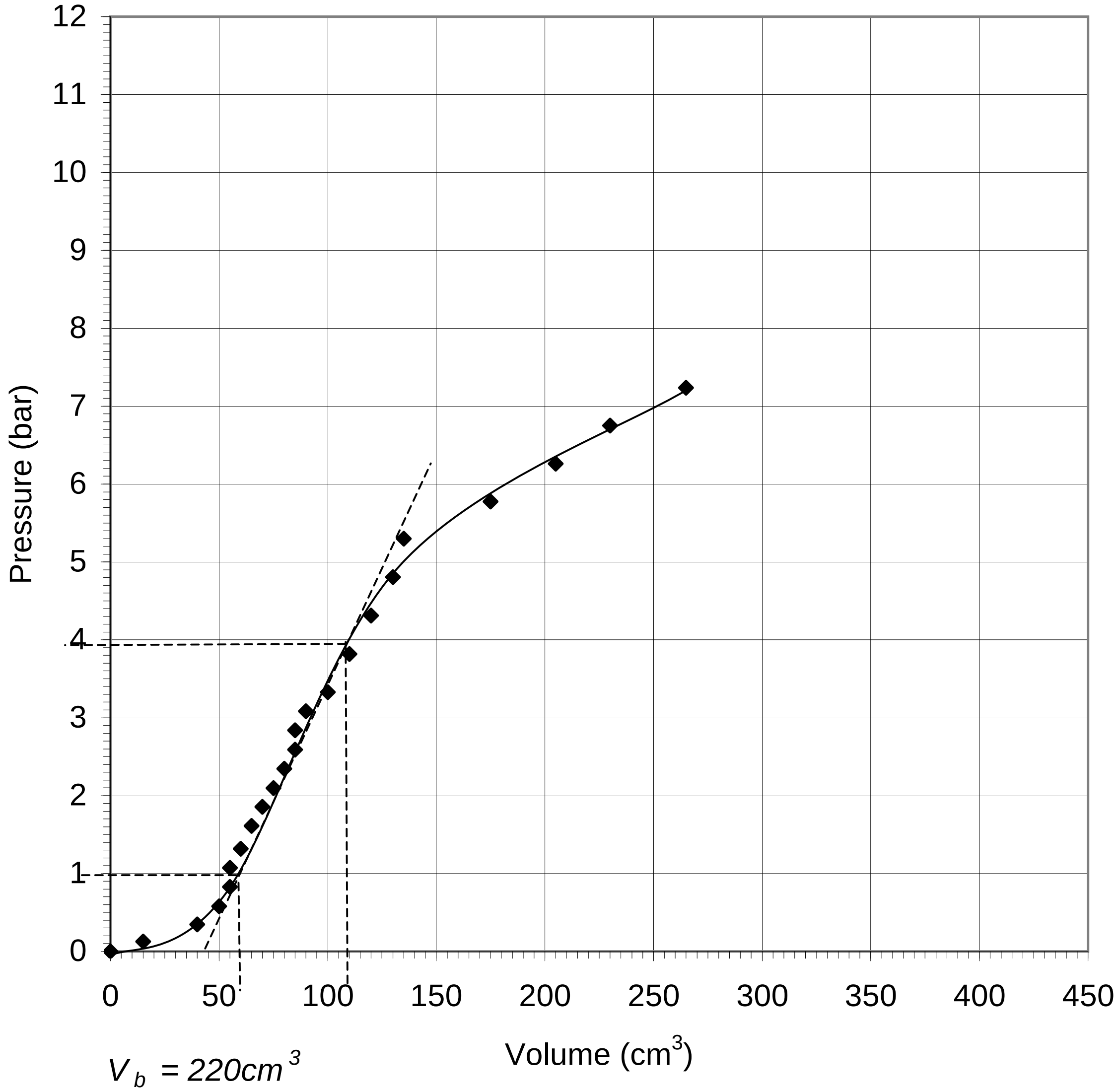



$V_b$ = 330cm$^3$

***Pressuremeter Modulus $E_m$ = 79kg/cm$^2$***

## Pressuremeter Test Curve - 21

Location : IPMT3
Depth (m) : 2m

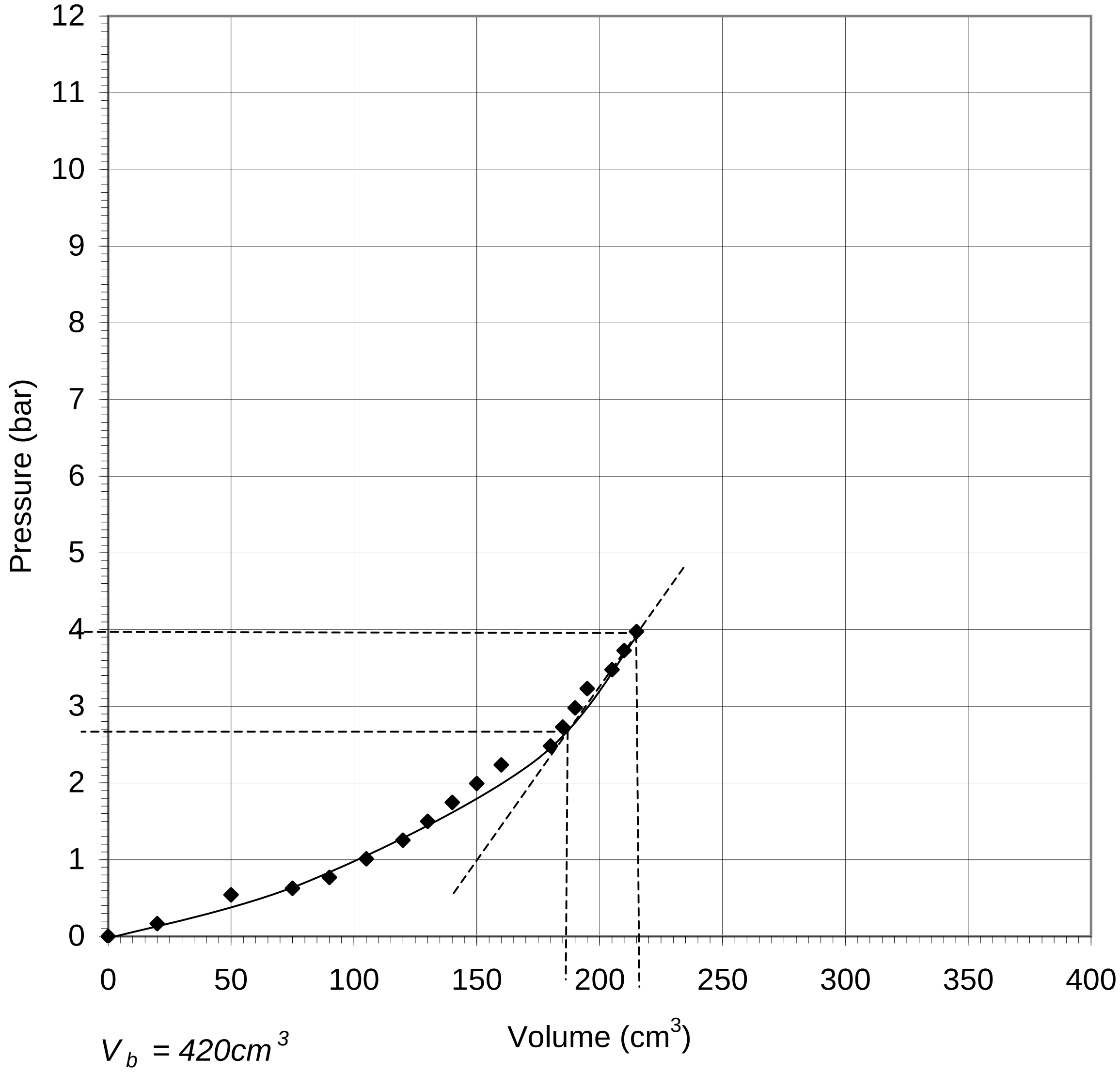



$V_b = 220cm^3$

***Pressuremeter Modulus $E_m$ = 152kg/cm$^2$***

**Pressuremeter Test Curve - 22**

Location : IPMT3
Depth (m) : 4m

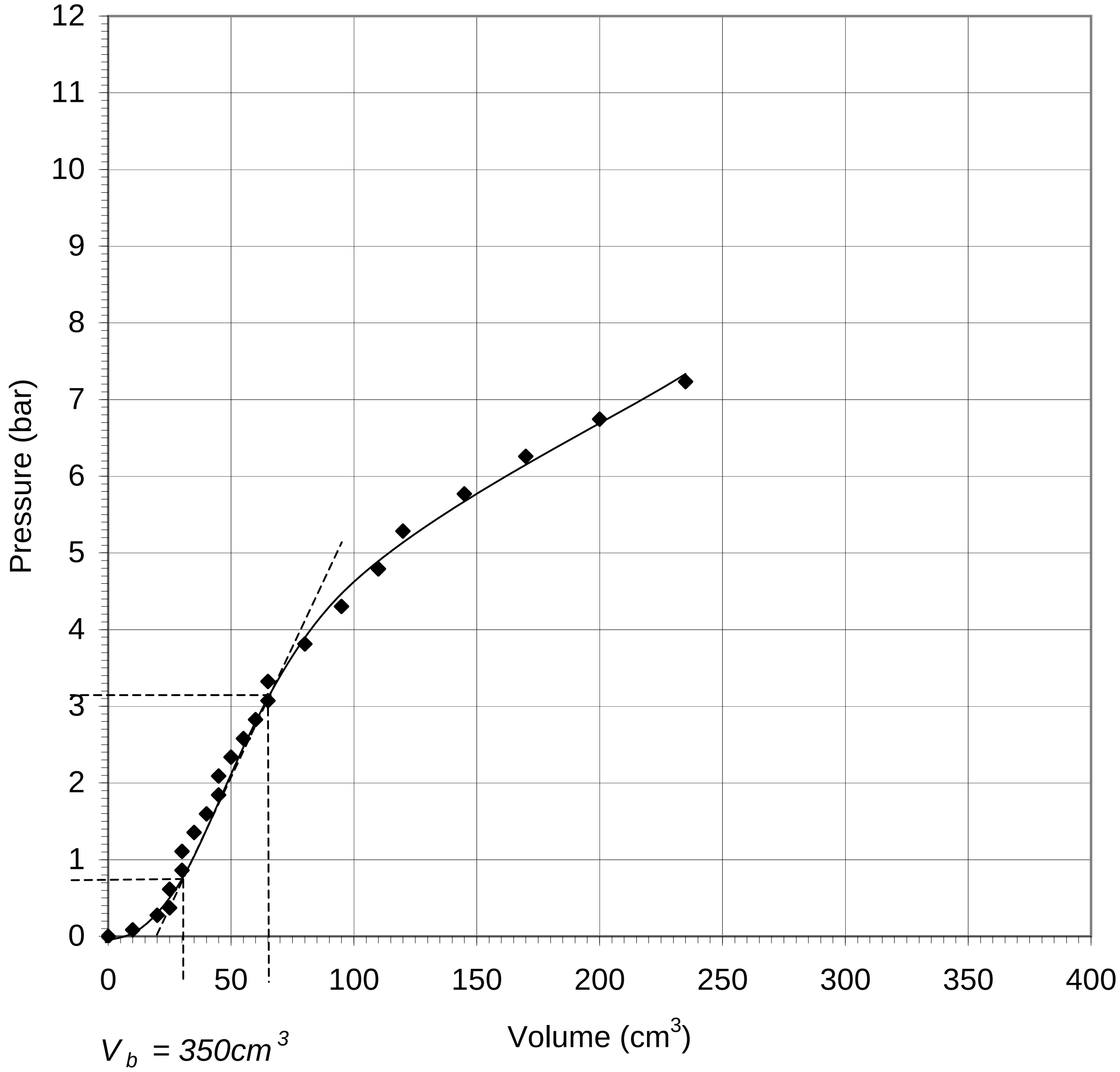



$V_b = 420cm^3$

***Pressuremeter Modulus*** $\boldsymbol{E_m = 146kg/cm^2}$

## Pressuremeter Test Curve - 23

Location : IPMT3
Depth (m) : 6m




*$V_b$ = 350cm$^3$*

***Pressuremeter Modulus $E_m$ = 191kg/cm$^2$***

**Pressuremeter Test Curve - 24**

Location : IPMT3
Depth (m) : 8m

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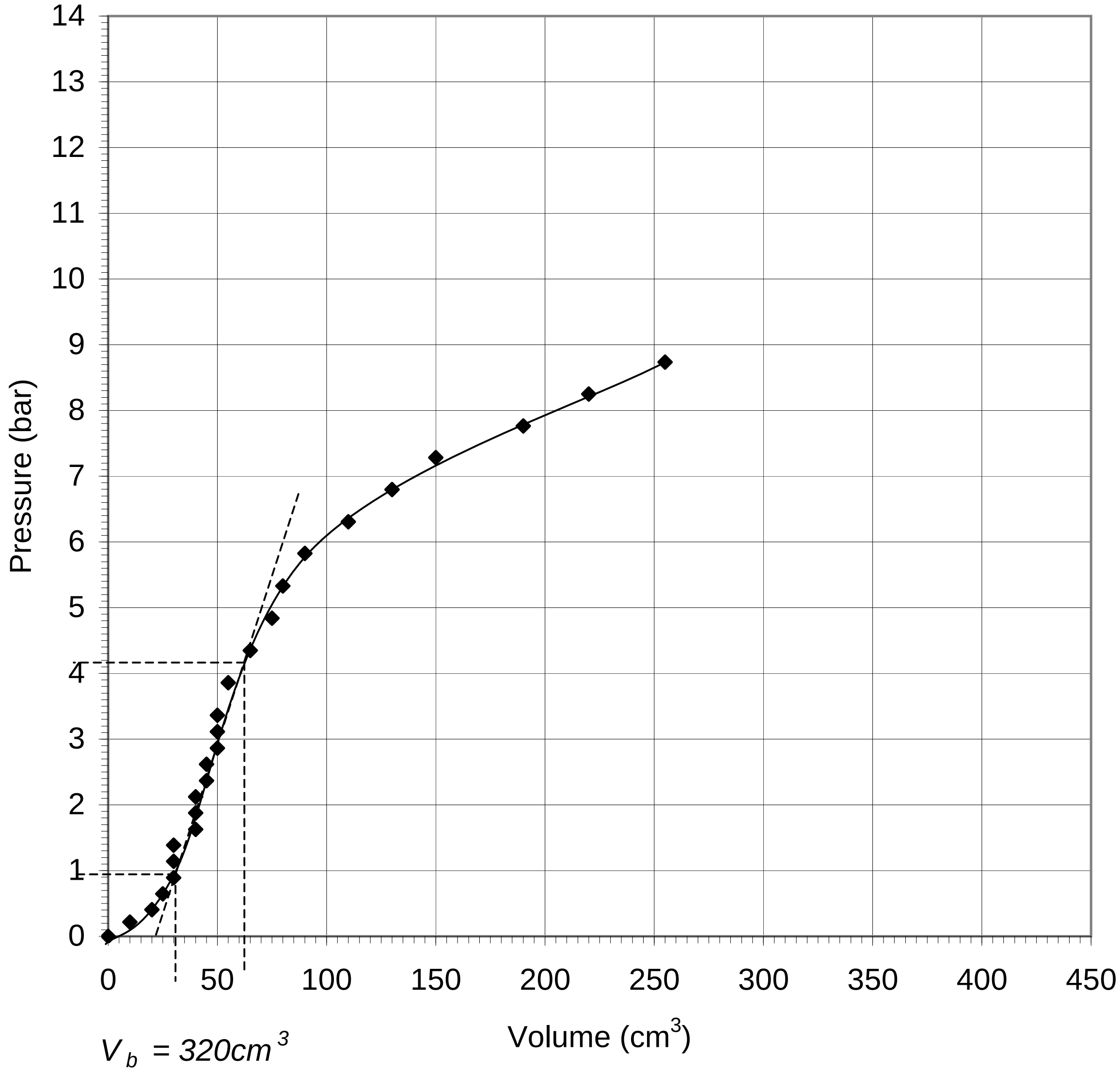
| | | | | |
|---|---|---|---|---|
| Delhi | : 011 (T) 26891980 | (F) 26897403 | delhi@nagadi.co.in |
| Bangalore | : 080 (T) 23156076 | (F) 23303007 | bangalore@nagadi.co.in |
| Chennai | : 044 (T) 24487870 | (F) 24488957 | chennai@nagadi.co.in |
| Secunderabad | : 040 (T) 27754446 | (F) 27751194 | secunderabad@nagadi.co.in |

Job No. : G(H)1658(9)

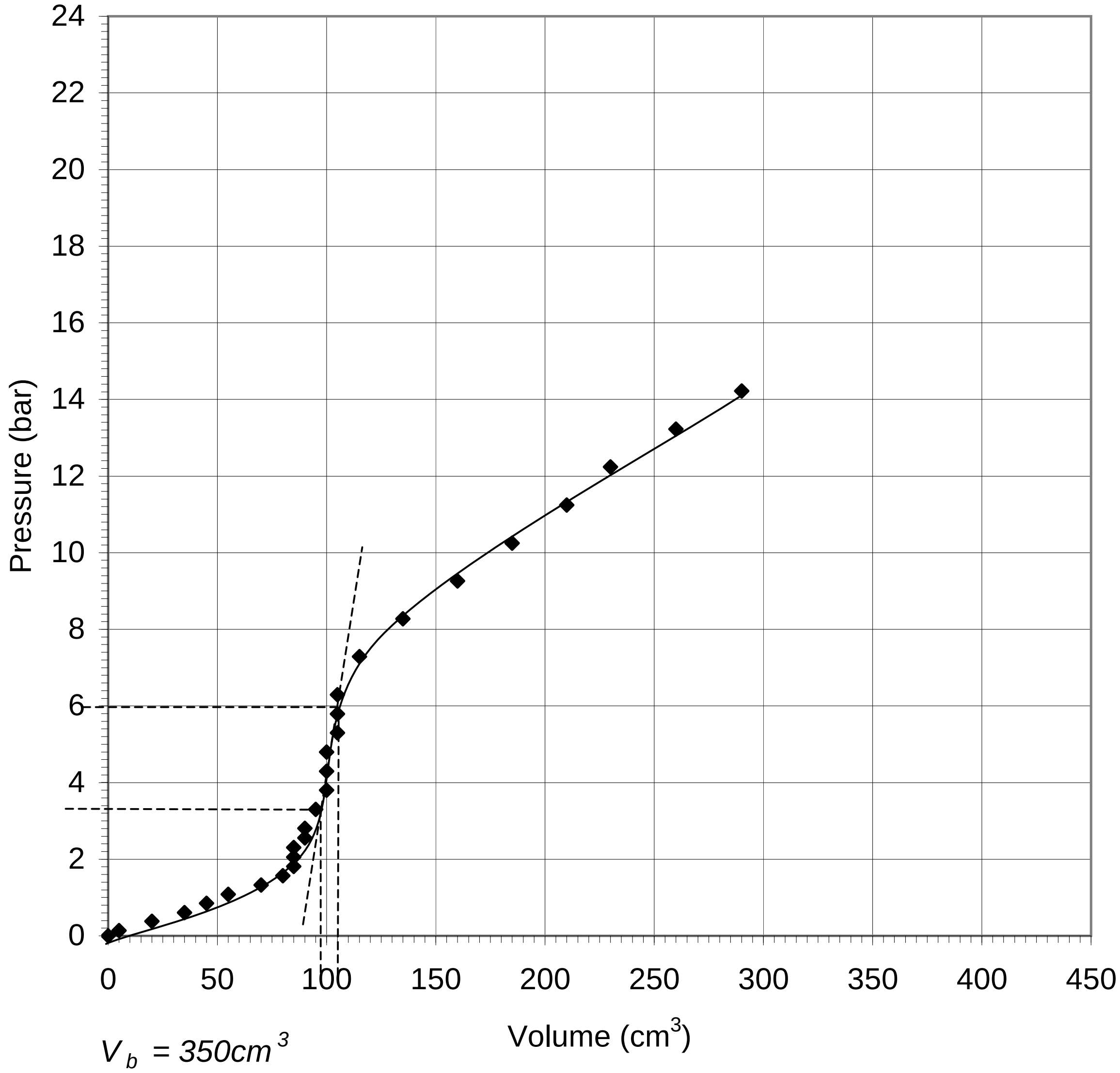



*$V_b$ = 320cm$^3$*

***Pressuremeter Modulus $E_m$ = 288kg/cm$^2$***

## Pressuremeter Test Curve - 25

Location : IPMT3
Depth (m) : 10m

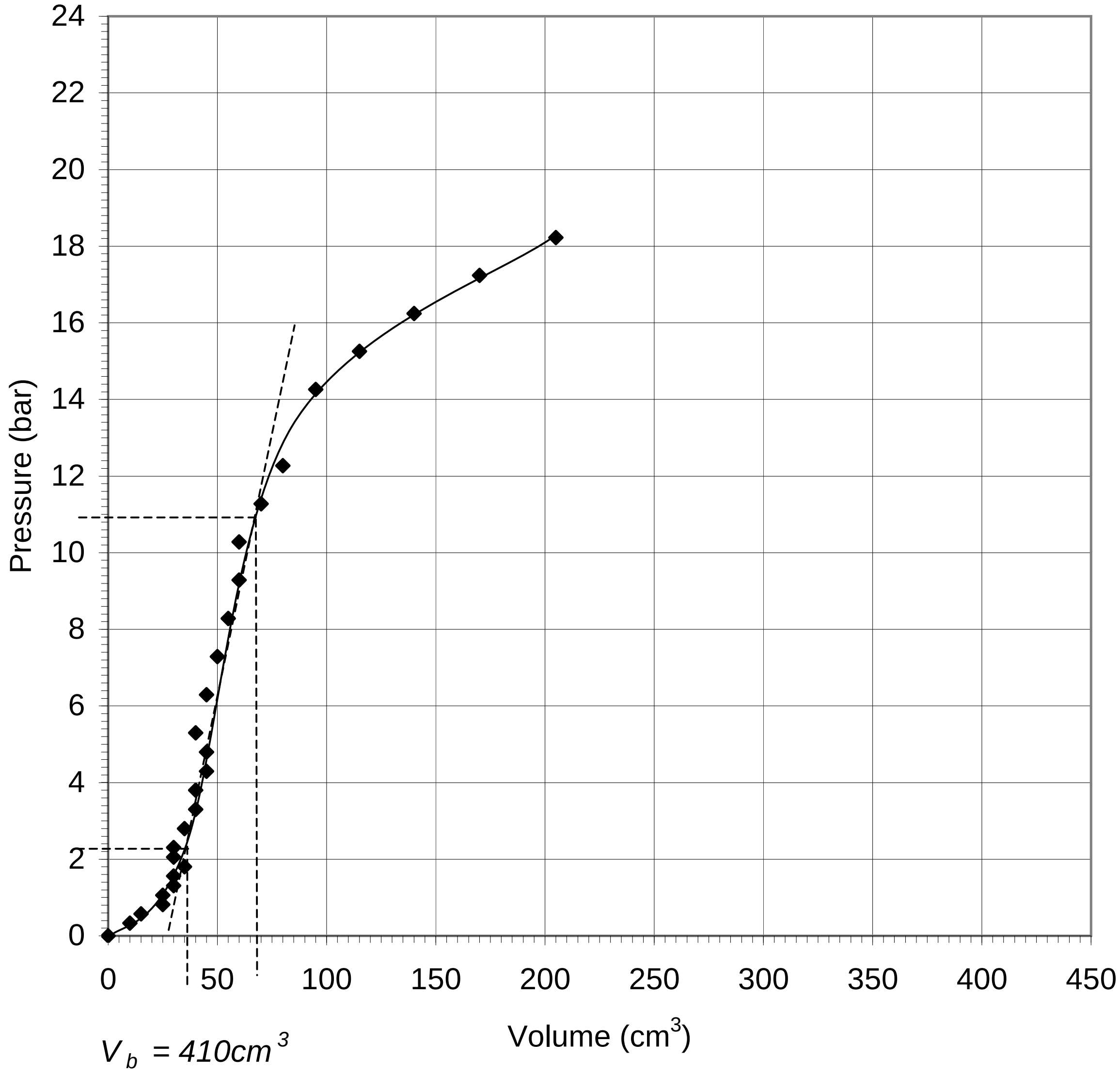



$V_b$ = 350cm$^3$

***Pressuremeter Modulus $E_m$ = 761kg/cm$^2$***

# Pressuremeter Test Curve - 26

Location : IPMT3
Depth (m) : 12m

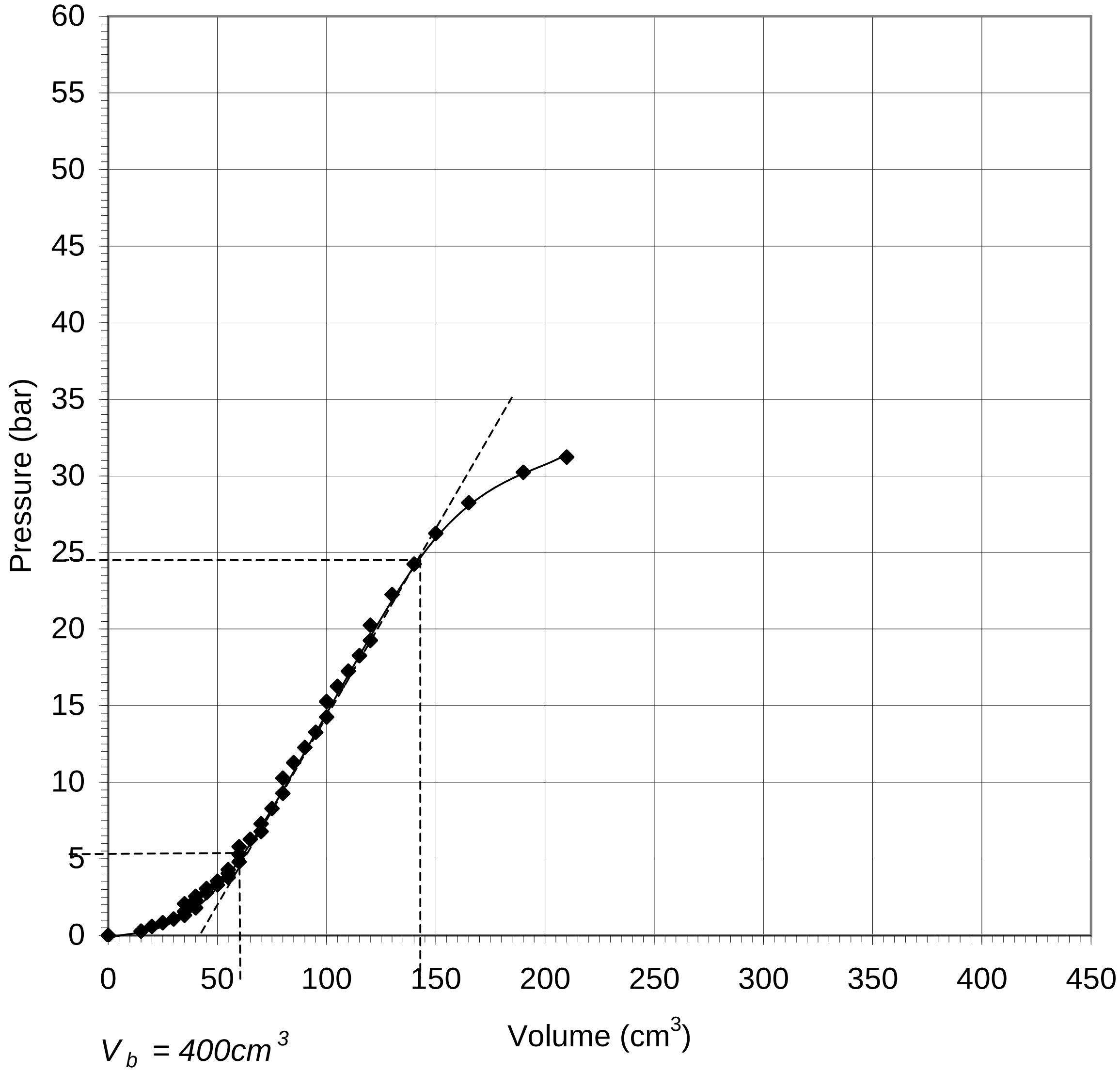



*$V_b$ = 410cm$^3$*

***Pressuremeter Modulus $E_m$ = 846kg/cm$^2$***

**Pressuremeter Test Curve - 27**

Location : IPMT3
Depth (m) : 15m

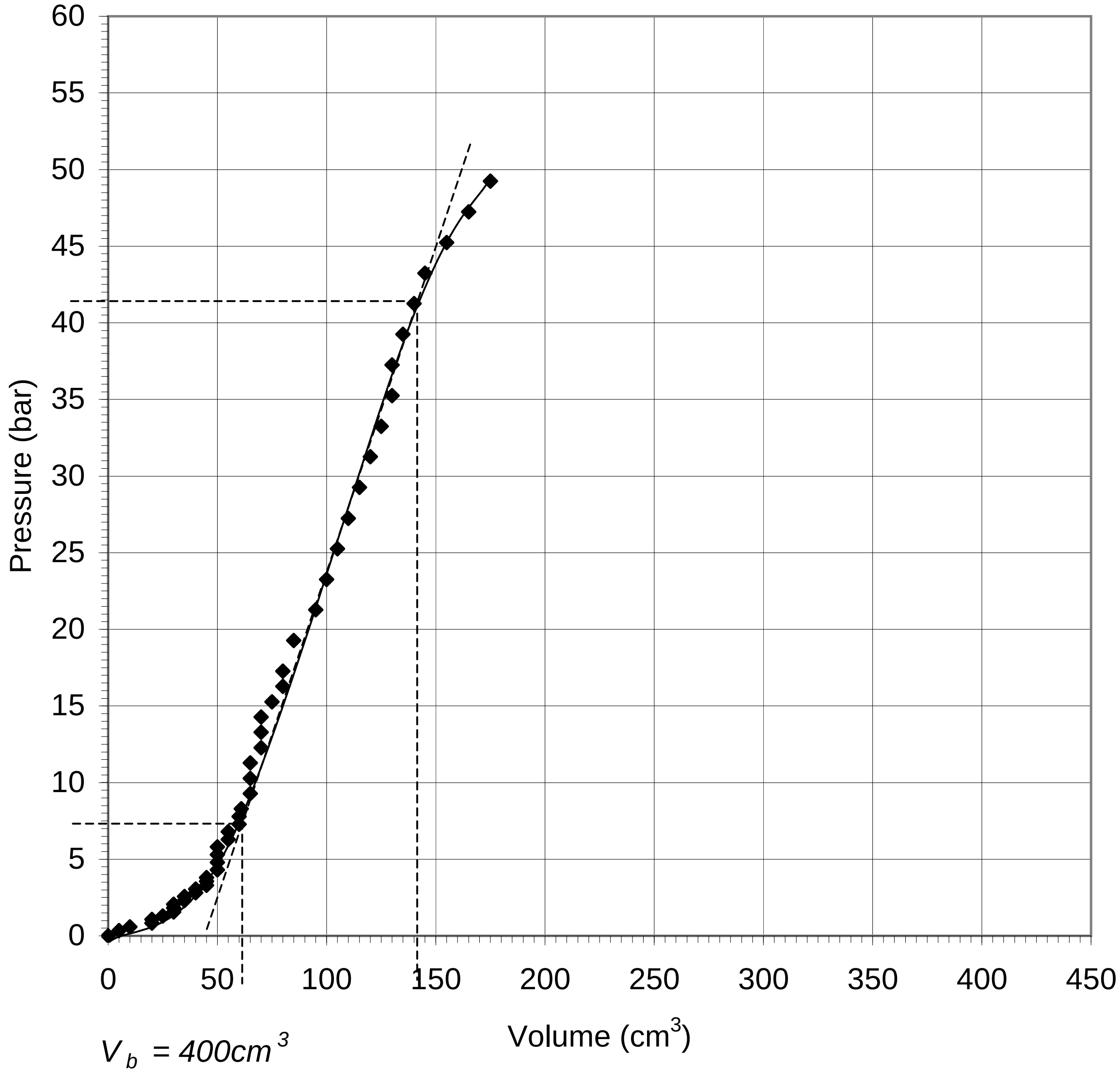



*$V_b$ = 400cm$^3$*

***Pressuremeter Modulus $E_m$ = 727kg/cm$^2$***

**Pressuremeter Test Curve - 28**

Location : IPMT3
Depth (m) : 18m

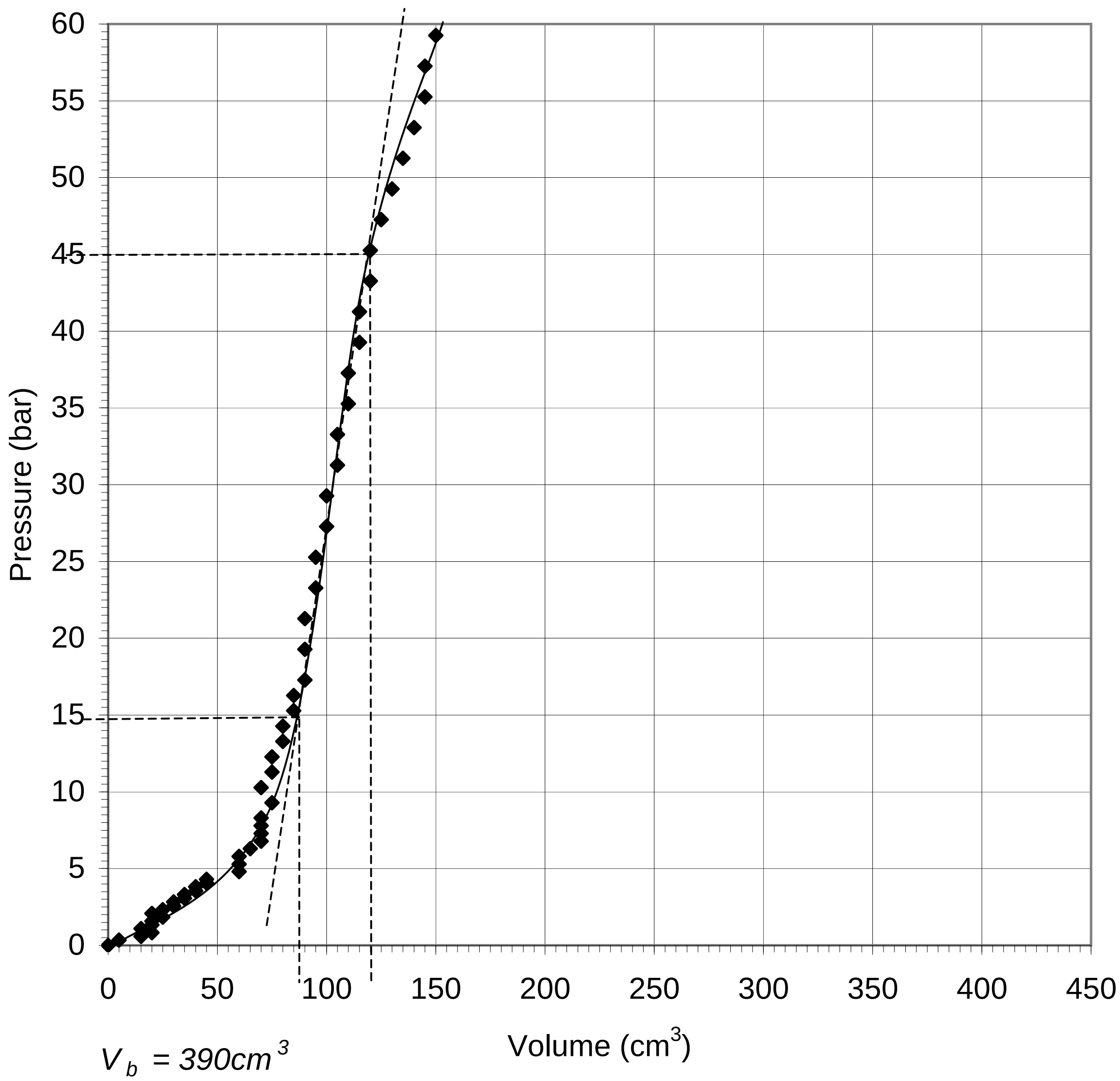



*$V_b$ = 400cm$^3$*

***Pressuremeter Modulus $E_m$ = 1300kg/cm$^2$***

**Pressuremeter Test Curve - 29**

Location : IPMT3
Depth (m) : 21m

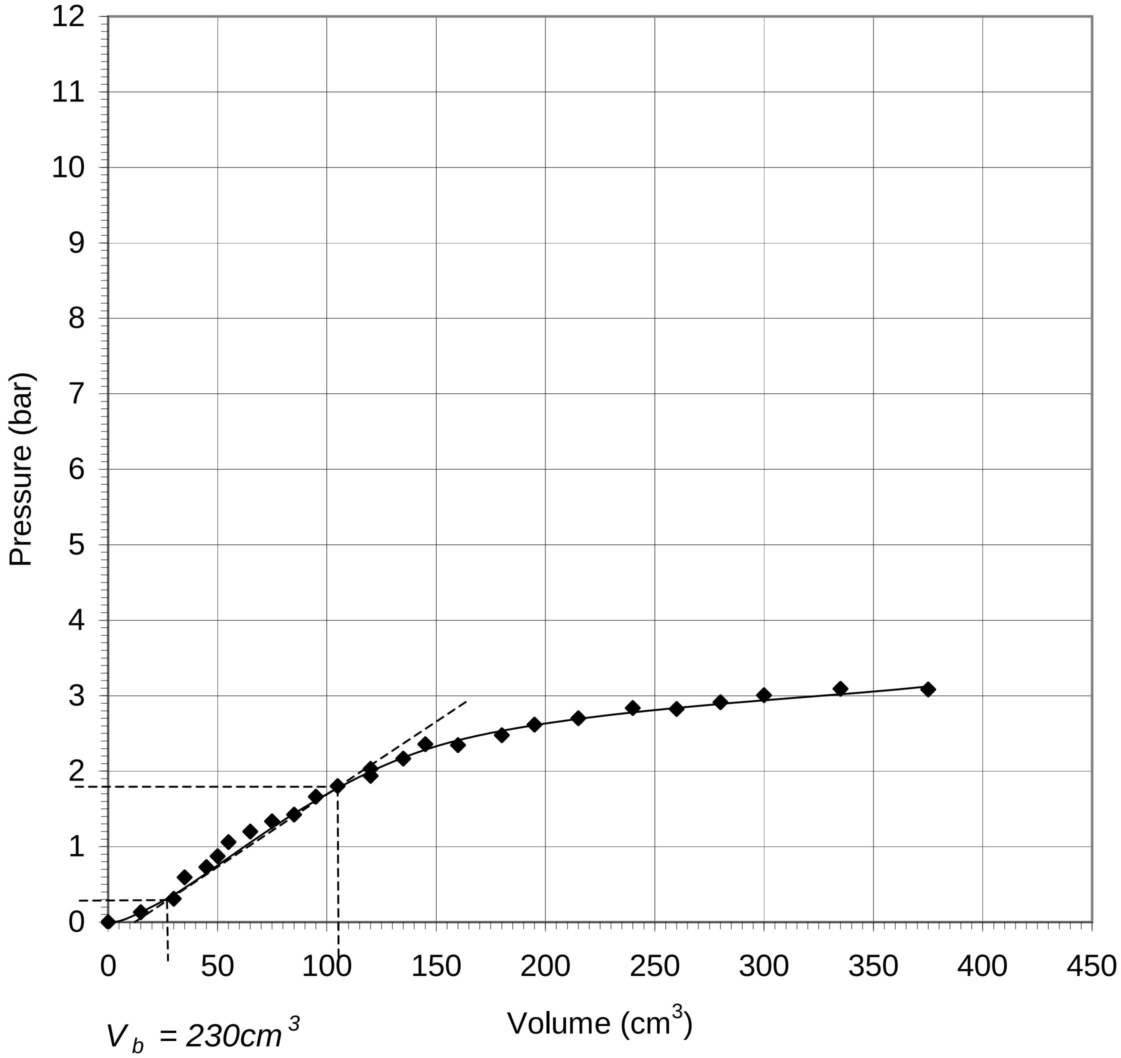



$V_b$ = 390cm$^3$

***Pressuremeter Modulus*** $\boldsymbol{E_m}$ ***= 2605kg/cm***$^{\boldsymbol{2}}$

**Pressuremeter Test Curve - 30**

Location : IPMT3
Depth (m) : 25m

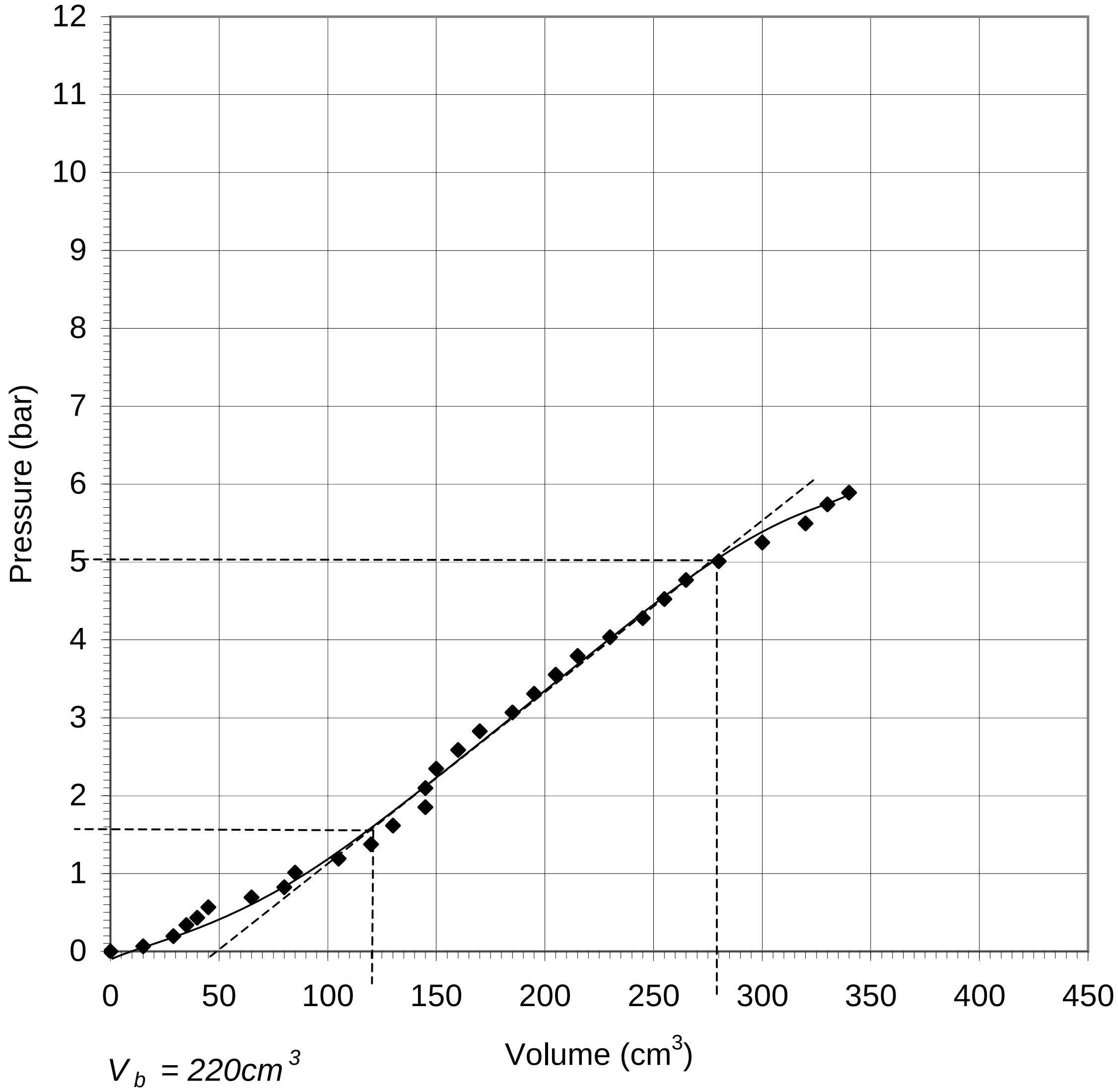



*$V_b$ = 230cm$^3$*

***Pressuremeter Modulus $E_m$ = 47kg/cm$^2$***

## Pressuremeter Test Curve - 31

Location : IPMT4
Depth (m) : 2m

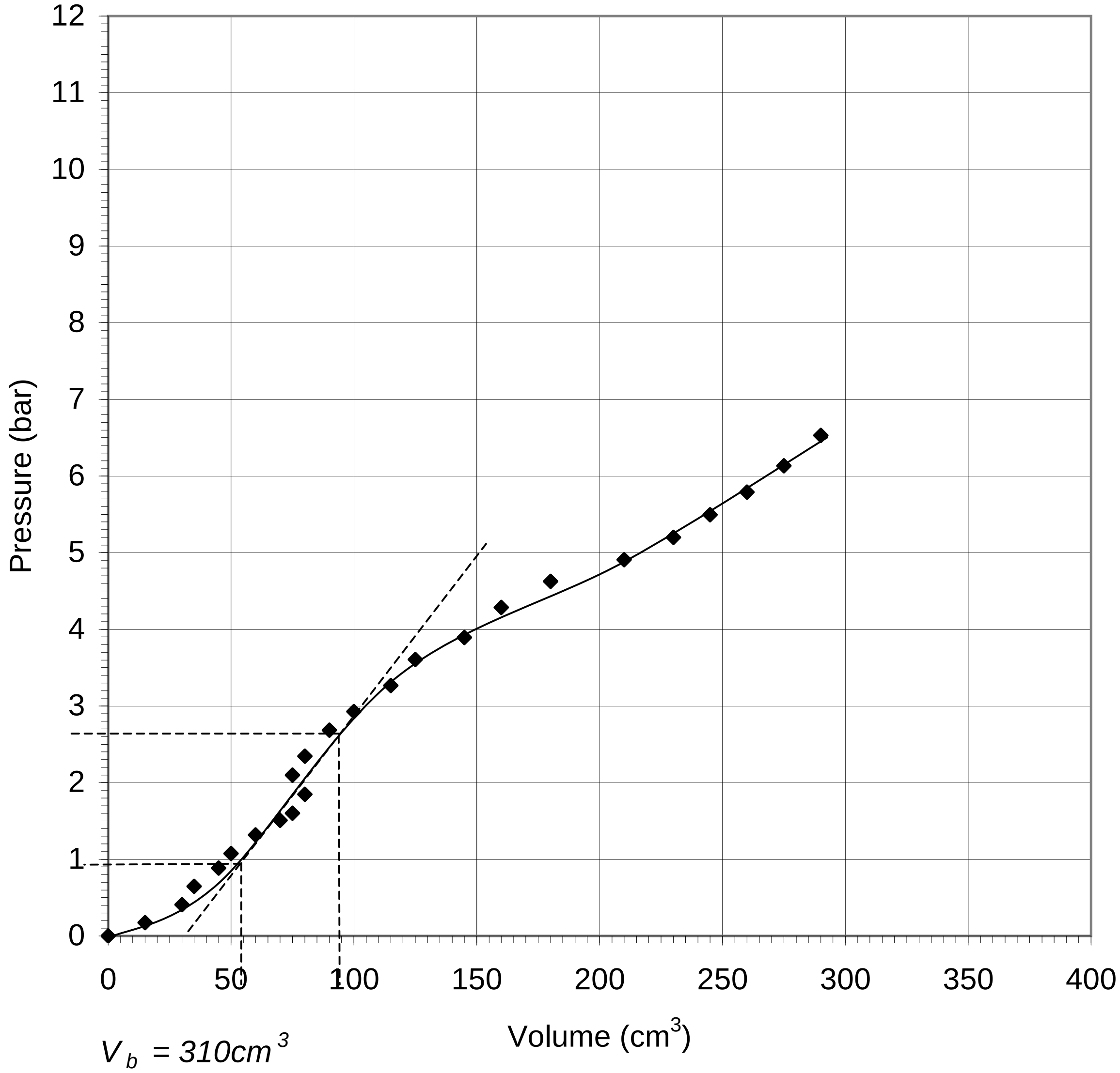



*$V_b$ = 220cm$^3$*

***Pressuremeter Modulus $E_m$ = 60kg/cm$^2$***

## Pressuremeter Test Curve - 32

Location : IPMT4
Depth (m) : 4m

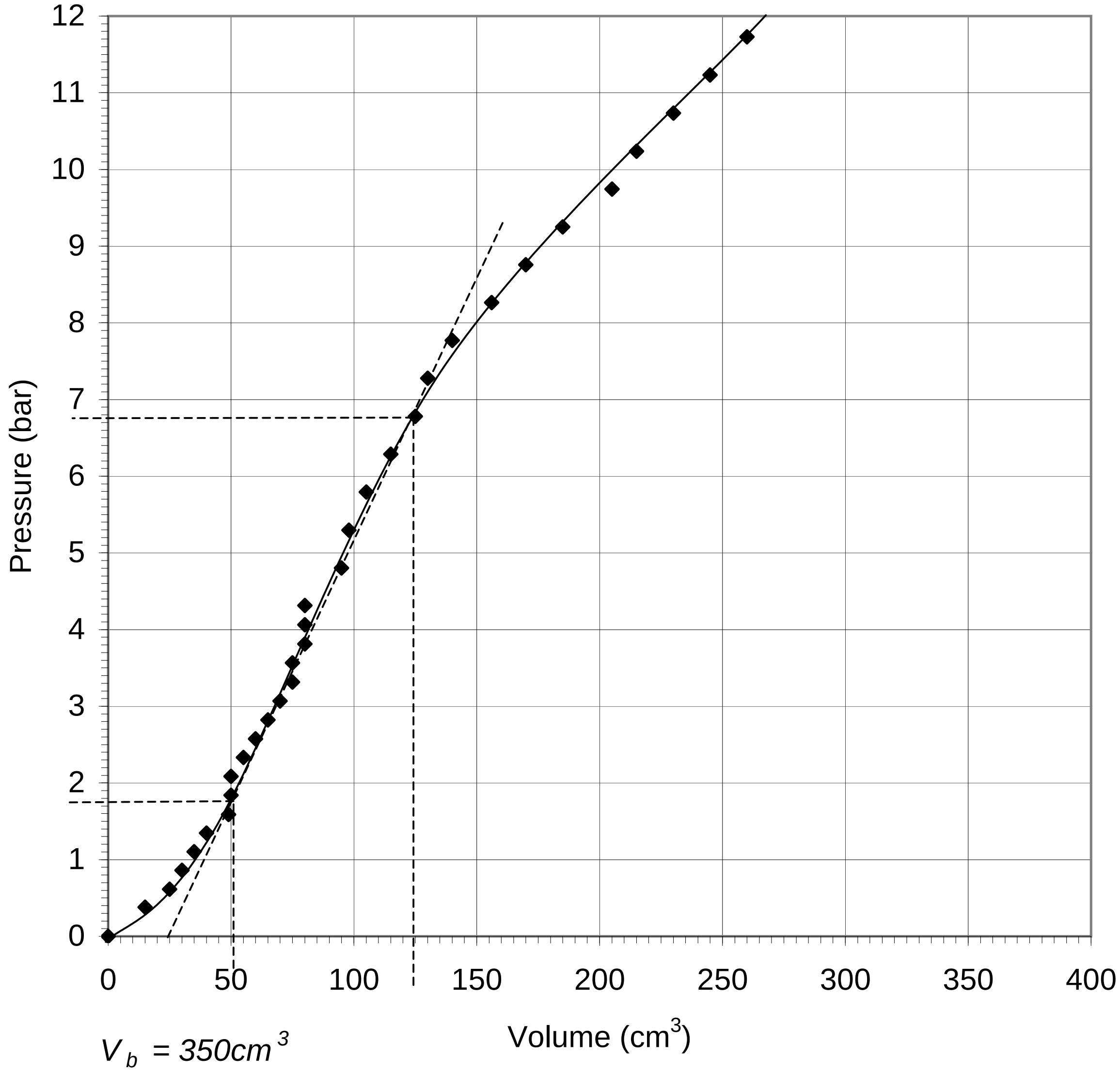



*$V_b$ = 310cm$^3$*

***Pressuremeter Modulus $E_m$ = 123kg/cm$^2$***

**Pressuremeter Test Curve - 33**

Location : IPMT4
Depth (m) : 6m

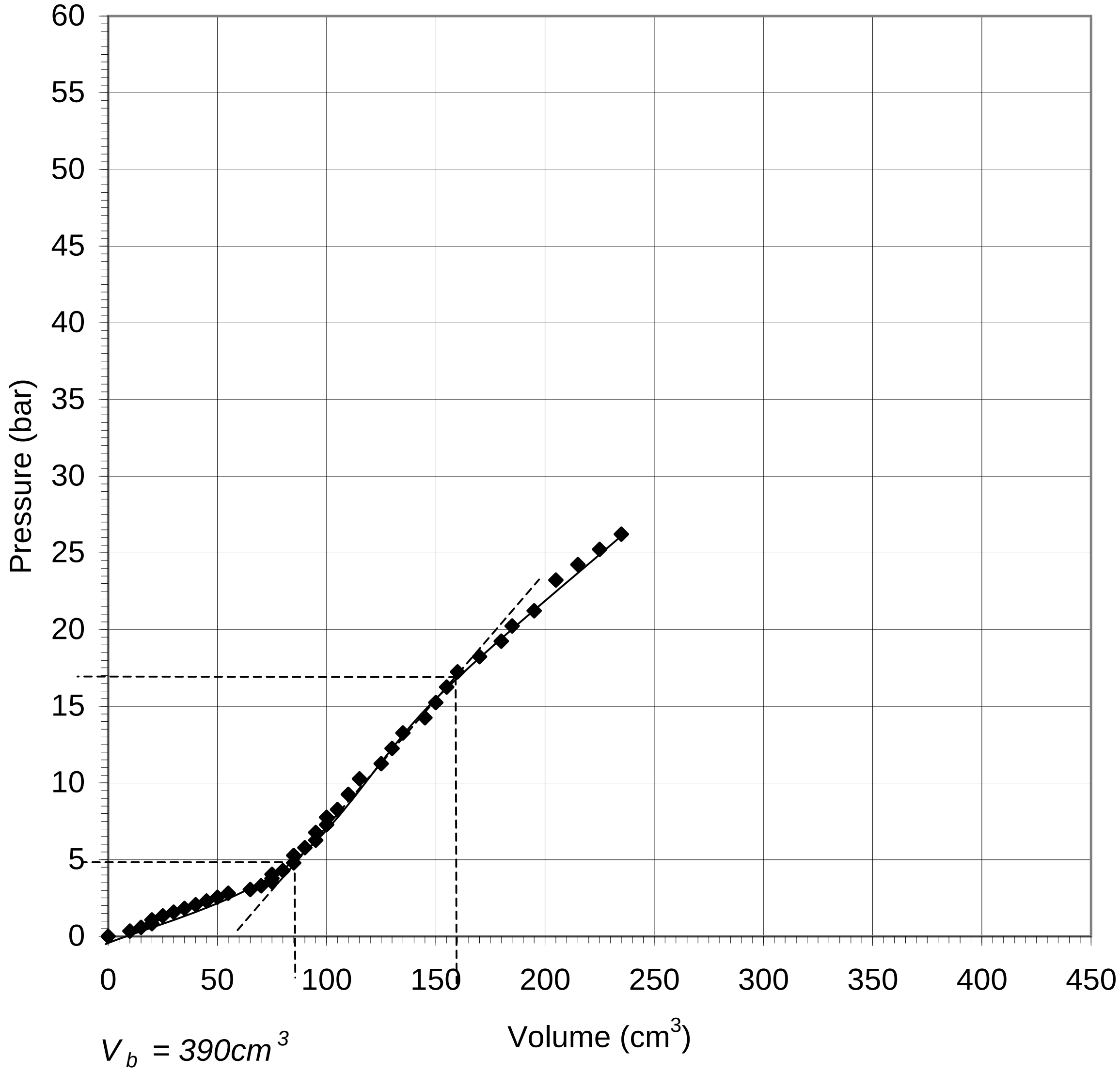



$V_b$ = 350cm$^3$

***Pressuremeter Modulus $E_m$ = 565kg/cm$^2$***

**Pressuremeter Test Curve - 34**

Location : IPMT4
Depth (m) : 8m

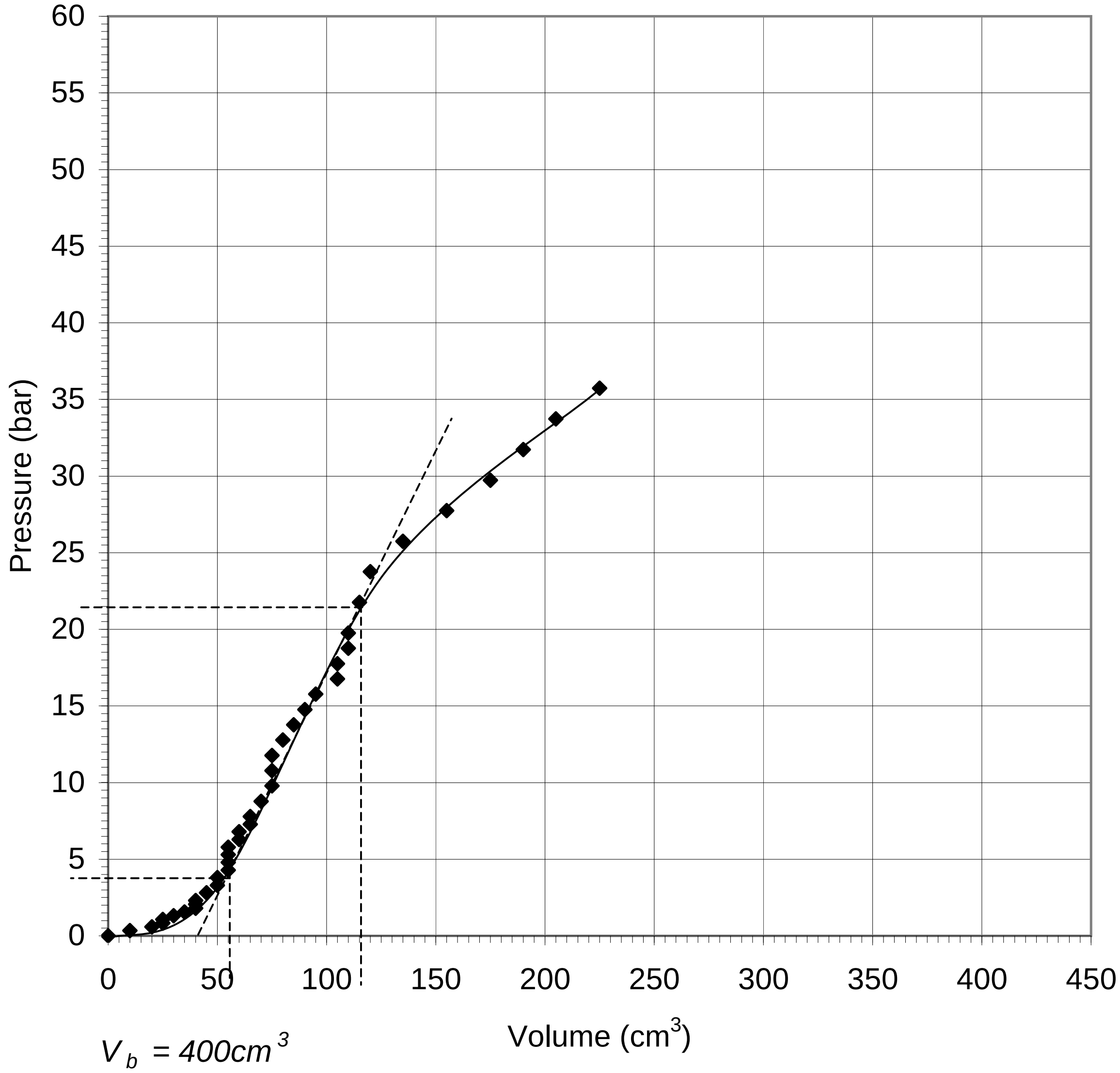



*$V_b$ = 390cm$^3$*

***Pressuremeter Modulus $E_m$ = 495kg/cm$^2$***

**Pressuremeter Test Curve - 35**

Location : IPMT4
Depth (m) : 10m

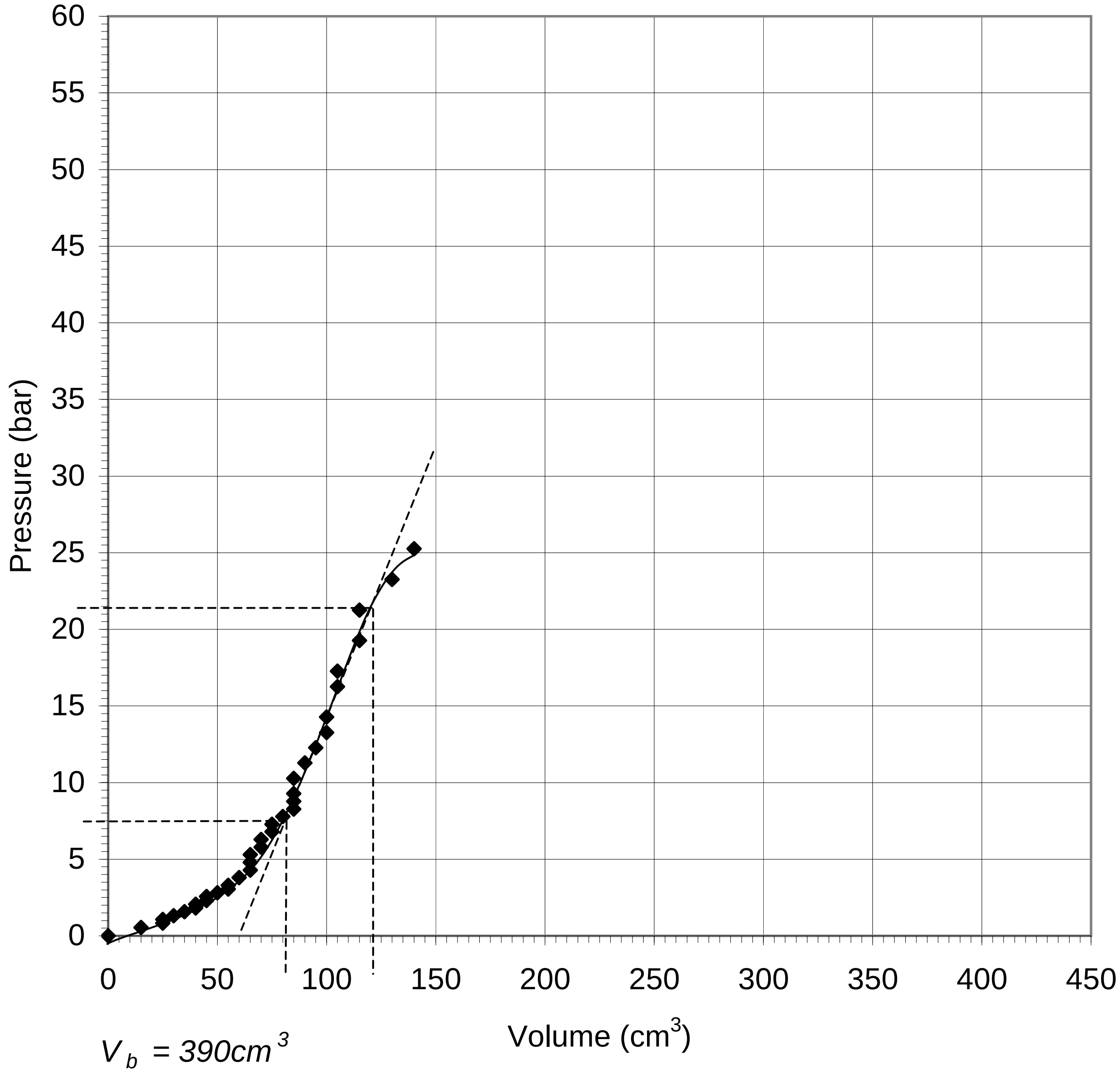



*$V_b$ = 400cm$^3$*

***Pressuremeter Modulus $E_m$ = 881kg/cm$^2$***

## Pressuremeter Test Curve - 36

Location : IPMT4
Depth (m) : 12m

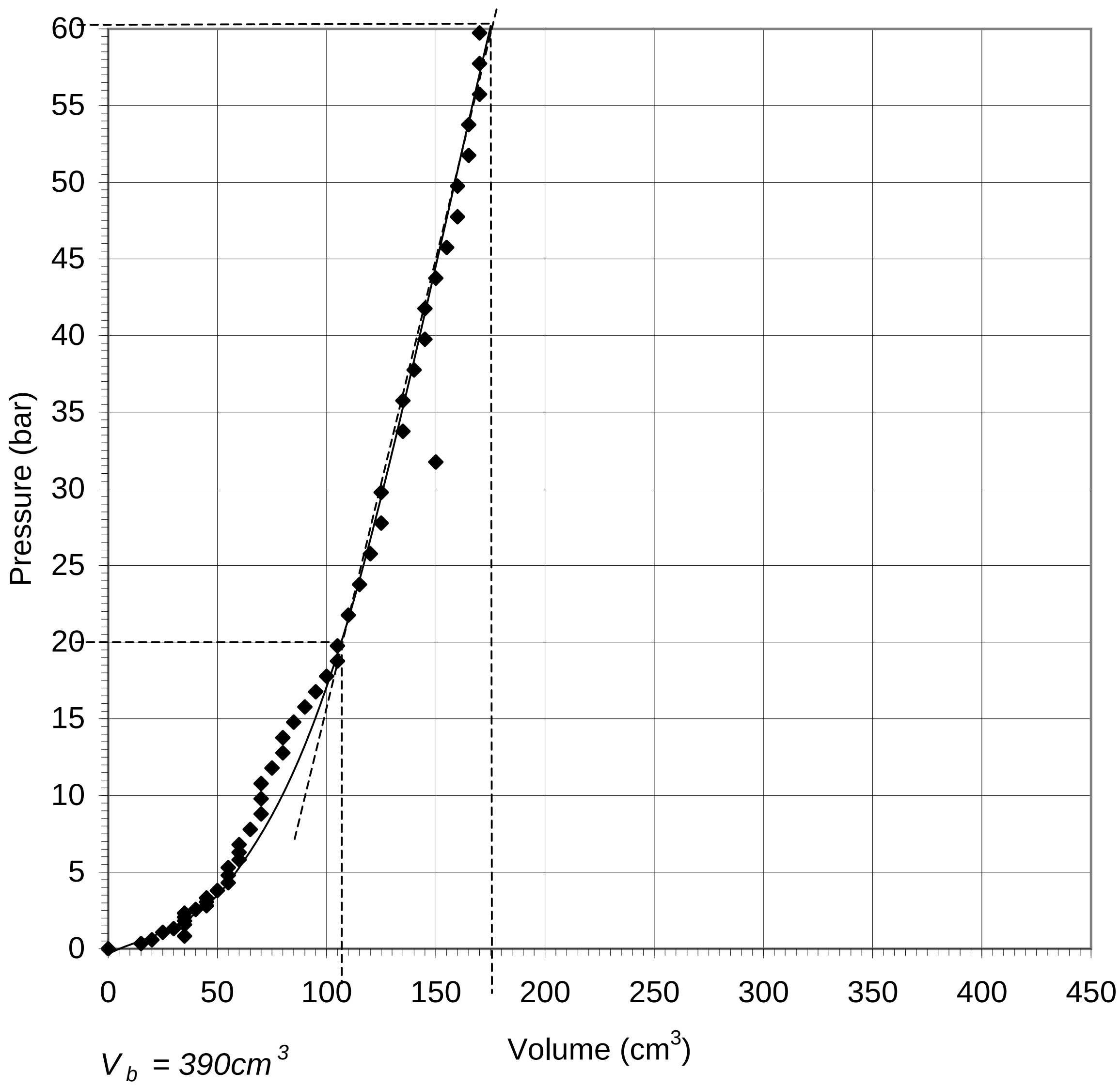



*$V_b$ = 390cm$^3$*

***Pressuremeter Modulus $E_m$ = 1061kg/cm$^2$***

**Pressuremeter Test Curve - 37**

Location : IPMT4
Depth (m) : 15m



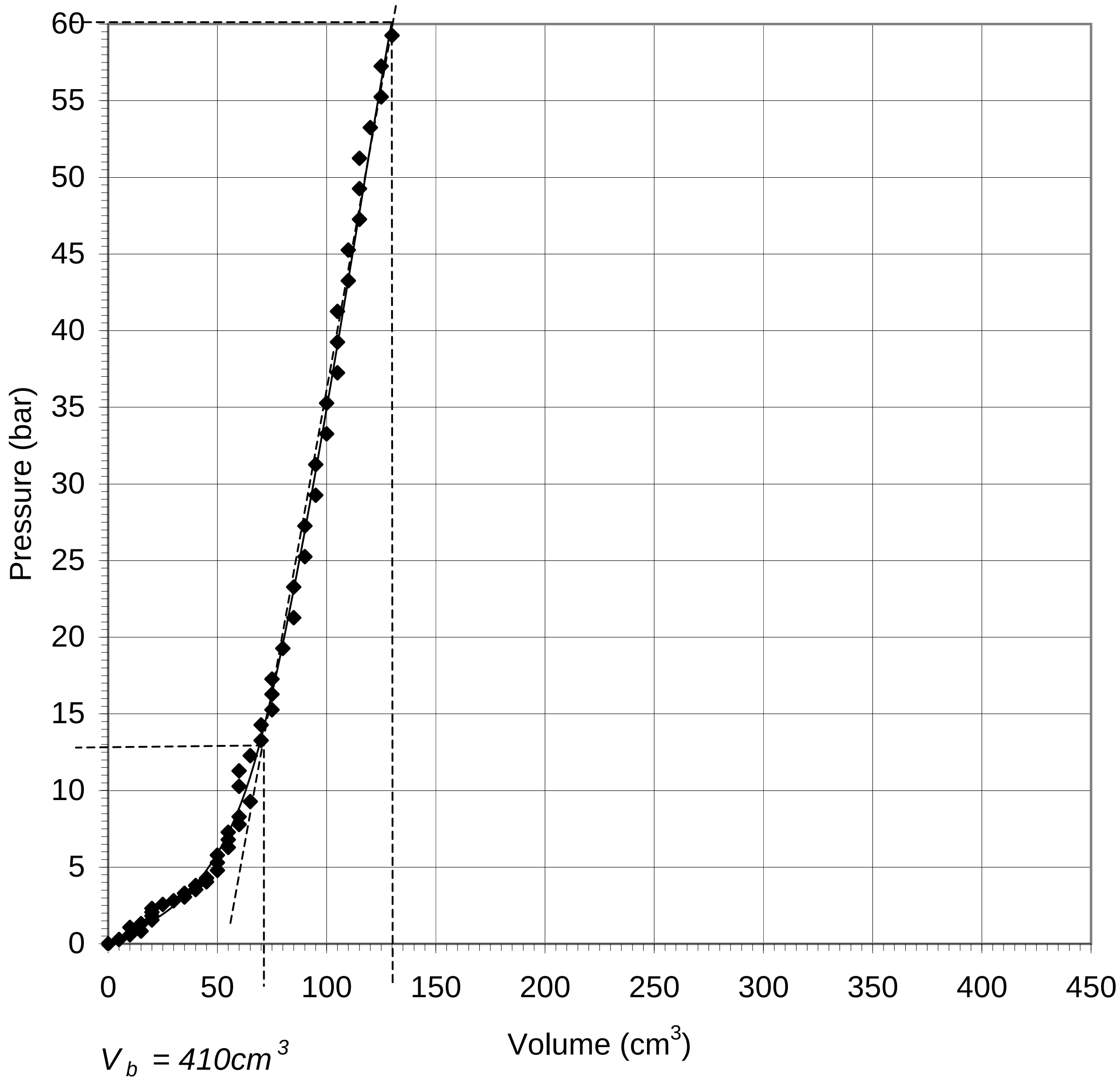

$V_b$ = 390cm$^3$

***Pressuremeter Modulus $E_m$ = 1794kg/cm$^2$***

## Pressuremeter Test Curve - 38

Location : IPMT4

Depth (m) : 18m

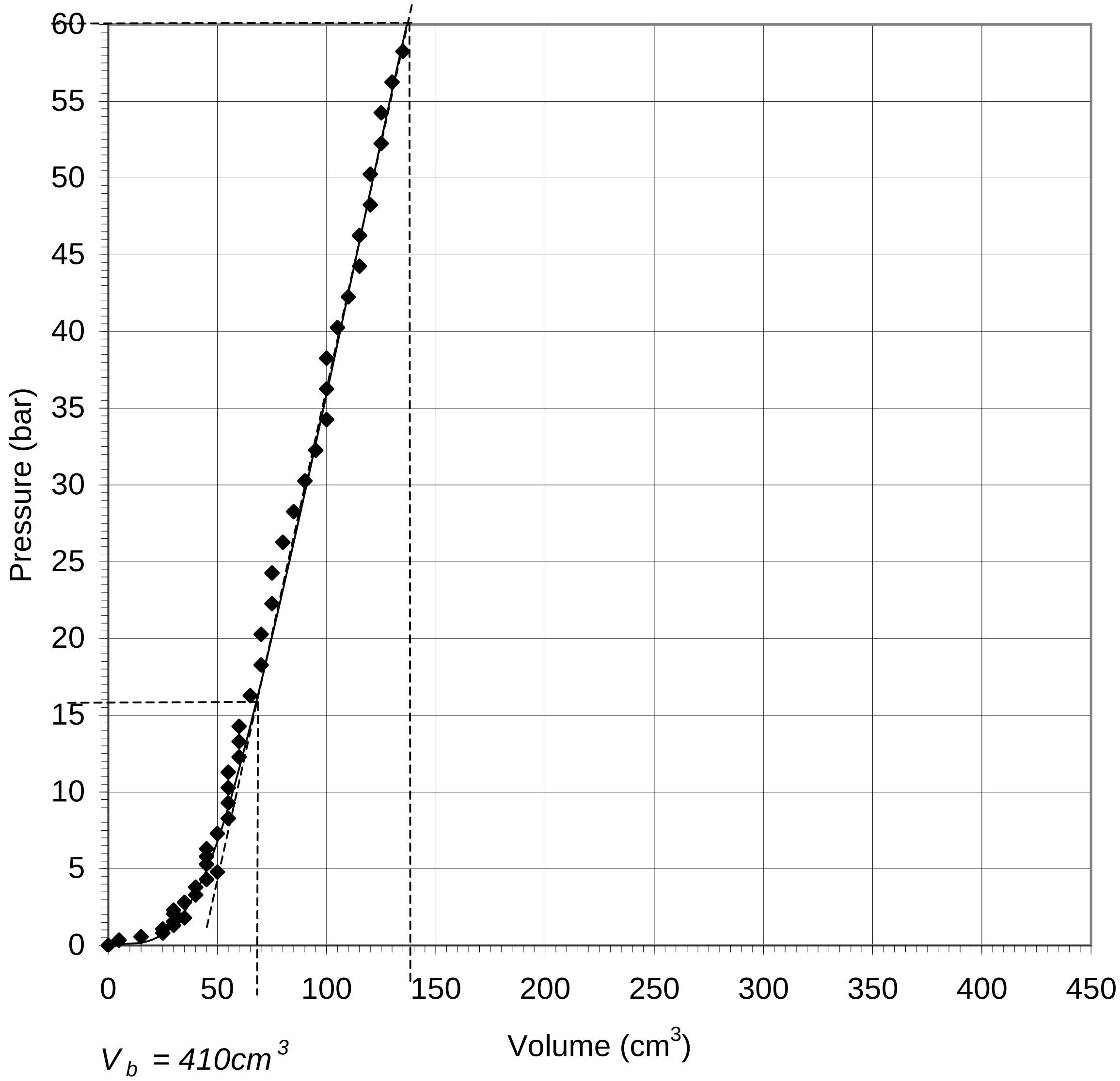



*$V_b$ = 410cm$^3$*

***Pressuremeter Modulus $E_m$ = 2417kg/cm$^2$***

**Pressuremeter Test Curve - 39**

Location : IPMT4
Depth (m) : 21m




*$V_b$ = 410cm³*

***Pressuremeter Modulus $E_m$ = 1940kg/cm²***

**Pressuremeter Test Curve - 40**

Location : IPMT4
Depth (m) : 25m

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | SPT (N Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 1 | 1.0 | SPT | 4 | 5 | 6 | 11 | | | | 2 | 36 | 35 | 27 | 40 | 24 | 16 | | CI | | 2.5 | | | | | | | | | | | | | | | | |
| 1 | 2.0 | UDS | | | | | 2.28 | 2.14 | 6.3 | | | | | | | | | | | | | | | | | | | | 0.23 | 35 | | | | | | |
| 1 | 3.0 | SPT | 20 | 20 | 12 | 32 | | | | 31 | 44 | 14 | 11 | L | P | | | SM | | | | | | | | | | | | | | | | | | |
| 1 | 4.0 | UDS | | | | | 1.99 | 1.68 | 17.8 | | | | | | | | 8.9 | | | | CD | 0.24 | 22 | | | | | | | 40 | | | | | | |
| 1 | 5.0 | SPT | 7 | 16 | 35 | 51 | | | | 0 | 9 | 50 | 41 | 64 | 28 | 36 | | CH | | 2.5 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No: G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 2 | 1.0 | SPT | 3 | 5 | 8 | 13 | | | | 0 | 11 | 39 | 50 | 76 | 30 | 46 | | CH | | 2.56 | | | | | | | | | | 110 | | | | | | |
| 2 | 2.0 | UDS | | | | | 1.98 | 1.48 | 33.6 | | | | | | | | | | | | UU | 0.06 | 12 | | | | | | 1.2 | 120 | | | | | | |
| 2 | 3.0 | SPT | 7 | 10 | 11 | 21 | | | | 6 | 10 | 36 | 48 | 66 | 29 | 37 | | CH | | | | | | | | | | | | | | | | | | |
| 2 | 4.0 | UDS | | | | | 2.03 | 1.62 | 24.6 | | | | | | | | | | | | | | | | | | | | 0.8 | 70 | | | | | | |
| 2 | 5.0 | SPT | 13 | 17 | 27 | 44 | | | | 0 | 21 | 32 | 47 | 68 | 31 | 37 | | CH | | 2.52 | | | | | | | | | | | | | | | | |
| 2 | 6.5 | UDS | | | | | 1.64 | 1.28 | 27.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 8.0 | SPT | 10 | 19 | 28 | 47 | | | | 3 | 31 | 31 | 35 | 52 | 26 | 26 | | CH | | 2.55 | | | | | | | | | | 100 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 3 | 1.0 | SPT | 3 | 6 | 9 | 15 | | | | 3 | 36 | 28 | 33 | 48 | 25 | 23 | | CI | | 2.54 | | | | | | | | | | | | | | | | |
| 3 | 2.0 | UDS | | | | | 1.94 | 1.46 | 32.9 | | | | | | | | 9.1 | | | | UCC | 1.21 | | | | | | | 0.81 | 70 | | | | | | |
| 3 | 3.0 | SPT | 11 | 21 | 30 | 51 | | | | 0 | 12 | 42 | 46 | 68 | 32 | 36 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 3 | 4.0 | UDS | | | | | 1.95 | 1.64 | 19.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 4 | 1.0 | SPT | 3 | 5 | 8 | 13 | | | | 4 | 35 | 26 | 35 | 48 | 25 | 23 | | CI | | 2.56 | | | | | | | | | | | | | | | | |
| 4 | 2.0 | UDS | | | | | 1.80 | 1.59 | 13.4 | | | | | | | | | | | | CD | 0.28 | 20 | | | | | | 0.53 | 60 | | | | | | |
| 4 | 3.0 | SPT | 8 | 14 | 21 | 35 | | | | 0 | 13 | 42 | 45 | 68 | 32 | 36 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 4 | 4.0 | UDS | | | | | 2.00 | 1.68 | 19.4 | | | | | | | | | | | | | | | | | | | | 0.48 | 70 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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Job No G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 5 | 1.0 | SPT | 2 | 3 | 4 | 7 | | | | 0 | 14 | 43 | 43 | 72 | 34 | 38 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 5 | 2.0 | UDS | | | | | 2.00 | 1.54 | 30.0 | | | | | | | | | | | | | | | | | | | 0.7 | 80 | | | | | | | |
| 5 | 3.0 | SPT | 2 | 4 | 7 | 11 | | | | 2 | 24 | 34 | 40 | 68 | 33 | 35 | | | | 2.53 | | | | | | | | | | | | | | | | |
| 5 | 4.0 | UDS | | | | | 1.90 | 1.64 | 15.4 | | | | | | | | 8.8 | | | | UCC | 1.32 | | | | | | 1.1 | 100 | | | | | | | |
| 5 | 5.0 | SPT | 8 | 14 | 21 | 35 | | | | 2 | 31 | 33 | 34 | 46 | 24 | 22 | | CI | | | | | | | | | | | | | | | | | | |
| 5 | 6.5 | UDS | | | | | 1.92 | 1.55 | 23.7 | | | | | | | | | | | 2.54 | | | | | | | | 0.4 | 60 | | | | | | | |
| 5 | 8.0 | SPT | 17 | 27 | 34 | 61 | | | | 2 | 29 | 34 | 35 | 42 | 24 | 18 | | CI | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' ($kg/cm^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' ($kg/cm^2$) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' ($cm^2/kg$) | Co. of Consolid. 'Cv' ($cm^2/min$) | Swelling Pressure ($kg/cm^2$) | Free Swell Index (%) | Max. Dry Dendity ($g/cm^3$) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 6 | 1.0 | SPT | 3 | 8 | 11 | 19 | | | | 2 | 21 | 40 | 37 | 72 | 32 | 40 | | CH | | | | | | | | | | | | | | | | | | |
| 6 | 2.0 | UDS | | | | | 1.86 | 1.44 | 28.8 | | | | | | | | | | | | CD | 0.28 | 18 | | | | | | 1.25 | 120 | | | | | | |
| 6 | 3.0 | SPT | 7 | 13 | 20 | 33 | | | | 8 | 13 | 32 | 47 | 69 | 30 | 39 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 6 | 4.0 | UDS | | | | | 1.88 | 1.56 | 20.4 | | | | | | | | | | | | | | | | | | | | | 100 | | | | | | |
| 6 | 5.0 | SPT | 14 | 21 | 28 | 49 | | | | 3 | 12 | 35 | 50 | 65 | 27 | 38 | | CH | | | | | | | | | | | | | | | | | | |
| 6 | 6.5 | UDS | | | | | 1.98 | 1.47 | 34.5 | | | | | | | | | | | | | | | | | | | | 1.17 | 110 | | | | | | |
| 6 | 8.0 | SPT | 12 | 24 | 31 | 55 | | | | 3 | 12 | 40 | 45 | 60 | 26 | 34 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
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| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' ($kg/cm^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' ($kg/cm^2$) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' ($cm^2/kg$) | Co. of Consolid. 'Cv' ($cm^2/min$) | Swelling Pressure ($kg/cm^2$) | Free Swell Index (%) | Max. Dry Dendity ($g/cm^3$) | Optimum Moisture Cont. (%) | | | | |
| 7 | 1.0 | SPT | 3 | 6 | 11 | 17 | | | | 0 | 31 | 33 | 36 | 48 | 24 | 24 | | CI | | 2.54 | | | | | | | | | | | | | | | | |
| 7 | 2.0 | UDS | | | | | 1.90 | 1.61 | 17.5 | | | | | | | | | | | | CD | 0.30 | 20 | | | | | | 0.42 | 50 | | | | | | |
| 7 | 3.0 | SPT | 9 | 15 | 20 | 35 | | | | 0 | 26 | 47 | 27 | 40 | 23 | 17 | | CI | | 2.56 | | | | | | | | | | | | | | | | |
| 7 | 4.0 | UDS | | | | | 1.95 | 1.64 | 18.6 | | | | | | | | | | | | | | | | | | | | | 50 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 8 | 1.0 | SPT | 3 | 4 | 8 | 12 | | | | 2 | 30 | 31 | 37 | 48 | 25 | 23 | | CI | | 2.57 | | | | | | | | | | | | | | | | |
| 8 | 2.0 | UDS | | | | | 1.94 | 1.59 | 22.3 | | | | | | | | | | | | | | | | | | | | | 65 | | | | | | |
| 8 | 3.0 | SPT | 4 | 4 | 7 | 11 | | | | 2 | 27 | 30 | 41 | 58 | 26 | 32 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 8 | 4.0 | UDS | | | | | 1.85 | 1.56 | 18.8 | | | | | | | | 9.8 | | | | UCC | 1.45 | | | | | | | 0.63 | 80 | | | | | | |
| 8 | 5.0 | SPT | 7 | 11 | 16 | 27 | | | | 2 | 32 | 33 | 33 | 45 | 24 | 21 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 8 | 6.5 | UDS | | | | | 1.78 | 1.57 | 13.5 | | | | | | | | | | | | | | | | | | | | | 40 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio 'e$_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index 'C$_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 9 | 1.0 | SPT | 2 | 2 | 4 | 6 | | | | 0 | 19 | 39 | 42 | 63 | 28 | 35 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 9 | 2.0 | UDS | | | | | 1.90 | 1.50 | 21.5 | | | | | | | | | | | | | | | | | | | | 0.34 | 60 | | | | | | |
| 9 | 3.0 | SPT | 2 | 5 | 8 | 13 | | | | 2 | 23 | 32 | 43 | 56 | 25 | 31 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 9 | 4.0 | UDS | | | | | 1.48 | 1.26 | 17.3 | | | | | | | | | | | | UCC | 1.63 | | | | | | | 0.56 | 80 | | | | | | |
| 9 | 5.0 | SPT | 11 | 27 | 29 | 56 | | | | 19 | 18 | 31 | 32 | 42 | 24 | 18 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 9 | 6.5 | UDS | | | | | 2.35 | 2.01 | 6.6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 1.0 | SPT | 3 | 7 | 10 | 17 | | | | 2 | 31 | 28 | 39 | 48 | 25 | 23 | | CI | | | | | | | | | | | | | | | | | | |
| 10 | 2.0 | UDS | | | | | 1.85 | 1.57 | 17.6 | | | | | | | | | | | | CD | 0.31 | 21 | | | | | | 0.72 | 100 | | | | | | |
| 10 | 3.0 | SPT | 7 | 14 | 21 | 35 | | | | 2 | 15 | 41 | 42 | 68 | 28 | 40 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 10 | 4.0 | UDS | | | | | 1.93 | 1.63 | 18.0 | | | | | | | | | | | | | | | | | | | | | 50 | | | | | | |

***Type of Sample***

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

***Type of Strength Tests***

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

## CHP/ AHP AREA

### Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSIT Y (g/cm$^3$) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm$^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm$^2$) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm$^2$/kg) | Co. of Consolid. 'Cv' (cm$^2$/min) | Swelling Pressure (kg/cm$^2$) | Free Swell Index (%) | Max. Dry Dendity (g/cm$^3$) | Optimum Moisture Cont. (%) | | | | |
| 11 | 1.0 | SPT | 5 | 6 | 8 | 14 | | | | 0 | 21 | 41 | 38 | 52 | 26 | 26 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 11 | 2.0 | UDS | | | | | 2.03 | 1.65 | 23.8 | | | | | | | | | | | | CD | 0.25 | 16 | | | | | | 0.52 | 70 | | | | | | |
| 11 | 3.0 | SPT | 10 | 21 | 24 | 45 | | | | 4 | 19 | 39 | 38 | 46 | 24 | 22 | | CI | | 2.58 | | | | | | | | | | | | | | | | |
| 11 | 4.0 | UDS | | | | | 1.85 | 1.57 | 18.0 | | | | | | | | | | | | | | | | | | | | | 55 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

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GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 12 | 1.0 | SPT | 3 | 9 | 16 | 25 | | | | 0 | 42 | 29 | 29 | 38 | 22 | 16 | | CI | | | | | | | | | | | | | | | | | | |
| 12 | 2.0 | UDS | | | | | 1.78 | 1.59 | 12.1 | | | | | | | | | | | | UCC | 1.62 | | | | | | | | 60 | | | | | | |
| 12 | 3.0 | SPT | 7 | 11 | 25 | 36 | | | | 11 | 18 | 38 | 33 | 40 | 23 | 17 | | CI | | | | | | | | | | | | | | | | | | |
| 12 | 4.0 | UDS | | | | | 2.10 | 1.53 | 36.7 | | | | | | | | | | | | | | | | | | | | 0.36 | 60 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 13 | 1.0 | SPT | 4 | 7 | 15 | 22 | | | | 0 | 43 | 25 | 32 | 53 | 24 | 29 | | CH | | 2.49 | | | | | | | | | | | | | | | | |
| 13 | 2.0 | UDS | | | | | 1.86 | 1.62 | 14.6 | | | | | | | | | | | | | | | | | | | | | 80 | | | | | | |
| 13 | 3.0 | SPT | 5 | 7 | 11 | 18 | | | | 9 | 38 | 23 | 30 | 48 | 24 | 24 | | CI | | | | | | | | | | | | | | | | | | |
| 13 | 4.0 | UDS | | | | | 1.93 | 1.59 | 20.7 | | | | | | | | | | | | UU | 0.80 | 19 | | | | | | 0.61 | 80 | | | | | | |
| 13 | 5.0 | SPT | 9 | 13 | 18 | 31 | | | | 7 | 38 | 28 | 27 | 40 | 23 | 17 | | CI | | 2.53 | | | | | | | | | | | | | | | | |
| 13 | 6.5 | UDS | | | | | 1.85 | 1.51 | 22.4 | | | | | | | | | | | | | | | | | | | | | 40 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 14 | 1.0 | SPT | 3 | 5 | 9 | 14 | | | | 0 | 35 | 27 | 38 | 44 | 23 | 21 | | CI | | 2.56 | | | | | | | | | | | | | | | | |
| 14 | 2.0 | UDS | | | | | 1.72 | 1.44 | 18.71 | | | | | | | | 10 | | | | | | | | | | | | | 70 | | | | | | |
| 14 | 3.0 | SPT | 3 | 6 | 7 | 13 | | | | 8 | 29 | 30 | 33 | 42 | 24 | 18 | | CI | | 2.57 | | | | | | | | | | | | | | | | |
| 14 | 4.0 | UDS | | | | | 2.01 | 1.76 | 14.10 | | | | | | | | | | | | | | | | | | | | 0.56 | 80 | | | | | | |
| 14 | 5.0 | SPT | 8 | 14 | 20 | 34 | | | | 0 | 18 | 37 | 45 | 56 | 26 | 30 | | CH | | 2.52 | | | | | | | | | | | | | | | | |
| 14 | 6.5 | UDS | | | | | 1.78 | 1.47 | 20.99 | | | | | | | | | | | | UCC | 1.91 | | | | | | | | 85 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 15 | 1.0 | SPT | 2 | 5 | 8 | 13 | | | | 0 | 5 | 35 | 60 | 76 | 28 | 48 | | CH | | 2.46 | | | | | | | | | | | | | | | | |
| 15 | 2.0 | UDS | | | | | 1.69 | 1.55 | 8.9 | | | | | | | | 8.9 | | | | | | | | | | | | | 40 | | | | | | |
| 15 | 3.0 | SPT | 7 | 11 | 12 | 23 | | | | 9 | 15 | 31 | 45 | 82 | 30 | 52 | | CH | | | | | | | | | | | | | | | | | | |
| 15 | 4.0 | UDS | | | | | 1.75 | 1.53 | 14.4 | | | | | | | | | | | UU | 1 | 20 | | | | | | | 1.23 | 120 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY ($g/cm^3$) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' ($kg/cm^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' ($kg/cm^2$) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' ($cm^2/kg$) | Co. of Consolid. 'Cv' ($cm^2/min$) | Swelling Pressure ($kg/cm^2$) | Free Swell Index (%) | Max. Dry Dendity ($g/cm^3$) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 16 | 1.0 | SPT | 4 | 6 | 9 | 15 | | | | 0 | 43 | 34 | 23 | 41 | 22 | 19 | | CI | | 2.47 | | | | | | | | | | | | | | | | |
| 16 | 2.0 | UDS | | | | | 1.82 | 1.56 | 16.1 | | | | | | | | | | | | CD | 0.20 | 22 | | | | | | 0.24 | 60 | | | | | | |
| 16 | 3.0 | SPT | 6 | 11 | 13 | 24 | | | | 12 | 23 | 41 | 24 | 42 | 23 | 19 | | CI | | 2.46 | | | | | | | | | | | | | | | | |
| 16 | 4.0 | UDS | | | | | 1.90 | 1.65 | 15.0 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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Job No. G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY ($g/cm^3$) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' ($kg/cm^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' ($kg/cm^2$) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' ($cm^2/kg$) | Co. of Consolid. 'Cv' ($cm^2/min$) | Swelling Pressure ($kg/cm^2$) | Free Swell Index (%) | Max. Dry Dendity ($g/cm^3$) | Optimum Moisture Cont. (%) | | | | |
| 17 | 1.0 | SPT | 2 | 4 | 6 | 10 | | | | 0 | 6 | 44 | 50 | 86 | 34 | 52 | | CH | | 2.52 | | | | | | | | | | | | | | | | |
| 17 | 2.0 | UDS | | | | | 1.86 | 1.51 | 22.9 | | | | | | | | 9.3 | | | | | | | | | | | | 1.32 | 130 | | | | | | |
| 17 | 3.0 | SPT | 5 | 8 | 12 | 20 | | | | 0 | 7 | 46 | 47 | 76 | 30 | 46 | | CH | | 2.58 | | | | | | | | | | | | | | | | |
| 17 | 4.0 | UDS | | | | | 1.92 | 1.66 | 15.6 | | | | | | | | | | | | UCC | 1.53 | | | | | | | | 100 | | | | | | |
| 17 | 5.0 | SPT | 12 | 21 | 23 | 44 | | | | 0 | 11 | 44 | 45 | 70 | 29 | 41 | | CH | | 2.53 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 18 | 1.0 | SPT | 5 | 10 | 10 | 20 | | | | 3 | 12 | 45 | 40 | 62 | 27 | 35 | | CH | | 2.52 | | | | | | | | | | | | | | | | |
| 18 | 2.0 | UDS | | | | | 1.67 | 1.52 | 9.7 | | | | | | | | | | | | UU | 0.80 | 17 | | | | | | | 50 | | | | | | |
| 18 | 3.0 | SPT | 16 | 9 | 10 | 19 | | | | 0 | 30 | 34 | 36 | 50 | 23 | 23 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 18 | 4.0 | UDS | | | | | 1.92 | 1.61 | 19.6 | | | | | | | | | | | | | | | | | | | | 0.69 | 100 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio 'e$_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex 'C$_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 1.0 | SPT | 3 | 7 | 10 | 17 | | | | 7 | 28 | 37 | 28 | 40 | 22 | 18 | | CI | | 2.49 | | | | | | | | | | | | | | | | |
| 19 | 2.0 | UDS | | | | | 1.65 | 1.56 | 6.1 | | | | | | | | | | | | UCC | 1.45 | | | | | | | 0.63 | 80 | | | | | | |
| 19 | 3.0 | SPT | 4 | 6 | 8 | 14 | | | | 3 | 13 | 42 | 42 | 64 | 28 | 36 | | CH | | 2.53 | | | | | | | | | | | | | | | | |
| 19 | 4.0 | UDS | | | | | 1.75 | 1.54 | 13.4 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |
| 19 | 5.0 | SPT | 14 | 23 | 36 | 59 | | | | 2 | 24 | 37 | 37 | 50 | 25 | 25 | | CH | | 2.56 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 1.0 | SPT | 4 | 7 | 13 | 20 | | | | 8 | 28 | 36 | 28 | 40 | 22 | 18 | | CI | | 2.56 | | | | | | | | | | | | | | | | |
| 20 | 2.0 | UDS | | | | | 1.86 | 1.64 | 15.4 | | | | | | | | | | | | UCC | 1.65 | | | | | | | | 50 | | | | | | |
| 20 | 3.0 | SPT | 9 | 14 | 18 | 32 | | | | 2 | 25 | 45 | 28 | 42 | 23 | 19 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 20 | 4.0 | UDS | | | | | 1.74 | 1.46 | 18.7 | | | | | | | | | | | | | | | | | | | | 0.21 | 50 | | | | | | |

***Type of Sample***

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

***Type of Strength Tests***

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 1.0 | SPT | 5 | 9 | 16 | 25 | | | | 16 | 43 | 23 | 18 | 32 | 20 | 12 | | CL | | 2.57 | | | | | | | | | | | | | | | | |
| 21 | 2.0 | UDS | | | | | 1.90 | 1.55 | 22.4 | | | | | | | | | | | | CD | 0.25 | 18 | | | | | | | | | | | | | |
| 21 | 3.0 | SPT | 12 | 19 | 24 | 43 | | | | 0 | 15 | 40 | 45 | 58 | 26 | 32 | | CH | | | | | | | | | | | 1.16 | 120 | | | | | | |
| 21 | 4.0 | UDS | | | | | 1.88 | 1.53 | 22.8 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | 5.0 | SPT | 10 | 16 | 22 | 38 | | | | 2 | 9 | 36 | 53 | 64 | 29 | 35 | | CH | | 2.49 | | | | | | | | | | | | | | | | |
| 21 | 6.5 | UDS | | | | | 1.75 | 1.64 | 6.8 | | | | | | | | 9.7 | | | | | | | | | | | | | 80 | | | | | | |
| 21 | 8.0 | SPT | 11 | 17 | 23 | 40 | | | | 2 | 13 | 39 | 46 | 60 | 28 | 32 | | CH | | | | | | | | | | | | | | | | | | |
| 21 | 9.5 | UDS | | | | | 1.85 | 1.60 | 15.7 | | | | | | | | | | | | UCC | 1.86 | | | | | | | | | | | | | | |
| 21 | 11.0 | SPT | 15 | 25 | 38 | 63 | | | | 3 | 22 | 37 | 38 | 54 | 27 | 30 | | CH | | 2.54 | | | | | | | | | 0.42 | 70 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 22 | 1.0 | SPT | 2 | 4 | 6 | 10 | | | | 0 | 45 | 32 | 23 | 38 | 22 | 16 | | CI | | 2.56 | | | | | | | | | | | | | | | | |
| 22 | 2.0 | UDS | | | | | 1.96 | 1.67 | 17.16 | | | | | | | | | | | | | | | | | | | | 0.56 | 80 | | | | | | |
| 22 | 3.0 | SPT | 2 | 4 | 7 | 11 | | | | 5 | 19 | 36 | 40 | 66 | 28 | 38 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 22 | 4.0 | UDS | | | | | 1.77 | 1.58 | 11.39 | | | | | | | | | | | | UU | 0.90 | 17 | | | | | | | 90 | | | | | | |
| 22 | 5.0 | SPT | 8 | 11 | 19 | 30 | | | | 0 | 21 | 37 | 42 | 60 | 26 | 40 | | CH | | | | | | | | | | | | | | | | | | |
| 22 | 6.5 | UDS | | | | | 1.82 | 1.53 | 18.70 | | | | | | | | | | | | | | | | | | | | 0.69 | 100 | | | | | | |
| 22 | 8.0 | SPT | 13 | 31 | 52 | 83 | | | | 13 | 33 | 30 | 24 | 40 | 26 | 14 | | CI | | 2.54 | | | | | | | | | | | | | | | | |
| 22 | 9.5 | UDS | | | | | 1.85 | 1.61 | 14.60 | | | | | | | | | | | | UCC | 1.90 | | | | | | | | 70 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio 'e$_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index 'C$_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 1.0 | SPT | 5 | 7 | 10 | 17 | | | | 0 | 10 | 34 | 56 | 72 | 32 | 40 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 23 | 2.0 | UDS | | | | | 2.09 | 1.64 | 27.3 | | | | | | | | | | | | CD | 0.32 | 18 | | | | | | 1.23 | 130 | | | | | | |
| 23 | 3.0 | SPT | 7 | 10 | 14 | 24 | | | | 5 | 9 | 36 | 50 | 74 | 31 | 43 | | CH | | 2.52 | | | | | | | | | | | | | | | | |
| 23 | 4.0 | UDS | | | | | 2.00 | 1.59 | 26.0 | | | | | | | | | | | | | | | | | | | | | 100 | | | | | | |
| 23 | 5.0 | SPT | 15 | 25 | 34 | 59 | | | | 2 | 10 | 40 | 48 | 72 | 30 | 42 | | CH | | | | | | | | | | | | | | | | | | |
| 23 | 6.5 | UDS | | | | | 2.22 | 1.71 | 29.3 | | | | | | | | 9.5 | | | | | | | | | | | | | | | | | | | |
| 23 | 8.0 | SPT | 11 | 20 | 28 | 48 | | | | 4 | 4 | 32 | 60 | 92 | 38 | 54 | | CH | | | | | | | | | | | | | | | | | | |
| 23 | 9.5 | UDS | | | | | 1.99 | 1.58 | 25.6 | | | | | | | | | | | | UCC | 1.72 | | | | | | | 1.26 | 125 | | | | | | |
| 23 | 11.0 | SPT | 11 | 19 | 29 | 48 | | | | 0 | 22 | 36 | 42 | 62 | 28 | 34 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 23 | 14.0 | SPT | 27 | 32 | 45 | 77 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 24 | 1.0 | SPT | 5 | 8 | 11 | 19 | | | | 0 | 41 | 33 | 26 | 42 | 23 | 19 | | CI | | 2.57 | | | | | | | | | | | | | | | | |
| 24 | 2.0 | UDS | | | | | 1.70 | 1.50 | 13.4 | | | | | | | | | | | | CD | 0.29 | 26 | | | | | | 0.24 | 55 | | | | | | |
| 24 | 3.0 | SPT | 16 | 28 | 37 | 65 | | | | 0 | 21 | 47 | 32 | 48 | 24 | 24 | | CI | | 2.58 | | | | | | | | | | | | | | | | |
| 24 | 4.0 | UDS | | | | | 1.80 | 1.52 | 18.8 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |

***Type of Sample***

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

***Type of Strength Tests***

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 25 | 1.0 | SPT | 6 | 13 | 18 | 31 | | | | 0 | 32 | 38 | 30 | 42 | 24 | 18 | | CI | | 2.54 | | | | | | | | | | | | | | | | |
| 25 | 2.0 | UDS | | | | | 1.93 | 1.62 | 18.9 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |

*Type of Sample*

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

*Type of Strength Tests*

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' ($kg/cm^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' ($kg/cm^2$) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' ($cm^2/kg$) | Co. of Consolid. 'Cv' ($cm^2/min$) | Swelling Pressure ($kg/cm^2$) | Free Swell Index (%) | Max. Dry Dendity ($g/cm^3$) | Optimum Moisture Cont. (%) | | | | |
| 26 | 1.0 | SPT | 7 | 9 | 13 | 22 | | | | 0 | 31 | 38 | 31 | 40 | 23 | 17 | | CI | | 2.53 | | | | | | | | | | | | | | | | |
| 26 | 2.0 | UDS | | | | | 1.99 | 1.66 | 19.9 | | | | | | | | | | | | | | | | | | | | | 40 | | | | | | |
| 26 | 3.0 | SPT | 11 | 18 | 27 | 45 | | | | 5 | 34 | 34 | 27 | 38 | 23 | 15 | | CI | | | | | | | | | | | | | | | | | | |
| 26 | 4.0 | UDS | | | | | 1.86 | 1.51 | 23.3 | | | | | | | | | | | | UU | 0.90 | 18 | | | | | | | 50 | | | | | | |
| 26 | 5.0 | SPT | 15 | 18 | 26 | 44 | | | | 15 | 13 | 38 | 34 | 46 | 24 | 22 | | CI | | 2.49 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 27 | 1.0 | SPT | 7 | 11 | 18 | 29 | | | | 2 | 11 | 47 | 40 | 48 | 24 | 24 | | CI | | 2.49 | | | | | | | | | | | | | | | | |
| 27 | 2.0 | UDS | | | | | 1.87 | 1.49 | 25.5 | | | | | | | | | | | | | | | | | | | | | 100 | | | | | | |
| 27 | 3.0 | SPT | 4 | 10 | 23 | 33 | | | | 0 | 12 | 46 | 42 | 56 | 26 | 30 | | CH | | | | | | | | | | | | | | | | | | |
| 27 | 4.0 | UDS | | | | | 1.82 | 1.46 | 24.4 | | | | | | | | | | | | UCC | 1.81 | | | | | | | 0.84 | 110 | | | | | | |
| 27 | 5.0 | SPT | 10 | 17 | 33 | 50 | | | | 2 | 11 | 42 | 45 | 58 | 27 | 31 | | CH | | 2.58 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | PARTICLE SIZE (%) SAND | PARTICLE SIZE (%) SILT | PARTICLE SIZE (%) CLAY | ATTERBERG'S LIMITS Liquid | ATTERBERG'S LIMITS Plastic | ATTERBERG'S LIMITS Plasticity Index | ATTERBERG'S LIMITS Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | STRENGTH TEST Cohesion 'c' (kg/cm²) | STRENGTH TEST Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio 'e$_o$' | CONSOLIDATION TEST Preconsolid. Press. 'Pc' (kg/cm²) | CONSOLIDATION TEST Compression Idex 'C$_c$' | CONSOLIDATION TEST Co. of Vol. Comp. 'mv' (cm²/kg) | CONSOLIDATION TEST Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | SWELL TEST Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | CT TEST Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 1.0 | SPT | 4 | 8 | 13 | 21 | | | | 0 | 23 | 40 | 37 | 48 | 24 | 24 | | CI | | 2.46 | | | | | | | | | | | | | | | | |
| 28 | 2.0 | UDS | | | | | 1.82 | 1.47 | 23.4 | | | | | | | | | | | | | | | | | | | | 0.54 | 80 | | | | | | |
| 28 | 3.0 | SPT | 14 | 25 | 37 | 62 | | | | 2 | 21 | 39 | 38 | 54 | 26 | 28 | | CH | | | | | | | | | | | | | | | | | | |
| 28 | 4.0 | UDS | | | | | 1.81 | 1.46 | 24.3 | | | | | | | | | | | | UU | 0.82 | 17 | | | | | | | 25 | | | | | | |
| 28 | 5.0 | SPT | 16 | 29 | 45 | 74 | | | | 0 | 22 | 43 | 35 | 55 | 26 | 29 | | CH | | 2.62 | | | | | | | | | | | | | | | | |
| 28 | 6.5 | UDS | | | | | 1.80 | 1.59 | 13.0 | | | | | | | | | | | | | | | | | | | | | 40 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No: G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 29 | 1.0 | SPT | 4 | 9 | 11 | 20 | | | | 0 | 21 | 46 | 33 | 46 | 24 | 22 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 29 | 2.0 | UDS | | | | | 2.17 | 1.82 | 18.7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 30 | 1.0 | SPT | 4 | 5 | 6 | 11 | | | | 0 | 14 | 34 | 52 | 74 | 30 | 43 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 30 | 2.0 | UDS | | | | | 1.95 | 1.53 | 27.7 | | | | | | | | | | | | | | | | | | | | 0.88 | 120 | | | | | | |
| 30 | 3.0 | SPT | 2 | 2 | 6 | 8 | | | | 8 | 18 | 43 | 31 | 52 | 24 | 28 | | CH | | | | | | | | | | | | | | | | | | |
| 30 | 4.0 | UDS | | | | | 1.81 | 1.58 | 22.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 5.0 | SPT | 2 | 4 | 7 | 11 | | | | 2 | 13 | 40 | 45 | 62 | 27 | 35 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 30 | 6.5 | UDS | | | | | 1.85 | 1.59 | 16.4 | | | | | | | | | | | | UCC | 1.12 | | | | | | | | 100 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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Job No. : G(H)1658(9)



## CHP/ AHP AREA

### Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 31 | 1.0 | SPT | 4 | 7 | 11 | 18 | | | | 0 | 11 | 44 | 45 | 58 | 28 | 30 | | CH | | 2.48 | | | | | | | | | | | | | | | | |
| 31 | 2.0 | UDS | | | | | 1.80 | 1.52 | 18.70 | | | | | | | | | | | | CD | 0.38 | 16 | | | | | | | 115 | | | | | | |
| 31 | 3.0 | SPT | 6 | 11 | 14 | 25 | | | | 0 | 8 | 41 | 51 | 65 | 30 | 35 | | CH | | | | | | | | | | | | | | | | | | |
| 31 | 4.0 | UDS | | | | | 1.93 | 1.58 | 22.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 5.0 | SPT | 9 | 12 | 20 | 32 | | | | 0 | 4 | 43 | 53 | 72 | 36 | 36 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 31 | 6.5 | UDS | | | | | 1.84 | 1.43 | 28.2 | | | | | | | | | | | | | | | | | | | | 1.19 | 125 | | | | | | |
| 31 | 8.0 | SPT | 12 | 25 | 36 | 61 | | | | 14 | 10 | 38 | 38 | 54 | 26 | 28 | | CH | | | | | | | | | | | | | | | | | | |
| 31 | 9.5 | UDS | | | | | 1.87 | 1.52 | 22.5 | | | | | | | | 8.9 | | | | UU | 1.68 | | | | | | | | | | | | | | |
| 31 | 11.0 | SPT | 10 | 16 | 14 | 30 | | | | 0 | 26 | 38 | 36 | 52 | 26 | 26 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 31 | 14.0 | SPT | 23 | 41 | 56 | 97 | | | | 0 | 22 | 40 | 38 | 58 | 27 | 31 | | CH | | | | | | | | | | | | 100 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 1.0 | SPT | 9 | 14 | 20 | 34 | | | | 2 | 21 | 41 | 36 | 54 | 25 | 29 | | CH | | | | | | | | | | | | | | | | | | |
| 32 | 2.0 | UDS | | | | | 2.16 | 1.76 | 22.4 | | | | | | | | | | | | | | | | | | | | | 100 | | | | | | |
| 32 | 3.0 | SPT | 13 | 19 | 24 | 43 | | | | 3 | 6 | 40 | 51 | 72 | 32 | 40 | | CH | | | | | | | | | | | | | | | | | | |
| 32 | 4.0 | UDS | | | | | 2.00 | 1.70 | 17.2 | | | | | | | | | | | | | | | | | | | | 1.32 | 130 | | | | | | |
| 32 | 5.0 | SPT | 14 | 26 | 37 | 63 | | | | 0 | 6 | 33 | 61 | 88 | 41 | 47 | | CH | | 2.50 | | | | | | | | | | | | | | | | |
| 32 | 6.5 | UDS | | | | | 1.87 | 1.45 | 28.7 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | |
| 32 | 8.0 | SPT | 16 | 29 | 37 | 66 | | | | 3 | 43 | 30 | 24 | 40 | 24 | 16 | | CI | | | | | | | | | | | | | | | | | | |
| 32 | 9.5 | UDS | | | | | 1.96 | 1.56 | 24.8 | | | | | | | | | | | | | | | | | | | | 0.75 | 100 | | | | | | |
| 32 | 11.0 | SPT | 13 | 19 | 31 | 50 | | | | 0 | 30 | 34 | 36 | 48 | 25 | 23 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 32 | 14.0 | UDS | | | | | 1.84 | 1.50 | 22.6 | | | | | | | | | | | | UU | 2.02 | | | | | | | | | | | | | | |

***Type of Sample***

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

***Type of Strength Tests***

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 33 | 1.0 | SPT | 4 | 6 | 9 | 15 | | | | 0 | 8 | 42 | 50 | 88 | 39 | 49 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 33 | 2.0 | UDS | | | | | 1.90 | 1.49 | 27.2 | | | | | | | | | | | | CD | 0.30 | 21 | | | | | | | 100 | | | | | | |
| 33 | 3.0 | SPT | 5 | 8 | 15 | 23 | | | | 0 | 12 | 39 | 49 | 76 | 36 | 40 | | CH | | | | | | | | | | | | | | | | | | |
| 33 | 4.0 | UDS | | | | | 1.85 | 1.52 | 21.4 | | | | | | | | | | | | | | | | | | | | 1.12 | 110 | | | | | | |
| 33 | 5.0 | SPT | 10 | 20 | 27 | 47 | | | | 0 | 23 | 35 | 42 | 72 | 33 | 41 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 33 | 6.5 | UDS | | | | | 1.90 | 1.54 | 23.40 | | | | | | | | | | | | UCC | 1.21 | | | | | | | | 90 | | | | | | |
| 33 | 8.0 | SPT | 7 | 18 | 28 | 46 | | | | 2 | 15 | 38 | 45 | 65 | 29 | 36 | | CH | | | | | | | | | | | | | | | | | | |
| 33 | 9.5 | SPT | 9 | 14 | 22 | 36 | | | | 2 | 19 | 37 | 42 | 68 | 30 | 38 | | CH | | | | | | | | | | | | | | | | | | |
| 33 | 11.0 | SPT | 11 | 14 | 22 | 36 | | | | 2 | 27 | 34 | 37 | 48 | 25 | 23 | | CI | | 2.54 | | | | | | | | | | 80 | | | | | | |
| 33 | 14.0 | SPT | 13 | 21 | 30 | 51 | | | | 3 | 22 | 37 | 38 | 52 | 27 | 25 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

***Type of Strength Tests***

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


Job No. : G(H)1658(9)

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 34 | 1.0 | SPT | 4 | 4 | 6 | 10 | | | | 3 | 5 | 47 | 45 | 72 | 33 | 39 | | CH | | 2.53 | | | | | | | | | | | | | | | | |
| 34 | 2.0 | UDS | | | | | 1.87 | 1.50 | 24.2 | | | | | | | | | | | | | | | | | | | | | 120 | | | | | | |
| 34 | 3.0 | SPT | 4 | 6 | 9 | 15 | | | | 0 | 8 | 44 | 48 | 85 | 41 | 44 | | CH | | | UU | 1.01 | 1.9 | | | | | | | | | | | | | |
| 34 | 4.0 | UDS | | | | | 1.97 | 1.63 | 21.1 | | | | | | | | | | | | | | | | | | | | 1.05 | 110 | | | | | | |
| 34 | 5.0 | SPT | 4 | 7 | 11 | 18 | | | | 0 | 7 | 47 | 46 | 69 | 37 | 32 | | CH | | 2.55 | | | | | | | | | | | | | | | | |
| 34 | 6.5 | UDS | | | | | 2.07 | 1.69 | 22.1 | | | | | | | | | | | | UCC | 1.32 | | | | | | | 0.85 | 100 | | | | | | |
| 34 | 8.0 | SPT | 5 | 7 | 13 | 20 | | | | 5 | 6 | 37 | 52 | 76 | 40 | 36 | | CH | | | | | | | | | | | | | | | | | | |
| 34 | 9.5 | SPT | 5 | 9 | 14 | 23 | | | | 8 | 37 | 25 | 30 | 46 | 25 | 21 | | CI | | 2.56 | | | | | | | | | | 70 | | | | | | |
| 34 | 11.0 | SPT | 6 | 10 | 13 | 23 | | | | 2 | 27 | 36 | 35 | 48 | 24 | 24 | | CI | | | | | | | | | | | | | | | | | | |
| 34 | 14.0 | SPT | 6 | 10 | 19 | 29 | | | | 0 | 23 | 37 | 40 | 50 | 26 | 24 | | CI | | | | | | | | | | | | 85 | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 35 | 1.0 | SPT | 4 | 6 | 8 | 14 | | | | 8 | 8 | 36 | 48 | 72 | 30 | 42 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 35 | 2.0 | UDS | | | | | 1.84 | 1.57 | 17.1 | | | | | | | | | | | | | | | | | | | | 1.21 | 120 | | | | | | |
| 35 | 3.0 | SPT | 4 | 5 | 7 | 12 | | | | 3 | 4 | 41 | 52 | 78 | 34 | 44 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 35 | 4.0 | UDS | | | | | 1.75 | 1.60 | 9.5 | | | | | | | | | | | | CD | 0.28 | 18 | | | | | | 1.12 | 110 | | | | | | |
| 35 | 5.0 | SPT | 2 | 5 | 9 | 14 | | | | 0 | 7 | 38 | 55 | 85 | 40 | 45 | | CH | | | | | | | | | | | | | | | | | | |
| 35 | 6.5 | UDS | | | | | 1.82 | 1.40 | 30.0 | | | | | | | | | | | | UU | 1.10 | 2 | | | | | | | 135 | | | | | | |
| 35 | 8.0 | SPT | 4 | 9 | 13 | 22 | | | | 5 | 5 | 40 | 50 | 80 | 39 | 41 | | CH | | 2.53 | | | | | | | | | | | | | | | | |
| 35 | 9.5 | UDS | | | | | 1.98 | 1.65 | 19.7 | | | | | | | | | | | | UCC | 1.64 | | | | | | | 1.46 | 140 | | | | | | |
| 35 | 11.0 | SPT | 5 | 10 | 15 | 25 | | | | 4 | 5 | 37 | 56 | 91 | 42 | 49 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 35 | 14.0 | SPT | 5 | 10 | 19 | 29 | | | | 8 | 8 | 39 | 45 | 65 | 29 | 36 | | CH | | | | | | | | | | | | 70 | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 36 | 1.0 | SPT | 5 | 8 | 11 | 19 | | | | 0 | 7 | 33 | 60 | 91 | 45 | 46 | | CH | | 2.51 | | | | | | | | | | | | | | | | |
| 36 | 2.0 | UDS | | | | | 1.96 | 1.55 | 25.7 | | | | | | | | | | | | | | | | | | | | | 140 | | | | | | |
| 36 | 3.0 | SPT | 4 | 10 | 17 | 27 | | | | 0 | 7 | 33 | 60 | 86 | 42 | 44 | | CH | | | | | | | | | | | | | | | | | | |
| 36 | 4.0 | UDS | | | | | 1.85 | 1.55 | 19.1 | | | | | | | | | | | | UU | 1.20 | 16 | | | | | | 1.42 | 145 | | | | | | |
| 36 | 5.0 | SPT | 8 | 14 | 22 | 36 | | | | 0 | 3 | 34 | 63 | 90 | 42 | 48 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 36 | 6.5 | UDS | | | | | 2.00 | 1.57 | 27.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | 8.0 | SPT | 9 | 16 | 23 | 39 | | | | 0 | 12 | 36 | 52 | 82 | 37 | 45 | | CH | | | | | | | | | | | | | | | | | | |
| 36 | 9.5 | UDS | | | | | 2.10 | 1.76 | 19.1 | | | | | | | | | | | | | | | | | | | | 1.22 | 120 | | | | | | |
| 36 | 11.0 | SPT | 12 | 22 | 29 | 51 | | | | 0 | 18 | 34 | 48 | 65 | 27 | 38 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 36 | 14.0 | SPT | 23 | 41 | 56 | 97 | | | | 0 | 22 | 36 | 42 | 58 | 26 | 32 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm$^3$) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm$^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm$^2$) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm$^2$/kg) | Co. of Consolid. 'Cv' (cm$^2$/min) | Swelling Pressure (kg/cm$^2$) | Free Swell Index (%) | Max. Dry Dendity (g/cm$^3$) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 37 | 1.0 | SPT | 11 | 12 | 18 | 30 | | | | 0 | 9 | 38 | 53 | 78 | 40 | 38 | | CH | | 2.48 | | | | | | | | | | | | | | | | |
| 37 | 2.0 | UDS | | | | | 1.85 | 1.45 | 27.2 | | | | | | | | | | | | | | | | | | | | 0.85 | 115 | | | | | | |
| 37 | 3.0 | SPT | 11 | 70 | 35 | >100 | | | | 0 | 12 | 42 | 46 | 70 | 39 | 31 | | CH | | | | | | | | | | | | | | | | | | |
| 37 | 4.0 | UDS | | | | | 1.87 | 1.49 | 25.5 | | | | | | | | | | | | | | | | | | | | | 120 | | | | | | |
| 37 | 5.0 | SPT | 16 | 37 | 55 | 92 | | | | 0 | 21 | 39 | 40 | 66 | 34 | 32 | | CH | | 2.47 | | | | | | | | | | | | | | | | |
| 37 | 6.5 | UDS | | | | | 1.95 | 1.61 | 21.40 | | | | | | | | 10 | | | | UCC | 2.24 | | | | | | | | 80 | | | | | | |
| 37 | 8.0 | SPT | 13 | 19 | 33 | 52 | | | | 0 | 24 | 38 | 38 | 62 | 30 | 32 | | CH | | | | | | | | | | | | | | | | | | |
| 37 | 9.5 | SPT | 22 | 33 | 45 | 78 | | | | 3 | 7 | 42 | 48 | 64 | 32 | 32 | | CH | | | | | | | | | | | | | | | | | | |
| 37 | 11.0 | SPT | 24 | 35 | 48 | 83 | | | | 0 | 13 | 42 | 45 | 66 | 32 | 34 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 38 | 1.0 | SPT | 6 | 9 | 12 | 21 | | | | 0 | 21 | 37 | 42 | 58 | 26 | 32 | | CH | | 2.49 | | | | | | | | | | | | | | | | |
| 38 | 2.0 | UDS | | | | | 1.90 | 1.57 | 21.0 | | | | | | | | | | | | | | | | | | | | | 110 | | | | | | |
| 38 | 3.0 | SPT | 7 | 15 | 25 | 40 | | | | 0 | 20 | 45 | 35 | 48 | 24 | 24 | | CI | | | | | | | | | | | | | | | | | | |
| 38 | 4.0 | UDS | | | | | 1.82 | 1.54 | 17.7 | | | | | | | | | | | | | | | | | | | | 0.32 | 80 | | | | | | |
| 38 | 5.0 | SPT | 8 | 13 | 20 | 33 | | | | 3 | 34 | 35 | 28 | 42 | 23 | 19 | | CI | | 2.50 | | | | | | | | | | | | | | | | |
| 38 | 6.5 | UDS | | | | | 1.88 | 1.52 | 23.5 | | | | | | | | | | | | CD | 0.32 | 22 | | | | | | | 90 | | | | | | |
| 38 | 8.0 | SPT | 9 | 12 | 16 | 28 | | | | 3 | 14 | 45 | 38 | 50 | 24 | 26 | | CH | | | | | | | | | | | | | | | | | | |
| 38 | 9.5 | SPT | 9 | 17 | 30 | 47 | | | | 0 | 11 | 41 | 48 | 64 | 28 | 36 | | CH | | | | | | | | | | | | | | | | | | |
| 38 | 11.0 | SPT | 16 | 30 | 34 | 64 | | | | 3 | 23 | 34 | 40 | 62 | 27 | 35 | | CH | | 2.53 | | | | | | | | | | | | | | | | |
| 38 | 12.5 | SPT | 11 | 17 | 33 | 50 | | | | 0 | 28 | 34 | 38 | 56 | 26 | 30 | | CH | | | | | | | | | | | | | | | | | | |
| 38 | 15.0 | SPT | 25 | 37 | 47 | 84 | | | | 0 | 20 | 38 | 42 | 52 | 26 | 26 | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

Sheet No. : 199 of 271

# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | 1.0 | SPT | 7 | 13 | 16 | 29 | | | | 5 | 10 | 43 | 42 | 58 | 26 | 32 | | CH | | 2.52 | | | | | | | | | | | | | | | | | |
| 39 | 2.0 | UDS | | | | | 2.02 | 1.56 | 29.0 | | | | | | | | | | | | | | | | | | | | 0.95 | 120 | | | | | | | |
| 39 | 3.0 | SPT | 5 | 8 | 12 | 20 | | | | 2 | 6 | 36 | 56 | 72 | 38 | 34 | | CH | | | | | | | | | | | | | | | | | | | |
| 39 | 4.0 | UDS | | | | | 1.87 | 1.58 | 18.1 | | | | | | | | | | | | UCC | 1.56 | | | | | | | | 125 | | | | | | | |
| 39 | 5.0 | SPT | 7 | 12 | 25 | 37 | | | | 0 | 4 | 43 | 53 | 76 | 40 | 36 | | CH | | | | | | | | | | | | | | | | | | | |
| 39 | 6.5 | UDS | | | | | 1.90 | 1.74 | 23.3 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | | |
| 39 | 8.0 | SPT | 14 | 22 | 33 | 55 | | | | 0 | 16 | 36 | 48 | 70 | 38 | 32 | | CH | | 2.56 | | | | | | | | | | | | | | | | | |
| 39 | 9.5 | UDS | | | | | 1.95 | 1.63 | 19.4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | 11.0 | SPT | 15 | 24 | 33 | 57 | | | | 2 | 4 | 38 | 56 | 82 | 41 | 41 | | CH | | | | | | | | | | | | | | | | | | | |
| 39 | 14.0 | SPT | 15 | 28 | 50 | 78 | | | | 0 | 15 | 37 | 48 | 72 | 37 | 35 | | CH | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1.0 | SPT | 2 | 5 | 8 | 13 | | | | 0 | 21 | 34 | 45 | 68 | 34 | 34 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 40 | 2.0 | UDS | | | | | 1.94 | 1.53 | 26.3 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |
| 40 | 3.0 | SPT | 5 | 8 | 13 | 21 | | | | 13 | 34 | 30 | 23 | 40 | 23 | 17 | | CI | | | | | | | | | | | | | | | | | | |
| 40 | 4.0 | UDS | | | | | 1.86 | 1.50 | 23.6 | | | | | | | | | | | | UU | 1.65 | 18 | | | | | | | | | | | | | |
| 40 | 5.0 | SPT | 7 | 14 | 25 | 39 | | | | 0 | 9 | 35 | 56 | 74 | 37 | 37 | | CH | | | | | | | | | | | | | | | | | | |
| 40 | 6.5 | UDS | | | | | 1.90 | 1.52 | 24.6 | | | | | | | | | | | | | | | | | | | | 0.54 | 90 | | | | | | |
| 40 | 8.0 | SPT | 10 | 14 | 21 | 35 | | | | 3 | 13 | 34 | 50 | 76 | 38 | 38 | | CH | | 2.48 | | | | | | | | | | | | | | | | |
| 40 | 9.5 | UDS | | | | | 2.20 | 1.71 | 28.4 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 11.0 | SPT | 9 | 21 | 30 | 51 | | | | 0 | 22 | 40 | 38 | 54 | 26 | 28 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in
Job No. : G(H)1658(9)


# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 41 | 1.0 | SPT | 3 | 4 | 6 | 10 | | | | 0 | 21 | 46 | 33 | 48 | 24 | 24 | | CI | | 2.57 | | | | | | | | | | | | | | | | |
| 41 | 2.0 | UDS | | | | | 1.70 | 1.40 | 20.7 | | | | | | | | | | | | | | | | | | | | | 80 | | | | | | |
| 41 | 3.0 | SPT | 8 | 13 | 17 | 30 | | | | 20 | 27 | 28 | 25 | 36 | 22 | 14 | | CI | | | | | | | | | | | | | | | | | | |
| 41 | 4.0 | UDS | | | | | 1.72 | 1.44 | 19.2 | | | | | | | | 9.2 | | | | CD | 0.28 | 26 | | | | | | 0.36 | 70 | | | | | | |
| 41 | 5.0 | SPT | 10 | 23 | 37 | 60 | | | | 0 | 9 | 43 | 48 | 64 | 29 | 35 | | CH | | 2.53 | | | | | | | | | | | | | | | | |
| 41 | 6.5 | UDS | | | | | 2.03 | 1.57 | 28.9 | | | | | | | | | | | | | | | | | | | | | 50 | | | | | | |
| 41 | 8.0 | SPT | 6 | 16 | 22 | 38 | | | | 3 | 12 | 35 | 50 | 72 | 35 | 37 | | CH | | | | | | | | | | | | | | | | | | |
| 41 | 9.5 | SPT | 19 | 28 | 40 | 68 | | | | 0 | 25 | 35 | 40 | 64 | 30 | 34 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 42 | 1.0 | SPT | 17 | 23 | 26 | 49 | | | | 4 | 44 | 26 | 26 | 42 | 22 | 20 | | CI | | 2.48 | | | | | | | | | | | | | | | | |
| 42 | 2.0 | UDS | | | | | 1.85 | 1.48 | 24.9 | | | | | | | | | | | | | | | | | | | | | 55 | | | | | | |
| 42 | 3.0 | SPT | 9 | 17 | 23 | 40 | | | | 0 | 6 | 45 | 49 | 74 | 38 | 36 | | CH | | | | | | | | | | | | | | | | | | |
| 42 | 4.0 | UDS | | | | | 1.90 | 1.50 | 26.8 | | | | | | | | | | | | | | | | | | | | 0.46 | 70 | | | | | | |
| 42 | 5.0 | SPT | 5 | 16 | 23 | 39 | | | | 0 | 4 | 45 | 51 | 82 | 40 | 42 | | CH | | | | | | | | | | | | | | | | | | |
| 42 | 6.5 | UDS | | | | | 1.92 | 1.56 | 22.6 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | |
| 42 | 8.0 | SPT | 10 | 15 | 21 | 36 | | | | 0 | 41 | 30 | 29 | 38 | 22 | 16 | | CI | | | | | | | | | | | | | | | | | | |
| 42 | 9.5 | UDS | | | | | 1.96 | 1.67 | 16.9 | | | | | | | | | | | | UCC | 1.75 | | | | | | | | 65 | | | | | | |
| 42 | 11.0 | SPT | 12 | 23 | 29 | 52 | | | | 0 | 25 | 37 | 38 | 56 | 26 | 28 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 42 | 14.0 | SPT | 10 | 17 | 22 | 39 | | | | 0 | 25 | 39 | 36 | 50 | 25 | 25 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 43 | 1.0 | SPT | 5 | 7 | 12 | 19 | | | | 3 | 58 | 20 | 19 | 35 | 20 | 15 | | CI | | 2.54 | | | | | | | | | | | | | | | | |
| 43 | 2.0 | UDS | | | | | 1.79 | 1.54 | 15.5 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |
| 43 | 3.0 | SPT | 6 | 11 | 13 | 24 | | | | 2 | 10 | 48 | 40 | 62 | 26 | 36 | | CH | | | | | | | | | | | | | | | | | | |
| 43 | 4.0 | UDS | | | | | 1.85 | 1.58 | 17.3 | | | | | | | | | | | | | | | | | | | | | 75 | | | | | | |
| 43 | 5.0 | SPT | 6 | 12 | 18 | 30 | | | | 2 | 17 | 35 | 46 | 66 | 35 | 31 | | CH | | | | | | | | | | | | | | | | | | |
| 43 | 6.5 | UDS | | | | | 2.03 | 1.71 | 18.6 | | | | | | | | | | | | UU | 1.40 | 16 | | | | | | 0.65 | 80 | | | | | | |
| 43 | 8.0 | SPT | 10 | 14 | 21 | 35 | | | | 2 | 12 | 42 | 44 | 62 | 36 | 26 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 43 | 9.5 | UDS | | | | | 1.82 | 1.45 | 25.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DENSITY (g/cm³) DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | SOIL DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio 'e$_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex 'C$_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | 1.0 | SPT | 6 | 6 | 10 | 16 | | | | 2 | 14 | 34 | 50 | 78 | 40 | 38 | | CH | | | | | | | | | | | | | | | | | | |
| 44 | 2.0 | UDS | | | | | 1.85 | 1.56 | 18.3 | | | | | | | | | | | | | | | | | | | | | 115 | | | | | | |
| 44 | 3.0 | SPT | 4 | 6 | 9 | 15 | | | | 0 | 8 | 38 | 54 | 86 | 42 | 44 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 44 | 4.0 | UDS | | | | | 2.03 | 1.66 | 21.8 | | | | | | | | | | | | UCC | 1.58 | | | | | | | 1.24 | 130 | | | | | | |
| 44 | 5.0 | SPT | 8 | 16 | 24 | 40 | | | | 0 | 11 | 39 | 50 | 80 | 41 | 39 | | CH | | | | | | | | | | | | | | | | | | |
| 44 | 6.5 | UDS | | | | | 1.91 | 1.56 | 22.4 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | |
| 44 | 8.0 | SPT | 8 | 21 | 31 | 52 | | | | 7 | 33 | 26 | 34 | 44 | 25 | 19 | | CI | | 2.53 | | | | | | | | | | | | | | | | |
| 44 | 9.5 | SPT | 18 | 22 | 32 | 54 | | | | 2 | 42 | 28 | 28 | 38 | 22 | 16 | | CI | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 45 | 1.0 | SPT | 3 | 6 | 8 | 14 | | | | 0 | 45 | 33 | 22 | 42 | 23 | 19 | | CI | | | | | | | | | | | | | | | | | | |
| 45 | 2.0 | UDS | | | | | 1.95 | 1.51 | 28.6 | | | | | | | | | | | | | | | | | | | | | 60 | | | | | | |
| 45 | 3.0 | SPT | 11 | 21 | 28 | 49 | | | | 12 | 16 | 37 | 35 | 54 | 26 | 28 | | CH | | 2.58 | | | | | | | | | | | | | | | | |
| 45 | 4.0 | UDS | | | | | 1.95 | 1.75 | 11.2 | | | | | | | | | | | | | | | | | | | | | 80 | | | | | | |
| 45 | 5.0 | SPT | 7 | 12 | 18 | 30 | | | | 0 | 25 | 38 | 37 | 58 | 27 | 31 | | CH | | | | | | | | | | | | | | | | | | |
| 45 | 6.5 | UDS | | | | | 1.92 | 1.54 | 24.6 | | | | | | | | | | | | CD | 0.28 | 27 | | | | | | | 30 | | | | | | |
| 45 | 8.0 | SPT | 8 | 15 | 21 | 36 | | | | 9 | 36 | 27 | 28 | 40 | 23 | 17 | | CI | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

Sheet No. : 206 of 271

## CHP/ AHP AREA

### Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm$^3$) BULK | DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm$^2$) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio 'e$_o$' | Preconsolid. Press. 'Pc' (kg/cm$^2$) | Compression Idex 'C$_c$' | Co. of Vol. Comp. 'mv' (cm$^2$/kg) | Co. of Consolid. 'Cv' (cm$^2$/min) | SWELL TEST Swelling Pressure (kg/cm$^2$) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm$^3$) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | 1.0 | SPT | 2 | 3 | 4 | 7 | | | | 0 | 11 | 31 | 58 | 78 | 40 | 38 | | CH | | | | | | | | | | | | | | | | | | |
| 46 | 2.0 | UDS | | | | | 1.97 | 1.51 | 30.5 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | |
| 46 | 3.0 | SPT | 2 | 4 | 7 | 11 | | | | 12 | 23 | 26 | 39 | 62 | 33 | 29 | | CH | | 2.58 | | | | | | | | | | | | | | | | |
| 46 | 4.0 | UDS | | | | | 1.93 | 1.56 | 23.5 | | | | | | | | | | | | | | | | | | | | 0.38 | 80 | | | | | | |
| 46 | 5.0 | SPT | 8 | 14 | 24 | 38 | | | | 2 | 21 | 37 | 40 | 66 | 35 | 31 | | CH | | | | | | | | | | | | | | | | | | |
| 46 | 6.5 | UDS | | | | | 1.87 | 1.54 | 21.40 | | | | | | | | | | | | UCC | 1.72 | | | | | | | | 40 | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) BULK | DRY | WATER CONTENT (%) | PARTICLE SIZE (%) GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS Liquid | Plastic | Plasticity Index | Shrinkage | SOIL IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | 1.0 | SPT | 3 | 5 | 12 | 17 | | | | 13 | 36 | 24 | 27 | 44 | 22 | 22 | | CI | | 2.58 | | | | | | | | | | | | | | | | |
| 47 | 2.0 | UDS | | | | | 1.78 | 1.60 | 11.5 | | | | | | | | | | | | CD | 0.24 | 29 | | | | | | | 60 | | | | | | |
| 47 | 3.0 | SPT | 15 | 29 | 88 | >100 | | | | 12 | 44 | 20 | 24 | 48 | 24 | 24 | | CI | | 2.47 | | | | | | | | | | | | | | | | |
| 47 | 4.0 | UDS | | | | | 1.97 | 1.54 | 25.8 | | | | | | | | 9.2 | | | | | | | | | | | | | 80 | | | | | | |
| 47 | 5.0 | SPT | 20 | 28 | 60 | 88 | | | | 0 | 25 | 35 | 40 | 58 | 27 | 31 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio 'e₀' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex 'Cc' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 48 | 1.0 | SPT | 4 | 5 | 10 | 15 | | | | 0 | 14 | 41 | 45 | 72 | 39 | 33 | | CH | | 2.56 | | | | | | | | | | | | | | | | |
| 48 | 2.0 | UDS | | | | | 2.11 | 1.67 | 26.2 | | | | | | | | | | | | | | | | | | | | | 90 | | | | | | |
| 48 | 3.0 | SPT | 5 | 6 | 10 | 16 | | | | 0 | 20 | 30 | 50 | 80 | 40 | 40 | | CH | | | | | | | | | | | | | | | | | | |
| 48 | 4.0 | UDS | | | | | 1.96 | 1.69 | 16.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | 5.0 | SPT | 7 | 11 | 14 | 25 | | | | 2 | 62 | 19 | 17 | L | P | | | SM | | | | | | | | | | | | | | | | | | |
| 48 | 6.5 | UDS | | | | | 1.98 | 1.57 | 25.8 | | | | | | | | | | | | UU | 0.95 | 15 | | | | | | | 45 | | | | | | |
| 48 | 8.0 | SPT | 7 | 10 | 17 | 27 | | | | 4 | 14 | 34 | 48 | 76 | 38 | 38 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 48 | 10.0 | SPT | 9 | 13 | 20 | 33 | | | | 2 | 21 | 37 | 40 | 72 | 39 | 33 | | CH | | | | | | | | | | | | | | | | | | |

***Type of Sample***

DS Disturbed Soil Sample
UDS Undisturbed Soil Sample
RMS Remoulded Soil Sample
WS Water Sample

UCC Unconfined Compression Test
VST Vane Shear Test
Tuu Unconsolidated undrained triaxial test
Tcu Consolidated Undrained triaxial test with pore pressure
Tcd Consolidated drained triaxial test

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 49 | 1.0 | SPT | 2 | 3 | 4 | 7 | | | | 0 | 35 | 33 | 32 | 44 | 24 | 20 | | CI | | | | | | | | | | | | | | | | | | |
| 49 | 2.0 | UDS | | | | | 1.84 | 1.67 | 10.35 | | | | | | | | | | | | CD | 0.28 | 30 | | | | | | 0.24 | 60 | | | | | | |
| 49 | 3.0 | SPT | 18 | 24 | 26 | 50 | | | | 0 | 35 | 30 | 35 | 52 | 26 | 26 | | CH | | | | | | | | | | | | | | | | | | |
| 49 | 4.0 | UDS | | | | | | | | | | | | | | | | | | | | | | | | | | | | 40 | | | | | | |
| 49 | 5.0 | SPT | 7 | 14 | 25 | 39 | | | | 2 | 61 | 17 | 20 | 36 | 21 | 15 | | CI | | 2.55 | | | | | | | | | | | | | | | | |
| 49 | 6.5 | UDS | | | | | 1.81 | 1.58 | 14.13 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³): BULK | DENSITY (g/cm³): DRY | WATER CONTENT (%) | PARTICLE SIZE (%): GRAVEL | SAND | SILT | CLAY | ATTERBERG'S LIMITS: Liquid | Plastic | Plasticity Index | Shrinkage | SOIL: IS CLASSIFICATION | SOIL: DESCRIPTION | SPECIFIC GRAVITY | STRENGTH TEST: Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | CONSOLIDATION TEST: Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | SWELL TEST: Swelling Pressure (kg/cm²) | Free Swell Index (%) | CT TEST: Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 1.0 | SPT | 3 | 5 | 7 | 12 | | | | 0 | 33 | 30 | 37 | 50 | 26 | 24 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 50 | 2.0 | UDS | | | | | 1.82 | 1.54 | 18.11 | | | | | | | | | | | | | | | | | | | | | 70 | | | | | | |
| 50 | 3.0 | SPT | 3 | 4 | 6 | 10 | | | | 5 | 29 | 32 | 34 | 52 | 25 | 27 | | CH | | 2.57 | | | | | | | | | | | | | | | | |
| 50 | 4.0 | UDS | | | | | 2.00 | 1.64 | 21.94 | | | | | | | | | | | | UCC | 1.46 | | | | | | | 0.66 | 110 | | | | | | |
| 50 | 5.0 | SPT | 19 | 33 | 50 | 83 | | | | 0 | 24 | 38 | 38 | 56 | 27 | 29 | | CH | | | | | | | | | | | | | | | | | | |
| 50 | 6.5 | UDS | | | | | 1.79 | 1.61 | 11.12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in




# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 51 | 1.0 | SPT | 2 | 4 | 6 | 10 | | | | 0 | 25 | 39 | 36 | 54 | 26 | 28 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 51 | 2.0 | UDS | | | | | 1.79 | 1.61 | 11.25 | | | | | | | | 8.8 | | | | | | | | | | | | | 60 | | | | | | |
| 51 | 3.0 | SPT | 5 | 6 | 6 | 12 | | | | 0 | 17 | 39 | 44 | 66 | 38 | 28 | | CH | | | | | | | | | | | | | | | | | | |
| 51 | 4.0 | UDS | | | | | 1.80 | 1.58 | 14.29 | | | | | | | | | | | | UCC | 1.18 | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 52 | 1.0 | SPT | 4 | 5 | 10 | 15 | | | | 0 | 9 | 33 | 58 | 84 | 42 | 42 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 52 | 2.0 | UDS | | | | | 1.76 | 1.49 | 17.6 | | | | | | | | | | | | | | | | | | | | 0.86 | 110 | | | | | | |
| 52 | 3.0 | SPT | 6 | 9 | 21 | 30 | | | | 5 | 20 | 26 | 49 | 76 | 39 | 37 | | CH | | | | | | | | | | | | | | | | | | |
| 52 | 4.0 | UDS | | | | | 1.85 | 1.56 | 18.4 | | | | | | | | | | | | UU | 1.50 | 20 | | | | | | | | | | | | | |
| 52 | 5.0 | SPT | 10 | 15 | 26 | 41 | | | | 0 | 15 | 35 | 50 | 80 | 40 | 40 | | CH | | 2.49 | | | | | | | | | | 100 | | | | | | |
| 52 | 6.5 | UDS | | | | | 2.01 | 1.72 | 16.6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Type of Sample*

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |
| | | Tcd | Consolidated drained triaxial test |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

Sheet No. : 213 of 271

# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm$^3$) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm$^2$) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm$^2$) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm$^2$/kg) | Co. of Consolid. 'Cv' (cm$^2$/min) | Swelling Pressure (kg/cm$^2$) | Free Swell Index (%) | Max. Dry Dendity (g/cm$^3$) | Optimum Moisture Cont. (%) | | | | |
| 53 | 1.0 | SPT | 7 | 10 | 16 | 26 | | | | 0 | 38 | 28 | 34 | 52 | 26 | 26 | | CH | | | | | | | | | | | | | | | | | | |
| 53 | 2.0 | UDS | | | | | 1.96 | 1.56 | 25.5 | | | | | | | | | | | | | | | | | | | | 0.75 | 80 | | | | | | |
| 53 | 3.0 | SPT | 30 | 30 | 65 | 95 | | | | 10 | 20 | 34 | 36 | 58 | 27 | 31 | | CH | | 2.53 | | | | | | | | | | | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

Sheet No. : 214 of 271

# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 54 | 1.0 | SPT | 8 | 11 | 13 | 24 | | | | 0 | 22 | 36 | 42 | 68 | 34 | 34 | | CH | | 2.54 | | | | | | | | | | | | | | | | |
| 54 | 2.0 | UDS | | | | | 2.03 | 1.65 | 22.4 | | | | | | | | | | | | | | | | | | | | | 80 | | | | | | |

*Type of Sample*

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)



# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | WATER CONTENT (%) | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | SPECIFIC GRAVITY | STRENGTH TEST | | | CONSOLIDATION TEST | | | | | SWELL TEST | | CT TEST | | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BULK | DRY | | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Index '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | | | | |
| 55 | 1.0 | SPT | 5 | 8 | 10 | 18 | | | | 4 | 19 | 33 | 44 | 72 | 37 | 35 | | CH | | | | | | | | | | | | | | | | | | |
| 55 | 2.0 | UDS | | | | | 2.05 | 1.69 | 20.6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | 3.0 | SPT | 30 | 40 | 35 | 75 | | | | 3 | 15 | 34 | 48 | 76 | 39 | 37 | | | | 2.54 | | | | | | | | | | | | | | | | |
| 55 | 4.0 | UDS | | | | | 1.78 | 1.56 | 13.9 | | | | | | | | | | | | CD | 0.35 | 31 | | | | | | 0.68 | 95 | | | | | | |

***Type of Sample***

| | | | |
|---|---|---|---|
| DS | Disturbed Soil Sample | UCC | Unconfined Compression Test |
| UDS | Undisturbed Soil Sample | VST | Vane Shear Test |
| RMS | Remoulded Soil Sample | Tuu | Unconsolidated undrained triaxial test |
| WS | Water Sample | Tcu | Consolidated Undrained triaxial test with pore pressure |

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

Job No. : G(H)1658(9)

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# CHP/ AHP AREA

## Results of Field and Laboratory Tests

| | | | Value ) Blows 15cm | | | | DENSITY (g/cm³) | | | PARTICLE SIZE (%) | | | | ATTERBERG'S LIMITS | | | | SOIL | | | STRENGTH TEST | | | CONSOLIDATION TEST | | | | SWELL TEST | | CT TEST | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOREHOLE / TRIAL PIT NO. | DEPTH (m) | TYPE OF SAMPLE | | | | | BULK | DRY | WATER CONTENT (%) | GRAVEL | SAND | SILT | CLAY | Liquid | Plastic | Plasticity Index | Shrinkage | IS CLASSIFICATION | DESCRIPTION | SPECIFIC GRAVITY | Type | Cohesion 'c' (kg/cm²) | Angle of Shearing Res. 'Φ' (deg) | Initial Void Ratio '$e_o$' | Preconsolid. Press. 'Pc' (kg/cm²) | Compression Idex '$C_c$' | Co. of Vol. Comp. 'mv' (cm²/kg) | Co. of Consolid. 'Cv' (cm²/min) | Swelling Pressure (kg/cm²) | Free Swell Index (%) | Max. Dry Dendity (g/cm³) | Optimum Moisture Cont. (%) | CALIFORNIA BEARING RATIO (%) | RELATIVE DENSITY | PERMEABILITY (m/hr) | REMARKS |
| 56 | 1.0 | SPT | 8 | 12 | 15 | 27 | | | | 0 | 19 | 31 | 50 | 82 | 41 | 41 | | CH | | 2.49 | | | | | | | | | | | | | | | | |
| 56 | 2.0 | UDS | | | | | 1.88 | 1.64 | 14.7 | | | | | | | | | | | | | | | | | | | | 1.04 | 115 | | | | | | |

***Type of Sample***

| | |
|---|---|
| DS | Disturbed Soil Sample |
| UDS | Undisturbed Soil Sample |
| RMS | Remoulded Soil Sample |
| WS | Water Sample |

| | |
|---|---|
| UCC | Unconfined Compression Test |
| VST | Vane Shear Test |
| Tuu | Unconsolidated undrained triaxial test |
| Tcu | Consolidated Undrained triaxial test with pore pressure |
| Tcd | Consolidated drained triaxial test |

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**Delhi** : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
**Bangalore** : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
**Chennai** : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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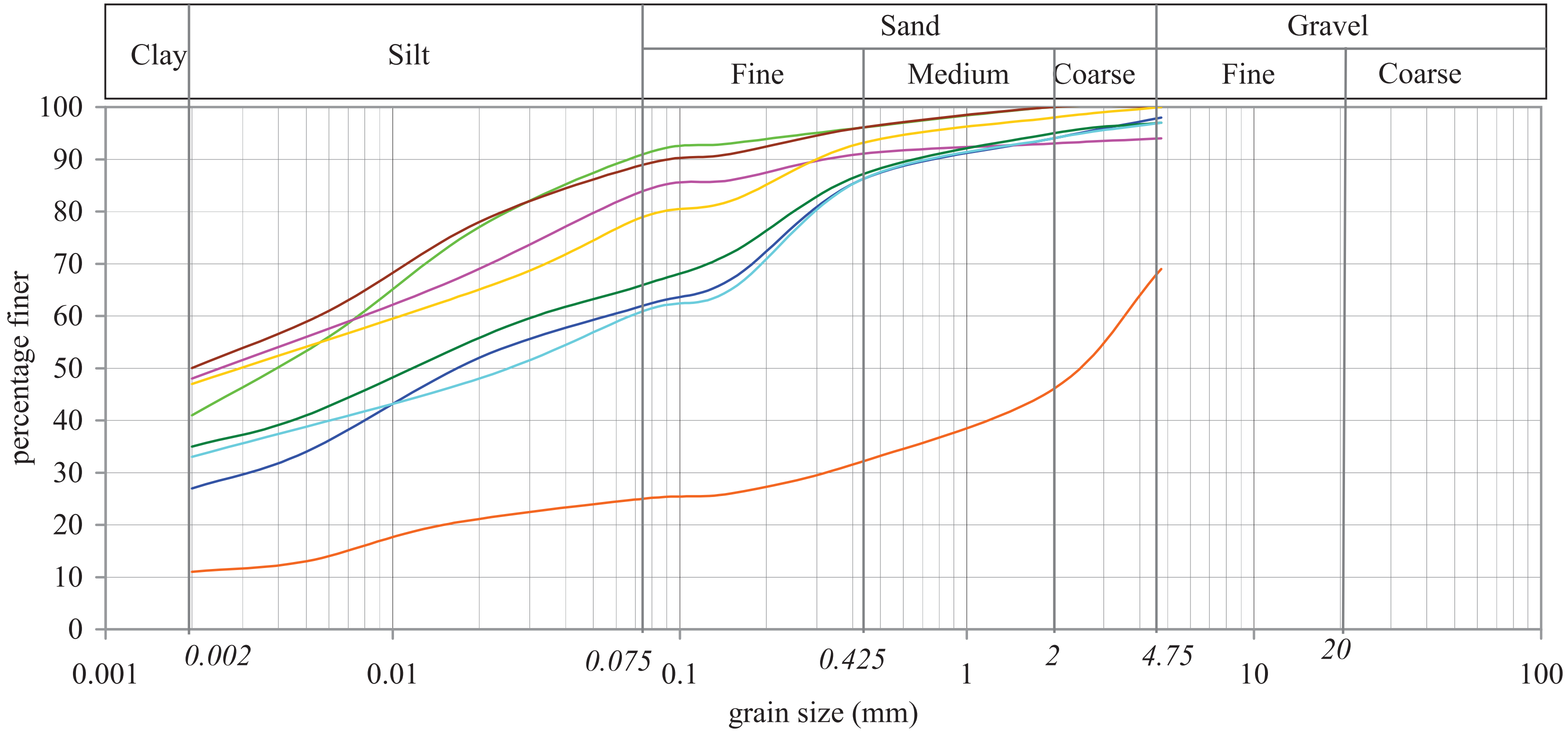


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | Clayey silty sand with gravel | 2 | 36 | 35 | 27 | 0.052 | - | - |
| | 1 | 3 | Clayey silty sand with gravel | 31 | 44 | 14 | 11 | 3.5 | - | - |
| | 1 | 5 | Sandy clayey silt | 0 | 9 | 50 | 41 | 0.0071 | - | - |
| | 2 | 1 | Sandy clayey silt | 0 | 11 | 39 | 50 | 0.0051 | - | - |
| | 2 | 3 | Sandy silty clay with gravel | 6 | 10 | 36 | 48 | 0.0072 | - | - |
| | 2 | 5 | Sandy silty clay | 0 | 21 | 32 | 47 | 0.012 | - | - |
| | 2 | 8 | Clayey silty sand with gravel | 3 | 31 | 31 | 35 | 0.029 | - | - |
| | 3 | 1 | Silty clayey sand with gravel | 3 | 36 | 28 | 33 | 0.062 | - | - |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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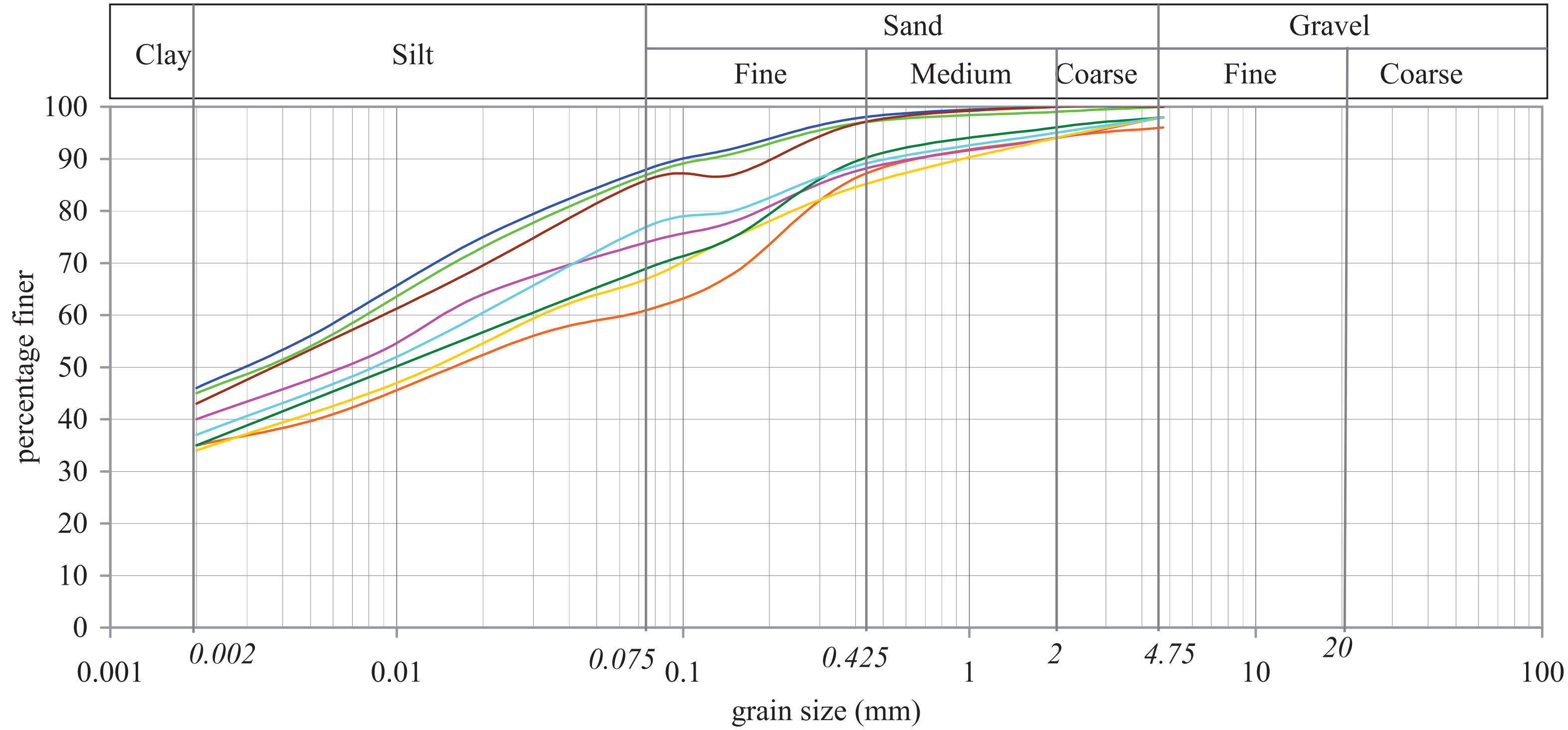
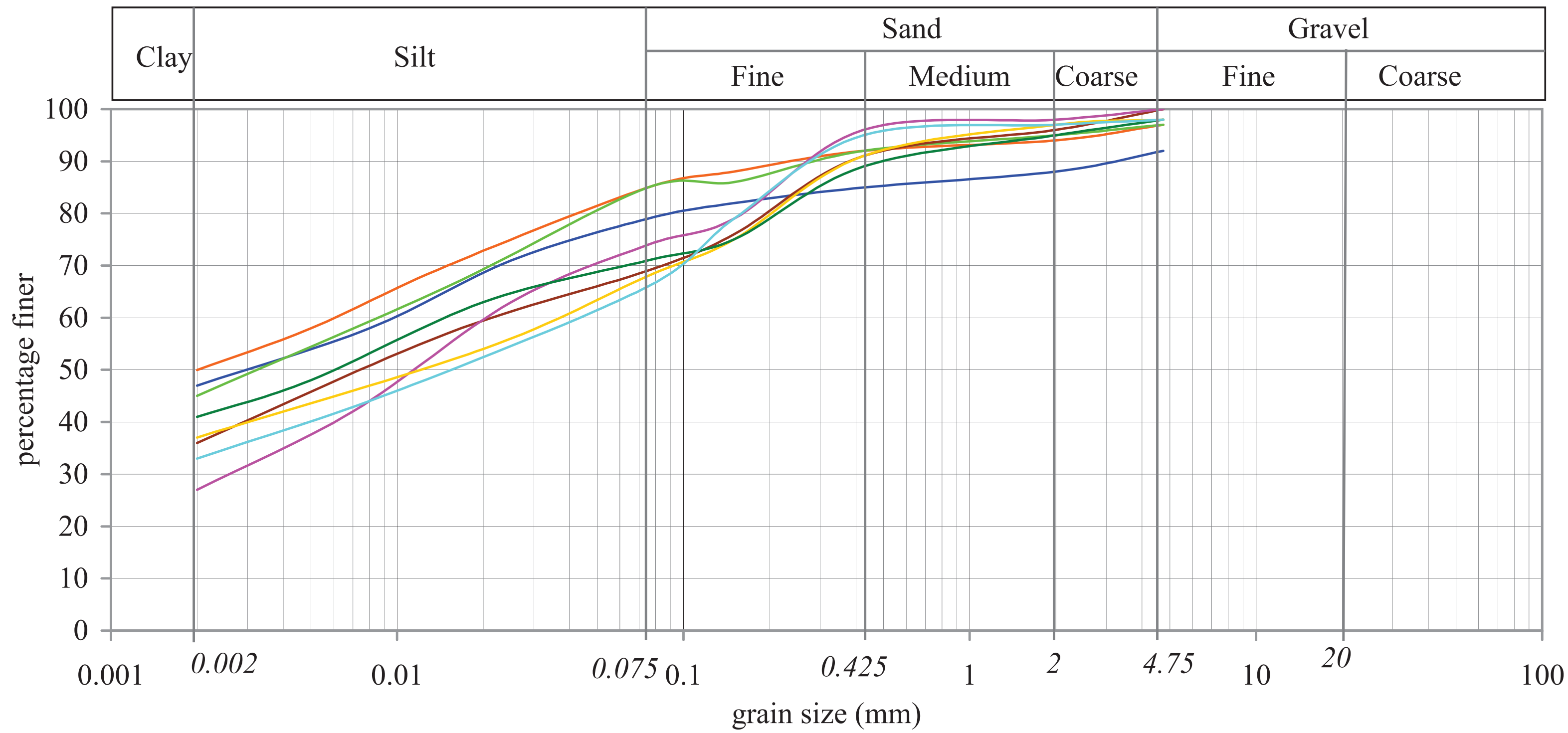



| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 3 | Sandy silty clay | 0 | 12 | 42 | 46 | 0.0065 | - | - |
| | 4 | 1 | Silty clayey sand with gravel | 4 | 35 | 26 | 35 | 0.059 | - | - |
| | 4 | 3 | Sandy silty clay | 0 | 13 | 42 | 45 | 0.0072 | - | - |
| | 5 | 1 | Sandy clayey silt | 0 | 14 | 43 | 43 | 0.009 | - | - |
| | 5 | 3 | Sandy silty clay with gravel | 2 | 24 | 34 | 40 | 0.015 | - | - |
| | 5 | 5 | Sandy silty clay with gravel | 2 | 31 | 33 | 34 | 0.029 | - | - |
| | 5 | 8 | Sandy silty clay with gravel | 2 | 29 | 34 | 35 | 0.028 | - | - |
| | 6 | 1 | Sandy clayey silt with gravel | 2 | 21 | 40 | 37 | 0.019 | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| blue line | 6 | 3 | Sandy silty clay with gravel | 8 | 13 | 32 | 47 | 0.0091 | - | - |
| orange line | 6 | 5 | Sandy silty clay with gravel | 3 | 12 | 35 | 50 | 0.0058 | - | - |
| light green line | 6 | 8 | Sandy silty clay with gravel | 3 | 12 | 40 | 45 | 0.0088 | - | - |
| brown line | 7 | 1 | Sandy silty clay | 0 | 31 | 33 | 36 | 0.021 | - | - |
| purple line | 7 | 3 | Sandy clayey silt | 0 | 26 | 47 | 27 | 0.021 | - | - |
| yellow line | 8 | 1 | Sandy silty clay with gravel | 2 | 30 | 31 | 37 | 0.037 | - | - |
| dark green line | 8 | 3 | Sandy silty clay with gravel | 2 | 27 | 30 | 41 | 0.015 | - | - |
| cyan line | 8 | 5 | Sandy silty clay with gravel | 2 | 32 | 33 | 33 | 0.042 | - | - |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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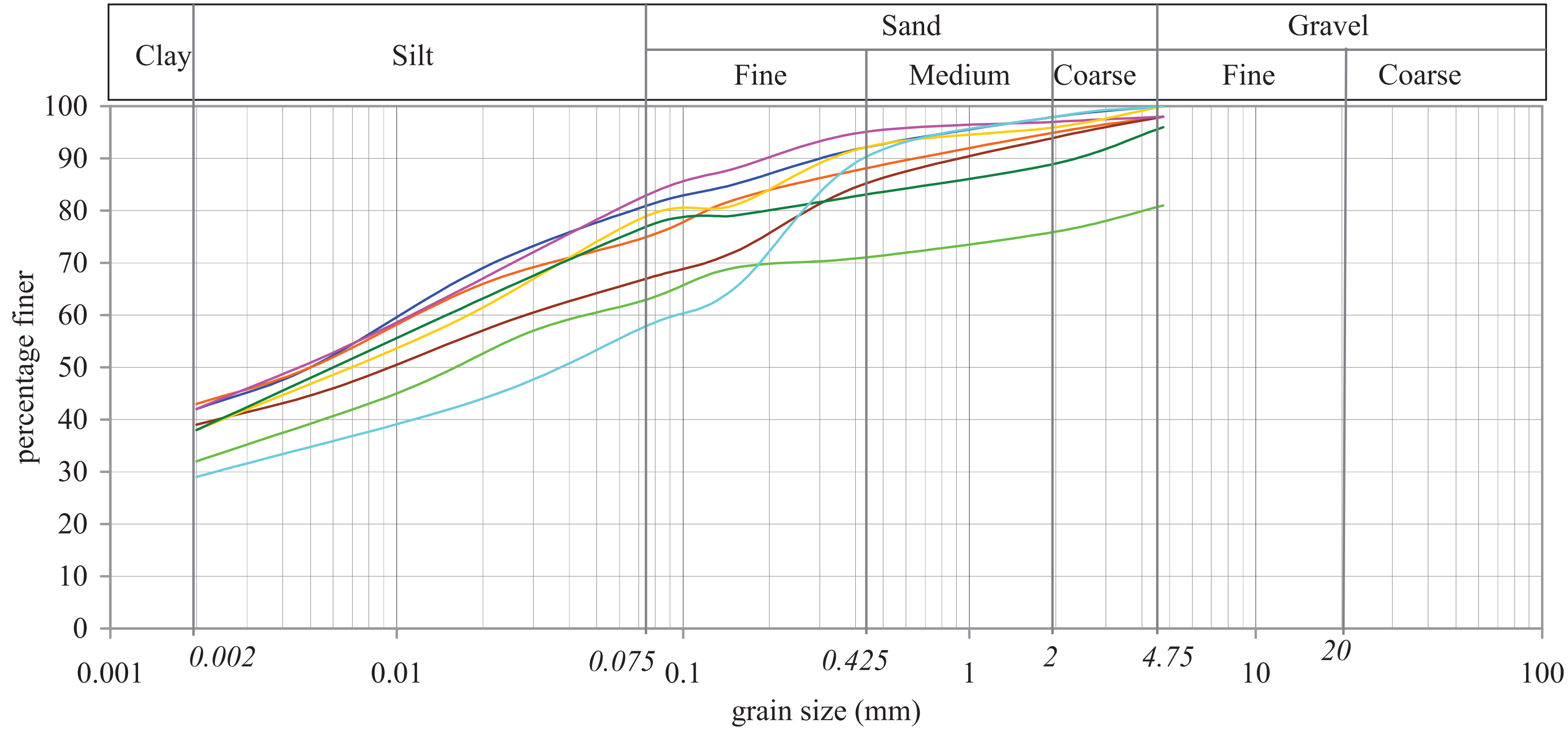


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| (blue) | 9 | 1 | Sandy silty clay | 0 | 19 | 39 | 42 | 0.011 | - | - |
| (orange) | 9 | 3 | Sandy silty clay with gravel | 2 | 23 | 32 | 43 | 0.012 | - | - |
| (light green) | 9 | 5 | Sandy silty clay with gravel | 19 | 18 | 31 | 32 | 0.045 | - | - |
| (brown) | 10 | 1 | Silty sandy clay with gravel | 2 | 31 | 28 | 39 | 0.028 | - | - |
| (purple) | 10 | 3 | Sandy silty clay with gravel | 2 | 15 | 41 | 42 | 0.012 | - | - |
| (yellow) | 11 | 1 | Sandy clay silt | 0 | 21 | 41 | 38 | 0.018 | - | - |
| (dark green) | 11 | 3 | Sandy clayey silt with gravel | 4 | 19 | 39 | 38 | 0.015 | - | - |
| (cyan) | 12 | 1 | Clayey silty sand | 0 | 42 | 29 | 29 | 0.091 | - | - |


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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS

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Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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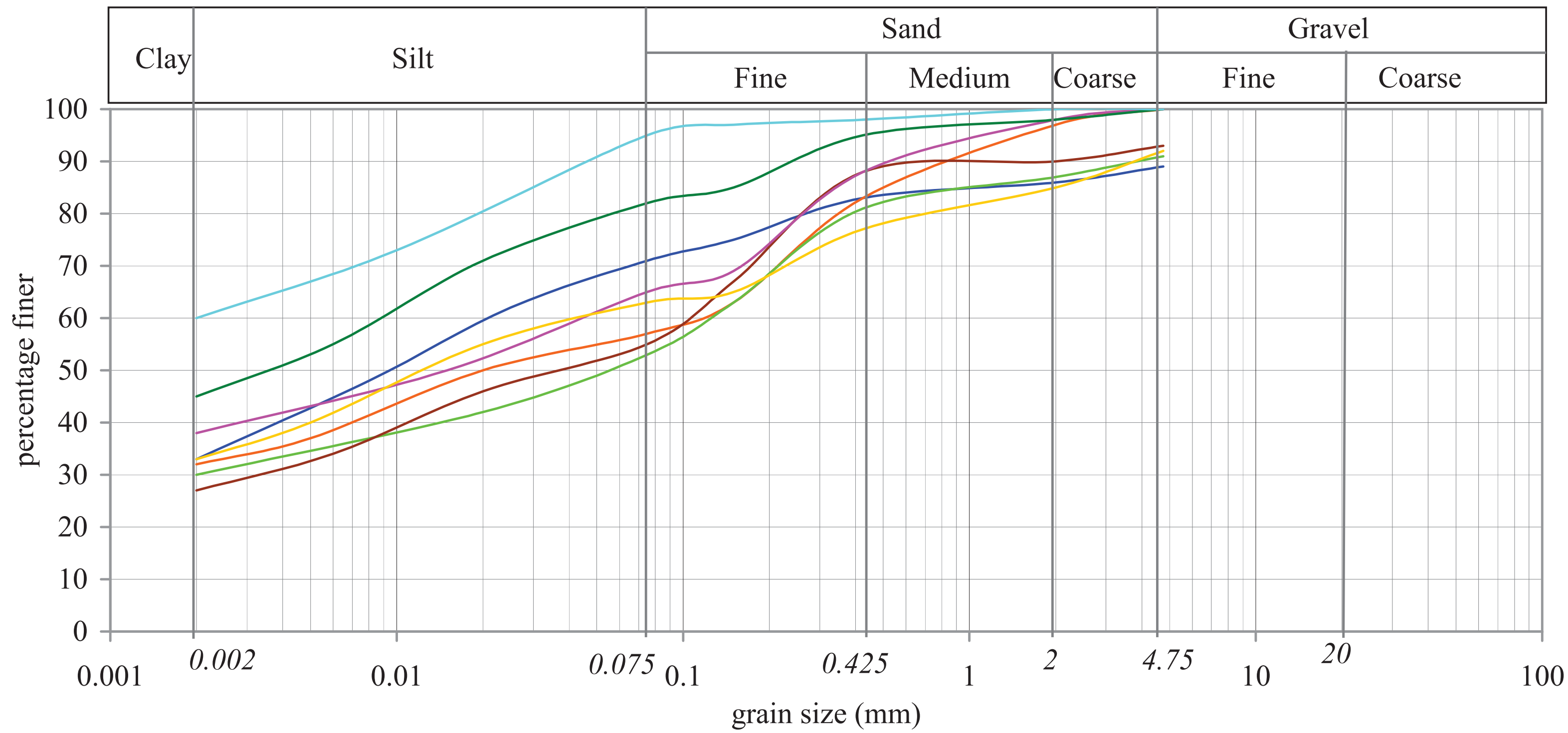
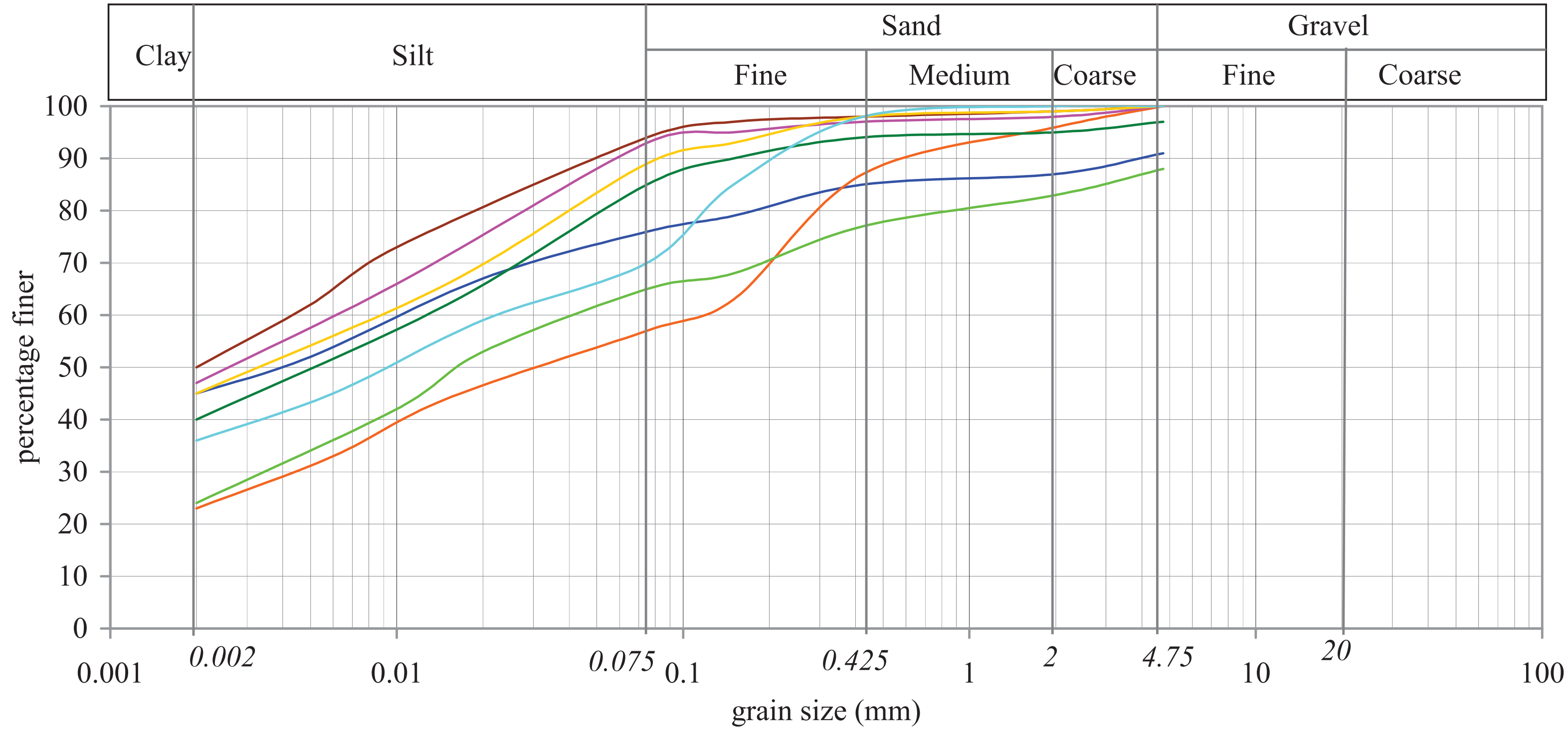



| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 12 | 3 | Sandy clayey silt with gravel | 11 | 18 | 38 | 33 | 0.021 | - | - |
| | 13 | 1 | Silty clayey sand | 0 | 43 | 25 | 32 | 0.12 | - | - |
| | 13 | 3 | Silty clayey sand with gravel | 9 | 38 | 23 | 30 | 0.13 | - | - |
| | 13 | 5 | Clayey silty sand with gravel | 7 | 38 | 28 | 27 | 0.11 | - | - |
| | 14 | 1 | Silty sandy clay | 0 | 35 | 27 | 38 | 0.042 | - | - |
| | 14 | 3 | Sandy silty clay with gravel | 8 | 29 | 30 | 33 | 0.041 | - | - |
| | 14 | 5 | Sandy silty clay | 0 | 18 | 37 | 45 | 0.0085 | - | - |
| | 15 | 1 | Sandy silty clay | 0 | 5 | 35 | 60 | - | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 3 | Sandy silty clay with gravel | 9 | 15 | 31 | 45 | 0.011 | - | - |
| | 16 | 1 | Clayey silty sand | 0 | 43 | 34 | 23 | 0.12 | - | - |
| | 16 | 3 | Sandy clayey silt with gravel | 12 | 23 | 41 | 24 | 0.039 | - | - |
| | 17 | 1 | Sandy silty clay | 0 | 6 | 44 | 50 | 0.0041 | - | - |
| | 17 | 3 | Snayd silty clay | 0 | 7 | 46 | 47 | 0.0061 | - | - |
| | 17 | 5 | Sandy silty clay | 0 | 11 | 44 | 45 | 0.0082 | - | - |
| | 18 | 1 | Sandy clayey silt with gravel | 3 | 12 | 45 | 40 | 0.013 | - | - |
| | 18 | 3 | Sandy silty clay | 0 | 30 | 34 | 36 | 0.021 | - | - |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NAGADI CONSULTANTS PRIVATE LIMITED

GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in

Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in

Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in

Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


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GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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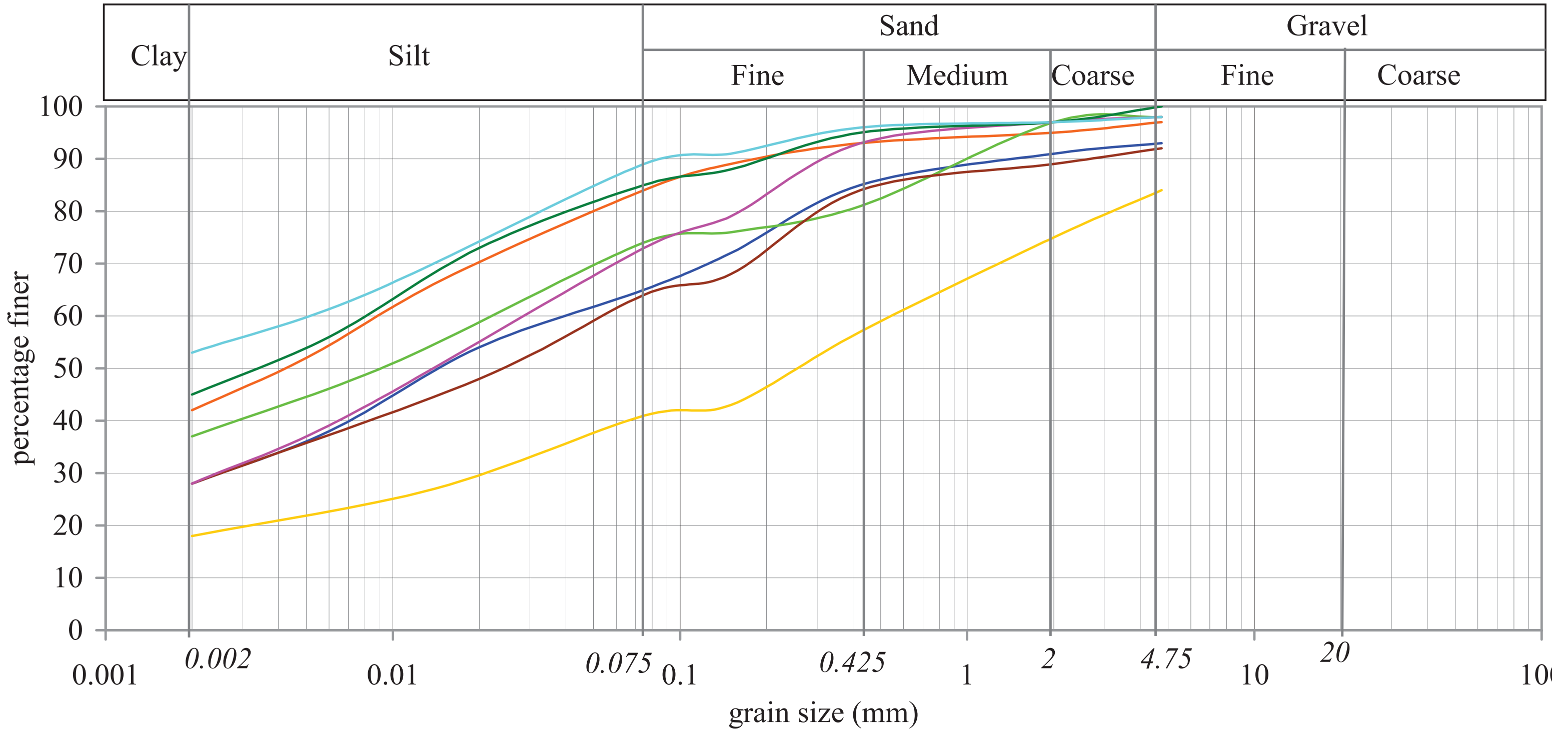
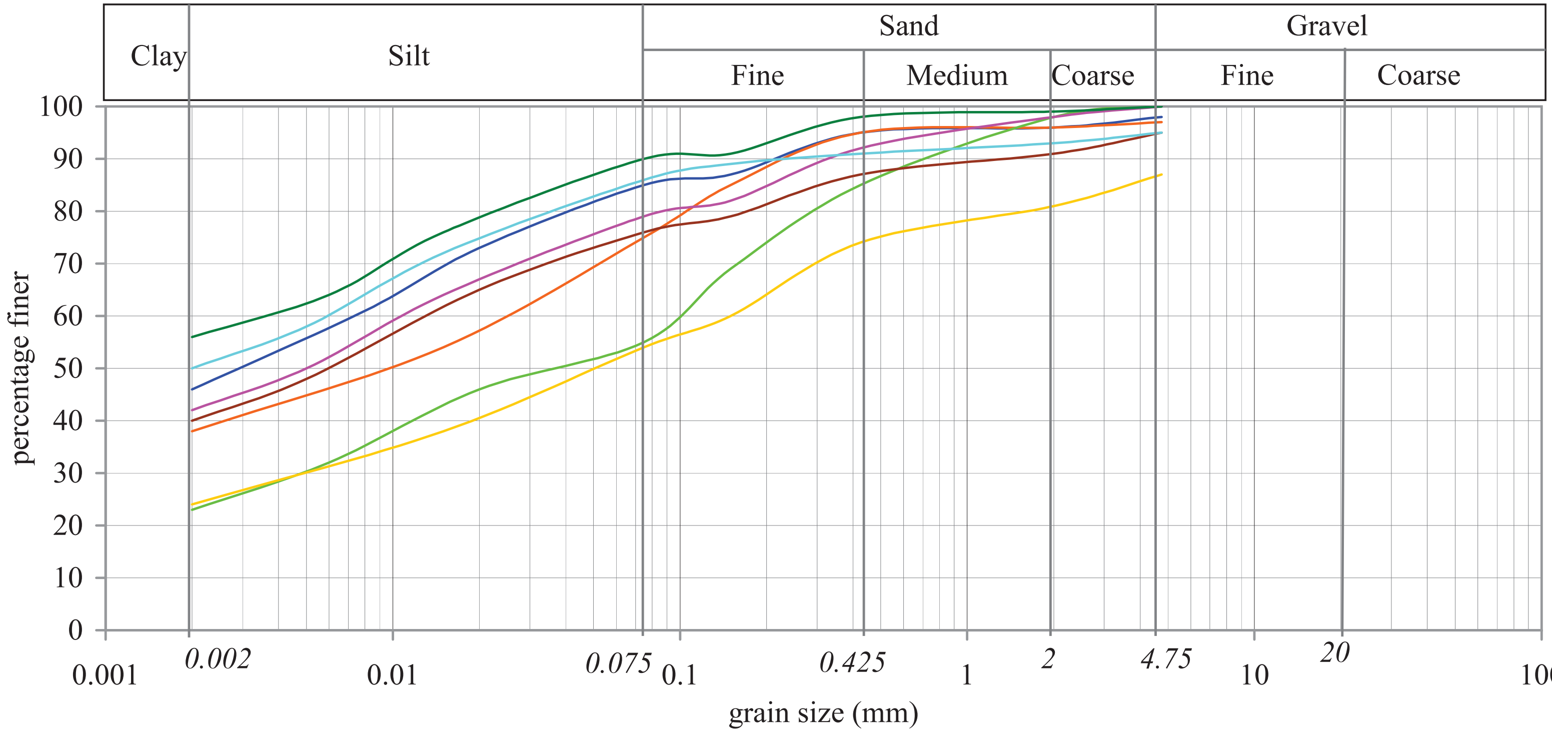
Job No. : G(H)1658(9)





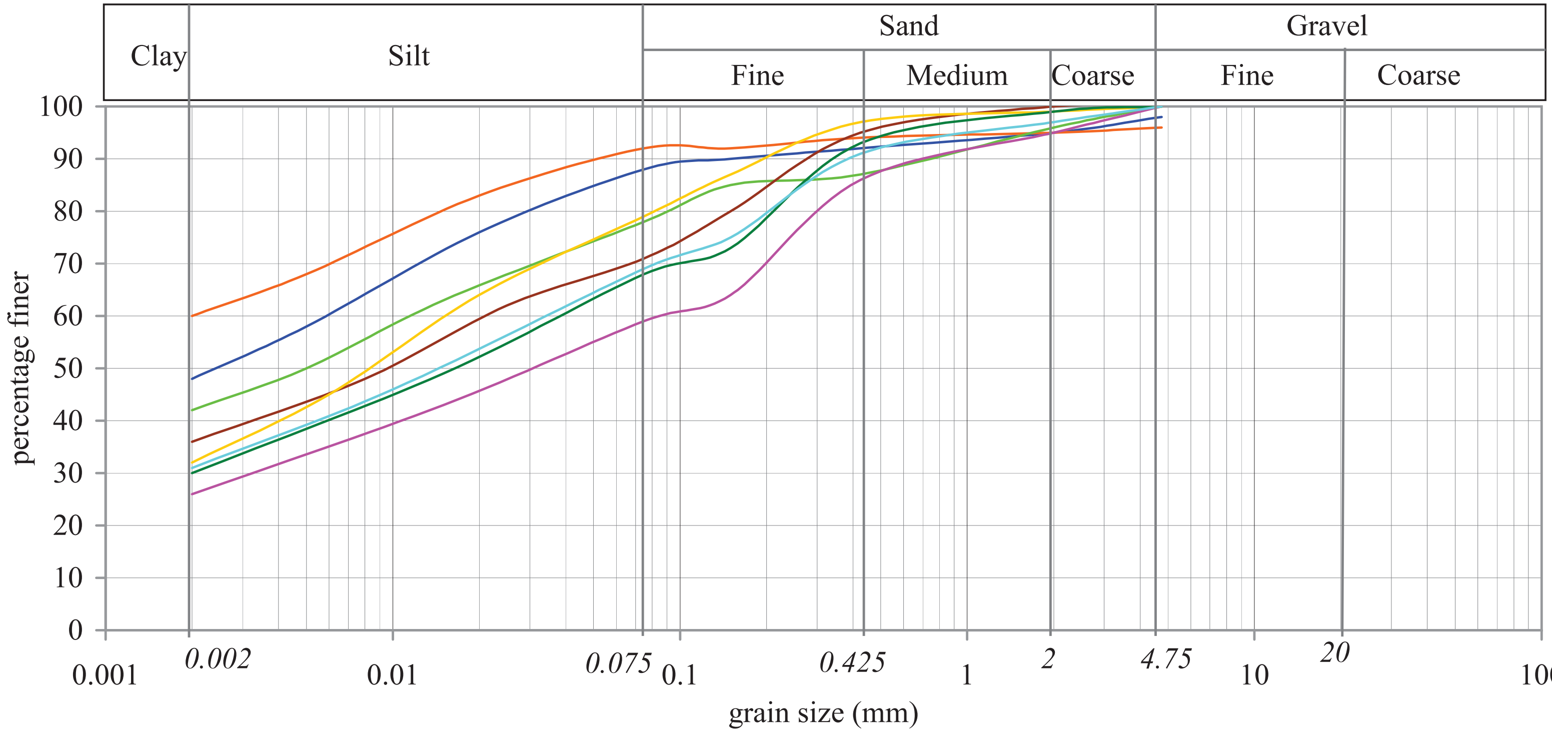

| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 19 | 1 | Clayey sandy silt with gravel | 7 | 28 | 37 | 28 | 0.039 | - | - |
| | 19 | 3 | Sandy clayey silt with gravel | 3 | 13 | 42 | 42 | 0.0075 | - | - |
| | 19 | 5 | Sandy clayey silt with gravel | 2 | 24 | 37 | 37 | 0.023 | - | - |
| | 20 | 1 | Sandy clayey silt with gravel | 8 | 28 | 36 | 28 | 0.052 | - | - |
| | 20 | 3 | Sandy clayey silt with gravel | 2 | 25 | 45 | 28 | 0.028 | - | - |
| | 21 | 1 | Clayey silty sand with gravel | 16 | 43 | 23 | 18 | 0.535 | - | - |
| | 21 | 3 | Sandy silty clay | 0 | 15 | 40 | 45 | 0.0081 | - | - |
| | 21 | 5 | Sandy silty clay with gravel | 2 | 9 | 36 | 53 | 0.0051 | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 8 | Sandy silty clay with gravel | 2 | 13 | 39 | 46 | 0.0072 | - | - |
| | 21 | 11 | Sandy silty clay with gravel | 3 | 22 | 37 | 38 | 0.025 | - | - |
| | 22 | 1 | Clayey silty sand | 0 | 45 | 32 | 23 | 0.1 | - | - |
| | 22 | 3 | Sandy silty clay with gravel | 5 | 19 | 36 | 40 | 0.013 | - | - |
| | 22 | 5 | Sandy silty clay | 0 | 21 | 37 | 42 | 0.011 | - | - |
| | 22 | 8 | Clayey silty sand with gravel | 13 | 33 | 30 | 24 | 0.15 | - | - |
| | 23 | 1 | Sandy silty clay | 0 | 10 | 34 | 56 | 0.036 | - | - |
| | 23 | 3 | Sandy silty clay with gravel | 5 | 9 | 36 | 50 | 0.0059 | - | - |


NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


Job No. : G(H)1658(9)




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 23 | 5 | Sandy silty clay with gravel | 2 | 10 | 40 | 48 | 0.0059 | - | - |
| | 23 | 8 | Sandy silty clay with gravel | 4 | 4 | 32 | 60 | 0.002 | - | - |
| | 23 | 11 | Sandy silty clay | 0 | 22 | 36 | 42 | 0.012 | - | - |
| | 23 | 14 | Sandy silty clay | 0 | 29 | 35 | 36 | 0.021 | - | - |
| | 24 | 1 | Clayey silty sand | 0 | 41 | 33 | 26 | 0.09 | - | - |
| | 24 | 3 | Snady clayey silt | 0 | 21 | 47 | 32 | 0.015 | - | - |
| | 25 | 1 | Clayey sandy silt | 0 | 32 | 38 | 30 | 0.035 | - | - |
| | 26 | 1 | Clayey sandy silt | 0 | 31 | 38 | 31 | 0.035 | - | - |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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in

Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in

Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in

Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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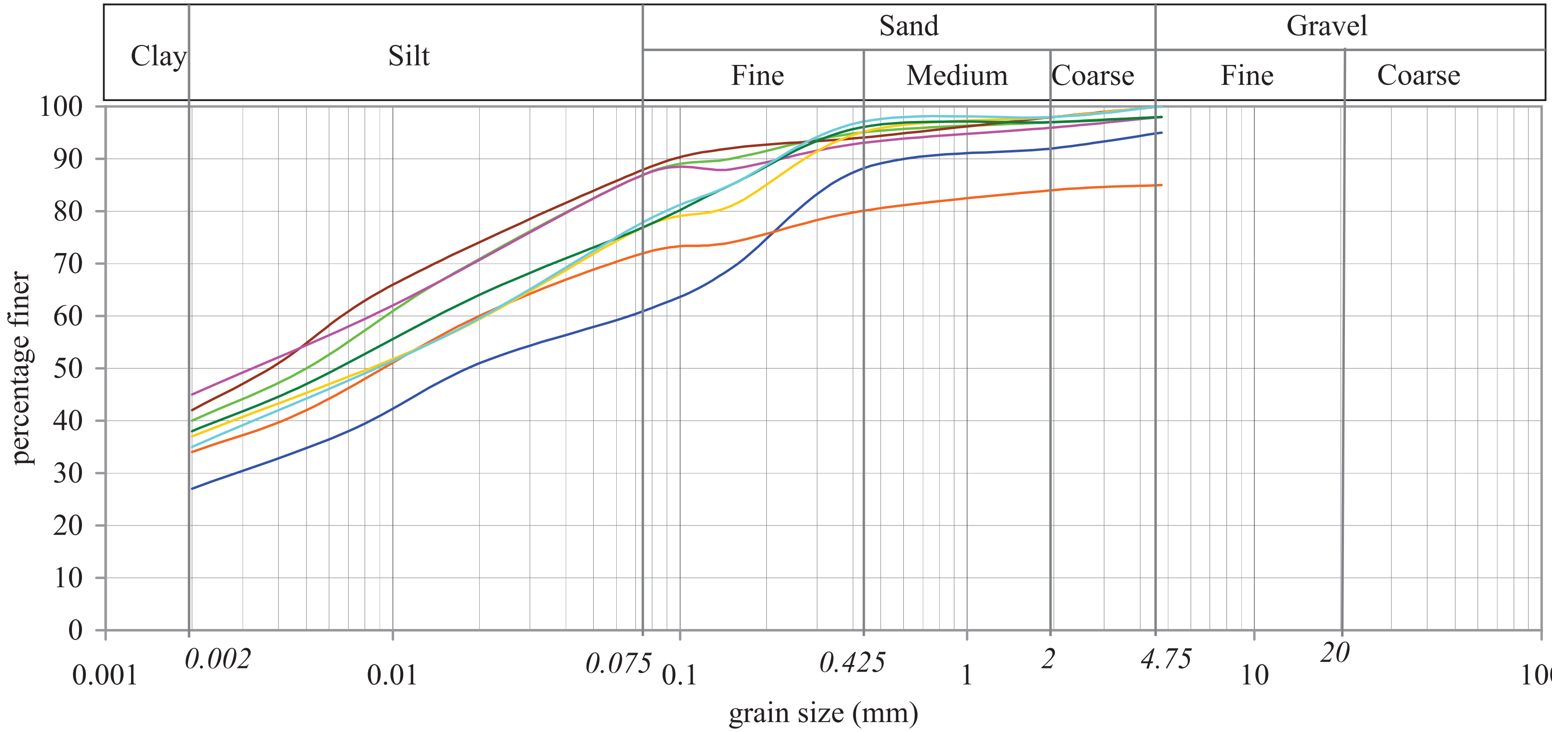


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 3 | Clayey sandy silt with gravel | 5 | 34 | 34 | 27 | 0.065 | - | - |
| | 26 | 5 | Sandy clayey silt with gravel | 15 | 13 | 38 | 34 | 0.021 | - | - |
| | 27 | 1 | Sandy clayey silt with gravel | 2 | 11 | 47 | 40 | 0.0091 | - | - |
| | 27 | 3 | Sandy clayey silt | 0 | 12 | 46 | 42 | 0.0065 | - | - |
| | 27 | 5 | Sandy silty clay with gravel | 2 | 11 | 42 | 45 | 0.0081 | - | - |
| | 28 | 1 | Sandy clayey silt | 0 | 23 | 40 | 37 | 0.019 | - | - |
| | 28 | 3 | Sandy clayey silt with gravel | 2 | 21 | 39 | 38 | 0.015 | - | - |
| | 28 | 5 | Sandy clayey silt | 0 | 22 | 43 | 35 | 0.021 | - | - |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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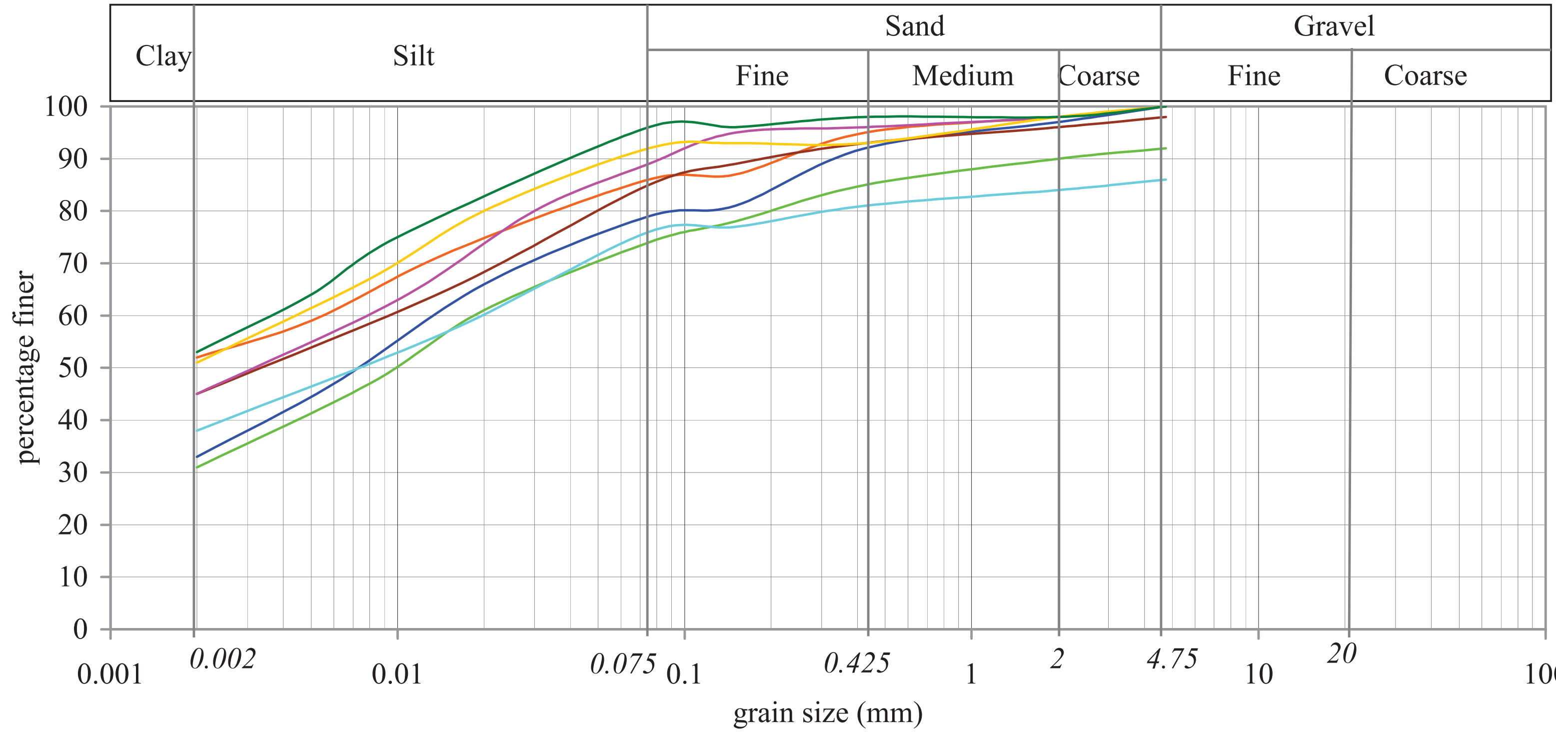


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 29 | 1 | Sandy clayey silt | 0 | 21 | 46 | 33 | 0.014 | - | - |
| | 30 | 1 | Sandy silty clay | 0 | 14 | 34 | 52 | 0.0055 | - | - |
| | 30 | 3 | Sandy clayey silt with gravel | 8 | 18 | 43 | 31 | 0.018 | - | - |
| | 30 | 5 | Sandy silty clay with gravel | 2 | 13 | 40 | 45 | 0.0091 | - | - |
| | 31 | 1 | Sandy silty clay | 0 | 11 | 44 | 45 | 0.0075 | - | - |
| | 31 | 3 | Sandy silty clay | 0 | 8 | 41 | 51 | 0.0045 | - | - |
| | 31 | 5 | Snady silty clay | 0 | 4 | 43 | 53 | 0.0035 | - | - |
| | 31 | 8 | Sandy clayey silt with gravel | 14 | 10 | 38 | 38 | 0.018 | - | - |

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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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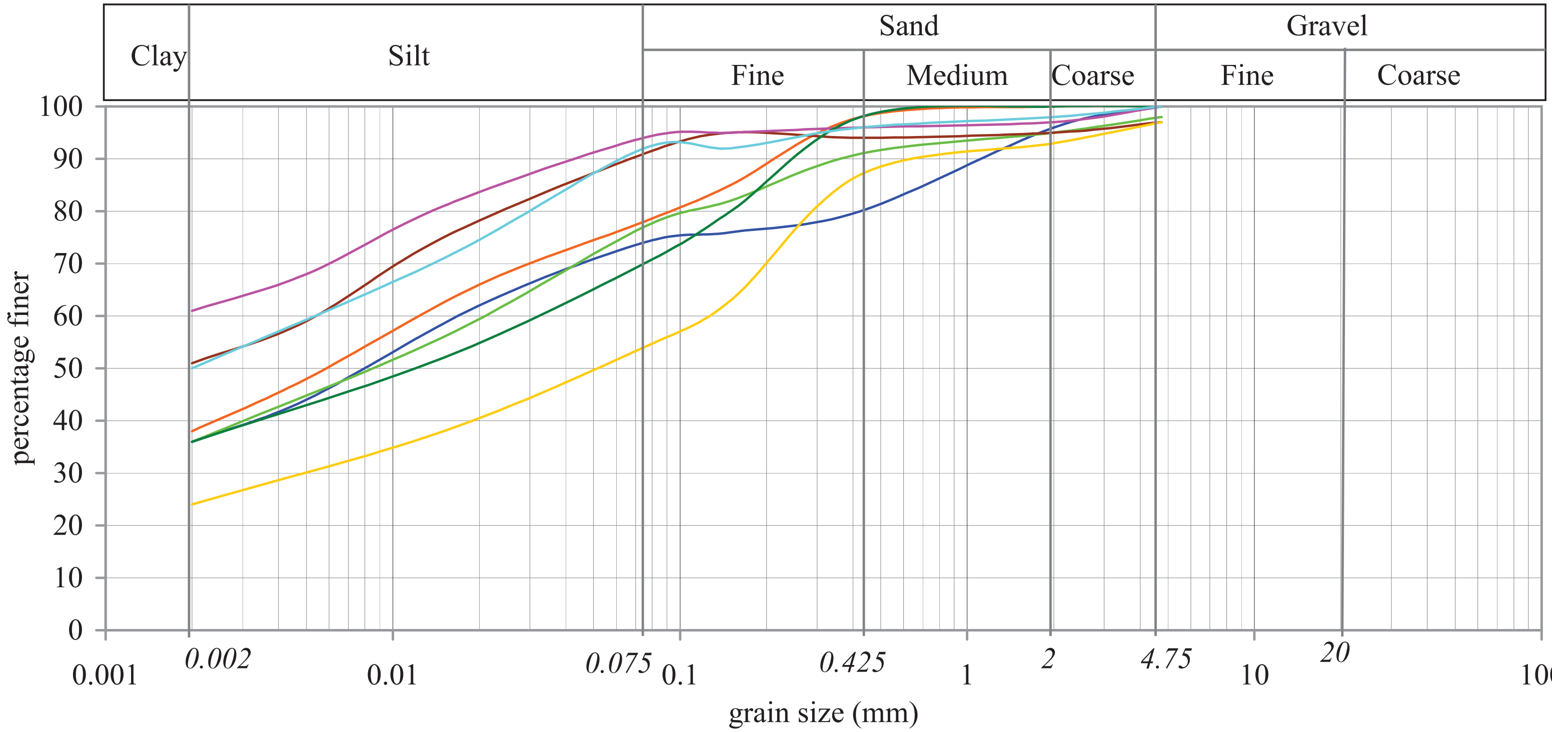


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | 11 | Sandy clayey silt | 0 | 26 | 38 | 36 | 0.016 | - | - |
| | 31 | 14 | Sandy clayey silt | 0 | 22 | 40 | 38 | 0.012 | - | - |
| | 32 | 1 | Sandy clayey silt with gravel | 2 | 21 | 41 | 36 | 0.021 | - | - |
| | 32 | 3 | Sandy silty clay with gravel | 3 | 6 | 40 | 51 | 0.0051 | - | - |
| | 32 | 5 | Sandy silty clay | 0 | 6 | 33 | 61 | - | - | - |
| | 32 | 8 | Clayey silty sand with gravel | 3 | 43 | 30 | 24 | 0.13 | - | - |
| | 32 | 11 | Sandy silty clay | 0 | 30 | 34 | 36 | 0.031 | - | - |
| | 33 | 1 | Sandy silty clay | 0 | 8 | 42 | 50 | 0.0052 | - | - |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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Job No. : G(H)1658(9)

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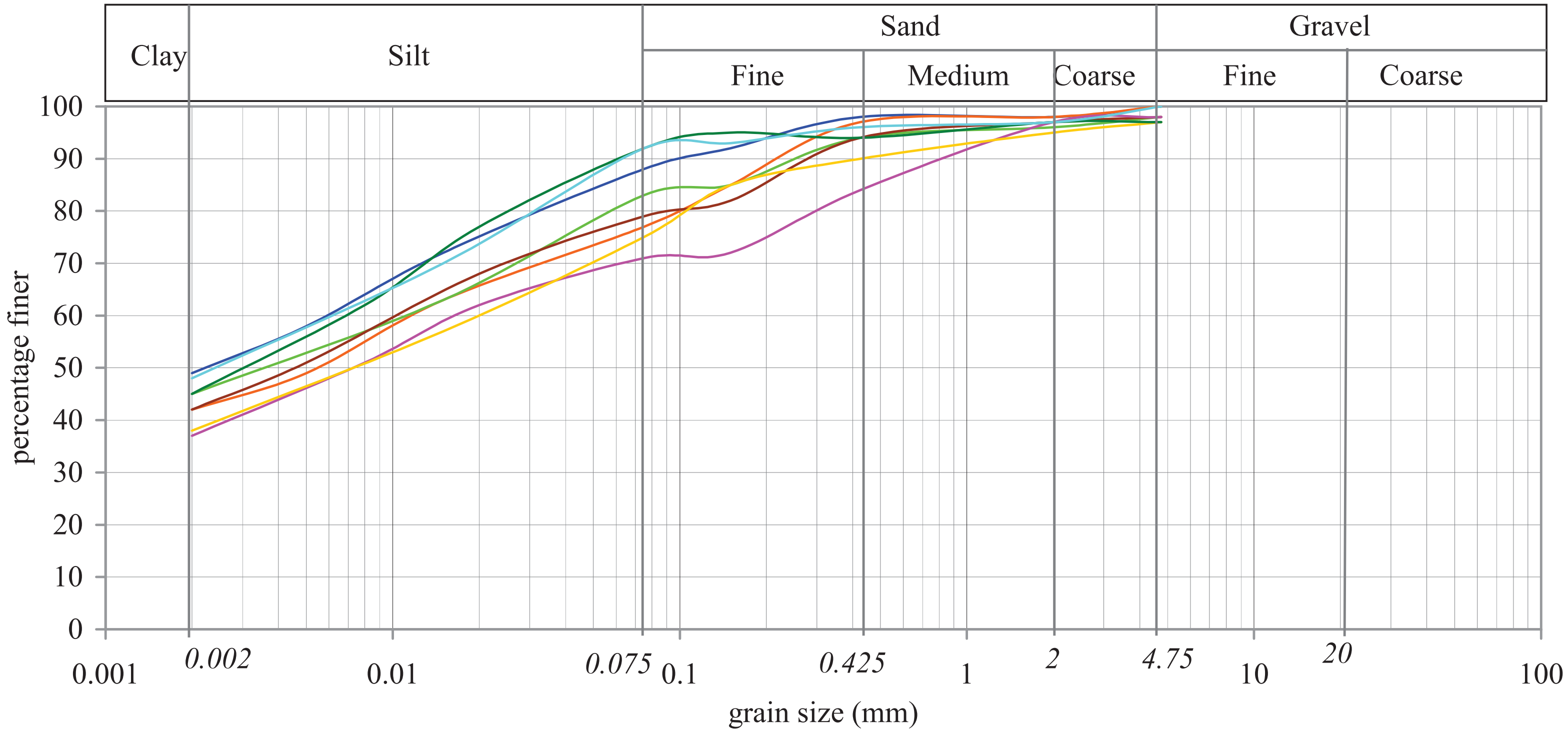
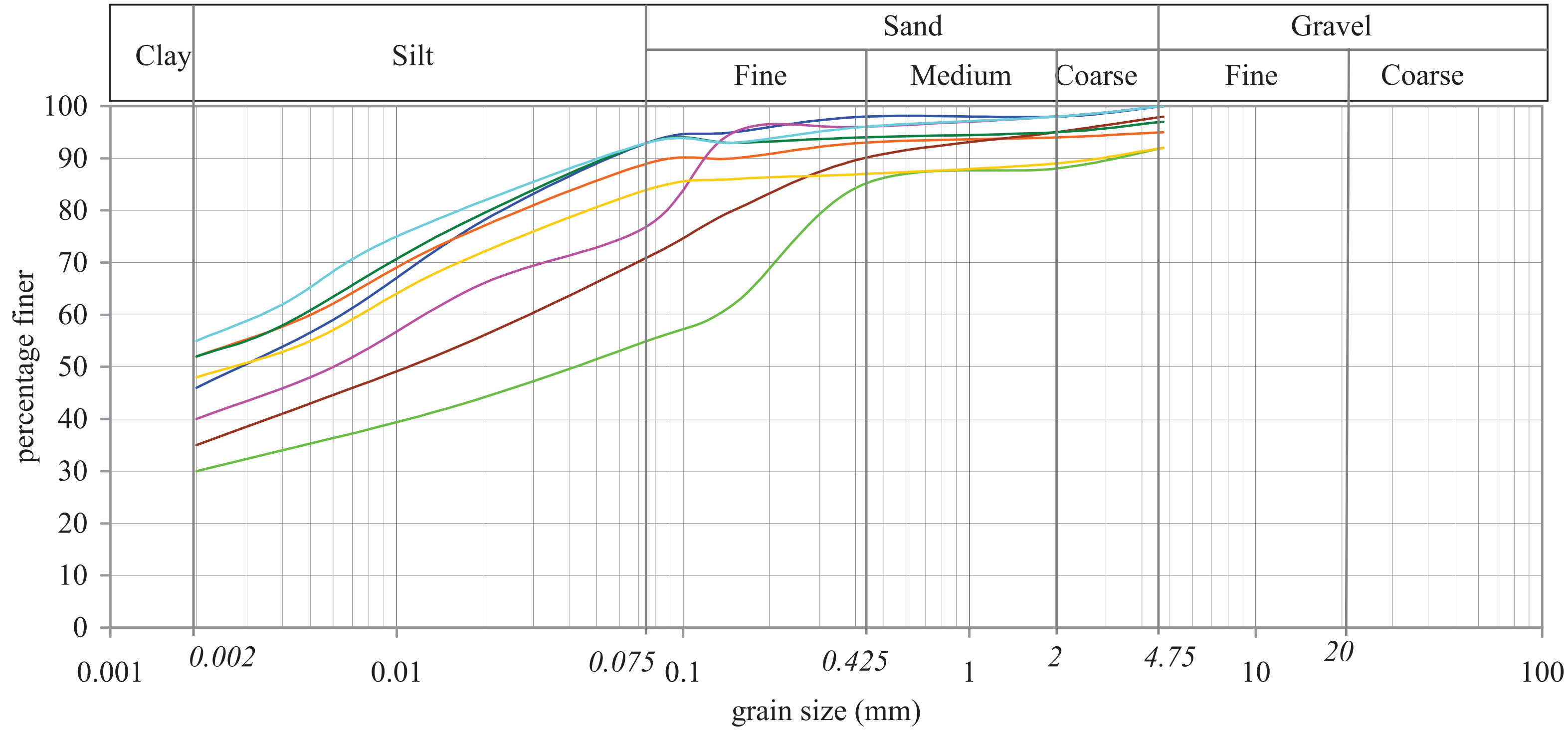



| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 33 | 3 | Sandy silty clay | 0 | 12 | 39 | 49 | 0.0058 | - | - |
| | 33 | 5 | Sandy silty clay | 0 | 23 | 35 | 42 | 0.012 | - | - |
| | 33 | 8 | Sandy silty clay with gravel | 2 | 15 | 38 | 45 | 0.011 | - | - |
| | 33 | 9.5 | Sandy silty clay with gravel | 2 | 19 | 37 | 42 | 0.011 | - | - |
| | 33 | 11 | Sandy silty clay with gravel | 2 | 27 | 34 | 37 | 0.017 | - | - |
| | 33 | 14 | Sandy silty clay with gravel | 3 | 22 | 37 | 38 | 0.019 | - | - |
| | 34 | 1 | Sandy clayey silt with gravel | 3 | 5 | 47 | 45 | 0.0068 | - | - |
| | 34 | 3 | Sandy silty clay | 0 | 8 | 44 | 48 | 0.0061 | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 34 | 5 | Sandy clayey silt | 0 | 7 | 47 | 46 | 0.0062 | - | - |
| | 34 | 8 | Sandy clayey silt with gravel | 5 | 6 | 37 | 52 | 0.0049 | - | - |
| | 34 | 9.5 | Silty clayey sand with gravel | 8 | 37 | 25 | 30 | 0.13 | - | - |
| | 34 | 11 | Sandy clayey silt with gravel | 2 | 27 | 36 | 35 | 0.029 | - | - |
| | 34 | 14 | Sandy silty clay | 0 | 23 | 37 | 40 | 0.013 | - | - |
| | 35 | 1 | Sandy silty clay with gravel | 8 | 8 | 36 | 48 | 0.0071 | - | - |
| | 35 | 3 | Sandy silty clay with gravel | 3 | 4 | 41 | 52 | 0.0048 | - | - |
| | 35 | 5 | Sandy silty clay | 0 | 7 | 38 | 55 | 0.0032 | - | - |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NAGADI CONSULTANTS PRIVATE LIMITED

GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in

Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in

Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in

Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


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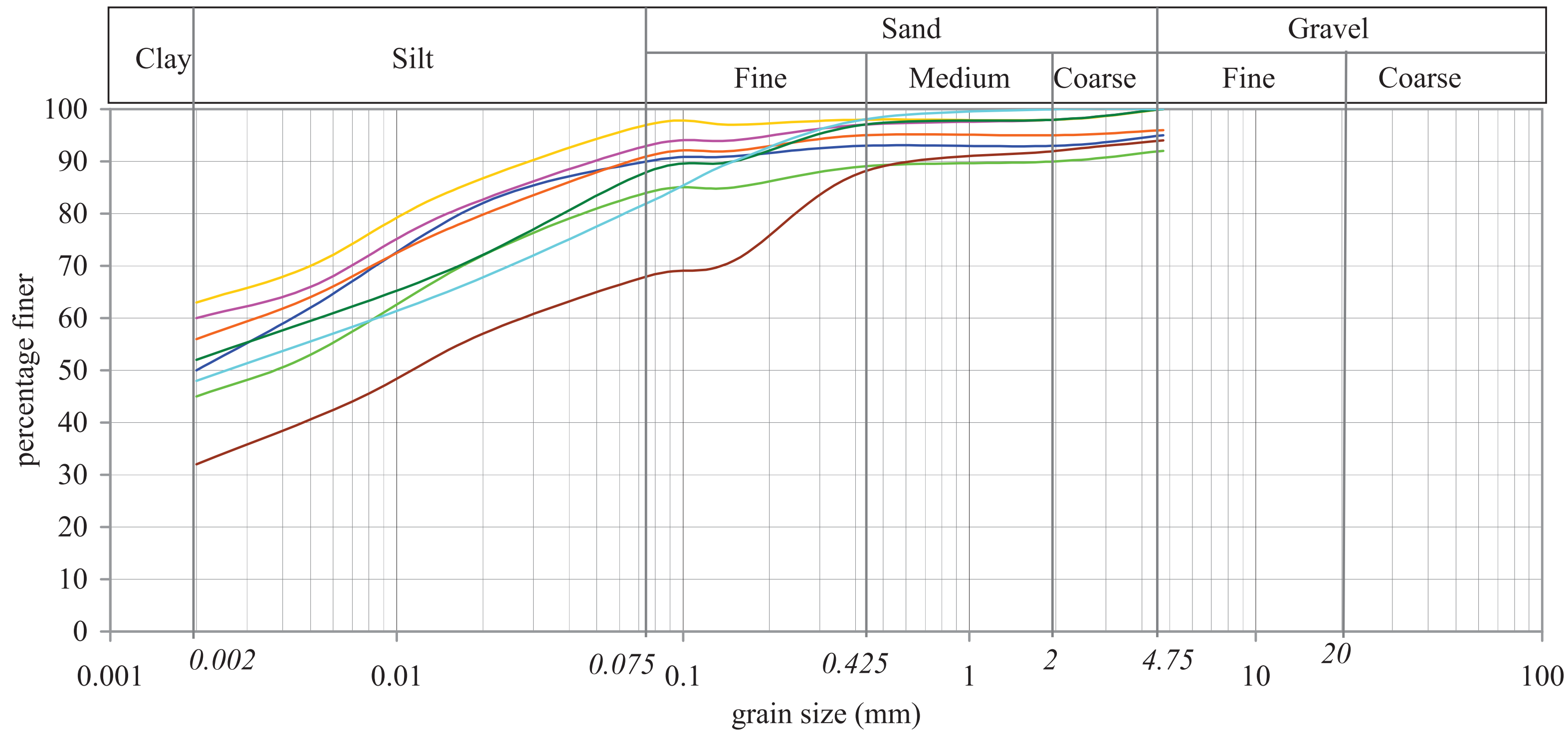


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| (blue) | 35 | 8 | Sandy silty clay with gravel | 5 | 5 | 40 | 50 | 0.0041 | - | - |
| (orange) | 35 | 11 | Sandy silty clay with gravel | 4 | 5 | 35 | 56 | 0.0032 | - | - |
| (light green) | 35 | 14 | Sandy silty clay with gravel | 8 | 8 | 39 | 45 | 0.0081 | - | - |
| (brown) | 36 | 1 | Sandy clayey silt with gravel | 6 | 26 | 36 | 32 | 0.027 | - | - |
| (purple) | 36 | 3 | Sandy silty clay | 0 | 7 | 33 | 60 | 0.002 | - | - |
| (yellow) | 36 | 5 | Sandy silty clay | 0 | 3 | 34 | 63 | - | - | - |
| (dark green) | 36 | 8 | Sandy silty clay | 0 | 12 | 36 | 52 | 0.0052 | - | - |
| (light blue) | 36 | 11 | Sandy silty clay | 0 | 18 | 34 | 48 | 0.0092 | - | - |


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Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in


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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
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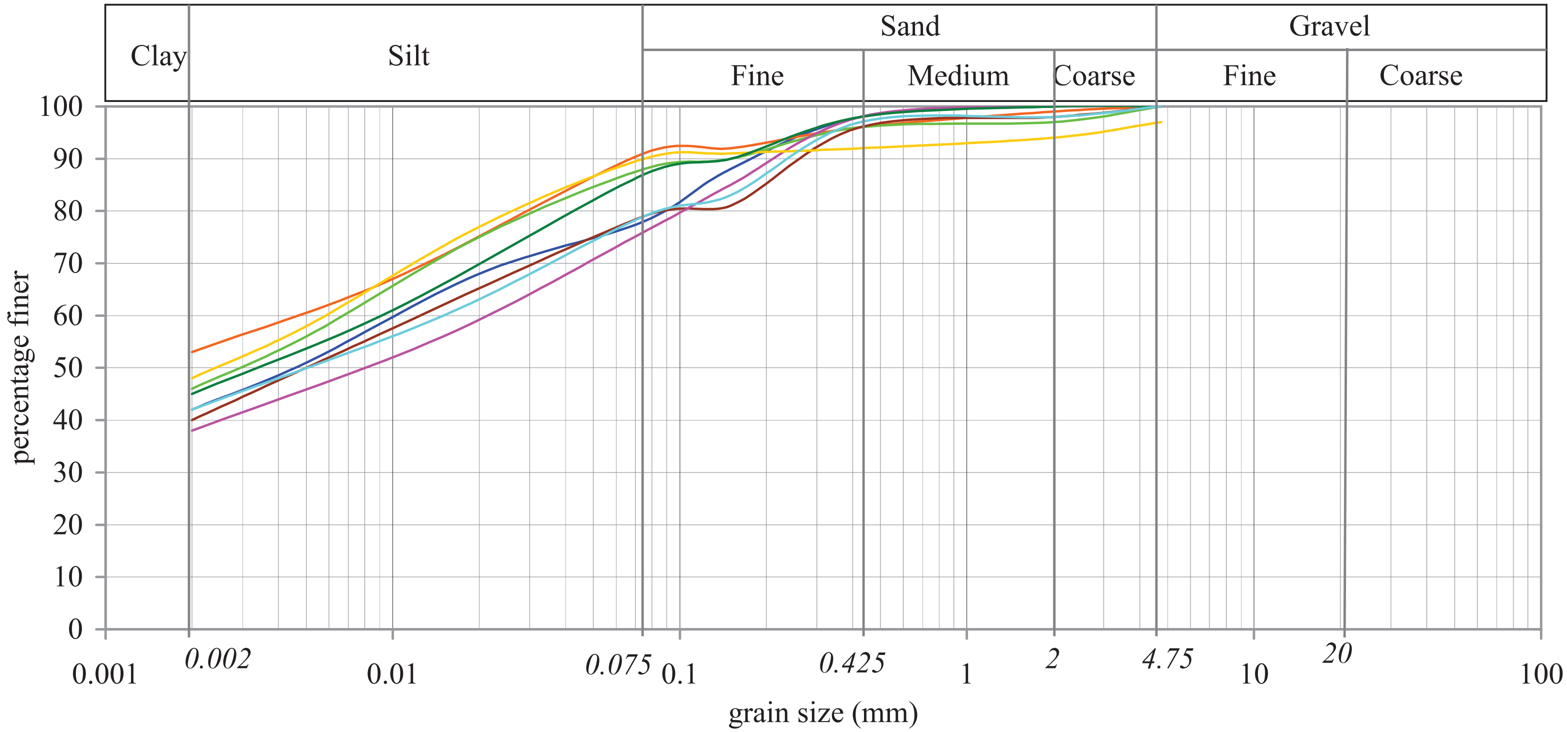


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 36 | 14 | Sandy silty clay | 0 | 22 | 36 | 42 | 0.011 | - | - |
| | 37 | 1 | Sandy silty clay | 0 | 9 | 38 | 53 | 0.0046 | - | - |
| | 37 | 3 | Sandy silty clay | 0 | 12 | 42 | 46 | 0.0067 | - | - |
| | 37 | 5 | Sandy silty clay | 0 | 21 | 39 | 40 | 0.013 | - | - |
| | 37 | 8 | Sandy silty clay | 0 | 24 | 38 | 38 | 0.022 | - | - |
| | 37 | 9.5 | Sandy silty clay with gravel | 3 | 7 | 42 | 48 | 0.0058 | - | - |
| | 37 | 11 | Sandy silty clay | 0 | 13 | 42 | 45 | 0.0095 | - | - |
| | 38 | 1 | Sandy silty clay | 0 | 21 | 37 | 42 | 0.015 | - | - |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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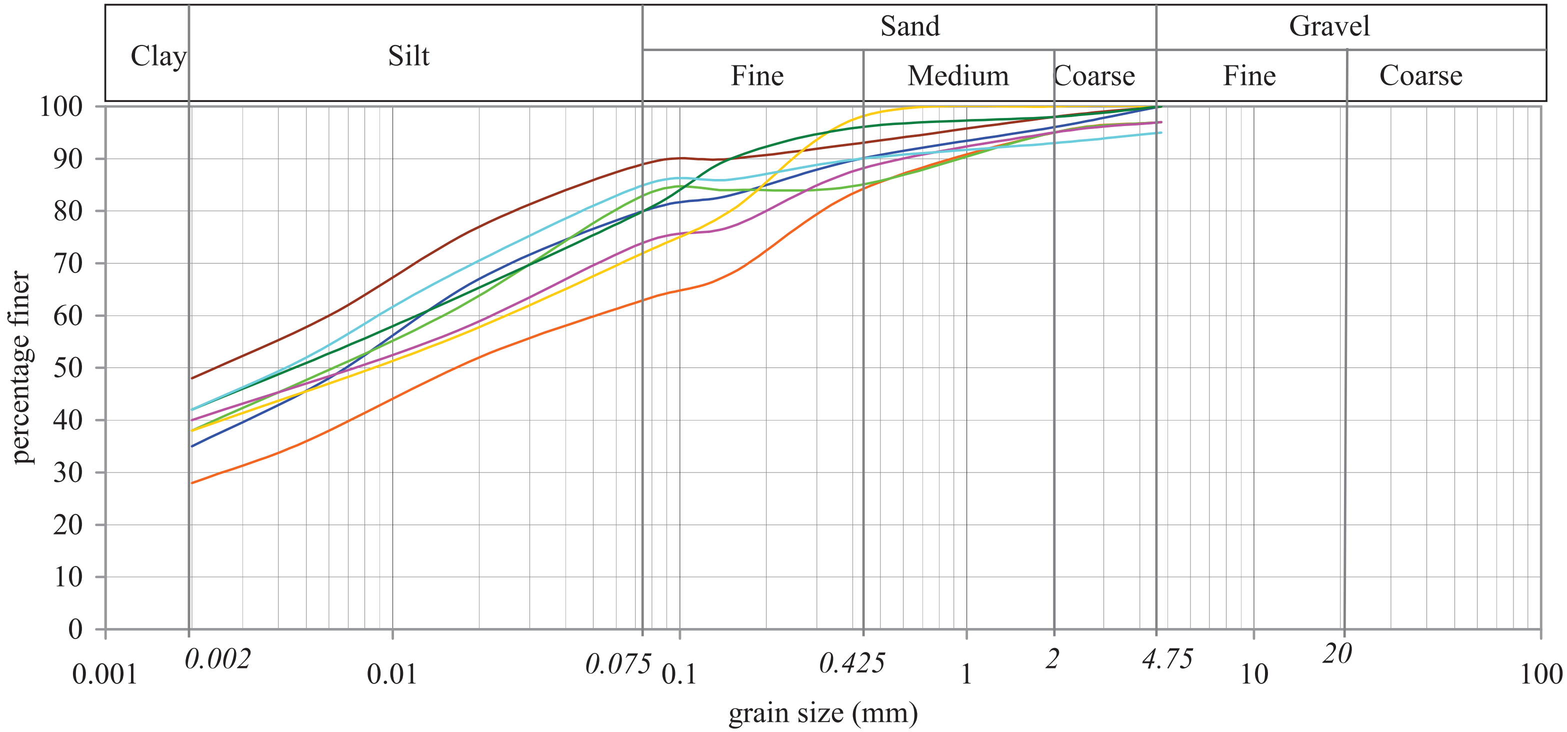
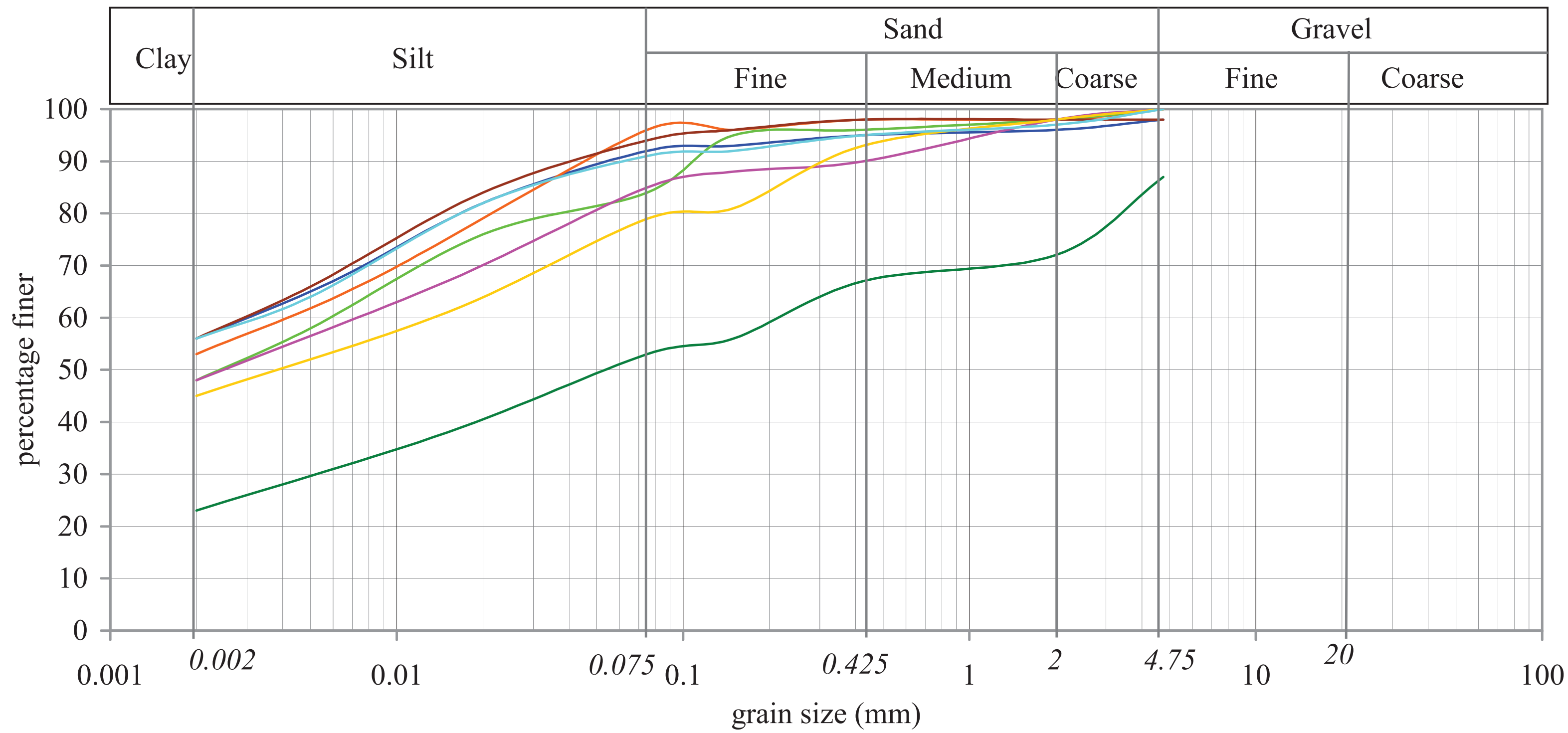



| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 38 | 3 | Sandy clayey silt | 0 | 20 | 45 | 35 | 0.013 | - | - |
| | 38 | 5 | Clayey sandy silt with gravel | 3 | 34 | 35 | 28 | 0.051 | - | - |
| | 38 | 8 | Sandy clayey silt with gravel | 3 | 14 | 45 | 38 | 0.015 | - | - |
| | 38 | 9.5 | Sandy silty clay | 0 | 11 | 41 | 48 | 0.0059 | - | - |
| | 38 | 11 | Sandy silty clay with gravel | 3 | 23 | 34 | 40 | 0.022 | - | - |
| | 38 | 12.5 | Sandy silty clay | 0 | 28 | 34 | 38 | 0.023 | - | - |
| | 38 | 15 | Sandy silty clay | 0 | 20 | 38 | 42 | 0.013 | - | - |
| | 39 | 1 | Sandy clayey silt with gravel | 5 | 10 | 43 | 42 | 0.0091 | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 39 | 3 | Sandy silty clay with gravel | 2 | 6 | 36 | 56 | 0.0032 | - | - |
| | 39 | 5 | Sandy silty clay | 0 | 4 | 43 | 53 | 0.0041 | - | - |
| | 39 | 8 | Sandy silty clay | 0 | 16 | 36 | 48 | 0.0058 | - | - |
| | 39 | 11 | Sandy silty clay with gravel | 2 | 4 | 38 | 56 | 0.0029 | - | - |
| | 39 | 14 | Sandy silty clay | 0 | 15 | 37 | 48 | 0.0072 | - | - |
| | 40 | 1 | Sandy silty clay | 0 | 21 | 34 | 45 | 0.013 | - | - |
| | 40 | 3 | Clayey silty sand with gravel | 13 | 34 | 30 | 23 | 0.22 | - | - |
| | 40 | 5 | Sandy silty clay | 0 | 9 | 35 | 56 | 0.0032 | - | - |

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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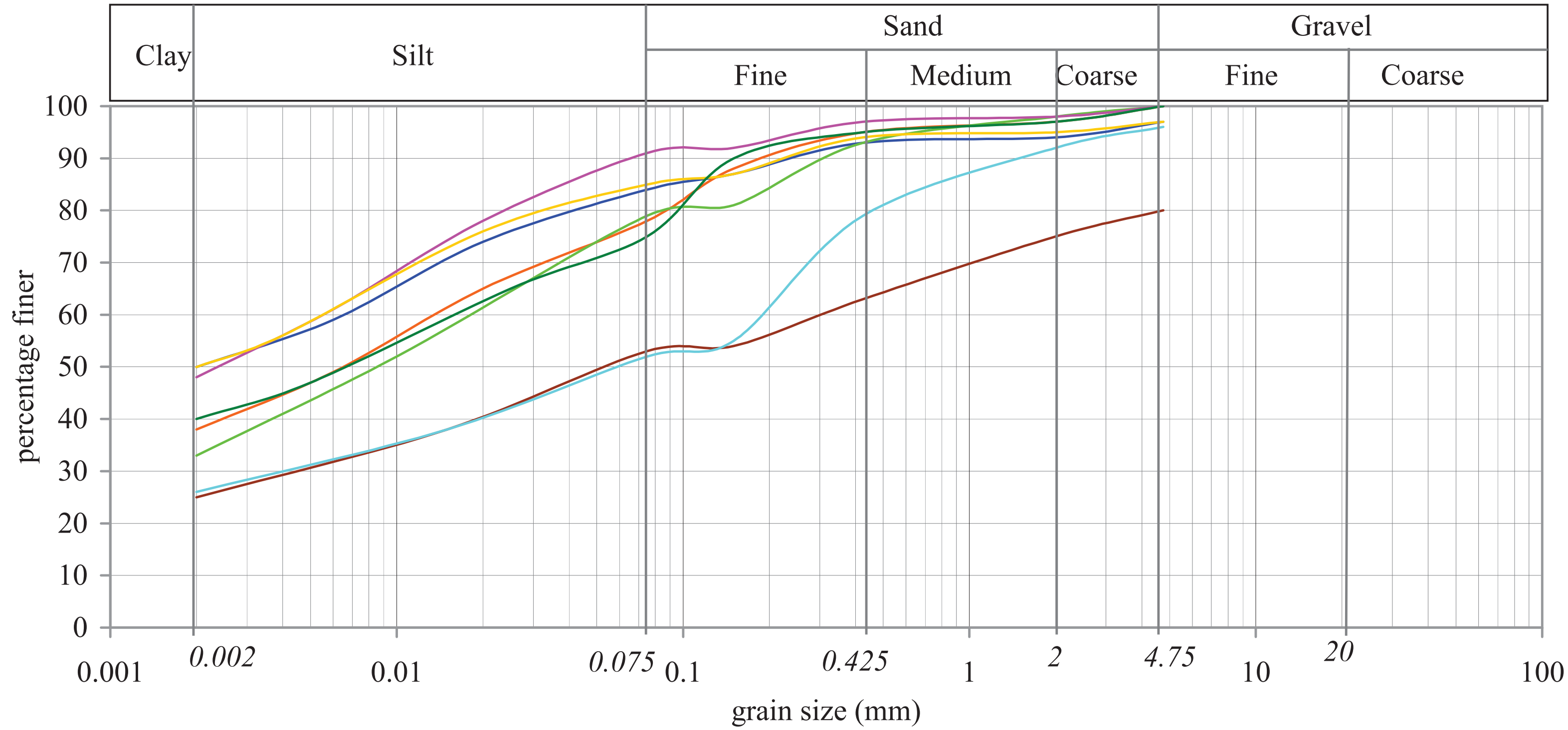


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| (blue) | 40 | 8 | Sandy silty clay with gravel | 3 | 13 | 34 | 50 | 0.0062 | - | - |
| (orange) | 40 | 11 | Sandy clayey silt | 0 | 22 | 40 | 38 | 0.013 | - | - |
| (light green) | 41 | 1 | Sandy clayey silt | 0 | 21 | 46 | 33 | 0.017 | - | - |
| (brown) | 41 | 3 | Clayey sandy silt with gravel | 20 | 27 | 28 | 25 | 0.29 | - | - |
| (purple) | 41 | 5 | Sandy silty clay | 0 | 9 | 43 | 48 | 0.0058 | - | - |
| (yellow) | 41 | 8 | Sandy silty clay with gravel | 3 | 12 | 35 | 50 | 0.0055 | - | - |
| (dark green) | 41 | 9.5 | Sandy silty clay | 0 | 25 | 35 | 40 | 0.015 | - | - |
| (cyan) | 42 | 1 | Clayey silty sand with gravel | 4 | 44 | 26 | 26 | 0.18 | - | - |

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GEOTECHNICAL CONSULTANTS

Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
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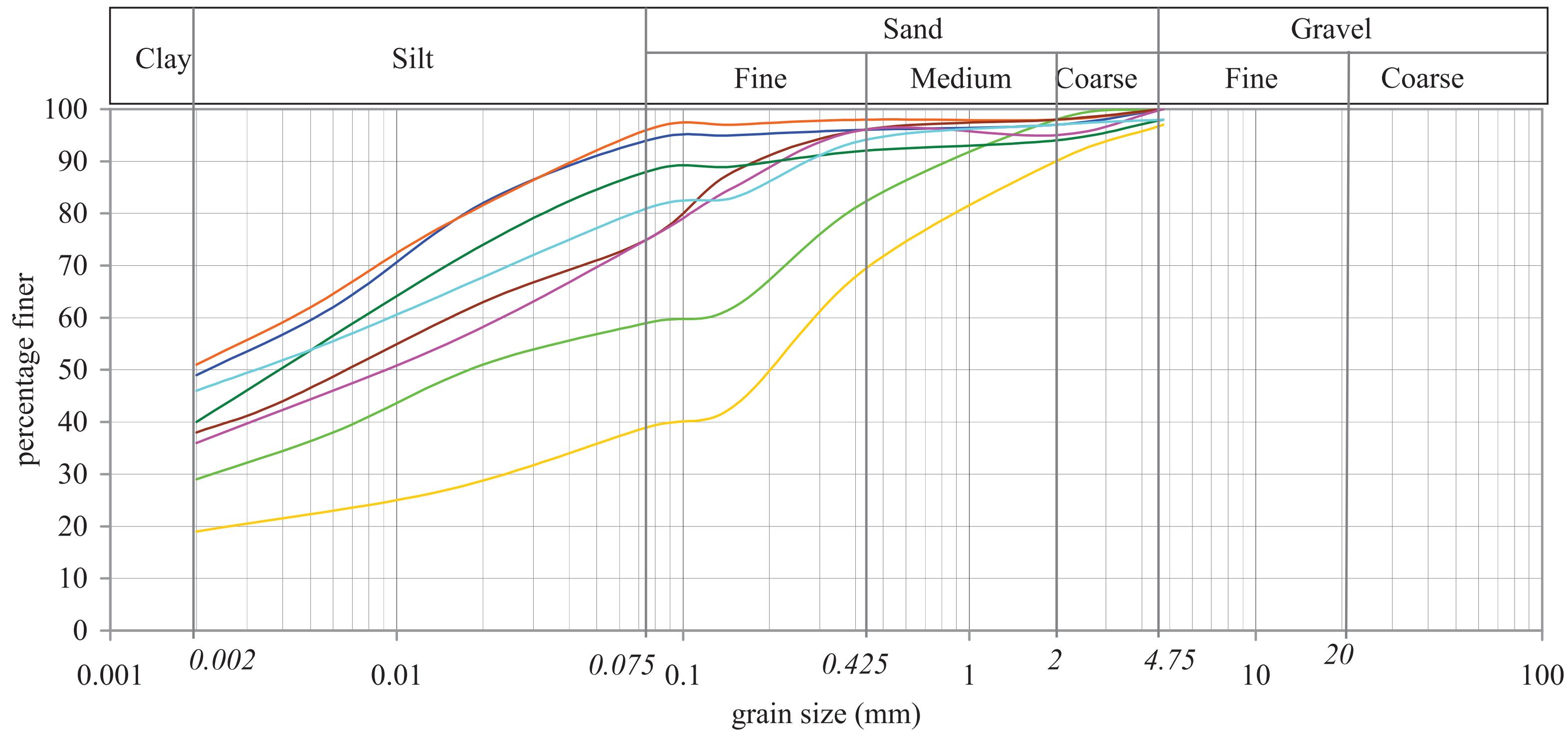
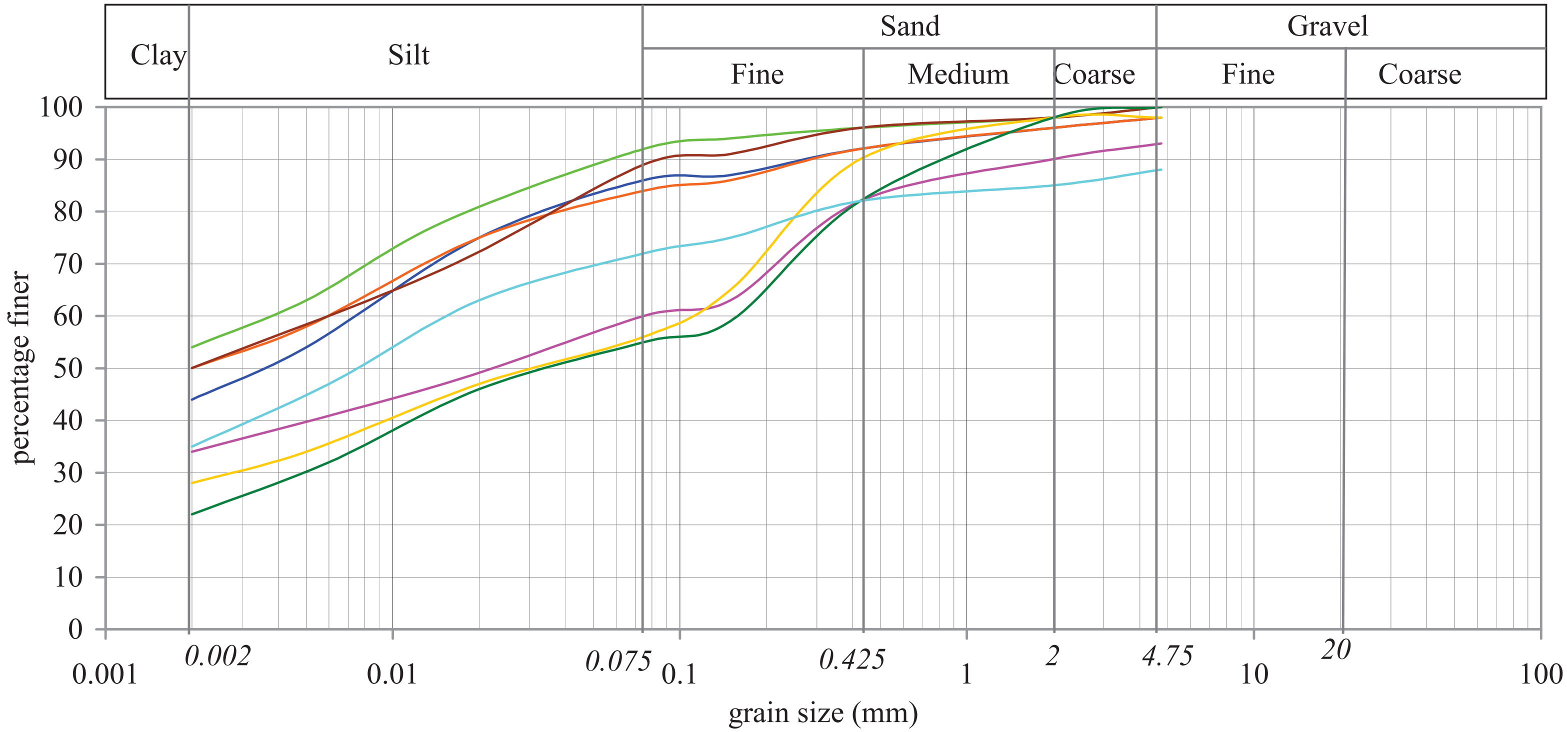
Job No. : G(H)1658(9)






| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| (blue line) | 42 | 3 | Sandy silty clay | 0 | 6 | 45 | 49 | 0.0051 | - | - |
| (orange line) | 42 | 5 | Sandy silty clay | 0 | 4 | 45 | 51 | 0.0042 | - | - |
| (light green line) | 42 | 8 | Silty clayey sand | 0 | 41 | 30 | 29 | 0.13 | - | - |
| (brown line) | 42 | 11 | Sandy silty clay | 0 | 25 | 37 | 38 | 0.015 | - | - |
| (purple line) | 42 | 14 | Sandy clayey silt | 0 | 25 | 39 | 36 | 0.023 | - | - |
| (yellow line) | 43 | 1 | Clayey silty sand with gravel | 3 | 58 | 20 | 19 | 0.29 | - | - |
| (dark green line) | 43 | 3 | Sandy clayey silt with gravel | 2 | 10 | 48 | 40 | 0.0075 | - | - |
| (light blue line) | 43 | 5 | Sandy siltyy clay with gravel | 2 | 17 | 35 | 46 | 0.0089 | - | - |




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 43 | 8 | Sandy silty clay with gravel | 2 | 12 | 42 | 44 | 0.0072 | - | - |
| | 44 | 1 | Sandy silty clay with gravel | 2 | 14 | 34 | 50 | 0.0057 | - | - |
| | 44 | 3 | Sandy silty clay | 0 | 8 | 38 | 54 | 0.0038 | - | - |
| | 44 | 5 | Sandy silty clay | 0 | 11 | 39 | 50 | 0.0058 | - | - |
| | 44 | 8 | Silty sandy clay with gravel | 7 | 33 | 26 | 34 | 0.0078 | - | - |
| | 44 | 9.5 | Clayey silty sand with gravel | 2 | 42 | 28 | 28 | 0.12 | - | - |
| | 45 | 1 | Clayey silty sand | 0 | 45 | 33 | 22 | 0.16 | - | - |
| | 45 | 3 | Sandy clayey silt with gravel | 12 | 16 | 37 | 35 | 0.015 | - | - |

NAGADI
NAGADI CONSULTANTS PRIVATE LIMITED
GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
Chennai : 044 (T) 24487870 (F) 24488957 chennai@nagadi.co.in
Secunderabad : 040 (T) 27754446 (F) 27751194 secunderabad@nagadi.co.in

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GEOTECHNICAL CONSULTANTS
Delhi : 011 (T) 26891980 (F) 26897403 delhi@nagadi.co.in
Bangalore : 080 (T) 23156076 (F) 23303007 bangalore@nagadi.co.in
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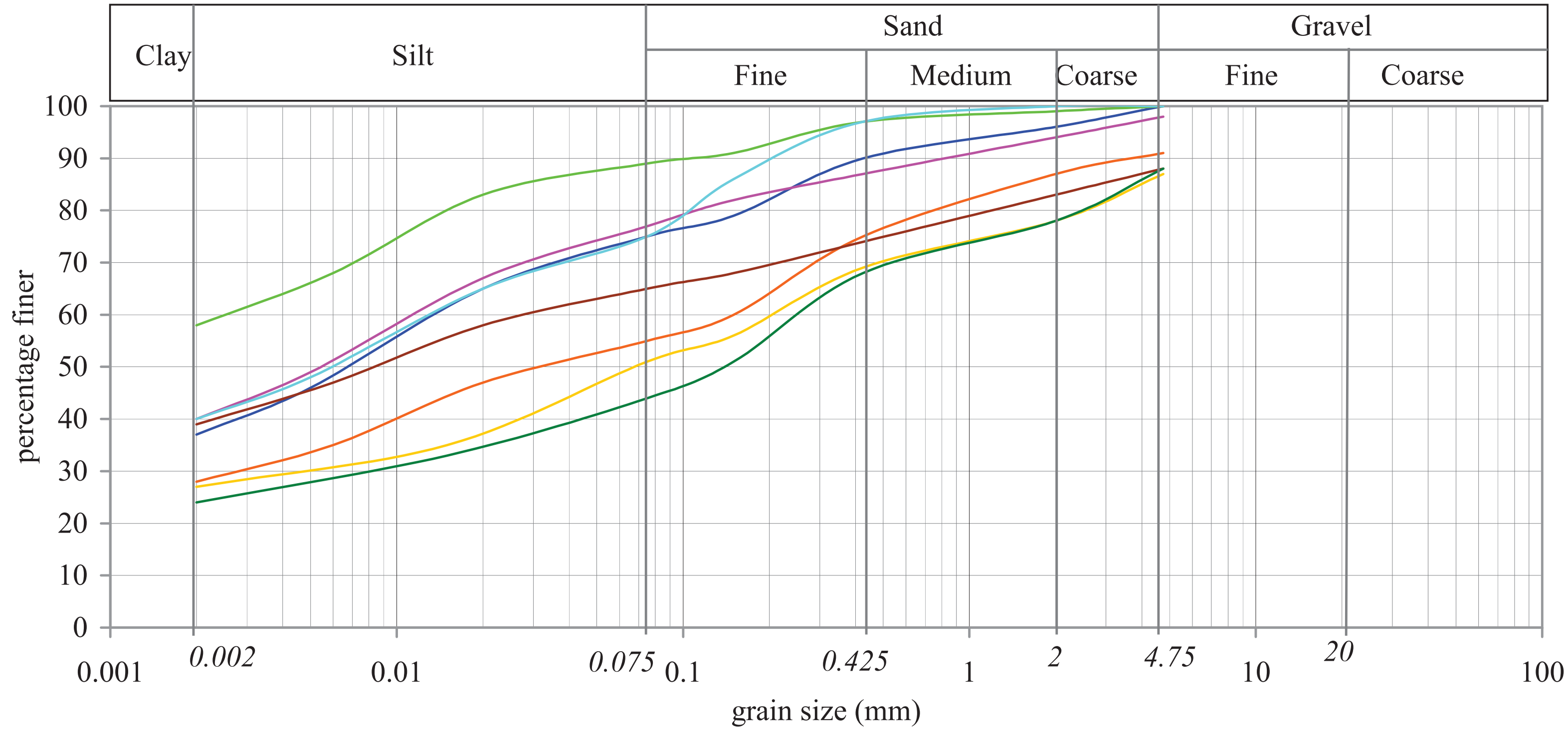


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 45 | 5 | Sandy clayey silt | 0 | 25 | 38 | 37 | 0.013 | - | - |
| | 45 | 8 | Silty clayey sand with gravel | 9 | 36 | 27 | 28 | 0.15 | - | - |
| | 46 | 1 | Sandy silty clay | 0 | 11 | 31 | 58 | 0.0025 | - | - |
| | 46 | 3 | Sandy silty clay with gravel | 12 | 23 | 26 | 39 | 0.026 | - | - |
| | 46 | 5 | Sandy silty clay with gravel | 2 | 21 | 37 | 40 | 0.012 | - | - |
| | 47 | 1 | Silty clayey sand with gravel | 13 | 36 | 24 | 27 | 0.21 | - | - |
| | 47 | 3 | Silty clayey sand with gravel | 12 | 44 | 20 | 24 | 0.25 | - | - |
| | 47 | 5 | Sandy silty clay | 0 | 25 | 35 | 40 | 0.013 | - | - |

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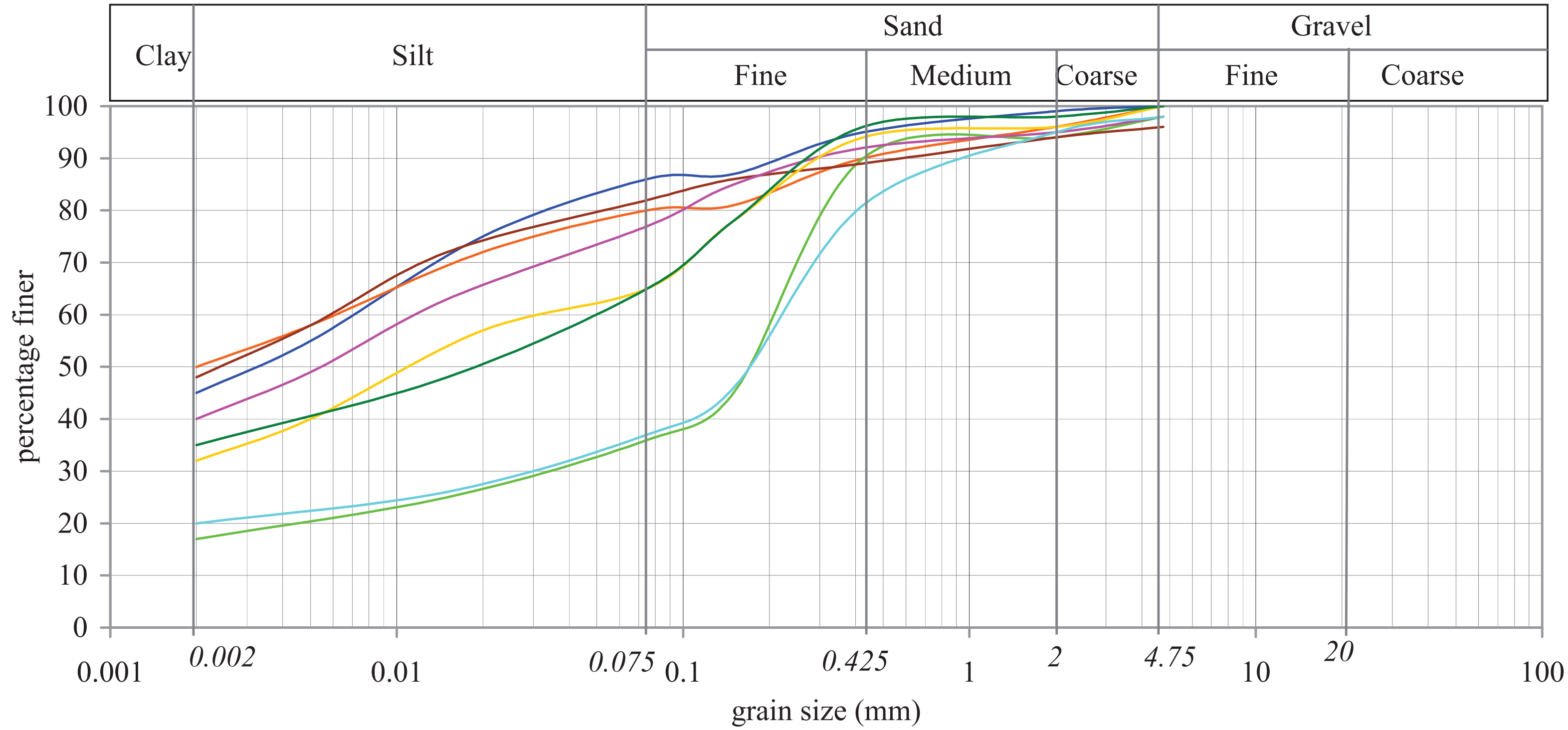


| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| (blue) | 48 | 1 | Sandy silty clay | 0 | 14 | 41 | 45 | 0.0071 | - | - |
| (orange) | 48 | 3 | Sandy silty clay | 0 | 20 | 30 | 50 | 0.0051 | - | - |
| (light green) | 48 | 5 | Clayey silty sand with gravel | 2 | 62 | 19 | 17 | 0.21 | - | - |
| (brown) | 48 | 8 | Sandy silty clay with gravel | 4 | 14 | 34 | 48 | 0.0058 | - | - |
| (purple) | 48 | 10 | Sandy silty clay with gravel | 2 | 21 | 37 | 40 | 0.012 | - | - |
| (yellow) | 49 | 1 | Clayey silty sand | 0 | 35 | 33 | 32 | 0.032 | - | - |
| (dark green) | 49 | 3 | Silty clayey sand | 0 | 35 | 30 | 35 | 0.049 | - | - |
| (light blue) | 49 | 5 | Silty clayey sand with gravel | 2 | 61 | 17 | 20 | 0.23 | - | - |

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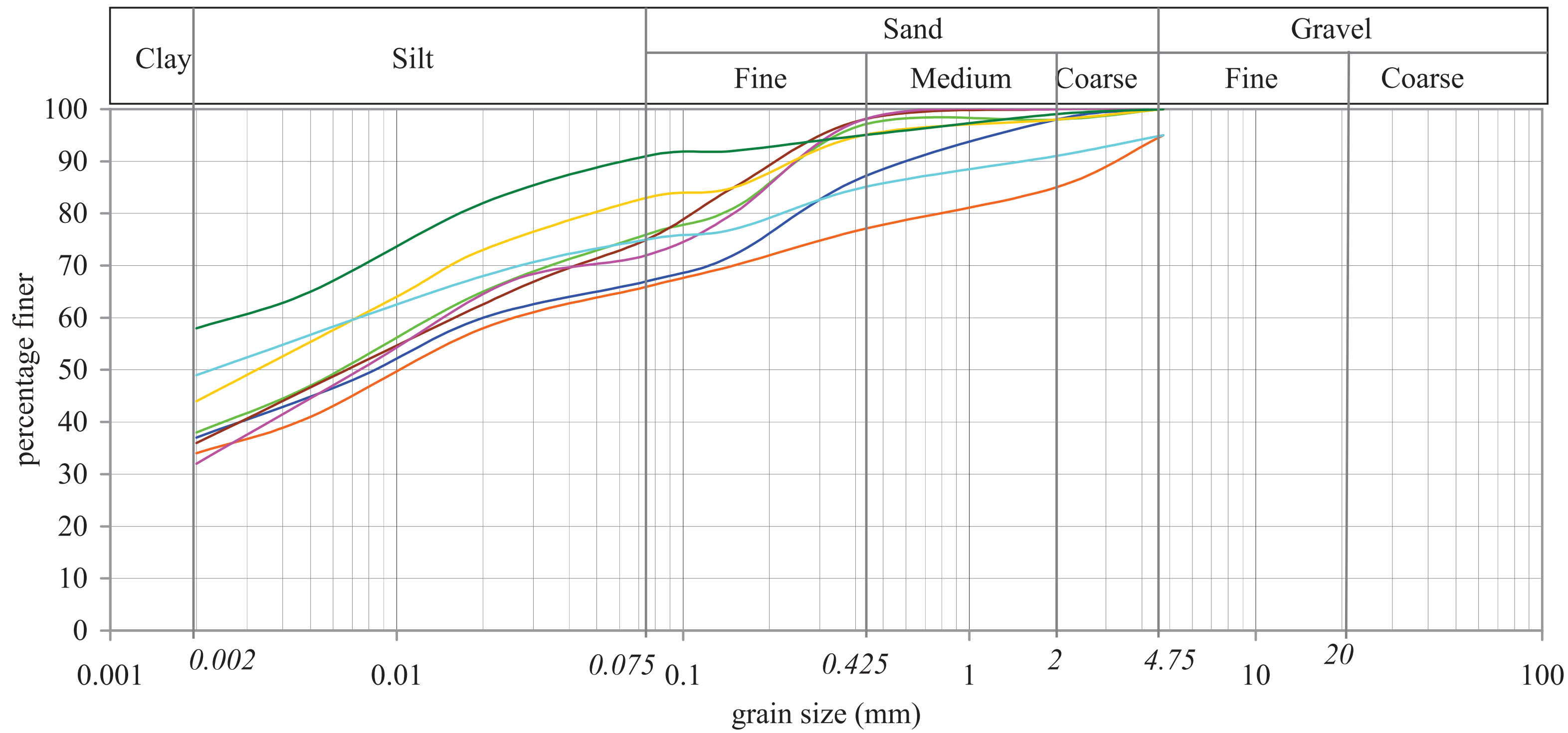
Job No. : G(H)1658(9)

Sheet No. : 240 of 271




| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 50 | 1 | Silty sandy clay | 0 | 33 | 30 | 37 | 0.019 | - | - |
| | 50 | 3 | Sandy silty clay with gravel | 5 | 29 | 32 | 34 | 0.025 | - | - |
| | 50 | 5 | Sandy clayey silt | 0 | 24 | 38 | 38 | 0.013 | - | - |
| | 51 | 1 | Sandy clayey silt | 0 | 25 | 39 | 36 | 0.015 | - | - |
| | 51 | 3 | Sandy clayey silt | 0 | 28 | 40 | 32 | 0.014 | - | - |
| | 51 | 5 | Sandy silty clay | 0 | 17 | 39 | 44 | 0.0071 | - | - |
| | 52 | 1 | Sandy silty clay | 0 | 9 | 33 | 58 | 0.0026 | - | - |
| | 52 | 3 | Sandy silty clay with gravel | 5 | 20 | 26 | 49 | 0.0072 | - | - |

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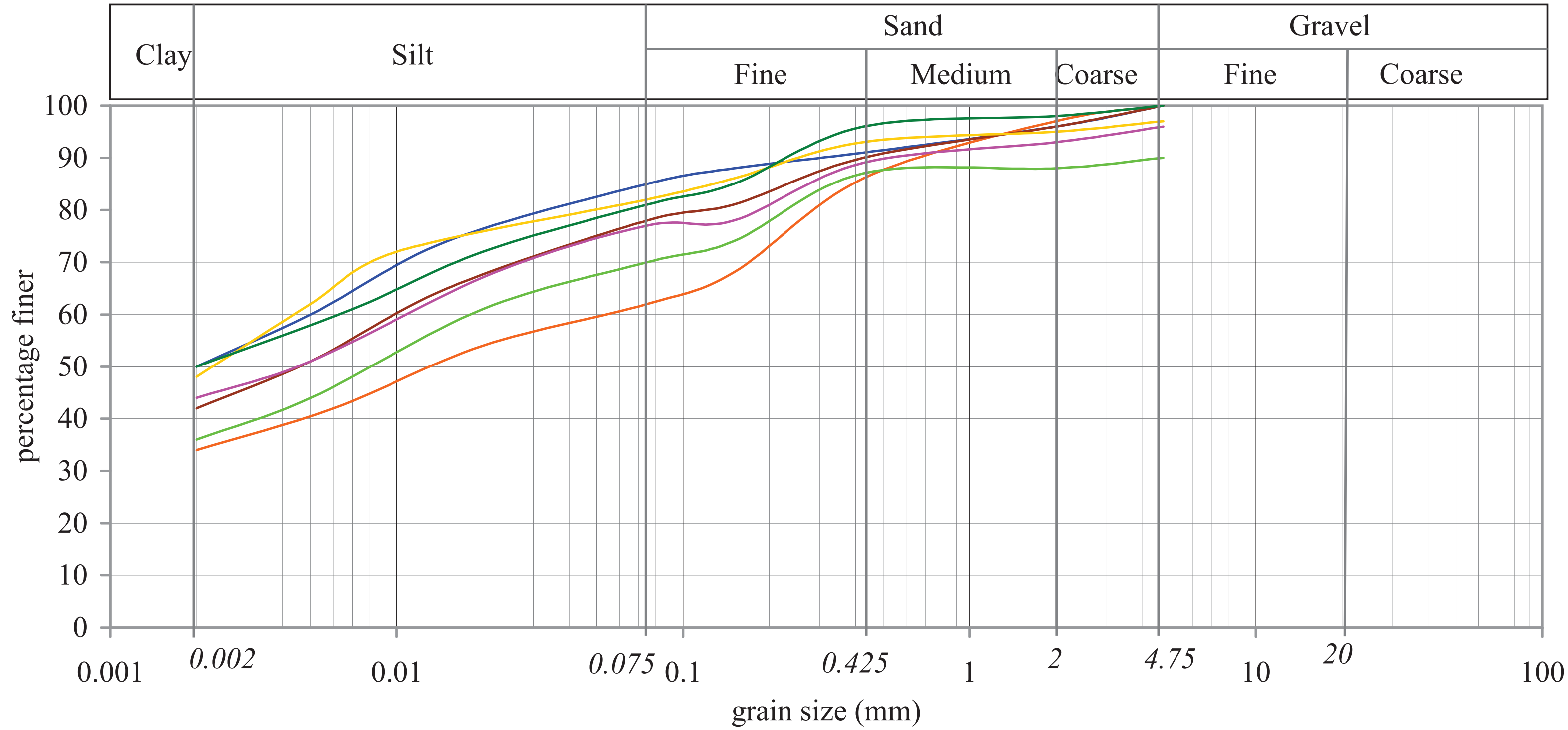
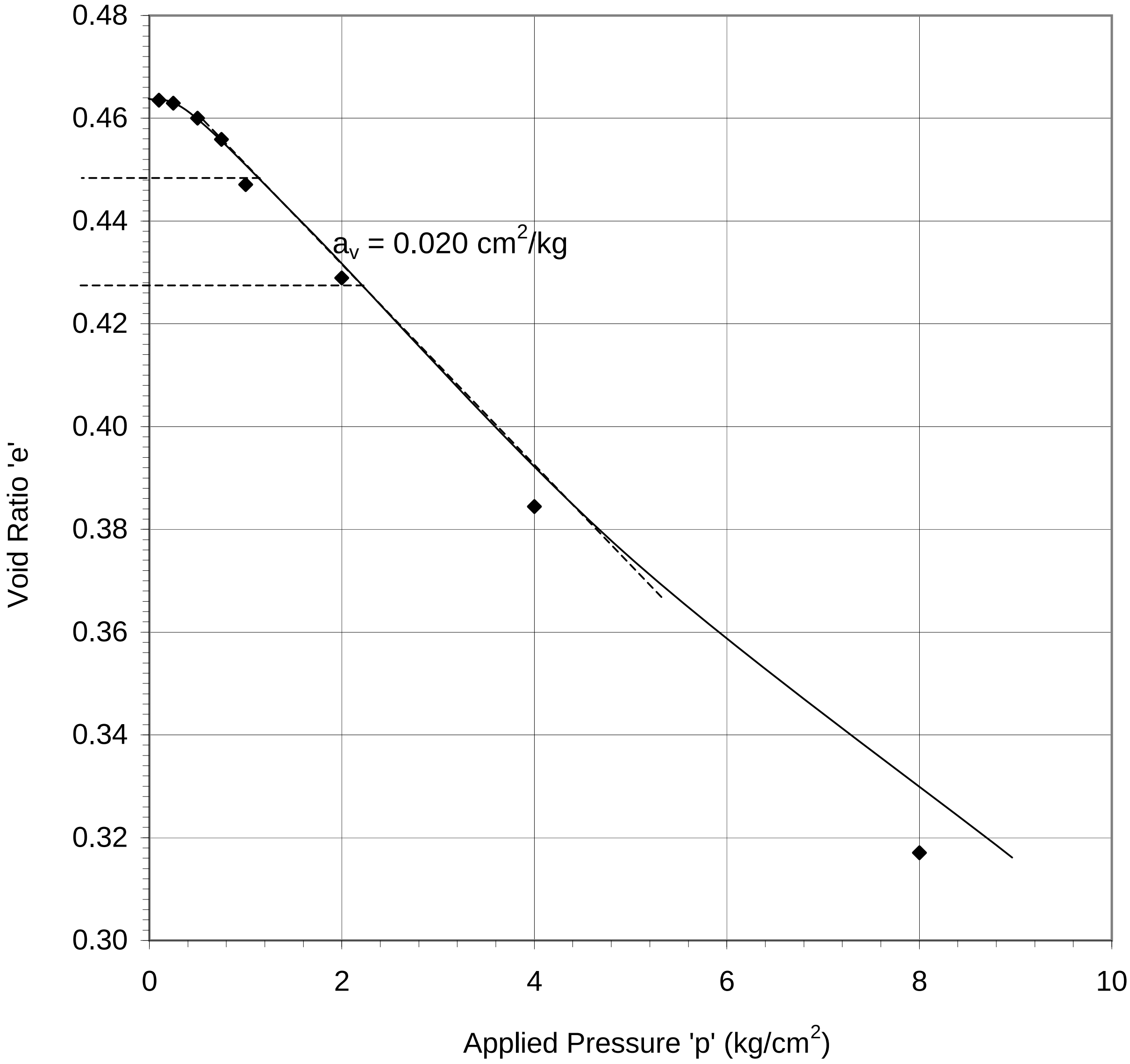



| Line Style | Bore hole | Depth (m) | Description | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | $d_{60}$ | $d_{10}$ | $c_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 52 | 5 | Sandy silty clay | 0 | 15 | 35 | 50 | 0.0051 | - | - |
| | 53 | 1 | Silty clayey sand | 0 | 38 | 28 | 34 | 0.052 | - | - |
| | 53 | 3 | Sandy silty clay with gravel | 10 | 20 | 34 | 36 | 0.018 | - | - |
| | 54 | 1 | Sandy silty clay | 0 | 22 | 36 | 42 | 0.0091 | - | - |
| | 55 | 1 | Sandy silty clay with gravel | 4 | 19 | 33 | 44 | 0.012 | - | - |
| | 55 | 3 | Sandy slty clay with gravel | 3 | 15 | 34 | 48 | 0.0042 | - | - |
| | 56 | 1 | Sandy silt clay | 0 | 19 | 31 | 50 | 0.0062 | - | - |
| | | | | | | | | | | |



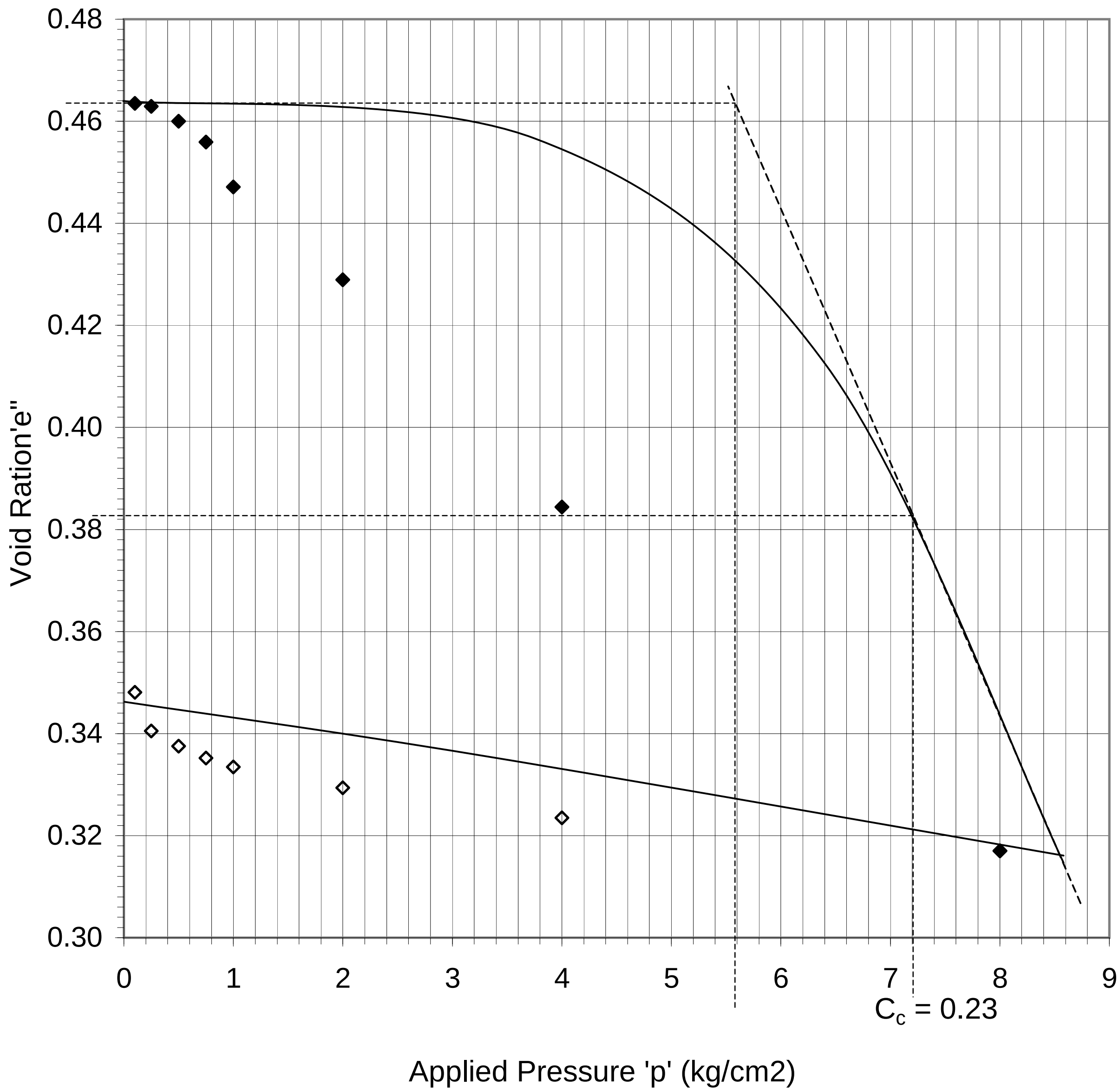

**Soil Sample Details**

Borehole - BH13

Depth - 6.5m

Soil Type - Silty clay

**Consolidation Test - 1**




**Soil Sample Details**

Borehole - BH13

Depth - 6.5m

Soil Type - Silty clay

**Consolidation Test - I**

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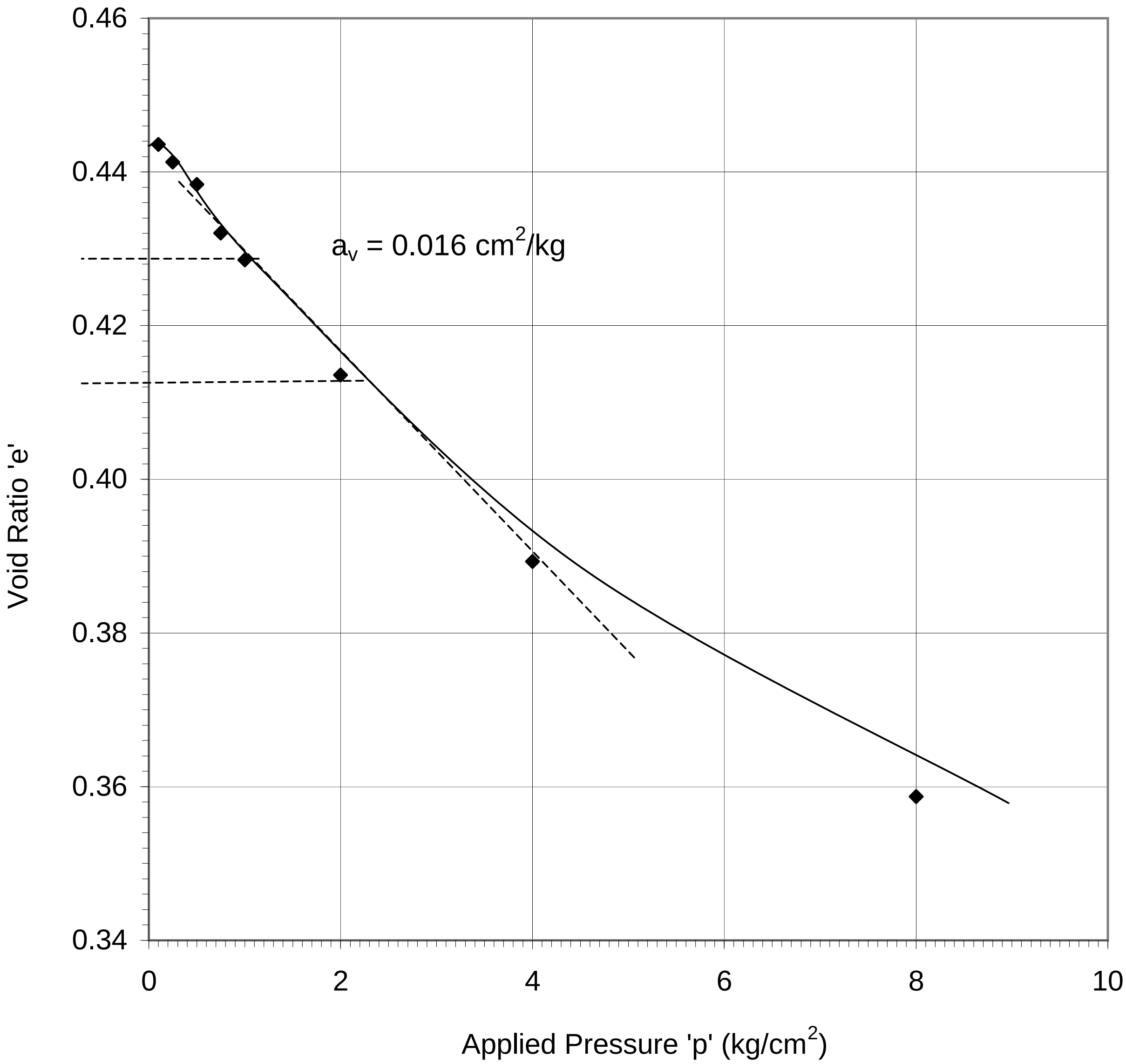


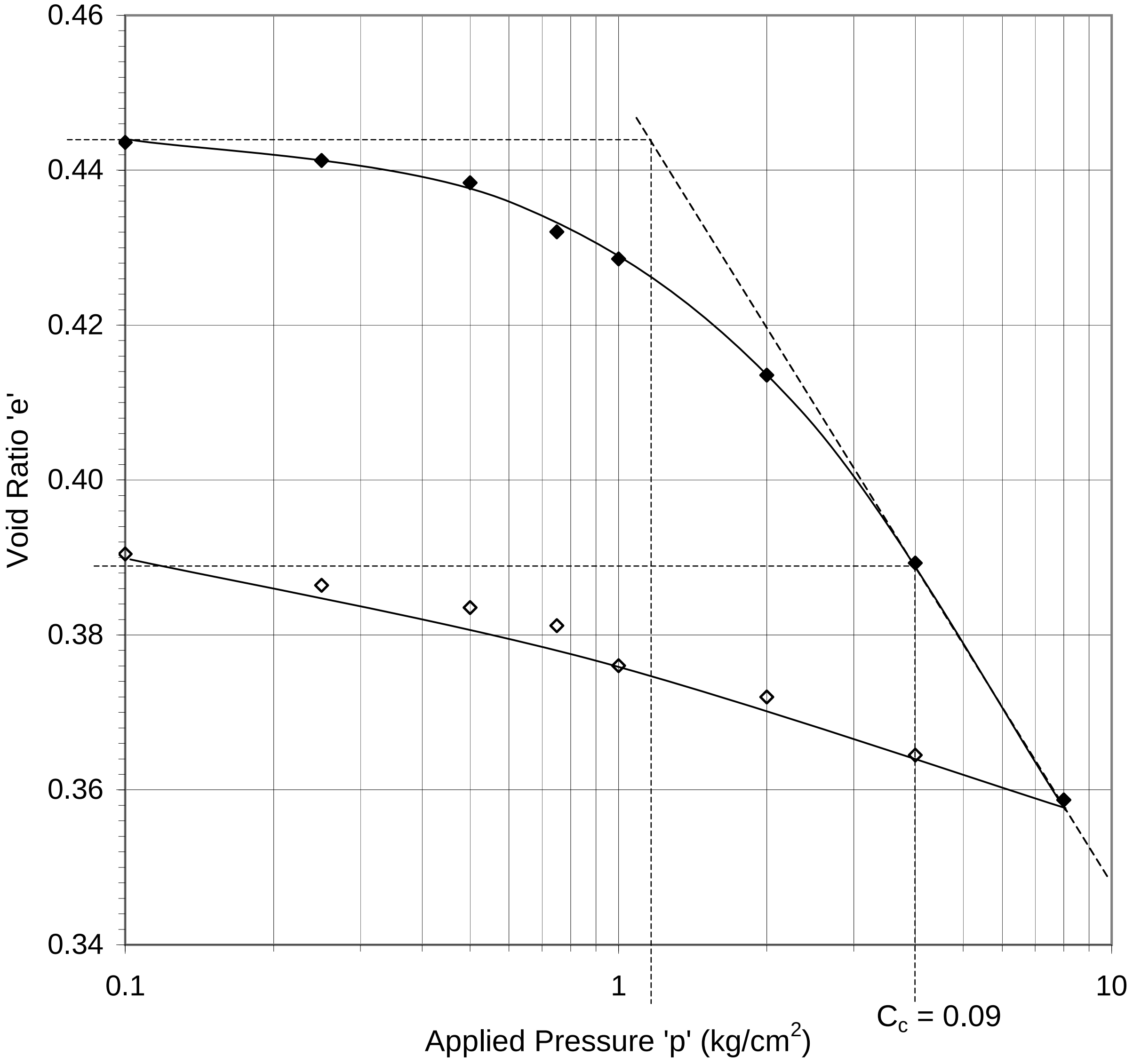

**Soil Sample Details**

Borehole - BH29

Depth - 4m

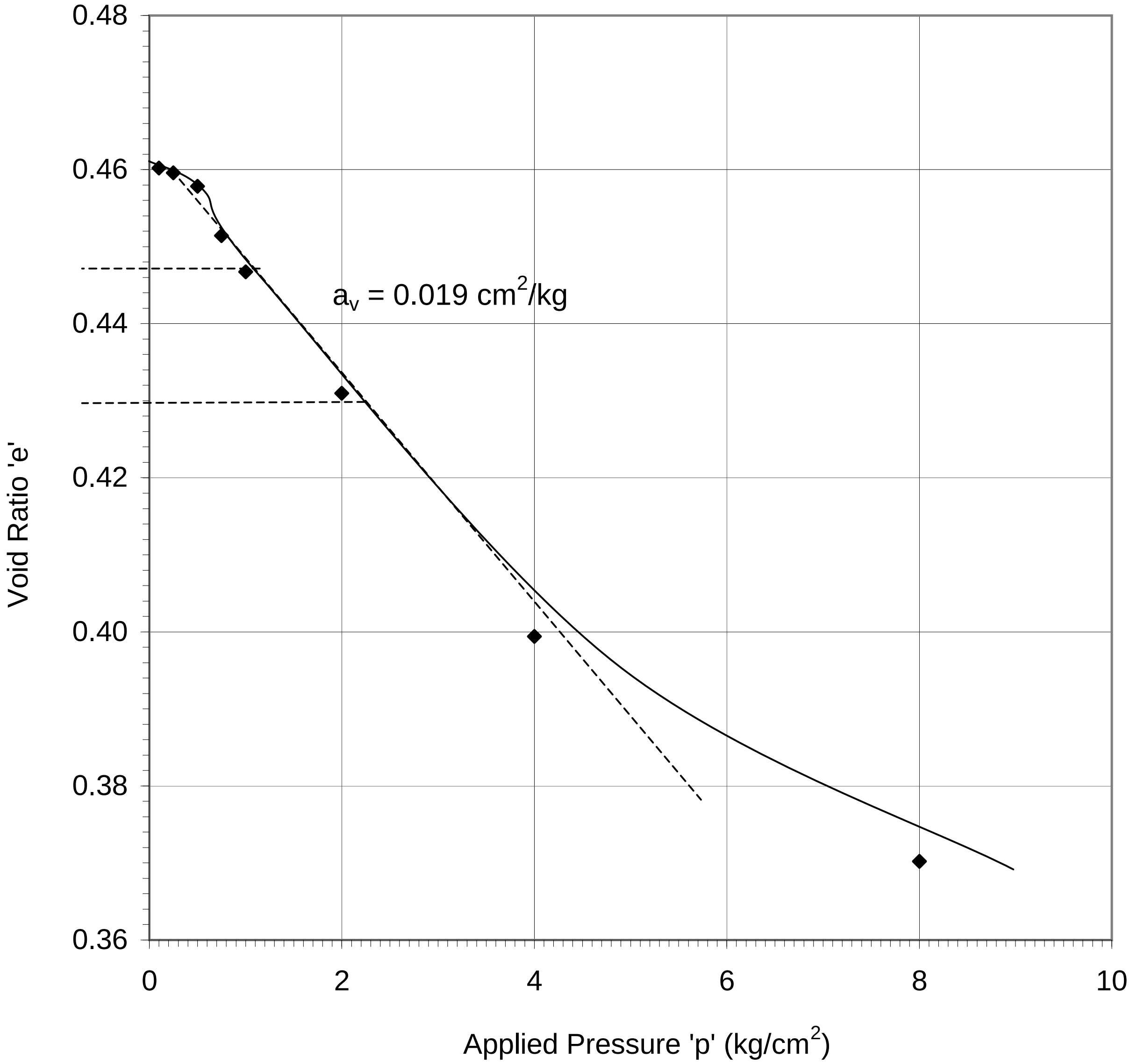
Soil Type - Silty clay

**Consolidation Test - 2**




**Soil Sample Details**
Borehole - BH29
Depth - 4m
Soil Type - Silty clay

**Consolidation Test - 2**



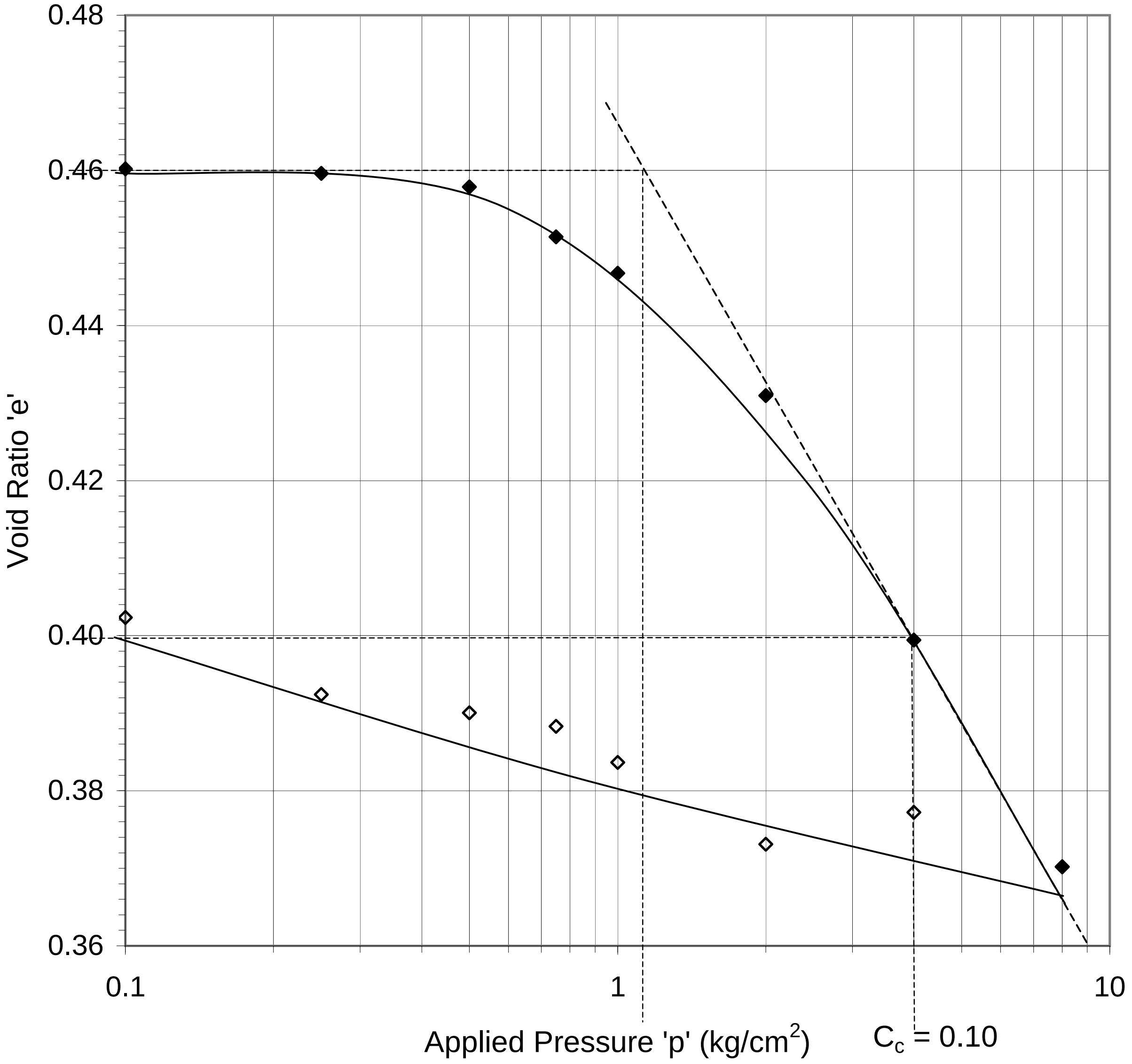

**Soil Sample Details**

Borehole - BH17

Depth - 4m

Soil Type - Silty clay

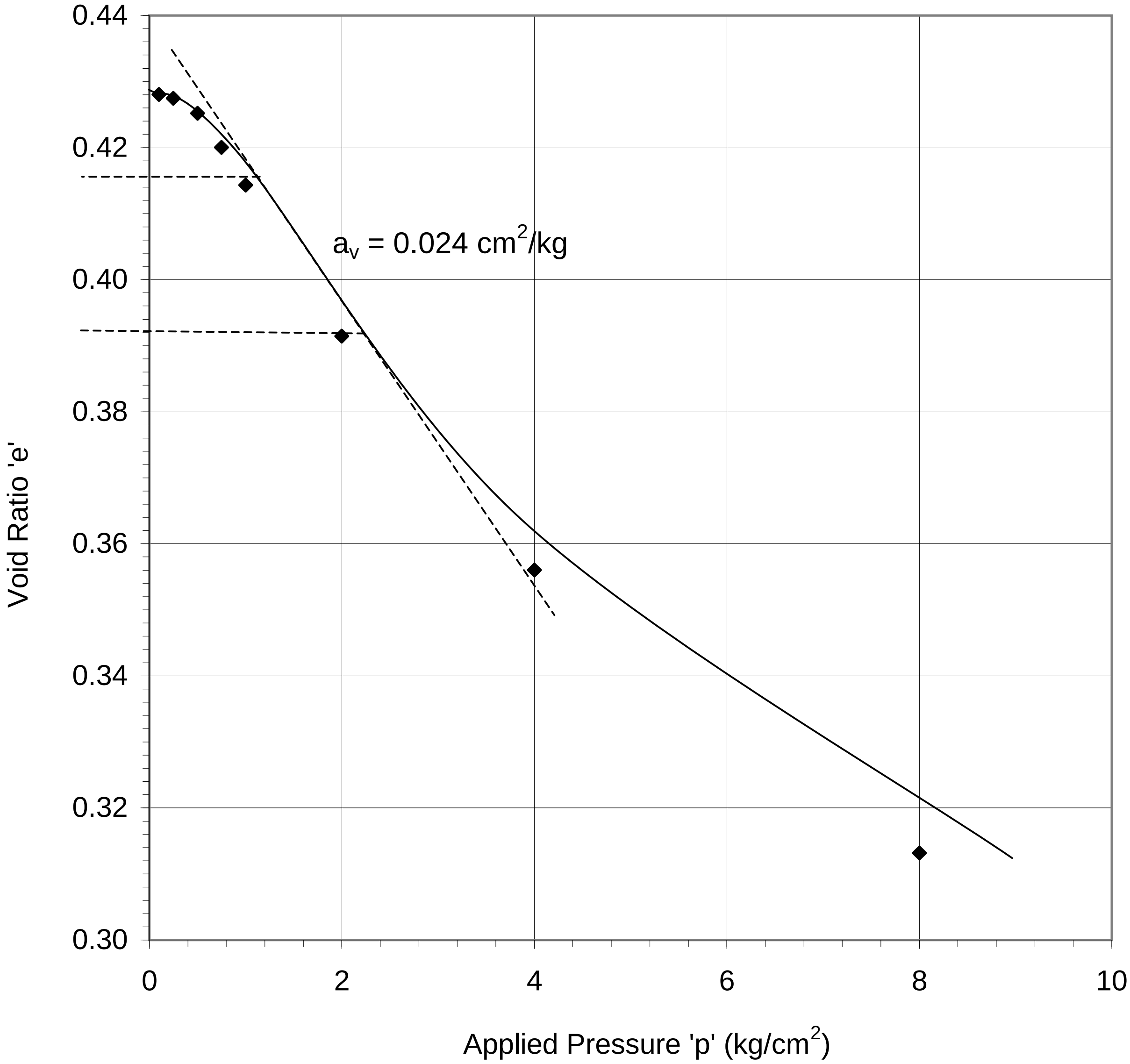
**Consolidation Test - 3**




**Soil Sample Details**

Borehole - BH17
Depth - 4m
Soil Type - Silty clay

**Consolidation Test - 3**



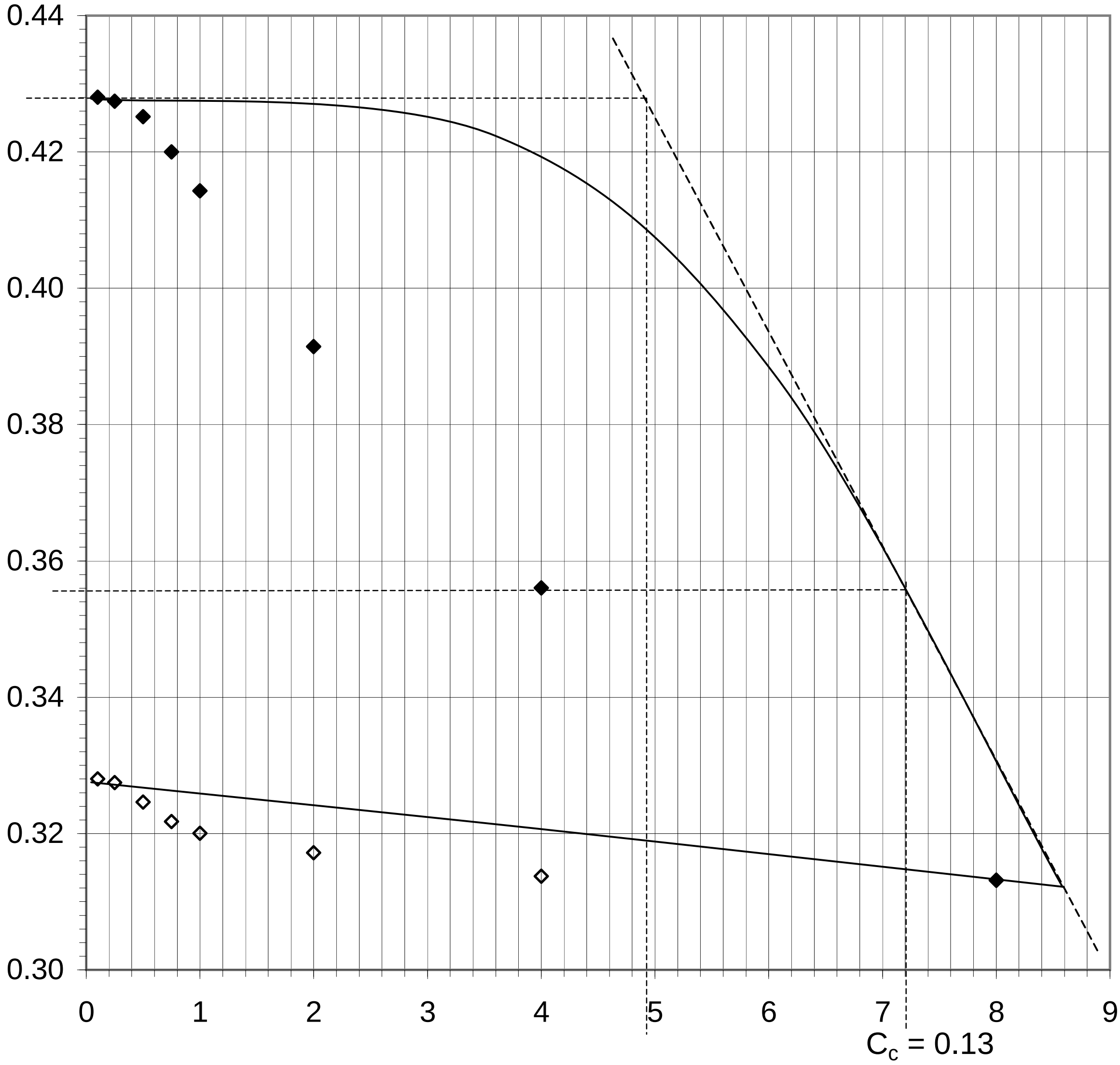

**Soil Sample Details**

Borehole - BH49

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 4**



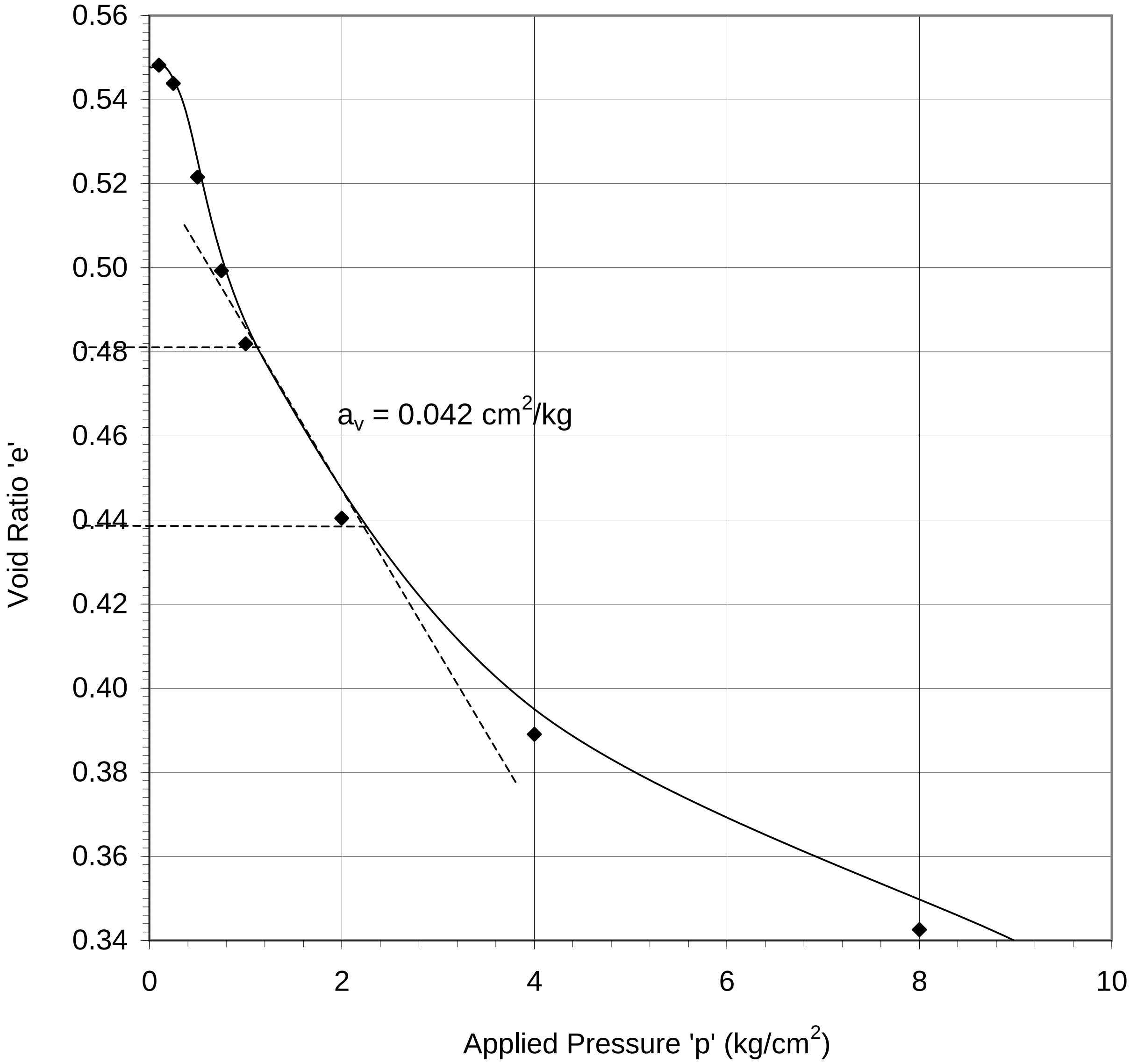

**Soil Sample Details**

Borehole - BH49

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 4**



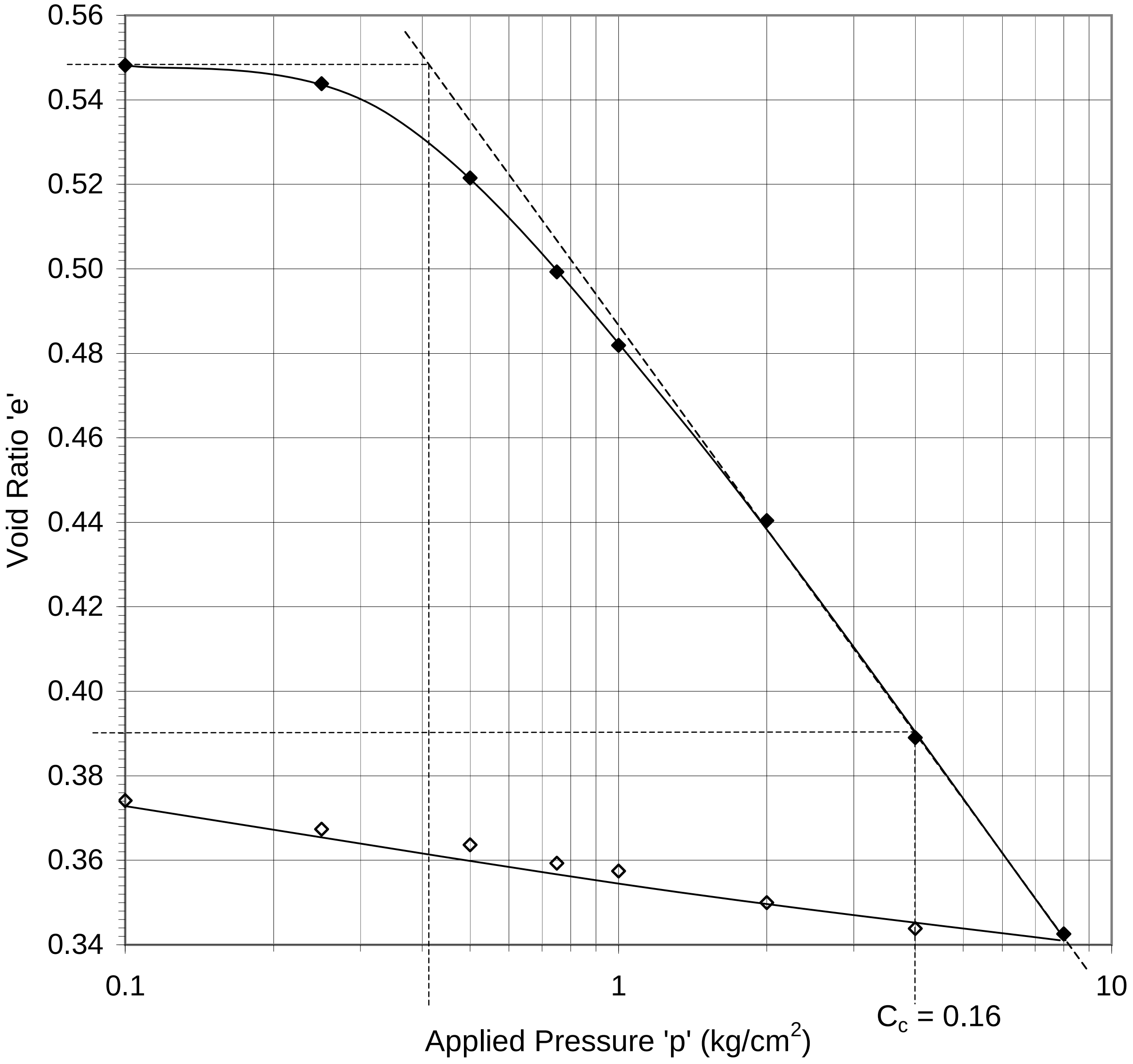

**Soil Sample Details**

Borehole - BH50

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 5**



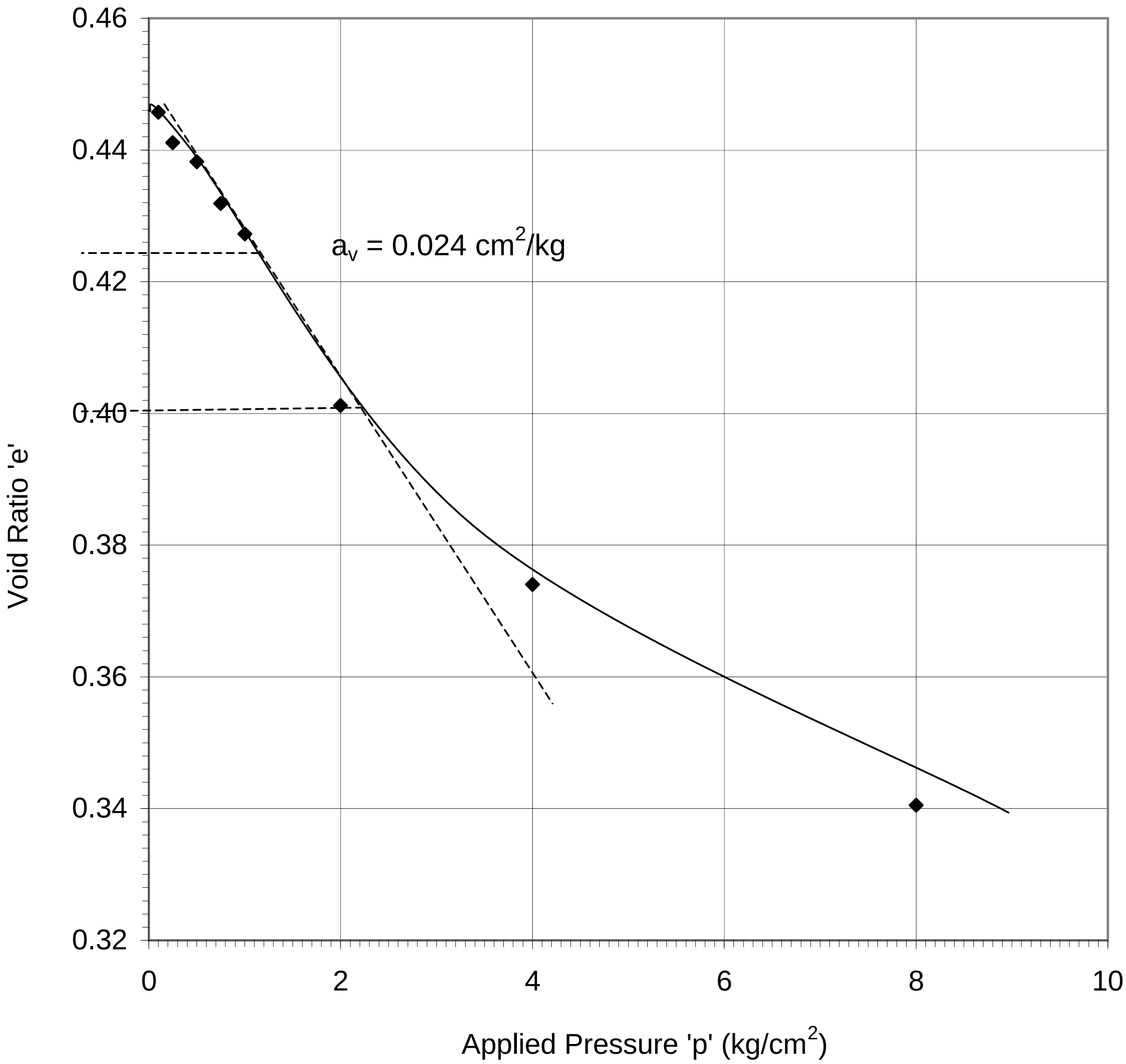

**Soil Sample Details**

Borehole - BH50

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 5**



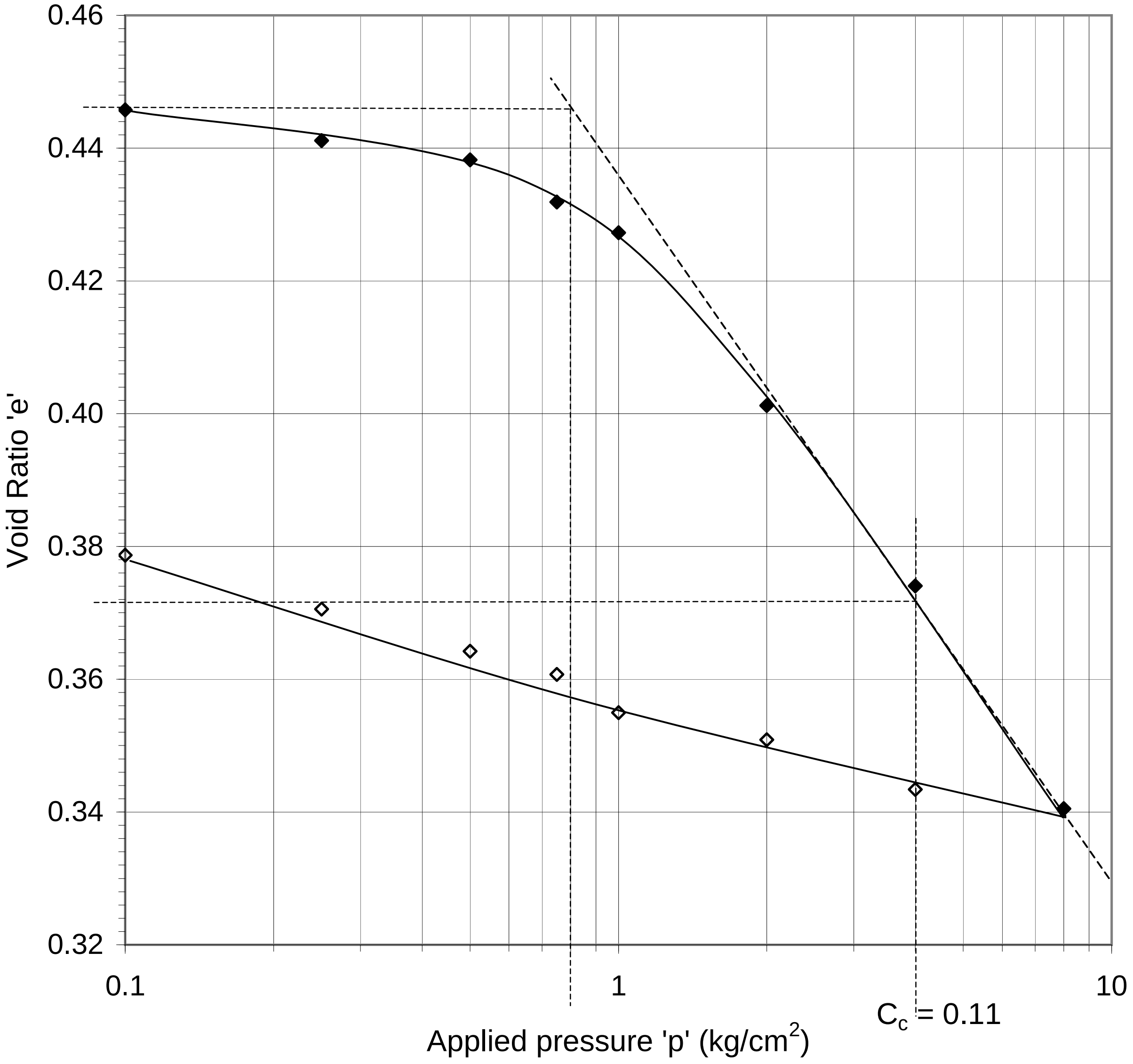

**Soil Sample Details**

Borehole - BH16

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 6**



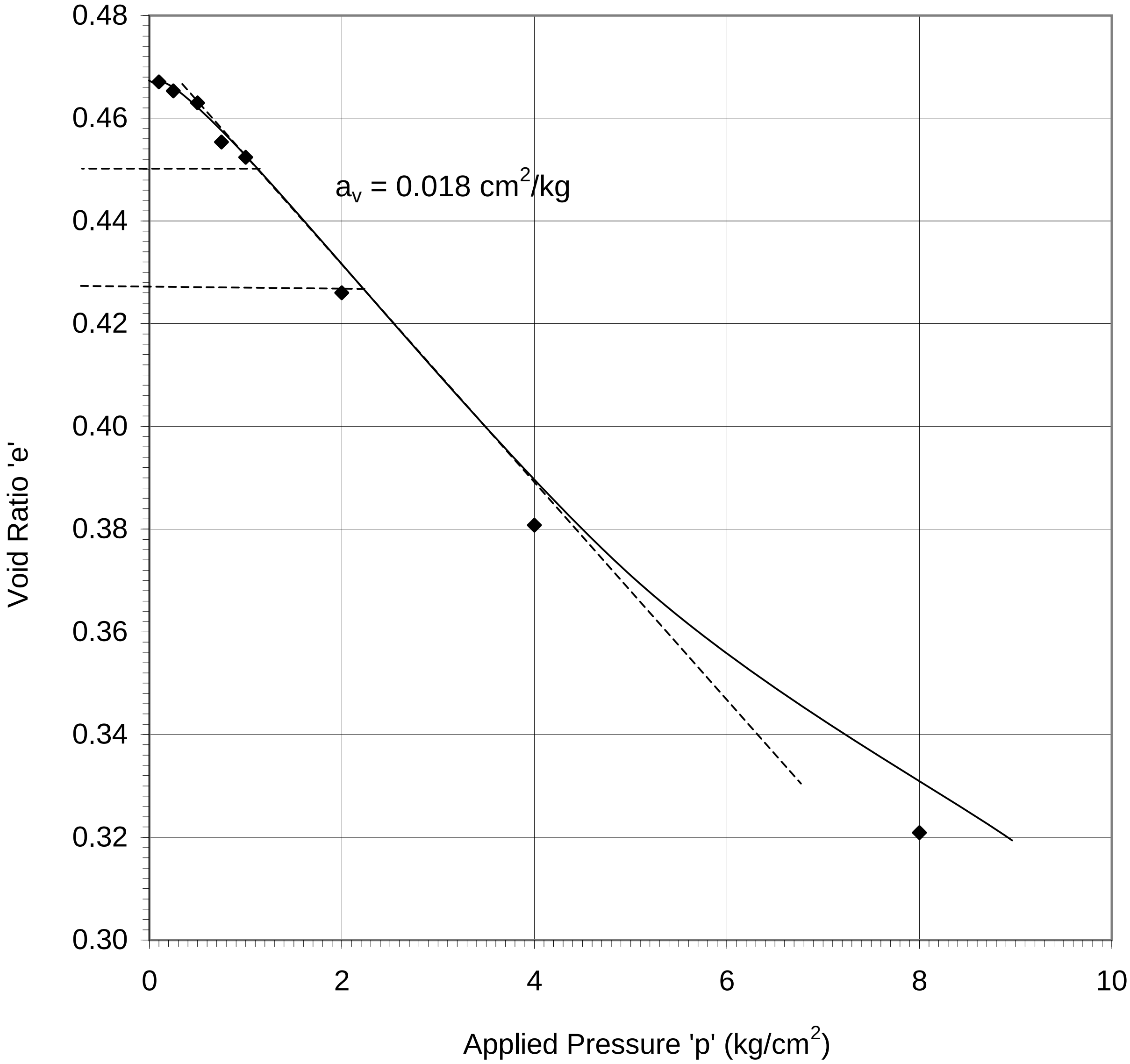

**Soil Sample Details**

Borehole - BH16

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 6**



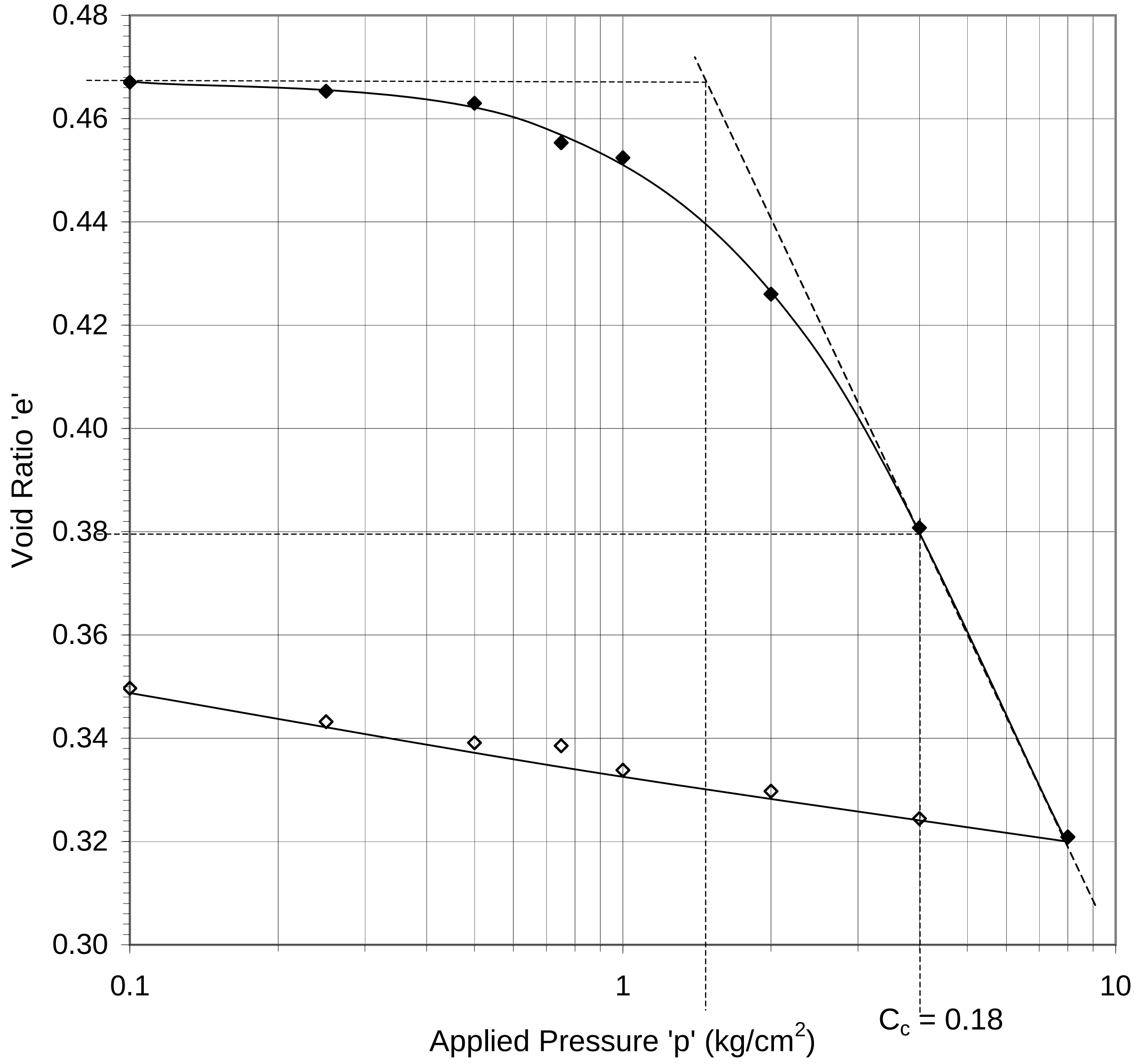

**Soil Sample Details**

Borehole - BH51

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 7**



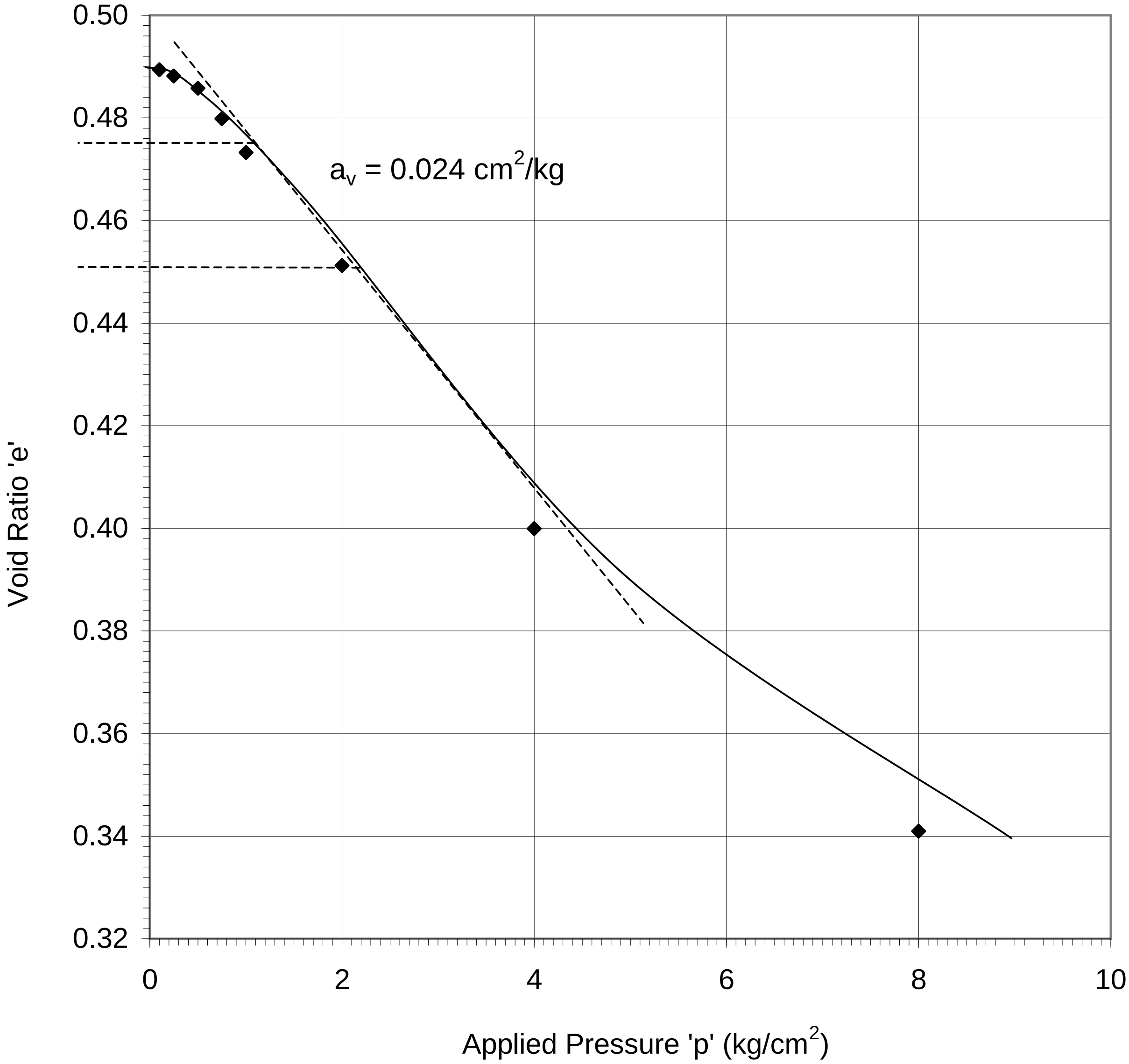

**Soil Sample Details**

Borehole - BH51

Depth - 4m

Soil Type - Silty clay

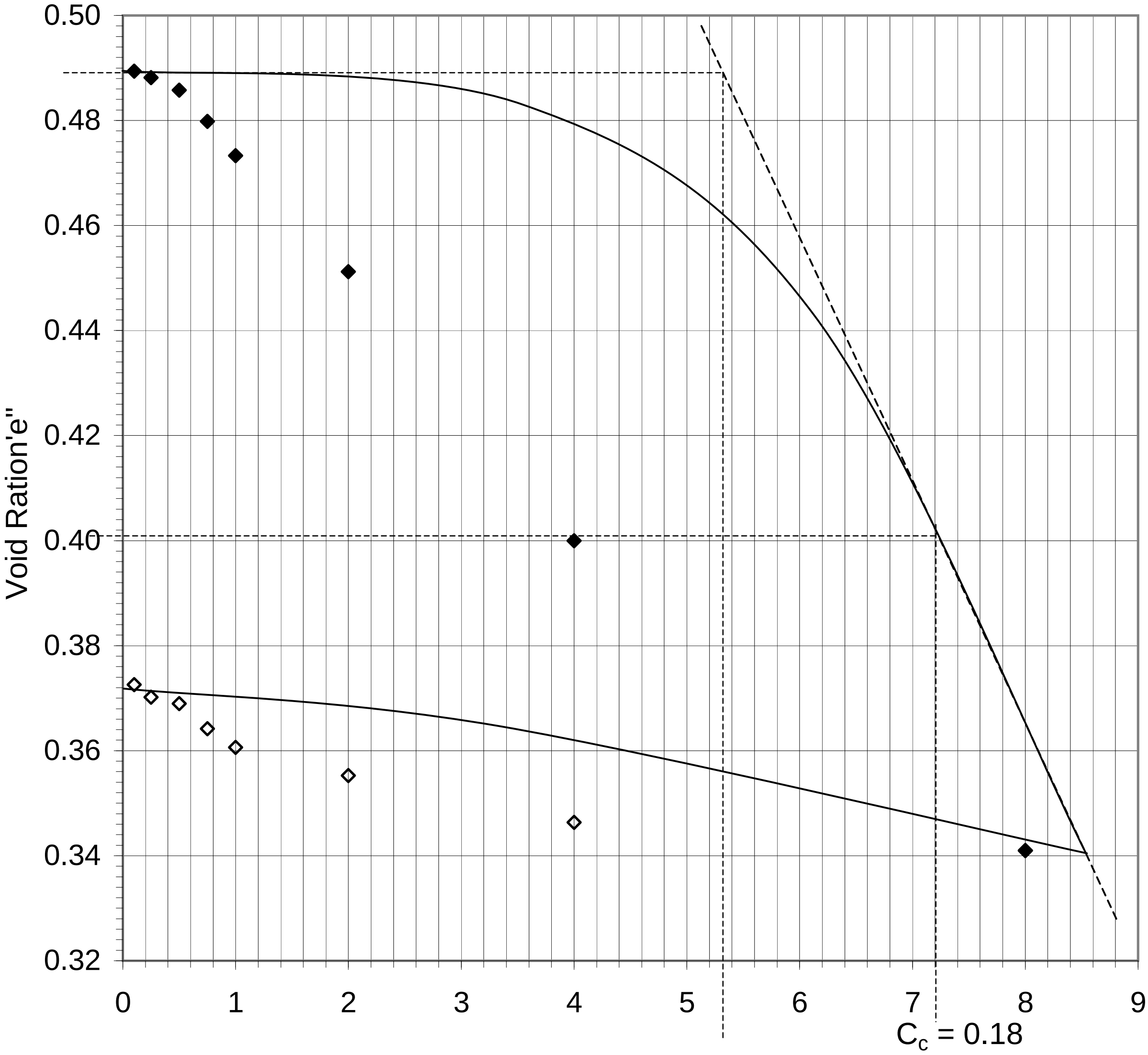
**Consolidation Test - 7**




**Soil Sample Details**

Borehole - BH27
Depth - 4m
Soil Type - Silty clay

**Consolidation Test - 8**



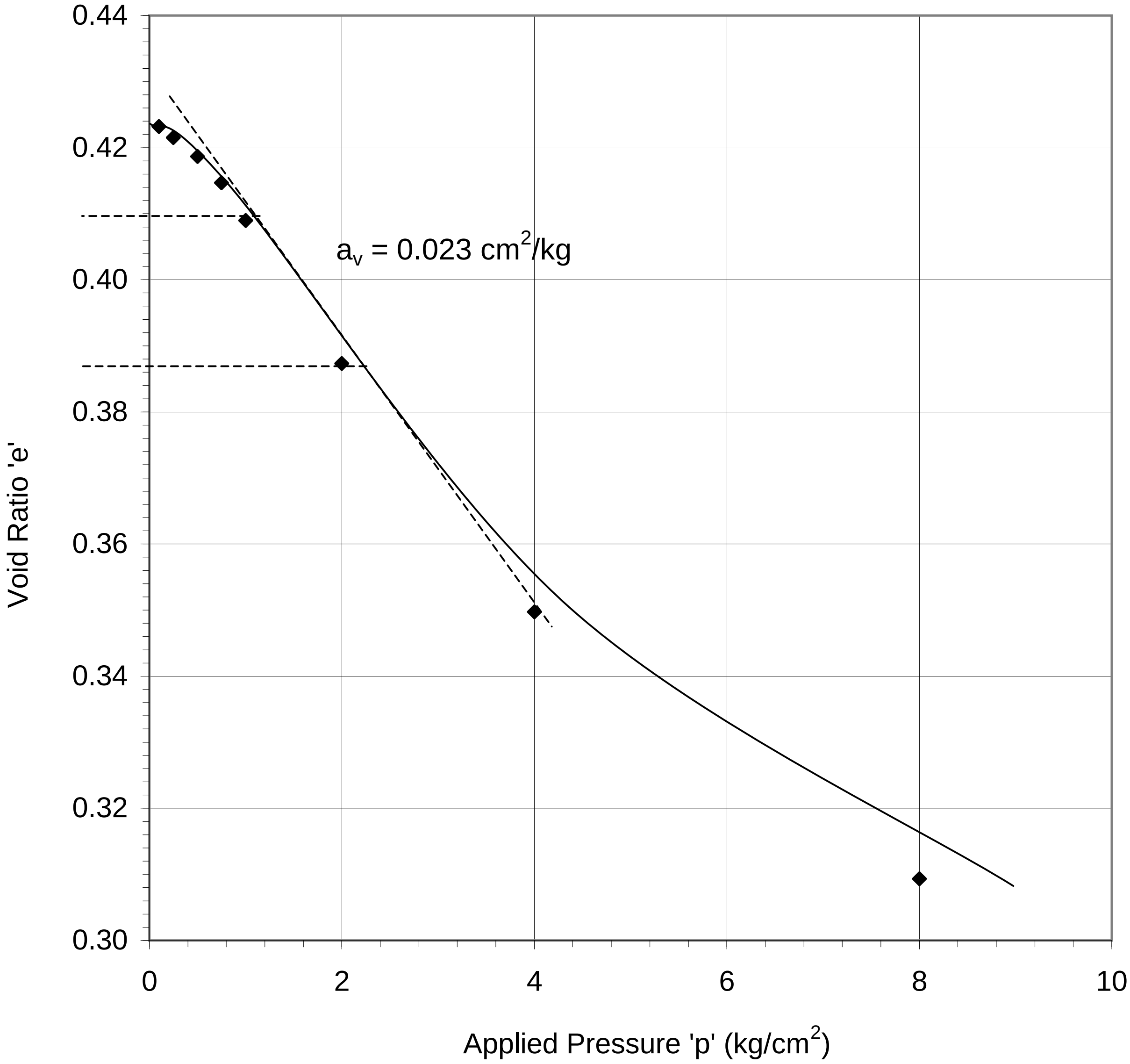

**Soil Sample Details**

Borehole - BH27

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 8**



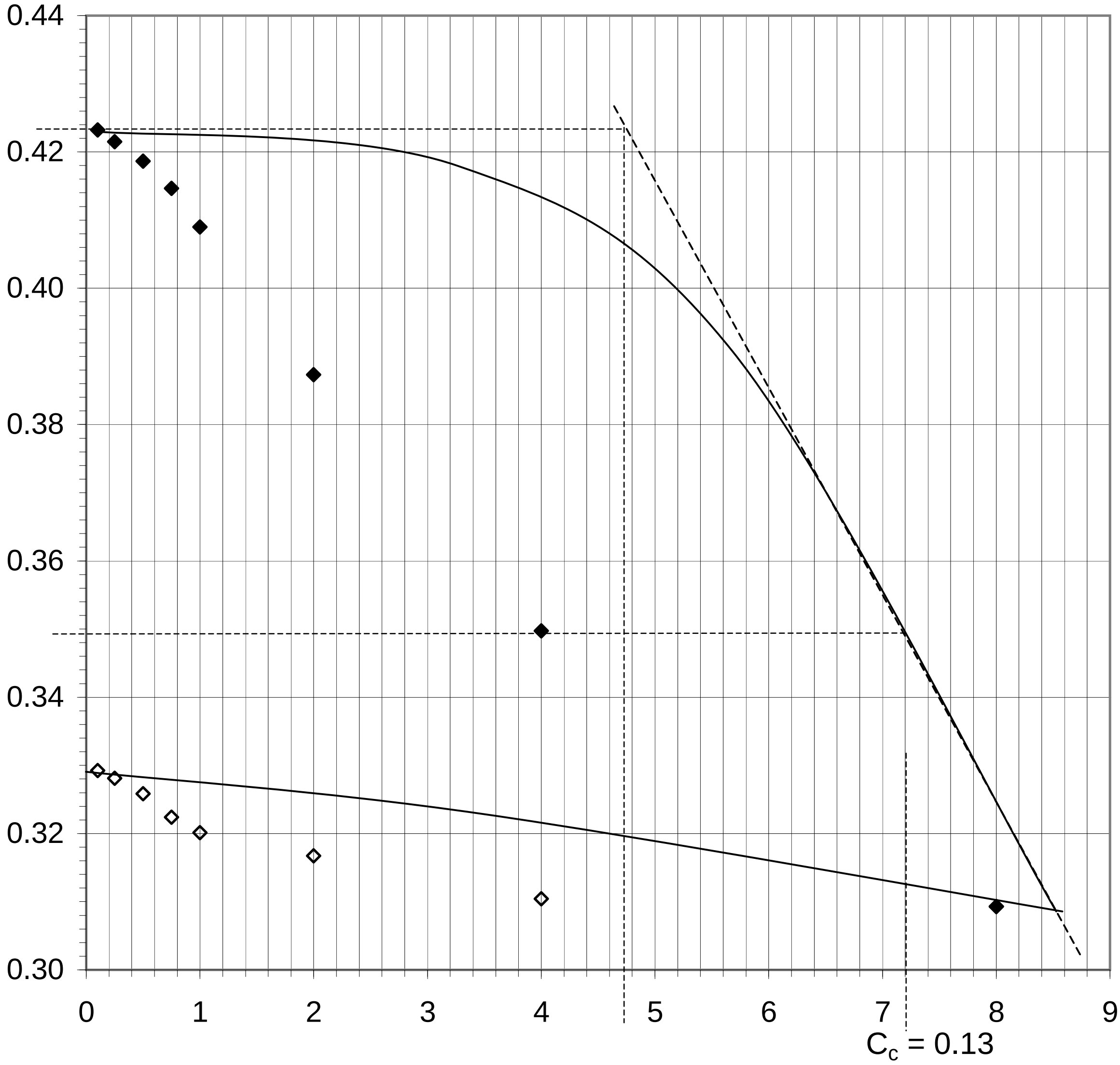

**Soil Sample Details**

Borehole - BH41

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 9**




**Soil Sample Details**
Borehole - BH41
Depth - 4m
Soil Type - Silty clay

**Consolidation Test - 9**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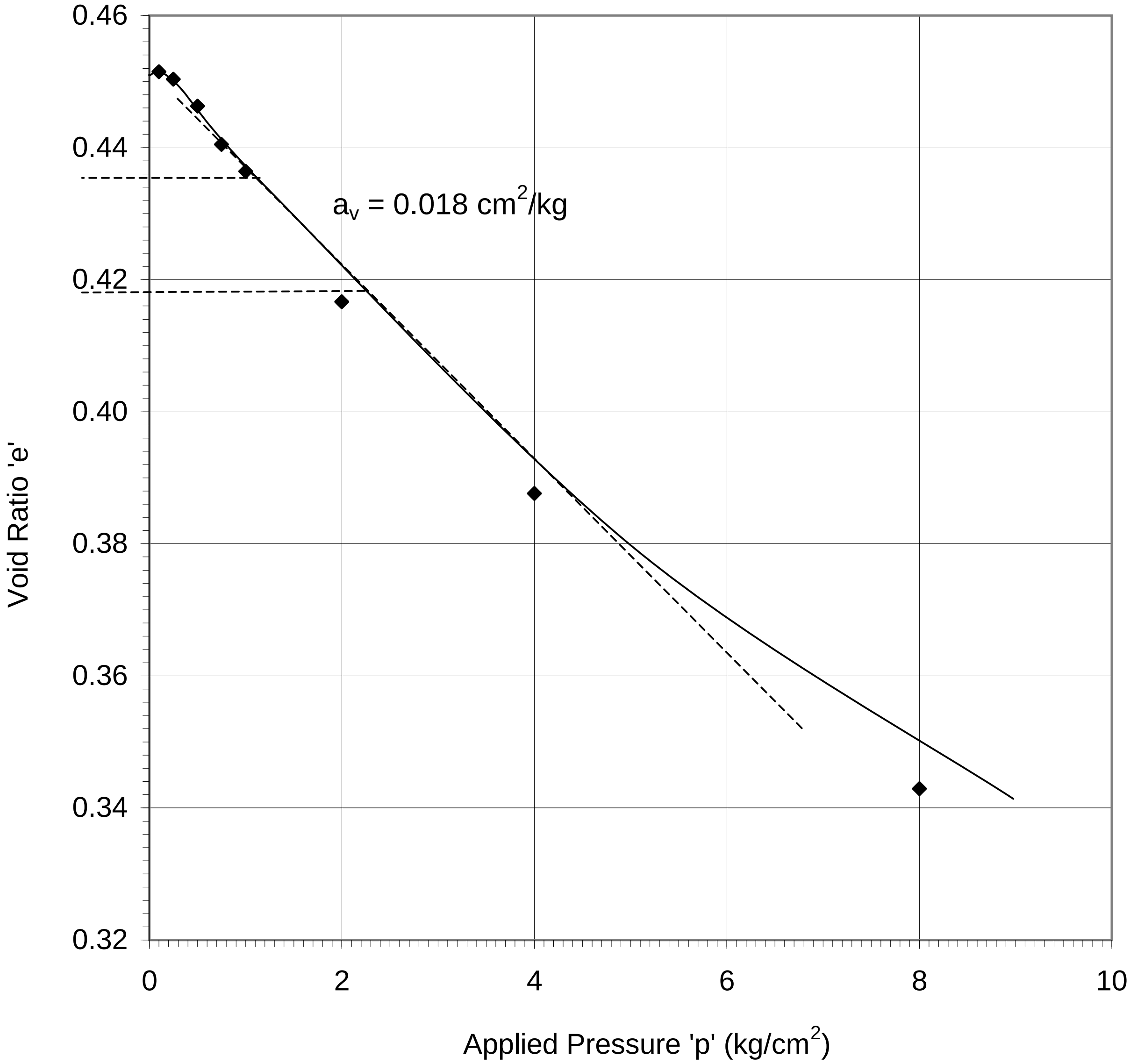


**Soil Sample Details**

Borehole - BH42

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 10**


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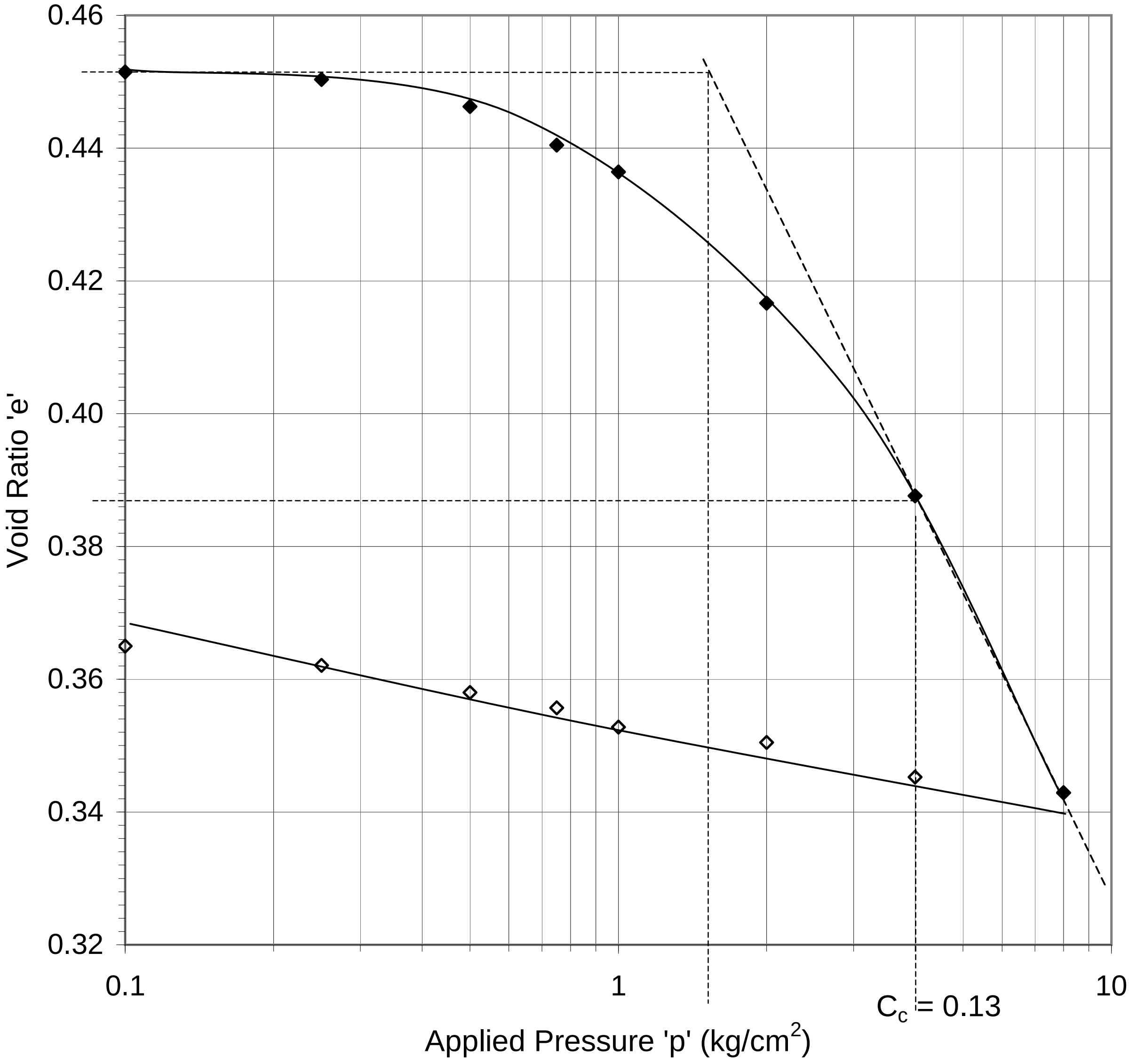


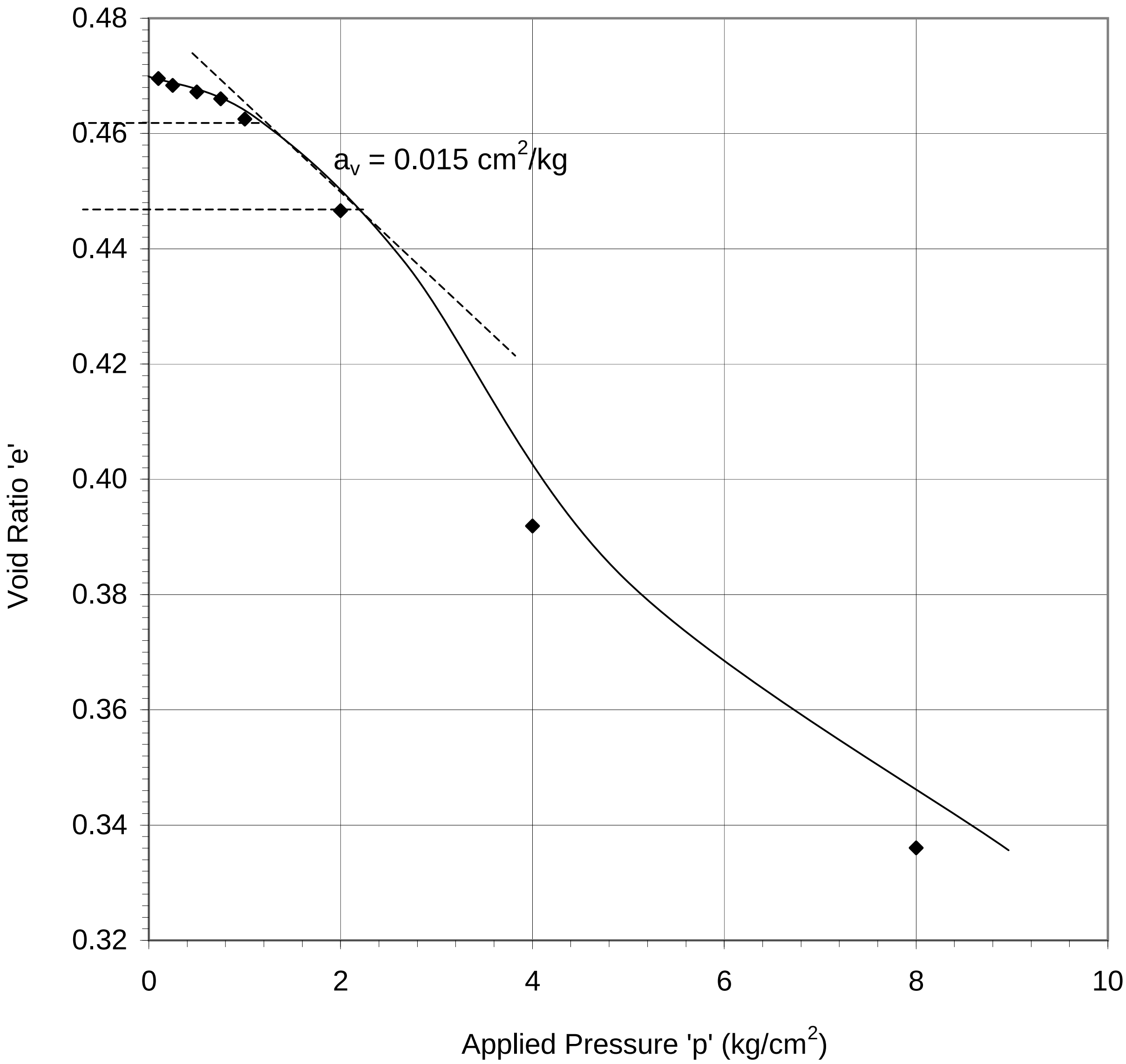

**Soil Sample Details**

Borehole - BH42

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 10**



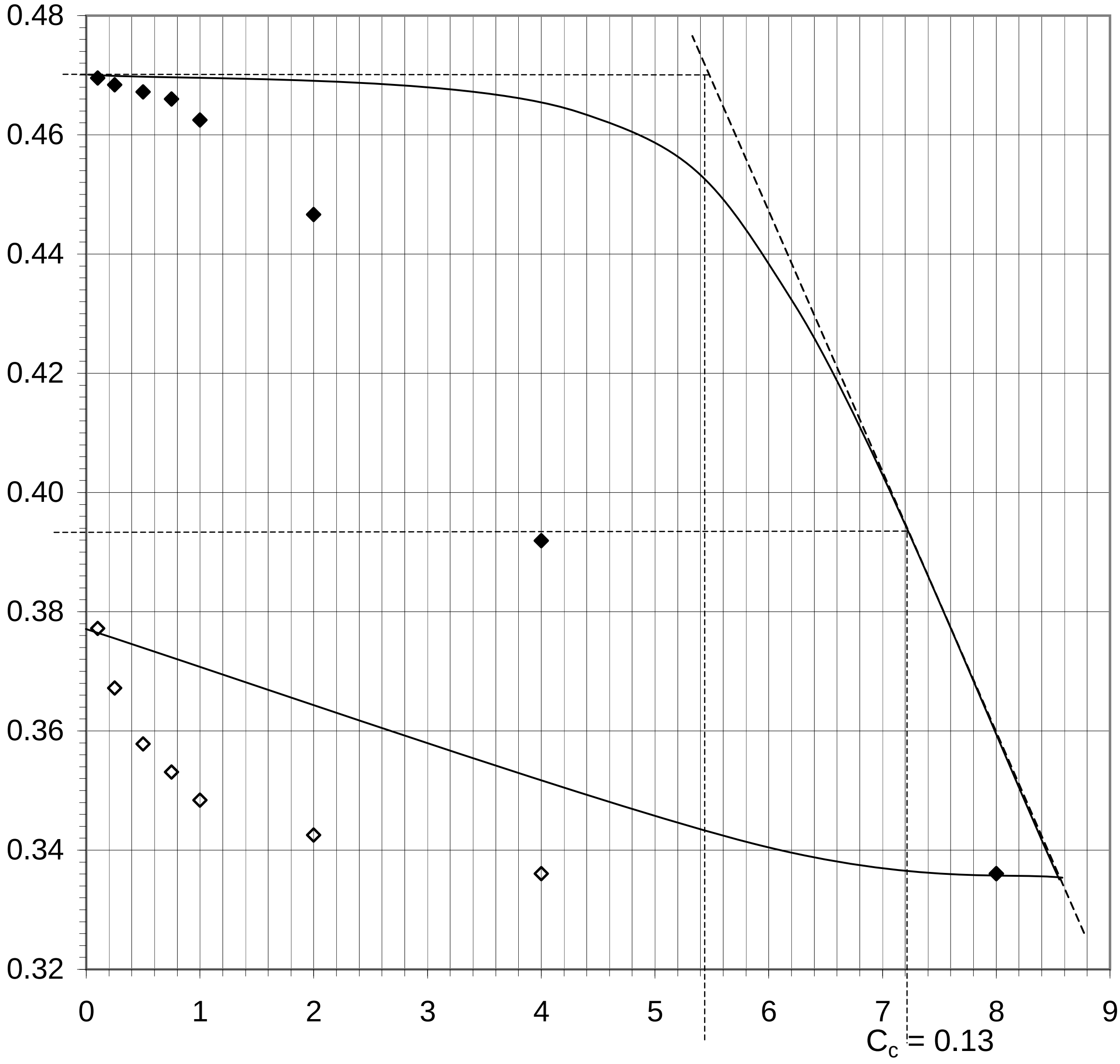

**Soil Sample Details**

Borehole - BH45

Depth - 6.5m

Soil Type - Silty clay

**Consolidation Test - 11**




**Soil Sample Details**

Borehole - BH45

Depth - 6.5m

Soil Type - Silty clay

**Consolidation Test - 11**

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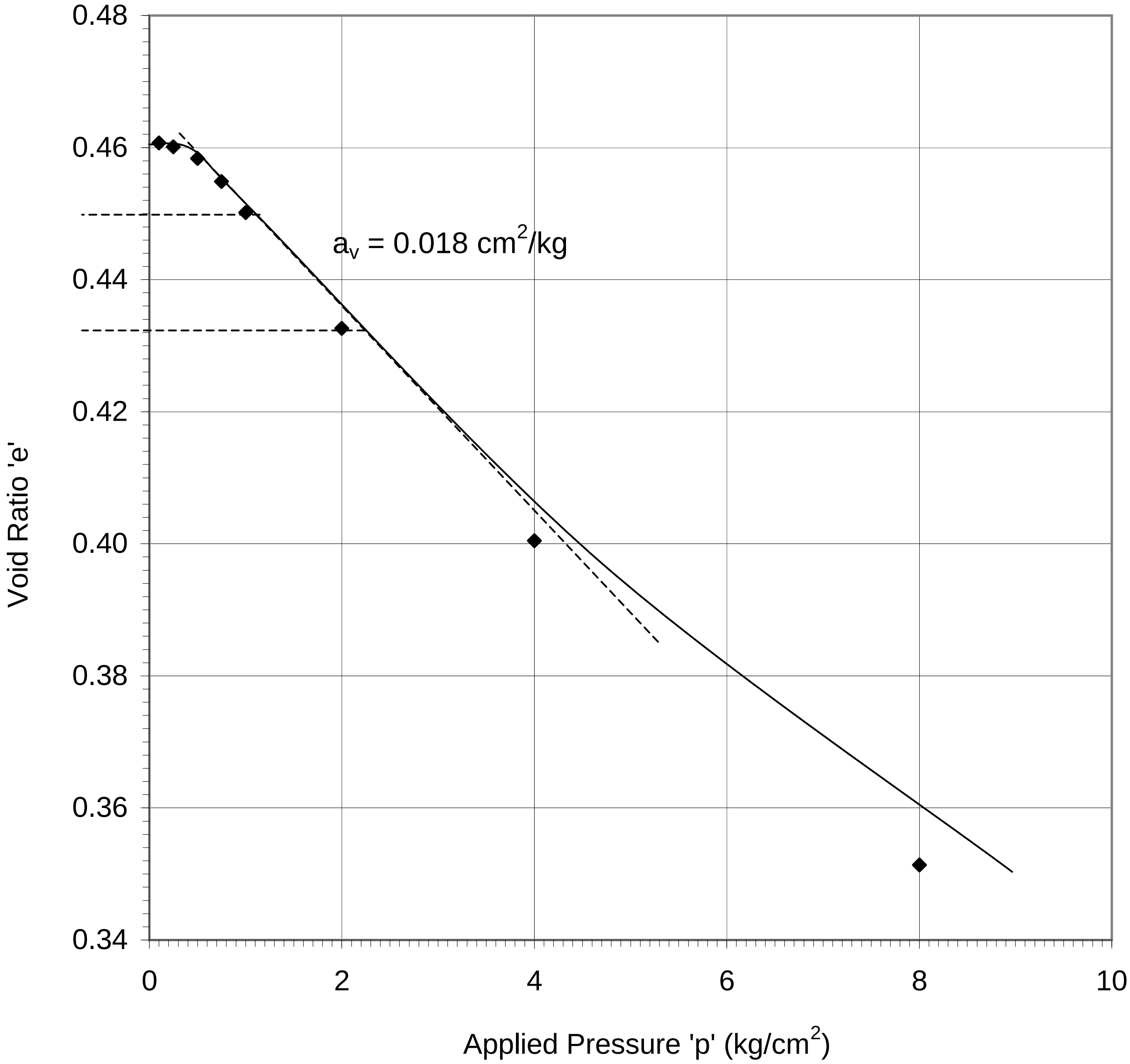


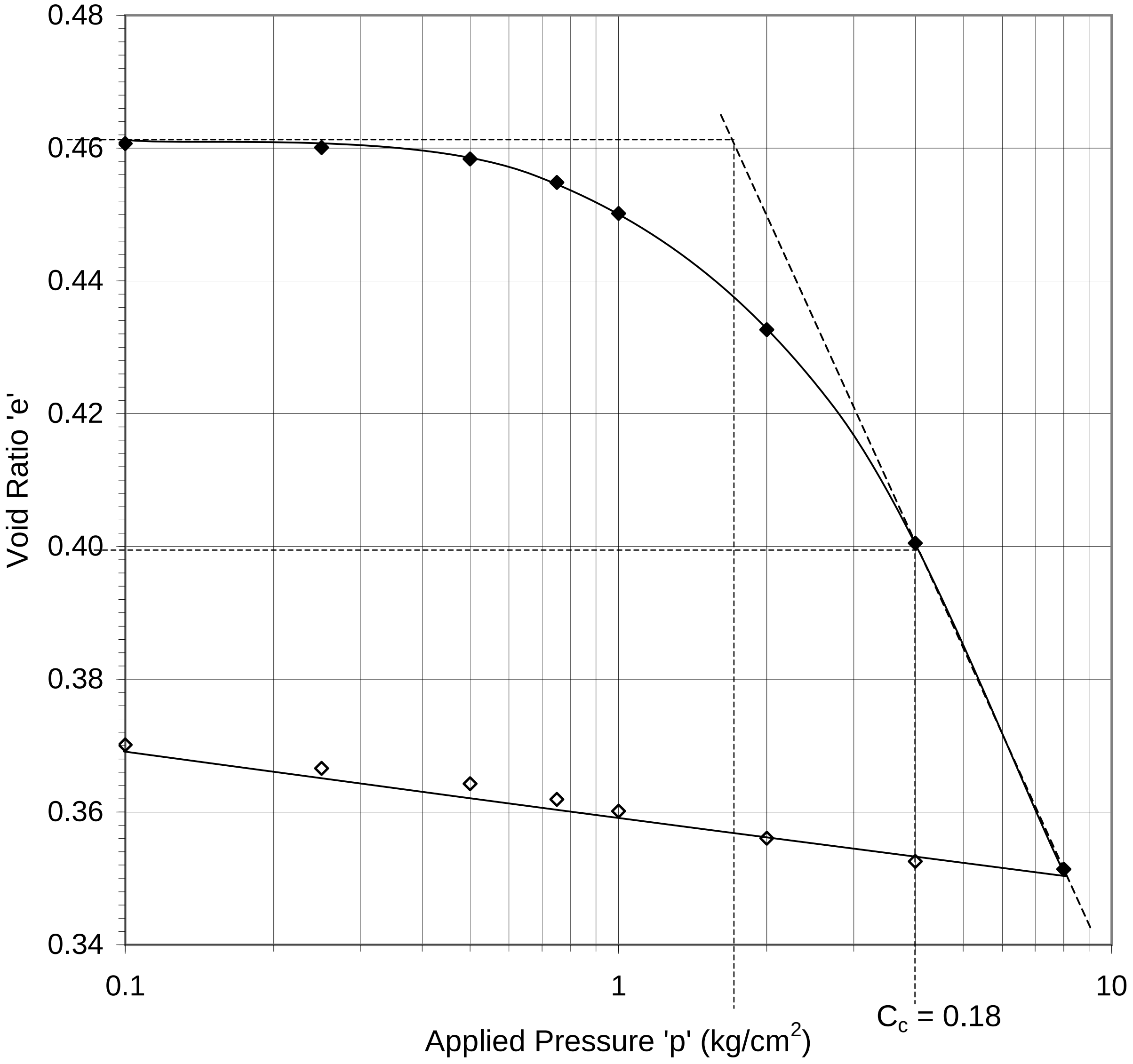

**Soil Sample Details**

Borehole - BH32

Depth - 2m

Soil Type - Silty clay

**Consolidation Test - 12**



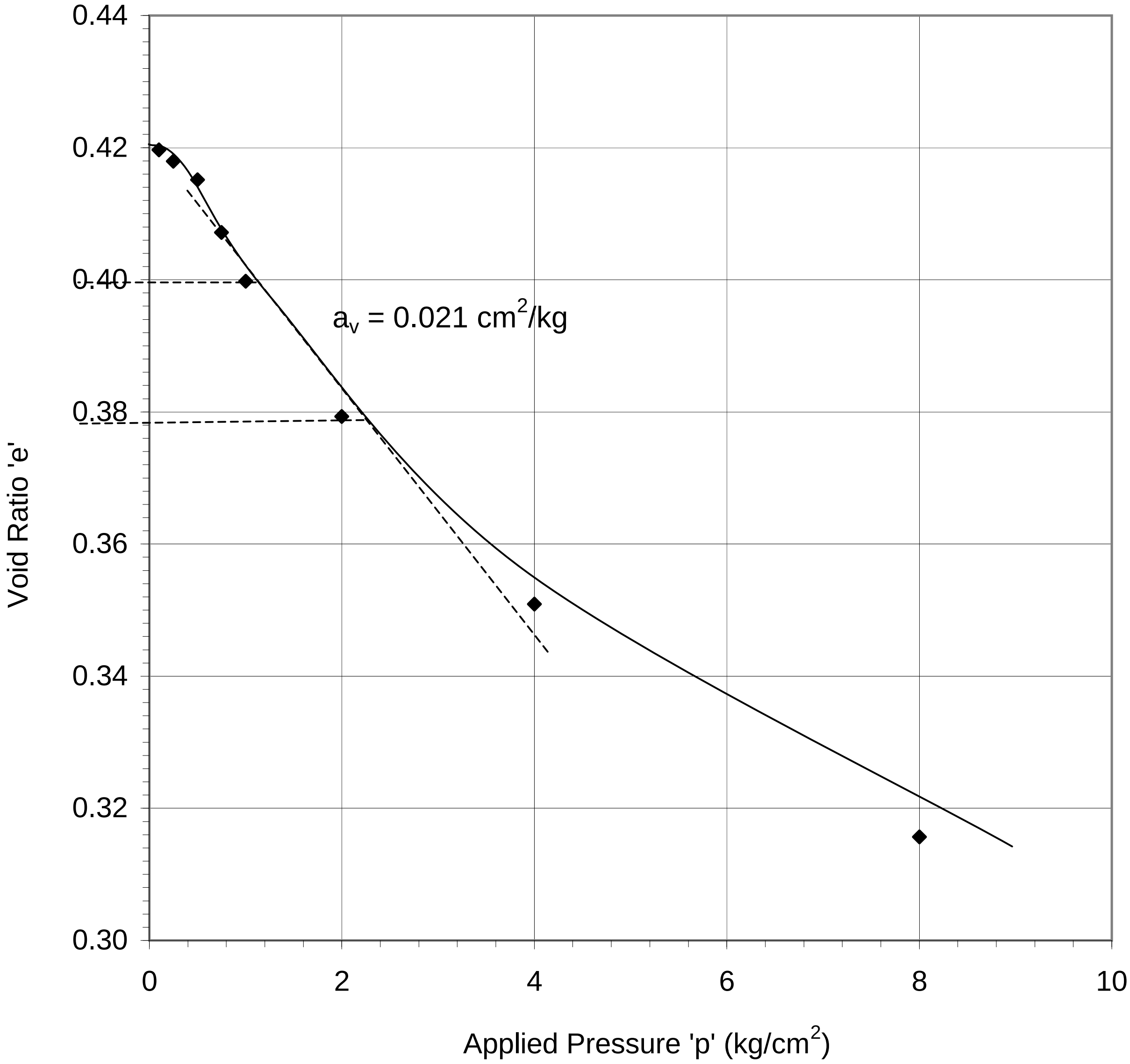

**Soil Sample Details**

Borehole - BH32

Depth - 2m

Soil Type - Silty clay

**Consolidation Test - 12**



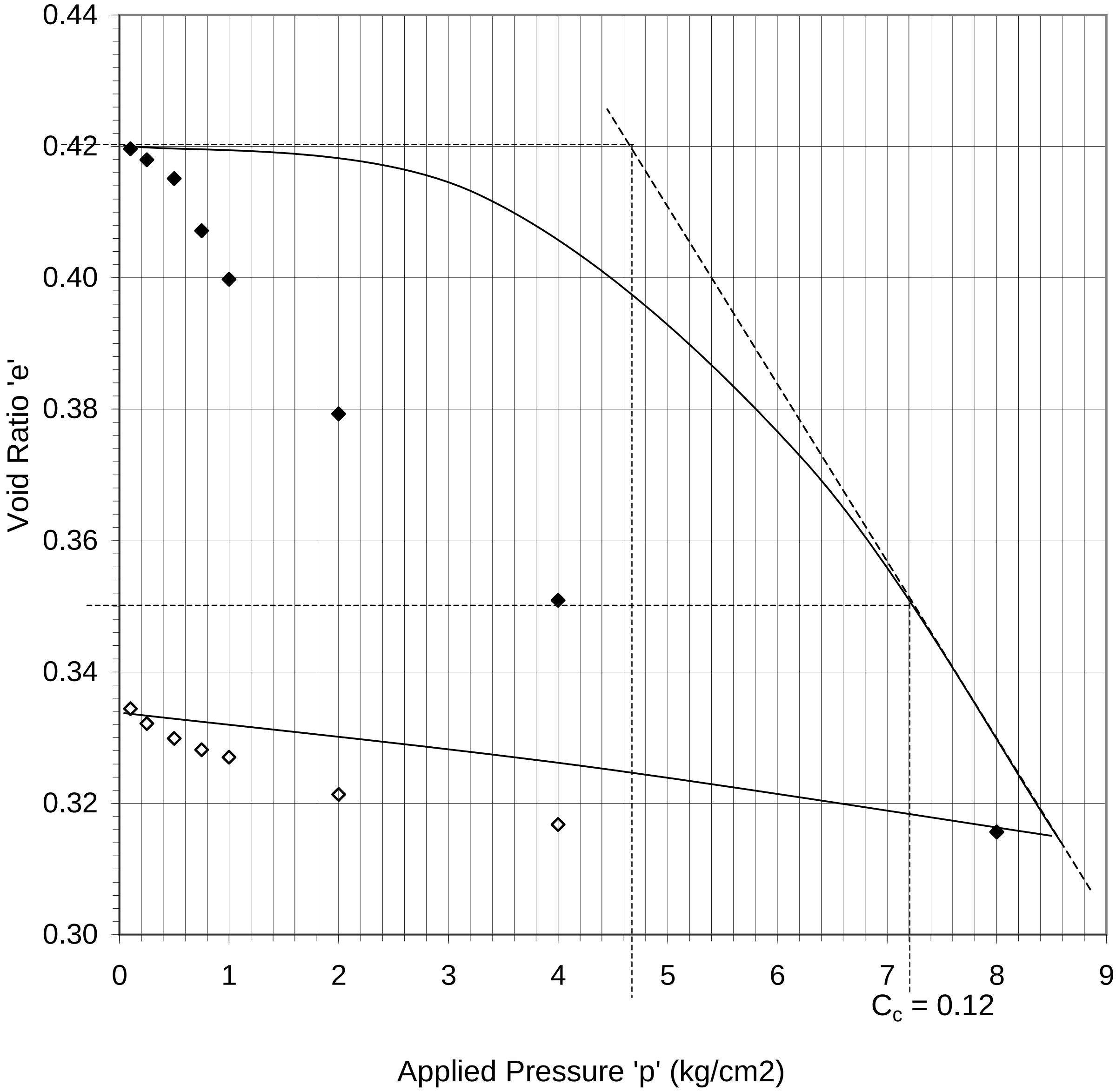

**Soil Sample Details**

Borehole - BH33

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 13**




**Soil Sample Details**

Borehole - BH33
Depth - 4m
Soil Type - Silty clay

**Consolidation Test - 13**

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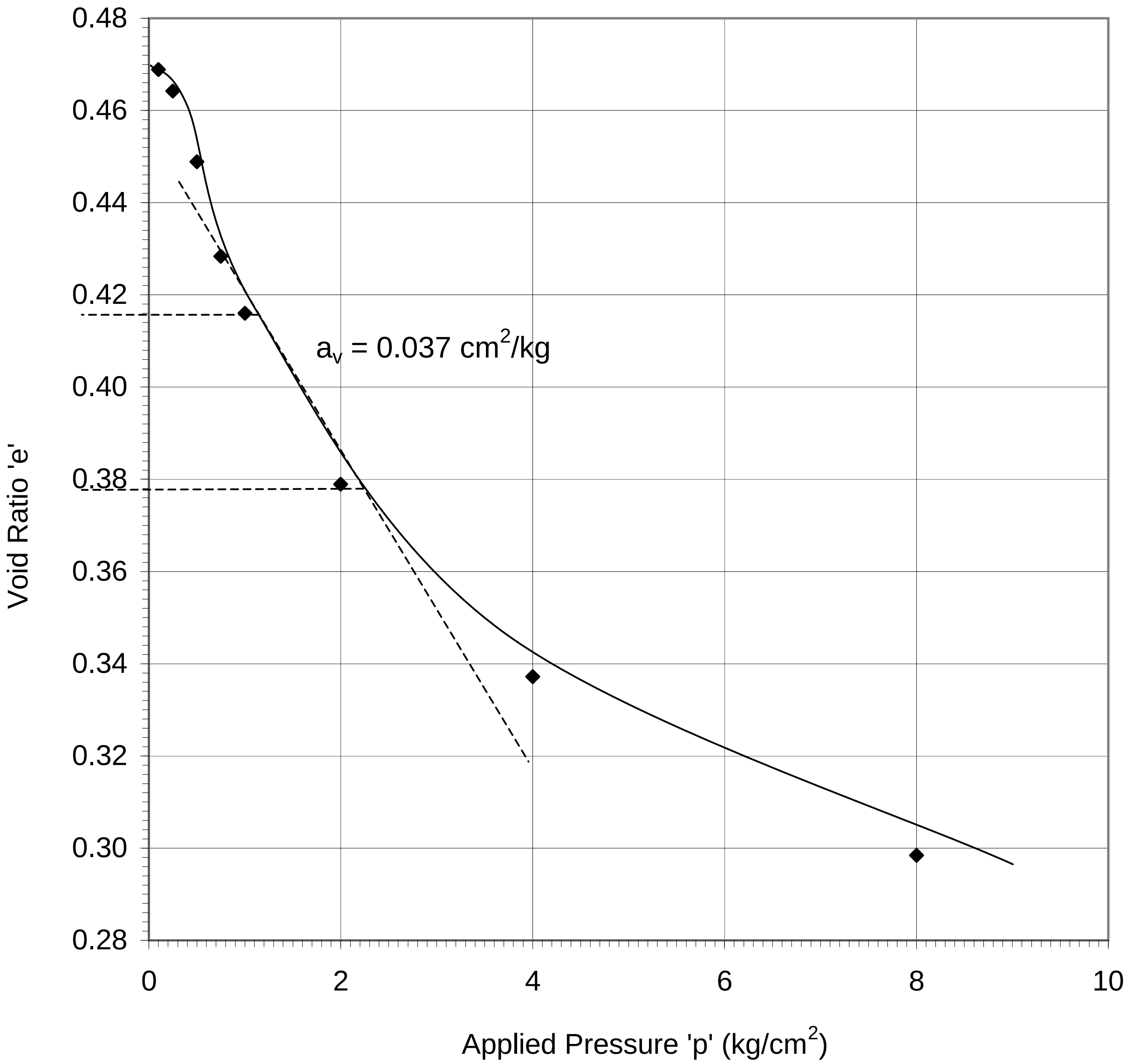


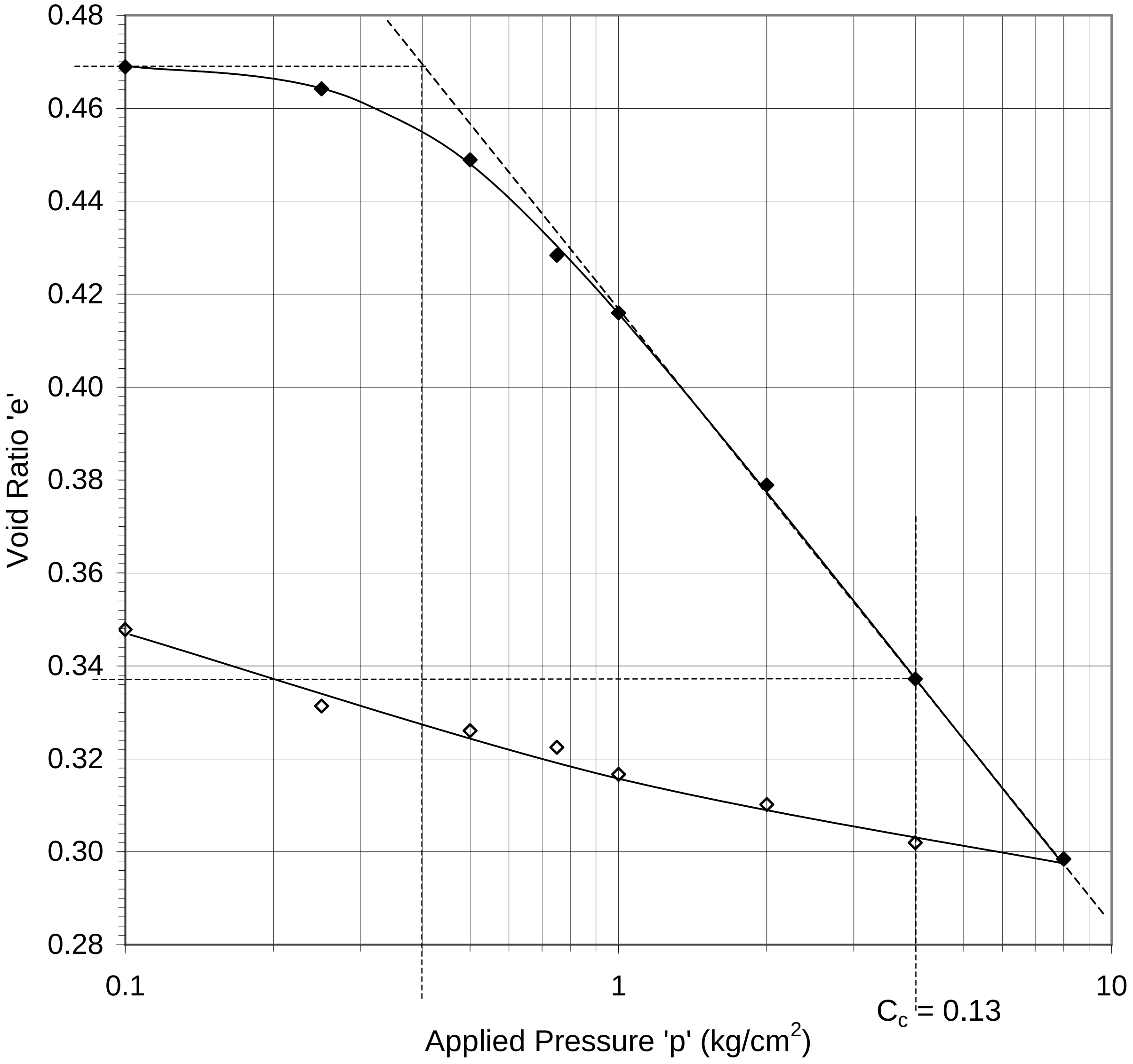

**Soil Sample Details**

Borehole - BH40

Depth - 4m

Soil Type - Silty clay

**Consolidation Test - 14**




**Soil Sample Details**

Borehole - BH40

Depth - 4m

Soil Type - Silty clay

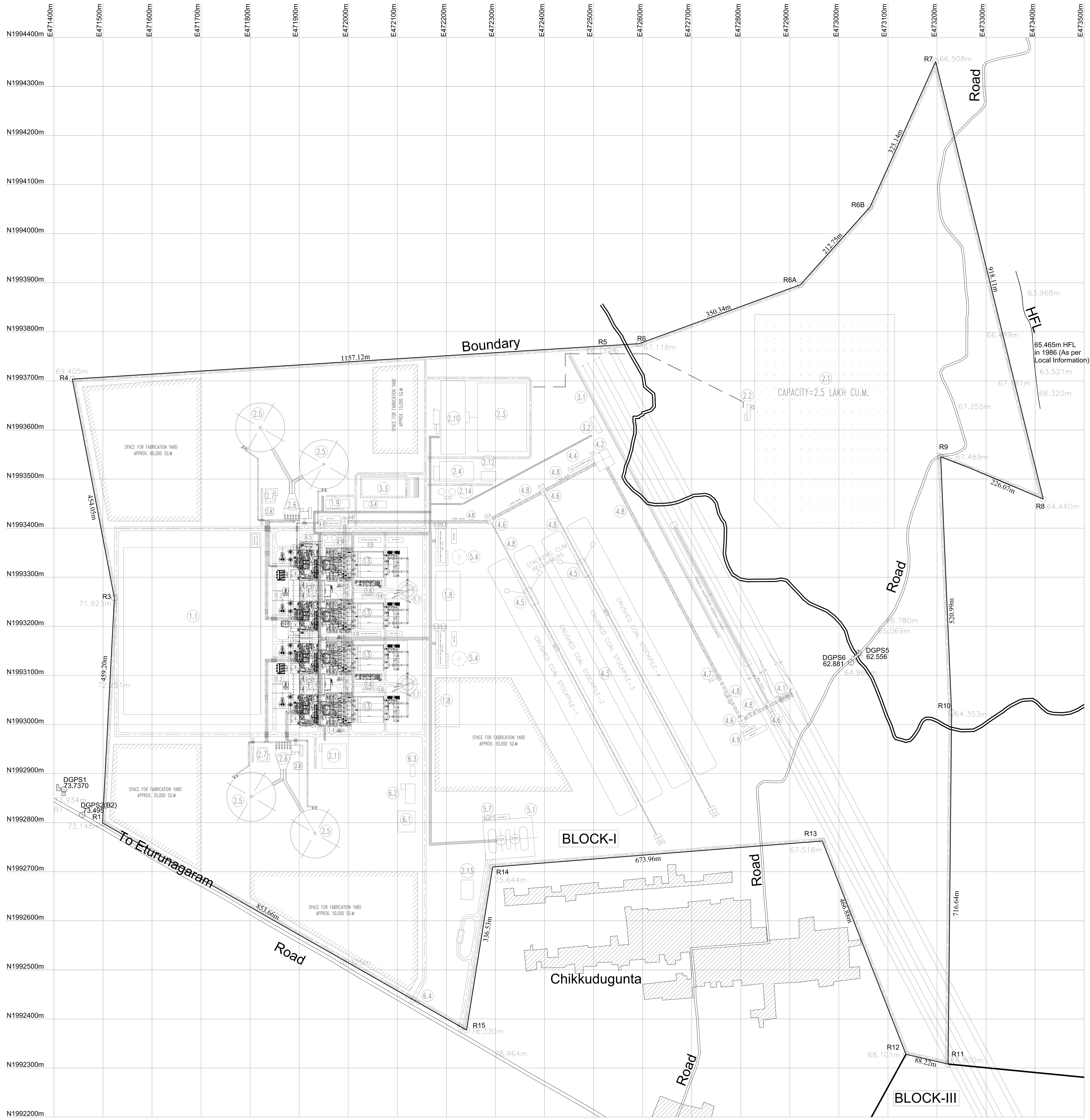
**Consolidation Test - 14**

PHOTOGRAPH SHOWING WORK UNDER PROGRESS

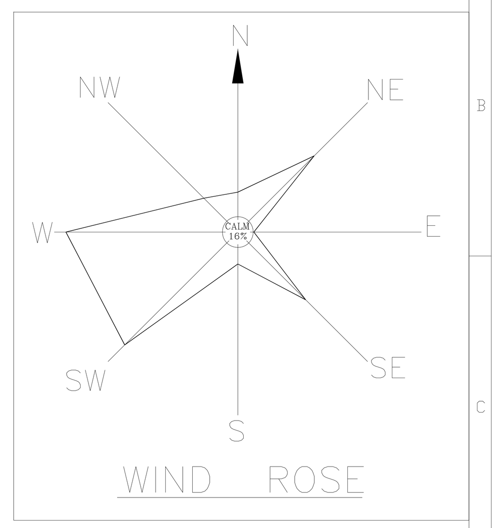
PHOTOGRAPH SHOWING CORE PIECES IN CORE BOX

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM








| TABLE | |
|---|---|
| FACILITY | DESCRIPTION OF FACILITIES |
| 1.0 | MAIN PLANT AREA |
| 1.1 | SWITCH YARD |
| 1.2 | TRANSFORMER YARD |
| 1.3 | TURBINE BUILDING |
| 1.4 | BOILER |
| 1.5 | ESP |
| 1.6 | ESP CONTROL ROOM |
| 1.7 | CHIMNEY |
| 1.8 | SPACE FOR FGD |
| 1.9 | IA & SA COMPRESSOR HOUSE |
| | |
| | |
| 2.0 | WATER SYSTEM |
| 2.1 | RAW WATER RESERVOIR |
| 2.2 | RAW WATER PUMP HOUSE |
| 2.3 | PT PLANT |
| 2.4 | DM PLANT |
| 2.5 | NDCT |
| 2.6 | CW PUMP AREA |
| 2.7 | CW CHLORINATION PLANT FOR CW SYSTEM |
| 2.8 | CW TREATMENT PLANT FOR CW SYSTEM |
| 2.9 | DELETED |
| 2.10 | CLARIFIED WATER STORAGE TANK & PUMP HOUSE |
| 2.11 | EFFLUENT TREATMENT PLANT |
| 2.12 | CHEMICAL LAB |
| 2.13 | SEWAGE TREATMENT PLANT |
| 2.14 | DM TANKS & DM TRANSFER PUMPS |
| 2.15 | CONDENSATE STORAGE TANKS AND CONDENSER MAKE UP & BOILER FILL PUMPS |
| 3.0 | FUEL OIL SYSTEM |
| 3.1 | FUEL OIL UNLOADING TRENCH |
| 3.2 | FUEL OIL UNLOADING AND PRESSURISING PUMP HOUSE |
| 3.3 | FUEL OIL STORAGE TANK AREA |
| 3.4 | FUEL OIL FORWARDING PUMP HOUSE |
| 4.0 | COAL HANDLING PLANT |
| 4.1 | WAGON TIPPLER |
| 4.2 | CRUSHER HOUSE |
| 4.3 | CRUSHED COAL STOCKPILE |
| 4.4 | CHP CONTROL ROOM |
| 4.5 | STACKER RECLAIMER |
| 4.6 | TRANSFER POINT (TP) |
| 4.7 | PENT HOUSE (PH) |
| 4.8 | COAL BELT CONVEYOR |
| 4.9 | DUST SUPPRESSION PUMP HOUSE |
| 5.0 | ASH HANDLING PLANT |
| 5.1 | FLY ASH SILOS |
| 5.2 | ASH SLURRY PIMP HOUSE |
| 5.3 | ASH WATER PUMP HOUSE |
| 5.4 | AHP CLARIFIER |
| 5.5 | AHP VACUUM CUM COMPRESSOR HOUSE |
| 5.6 | AHP VACUUM PUMP HOUSE – ADDED |
| 5.7 | SILO UTILITY BUILDING |
| 6.0 | NON – PLANT BUILDING |
| 6.1 | ADMN. BUILDING |
| 6.2 | CANTEEN |
| 6.3 | FIRE STATION |
| 6.4 | MAIN GATE |
| 6.5 | SERVICE BUILDING |
| 6.6 | DELETED |
| | |

LEGENDS:

Area Boundary

Road

River, Stream

DGPS Point with MSL Level in Metres — DGPS-5 62,556

Village

Pipe/Cable Rack

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ASH DYKE LOCATION CONSIDERED IN BLOCK-II AS PER DESEIN PLOT PLAN 111-29-0200 R1 DT. 31.12.14 RECD. VIDE MAIL DTD. 09.01.15.

FOR TENDER PURPOSE ONLY

CUSTOMER: TELANGANA STATE POWER GENERATION CO. LTD.

CUSTOMER'S CONSULTANT: DESEIN CONSULTING ENGINEERS NEW DELHI

JOB No. K27

STATUS PROPOSAL

DISTRIBUTION

TO

No.OFF

**4X270 MW MANUGURU TPP**

| REV | DATE | ALTD | CHD | APPD | REV | DATE | ALTD | CHD | APPD |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | P01 | 15.01.15 | RK | LKJ | SPV |

1. WIND ROSE, ROADS & SPACES FOR FABRICATION YARD MARKED.
2. FACILITIES 2.7, 2.8, 5.2, 5.3 & 5.4 RELOCATED.
3. FACILITY 2.9 & 6.6 DELETED.
4. NDCTs LOCATIONS AND CW CHANNELS & CW PIPES ROUTING MODIFIED.
5. DG BLDGS., AIR WASHERS & CENTRAL LUBE OIL ROOM RELOCATED.
6. RW RESERVOIR CAPACITY UPDATED.

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

| DEPT CODE | | NAME | SIGN | DATE |
|---|---|---|---|---|
| M | DRN | RK | | 25.09.2014 |
| | DESN | RK | | 25.09.2014 |
| | CHD | LKJ | | 25.09.2014 |
| | APPD | SPV | | 25.09.2014 |

TITLE: PLOT PLAN

| MPL | C | MSE | I | MAX | E | DEPT. |
|---|---|---|---|---|---|---|

SIGN

DATE

SCALE 1: 3000

DRAWING No. PE-DG-K27-100-M001

SHEET 1 OF 1 REV P01

SIZE-A0