2000 TPD BCGCL COAL TO AMMONIUM NITRATE - LSTK-1

TECHNICAL SPECIFICATION FOR AUXILIARY INDUCED DRAFT COOLING TOWER

BOOK 2 OF 2

(CIVIL SPECIFICATION)

SPECIFICATION No. PE-TS-544-165-W001
REV NO. 01

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA

TECHNICAL SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR INDUCED DRAFT COOLING TOWER

SPECIFICATION NO. IS-1-25-2002/TS/IDCT (R0)

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore - 560012

CONTENT

VOLUME: II

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

SECTION - A

SCOPE OF WORK

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore - 560012

1. SCOPE OF WORK:

The scope of the work for cooling tower shall include preparation of detailed design and construction drawings, submission of design basis report, calculation of BOQ against drawing submitted, complete all as required to give satisfactory performance and as stipulated in various clauses in this document. Bidder shall also submit all drawings in AutoCAD format along with PDF files. All excel sheets depicting all formulae used in calculations, structural analysis files and other files used in detail design shall also be submitted in executable form along with design documents. Overall quantities for cooling tower as a whole shall also be prepared and submitted.

In case, STAAD is not used for carrying out structural analysis of Tower, a licensed version of the used software shall then be installed in BHEL computer (to enable review of document) along with submission of all the related design and calculation files.

Bidder has the freedom of proposing both RCC as well as FRP cooling towers and submit the cost benefit analysis for chosen option.

In case FRP cooling tower is selected, one set of all latest relevant design standards pertaining to analysis and design of FRP towers used in design shall be submitted to BHEL.

The specification covers general requirements of materials, design and testing of RCC/ FRP works, structural works and finishing work etc. involved in the design of Reinforced Concrete/ FRP Induced Draft Cooling Tower.

Various plant facilities are envisaged around IDCT area which may or may not have interface with IDCT system. Bidder is required to establish that the conceptualized IDCT is in sync with these facilities. These facilities include but not limited to storm water drainage system,

sewerage discharge, effluent discharge, foundations of nearby structures etc. Bidder drawings shall be prepared so as the other facilities are not affected.

This document is not exhaustive. Relevant codes and standard practices to be followed by bidder where ever required, not conflicting with the provisions of this specification, for delivering performance as per the satisfaction of owner.

Any other design, drawing etc. if required for completion of the system but not mentioned above shall also be included in the scope of bidder.

VOLUME: II

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

SECTION - B

PROJECT INFORMATION

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore - 560012

1. BACKGROUND:

The present proposal is for setting up a Coal Gasification and Raw Syngas Cleaning Plant for Bharat Coal Gasification and Chemicals Limited (BCGCL), as a part of the coal based chemical complex to produce 2000 TPD ammonium nitrate.

2. LOCATION AND APPROACH:

The proposed project will be located in Lakhanpur area of Mahanadi coalfields Limited (MCL) Odisha. The total land area of the site is 350 acre. The proposed plant is situated at 21°46'0" N Latitude and 83°46'0" E Longitude.

3. ROAD & RAIL LINK:

The plant site is located at Lakhanpur in Jharsuguda district of Odisha. National Highway NH-49 is passing at about 10 km from the site. The nearest railway station Belpahar is 10 km from the site.

4. AIRPORT:

The nearest airport is Veer Surendra Sai Airport, Jharsuguda, which is approximately 38 km from the plant site. Travel time from airport to site is approximately 1.5 hours by road/ rail.

5. SEA PORT:

The nearest sea port is Paradeep, which is approximately 450 km by rail/road from the site.

VOLUME: II

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

SECTION – C

TECHNICAL SPECIFICATIONS

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore - 560012

1. GENERAL REQUIREMENTS

The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in mechanical section of this document.

CONTRACTOR shall submit detailed design calculations and construction drawings shall be submitted to OWNER for obtaining approval prior to commencement of work at site.

In the event, Bidder has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator's seal and signature indicating their approval. Bidder shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.

All the material specification and design criteria mentioned here shall be read in conjunction with the customer specification.

2. CODES AND STANDARDS

2.1 MATERIALS

(a) IS: 432 Mild steel and medium tensile steel bars. (parts1&2) and hard drawn steel wire for concrete reinforcement.
(b) IS: 1785 Plain hard drawn steel wire for pre-stressed (parts 1 & 2) concrete.
(c) IS: 1786 High strength deformed steel bars and wires for concrete reinforcement.
(d) IS: 2062 Steel for general structural purposes.
(e) IS: 3589 Seamless or electrically welded steel pipes for water, gas & sewage (168.3mm- 2032mm).
(f) IS: 8112 43 Grade Ordinary Portland cement.
(g) IS: 12330 Sulphate resisting Portland cement.

2.2 CODES OF PRACTICE

(a) IS: 456 Code of practice for plain and reinforced concrete.
(b) IS: 800 Code of practice for general construction in steel.
(c) IS: 875 Code of practice (part 1 to 5) for design loads other than earthquake for building and structures.
(d) IS: 1080 Code of practice for design and construction of simple spread foundations.
(e) IS: 1343 Code of practice for pre-stressed concrete
(f) IS: 1893 Criteria for earthquake resistant design of structures.
(g) IS: 2309 Code of practice for the protection of buildings and allied structures against lightning.

(h) IS: 2629 recommended practice for hot dip galvanizing on iron and steel.

(i) IS: 2950 Code for practice for design and (part 1) construction of raft foundation.

(j) IS: 3043 Code of practice for earthing.

(k) IS: 3370 Code of practice for concrete structures (part 1 to 4) for storage of liquids.

(l) IS: 12200 Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.

(m) BS: 4485 Specification for water cooling towers. (All parts)

(n) BS: 8007 B.S. Code of Practice for design of concrete structures for retaining aqueous liquid.

(o) IS 13920: 1993 Ductile detailing of reinforced concrete structures subjected to seismic forces — code of practice.

(p) IS: 1904 Code of practice for design and construction of foundations in soil: General requirement.

(q) IS: 2950 (PART-1) Code of practice for design and construction of raft foundations - design.

2.3 CODES FOR STOP-LOGS AND TRASH RACK

(a) IS: 4622 Recommendations for fixed - wheel gates structural design.

(b) IS: 5620 Recommendations for structural design criteria for low head slide gates.

(c) IS: 11388 Recommendations for design of trash rack for intakes.

(d) IS: 11855 General requirements for rubber seals for hydraulic gates.

The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order:

(a) Bureau of Indian Standards.

(b) British Standards Institution.

Wherever the above standards are in conflict with the stipulations of this specification, the technical specification shall govern.

2.4 CODES AND STANDARDS FOR FRP COMPONENTS

The design of FRP components of cooling tower shall comply with the requirements stipulated in CTI STD- 131, CTI STD -137, and CTI ESG-152. The cooling tower and its components shall be designed to withstand the most onerous loading case / combination resulting from the various loading cases / combinations stipulated in CTI ESG 152. All material properties, stresses and their reduction factors, deflection criteria, material service factors, connection details and their tolerances etc., as applicable as per CTI codes CTI STD- 131, CTI STD - 137, CTI ESG-152, shall be so considered such that the cooling tower and its components withstand the severest temperatures in the place of installation and application and serve a reasonably long life not less than CTI indicated life expectancy.

Following is the list of few codes/ standards to be followed for FRP cooling tower design:

i. CTI STD – 131: Fiberglass-Reinforced Plastic Panels
ii. CTI STD – 137: Fiberglass Pultruded Structural Products for Use in Cooling Towers

iii. CTI ESG – 152: Structural Design of FRP Components

iv. CTI STD – 203: Industrial Cooling Tower Standard

v. ASCE 7 -10: Minimum design loads of buildings and other structures. (as per CTI ESG – 152)

3 GENERAL DESIGN REQUIREMENTS

The basin of the cooling tower for collection of cold water shall be made of Reinforced Cement Concrete (RCC M - 30 grade as per IS: 456). The floor of the basin shall be sloped to minimum 1 in 80 towards the sludge drains. The required slope shall be achieved by screed concrete of grade M-15 as per IS:456 having minimum thickness at edge as 25 mm. Drainage arrangement of basin shall be as specified elsewhere in the Technical Specifications. If the cooling tower basin and sludge sump is below ground level, FRP hand railing shall be provided all around the cooling tower basin and sludge sump pit. The bottom 500 mm of hand railing shall also have FRP/PVC wire mesh with opening size of 50mm grid to avoid ingress of leaves, vegetation, and debris into the basin. The basin shall be tested for water tightness as per IS:3370.

Bottom of the lowest level beam shall be at least at free board level. In case, the beams are provided into the water, the same shall be designed for un-cracked section as per IS:3370.

The outlet channel shall be covered on top with removable precast concrete slabs for about 5m length from cooling tower basin and the entire length of cold water outlet channel shall be provided with 32 NB (Medium) G.I pipes. Hot water duct around cooling towers, if placed below ground shall be encased with min. 500mm thick PCC (M20 grade).

The civil works for cooling towers are related mainly to following areas:

3.1 FOUNDATION OF COOLING TOWER

For all major foundations, the minimum founding depth and the minimum size of foundation shall be as per foundation system specified elsewhere in the specification and geotechnical data.

For open foundations, the total permissible settlement shall be as per the criteria furnished under the foundation system specified elsewhere in this specification. The sizing of foundation, design criteria & clear cover shall conform to IS: 1904, IS: 456 and other relevant Indian codes. However minimum 0.12% of reinforcement shall be provided on the top face of the foundation concrete on either direction and minimum percentage of reinforcement at bottom face of foundation shall be same as that stipulated for beam as per IS:456.

No major foundation shall rest on filled up soil. Loose soil if any below foundation is to be removed and replaced with PCC of grade M7.5.

NTPC had carried out geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at some bore holes in the cooling tower area are enclosed as Annexure-A. The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of

correct assessment/ interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.

Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/ permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work. However, the net safe bearing capacity (SBC) of shallow foundation to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of net SBC higher than the one indicated shall not be accepted. However, bidder shall note that the net safe bearing capacity and foundation depth to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

3.2 SUPER STRUCTURE OF COOLING TOWER (applicable in case of RCC cooling tower)

Columns, beams and other structures like tie beams, slabs etc. shall be of reinforced cement concrete of grade M-30 (minimum) as per IS: 456. Uniform concrete grade shall be used for the entire cast-in-situ reinforced concrete superstructure.

The fan deck slab shall be properly sloped so that rain water does not accumulate over the deck slab. The slope shall be 1: 120 (min.). The slope shall be provided with screed concrete of grade M-15 (minimum) as per IS: 456. Fan Deck slab and all other over ground platforms shall be provided with FRP handrailing. Suitable arrangement for drainage of rain water to be provided. However, there is no specific requirement of Rain Water down comers.

3.3 CELLS, DISTRIBUTION SYSTEM AND STACK (applicable in case of RCC cooling tower)

Cooling tower cells shall consist of RCC columns, beams and walls. The spacing of

columns shall be minimum 4000 mm c/c. Inclined bracings shall not be provided between the columns. Hot water distribution channel shall also be of RCC. Cell division partition walls shall be of precast solid concrete blocks with provision of pilasters for walls, if required. The peripheral wall shall be Cast-in-Situ

RCC wall and shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8 mm and maximum spacing as 150 mm c/c. Minimum thickness of Cast-in-Situ RCC peripheral walls shall be 200 mm.

Hot water channel shall be covered with suitably designed precast / cast - in – situ concrete slab. Wherever flow control valves are located over hot water basin, these shall be placed over precast concrete covers / concrete slab and designed for specified load. The minimum thickness of RCC fan stack shall be 150 mm. The fanstack shall have two layers of reinforcement on either faces in both directions with minimum dia of reinforcement bars as 8mm and maximum spacing as 200mm c/c.

3.4 STAIRS

RCC staircase for approach to fan deck for each cooling tower shall be provided. The stairs shall have 1000 mm clear width and FRP hand railing. The riser shall be maximum 175 mm & treads 250 mm (minimum). Edge protection angle (min 35X35X6, made of aluminium) shall be provided to the treads with the lugs.

3.5 STEEL STRUCTURES

All mild steel parts of structures used in cooling towers shall be hot dip galvanized or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). The minimum coating for galvanization shall be 610 gm/sq.m and shall comply with relevant IS Codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of SS 316.

3.6 WATER PROOFING OF STRUCTURES AND CONSTRUCTION JOINTS

For water proofing of underground structures including basin slab and hot water distribution channel, water proofing cum plasticizer compound shall be mixed with the concrete. In addition, Chemical injection treatment shall be provided for the construction joints of all underground structures.

3.7 EXPANSION / CONSTRUCTION JOINTS

PVC sealing strips shall be used for all expansion joints where water is retained. The minimum thickness of PVC sealing strip will be 6 mm (minimum) and minimum width 225 mm. The expansion joint shall be as per IS: 3370. At expansion joints, joints filler material with sealing compound on both sides shall be provided throughout the length of the joint.

The number of construction joints shall be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting shall be carried out continuously up to construction joints.

3.8 GRADE OF CONCRETE

All RCC associated with induced draught cooling towers including switchgear and control room, unless specified otherwise, shall be design mix (controlled) concrete of grade M 30 of IS: 456. Water - cement ratio shall not exceed 0.45. Minimum 75 mm thick PCC of grade M-7.5 as per IS: 456 shall be provided as mud mat below foundation unless specified otherwise. The PCC shall extend 75 mm beyond the outer edge of structural concrete.

For water retaining structure minimum 100 mm thick PCC of grade M-10 as per IS:456 shall be provided as mud mat below the bottom slab / raft. The PCC shall extend 100 mm beyond the outer edge of the structural concrete.

3.9 FORM-WORK

Plywood Form-work shall be used for basin, basin walls, outlet channel and super structures.

3.10 DOORS (applicable in case of RCC cooling tower)

FRP door shall be provided in each fan stack at fan deck level. Door height & width as per requirement for equipment movement (clear) shall be provided. However, door size shall be minimum 2100 mm high (clear) & 1200 mm wide (clear). Door shall have locking facility.

3.11 COATING

All concrete surfaces in direct contact with water/ water spray/moist air shall be applied with Moisture Compatible Corrosion Resistant Coating System or its equivalent as specified in Annexure-G of specification. All concrete surfaces subject to water/ water spray/moist air up to and including Fan Deck slab level including basin slab, inner faces of peripheral walls, all faces of cell partition wall, all faces of columns, all faces of beams (both cast in situ and precast), bottom surface of fan deck slab for counter flow tower and both surface of fan deck slab for cross flow tower, inner face of fan stack, all faces of hot water basin (for cross flow tower), etc as applicable shall receive the said coating after cleaning and drying of the concrete surface. The detailed specification of the coating system on concrete surfaces is given in Annexure-G of customer specification.

External surfaces of Cooling tower peripheral walls and fan stack shall be painted with two or more coats of waterproof cement paint of approved shade, make and color.

3.12 PAVING

Paving shall be provided for a minimum clear width of 5.0 m from the outer face of the HW pipes all around the cooling tower basin. Paving shall also be provided in between the hot water pipes and space available between HW pipes and CT basin wall spray catcher. The minimum total width of paving around CT basin shall be at least 8.5 m from outer edge of the spray catcher or basin wall. Paving shall consist of reinforced concrete base slab laid over 75 mm thick PCC of grade M-10 as per IS:456 sub-base and 200 mm thick stone soling. The sub-base shall be laid on the compacted and suitably prepared sub-grade. The degree of compaction of sub-grade shall be as specified elsewhere in the specification. The thickness of the RCC base slab of grade M - 25 shall be suitably designed considering a superimposed load intensity of 5T / Sq.m. However, the minimum thickness of base slab shall be not less than 150 mm having double layered reinforcement in both directions both top and bottom. The maximum spacing of the reinforcement bars shall be 150mm c/c and minimum dia of reinforcement bars shall be 8mm.

RCC peripheral drain of minimum cross-sectional dimensions 300mm X 300mm to dispose storm water shall be provided around area paving and shall be connected to
nearest Owner's storm water drains.

RCC paving all around cooling towers shall be connected to the existing road so as to provide approach to both cooling towers and switchgear & control room building as indicated in tender drawing. The clear width of this approach road shall be 5.5M and top of approach road shall be 350 mm above FGL.

3.13 WALKWAYS

Permanent walkways at least 1000mm clear width shall be provided at hot water distribution level and at drift eliminator level for counter flow type cooling towers. The clear working height available above these walkways shall be at least 2.0 meters. The walkway and its supporting structure shall be of RCC M - 30 grade. Suitable RCC guard rails 300 mm high shall also be provided on both sides of these walkways. Over the guard rails FRP hand railing shall be provided. The vertical post of handrail shall be 700 mm high and at an interval of 1500mm c/c. There shall be two levels of horizontal pipes for hand railing spaced equally in vertical plane.

Permanent walkways at least 1000 mm clear width shall also be provided for access to fan and around gear box with FRP gratings of clear opening size not more than 50 MM x 50 mm and grating thickness of 50 mm on RCC supports at fan deck level.

4 DESIGN CRITERIA

4.1 R.C.C. STRUCTURES

(a) The design of all liquid retaining/conveying structures like of cooling tower like C.W. basin, sump, hot water distribution channel/basin, sludge drain and pits shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009. These structures shall be designed for following conditions: -

1. Water filled inside up to the designed level and no earth outside.
2. Earth pressure plus 2.0 T / M2 surcharge (Vertical direction) plus ground water table at Finished Graded ground Level (FGL) outside and no water inside.

(b) The design of all structures other than liquid retaining/conveying structures of cooling tower above CW basin slab such as columns, beams, fins, walkways, slabs, cladding/partition wall, fan stack, precast beams etc. as applicable shall be carried out by limit state method as outlined in Clause 4.4 of IS: 3370 (Part 2): 2009. Further, for limiting the crack width, the stress for the reinforcement steel shall be limited to 130 MPa (on all faces) as per clause 4.4.3.1 of IS: 3370 (Part 2): 2009 using the partial safety factor for serviceability condition as per clause 4.4.1.3.

Wherever, the foundation raft of cooling tower is same as CW basin slab, the foundation shall be designed by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 (all faces). However, if the cooling tower foundation is not the same as the CW basin slab and a separate foundation for the cooling tower is provided below the CW basin slab due to founding level requirements, the basin slab shall be designed as a structural slab resting on grid of beams taking support from columns or as a flat slab taking support from columns. Arrangement with providing walls between the columns and the periphery to support the structural basin slab is not permitted. The CW basin slab (both faces, including beams at CW basin slab level) shall be designed as structural slab by working stress method as outlined in Clause 4.5 of IS 3370 (Part 2): 2009 and the structures below CW basin slab shall be designed as per IS:456 (2000). However, the size of the column below CW basin slab up to foundation shall be maintained same as the size of the columns just above CW basin slab.

(c) The design of staircase, switchgear building, control room/RIO room, transformer and trestle foundation, storm water drain shall be as per IS: 456 (2000).

(d) The Cold Water basin shall be checked against uplift for basin empty condition with ground water table at FGL. Stability against uplift shall be ensured both for construction & operating stage with no water

inside. The provision of flap valve / pressure release valves is not permitted. The factor of safety against uplift shall be as per IS: 3370.

(e) Fan deck shall also be designed for rolling loads due to movement of equipment during Installation / maintenance operation.

Minimum Clear cover for all RCC structures/elements of cooling towers to meet durability requirements shall conform to severe exposure condition as per IS: 456 (2000).

4.1.1 FAN SUPPORTING STRUCTURES (applicable in case of RCC cooling tower)

STATIC ANALYSIS & DESIGN

The following load conditions and load combinations shall be considered for the design of the Fan supporting structures.

(a) Machine Load

(b) Load case (a) + unbalance load for the balance of the fan corresponding to G16 as per ISO 1940-1: 2003

(c) Load case (a) + unbalance load corresponding to one blade failure load condition. The strength design of the Fan supporting structure shall be done for worst loading combinations as stated above.

DYNAMIC ANALYSIS

(a) ***Free vibration analysis***

A free vibration analysis of the fan supporting structure including the intermediate

supporting structure for motor, gear box and pillow block (if applicable) shall be carried out to calculate the natural frequency of the fan supporting structure and its fundamental natural frequency shall be at least + 20% away from the operating speed of the fan and motor.

(b) ***Forced vibration analysis***

Forced response analysis shall be carried out on the fan supporting structure including the intermediate structure supporting the motor, gear box and pillow block to calculate the vibration amplitudes for the following unbalance condition:

1. For unbalance load corresponding to G16 as per ISO 1940-1: 2003
2. For unbalance load corresponding to one blade failure condition.

The amplitude derived shall be within the permissible values as specified by the fan manufacturer or IS: 2974 (Part - IV), whichever is more stringent.

4.1.2 MID BEARING SUPPORTING STRUCTURE

The intermediate supporting structure for motor, gear box and pillow block if provided shall be so arranged that it does not cause any torsional moments on the beams / pedestals on which the intermediate support rests. The intermediate supporting structure shall be orthogonal to the grid of beams on which it rests. The motor shall be supported on a base frame. The concrete block supporting the fan/gear reducer shall be connected to immediate lower level of beam column junctions by means of at least four diagonal columns.

4.1.3 FAN STACK

The fan stack shall be made of RCC with minimum 150 mm thickness. With reinforcement provided on both faces in either direction. Design of the fan stack shall be made on the basis of relevant stipulations of IS: 11504 for Natural Draught Cooling Towers. The fan stack shall have two layers of reinforcement on either surface in both directions with minimum dia of reinforcement bars as 10mm and maximum spacing as 150mm c/c.

4.2 STEEL STRUCTURE

These structures shall be designed, fabricated and erected as per IS: 800 (latest revision).

All mild steel parts or structural steel works used in the cooling towers shall be hot dip - galvanised as per IS: 4759 with 610gm/sq.m. coating or seal spray zinc coated as per BS:5493 (for a very long period of maintenance of more than 20 years). Nails and all components coming in direct contact with water shall be of stainless steel of SS 316 or equivalent.

For all steel structures, other than hot water pipes, sludge pipes and hot water distribution pipes, which are outside cooling tower painting shall be as specified in corrosion protection clause. However, for painting of hot water pipes, sludge pipes and hot water distribution pipes, relevant clause for painting specified elsewhere in the technical specification shall be referred.

The minimum cement content as specified in subsequent clauses of this specification shall be applicable for all structures of cooling towers.

4.3 Test for water tightness

The water tightness of C.W. basin, outlet channel, CW channel and all other water retaining structures shall be tested for water tightness as per the provisions of IS: 3370.

5 Stoplog gates and Trash racks for Cooling Tower

Stoplog gate and trash rack/screen shall be provided in the outlet channel of each cooling tower. The design criteria and material specification for Stoplog gates and Trash racks is as follows:

5.1 Stop-log gates

Clear size of the stop logs shall be equal to the clear opening size of water inlet opening below breast wall. Number of segments of the stop log shall be decided to match the capacity of the electrically operated monorail hoist provided to handle it. Structural design of stop log shall conform to IS: 5620 and IS: 4622. Maximum water level for designing the stop logs shall be taken as maximum water level of the forebay. Top and bottom unit of stop log gates shall be designed for their respective water head, whereas the remaining interchangeable units shall be designed for the water head corresponding to the lower most interchangeable unit. The stop logs shall be operated under balanced water head and they are not to be designed for operating under flowing water. Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. These stop logs are used only during maintenance / inspection of pumps. The stop logs shall be operated by means of an electrically operated hoist. Suitable lifting beam shall be provided to operate the stop logs.

5.2 Trash Racks

Bar screen trash rack is to be provided at inlet of the sump of the pump house in order to prevent ingress of timber & other floating particles which could damage the Pumps.

Each bay of pump sump shall be provided with Type - 1 trash rack (removable section rack), conforming to IS: 11388. Centre to centre spacing of trash rack bars shall be 100mm (max). The trash racks shall be provided with number of interchangeable segments, to facilitate easier handling by means of a lifting beam and electrically operated hoist. Trash rack bars shall be designed for a differential water head of 2.0m. and other structural members shall be designed for a differential water head of 1.0m. Minimum thickness of trash rack bars shall be 10mm. Suitable size of horizontal members and end members shall be provided as per design requirements, for efficient operation of trash rack.

All trash racks should be capable of being lowered in the associated stop log groove to enable drawal of clean water while a particular trash rack is raised for cleaning purpose.

Suitable arrangement for storing all the stop logs and stand by trash rack shall be provided by the Bidder, to keep them in good working condition.

5.3 Lifting Beams

Separate lifting beams (automatic) shall be designed & fabricated with guide shoes, hooks, links and counter weights etc. complete for automatic operation to engage and disengage the stop logs and trash racks in the required position.

5.4 Leakage Tests of Stop logs

Leakage tests shall be carried out with the stop logs lowered onto the sill. Before observation for leakage, the stop log shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals, the leakage shall then be measured and it should not be more than 5 litres / minute / meter of length of seal under maximum head.

5.5 Material Specifications of Stop logs & Trash racks

All material used in the fabrication of stop log or trash rack shall be of high grade, free from defects and imperfections and shall be of the highest standard commercial quality suitable for the intended use. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the Bidder, if asked for by the Employer.

5.6 Materials for the various components of Stop logs

Sl. No.	Component Parts	Recommended Materials	Reference
1.	Stop log Leaf	Structural steel	IS 2062
2.	Stop log Frames, 1st stage embedded parts and structural steel members	Structural steel	IS 2062
3.	2nd stage embedment	Structural steel	SS316L or IS:1570 (part-5)
4.	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread)	Cast steel	IS: 1030
5.	Wheel axles, wheel track	Corrosion resistant steel.	IS 1570
6.	Seals	Rubber	IS 11855

Sl. No.	Component Parts	Recommended Materials	Reference
7.	Bearings	SKF or equivalent	04Cr19Ni
8.	Seal seats	Stainless steel	SS316L or IS 1570 (part-5)
9.	Lifting pin	Stainless steel	SS316L or IS 1570 (part-5)
10.	Guide	Corrosion resistant steel	IS 6603
11.	Guide shoe	Structural steel	IS 2062

5.7 Materials for various components of Trash Rack:

Sl. No.	Component Parts	Recommended Materials	Reference
1.	Trash rack and 1st stage embedded parts	Structural steel	IS 2062
2.	2nd stage embedment	Stainless steel	SS 316L or IS 1570 (Part–5)
3.	Slide Block	Structural steel with bronze padding	IS 2062 & IS 305
4.	Track base	Stainless steel	SS 316L or IS 1570 (Part–5)
5.	Track	Stainless steel	SS 316L or IS 1570 (Part–5)
6.	Guides	Corrosion resistant steel.	IS 6603

5.8 Painting Specification for Structural Steel parts for Stoplog Gates and Trash Racks

(i) All structural steel surfaces shall be cleaned by shot blasting.

(ii) All MS structural parts shall be galvanised to minimum coating of Sealed Zinc spray (250 Micron) as per BS 5493.

(iii) Over zinc coating one coat of zinc Phosphate Epoxy primer having minimum 30 micron DFT and three coats of coal tar Epoxy paint having minimum 75 micron DFT / coat shall be provided. Total DFT of epoxy paint including primer shall be minimum 250 microns.

6 FRP STRUCTURE

Design criteria for FRP cooling tower shall be as specified elsewhere in the mechanical specification. However, design has to be strictly carried out as per relevant codes and standards.

7 LOADING

For consideration of loads on structures and load combinations IS: 875 (Part -1 to 5) Code of Practice for design loads (other than Earthquake) for Buildings and Structures shall be followed. Site specific seismic data and wind data shall be followed for design of cooling towers.

7.1 LIVE LOADS

The following live loads (minimum) shall be adopted for the design of buildings and structures Associated with Cooling Towers:

i) Roof / Fan deck 500 Kg / Sq. M.
ii) RCC Floors 500 Kg / Sq. M.
iii) Stair, landings 500 Kg / Sq. M.
iv) Chequered & Grating floor 400 Kg / Sq. M.
v) Basin, sump and duct Earth pressure; water pressure as applicable and additional surcharge load of 2.0 T/Sq. M.
vi) Covers for H.W. channels / H.W. distribution basin 300 Kg / Sq. M.
vii) Walkways inside cooling towers 300 Kg / Sq. M.
viii) Underground pipes and ducts Earth pressure and surcharge load of 2.0 T / Sq. M.

8 MISCELLANEOUS WORK

I) Concrete structures, floors and foundation coming in direct contact with acid/alkalis/other Corrosive chemicals shall be provided with lining/treatment.

II) Concrete structures, floors and foundations indirectly affected by acid/acidic fumes shall be treated with appropriate acid proof treatment in line with customer specification.

III) Epoxy phenolic coating shall be applied on internal surfaces of the RCC water retaining structures in line with customer specification. All concrete surfaces shall be provided with two component

transparent polyamide cured epoxy sealer coating (having solid by volume minimum 40% ±2%) of minimum 50-micron DFT. Surface to be coated shall be absolutely dry, clean and dust free.
Sealer coat shall be followed with the application of epoxy phenolic coating (solid by volume minimum 63%) of minimum 400-micron DFT. This coat shall be applied after an interval of minimum 24 hours (from the application of primer coat) by airless spray technique.

IV) For all underground structures and water retaining structures special care shall be taken to water-proof them and water proofing shall conform to provision of relevant IS standards or as per the specifications of approved manufacturer. Water-tightness shall be ensured by provision of PVC water bars of approved type with all necessary fittings and clippings to keep it in position during concreting. Water proofing compound as admixtures must be used in concrete.

V) Internal surface of all water retaining structures shall be plastered in line with requirement mentioned in customer specification.

VI) Any surface treatment required for RCC structure not covered here shall be provided as mentioned elsewhere in the customer specification.

BHEL has developed General Technical specifications based on which all kinds of excavation, construction, erection etc of civil & steel structures are carried out at site. Bidder will be required to comply with those specifications during execution.

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

ANNEXURE-K

GEO-TECHNICAL INVESTIGATION REPORT

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore - 560012

SOIL INVESTIGATION REPORT

SUBMITTED TO: PROJECTS AND DEVELOPMENT INDIA LIMITED

REPORT NO.: NECTL/2412083951

DATE OF REPORT: 18/09/2024

ACKNOWLEDGEMENTS

We feel pleasure to submit the report of Sub soil investigation conducted at site for High Ash Coal to Ammonium Nitrate Plant. We convey hereby our sincere thanks to PDIL, BCGCL for his trust shown to us by awarding the work of soil investigation. We also grateful to site staff, for their co-operation and help rendered during and prior to the investigation work.

We are also thankful to our staff members for conducting field and laboratory test, preparing the sketches and typing the report.

CONTENTS

APPENDICES

1. INTRODUCTION:

This report deals with Geo-technical investigation at the site for High Ash Coal to Ammonium Nitrate Plant. The work of conducting the detailed Geotechnical Investigation has been awarded to us via contract No. No: GEMC-511687728870200 dated 08th August 2024, which scope of includes investigation in field, laboratory testing of bulk samples collected from the site and submission of the test report.

Geotechnical investigation carried out, with the locations which were planned by the client. Purpose of the investigation is to determine the nature and properties of soil strata in the bore holes and representing them through log sections showing the levels, nature and properties of various strata up to a sufficient depth below the level suitable for foundation, proneness of site to artesian conditions, seismic disturbance and other engineering properties of soil.

This part of report includes the detailed methodology of investigation, collection of samples, field and laboratory test result including their interpretation/ analysis, recommendations on the properties of soils required for design of foundation and suggesting suitable type of foundation with safe allowable bearing capacity for safe and strong foundation.

A summarized table with reference of boreholes notation is given below

Part No.	Reference of bore holes
1	BH-1 to BH-20

2. SCOPE OF WORK:

For the Construction High Ash Coal to Ammonium Nitrate Plant, it is required to determine the safe allowable bearing capacity together with necessary engineering characteristics of underlying soil strata. Since the safe bearing capacity of soils must be evaluated on the considerations covering shear failure and permissible settlement of sub-soil strata as per IS: 6403, IS: 1904 and IS: 8009 (part-I) hence the scope of work is as follows:

2.1. Mobilization of all tools & plants along with accessories, materials, labours etc. at site of work for drilling and testing work, including setting up boring and shifting to different bore holes point etc.

2.2. Exploratory drilling of 150mmm diameter bore holes through soil deposits and 76mm (NX) diameter boreholes through rock deposits within the proposed area of construction up to required depth.

2.3. Collection of disturbed soil samples at an interval of 0.50, 1.50 & 3.0 meter in all the bore holes.

2.4. Collection of undisturbed soil samples at every 2.0 m interval or at change of stratum from all the boreholes.

2.5. Conducting the Standard Penetration Test (SPT) at an interval of 1.50 m or noticeable change of stratum in soil deposits in all bore holes.

2.6. Transporting all the disturbed and undisturbed soils and rock core samples collected during the field investigation to our Geo-tech Engineering laboratory in Delhi.

2.7. Conducting the laboratory tests on all the soil samples, collected during field investigation for determination of their engineering characteristics.

2.8. Compilation of field and laboratory test results, working out the safe allowable bearing capacity and preparing the report including detailed recommendations and necessary precautions.

3. GEOLOGICAL INFORMATION OF THE REGION:

3.1. Geology:

The geology of Jharsuguda district in Odisha, India is diverse and includes a variety of rock types, formations, and minerals:

- **Rock types**

  The district has many types of rock, including phyllite, mica schist, shale, calcareous shale, quartzite, coarse sandstone, conglomerate, and red clay, granite, and granite gneiss

- **Formations**

  The district has several rock formations, including the Gangpur Group, the Raipur Group, the Chandarpur Group, the Gondwana Super Group, and the Kamthi Formation

- **Minerals**

  The district has many minerals, including coal, fire clay, quartz, quartzite, sand, gravel, kyanite, sillimanite, opaque beryl, tourmaline, columbite-tantalite, feldspar, and pyroxene granulites

- **Pegmatites**

  The district has pegmatites, including the Dhubenbud pegmatite and the Gantamal pegmatite, which contain rare metal mineralization and beryl crystals

3.2. Geography:

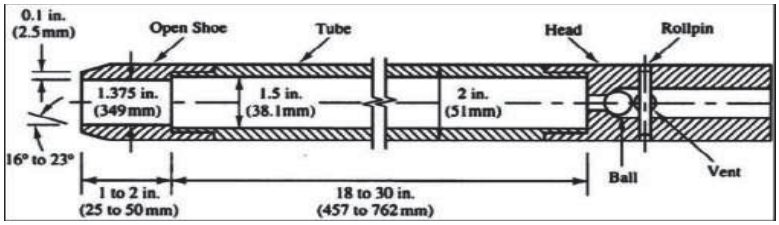
Jharsuguda district is bounded between the latitudes 21° 34’ North and 22°02’ North and longitudes 83°25’ East and 84°23’ East. Prior to 1993, Jharsuguda was a subdivision of Sambalpur District and was subsequently awarded the status of a new district. It is bounded in the north by Sundergarh district, east by Sambalpur district, south by Sambalpur and Baragarh district and west by Raigarh district of Chattisgarh State. The total geographical area is 1874.98 sq. km. It is divided into five administrative blocks namely Lakhanpur, Jharsuguda, Kirimira, Laikera, Kolabira.

4. FIELD INVESTIGATION:

The field investigation work at this site was carried out on August 24th to 06th, September 2023. The following investigation work was carried out:

4.1. Total Twenty number of **boreholes** of diameter 150 mm through soil deposits and 76mm (NX) diameter through rock deposits were made within the proposed layout of the site. The boreholes were progressed using wash boring under percussion method of drilling. Casing was used to keep the borehole stable. The records of achieved depth of bore holes have been given in Para No. 6.

4.2. **Standard Penetration Tests** were conducted at 1.50 metre as per the procedure in IS 2131-1981 in all the bore holes. For conducting the test, the bottom of the borehole was properly cleaned and split spoon sampler was properly seated in position in the borehole. The split spoon sampler resting on the bottom of borehole was allowed to sink under its own weight; then the sampler was allowed to penetrate 15 cm with the blows of the hammer 63.50 kg weight falling free through 75cm, thereafter the split spoon sampler was further driven by another 15 cm. For the 3rd and final drive, the sampler was further allowed to penetrate 15 cm. The number of blows required to affect each 15 cm of penetration was recorded. The first 15 cm of drive is considered to be seating drive.



Structure of SPT Sampler

The SPT Samplers used were without liner type and with no space for liner.

The total blows of penetration for the second and third 15 cm of penetration is termed the penetration resistance N. The N' values are indicative of the compactness/ relative density of cohesion less soils and consistency of cohesive soils.

In case the blows count of SPT in soil (including the number of blows of seating) exceeds 100, the corresponding penetration was recorded and this particular test at that depth stopped. If the total penetration is more than the seating penetration of 15 cm, then breakup of blows count for 15 cm seating penetration and for remaining portion of penetration is also given.

SPT 'N' values are correlated with relative of non-cohesive stratum as per BS: 5930 (1999) - for sandy strata and with consistency of cohesive stratum.

CORRELATION FOR CLAY/PLASTIC SILT		CORRELATION FOR SAND/NON-PLASTIC SILT	
Consistency of clays	Penetration Value	Relative Density of sand	Penetration Value
Very Soft	0 to 2 Blows	Very loose	0 to 4 Blows
Soft	3 to 4 Blows	Loose	5 to 10 Blows
Medium Stiff	5 to 8 Blows	Medium	11 to 30 Blows
Stiff	9 to 16 Blows	Dense	31 to 50 Blows
Very Stiff	17 to 32 Blows	Very Dense	Above 50
Hard	Above 32		

In this method, the sampler acts as a probe and the driving energy is supplied by the fall of the drop weight. The values of 'N' depend on the compactness or relative density of the materiel. In hard formations, the testing is discontinued if 'N' value is found to be more than 100. It is termed as refusal.

'N' value depends upon degree of saturation and over burden pressure of the formation. Silty fine sand and fine sand below the water table develop pore water pressure depending on the in-situ void ratio which in turn affects the effective stress. This change in effective stress influences the 'N' value considerably.

Terzaghi and peck have recommended a correction for 'N' values in case of saturated silty and fine sand when the 'N' observed in the field is higher than

Modified value 'N'= 15+ (N-15)/2.

Soil sample obtained from standard spoon sampler for all above standard penetration tests were collected in the polythene bags of suitable size. These samples were property seal, labelled, record and carefully transported to the laboratory for testing. The results have been reported in Appendix C under the title “RESULTS OF LAB TESTS”

4.3. Disturbed soil samples were collected at 0.50, 1.25 & 3.0m interval and at significant change of stratum. Soil from cutting edge of SPT samplers and retained in split spoon sampler, used for Standard Penetration Tests was taken as disturbed samples. These samples were placed without delay in adequately sealed polythene bags. Where the collection of disturbed soil samples could not be collected from SPT samples, Shelby tubes were driven and retained soil samples were obtained. The laboratory tests were conducted on the collected soil samples and reported in Appendix C under the title “RESULTS OF LAB TESTS”.

4.4. Undisturbed soil samples were collected in accordance with IS: 2132-1986. Undisturbed soil samples (UDS) was obtained at every 2.0 metre interval. Undisturbed samples were collected using 100 mm dia and 450 mm long MS tubes provided with sampler head with ball check arrangement. Collection of Undisturbed samples in very hard cohesive soils/ dense granular soils/gravels/ cobbles/ pebbles/ boulders, refusal strata is practically not possible and such collected samples will not truly represent the undisturbed conditions. Immediately after taking undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the samples shall each be trimmed off any wet disturbed soil. The ends will then be coated alternately with four layers of just molten wax. More molten wax will then be added to give a total thickness of not less than 25mm.Thelaboratory test results have been reported in Appendix C.

5. LABORATORY TESTS:

The following laboratory tests were conducted in our in-house NABL Accredited Laboratory under the supervision of trained personnel so as to determine the engineering characteristics of sub-soils:

5.1. **Moisture contents** were determined by oven drying method as per IS 2720 (part II)-2010. The results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.2. **Bulk density** of soil strata were obtained using Shelby tubes in accordance with IS 2720 (part XXIX)-1975. The results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.3. **Mechanical sieve analysis** test were performed in accordance with IS 2720 (Part IV) - 2010, for the purpose of identification by grain size analysis, on coarse part of the soil samples and the results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.4. **Particle size analysis** test by **hydrometer method** were performed in accordance with IS 2720 (Part IV) - 1965 on the part of soil samples obtained after the sieve analysis. The results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.5. **Atterbergs' limits tests** were performed in accordance with IS 2720 (part V)-2010 and results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.6. **Specific gravity tests** were performed in accordance with IS 2720 (part III-sec. 1) - 2011 and the results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.7. **Consolidation tests** were performed on cohesive soil samples in accordance with IS: 2720 (part XV)-2011. The results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.8. **Direct shear tests** were performed as per IS 2720 (part XIII)-2016, on the undisturbed soil samples obtained during the field investigation. The results and the density of samples have been reported in "RESULTS OF LAB TESTS" of Appendix C.

5.9. Tri-axial Compression Test under Unconsolidated Un-drained (UU) conditions as per IS: 2720 (Part-XI)-2011 were performed on the undisturbed soil samples obtained during the field investigation. The results have been reported in "RESULTS OF LAB TESTS" of Appendix C.

6. GROUND WATER TABLE:

The water table at this site was encountered during the boring operation up to the depth of exploration.

Borehole No.	Depth of Borehole (m)	Water Table (m)	Borehole No.	Depth of Borehole (m)	Water Table (m)
BH-1	30.00	2.10	BH-11	30.00	2.50
BH-2	20.00	2.40	BH-12	20.00	1.70
BH-3	30.00	1.90	BH-13	30.00	2.50
BH-4	20.00	2.30	BH-14	20.00	2.60
BH-5	30.00	1.80	BH-15	30.00	2.80
BH-6	20.00	2.10	BH-16	20.00	2.20
BH-7	30.00	1.90	BH-17	30.00	2.25
BH-8	20.00	2.25	BH-18	20.00	2.00
BH-9	30.00	2.30	BH-19	30.00	2.45
BH-10	20.00	2.10	BH-20	20.00	2.10

7. DETAILS OF SOIL STRATA:

The classification of soil stratum has been done with the help of soil characteristics obtained in laboratory tests as per IS 1498-1978. The detailed nature of the soil strata has been reported in: "RESULTS OF LAB TESTS" of Appendix C.

Borehole wise description of the formations has been given in the individual borelogs in Appendix B.

8. CALCULATIONS AND RESULTS:

For the High Ash Coal to Ammonium Nitrate Plant Isolated, Raft, Strip, Combined footing has been considered for computation of load bearing capacity of the underlying soil strata. The safe allowable bearing capacity for the open foundations have been calculated on the shear failure criteria suggested as per IS 6403, IS: 1904 and settlement criteria as per IS: 8009 (part-I).

8.1 RAFTS/STRIP/ISOLATED/COMBINED FOOTINGS:

8.1.1. Shear Failure Criteria:

Type of shear failure	=	Mixed (Interpolation in between General and Local shear failure)
Factor of safety (F.S.)	=	2.50
Depth of critical water table	=	0.00 metre (at Natural Ground Level)
Net allowable bearing capacity:	=	q_{na}(kN/m^2)

$$q_{na} = (1 / F.S.) [0.667c N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma W']$$

Were,

B = Width of footing (metre)

D = Depth of footing (metre)

Φ = Angle of shearing resistance (degree)

c = Cohesion intercept (kN/m^2)

γ = Bulk density of soil above the base of footing (kN/m^3)

q = γ = Effective overburden (kN/m^2)

N_c, N_q, N_γ = Bearing capacity coefficient based on initial void ratio e_0

d_c, d_q, d_γ = depth factors

W' = Water tale correction factor

Shape Factors:

S_c = 1.30

S_q = 1.20

S_γ = 0.80

Calculations based on Shear failure criteria have been provided in **Appendix-D**

8.2 SETTLEMENT CRITERA:

Soil strata at this site mainly consists of silty sands with gravels and rock, hence the settlement of the soil layers below the base of footing has been calculated on the basis of SPT values obtained during the field Investigation

Settlement for applied pressure (S_f) = (q_s x S_u x d_f)/ (W'x100)

Where:

q_s=Permissible pressure (kN/m^2)

S_u=Settlement for unit pressure of 1.00 kg/cm^2

W'=Water table correction factor

N =Corrected average SPT value

B =Base width

D =Depth of footing

d_f = depth factor

The calculated values of settlements have been kept within the permissible limits of 50 mm for isolated footings and 75mm for raft footings.

Calculations based on Settlement criteria have been provided in Appendix -D

9 RECOMMENDATIONS:

Keeping in mind, the field test results, laboratory test results and IS codes of practice the following recommendations are hereby made.

9.1 Isolated/Strip/Raft/Combined footing the suitable depth and corresponding recommended bearing capacity shall be read from the table below:

For all building structures we recommended the following bearing capacities mentioned below in tables: -

Average Soil Profile Adopted for SBC Calculations													
Borehole (BH-1 -20)								Water correction factor = 0.5					
Depth of Foundation, m	Avergae N Value Adopted	Bulk Density of Soil, gm/cc	Cohesion 'c' t/m2	Angle of Shearing Resistance 'f' degree	Bearing Capacity Factors			Depth Factors			Shape Factors		
D	N	g	c	f	Nc	Nq	Ng	dc	dq	dg	sc	sq	sg
1.0	21	1.735	0.0	33.00	38.63	26.09	35.18	1.1	1.1	1.1	1.3	1.2	0.8
2.0	21	1.735	0.0	33.00	38.63	26.09	35.18	1.2	1.1	1.1	1.3	1.2	0.8
3.0	21	1.735	0.0	33.00	38.63	26.09	35.18	1.3	1.1	1.1	1.3	1.2	0.8

Notes: -

1. The shear parameters for calculating bearing capacities of soil have been taken as per IS 6403:1981 (Fig. 1).
2. Rigidity factor is taken as 1 for 25mm & 40mm settlement and 0.80 for 75mm settlement.
3. SBC of rock has been calculated by RMR system as Per IS 12070-1987.

Depth of Foundation below EGL	Width of Foundation	Recommended Allowable bearing pressure (t/sqm)	
		Borehole Group (BH-1 - 20)	
(m)	(m)	Founding layer	NABC (t/sqm)
1.0	1.0 to 6.0m	Soil	10.0
2.0		Soil	15.0
3.0		Soil	20.0

For foundations which are to be placed on rocky strata, allowable bearing pressure is worked out based on RMR as per IS 12070: 1987 and other field/lab test results. and the same is recommended as 50 t/sqm considering 0.5m embedment inside the rock.

9.2 All depth referred in recommendation of SBC, have been measured from below ground level.

9.3 Since all the locations incorporated in this report do not consist of harmful chemicals, OPC/Flyash based cement may be used for all civil constructions in accordance with IS 456: 2000 (RA 2021).

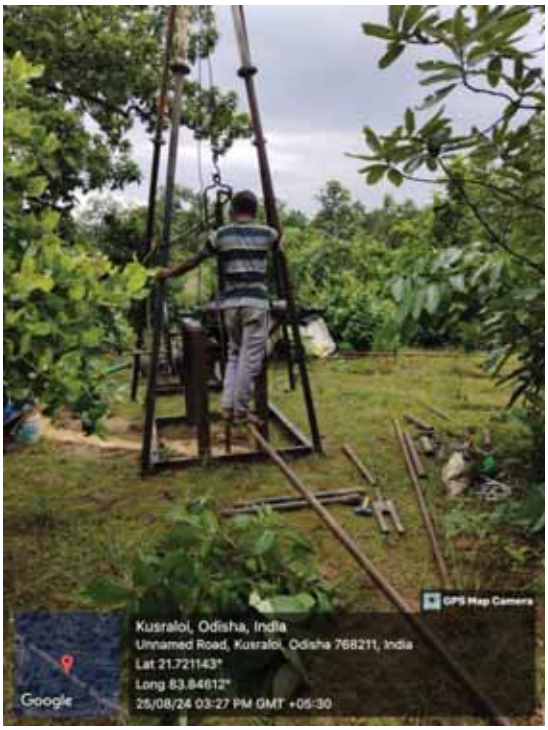
9.4 The soil available at site is suitable for filling/backfilling purposes.

10 References:

Latest Indian/International published standards have been used for testing and analysis purposes as listed below:

1. IS 6403 – 1981 (RA 2021): Code of Practice for Determination of Bearing Capacity of shallow Foundations.
2. IS 8009 (Part I) – 1978 (RA 2023): Code of Practice for Calculation of Settlements of Foundations.
3. IS: 1904-2021 “General requirements for design and construction of foundations in soils”.
4. Foundation Design Manual, N. V. Nayak, 4th Edition, 1996.
5. Foundation Analysis and Design, Joseph E. Bowels.
6. IS-1498, IS-2131, IS-2132, IS-1892 and Various Parts of IS-2720
7. IS 12070: 1987 (RA 2020): Code of Practice for Design and Construction of Shallow Foundations on Rocks.

APPENDIX – A
SITE PHOTOGRAPHS




Latitude: 21.718414
Longitude: 83.84295
Elevation: 228.59±61 m
Accuracy: 9.6 m
Time: 25-08-2024 10:41
Note: udisha bh 12


Latitude: 21.720961
Longitude: 83.84499
Elevation: 236.58±100 m
Accuracy: 12.2 m
Time: 25-08-2024 12:21
Note: udisha bh 13


Latitude: 21.717286
Longitude: 83.839665
Altitude: 206.0±25 m
Accuracy: 7.4 m
Time: 25-08-2024 10:19
Note: udisha bh 14

APPENDIX – B
LOG of BORE HOLES

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
24/08/2024 - 26/08/2024	B-1	30.00	2.10	ROTARY DRILLING

R.L (m)	DRILL DEPTH (m) FROM	TO	SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA		SPT 'N' Values SPT No.s	Observed	Corrected	Core recovery	RQD
225.7											
225.2	0.00	0.50	DS-1	0.50	Gravely sand	SM	SPT-1	16	23	-	-
224.2	0.50	1.50	DS-2	1.50							
222.7	1.50	3.00	DS-3	3.00			SPT-2	22	20	-	-
221.2	3.00	4.50	DS-4	4.50			SPT-3	25	20	-	-
219.7	4.50	6.00	DS-5	6.00	Highly weathered rock		SPT-4	>75		8.8%	
218.2	6.00	7.50	DS-6	7.50			SPT-5	>75		9.6%	-
216.7	7.50	9.00	DS-7	9.00			SPT-6	>75		9.4%	-
215.2	9.00	10.50	DS-8	10.50			SPT-7	>75		11.3%	-
213.7	10.50	12.00									
212.2	12.00	13.50	DS-9	12.50			SPT-8	>75		10.4%	-
210.7	13.50	15.00	DS-10	14.50			SPT-9	>75		10.2%	-
209.2	15.00	16.50	DS-11	16.50			SPT-10	>75		11.5%	-
207.7	16.50	18.00									
206.2	18.00	19.50	DS-12	18.50			SPT-11	>75		12.4%	-
204.7	19.50	21.00	DS-13	20.50			SPT-12	>75		15.7%	-
203.2	21.00	22.50									
201.7	22.50	24.00	DS-14	23.50			SPT-13	>75		13.4%	-
200.2	24.00	25.50									
198.7	25.50	27.00	DS-15	26.50			SPT-14	>75		13.0%	-
197.2	27.00	28.50									
195.7	28.50	30.00	DS-16	29.50			SPT-15	>75		14.2%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	24/08/2024-25/08/2024	B-2	20.00	2.40	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
220.1	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
219.6	0.00	0.50	DS-1	0.50	Gravely sand		SM	SPT-1	14	20	-	-
218.6	0.50	1.50	DS-2	1.50								
217.1	1.50	3.00	DS-3	3.00				SPT-2	20	19	-	-
215.6	3.00	4.50	DS-4	4.50				SPT-3	27	21	-	-
214.1	4.50	6.00	DS-5	6.00	Highly weathered rock			SPT-4	>75		7.4%	-
212.6	6.00	7.50	DS-6	7.50				SPT-5	>75		8.2%	-
211.1	7.50	9.00	DS-7	9.00				SPT-6	>75		8.0%	-
209.6	9.00	10.50	DS-8	10.50				SPT-7	>75		9.4%	-
208.1	10.50	12.00										
206.6	12.00	13.50	DS-9	12.50				SPT-8	>75		10.3%	-
205.1	13.50	15.00	DS-10	14.50				SPT-9	>75		10.5%	-
203.6	15.00	16.50	DS-11	16.50				SPT-10	>75		12.5%	-
202.1	16.50	18.00										
200.6	18.00	19.50	DS-12	18.50				SPT-11	>75		13.1%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	25/08/2024-27/08/2024	B-3	30.00	1.90	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
213.9	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
213.4	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	13	19		-
212.4	0.50	1.50	DS-2	1.50			1.50					
210.9	1.50	3.00	DS-3	3.00			3.00	SPT-2	28	24		-
209.4	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		8.8%	-
207.9	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		10.7%	-
206.4	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		11.4%	-
204.9	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		10.5%	-
203.4	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		9.8%	-
201.9	10.50	12.00										
200.4	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		12.2%	-
198.9	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.4%	-
197.4	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.7%	-
195.9	16.50	18.00										
194.4	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		13.2%	-
192.9	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		13.2%	-
191.4	21.00	22.50										
189.9	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		14.2%	-
188.4	24.00	25.50										
186.9	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		15.3%	-
185.4	27.00	28.50										
183.9	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		15.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	25/08/2024-26/08/2024	B-4	20.00	2.30	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
213.5	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
213.0	0.00	0.50	DS-1	0.50	Gravely sand		SM	SPT-1	13	19	-	-
212.0	0.50	1.50	DS-2	1.50								
210.5	1.50	3.00	DS-3	3.00				SPT-2	26	23	-	-
209.0	3.00	4.50	DS-4	4.50				SPT-3	33	25	-	-
207.5	4.50	6.00	DS-5	6.00	Highly weathered rock			SPT-4	>75		8.5%	-
206.0	6.00	7.50	DS-6	7.50				SPT-5	>75		9.2%	-
204.5	7.50	9.00	DS-7	9.00				SPT-6	>75		8.8%	-
203.0	9.00	10.50	DS-8	10.50				SPT-7	>75		10.4%	-
201.5	10.50	12.00										
200.0	12.00	13.50	DS-9	12.50				SPT-8	>75		11.4%	-
198.5	13.50	15.00	DS-10	14.50				SPT-9	>75		11.0%	-
197.0	15.00	16.50	DS-11	16.50				SPT-10	>75		12.3%	-
195.5	16.50	18.00										
194.0	18.00	19.50	DS-12	18.50				SPT-11	>75		14.4%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	26/08/2024-28/08/2024	B-5	30.00	1.80	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
212.6	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
212.1	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	14	20	-	-
211.1	0.50	1.50	DS-2	1.50			1.50					
209.6	1.50	3.00	DS-3	3.00			3.00	SPT-2	30	25	-	-
208.1	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		9.4%	-
206.6	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		9.8%	-
205.1	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		11.2%	-
203.6	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		10.5%	-
202.1	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		12.3%	-
200.6	10.50	12.00										
199.1	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		13.4%	-
197.6	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		13.8%	-
196.1	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		14.5%	-
194.6	16.50	18.00										
193.1	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		13.9%	-
191.6	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		15.2%	-
190.1	21.00	22.50										
188.6	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		15.0%	-
187.1	24.00	25.50										
185.6	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		15.5%	-
184.1	27.00	28.50										
182.6	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		14.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	26/08/2024-27/08/2024	B-6	20.00	2.10	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
209.1	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
208.6	0.00	0.50	DS-1	0.50	Gravely sand		SM	SPT-1	16	23	-	-
207.6	0.50	1.50	DS-2	1.50								
206.1	1.50	3.00	DS-3	3.00				SPT-2	21	20	-	-
204.6	3.00	4.50	DS-4	4.50				SPT-3	29	23	-	-
203.1	4.50	6.00	DS-5	6.00	Highly weathered rock			SPT-4	>75		7.4%	-
201.6	6.00	7.50	DS-6	7.50				SPT-5	>75		8.2%	-
200.1	7.50	9.00	DS-7	9.00				SPT-6	>75		9.2%	-
198.6	9.00	10.50	DS-8	10.50				SPT-7	>75		8.9%	-
197.1	10.50	12.00										
195.6	12.00	13.50	DS-9	12.50				SPT-8	>75		10.4%	-
194.1	13.50	15.00	DS-10	14.50				SPT-9	>75		11.2%	-
192.6	15.00	16.50	DS-11	16.50				SPT-10	>75		12.3%	-
191.1	16.50	18.00										
189.6	18.00	19.50	DS-12	18.50				SPT-11	>75		13.9%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	27/08/2024-29/08/2024	B-7	30.00	1.90	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
211.3	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
210.8	0.00	0.50	DS-1	0.50	Gravely sand		0.50	SPT-1	18	26	-	-
209.8	0.50	1.50	DS-2	1.50		SM	1.50					
208.3	1.50	3.00	DS-3	3.00			3.00	SPT-2	>75		8.5%	-
206.8	3.00	4.50	DS-4	4.50			4.50	SPT-3	>75		9.3%	-
205.3	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		10.4%	-
203.8	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		11.5%	-
202.3	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		12.4%	-
200.8	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		11.5%	-
199.3	10.50	12.00										
197.8	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		9.8%	-
196.3	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.2%	-
194.8	15.00	16.50	DS-11	16.50	Highly weathered rock		16.50	SPT-10	>75		13.5%	-
193.3	16.50	18.00										
191.8	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		14.2%	-
190.3	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		15.9%	-
188.8	21.00	22.50										
187.3	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		15.3%	-
185.8	24.00	25.50										
184.3	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		14.4%	-
182.8	27.00	28.50										
181.3	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		14.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	27/08/2024-28/08/2024	B-8	20.00	2.25	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA		SPT 'N' Values				
219.1	FROM	TO					SPT No.s	Observed	Corrected	Core recovery	RQD
218.6	0.00	0.50	DS-1	0.50	Gravely sand	0.50	SPT-1	13	19	-	-
217.6	0.50	1.50	DS-2	1.50		1.50					
216.1	1.50	3.00	DS-3	3.00		3.00	SPT-2	25	22	-	-
214.6	3.00	4.50	DS-4	4.50		4.50	SPT-3	34	25	-	-
213.1	4.50	6.00	DS-5	6.00		6.00	SPT-4	41	27	-	-
211.6	6.00	7.50	DS-6	7.50	Highly weathered rock	7.50	SPT-5	>75		8.1%	-
210.1	7.50	9.00	DS-7	9.00		9.00	SPT-6	>75		7.5%	-
208.6	9.00	10.50	DS-8	10.50		10.50	SPT-7	>75		7.9%	-
207.1	10.50	12.00									
205.6	12.00	13.50	DS-9	12.50		12.50	SPT-8	>75		9.6%	-
204.1	13.50	15.00	DS-10	14.50		14.50	SPT-9	>75		10.4%	-
202.6	15.00	16.50	DS-11	16.50		16.50	SPT-10	>75		11.2%	-
201.1	16.50	18.00									
199.6	18.00	19.50	DS-12	18.50		18.50	SPT-11	>75		13.5%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	28/08/2024-30/08/2024	B-9	30.00	2.30	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
214.5	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
214.0	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	20	29	-	-
213.0	0.50	1.50	DS-2	1.50			1.50					
211.5	1.50	3.00	DS-3	3.00			3.00	SPT-2	38	30	-	-
210.0	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		7.6%	-
208.5	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		8.4%	-
207.0	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		9.3%	-
205.5	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		8.9%	-
204.0	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		10.5%	-
202.5	10.50	12.00										
201.0	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		10.4%	-
199.5	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.5%	-
198.0	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.3%	-
196.5	16.50	18.00										
195.0	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		13.6%	-
193.5	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		14.5%	-
192.0	21.00	22.50										
190.5	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		13.9%	-
189.0	24.00	25.50										
187.5	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		14.8%	-
186.0	27.00	28.50										
184.5	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		15.0%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	28/08/2024-29/08/2024	B-10	20.00	2.10	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
225.4	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
224.9	0.00	0.50	DS-1	0.50	Gravely sand		0.50	SPT-1	15	22	-	-
223.9	0.50	1.50	DS-2	1.50		SM	1.50					
222.4	1.50	3.00	DS-3	3.00			3.00	SPT-2	23	21	-	-
220.9	3.00	4.50	DS-4	4.50			4.50	SPT-3	32	24	-	-
219.4	4.50	6.00	DS-5	6.00	Highly weathered rock		6.00	SPT-4	>75		8.8%	-
217.9	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		9.5%	-
216.4	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		10.3%	-
214.9	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		10.8%	-
213.4	10.50	12.00										
211.9	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		11.5%	-
210.4	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.6%	-
208.9	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.3%	-
207.4	16.50	18.00										
205.9	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		14.2%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	29/08/2024-31/08/2024	B-11	30.00	2.50	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
221.4	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
220.9	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	18	26	-	-
219.9	0.50	1.50	DS-2	1.50			1.50					
218.4	1.50	3.00	DS-3	3.00			3.00	SPT-2	35	28	-	-
216.9	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		7.1%	-
215.4	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		8.4%	-
213.9	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		8.8%	-
212.4	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		9.5%	-
210.9	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		10.1%	-
209.4	10.50	12.00										
207.9	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		10.5%	-
206.4	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.5%	-
204.9	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		13.4%	-
203.4	16.50	18.00										
201.9	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		14.4%	-
200.4	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		14.7%	-
198.9	21.00	22.50										
197.4	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		15.2%.	-
195.9	24.00	25.50										
194.4	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		15.7%	-
192.9	27.00	28.50										
191.4	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		14.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	29/08/2024-30/08/2024	B-12	20.00	1.70	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
213.3	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
212.8	0.00	0.50	DS-1	0.50	Gravely sand		0.50	SPT-1	16	23	-	-
211.8	0.50	1.50	DS-2	1.50		SM	1.50					
210.3	1.50	3.00	DS-3	3.00			3.00	SPT-2	25	22	-	-
208.8	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		8.4%	-
207.3	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		10.2%	-
205.8	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		9.4%	-
204.3	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		8.8%	-
202.8	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		9.6%	-
201.3	10.50	12.00										
199.8	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		10.8%	-
198.3	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.5%	-
196.8	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.4%	-
195.3	16.50	18.00										
193.8	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		12.9%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	30/08/2024-01/09/2024	B-13	30.00	2.50	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
216.5	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
216.0	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	16	23	-	-
215.0	0.50	1.50	DS-2	1.50			1.50					
213.5	1.50	3.00	DS-3	3.00			3.00	SPT-2	36	29	-	-
212.0	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		9.1%	-
210.5	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		8.5%	-
209.0	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		10.2%	-
207.5	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		9.4%	-
206.0	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		11.4%	-
204.5	10.50	12.00										
203.0	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		12.3%	-
201.5	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		14.5%	-
200.0	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.8%	-
198.5	16.50	18.00										
197.0	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		13.3%	-
195.5	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		14.5%	-
194.0	21.00	22.50										
192.5	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		15.2%	-
191.0	24.00	25.50										
189.5	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		13.8%	-
188.0	27.00	28.50										
186.5	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		15.7%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	31/08/2024-01/08/2024	B-14	20.00	2.60	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
223.4	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
222.9	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	14	20	-	-
221.9	0.50	1.50	DS-2	1.50			1.50					
220.4	1.50	3.00	DS-3	3.00			3.00	SPT-2	>75		8.2%	-
218.9	3.00	4.50	DS-4	4.50			4.50	SPT-3	>75		9.8%	-
217.4	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		10.5%	-
215.9	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		11.5%	-
214.4	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		12.3%	-
212.9	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		9.6%	-
211.4	10.50	12.00			Highly weathered rock							
209.9	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		10.8%	-
208.4	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.5%	-
206.9	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.0%	-
205.4	16.50	18.00										
203.9	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		14.3%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	31/08/2024-02/09/2024	B-15	30.00	2.80	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
217.6	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
217.1	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	18	26	-	-
216.1	0.50	1.50	DS-2	1.50			1.50					
214.6	1.50	3.00	DS-3	3.00			3.00	SPT-2	32	26	-	-
213.1	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		8.3%	-
211.6	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		9.3%	-
210.1	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		10.4%	-
208.6	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		8.3%	-
207.1	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		9.8%	-
205.6	10.50	12.00										
204.1	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		10.5%	-
202.6	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.3%	-
201.1	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		12.4%	-
199.6	16.50	18.00										
198.1	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		11.6%	-
196.6	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		12.5%	-
195.1	21.00	22.50										
193.6	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		13.4%	-
192.1	24.00	25.50										
190.6	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		14.2%	-
189.1	27.00	28.50										
187.6	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		14.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	01/09/2024-02/09/2024	B-16	20.00	2.20	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
217.6	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
217.1	0.00	0.50	DS-1	0.50	Gravely sand		SM	0.50	SPT-1	16	23	-	-
216.1	0.50	1.50	DS-2	1.50				1.50					
214.6	1.50	3.00	DS-3	3.00				3.00	SPT-2	30	25	-	-
213.1	3.00	4.50	DS-4	4.50	Highly weathered rock			4.50	SPT-3	>75		9.2%	-
211.6	4.50	6.00	DS-5	6.00				6.00	SPT-4	>75		8.3%	-
210.1	6.00	7.50	DS-6	7.50				7.50	SPT-5	>75		7.4%	-
208.6	7.50	9.00	DS-7	9.00				9.00	SPT-6	>75		9.1%	-
207.1	9.00	10.50	DS-8	10.50				10.50	SPT-7	>75		10.6%	-
205.6	10.50	12.00											
204.1	12.00	13.50	DS-9	12.50				12.50	SPT-8	>75		10.8%	-
202.6	13.50	15.00	DS-10	14.50				14.50	SPT-9	>75		12.2%	-
201.1	15.00	16.50	DS-11	16.50				16.50	SPT-10	>75		13.4%	-
199.6	16.50	18.00											
198.1	18.00	19.50	DS-12	18.50				18.50	SPT-11	>75		15.4%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	01/09/2024-03/09/2024	B-17	30.00	2.25	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
219.2	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
218.7	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	19	28	-	-
217.7	0.50	1.50	DS-2	1.50			1.50					
216.2	1.50	3.00	DS-3	3.00			3.00	SPT-2	39	30	-	-
214.7	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		7.2%	-
213.2	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		6.8%	-
211.7	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		8.4%	-
210.2	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		9.6%	-
208.7	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		10.2%	-
207.2	10.50	12.00										
205.7	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		15.6%	-
204.2	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		13.2%	-
202.7	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		14.8%	-
201.2	16.50	18.00										
199.7	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		13.2%	-
198.2	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		12.7%	-
196.7	21.00	22.50										
195.2	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		11.8%	-
193.7	24.00	25.50										
192.2	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		14.3%	-
190.7	27.00	28.50										
189.2	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		13.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	02/09/2024-03/09/2024	B-18	20.00	2.00	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
215.7	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
215.2	0.00	0.50	DS-1	0.50	Gravely sand		SM	0.50	SPT-1	14	20	-	-
214.2	0.50	1.50	DS-2	1.50				1.50					
212.7	1.50	3.00	DS-3	3.00				3.00	SPT-2	28	24	-	-
211.2	3.00	4.50	DS-4	4.50	Highly weathered rock			4.50	SPT-3	>75		7.5%	-
209.7	4.50	6.00	DS-5	6.00				6.00	SPT-4	>75		7.9%	-
208.2	6.00	7.50	DS-6	7.50				7.50	SPT-5	>75		10.2%	-
206.7	7.50	9.00	DS-7	9.00				9.00	SPT-6	>75		11.4%	-
205.2	9.00	10.50	DS-8	10.50				10.50	SPT-7	>75		12.3%	-
203.7	10.50	12.00											
202.2	12.00	13.50	DS-9	12.50				12.50	SPT-8	>75		11.8%	-
200.7	13.50	15.00	DS-10	14.50				14.50	SPT-9	>75		12.6%	-
199.2	15.00	16.50	DS-11	16.50				16.50	SPT-10	>75		14.3%	-
197.7	16.50	18.00											
196.2	18.00	19.50	DS-12	18.50				18.50	SPT-11	>75		13.8%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	04/09/2024-06/09/2024	B-19	30.00	2.45	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
211.0	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
210.5	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	12	17	-	-
209.5	0.50	1.50	DS-2	1.50			1.50					
208.0	1.50	3.00	DS-3	3.00			3.00	SPT-2	23	21	-	-
206.5	3.00	4.50	DS-4	4.50			4.50	SPT-3	38	27	-	-
205.0	4.50	6.00	DS-5	6.00	Highly weathered rock		6.00	SPT-4	>75		9.6%	-
203.5	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		10.3%	-
202.0	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		12.4%	-
200.5	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		13.6%	-
199.0	10.50	12.00										
197.5	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		12.7%	-
196.0	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		11.5%	-
194.5	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		13.7%	-
193.0	16.50	18.00										
191.5	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		15.4%	-
190.0	19.50	21.00	DS-13	20.50			20.50	SPT-12	>75		15.8%	-
188.5	21.00	22.50										
187.0	22.50	24.00	DS-14	23.50			23.50	SPT-13	>75		16.4%	-
185.5	24.00	25.50										
184.0	25.50	27.00	DS-15	26.50			26.50	SPT-14	>75		14.8%	-
182.5	27.00	28.50										
181.0	28.50	30.00	DS-16	29.50			29.50	SPT-15	>75		15.0%	-

Note: (-) * refer to nil in Core recovery & RQD column's

Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

R.L	Date of Drilling	BH No.	TERMINAL DEPTH (m)	WATER TABLE (m)	DRILL TYPE
	04/09/2024-05/09/2024	B-20	20.00	2.10	ROTARY DRILLING

(m)	DRILL DEPTH (m)		SAMPLE NUMBER	DEPTH OF SAMPLE IN M	DESCRIPTION OF STRATA			SPT 'N' Values				
212.7	FROM	TO						SPT No.s	Observed	Corrected	Core recovery	RQD
212.2	0.00	0.50	DS-1	0.50	Gravely sand	SM	0.50	SPT-1	16	23	-	-
211.2	0.50	1.50	DS-2	1.50			1.50					
209.7	1.50	3.00	DS-3	3.00			3.00	SPT-2	30	25	-	-
208.2	3.00	4.50	DS-4	4.50	Highly weathered rock		4.50	SPT-3	>75		7.4%	-
206.7	4.50	6.00	DS-5	6.00			6.00	SPT-4	>75		6.5%	-
205.2	6.00	7.50	DS-6	7.50			7.50	SPT-5	>75		8.8%	-
203.7	7.50	9.00	DS-7	9.00			9.00	SPT-6	>75		9.2%	-
202.2	9.00	10.50	DS-8	10.50			10.50	SPT-7	>75		10.3%	-
200.7	10.50	12.00										
199.2	12.00	13.50	DS-9	12.50			12.50	SPT-8	>75		9.7%	-
197.7	13.50	15.00	DS-10	14.50			14.50	SPT-9	>75		10.5%	-
196.2	15.00	16.50	DS-11	16.50			16.50	SPT-10	>75		11.3%	-
194.7	16.50	18.00										
193.2	18.00	19.50	DS-12	18.50			18.50	SPT-11	>75		12.5%	-

Note: (-) * refer to nil in Core recovery & RQD column's

APPENDIX – C
RESULTS OF LAB TESTS

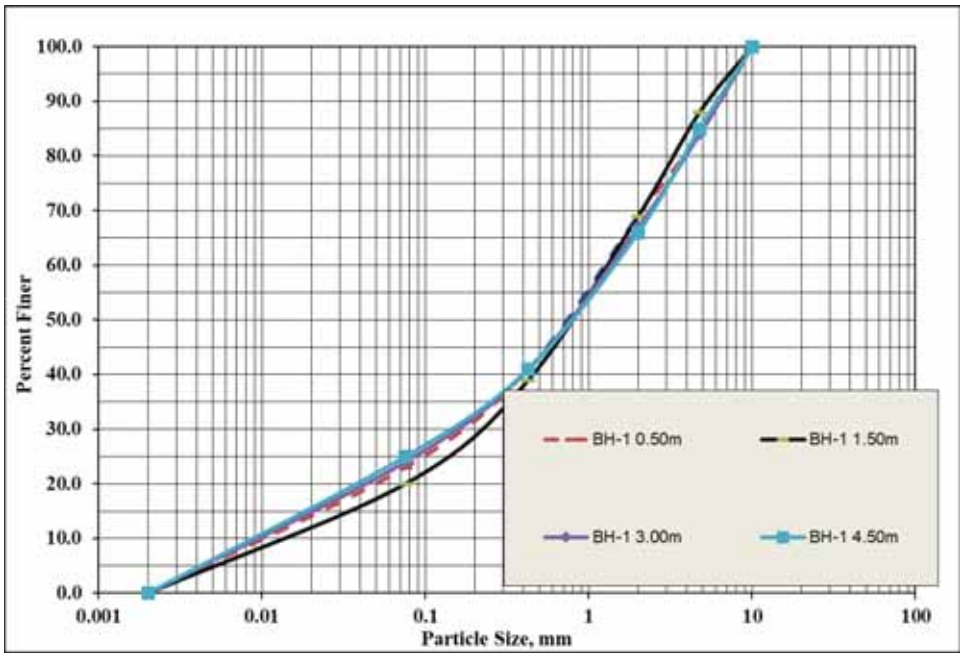
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.10M

Bh No.:		1																Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	23.0	18.0	28.0	15.0	16.0	SM	2.64	1.741	1.608	0.64	8.25	NP	NP	NP	DIR	0.00	28.9	1.43	0.25	0.10	13.31	0.42
1.50	DS-2	0.0	20.0	19.0	30.0	19.0	12.0	SM	2.64	1.765	1.601	0.65	10.25	NP	NP	NP	DIR	0.00	29.1	1.38	0.30	1.11	12.31	0.57
3.00	DS-3	0.0	24.0	17.0	26.0	17.0	16.0	SM	2.63	1.794	1.621	0.62	10.65	NP	NP	NP	DIR	0.00	29.0	1.55	0.25	0.10	14.67	0.37
4.50	DS-4	0.0	25.0	16.0	25.0	19.0	15.0	SM	2.64	1.799	1.615	0.63	11.36	NP	NP	NP	DIR	0.00	29.9	1.59	0.24	0.10	15.14	0.35

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



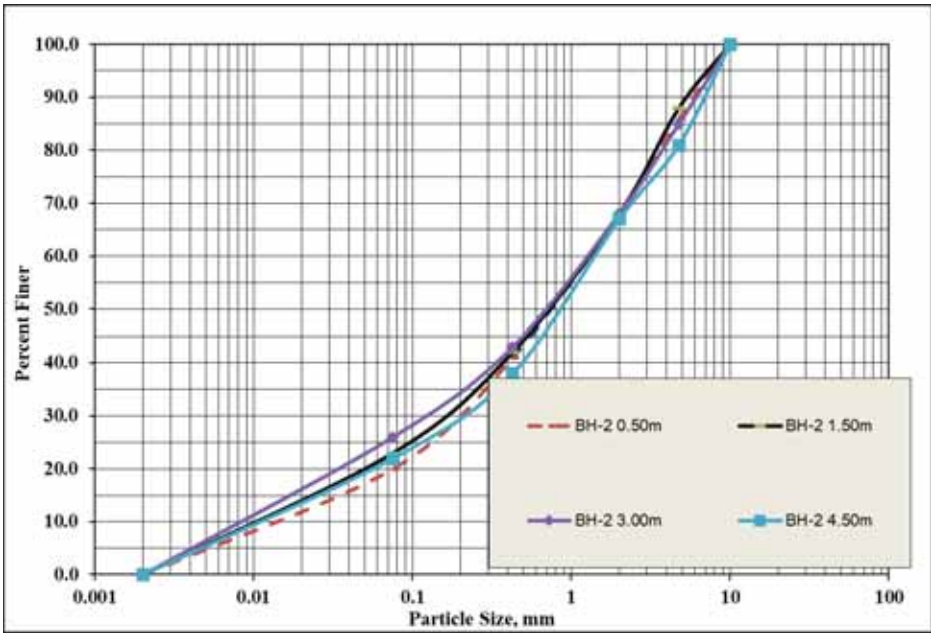
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.40M

Bh No.:						2												Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI									
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	20.0	21.0	27.0	18.0	14.0	SM	2.65	1.738	1.616	0.64	7.58	NP	NP	NP	DIR	0.00	29	1.49	0.30	0.11	13.29	0.53
1.50	DS-2	0.0	23.0	19.0	26.0	20.0	12.0	SM	2.64	1.758	1.611	0.64	9.15	NP	NP	NP	DIR	0.00	29.5	1.34	0.26	0.10	12.48	0.49
3.00	DS-3	0.0	26.0	17.0	25.0	17.0	15.0	SM	2.64	1.789	1.623	0.63	10.25	NP	NP	NP	DIR	0.00	29.6	1.34	0.21	0.10	12.94	0.33
4.50	DS-4	0.0	22.0	16.0	29.0	14.0	19.0	SM	2.63	1.791	1.618	0.63	10.68	NP	NP	NP	DIR	0.00	30.2	1.52	0.30	0.11	13.94	0.54

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



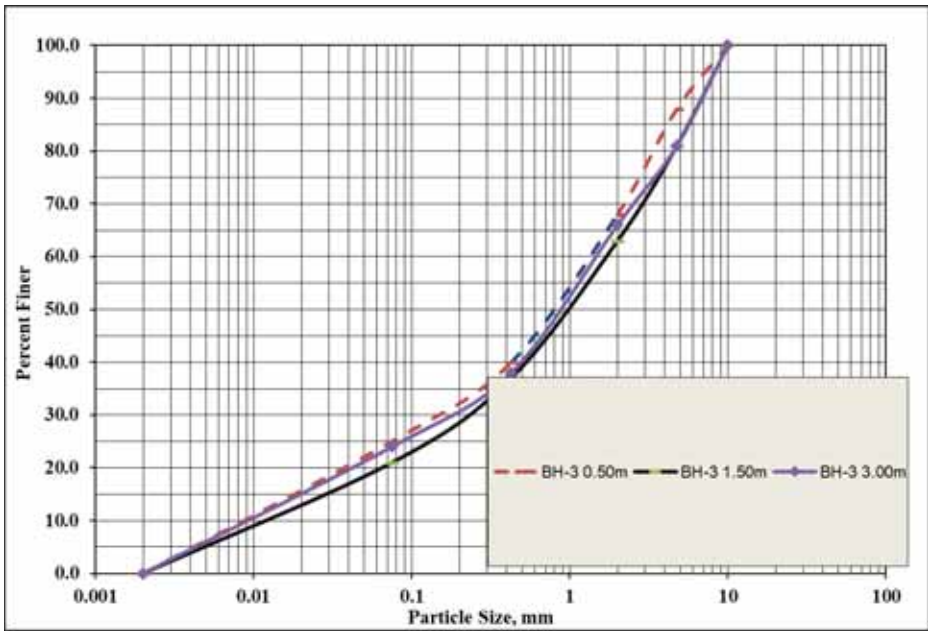
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 1.90M

Bh No.:		3																						
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Shear Parameters: Cohesion C	Shear Parameters: Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI				D60	D30	D10	C_U	C_C
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.					
0.50	DS-1	0.0	25.0	15.0	28.0	20.0	12.0	SM	2.66	1.748	1.609	0.65	8.65	NP	NP	NP	DIR	0.00	28.7	1.33	0.24	0.10	12.80	0.42
1.50	DS-2	0.0	21.0	16.0	26.0	18.0	19.0	SM	2.65	1.774	1.624	0.63	9.25	NP	NP	NP	DIR	0.00	29.3	1.75	0.31	0.11	15.84	0.52
3.00	DS-3	0.0	24.0	14.0	28.0	15.0	19.0	SM	2.65	1.790	1.625	0.63	10.14	NP	NP	NP	DIR	0.00	29.5	1.55	0.27	0.11	14.61	0.47

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



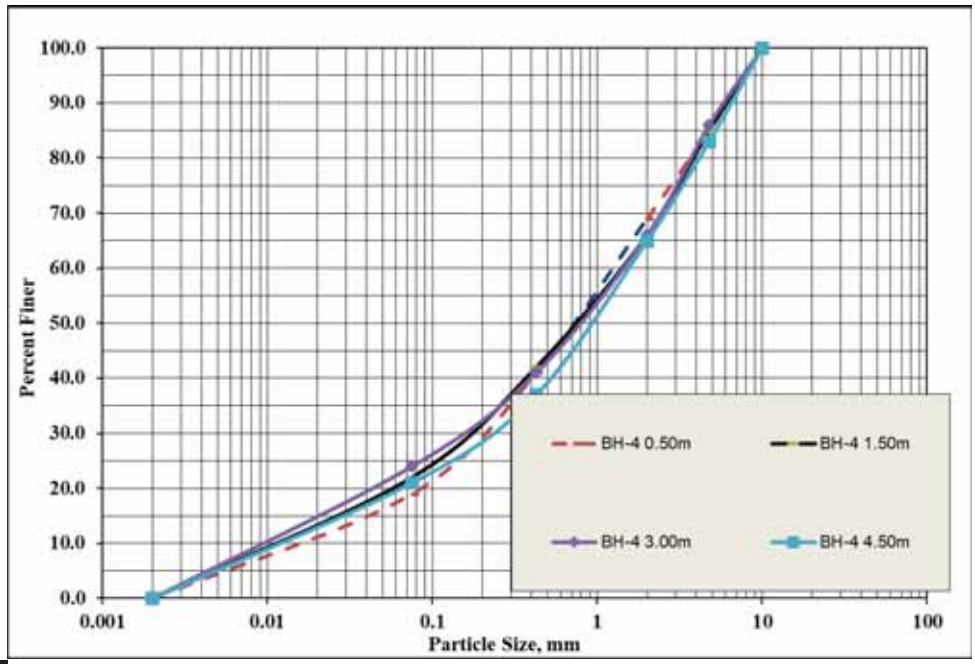
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.30M

Bh No.:		4																Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	19.0	22.0	28.0	16.0	15.0	SM	2.63	1.729	1.587	0.66	8.93	NP	NP	NP	DIR	0.00	28.7	1.38	0.30	0.11	12.09	0.56
1.50	DS-2	0.0	22.0	20.0	24.0	19.0	15.0	SM	2.64	1.749	1.601	0.65	9.25	NP	NP	NP	DIR	0.00	29.1	1.50	0.27	0.11	13.82	0.44
3.00	DS-3	0.0	24.0	17.0	25.0	20.0	14.0	SM	2.64	1.776	1.616	0.63	9.88	NP	NP	NP	DIR	0.00	29.4	1.59	0.28	0.11	14.13	0.44
4.50	DS-4	0.0	21.0	16.0	28.0	18.0	17.0	SM	2.65	1.789	1.624	0.63	10.14	NP	NP	NP	DIR	0.00	30	1.65	0.32	0.11	14.97	0.55

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



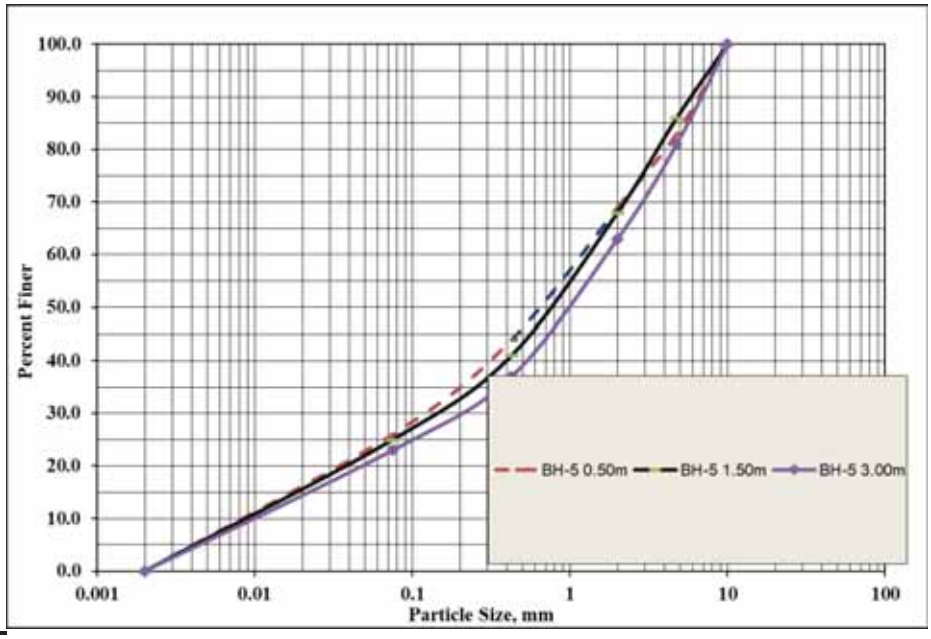
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 1.80M

Bh No.:						5																				
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Shear Parameters		Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI		Cohesion C	Angle of Internal Friction					
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	26.0	18.0	25.0	14.0	17.0	SM	2.64	1.729	1.603	0.65	7.85	NP	NP	NP	DIR	0.00	28.5	1.26	0.22	0.10	12.15	0.35
1.50	DS-2	0.0	25.0	16.0	27.0	18.0	14.0	SM	2.63	1.758	1.601	0.64	9.84	NP	NP	NP	DIR	0.00	29	1.40	0.24	0.10	13.36	0.40
3.00	DS-3	0.0	23.0	14.0	26.0	18.0	19.0	SM	2.64	1.788	1.632	0.62	9.56	NP	NP	NP	DIR	0.00	29.7	1.75	0.30	0.11	16.30	0.47

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



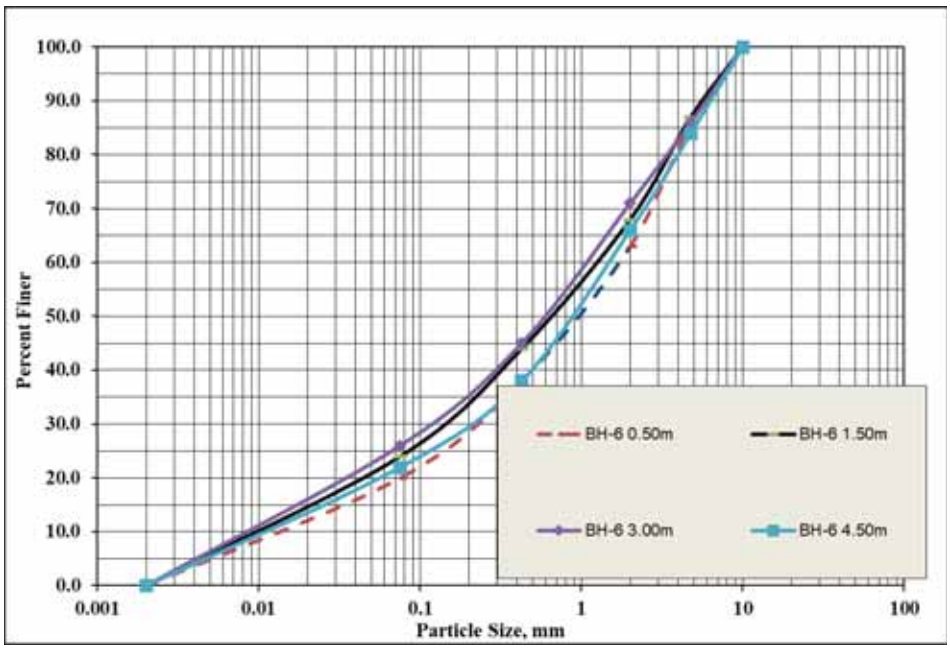
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.10M

Bh No.:		6															Shear Parameters								
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	20.0	18.0	25.0	23.0	14.0	SM	2.65	1.731	1.612	0.64	7.36	NP	NP	NP	DIR	0.00	29	1.75	0.32	0.11	15.60	0.50
1.50	DS-2	0.0	24.0	20.0	24.0	19.0	13.0	SM	2.63	1.758	1.609	0.63	9.25	NP	NP	NP	DIR	0.00	29.4	1.34	0.25	0.10	12.69	0.43
3.00	DS-3	0.0	26.0	19.0	26.0	15.0	14.0	SM	2.66	1.789	1.636	0.63	9.36	NP	NP	NP	DIR	0.00	29.2	1.10	0.21	0.10	10.66	0.38
4.50	DS-4	0.0	22.0	16.0	28.0	18.0	16.0	SM	2.64	1.801	1.635	0.61	10.17	NP	NP	NP	DIR	0.00	30.3	1.50	0.30	0.11	13.82	0.54

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



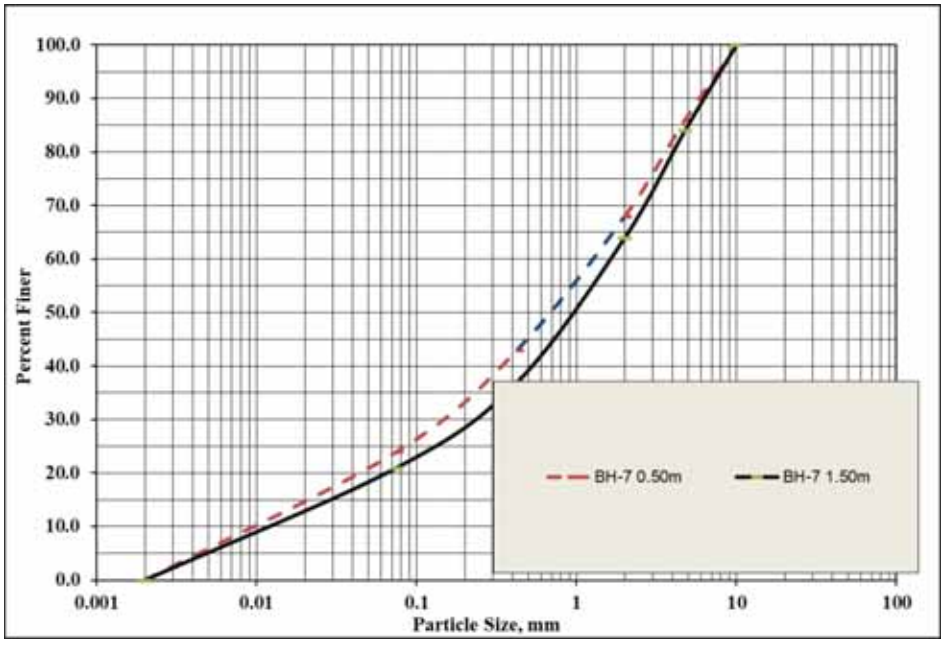
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 1.90M

Bh No.:						7													Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI										
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	24.0	19.0	25.0	18.0	14.0	SM	2.65	1.738	1.600	0.66	8.65	NP	NP	NP	DIR	0.00	29.1	1.34	0.25	0.10	12.64	0.43
1.50	DS-2	0.0	21.0	16.0	27.0	20.0	16.0	SM	2.65	1.754	1.607	0.65	9.14	NP	NP	NP	DIR	0.00	29.4	1.67	0.32	0.11	15.10	0.54

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



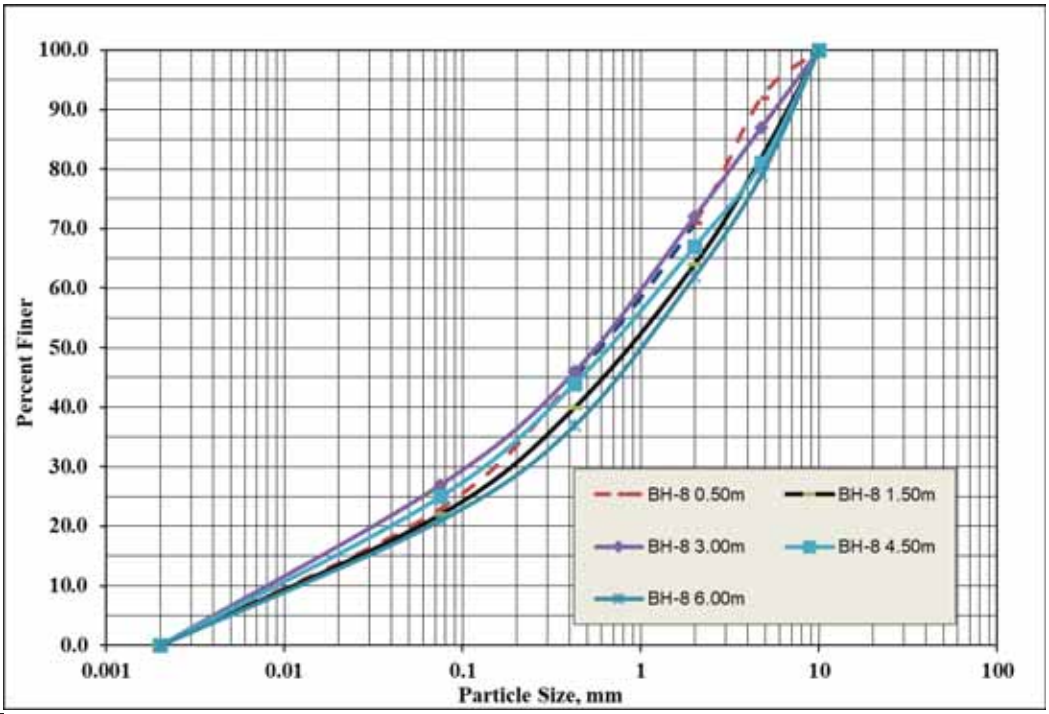
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.25M

Sample Depth	Sample Type	Bh No.:						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Shear Parameters		Soil classification				
		8																Cohesion C	Angle of Internal Friction					
		Grain Size Analysis (%)																						
		Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	23.0	22.0	26.0	21.0	8.0	SM	2.63	1.728	1.608	0.64	7.45	NP	NP	NP	DIR	0.00	28.7	1.24	0.24	0.10	11.60	0.45
1.50	DS-2	0.0	22.0	18.0	24.0	18.0	18.0	SM	2.64	1.741	1.599	0.65	8.88	NP	NP	NP	DIR	0.00	29.1	1.70	0.28	0.11	15.60	0.43
3.00	DS-3	0.0	27.0	19.0	26.0	15.0	13.0	SM	2.64	1.761	1.627	0.62	8.25	NP	NP	NP	DIR	0.00	29.0	1.03	0.20	0.10	10.07	0.37
4.50	DS-4	0.0	25.0	19.0	23.0	14.0	19.0	SM	2.65	1.781	1.629	0.63	9.36	NP	NP	NP	DIR	0.00	29.9	1.42	0.23	0.10	13.58	0.36
6.00	DS-5	0.0	21.0	16.0	25.0	17.0	21.0	SM	2.65	1.811	1.651	0.61	9.69	NP	NP	NP	DIR	0.00	30.2	1.83	0.32	0.11	16.58	0.50

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



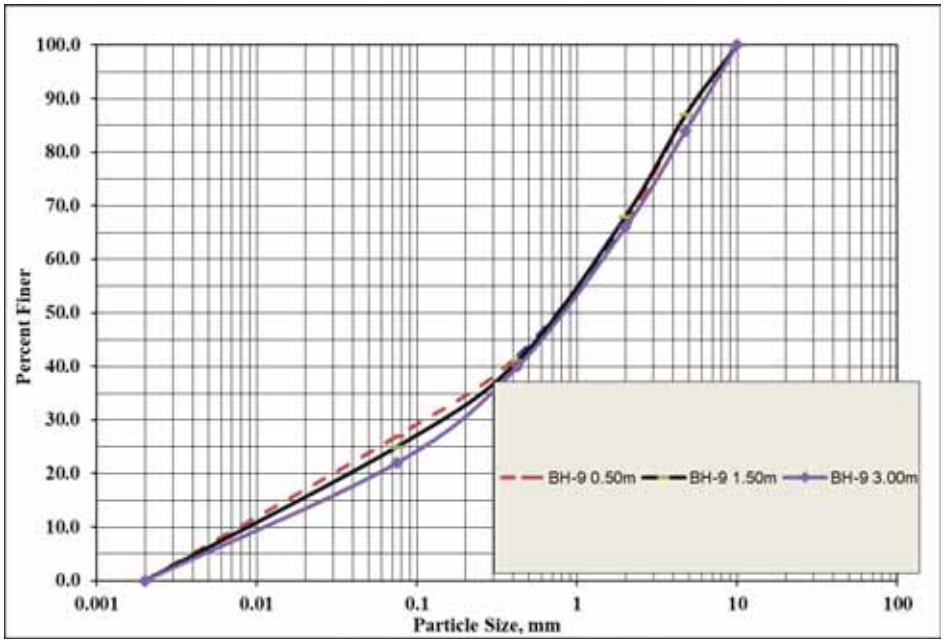
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.30M

Bh No.:						9												Shear Parameters								
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification					
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI									
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	27.0	15.0	25.0	20.0	13.0	SM	2.65	1.728	1.597	0.66	8.21	NP	NP	NP	DIR	0.00	29	1.42	0.21	0.10	13.87	0.31
1.50	DS-2	0.0	25.0	16.0	27.0	19.0	13.0	SM	2.63	1.760	1.615	0.63	8.98	NP	NP	NP	DIR	0.00	29.5	1.27	0.24	0.10	12.10	0.44
3.00	DS-3	0.0	22.0	18.0	26.0	18.0	16.0	SM	2.64	1.789	1.638	0.61	9.25	NP	NP	NP	DIR	0.00	29.9	1.50	0.30	0.11	13.82	0.54

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



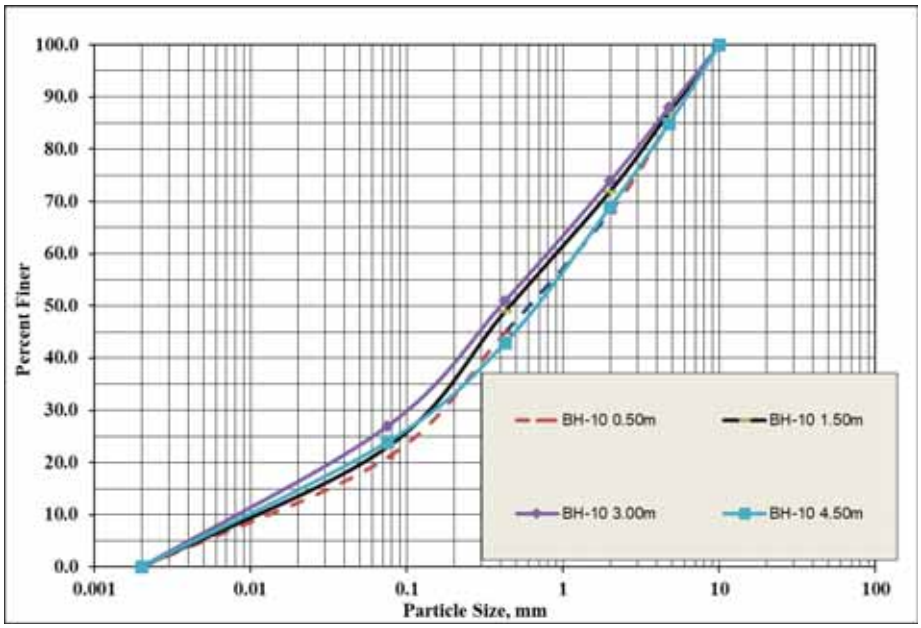
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.10M

Sample Depth	Sample Type	Bh No.:				10		Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Shear Parameters								
		Grain Size Analysis (%)															Test Type	Cohesion C	Angle of Internal Friction	Soil classification					
		Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI									
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	21.0	24.0	23.0	17.0	15.0	SM	2.66	1.721	1.603	0.66	7.36	NP	NP	NP	DIR	0.00	28.7	1.34	0.26	0.11	12.13	28.7
1.50	DS-2	0.0	23.0	26.0	23.0	15.0	13.0	SM	2.64	1.746	1.608	0.64	8.55	NP	NP	NP	DIR	0.00	29.3	1.01	0.23	0.10	9.42	0.48
3.00	DS-3	0.0	27.0	24.0	23.0	14.0	12.0	SM	2.63	1.789	1.649	0.59	8.48	NP	NP	NP	DIR	0.00	29.2	0.84	0.18	0.10	8.25	0.40
4.50	DS-4	0.0	24.0	19.0	26.0	16.0	15.0	SM	2.65	1.793	1.640	0.62	9.32	NP	NP	NP	DIR	0.00	29.9	1.26	0.25	0.10	11.87	0.46

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



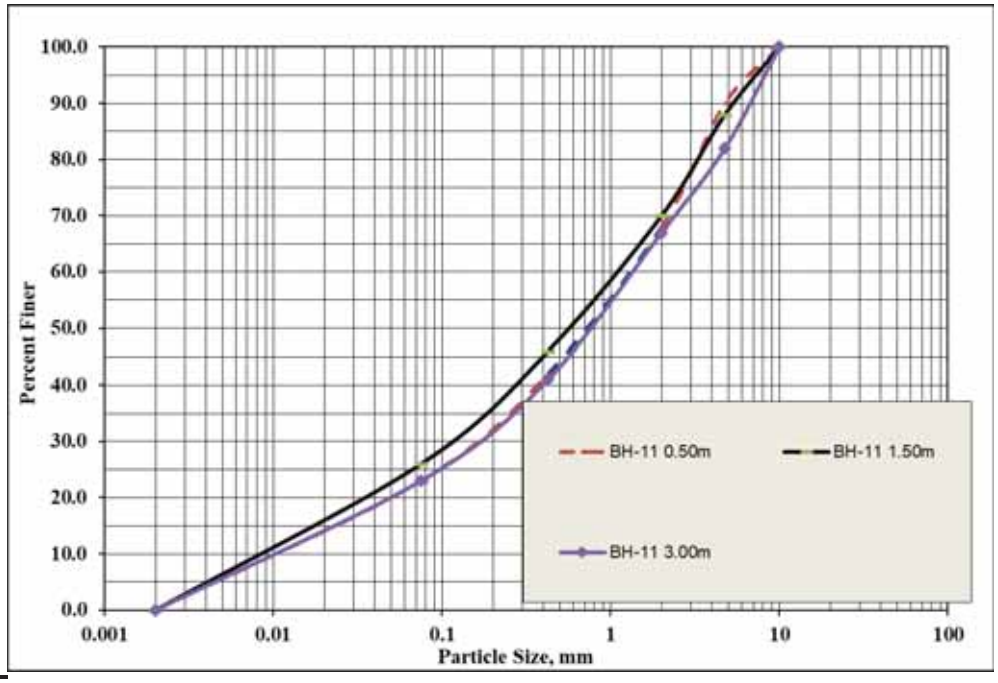
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.50M

Bh No.:		11															Shear Parameters								
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	23.0	19.0	26.0	22.0	10.0	SM	2.64	1.738	1.603	0.65	8.45	NP	NP	NP	DIR	0.00	28.9	1.34	0.26	0.11	12.48	0.49
1.50	DS-2	0.0	26.0	20.0	24.0	18.0	12.0	SM	2.63	1.766	1.616	0.63	9.31	NP	NP	NP	DIR	0.00	29.3	1.18	0.21	0.10	11.36	0.36
3.00	DS-3	0.0	23.0	18.0	26.0	15.0	18.0	SM	2.64	1.801	1.650	0.60	9.14	NP	NP	NP	DIR	0.00	29.7	1.42	0.26	0.11	13.25	0.46

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



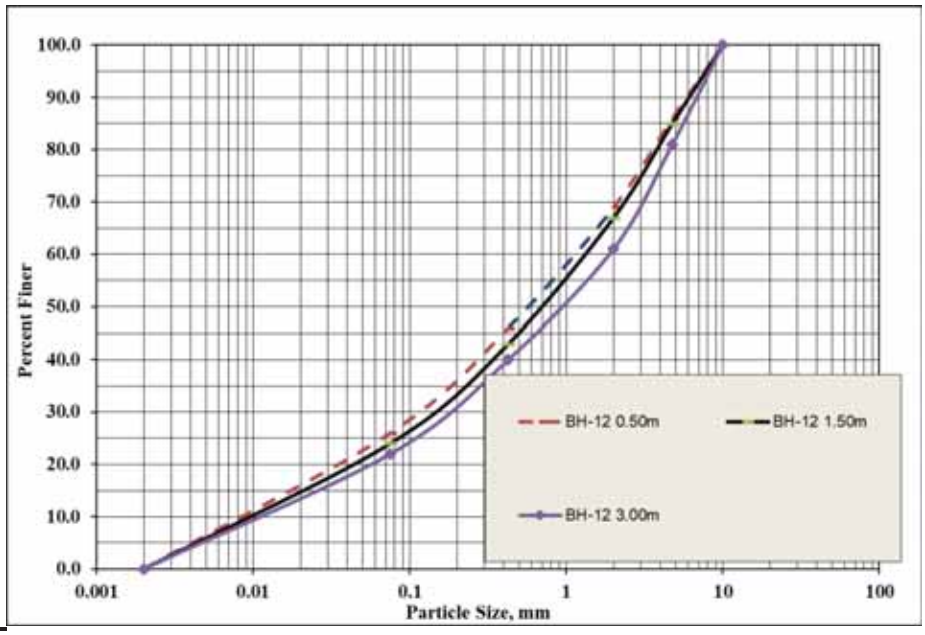
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 1.70M

Sample Depth	Sample Type	Bh No.: 12 — Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Shear Parameters: Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
		Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	26.0	20.0	23.0	17.0	14.0	SM	2.65	1.729	1.612	0.64	7.23	NP	NP	NP	DIR	0.00	29	1.26	0.21	0.10	12.15	0.33
1.50	DS-2	0.0	24.0	19.0	24.0	18.0	15.0	SM	2.64	1.754	1.617	0.63	8.45	NP	NP	NP	DIR	0.00	29.2	1.36	0.25	0.11	12.82	0.43
3.00	DS-3	0.0	22.0	18.0	21.0	20.0	19.0	SM	2.63	1.788	1.631	0.61	9.63	NP	NP	NP	DIR	0.00	29.6	1.90	0.28	0.11	17.49	0.38

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



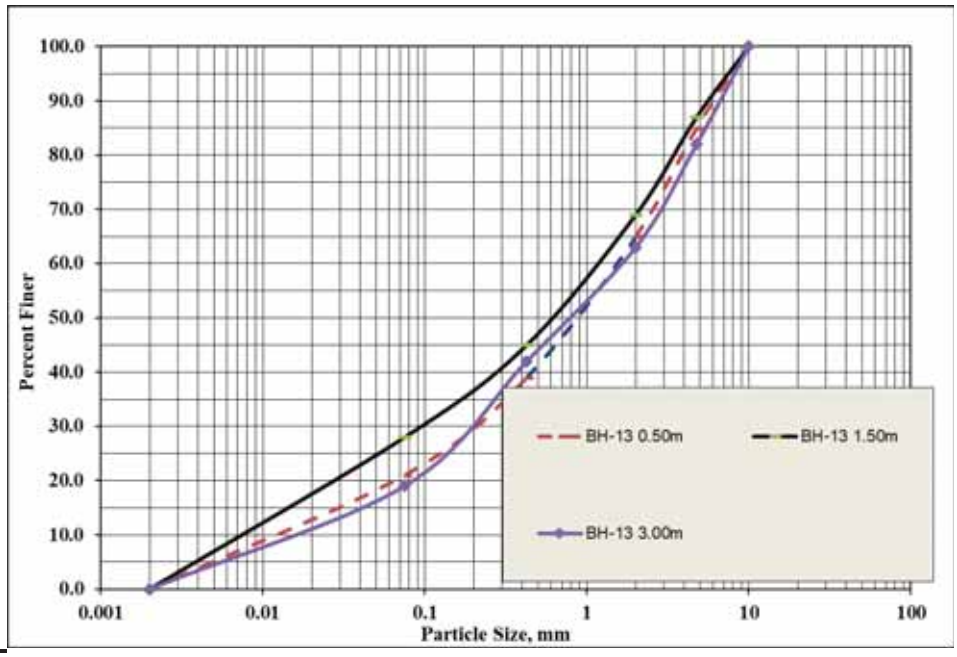
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.50M

Bh No.:						13												Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	21.0	18.0	26.0	20.0	15.0	SM	2.66	1.731	1.612	0.65	7.36	NP	NP	NP	DIR	0.00	29.1	1.59	0.30	0.11	14.36	0.51
1.50	DS-2	0.0	28.0	17.0	24.0	18.0	13.0	SM	2.65	1.759	1.625	0.63	8.24	NP	NP	NP	DIR	0.00	29.8	1.18	0.19	0.10	11.59	0.31
3.00	DS-3	0.0	19.0	23.0	21.0	19.0	18.0	SM	2.64	1.793	1.640	0.61	9.36	NP	NP	NP	DIR	0.00	30.1	1.69	0.27	0.11	14.78	0.40

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



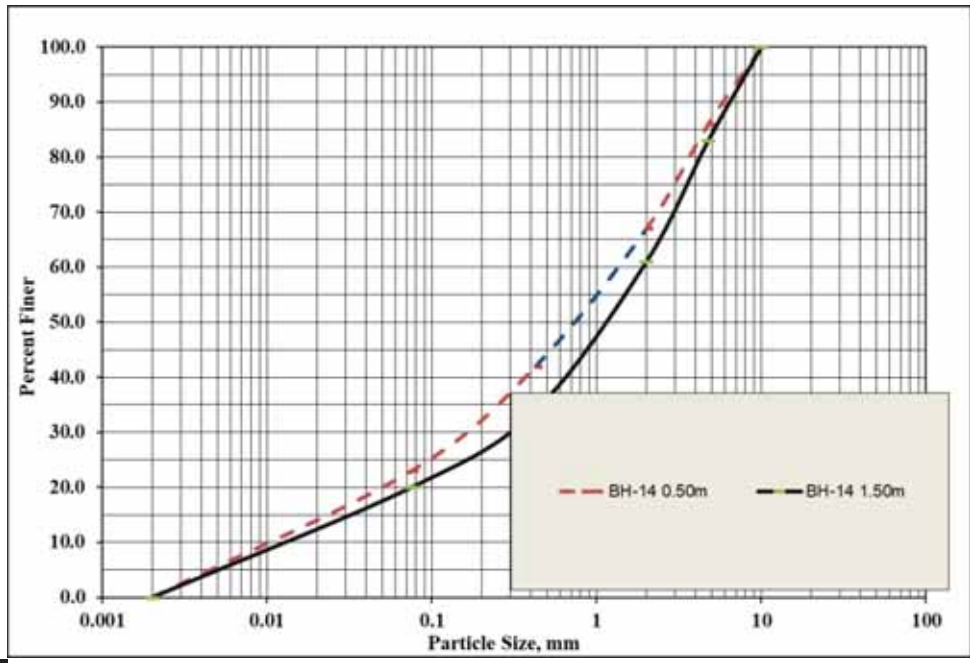
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.60M

Sample Depth	Sample Type	Bh No.:				14		Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Shear Parameters: Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
		Grain Size Analysis (%)							Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	23.0	19.0	25.0	19.0	14.0	SM	2.66	1.746	1.623	0.64	7.55	NP	NP	NP	DIR	0.00	29.2	1.42	0.26	0.10	13.25	0.46
1.50	DS-2	0.0	20.0	14.0	27.0	22.0	17.0	SM	2.64	1.759	1.623	0.63	8.36	NP	NP	NP	DIR	0.00	29.5	1.91	0.36	0.11	17.04	0.61

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



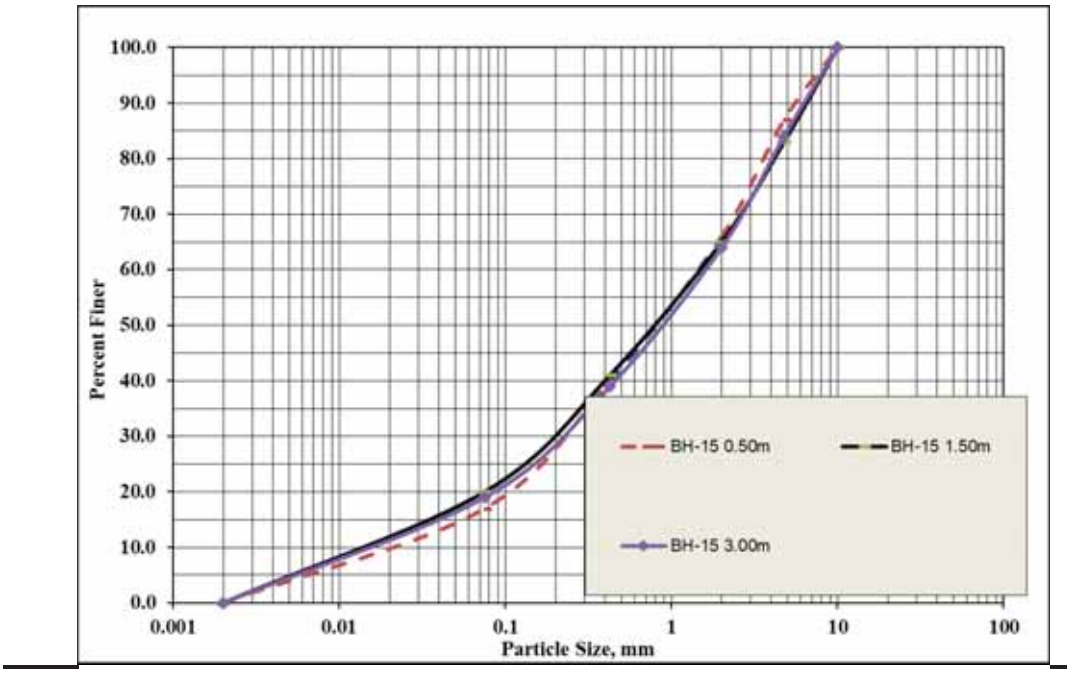
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.80M

Bh No.:		15															Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	17.0	23.0	26.0	21.0	13.0	SM	2.63	1.727	1.609	0.63	7.36	NP	NP	NP	DIR	0.00	28.9	1.50	0.30	0.12	12.65	0.50
1.50	DS-2	0.0	20.0	21.0	24.0	18.0	17.0	SM	2.65	1.764	1.630	0.63	8.24	NP	NP	NP	DIR	0.00	29.3	1.59	0.28	0.11	14.13	0.45
3.00	DS-3	0.0	19.0	20.0	25.0	20.0	16.0	SM	2.65	1.789	1.636	0.62	9.36	NP	NP	NP	DIR	0.00	30.0	1.67	0.31	0.11	14.60	0.52

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



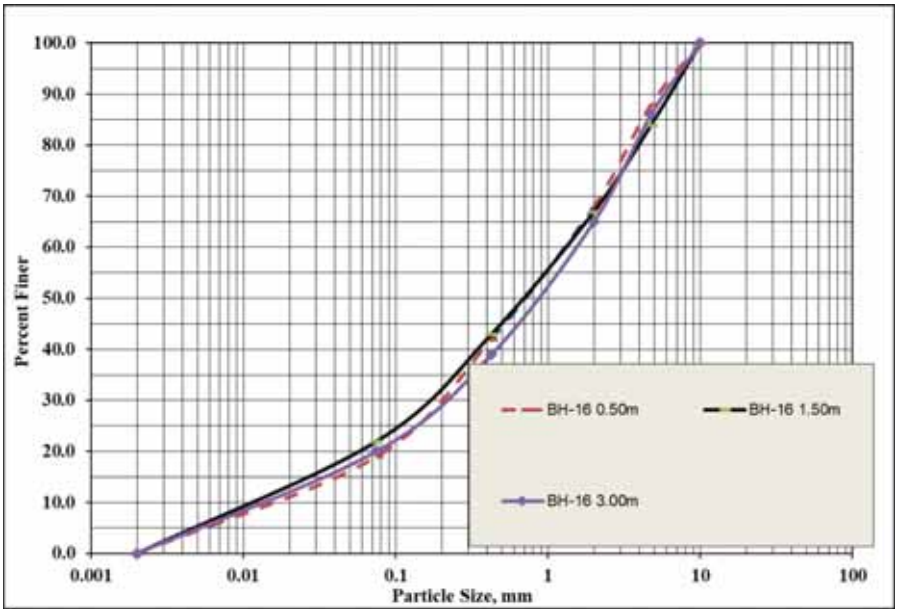
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.20M

Bh No.:		16																Shear Parameters								
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification					
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI										
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	19.0	23.0	26.0	20.0	12.0	SM	2.64	1.731	1.595	0.66	8.52	NP	NP	NP	DIR	0.00	29	1.34	0.27	0.11	11.74	0.49
1.50	DS-2	0.0	22.0	21.0	24.0	17.0	16.0	SM	2.64	1.781	1.632	0.62	9.11	NP	NP	NP	DIR	0.00	29.8	1.28	0.26	0.11	11.75	0.48
3.00	DS-3	0.0	20.0	19.0	26.0	21.0	14.0	SM	2.66	1.793	1.628	0.63	10.14	NP	NP	NP	DIR	0.00	30.1	1.48	0.32	0.11	13.22	0.60

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



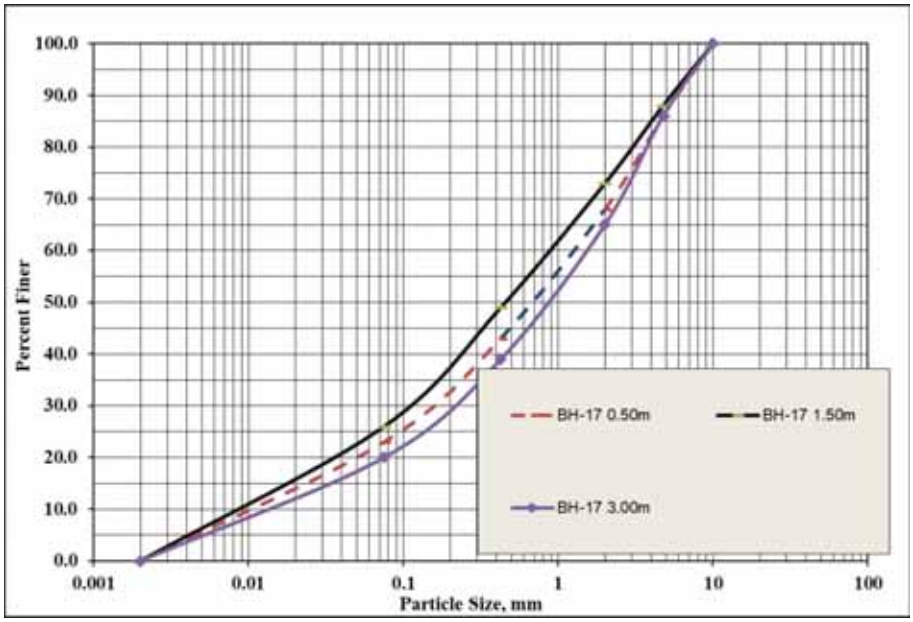
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.25M

Bh No.:		17																						
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Shear Parameters			Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI	Test Type	Cohesion C	Angle of Internal Friction					
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	23.0	20.0	25.0	18.0	14.0	SM	2.65	1.735	1.603	0.65	8.23	NP	NP	NP	DIR	0.00	29.1	1.18	0.25	0.10	10.96	0.51
1.50	DS-2	0.0	26.0	23.0	24.0	15.0	12.0	SM	2.64	1.776	1.623	0.63	9.45	NP	NP	NP	DIR	0.00	29.6	0.81	0.19	0.10	7.87	0.45
3.00	DS-3	0.0	20.0	19.0	26.0	21.0	14.0	SM	2.63	1.803	1.626	0.62	10.88	NP	NP	NP	DIR	0.00	30.2	1.48	0.31	0.11	13.22	0.58

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



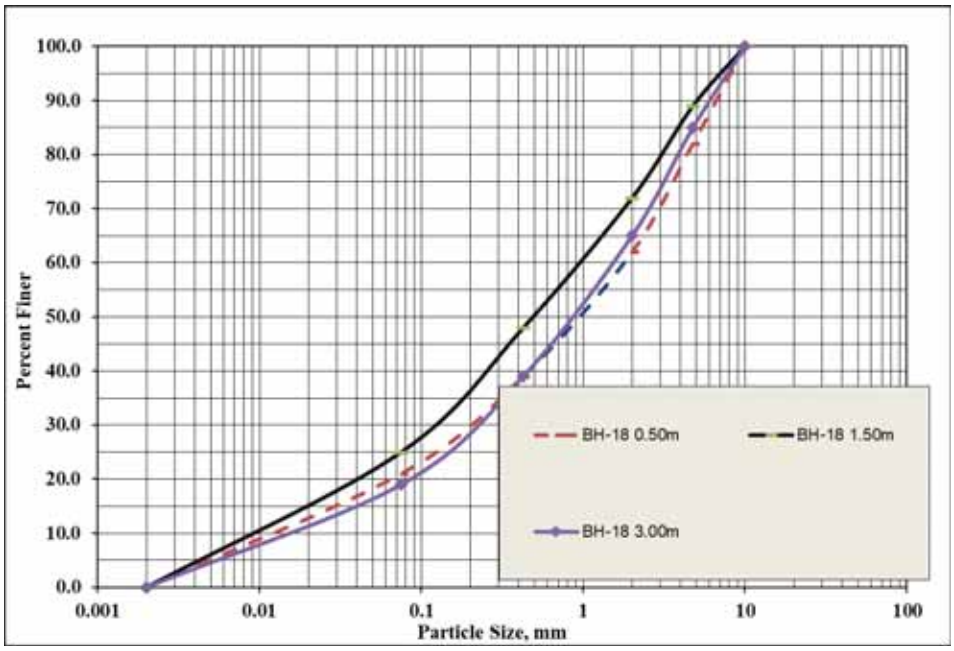
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.0M

Sample Depth	Sample Type	Bh No.:				18		Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Shear Parameters			Soil classification				
		Grain Size Analysis (%)															Test Type	Cohesion C	Angle of Internal Friction					
		Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	21.0	18.0	23.0	20.0	18.0	SM	2.66	1.722	1.602	0.66	7.52	NP	NP	NP	DIR	0.00	29.3	1.79	0.30	0.11	16.21	0.45
1.50	DS-2	0.0	25.0	23.0	24.0	17.0	11.0	SM	2.64	1.754	1.619	0.63	8.36	NP	NP	NP	DIR	0.00	29.7	0.77	0.20	0.10	7.33	0.49
3.00	DS-3	0.0	19.0	20.0	26.0	20.0	15.0	SM	2.64	1.776	1.621	0.63	9.58	NP	NP	NP	DIR	0.00	30.0	1.59	0.31	0.11	13.88	0.53

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



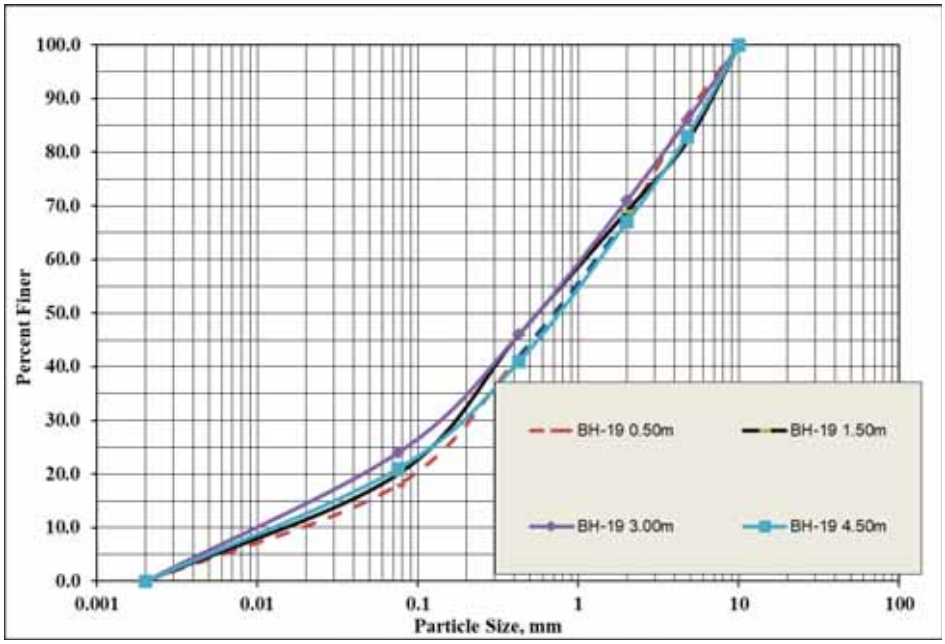
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.45M

Bh No.:						19											Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	18.0	24.0	26.0	19.0	13.0	SM	2.65	1.741	1.610	0.65	8.12	NP	NP	NP	DIR	0.00	28.5	1.34	0.27	0.11	11.52	0.48
1.50	DS-2	0.0	20.0	26.0	23.0	13.0	18.0	SM	2.64	1.759	1.619	0.63	8.63	NP	NP	NP	DIR	0.00	29	1.26	0.22	0.11	11.21	0.35
3.00	DS-3	0.0	24.0	22.0	25.0	15.0	14.0	SM	2.64	1.770	1.617	0.63	9.45	NP	NP	NP	DIR	0.00	29.8	1.10	0.23	0.10	10.42	0.45
4.50	DS-4	0.0	21.0	20.0	26.0	16.0	17.0	SM	2.63	1.793	1.632	0.61	9.88	NP	NP	NP	DIR	0.00	29.3	1.42	0.28	0.11	12.88	0.51

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



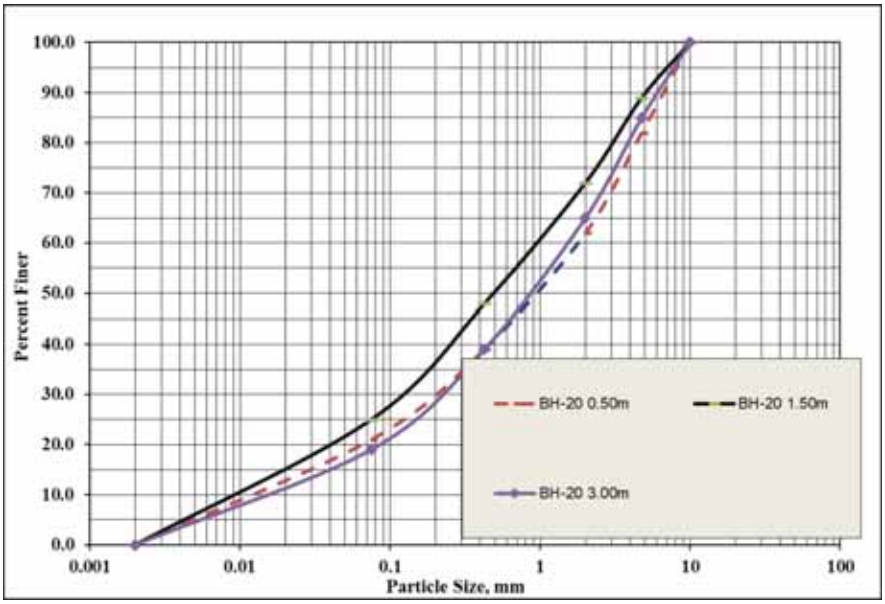
Geotechnical Investigations for High Ash Coal to Ammonium Nitrate Plant (MCL).

Table 2: RESULTS OF LAB TESTS — Water Level: 2.10M

Bh No.:		20															Shear Parameters							
		Grain Size Analysis (%)						Soil Classification	Sp. Gravity	Bulk Density	Dry Density	Void Ratio	Moisture Content	Atterberg's Limits			Test Type	Cohesion C	Angle of Internal Friction	Soil classification				
Sample Depth	Sample Type	Clay	Silt	Fine Sand	Med. Sand	Coarse Sand	Gravel		Gs	y	Yd		m	LL	PL	PI								
(m)		<0.002 MM	0.002 - 0.075	0.075 - 0.425	0.425 - 2.00	2.00 - 4.75	>4.75 MM			g/cc	g/cc		%	%	%	%		Kg/cm^2	Deg.	D60	D30	D10	C_U	C_C
0.50	DS-1	0.0	21.0	18.0	23.0	20.0	18.0	SM	2.66	1.722	1.602	0.66	7.52	NP	NP	NP	DIR	0.00	29.3	1.83	0.30	0.11	16.58	0.44
1.50	DS-2	0.0	25.0	23.0	24.0	17.0	11.0	SM	2.64	1.754	1.619	0.63	8.36	NP	NP	NP	DIR	0.00	29.7	1.01	0.20	0.10	9.65	0.40
3.00	DS-3	0.0	19.0	20.0	26.0	20.0	15.0	SM	2.64	1.776	1.621	0.63	9.58	NP	NP	NP	DIR	0.00	30.0	1.59	0.31	0.11	13.88	0.53

TxUU= Triaxial Test NP= Non Plastic DIR = Direct Shear Test

Grain Size Analysis Graph



APPENDIX – D

BEARING CAPACITY CALCULATIONS

BEARING CAPACITY: SHEAR CRITERIA

SBC of Soil based on Shear Criteria

Sample Calculations | **Type of Foundation =** Isolated | **Water Table Correction factor = 0.5**

Depth of Foundation, m	Size of Footing, m	Bulk Density of Soil, gm/cc	Cohesion 'c' t/m2	Angle of Shearing Resistance 'f' degree	Bearing Capacity Factors			Depth Factors			Shape Factors			Bearing Capacity BC1=2/3c.Nc.dc.sc.ic	Bearing Capacity BC2=g.D.(Nq-1).dq.sq.iq	Bearing Capacity BC3=0.5.g.B.Ng.dg.sg.ig.W'	Total Bearing Capacity BC=BC1+BC2+BC3	Net Safe Bearing Capacity S.B.C.(Net)=BC/FOS (Between Local and General Shear Failure)
D	B	g	c	f	Nc	Nq	Ng	dc	dq	dg	sc	sq	sg	BC1	BC2	BC3		T/m^2
1.0	1.0	1.735	0.0	33.0	38.63	26.09	35.18	1.1	1.1	1.1	1.3	1.2	0.8	0.0	23.4	12.9	36.3	15
2.0	1.0	1.735	0.0	33.0	38.63	26.09	35.18	1.2	1.1	1.1	1.3	1.2	0.8	0.0	49.2	13.6	62.8	25
3.0	1.0	1.735	0.0	33.0	38.63	26.09	35.18	1.3	1.1	1.1	1.3	1.2	0.8	0.0	73.0	13.4	86.5	35

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 1													
4.50	-	6.00	219.700	1	3	8	10	7	-2	27	IV	POOR ROCK	65
6.00	-	7.50	218.200	1	3	8	10	7	-2	27	IV	POOR ROCK	62
7.50	-	9.00	216.700	1	3	8	10	7	-2	27	IV	POOR ROCK	60
9.00	-	10.50	215.200	1	3	8	10	7	-2	27	IV	POOR ROCK	67
12.00	-	13.50	212.200	1	3	8	10	7	-2	27	IV	POOR ROCK	69
13.50	-	15.00	210.700	1	3	8	10	7	-2	27	IV	POOR ROCK	65
15.00	-	16.50	209.200	1	3	8	10	7	-2	27	IV	POOR ROCK	64
18.00	-	19.50	206.200	1	3	8	10	7	-2	27	IV	POOR ROCK	63
19.50	-	21.00	204.700	1	3	8	10	7	-2	27	IV	POOR ROCK	62
22.50	-	24.00	201.700	1	3	8	10	7	-2	27	IV	POOR ROCK	71
25.50	-	27.00	198.700	1	3	8	10	7	-2	27	IV	POOR ROCK	60
28.50	-	30.00	195.700	1	3	8	10	7	-2	27	IV	POOR ROCK	67

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 2													
4.50	-	6.00	214.100	1	3	8	10	7	-2	27	IV	POOR ROCK	62
6.00	-	7.50	212.600	1	3	8	10	7	-2	27	IV	POOR ROCK	64
7.50	-	9.00	211.100	1	3	8	10	7	-2	27	IV	POOR ROCK	64
9.00	-	10.50	209.600	1	3	8	10	7	-2	27	IV	POOR ROCK	69
12.00	-	13.50	206.600	1	3	8	10	7	-2	27	IV	POOR ROCK	67
13.50	-	15.00	205.100	1	3	8	10	7	-2	27	IV	POOR ROCK	71
15.00	-	16.50	203.600	1	3	8	10	7	-2	27	IV	POOR ROCK	70
18.00	-	19.50	200.600	1	3	8	10	7	-2	27	IV	POOR ROCK	74

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 3													
3.00	-	4.50	209.400	1	3	8	10	7	-2	27	IV	POOR ROCK	64
4.50	-	6.00	207.900	1	3	8	10	7	-2	27	IV	POOR ROCK	66
6.00	-	7.50	206.400	1	3	8	10	7	-2	27	IV	POOR ROCK	67
7.50	-	9.00	204.900	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	203.400	1	3	8	10	7	-2	27	IV	POOR ROCK	61
12.00	-	13.50	200.400	1	3	8	10	7	-2	27	IV	POOR ROCK	70
13.50	-	15.00	198.900	1	3	8	10	7	-2	27	IV	POOR ROCK	71
15.00	-	16.50	197.400	1	3	8	10	7	-2	27	IV	POOR ROCK	73
18.00	-	19.50	194.400	1	3	8	10	7	-2	27	IV	POOR ROCK	75
19.50	-	21.00	192.900	1	3	8	10	7	-2	27	IV	POOR ROCK	76
22.50	-	24.00	189.900	1	3	8	10	7	-2	27	IV	POOR ROCK	74
25.50	-	27.00	186.900	1	3	8	10	7	-2	27	IV	POOR ROCK	73
28.50	-	30.00	183.900	1	3	8	10	7	-2	27	IV	POOR ROCK	75

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION											As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 4													
4.50	-	6.00	207.500	1	3	8	10	7	-2	27	IV	POOR ROCK	62
6.00	-	7.50	206.000	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	204.500	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	203.000	1	3	8	10	7	-2	27	IV	POOR ROCK	66
12.00	-	13.50	200.000	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	198.500	1	3	8	10	7	-2	27	IV	POOR ROCK	69
15.00	-	16.50	197.000	1	3	8	10	7	-2	27	IV	POOR ROCK	71
18.00	-	19.50	194.000	1	3	8	10	7	-2	27	IV	POOR ROCK	74

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 5													
3.00	-	4.50	208.100	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	206.600	1	3	8	10	7	-2	27	IV	POOR ROCK	64
6.00	-	7.50	205.100	1	3	8	10	7	-2	27	IV	POOR ROCK	68
7.50	-	9.00	203.600	1	3	8	10	7	-2	27	IV	POOR ROCK	65
9.00	-	10.50	202.100	1	3	8	10	7	-2	27	IV	POOR ROCK	69
12.00	-	13.50	199.100	1	3	8	10	7	-2	27	IV	POOR ROCK	72
13.50	-	15.00	197.600	1	3	8	10	7	-2	27	IV	POOR ROCK	71
15.00	-	16.50	196.100	1	3	8	10	7	-2	27	IV	POOR ROCK	74
18.00	-	19.50	193.100	1	3	8	10	7	-2	27	IV	POOR ROCK	73
19.50	-	21.00	191.600	1	3	8	10	7	-2	27	IV	POOR ROCK	75
22.50	-	24.00	188.600	1	3	8	10	7	-2	27	IV	POOR ROCK	74
25.50	-	27.00	185.600	1	3	8	10	7	-2	27	IV	POOR ROCK	72
28.50	-	30.00	182.600	1	3	8	10	7	-2	27	IV	POOR ROCK	75

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 6													
4.50	-	6.00	208.100	1	3	8	10	7	-2	27	IV	POOR ROCK	60
6.00	-	7.50	206.600	1	3	8	10	7	-2	27	IV	POOR ROCK	62
7.50	-	9.00	205.100	1	3	8	10	7	-2	27	IV	POOR ROCK	66
9.00	-	10.50	203.600	1	3	8	10	7	-2	27	IV	POOR ROCK	63
12.00	-	13.50	202.100	1	3	8	10	7	-2	27	IV	POOR ROCK	68
13.50	-	15.00	199.100	1	3	8	10	7	-2	27	IV	POOR ROCK	70
15.00	-	16.50	197.600	1	3	8	10	7	-2	27	IV	POOR ROCK	69
18.00	-	19.50	196.100	1	3	8	10	7	-2	27	IV	POOR ROCK	72

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION											As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 7													
3.00	-	4.50	206.800	1	3	8	10	7	-2	27	IV	POOR ROCK	62
4.50	-	6.00	205.300	1	3	8	10	7	-2	27	IV	POOR ROCK	63
6.00	-	7.50	203.800	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	202.300	1	3	8	10	7	-2	27	IV	POOR ROCK	68
9.00	-	10.50	200.800	1	3	8	10	7	-2	27	IV	POOR ROCK	67
12.00	-	13.50	197.800	1	3	8	10	7	-2	27	IV	POOR ROCK	70
13.50	-	15.00	196.300	1	3	8	10	7	-2	27	IV	POOR ROCK	68
15.00	-	16.50	194.800	1	3	8	10	7	-2	27	IV	POOR ROCK	72
18.00	-	19.50	191.800	1	3	8	10	7	-2	27	IV	POOR ROCK	74
19.50	-	21.00	190.300	1	3	8	10	7	-2	27	IV	POOR ROCK	75
22.50	-	24.00	187.300	1	3	8	10	7	-2	27	IV	POOR ROCK	73
25.50	-	27.00	184.300	1	3	8	10	7	-2	27	IV	POOR ROCK	71
28.50	-	30.00	181.300	1	3	8	10	7	-2	27	IV	POOR ROCK	75

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 8													
6.00	-	7.50	211.600	1	3	8	10	7	-2	27	IV	POOR ROCK	61
7.50	-	9.00	210.100	1	3	8	10	7	-2	27	IV	POOR ROCK	60
9.00	-	10.50	208.600	1	3	8	10	7	-2	27	IV	POOR ROCK	62
12.00	-	13.50	205.600	1	3	8	10	7	-2	27	IV	POOR ROCK	64
13.50	-	15.00	204.100	1	3	8	10	7	-2	27	IV	POOR ROCK	66
15.00	-	16.50	202.600	1	3	8	10	7	-2	27	IV	POOR ROCK	68
18.00	-	19.50	199.600	1	3	8	10	7	-2	27	IV	POOR ROCK	69

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 9													
3.00	-	4.50	210.000	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	208.500	1	3	8	10	7	-2	27	IV	POOR ROCK	64
6.00	-	7.50	207.000	1	3	8	10	7	-2	27	IV	POOR ROCK	63
7.50	-	9.00	205.500	1	3	8	10	7	-2	27	IV	POOR ROCK	65
9.00	-	10.50	204.000	1	3	8	10	7	-2	27	IV	POOR ROCK	68
12.00	-	13.50	201.000	1	3	8	10	7	-2	27	IV	POOR ROCK	70
13.50	-	15.00	199.500	1	3	8	10	7	-2	27	IV	POOR ROCK	71
15.00	-	16.50	198.000	1	3	8	10	7	-2	27	IV	POOR ROCK	69
18.00	-	19.50	195.000	1	3	8	10	7	-2	27	IV	POOR ROCK	72
19.50	-	21.00	193.500	1	3	8	10	7	-2	27	IV	POOR ROCK	70
22.50	-	24.00	190.500	1	3	8	10	7	-2	27	IV	POOR ROCK	73
25.50	-	27.00	187.500	1	3	8	10	7	-2	27	IV	POOR ROCK	71
28.50	-	30.00	184.500	1	3	8	10	7	-2	27	IV	POOR ROCK	74

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 10													
4.50	-	6.00	219.400	1	3	8	10	7	-2	27	IV	POOR ROCK	60
6.00	-	7.50	217.900	1	3	8	10	7	-2	27	IV	POOR ROCK	62
7.50	-	9.00	216.400	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	214.900	1	3	8	10	7	-2	27	IV	POOR ROCK	63
12.00	-	13.50	211.900	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	210.400	1	3	8	10	7	-2	27	IV	POOR ROCK	64
15.00	-	16.50	208.900	1	3	8	10	7	-2	27	IV	POOR ROCK	66
18.00	-	19.50	205.900	1	3	8	10	7	-2	27	IV	POOR ROCK	68

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION												As Per IS 12070-1987	
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 11													
3.00	-	4.50	216.900	1	3	8	10	7	-2	27	IV	POOR ROCK	60
4.50	-	6.00	215.400	1	3	8	10	7	-2	27	IV	POOR ROCK	61
6.00	-	7.50	213.900	1	3	8	10	7	-2	27	IV	POOR ROCK	61
7.50	-	9.00	212.400	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	210.900	1	3	8	10	7	-2	27	IV	POOR ROCK	64
12.00	-	13.50	207.900	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	206.400	1	3	8	10	7	-2	27	IV	POOR ROCK	68
15.00	-	16.50	204.900	1	3	8	10	7	-2	27	IV	POOR ROCK	67
18.00	-	19.50	201.900	1	3	8	10	7	-2	27	IV	POOR ROCK	69
19.50	-	21.00	200.400	1	3	8	10	7	-2	27	IV	POOR ROCK	71
22.50	-	24.00	197.400	1	3	8	10	7	-2	27	IV	POOR ROCK	72
25.50	-	27.00	194.400	1	3	8	10	7	-2	27	IV	POOR ROCK	74
28.50	-	30.00	191.400	1	3	8	10	7	-2	27	IV	POOR ROCK	73

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION											As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 12													
3.00	-	4.50	208.800	1	3	8	10	7	-2	27	IV	POOR ROCK	62
4.50	-	6.00	207.300	1	3	8	10	7	-2	27	IV	POOR ROCK	64
6.00	-	7.50	205.800	1	3	8	10	7	-2	27	IV	POOR ROCK	61
7.50	-	9.00	204.300	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	202.800	1	3	8	10	7	-2	27	IV	POOR ROCK	62
12.00	-	13.50	199.800	1	3	8	10	7	-2	27	IV	POOR ROCK	64
13.50	-	15.00	198.300	1	3	8	10	7	-2	27	IV	POOR ROCK	65
15.00	-	16.50	196.800	1	3	8	10	7	-2	27	IV	POOR ROCK	66
18.00	-	19.50	193.800	1	3	8	10	7	-2	27	IV	POOR ROCK	68

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 13													
3.00	-	4.50	212.000	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	210.500	1	3	8	10	7	-2	27	IV	POOR ROCK	60
6.00	-	7.50	209.000	1	3	8	10	7	-2	27	IV	POOR ROCK	63
7.50	-	9.00	207.500	1	3	8	10	7	-2	27	IV	POOR ROCK	64
9.00	-	10.50	206.000	1	3	8	10	7	-2	27	IV	POOR ROCK	64
12.00	-	13.50	203.000	1	3	8	10	7	-2	27	IV	POOR ROCK	68
13.50	-	15.00	201.500	1	3	8	10	7	-2	27	IV	POOR ROCK	67
15.00	-	16.50	200.000	1	3	8	10	7	-2	27	IV	POOR ROCK	65
18.00	-	19.50	197.000	1	3	8	10	7	-2	27	IV	POOR ROCK	69
19.50	-	21.00	195.500	1	3	8	10	7	-2	27	IV	POOR ROCK	71
22.50	-	24.00	192.500	1	3	8	10	7	-2	27	IV	POOR ROCK	73
25.50	-	27.00	189.500	1	3	8	10	7	-2	27	IV	POOR ROCK	75
28.50	-	30.00	186.500	1	3	8	10	7	-2	27	IV	POOR ROCK	73

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 14													
1.50	-	3.00	220.400	1	3	8	10	7	-2	27	IV	POOR ROCK	60
3.00	-	4.50	218.900	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	217.400	1	3	8	10	7	-2	27	IV	POOR ROCK	63
6.00	-	7.50	215.900	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	214.400	1	3	8	10	7	-2	27	IV	POOR ROCK	66
9.00	-	10.50	212.900	1	3	8	10	7	-2	27	IV	POOR ROCK	63
12.00	-	13.50	209.900	1	3	8	10	7	-2	27	IV	POOR ROCK	61
13.50	-	15.00	208.400	1	3	8	10	7	-2	27	IV	POOR ROCK	60
15.00	-	16.50	206.900	1	3	8	10	7	-2	27	IV	POOR ROCK	63
18.00	-	19.50	203.900	1	3	8	10	7	-2	27	IV	POOR ROCK	68

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 15													
3.00	-	4.50	213.100	1	3	8	10	7	-2	27	IV	POOR ROCK	60
4.50	-	6.00	211.600	1	3	8	10	7	-2	27	IV	POOR ROCK	61
6.00	-	7.50	210.100	1	3	8	10	7	-2	27	IV	POOR ROCK	63
7.50	-	9.00	208.600	1	3	8	10	7	-2	27	IV	POOR ROCK	62
9.00	-	10.50	207.100	1	3	8	10	7	-2	27	IV	POOR ROCK	62
12.00	-	13.50	204.100	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	202.600	1	3	8	10	7	-2	27	IV	POOR ROCK	63
15.00	-	16.50	201.100	1	3	8	10	7	-2	27	IV	POOR ROCK	67
18.00	-	19.50	198.100	1	3	8	10	7	-2	27	IV	POOR ROCK	69
19.50	-	21.00	196.600	1	3	8	10	7	-2	27	IV	POOR ROCK	70
22.50	-	24.00	193.600	1	3	8	10	7	-2	27	IV	POOR ROCK	68
25.50	-	27.00	190.600	1	3	8	10	7	-2	27	IV	POOR ROCK	71
28.50	-	30.00	187.600	1	3	8	10	7	-2	27	IV	POOR ROCK	73

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 16													
3.00	-	4.50	213.100	1	3	8	10	7	-2	27	IV	POOR ROCK	62
4.50	-	6.00	211.600	1	3	8	10	7	-2	27	IV	POOR ROCK	61
6.00	-	7.50	210.100	1	3	8	10	7	-2	27	IV	POOR ROCK	60
7.50	-	9.00	208.600	1	3	8	10	7	-2	27	IV	POOR ROCK	62
9.00	-	10.50	207.100	1	3	8	10	7	-2	27	IV	POOR ROCK	64
12.00	-	13.50	204.100	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	202.600	1	3	8	10	7	-2	27	IV	POOR ROCK	66
15.00	-	16.50	201.100	1	3	8	10	7	-2	27	IV	POOR ROCK	68
18.00	-	19.50	198.100	1	3	8	10	7	-2	27	IV	POOR ROCK	69

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 17													
3.00	-	4.50	214.700	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	213.200	1	3	8	10	7	-2	27	IV	POOR ROCK	62
6.00	-	7.50	211.700	1	3	8	10	7	-2	27	IV	POOR ROCK	63
7.50	-	9.00	210.200	1	3	8	10	7	-2	27	IV	POOR ROCK	62
9.00	-	10.50	208.700	1	3	8	10	7	-2	27	IV	POOR ROCK	65
12.00	-	13.50	205.700	1	3	8	10	7	-2	27	IV	POOR ROCK	64
13.50	-	15.00	204.200	1	3	8	10	7	-2	27	IV	POOR ROCK	65
15.00	-	16.50	202.700	1	3	8	10	7	-2	27	IV	POOR ROCK	67
18.00	-	19.50	199.700	1	3	8	10	7	-2	27	IV	POOR ROCK	69
19.50	-	21.00	198.200	1	3	8	10	7	-2	27	IV	POOR ROCK	68
22.50	-	24.00	195.200	1	3	8	10	7	-2	27	IV	POOR ROCK	70
25.50	-	27.00	192.200	1	3	8	10	7	-2	27	IV	POOR ROCK	65
28.50	-	30.00	189.200	1	3	8	10	7	-2	27	IV	POOR ROCK	68

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 18													
3.00	-	4.50	211.200	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	209.700	1	3	8	10	7	-2	27	IV	POOR ROCK	63
6.00	-	7.50	208.200	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	206.700	1	3	8	10	7	-2	27	IV	POOR ROCK	66
9.00	-	10.50	205.200	1	3	8	10	7	-2	27	IV	POOR ROCK	64
12.00	-	13.50	202.200	1	3	8	10	7	-2	27	IV	POOR ROCK	66
13.50	-	15.00	200.700	1	3	8	10	7	-2	27	IV	POOR ROCK	68
15.00	-	16.50	199.200	1	3	8	10	7	-2	27	IV	POOR ROCK	69
18.00	-	19.50	196.200	1	3	8	10	7	-2	27	IV	POOR ROCK	69

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 19													
4.50	-	6.00	205.000	1	3	8	10	7	-2	27	IV	POOR ROCK	63
6.00	-	7.50	203.500	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	202.000	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	200.500	1	3	8	10	7	-2	27	IV	POOR ROCK	66
12.00	-	13.50	197.500	1	3	8	10	7	-2	27	IV	POOR ROCK	63
13.50	-	15.00	196.000	1	3	8	10	7	-2	27	IV	POOR ROCK	68
15.00	-	16.50	194.500	1	3	8	10	7	-2	27	IV	POOR ROCK	69
18.00	-	19.50	191.500	1	3	8	10	7	-2	27	IV	POOR ROCK	71
19.50	-	21.00	190.000	1	3	8	10	7	-2	27	IV	POOR ROCK	72
22.50	-	24.00	187.000	1	3	8	10	7	-2	27	IV	POOR ROCK	70
25.50	-	27.00	184.000	1	3	8	10	7	-2	27	IV	POOR ROCK	69
28.50	-	30.00	181.000	1	3	8	10	7	-2	27	IV	POOR ROCK	70

BEARING CAPACITY ON THE BASIS OF RMR CALCULATION										As Per IS 12070-1987			
DEPTH OF BORE HOLE			REDUCED LEVEL	UCS RATING\ POINT LOAD	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	CLASS No.	DESCRIPTION	Net safe Bearing Pressure qns tonn/m2
metre			metre										
Bore Hole No. - 20													
3.00	-	4.50	208.200	1	3	8	10	7	-2	27	IV	POOR ROCK	61
4.50	-	6.00	206.700	1	3	8	10	7	-2	27	IV	POOR ROCK	60
6.00	-	7.50	205.200	1	3	8	10	7	-2	27	IV	POOR ROCK	65
7.50	-	9.00	203.700	1	3	8	10	7	-2	27	IV	POOR ROCK	63
9.00	-	10.50	202.200	1	3	8	10	7	-2	27	IV	POOR ROCK	64
12.00	-	13.50	199.200	1	3	8	10	7	-2	27	IV	POOR ROCK	65
13.50	-	15.00	197.700	1	3	8	10	7	-2	27	IV	POOR ROCK	68
15.00	-	16.50	196.200	1	3	8	10	7	-2	27	IV	POOR ROCK	67
18.00	-	19.50	193.200	1	3	8	10	7	-2	27	IV	POOR ROCK	69

CHEMICAL ANALYSIS

- SOIL SAMPLE

The results are given below:-

S.No	Locations	Chemical Tests		
		Ph value	Chloride (%)	Sulphate (%)
1.	BH-1	7.45	0.34	0.04
2.	BH-2	6.69	0.31	0.06
3.	BH-3	7.12	0.36	0.07
4.	BH-4	6.65	0.33	0.05
5.	BH-5	6.88	0.29	0.04
6.	BH-6	7.40	0.30	0.08
7.	BH-7	7.36	0.35	0.09
8.	BH-8	6.79	0.32	0.06
9.	BH-9	6.26	0.37	0.05
10.	BH-10	7.11	0.26	0.03
11.	BH-11	7.81	0.38	0.08
12.	BH-12	7.40	0.27	0.04
13.	BH-13	6.63	0.37	0.06
14.	BH-14	7.20	0.32	0.05
15.	BH-15	7.48	0.29	0.07
16.	BH-16	6.89	0.30	0.09
17.	BH-17	7.82	0.25	0.06
18.	BH-18	7.34	0.28	0.03
19.	BH-19	6.89	0.30	0.08
20.	BH-20	7.15	0.33	0.07

Note: As per IS 456 Permissible limit of Sulphate is 0.5 %.

- WATER SAMPLE

The results are given below:-

S.No	Locations	Chemical Tests		
		Ph value	Chloride (mg/l)	Sulphate (mg/l)
1.	BH-1	7.88	274	127
2.	BH-2	7.15	288	120
3.	BH-3	7.20	271	121
4.	BH-4	6.87	287	119
5.	BH-5	7.13	284	129
6.	BH-6	8.15	280	118
7.	BH-7	7.48	289	131
8.	BH-8	7.30	276	128
9.	BH-9	6.58	271	124
10.	BH-10	6.84	277	121
11.	BH-11	7.44	269	126
12.	BH-12	6.57	273	130
13.	BH-13	7.82	281	119
14.	BH-14	7.36	280	125
15.	BH-15	7.12	269	118
16.	BH-16	8.14	288	128
17.	BH-17	7.30	274	120
18.	BH-18	6.69	279	129
19.	BH-19	7.41	270	121
20.	BH-20	7.65	281	126

Note:

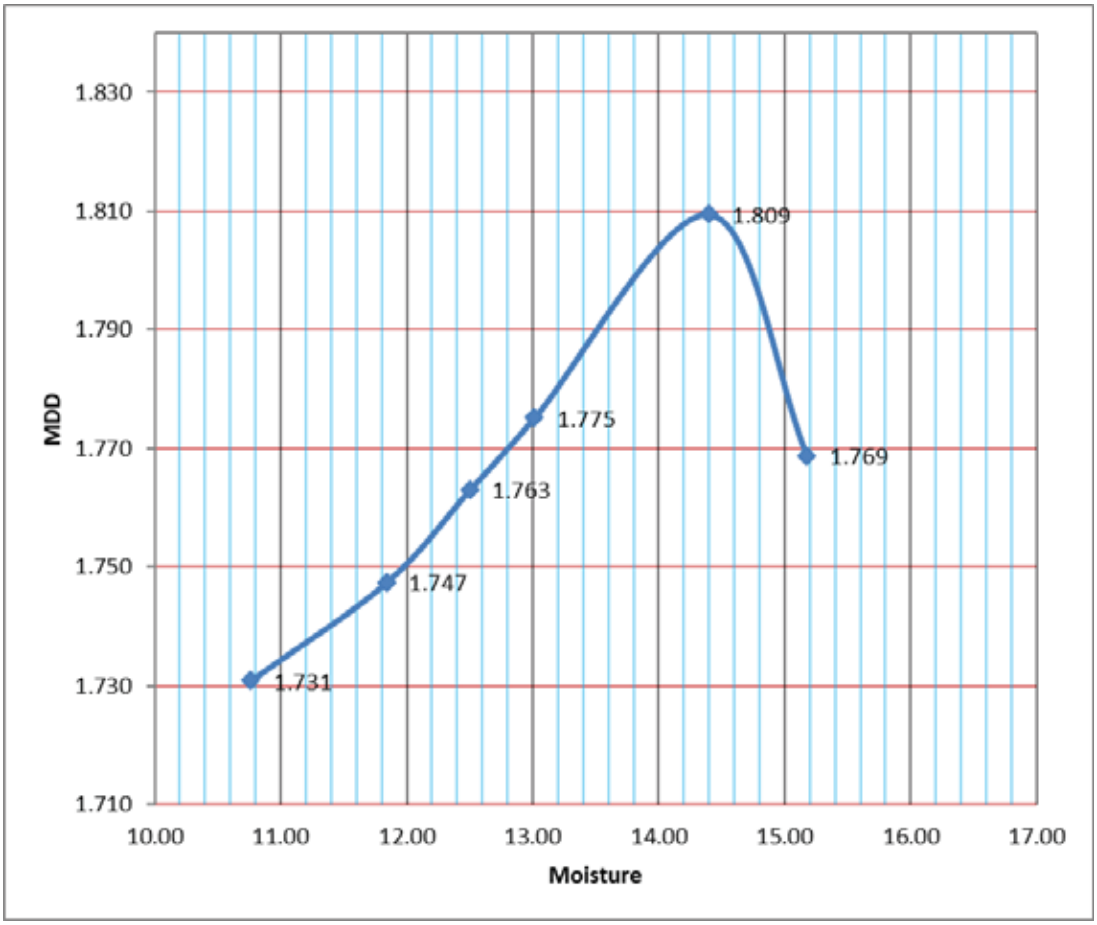
1. As per IS 456 Permissible limit of Sulphate is 400 Max.
2. As per IS 456 Permissible limit of Chloride is 500/2000 Max for RCC/C.C

Modified Proctor Density Test

MOISTURE - DENSITY RELATIONSHIP OF SOIL

S.no	Location	MDD (gm/cc)	OMC (%)
1.	BH-1	1.81	14.40

GRAPH



S.no	Location	OMC (%)	MDD (gm/cc)
2.	BH-2	14.19	1.83
3.	BH-3	13.48	1.76
4.	BH-4	12.85	1.75
5.	BH-5	15.14	1.84
6.	BH-6	13.21	1.75
7.	BH-7	12.35	1.74
8.	BH-8	13.29	1.76
9.	BH-9	12.88	1.76
10.	BH-10	13.47	1.75
11.	BH-11	12.91	1.74
12.	BH-12	14.69	1.81
13.	BH-13	13.59	1.77
14.	BH-14	12.79	1.75
15.	BH-15	15.57	1.82
16.	BH-16	14.58	1.82
17.	BH-17	12.87	1.76
18.	BH-18	13.67	1.76
19.	BH-19	14.11	1.77
20.	BH-20	14.97	1.80

CALIFORNIA BEARING RATIO RESULTS

S No.	Location	CBR Unsoaked (%)	S No.	Location	CBR Unsoaked (%)
1.	BH-1	9.7	11.	BH-11	9.4
2.	BH-2	9.3	12.	BH-12	8.2
3.	BH-3	10.1	13.	BH-13	8.9
4.	BH-4	8.4	14.	BH-14	9.6
5.	BH-5	7.8	15.	BH-15	7.1
6.	BH-6	7.6	16.	BH-16	9.3
7.	BH-7	8.1	17.	BH-17	10.1
8.	BH-8	7.5	18.	BH-18	8.6
9.	BH-9	7.1	19.	BH-19	9.4
10.	BH-10	8.3	20.	BH-20	8.5

****End of Report****

**Standard Proctor test has been performed*
**CBR has been performed on the actual MDD achieved while test.*

CYCLIC PLATE LOAD TEST

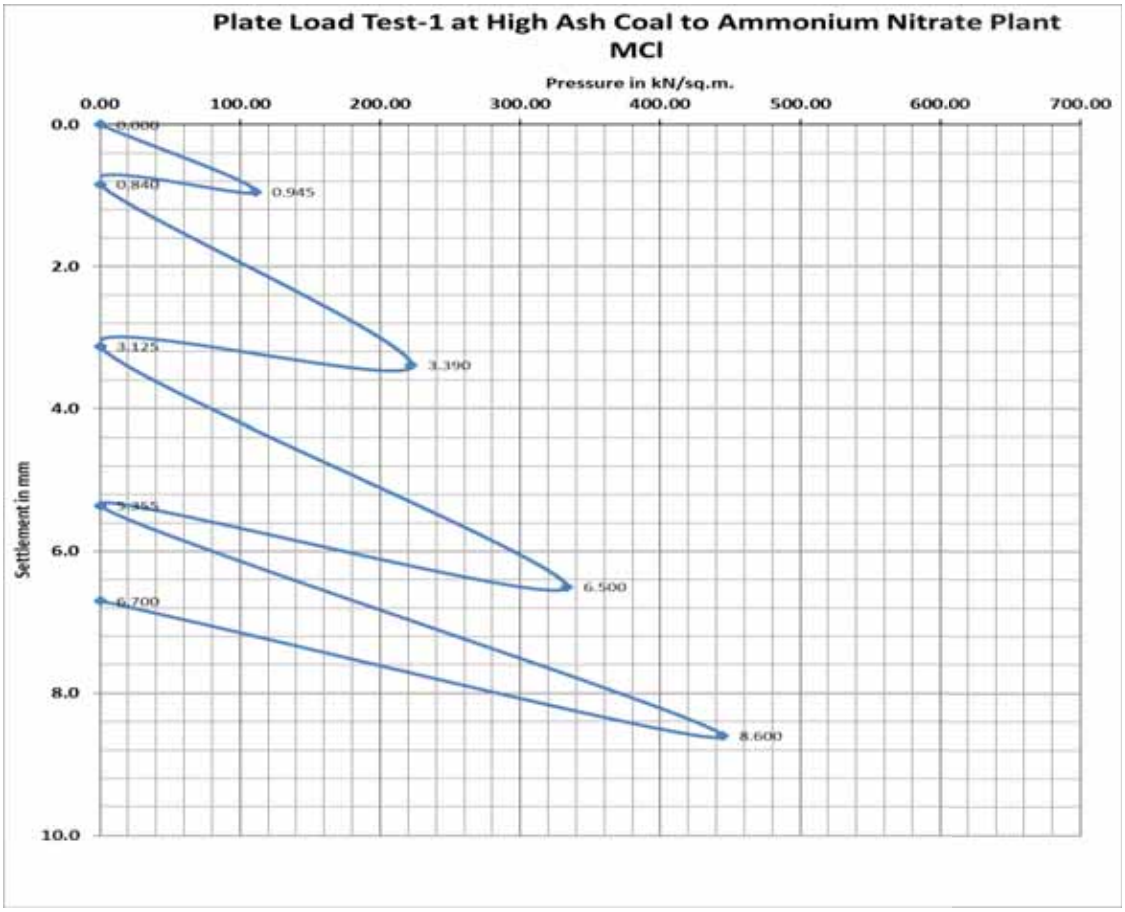
THE COEFFICIENT OF ELASTIC UNIFORM SHEAR AND ELASTIC NON- UNIFROM SHEAR

Location	Coefficient of elastic uniform Compression (C_u)	Coefficient of elastic uniform shear (C_t)	Coefficient of elastic Non- uniform Compression (C_q)
BH-1	3.01 x 10^4 Kn/m3	1.50 x 10^4 Kn/m3	5.20 x 10^4 Kn/m3
BH-2	2.20 x 10^4 Kn/m3	1.10 x 10^4 Kn/m3	3.80 x 10^4 Kn/m3
BH-3	2.41 x 10^4 Kn/m3	1.20 x 10^4 Kn/m3	4.16 x 10^4 Kn/m3
BH-4	2.04 x 10^4 Kn/m3	1.02 x 10^4 Kn/m3	3.52 x 10^4 Kn/m3
BH-5	2.08 x 10^4 Kn/m3	1.04 x 10^4 Kn/m3	3.59 x 10^4 Kn/m3
BH-6	1.68 x 10^4 Kn/m3	8.40 x 10^3 Kn/m3	2.90 x 10^4 Kn/m3
BH-7	2.26 x 10^4 Kn/m3	1.13 x 10^4 Kn/m3	3.90 x 10^4 Kn/m3
BH-8	2.95 x 10^4 Kn/m3	1.47 x 10^4 Kn/m3	5.10 x 10^4 Kn/m3
BH-9	2.97 x 10^4 Kn/m3	1.48 x 10^4 Kn/m3	5.13 x 10^4 Kn/m3
BH-10	1.53 x 10^4 Kn/m3	7.65 x 10^3 Kn/m3	2.64 x 10^4 Kn/m3
BH-11	2.50 x 10^4 Kn/m3	1.25 x 10^4 Kn/m3	4.37 x 10^4 Kn/m3
BH-12	2.85 x 10^4 Kn/m3	1.42 x 10^4 Kn/m3	4.93 x 10^4 Kn/m3
BH-13	2.62 x 10^4 Kn/m3	1.31 x 10^4 Kn/m3	4.53 x 10^4 Kn/m3
BH-14	2.79 x 10^4 Kn/m3	1.39 x 10^4 Kn/m3	4.82 x 10^4 Kn/m3
BH-15	2.44 x 10^4 Kn/m3	1.22 x 10^4 Kn/m3	4.22 x 10^4 Kn/m3
BH-16	2.59 x 10^4 Kn/m3	1.29 x 10^4 Kn/m3	4.48 x 10^4 Kn/m3
BH-17	2.17 x 10^4 Kn/m3	1.08 x 10^4 Kn/m3	3.75 x 10^4 Kn/m3
BH-18	2.52 x 10^4 Kn/m3	1.26 x 10^4 Kn/m3	4.35 x 10^4 Kn/m3
BH-19	1.60 x 10^4 Kn/m3	8.02 x 10^3 Kn/m3	2.76 x 10^4 Kn/m3
BH-20	2.13 x 10^3 Kn/m3	1.06 x 10^4 Kn/m3	3.68 x 10^4 Kn/m3

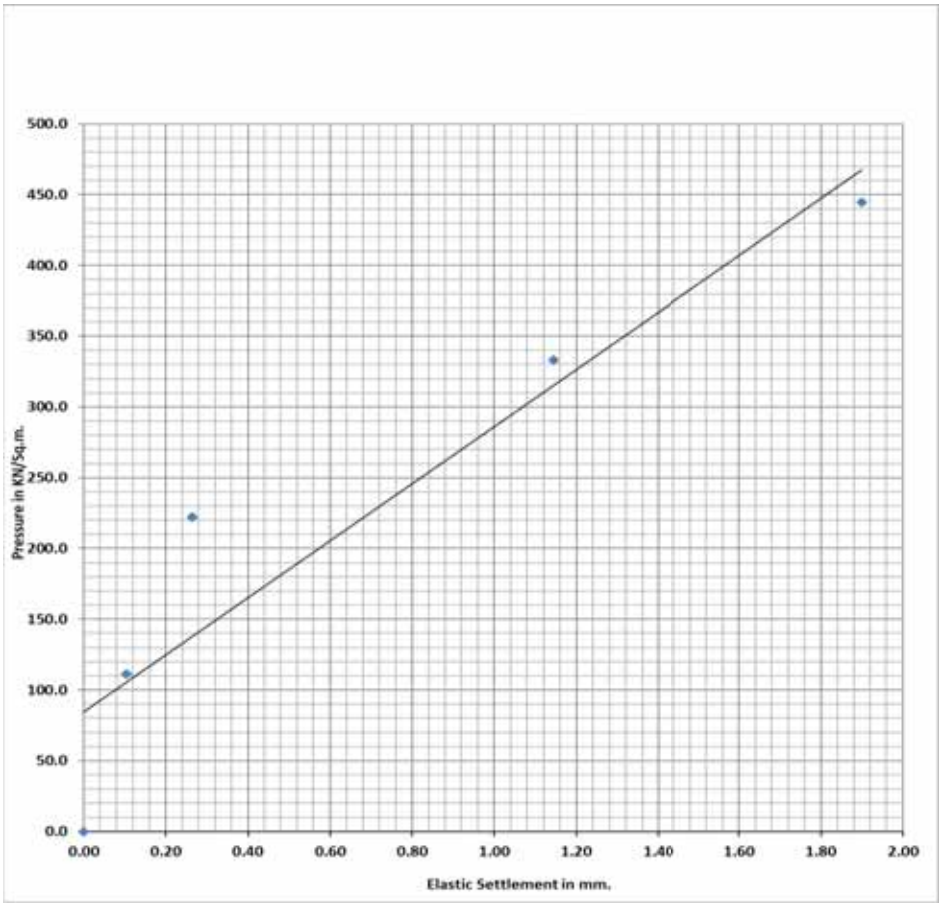
TEST NO 1

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	*0.945*
0.00	*0.840*
222.2	*3.390*
0.00	*3.125*
333.3	*6.500*
0.00	*5.355*
444.4	*8.600*
0.00	*6.700*



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.105
222.2	0.265
333.3	1.145
444.4	1.900



Thus, for 4 m^2 base area

$$C_u = 20.1 \times 10^4 \times \sqrt{0.09/4} = 3.01 \times 10^4 \text{ Kn/m}^3$$

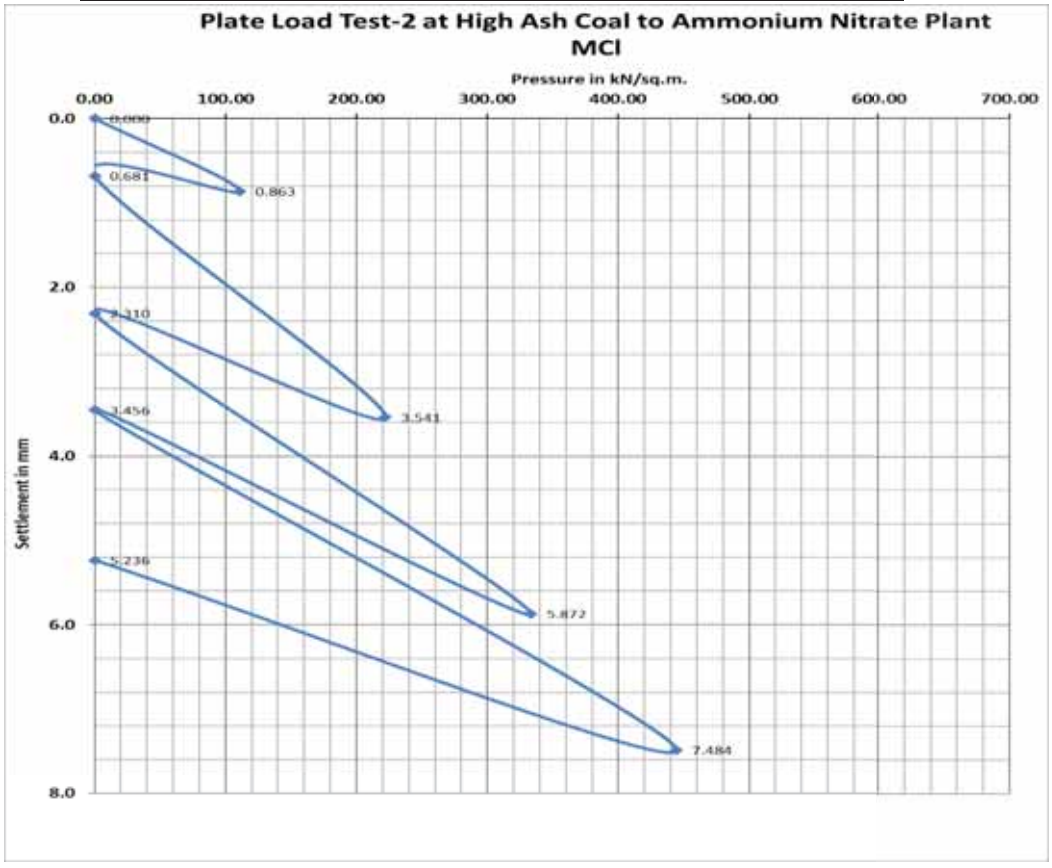
$$C_t = 0.5 \times C_u = 0.5 \times 3.01 \times 10^4 \text{ Kn/m}^3$$
$$= 1.50 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 3.01 \times 10^4 \text{ Kn/m}^3$$
$$= 5.20 \times 10^4 \text{ Kn/m}^3$$

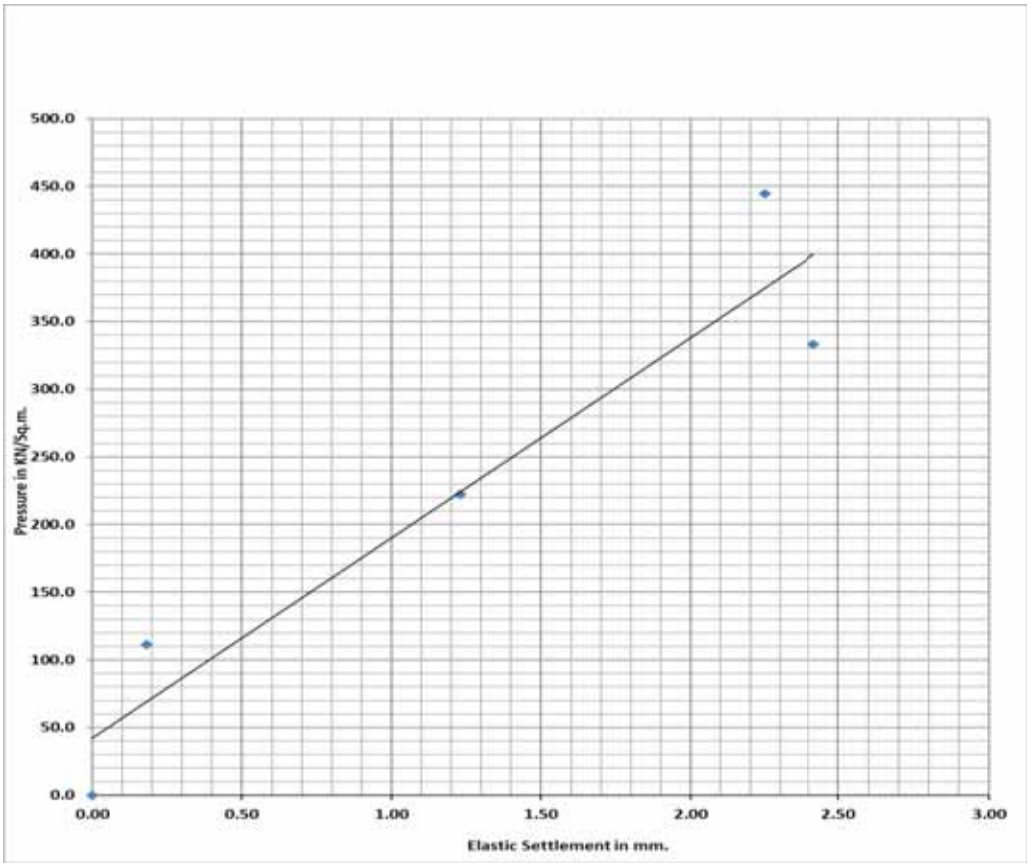
TEST NO 2

Pressure (Kn/m^2)	Settlement (mm)
111.1	*0.863*
0.00	*0.681*
222.2	*3.541*
0.00	*2.310*
333.3	*5.872*
0.00	*3.456*
444.4	*7.484*
0.00	*5.236*

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.182
222.2	1.231
333.3	2.416
444.4	2.248



Thus, for 4 m^2 base area

$$C_u = 14.7 \times 10^4 \times \sqrt{0.09/4} = 2.20 \times 10^4 \text{ Kn/m}^3$$

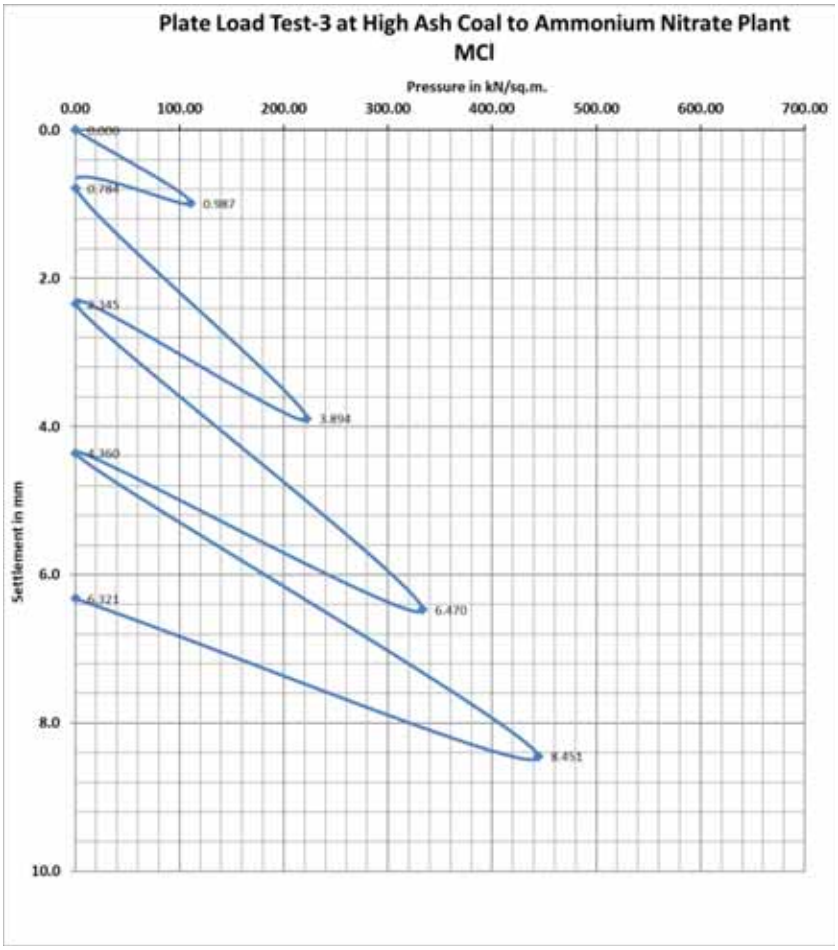
$$C_t = 0.5 \times C_u = 0.5 \times 2.20 \times 10^4 \text{ Kn/m}^3$$
$$= 1.10 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.20 \times 10^4 \text{ Kn/m}^3$$
$$= 3.80 \times 10^4 \text{ Kn/m}^3$$

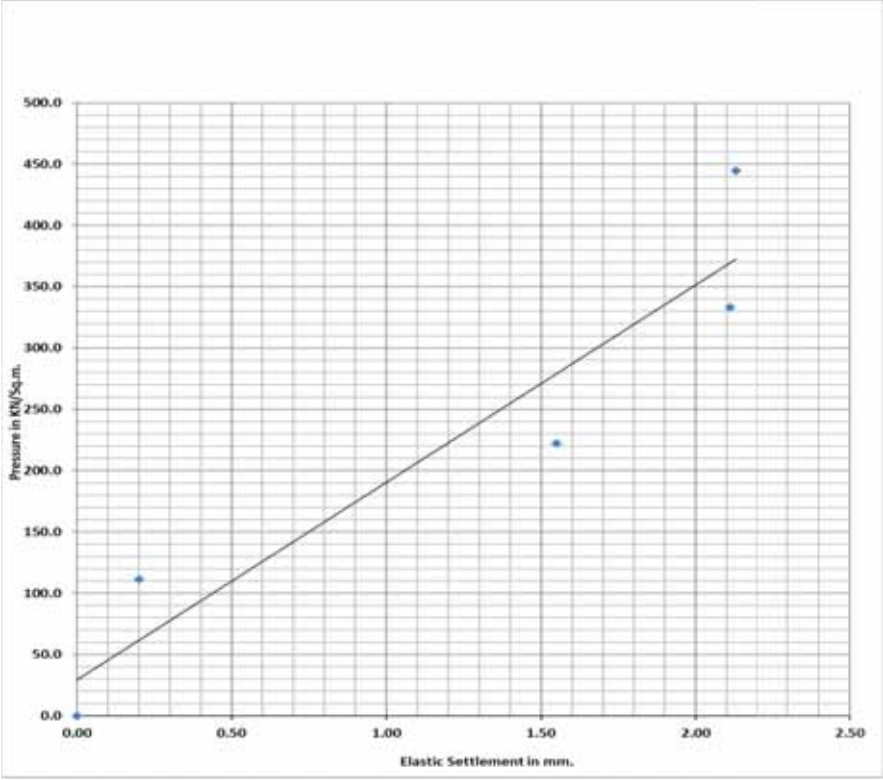
TEST NO 3

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.987
0.00	0.784
222.2	3.894
0.00	2.345
333.3	6.470
0.00	4.360
444.4	8.451
0.00	6.321



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.203
222.2	1.549
333.3	2.110
444.4	2.130



Thus, for 4 m^2 base area

$$C_u = 16.1 \times 10^4 \times \sqrt{0.09/4} = 2.41 \times 10^4 \text{ Kn/m}^3$$

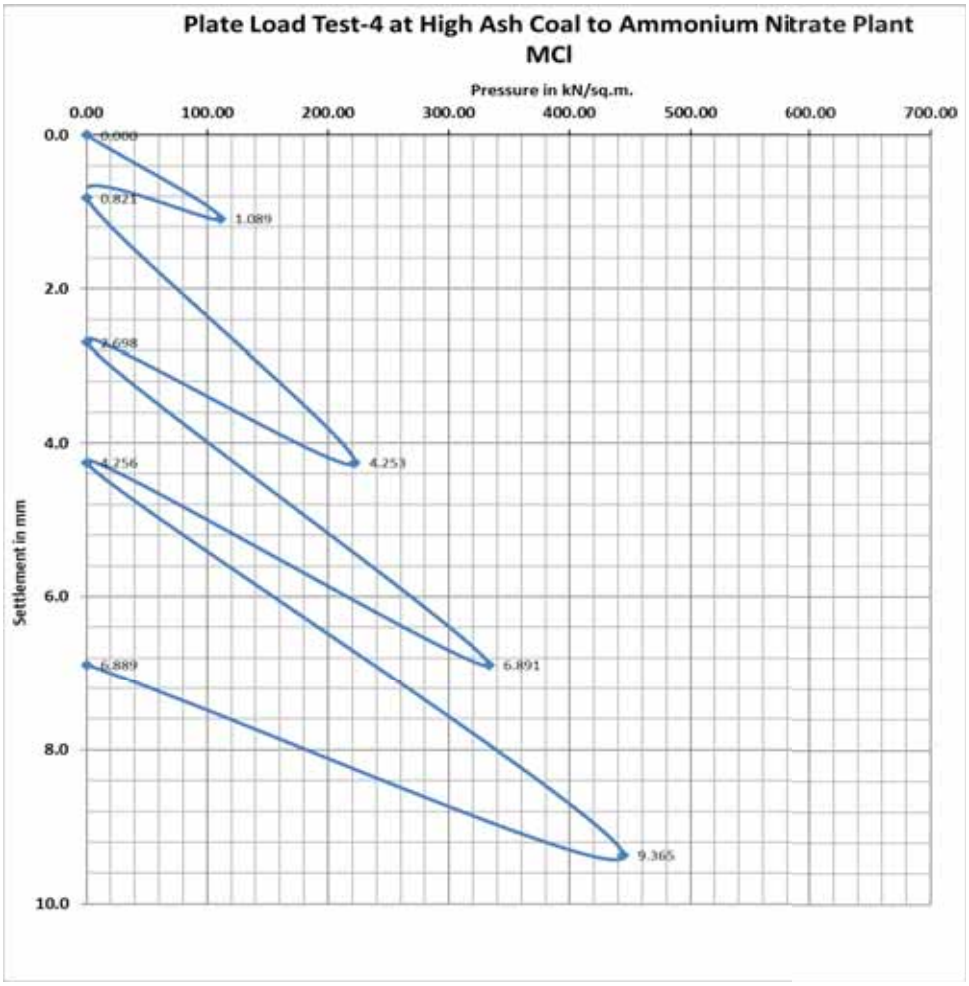
$$C_t = 0.5 \times C_u = 0.5 \times 2.41 \times 10^4 \text{ Kn/m}^3$$
$$= 1.20 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.41 \times 10^4 \text{ Kn/m}^3$$
$$= 4.16 \times 10^4 \text{ Kn/m}^3$$

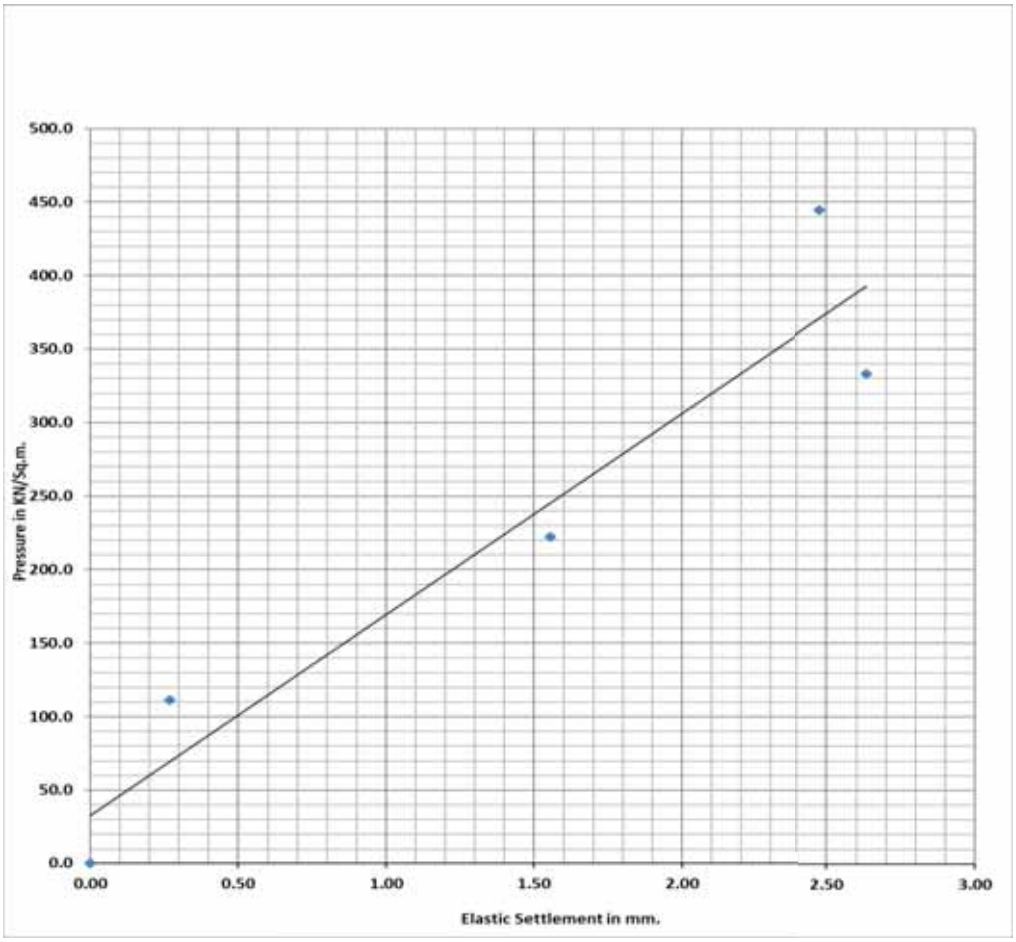
TEST NO 4

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.089
0.00	0.821
222.2	4.253
0.00	2.698
333.3	6.891
0.00	4.256
444.4	9.365
0.00	6.889



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.268
222.2	1.555
333.3	2.635
444.4	2.476



Thus, for 4 m^2 base area

$$C_u = 13.6 \times 10^4 \times \sqrt{0.09/4} = 2.04 \times 10^4 \text{ Kn/m}^3$$

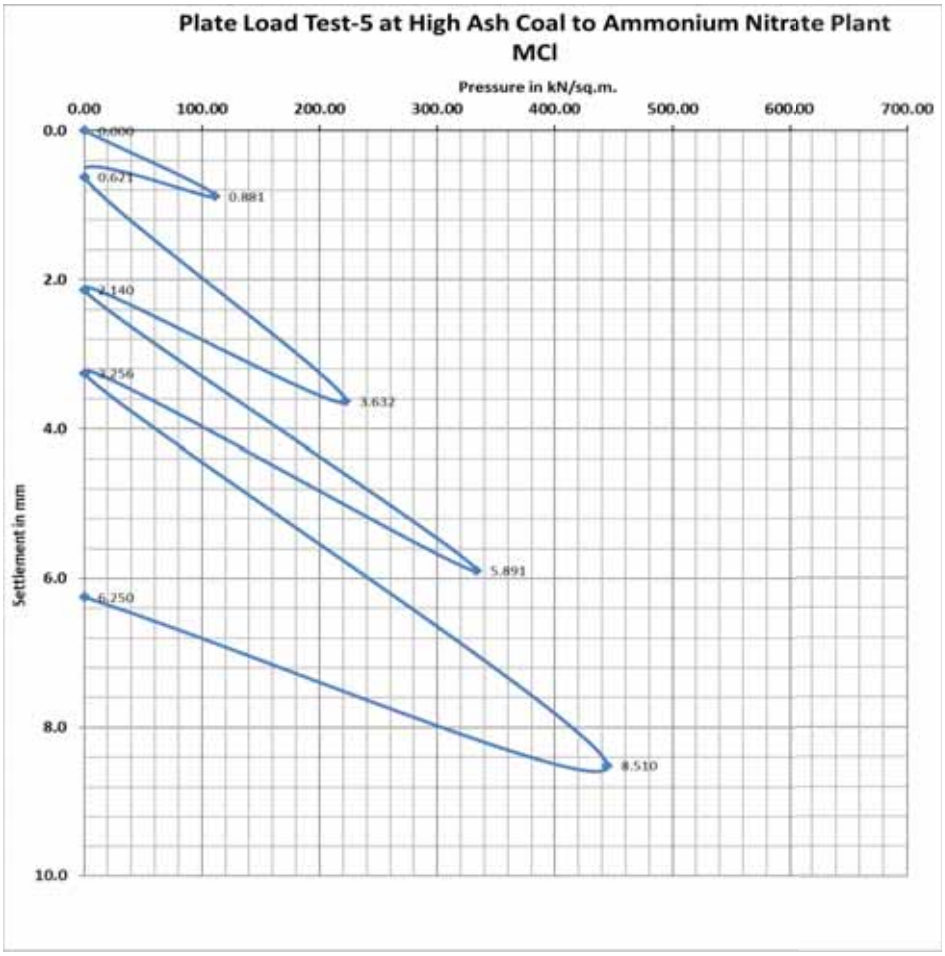
$$C_t = 0.5 \times C_u = 0.5 \times 2.04 \times 10^4 \text{ Kn/m}^3$$
$$= 1.02 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.04 \times 10^4 \text{ Kn/m}^3$$
$$= 3.52 \times 10^4 \text{ Kn/m}^3$$

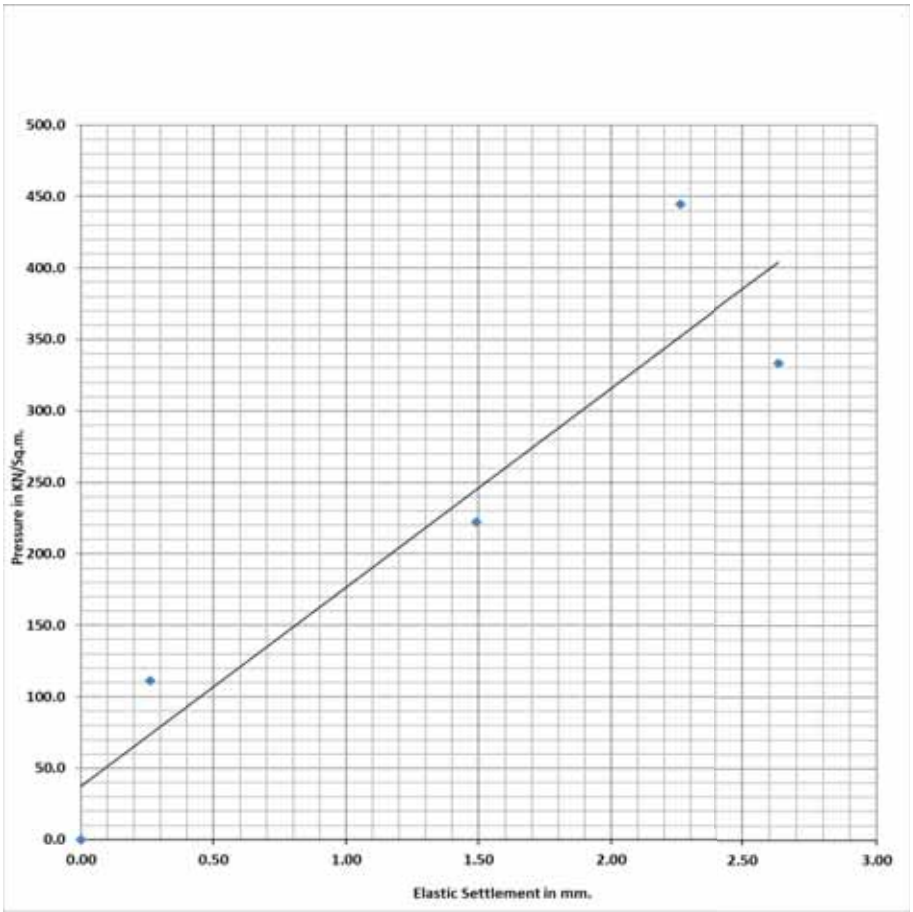
TEST NO 5

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.881
0.00	0.621
222.2	3.632
0.00	2.140
333.3	5.891
0.00	3.256
444.4	8.510
0.00	6.250



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.260
222.2	1.492
333.3	2.635
444.4	2.260



Thus, for 4 m^2 base area

$$C_u = 13.9 \times 10^4 \times \sqrt{0.09/4} = 2.08 \times 10^4 \text{ Kn/m}^3$$

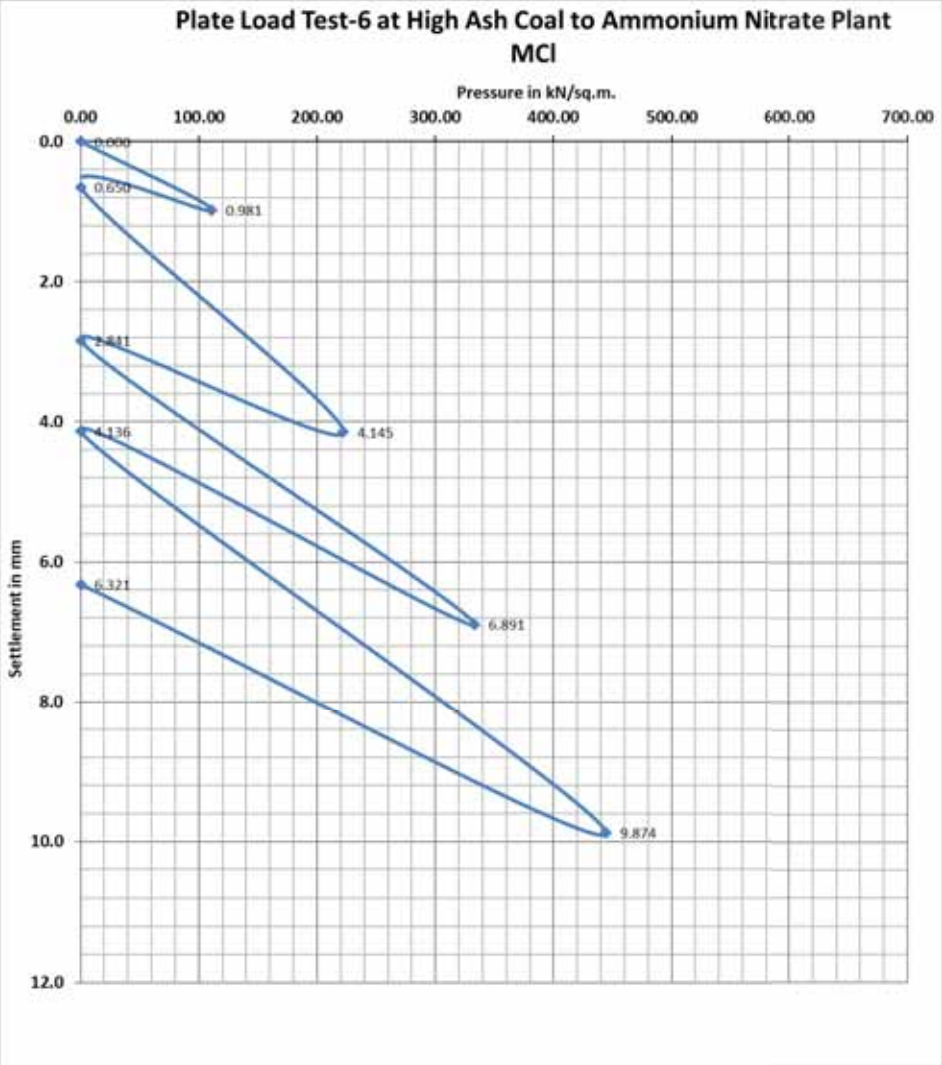
$$C_t = 0.5 \times C_u = 0.5 \times 2.08 \times 10^4 \text{ Kn/m}^3$$
$$= 1.04 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.08 \times 10^4 \text{ Kn/m}^3$$
$$= 3.59 \times 10^4 \text{ Kn/m}^3$$

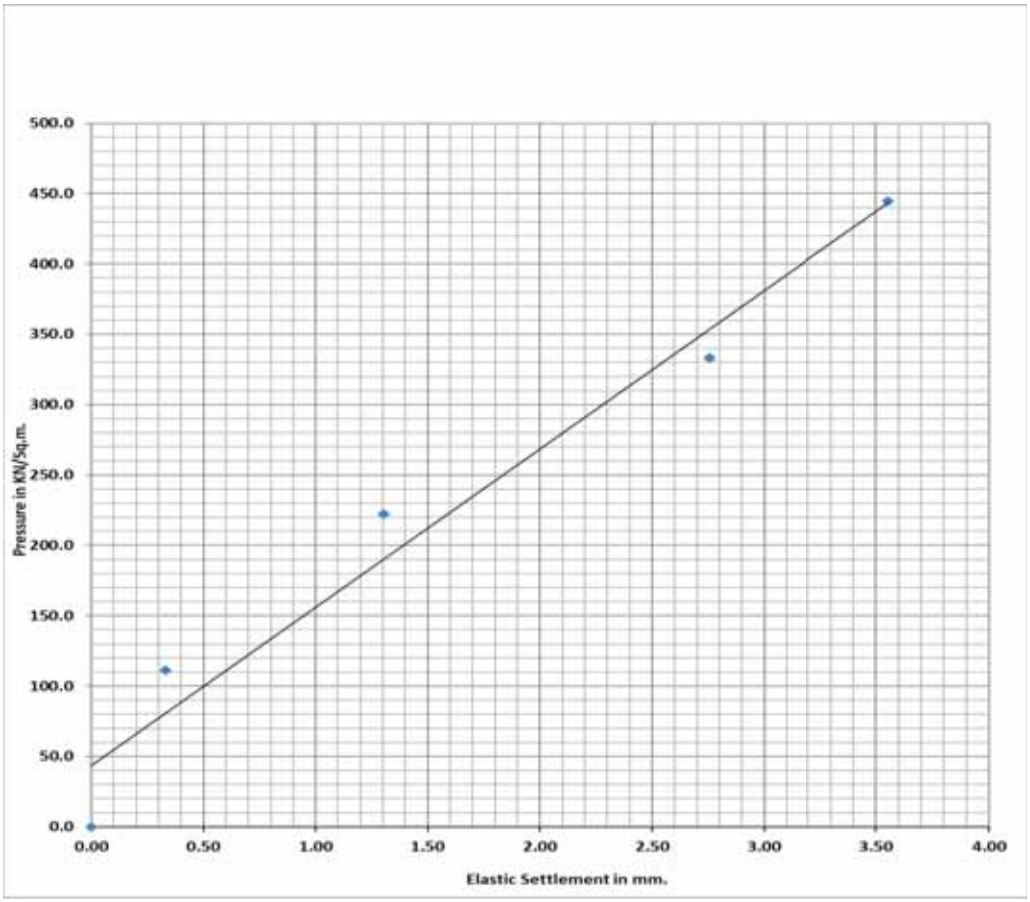
TEST NO 6

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.981
0.00	0.650
222.2	4.145
0.00	2.841
333.3	6.891
0.00	4.136
444.4	9.874
0.00	6.321



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.331
222.2	1.304
333.3	2.755
444.4	3.553



Thus, for 4 m^2 base area

$$C_u = 11.2 \times 10^4 \times \sqrt{0.09/4} = 1.68 \times 10^4 \text{ Kn/m}^3$$

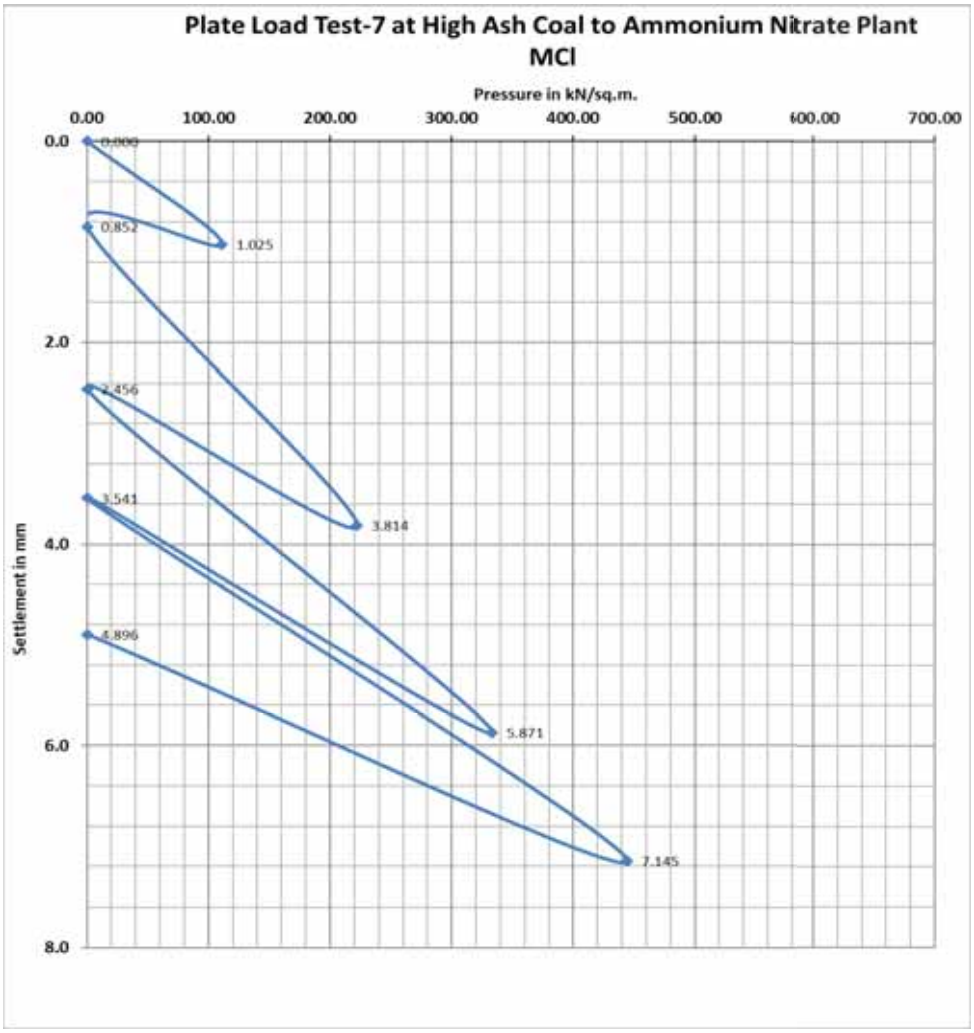
$$C_t = 0.5 \times C_u = 0.5 \times 1.68 \times 10^4 \text{ Kn/m}^3$$
$$= 8.40 \times 10^3 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 1.68 \times 10^4 \text{ Kn/m}^3$$
$$= 2.90 \times 10^4 \text{ Kn/m}^3$$

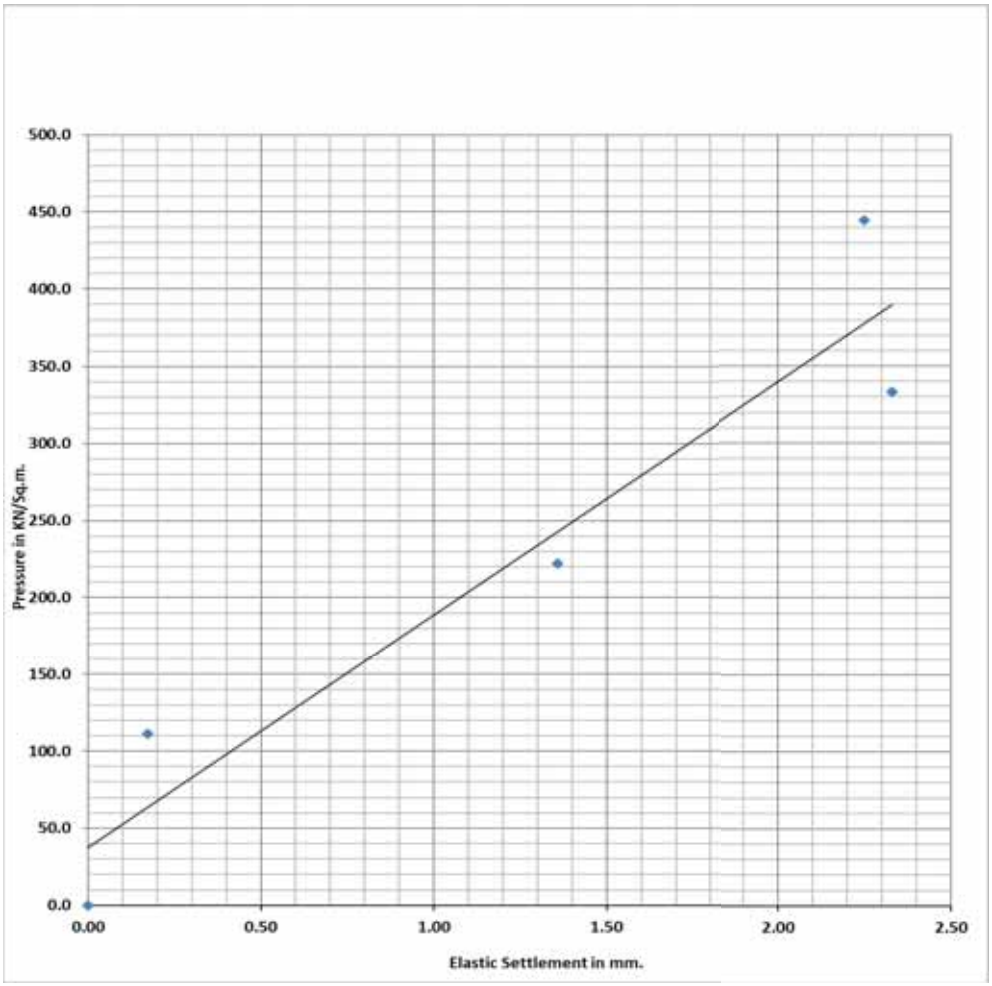
TEST NO 7

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.025
0.00	0.852
222.2	3.814
0.00	2.456
333.3	5.871
0.00	3.541
444.4	7.145
0.00	4.896



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.173
222.2	1.358
333.3	2.330
444.4	2.249



Thus, for 4 m^2 base area

$$C_u = 15.1 \times 10^4 \times \sqrt{0.09/4} = 2.26 \times 10^4 \text{ Kn/m}^3$$

$$C_t = 0.5 \times C_u = 0.5 \times 2.26 \times 10^4 \text{ Kn/m}^3$$
$$= 1.13 \times 10^4 \text{ Kn/m}^3$$

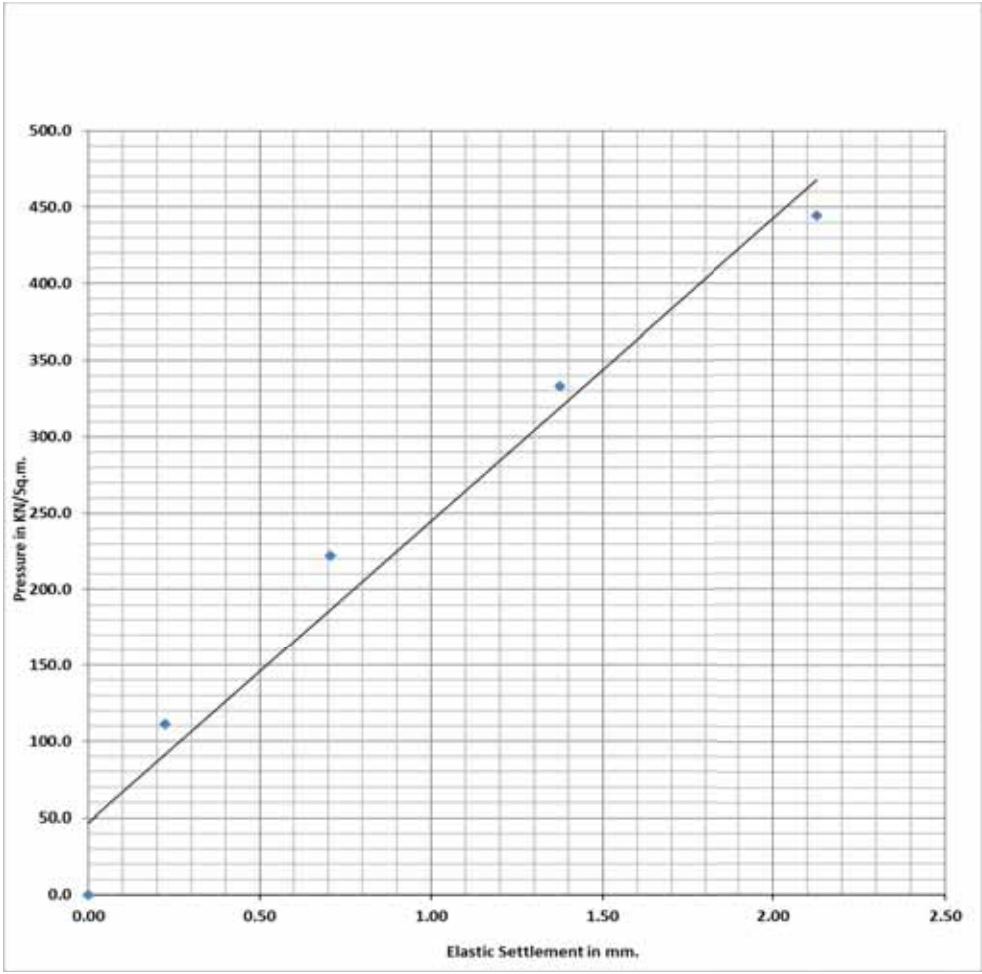
$$C_q = 1.73 \times C_u = 1.73 \times 2.26 \times 10^4 \text{ Kn/m}^3$$
$$= 3.90 \times 10^4 \text{ Kn/m}^3$$

TEST NO 8

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.874
0.00	0.651
222.2	2.593
0.00	1.887
333.3	4.896
0.00	3.521
444.4	7.490
0.00	5.362

Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.223
222.2	0.706
333.3	1.375
444.4	2.128



Thus, for 4 m^2 base area

$$C_u = 19.7 \times 10^4 \times \sqrt{0.09/4} = 2.95 \times 10^4 \text{ Kn/m}^3$$

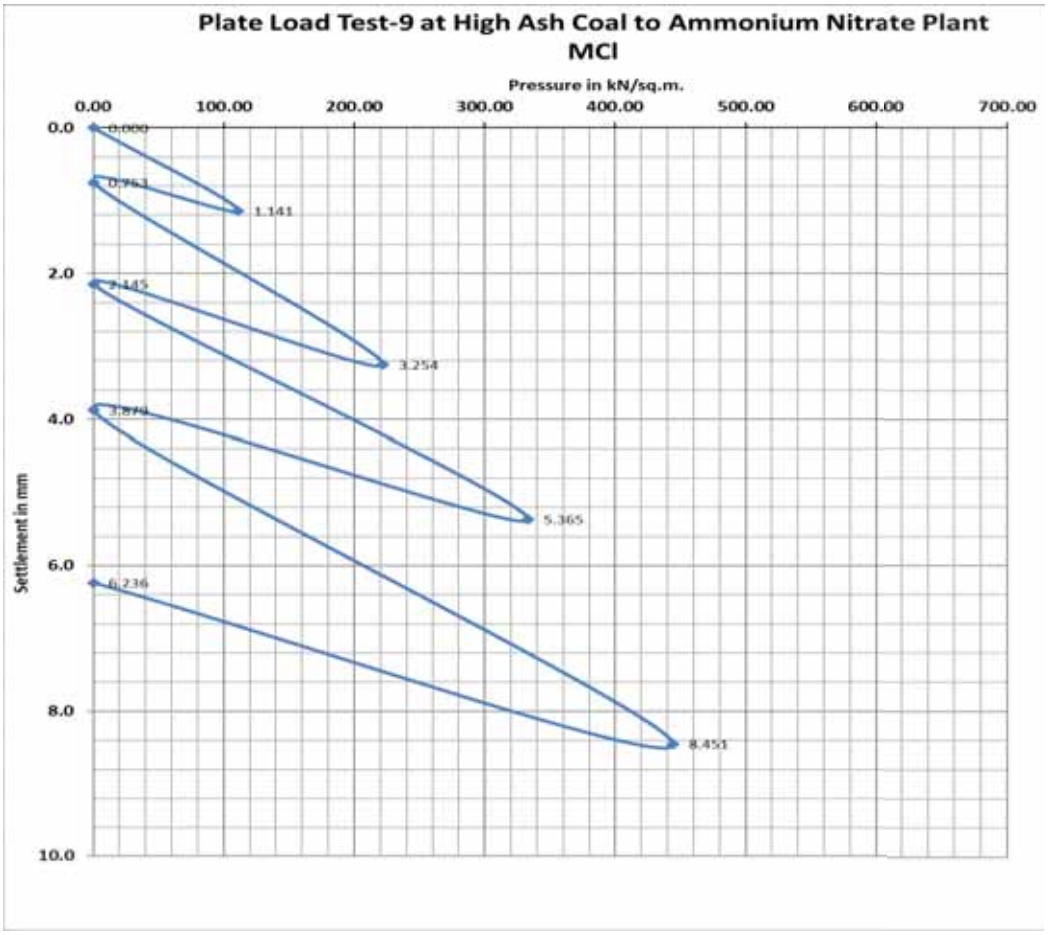
$$C_t = 0.5 \times C_u = 0.5 \times 2.95 \times 10^4 \text{ Kn/m}^3$$
$$= 1.47 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.95 \times 10^4 \text{ Kn/m}^3$$
$$= 5.10 \times 10^4 \text{ Kn/m}^3$$

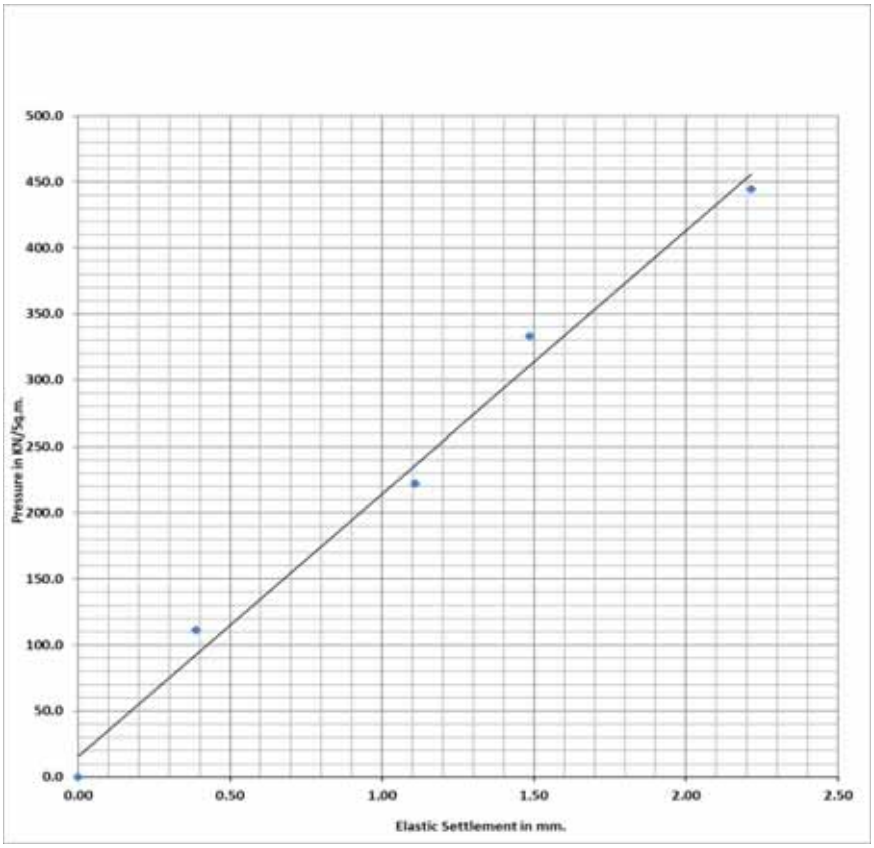
TEST NO 9

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.141
0.00	0.753
222.2	3.254
0.00	2.145
333.3	5.365
0.00	3.879
444.4	8.451
0.00	6.236



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.388
222.2	1.109
333.3	1.486
444.4	2.215



Thus, for 4 m^2 base area

$$C_u = 19.8 \times 10^4 \times \sqrt{0.09/4} = 2.97 \times 10^4 \text{ Kn/m}^3$$

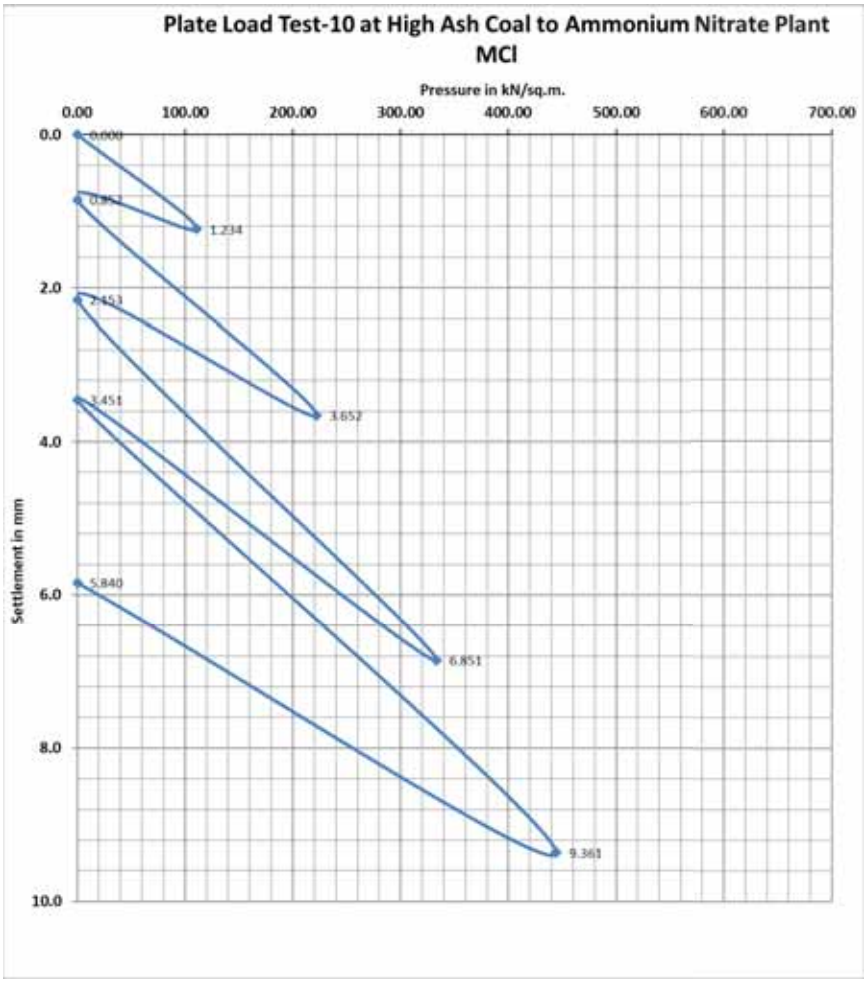
$$C_t = 0.5 \times C_u = 0.5 \times 2.97 \times 10^4 \text{ Kn/m}^3$$
$$= 1.48 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.97 \times 10^4 \text{ Kn/m}^3$$
$$= 5.13 \times 10^4 \text{ Kn/m}^3$$

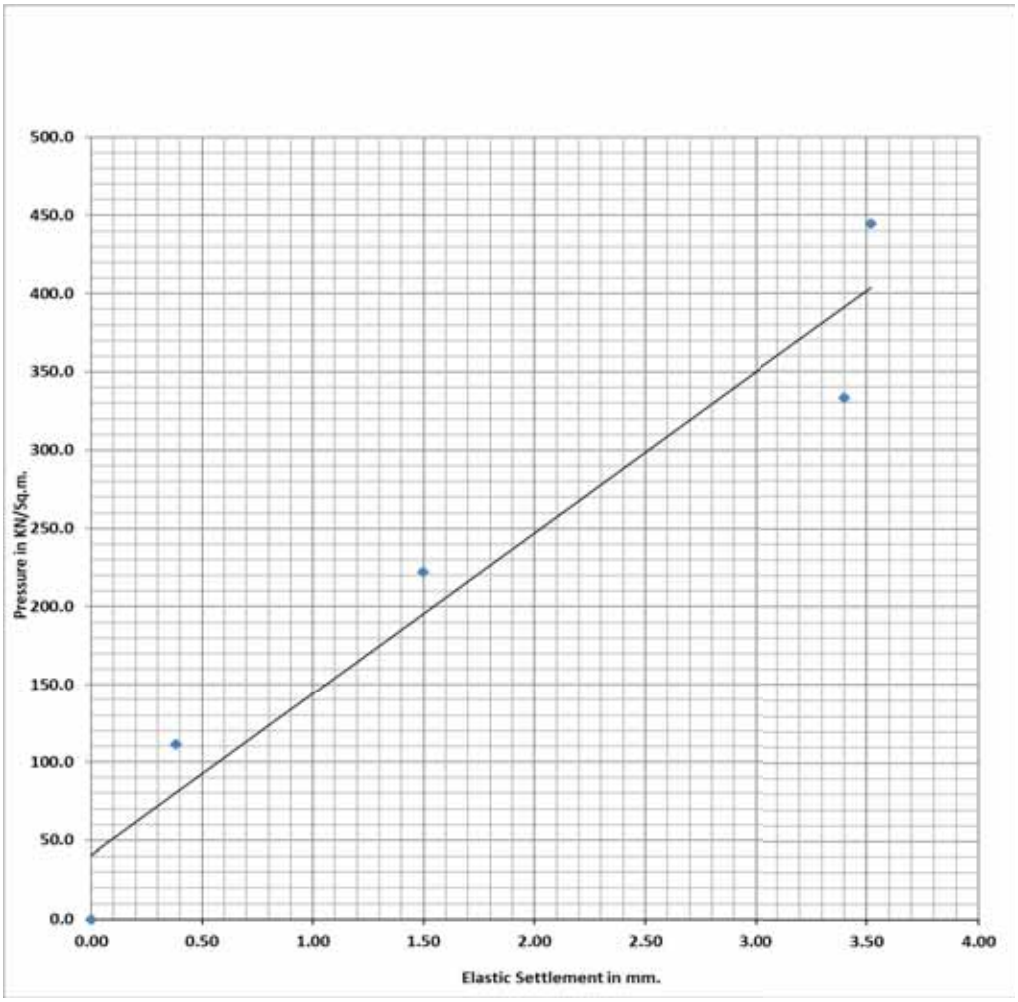
TEST NO 10

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.234
0.00	0.852
222.2	3.652
0.00	2.153
333.3	6.851
0.00	3.451
444.4	9.361
0.00	5.840



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.382
222.2	1.499
333.3	3.400
444.4	3.521



Thus, for 4 m^2 base area

$$C_u = 10.2 \times 10^4 \times \sqrt{0.09/4} = 1.53 \times 10^4 \text{ Kn/m}^3$$

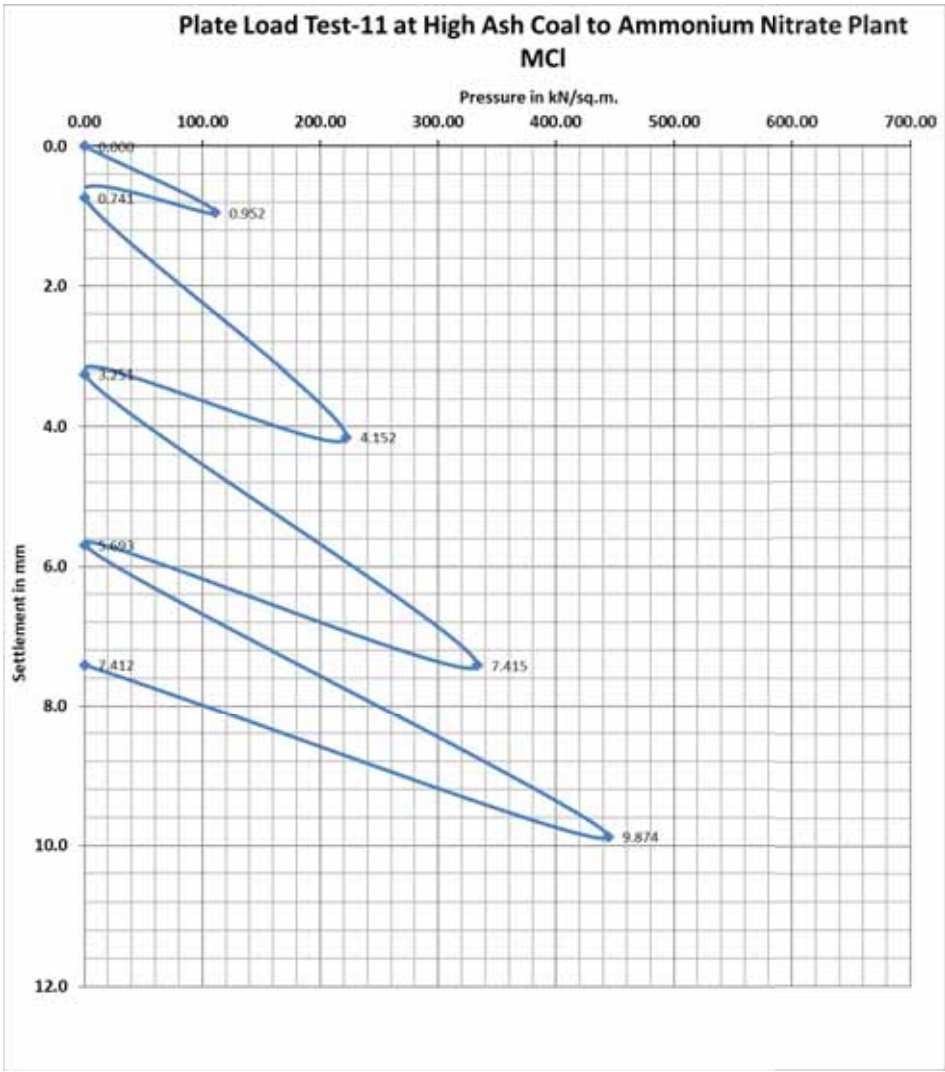
$$C_t = 0.5 \times C_u = 0.5 \times 1.53 \times 10^4 \text{ Kn/m}^3$$
$$= 7.65 \times 10^3 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 1.53 \times 10^4 \text{ Kn/m}^3$$
$$= 2.64 \times 10^4 \text{ Kn/m}^3$$

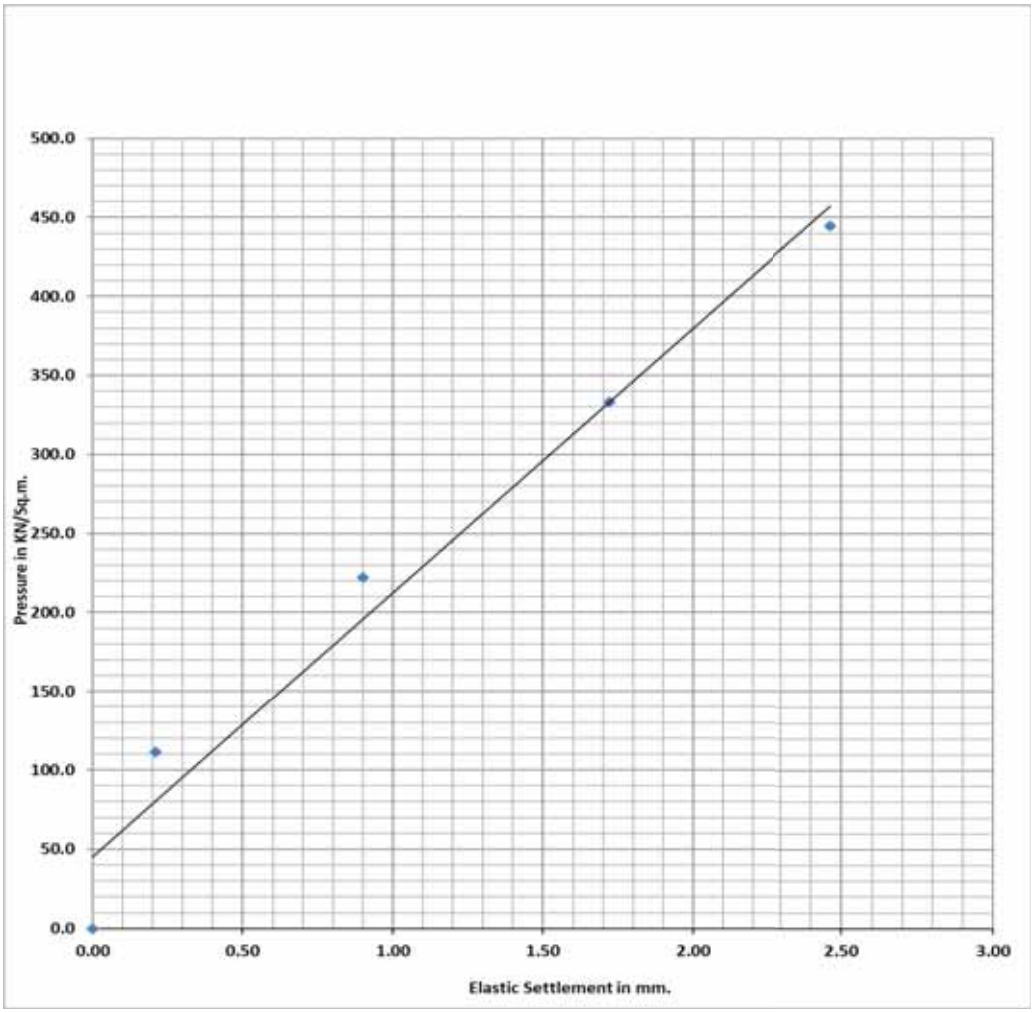
TEST NO 11

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.952
0.00	0.741
222.2	4.152
0.00	3.251
333.3	7.415
0.00	5.693
444.4	9.874
0.00	7.412



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.211
222.2	0.901
333.3	1.722
444.4	2.462



Thus, for 4 m^2 base area

$$C_u = 16.7 \times 10^4 \times \sqrt{0.09/4} = 2.50 \times 10^4 \text{ Kn/m}^3$$

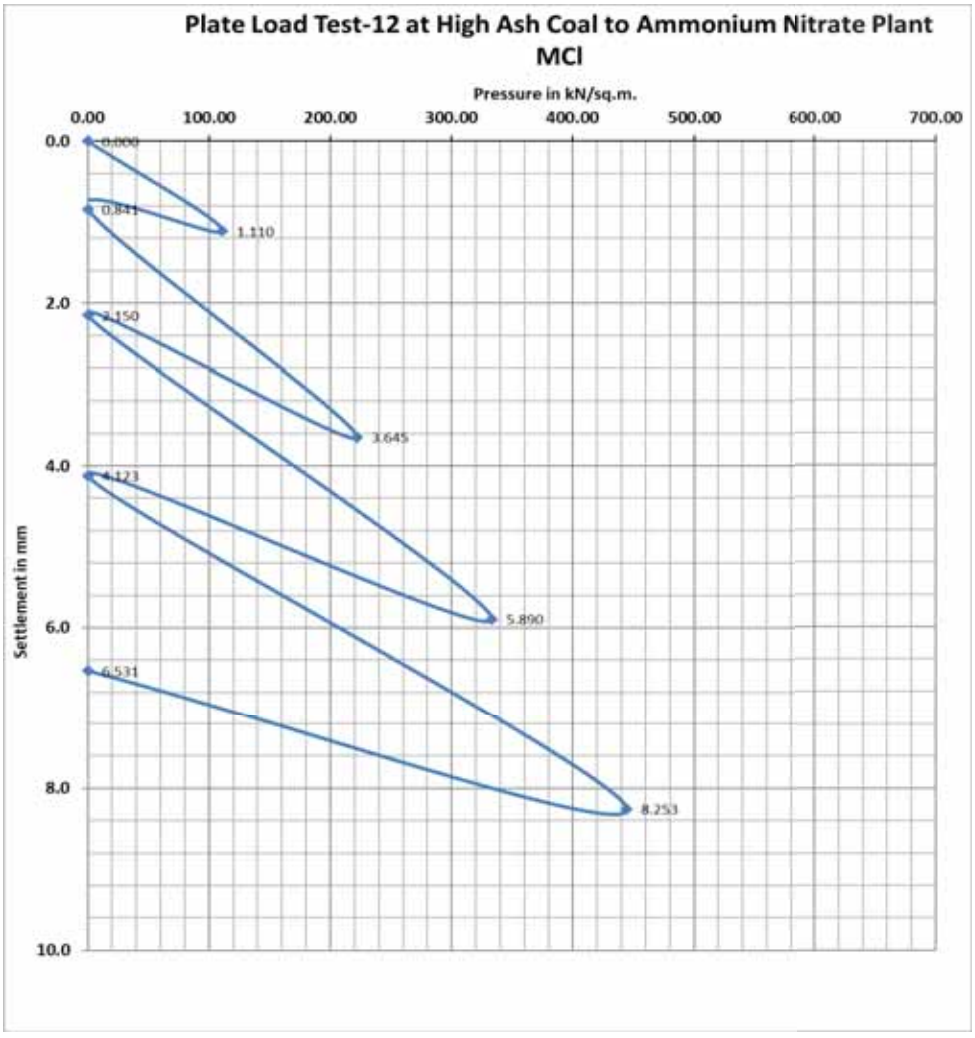
$$C_t = 0.5 \times C_u = 0.5 \times 2.50 \times 10^4 \text{ Kn/m}^3$$
$$= 1.25 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.53 \times 10^4 \text{ Kn/m}^3$$
$$= 4.37 \times 10^4 \text{ Kn/m}^3$$

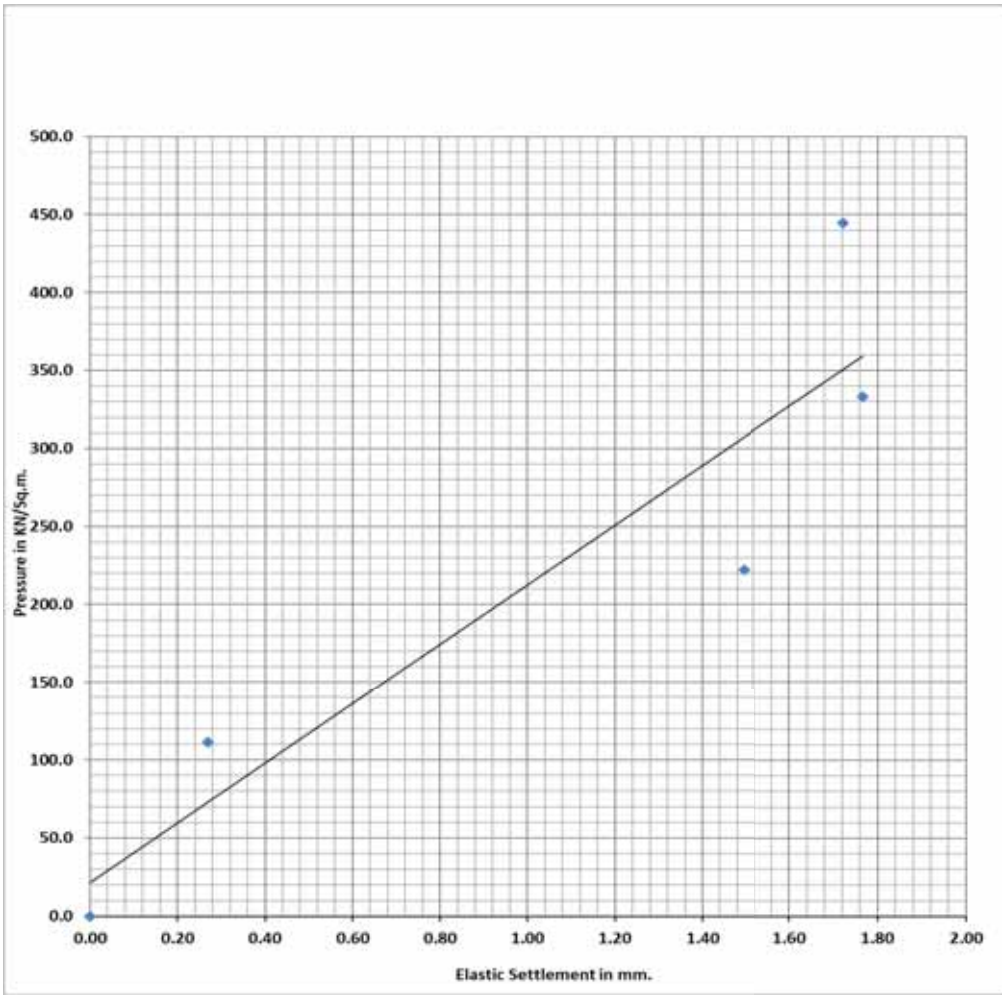
TEST NO 12

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.110
0.00	0.841
222.2	3.645
0.00	2.150
333.3	5.890
0.00	4.123
444.4	8.253
0.00	6.531



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.269
222.2	1.495
333.3	1.767
444.4	1.722



Thus, for 4 m^2 base area

$$C_u = 19.0 \times 10^4 \times \sqrt{0.09/4} = 2.85 \times 10^4 \text{ Kn/m}^3$$

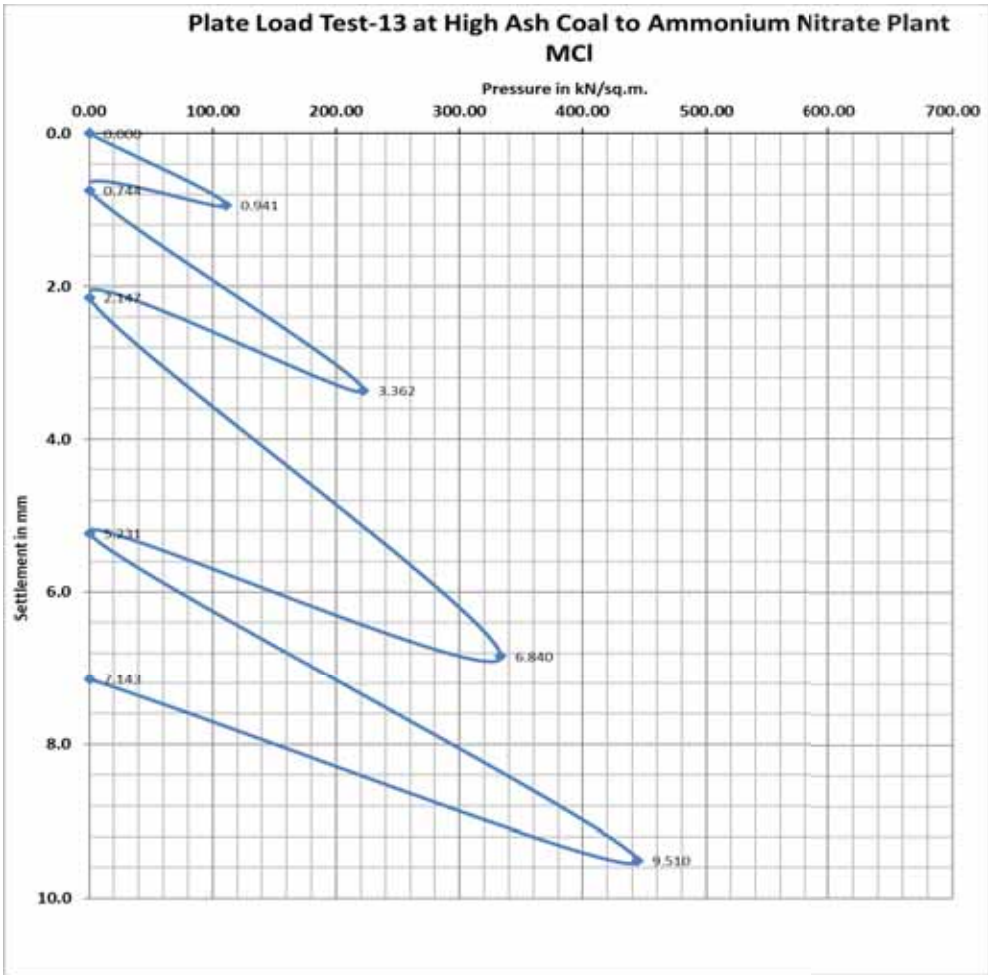
$$C_t = 0.5 \times C_u = 0.5 \times 2.85 \times 10^4 \text{ Kn/m}^3$$
$$= 1.42 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.85 \times 10^4 \text{ Kn/m}^3$$
$$= 4.93 \times 10^4 \text{ Kn/m}^3$$

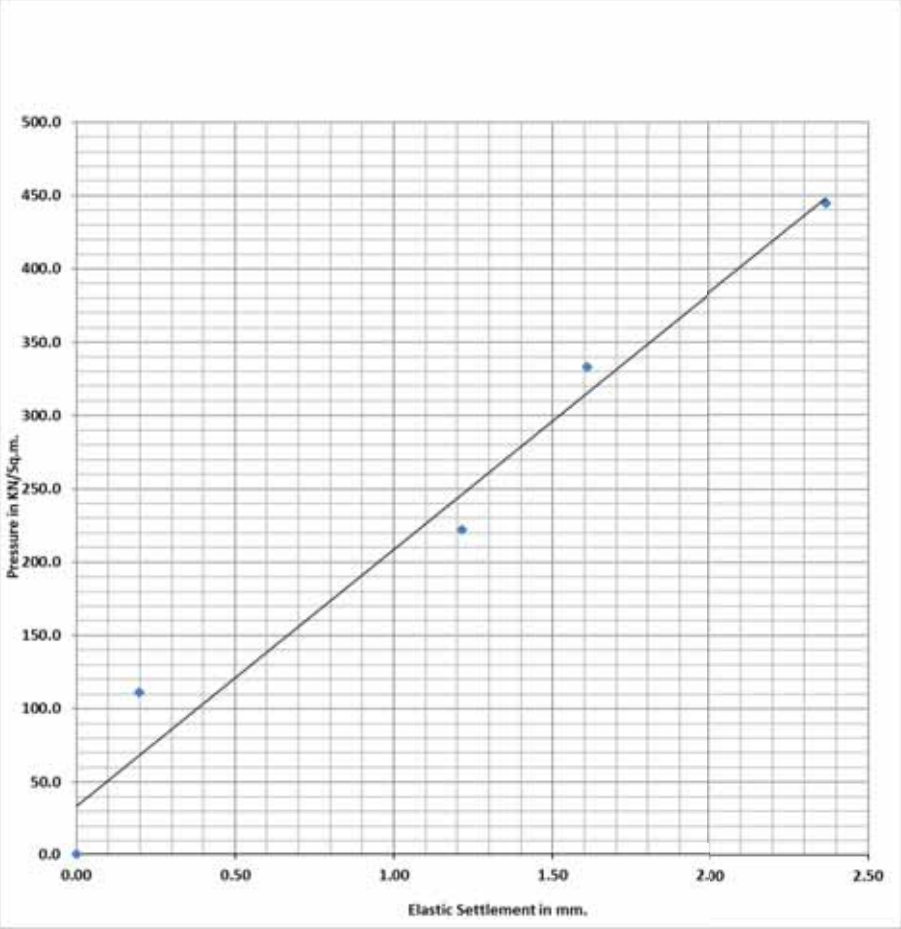
TEST NO 13

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.941
0.00	0.744
222.2	3.362
0.00	2.147
333.3	6.840
0.00	5.231
444.4	9.510
0.00	7.143



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.197
222.2	1.215
333.3	1.609
444.4	2.367



Thus, for 4 m^2 base area

$$C_u = 17.5 \times 10^4 \times\sqrt{0.09/4} = 2.62 \times 10^4 \text{ Kn/m}^3$$

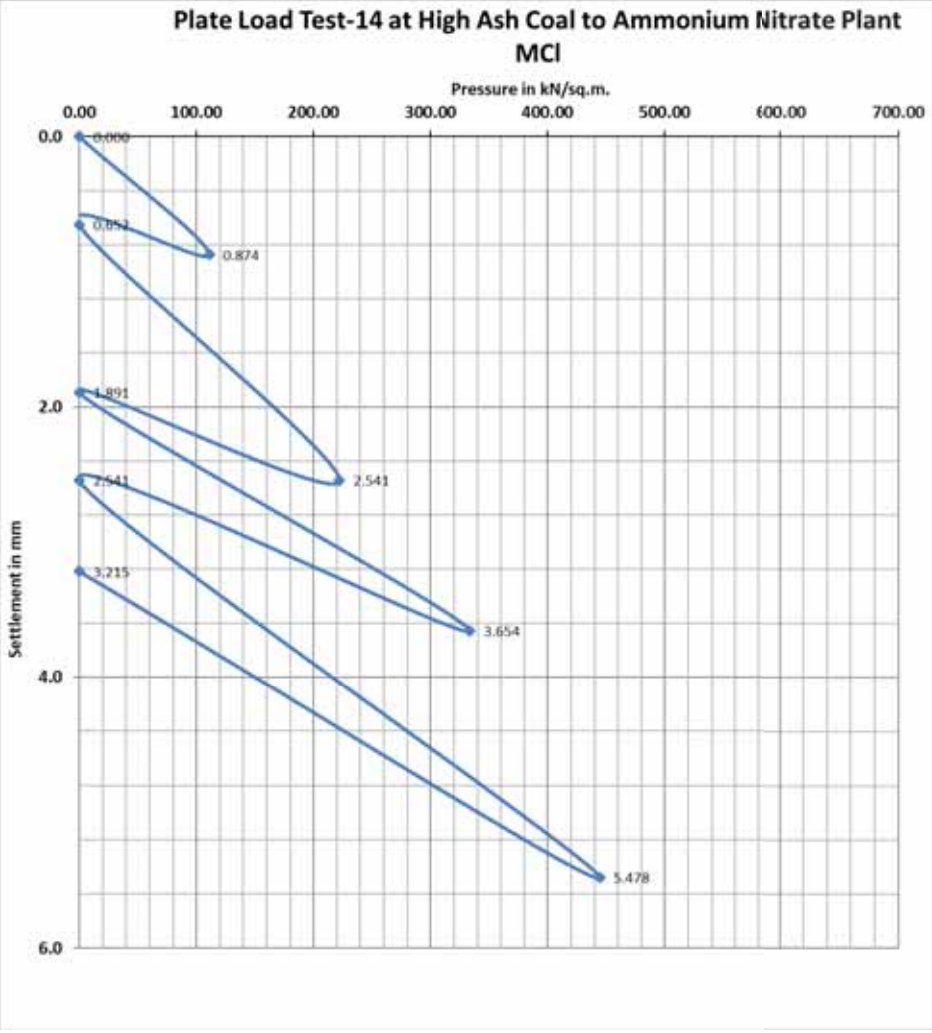
$$C_t = 0.5 \times C_u = 0.5 \times 2.62 \times 10^4 \text{ Kn/m}^3$$
$$= 1.31 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.62 \times 10^4 \text{ Kn/m}^3$$
$$= 4.53 \times 10^4 \text{ Kn/m}^3$$

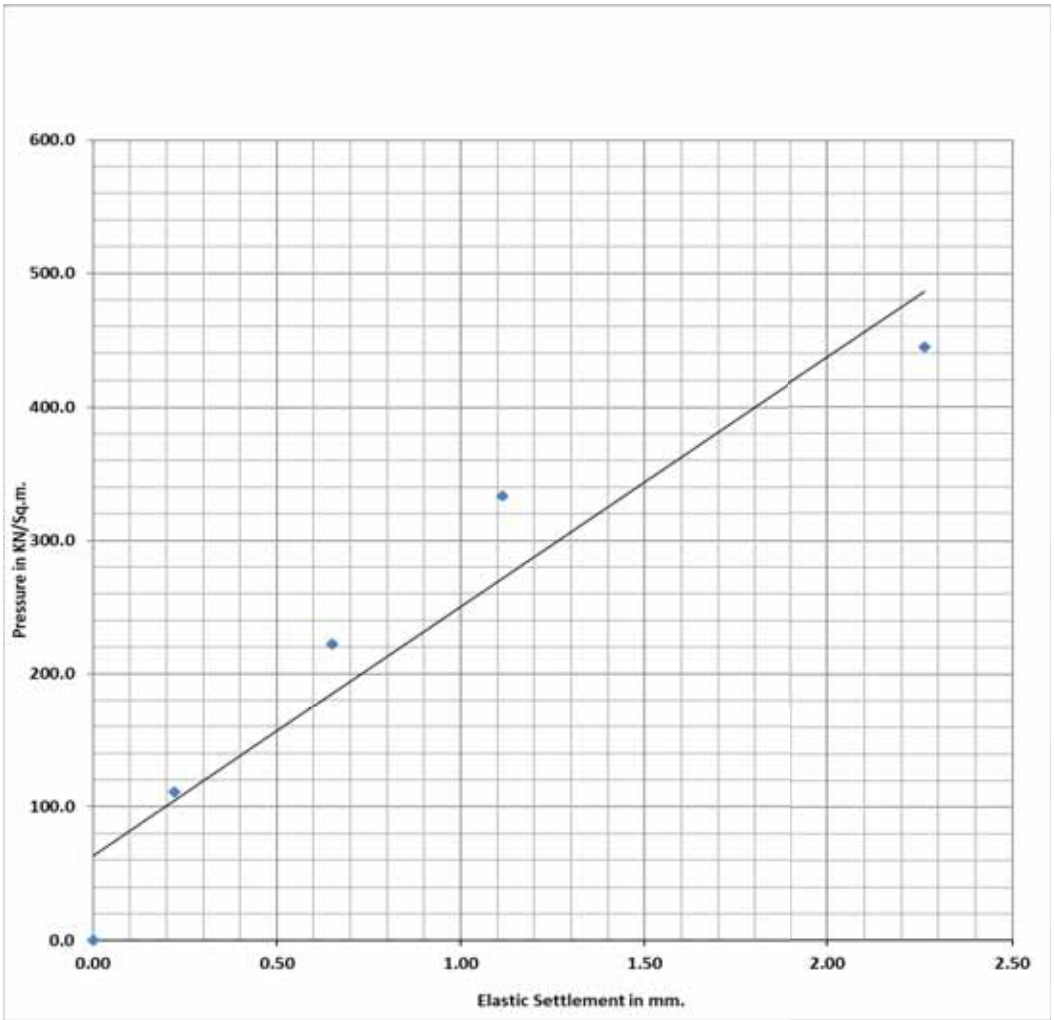
TEST NO 14

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.874
0.00	0.652
222.2	2.541
0.00	1.891
333.3	3.654
0.00	2.541
444.4	5.476
0.00	3.215



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.222
222.2	0.650
333.3	1.113
444.4	2.263



Thus, for 4 m^2 base area

$$C_u = 18.6 \times 10^4 \times \sqrt{0.09/4} = 2.79 \times 10^4 \text{ Kn/m}^3$$

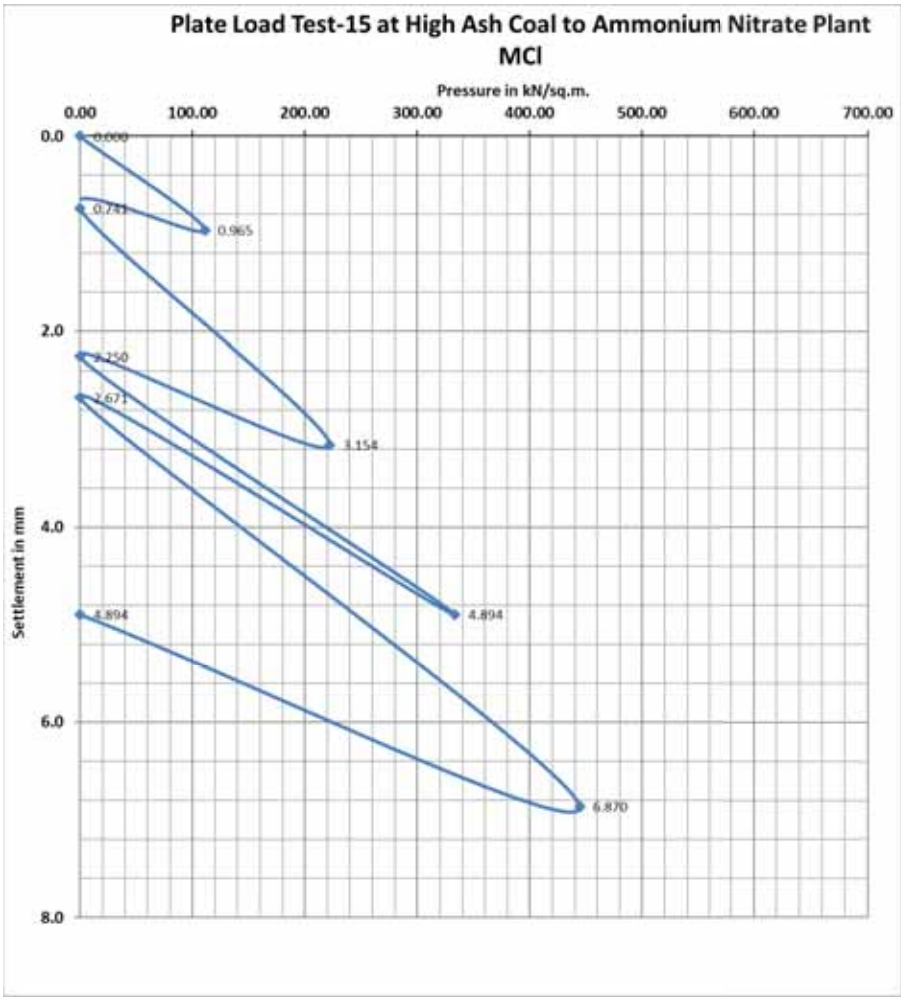
$$C_t = 0.5 \times C_u = 0.5 \times 2.79 \times 10^4 \text{ Kn/m}^3$$
$$= 1.39 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.79 \times 10^4 \text{ Kn/m}^3$$
$$= 4.82 \times 10^4 \text{ Kn/m}^3$$

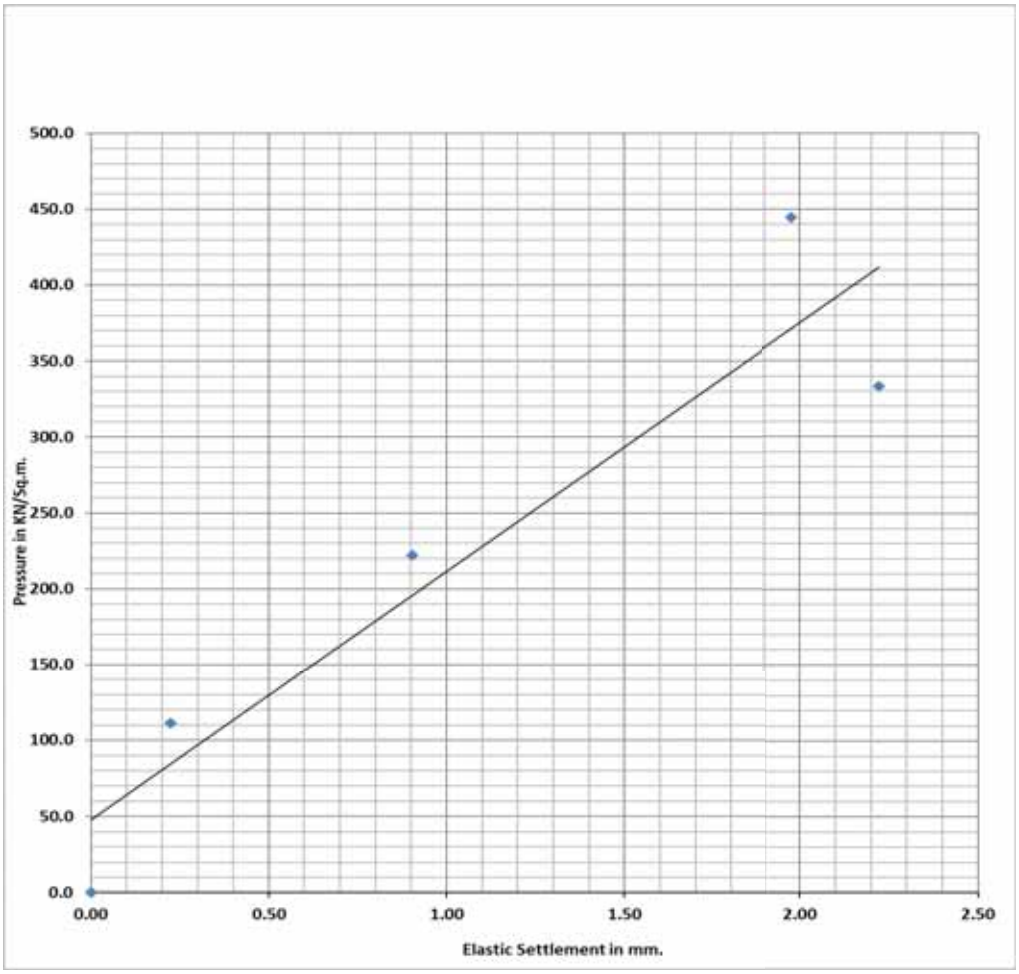
TEST NO 15

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.965
0.00	0.741
222.2	3.154
0.00	2.250
333.3	4.894
0.00	2.671
444.4	6.870
0.00	4.894



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.224
222.2	0.904
333.3	2.223
444.4	1.976



Thus, for 4 m^2 base area

$$C_u = 16.3 \times 10^4 \times \sqrt{0.09/4} = 2.44 \times 10^4 \text{ Kn/m}^3$$

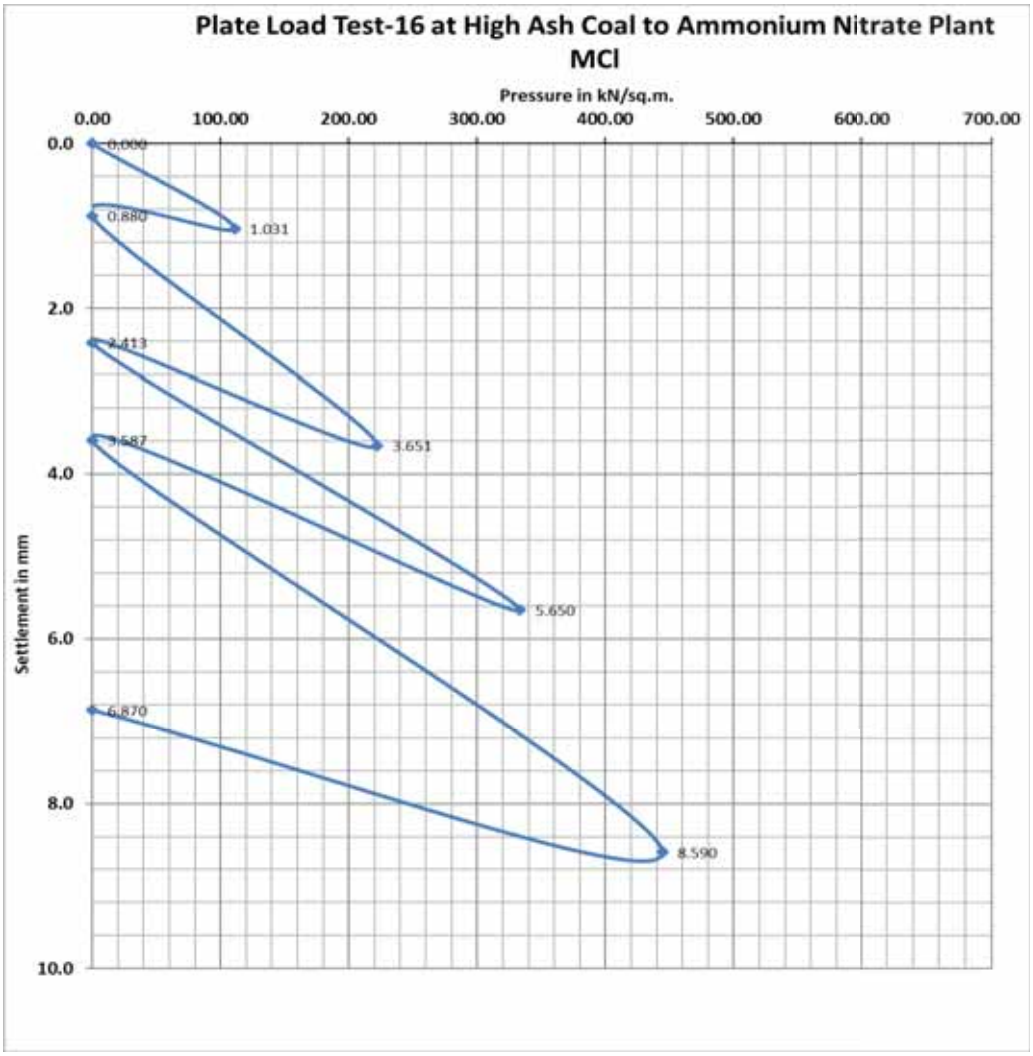
$$C_t = 0.5 \times C_u = 0.5 \times 2.44 \times 10^4 \text{ Kn/m}^3$$
$$= 1.22 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.44 \times 10^4 \text{ Kn/m}^3$$
$$= 4.22 \times 10^4 \text{ Kn/m}^3$$

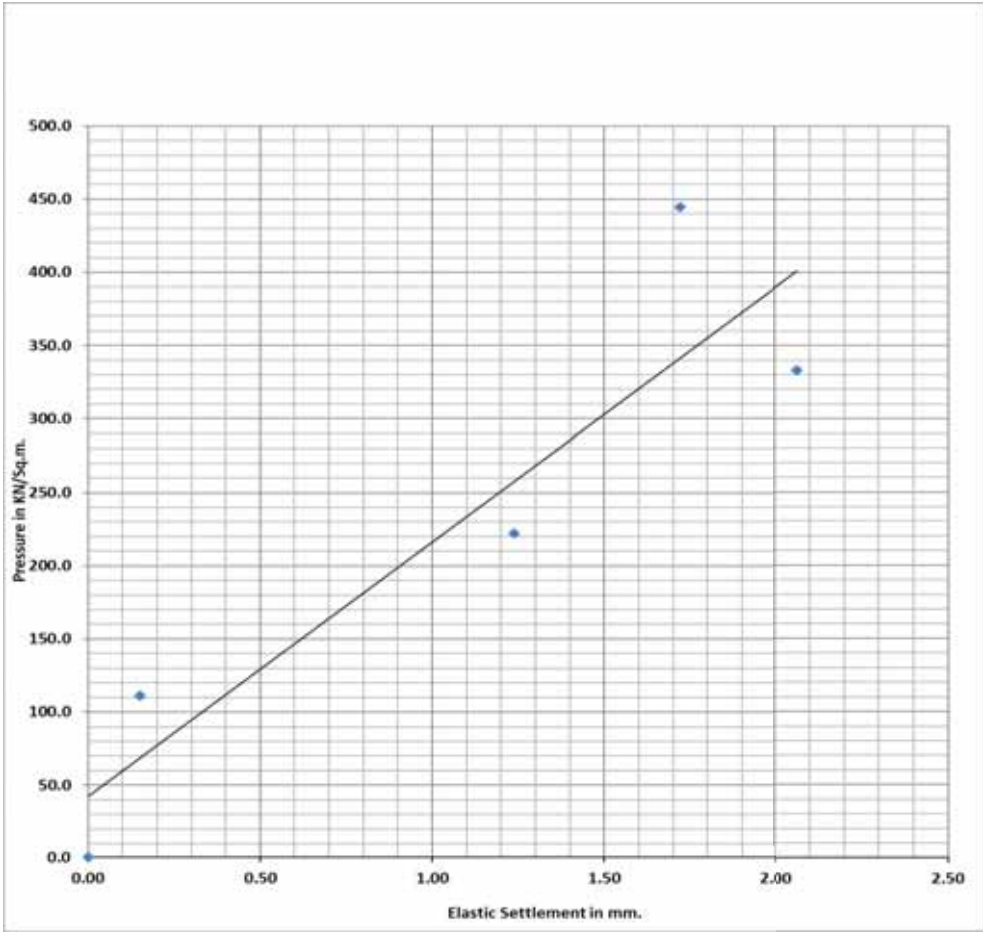
TEST NO 16

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.031
0.00	0.880
222.2	3.651
0.00	2.413
333.3	5.650
0.00	3.587
444.4	8.590
0.00	6.870



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.151
222.2	1.238
333.3	2.063
444.4	1.720



Thus, for 4 m^2 base area

$$C_u = 17.3 \times 10^4 \times \sqrt{0.09/4} = 2.59 \times 10^4 \text{ Kn/m}^3$$

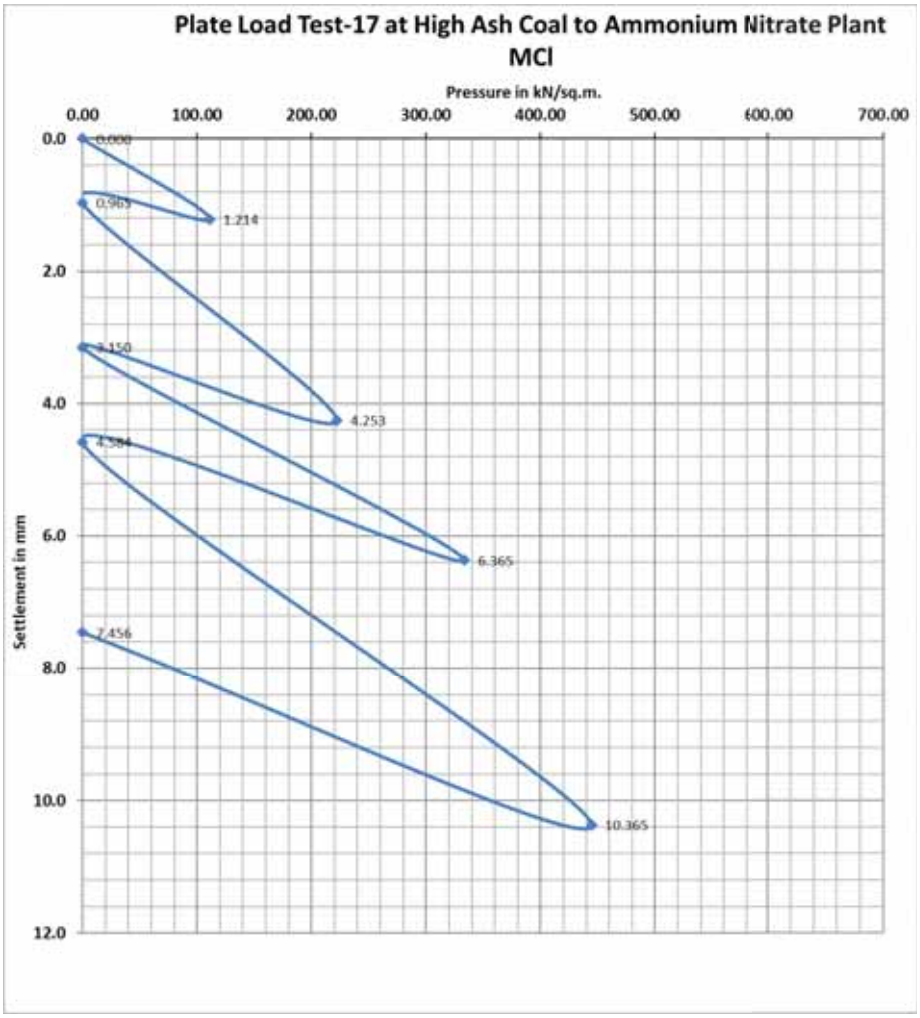
$$C_t = 0.5 \times C_u = 0.5 \times 2.59 \times 10^4 \text{ Kn/m}^3$$
$$= 1.29 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.59 \times 10^4 \text{ Kn/m}^3$$
$$= 4.48 \times 10^4 \text{ Kn/m}^3$$

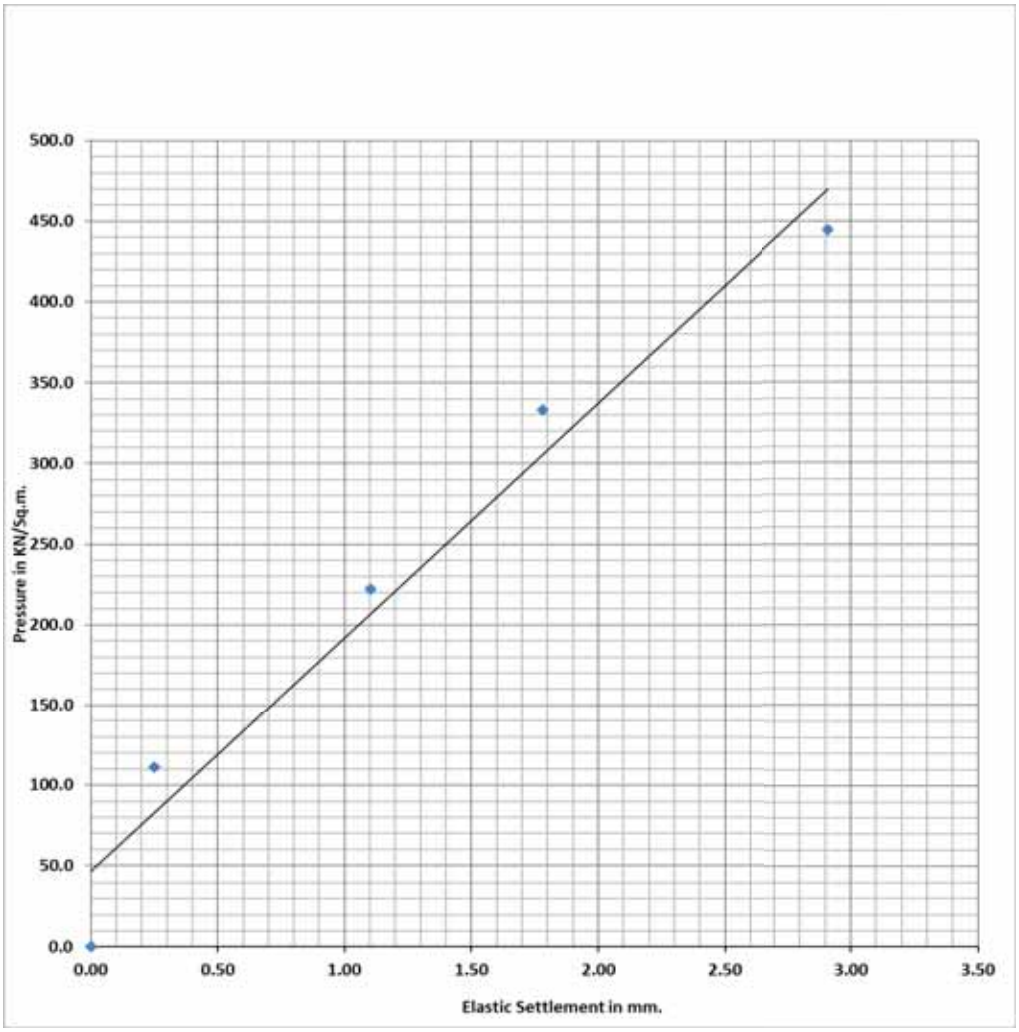
TEST NO 17

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.214
0.00	0.965
222.2	4.253
0.00	3.150
333.3	6.365
0.00	4.584
444.4	10.365
0.00	7.456



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.249
222.2	1.103
333.3	1.781
444.4	2.909



Thus, for 4 m^2 base area

$$C_u = 14.5 \times 10^4 \times \sqrt{0.09/4} = 2.17 \times 10^4 \text{ Kn/m}^3$$

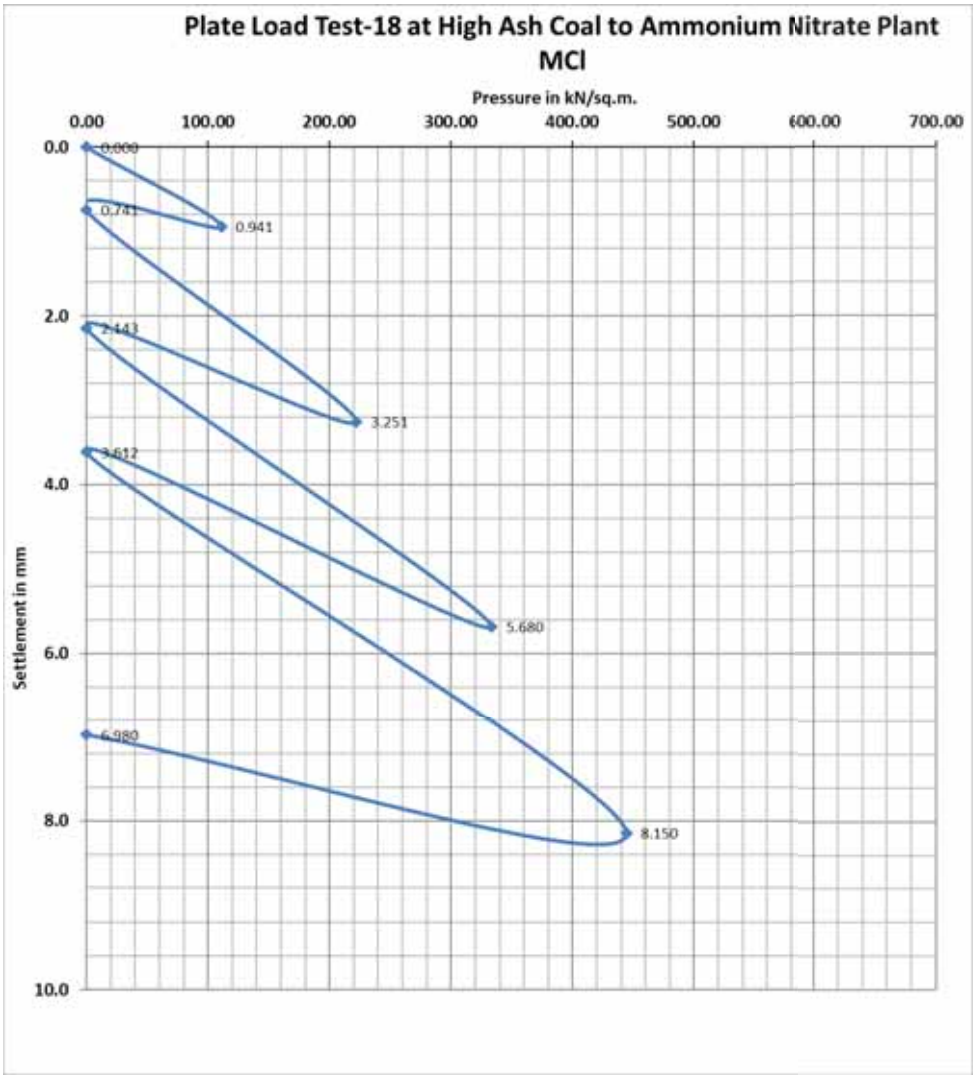
$$C_t = 0.5 \times C_u = 0.5 \times 2.17 \times 10^4 \text{ Kn/m}^3$$
$$= 1.08 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.17 \times 10^4 \text{ Kn/m}^3$$
$$= 3.75 \times 10^4 \text{ Kn/m}^3$$

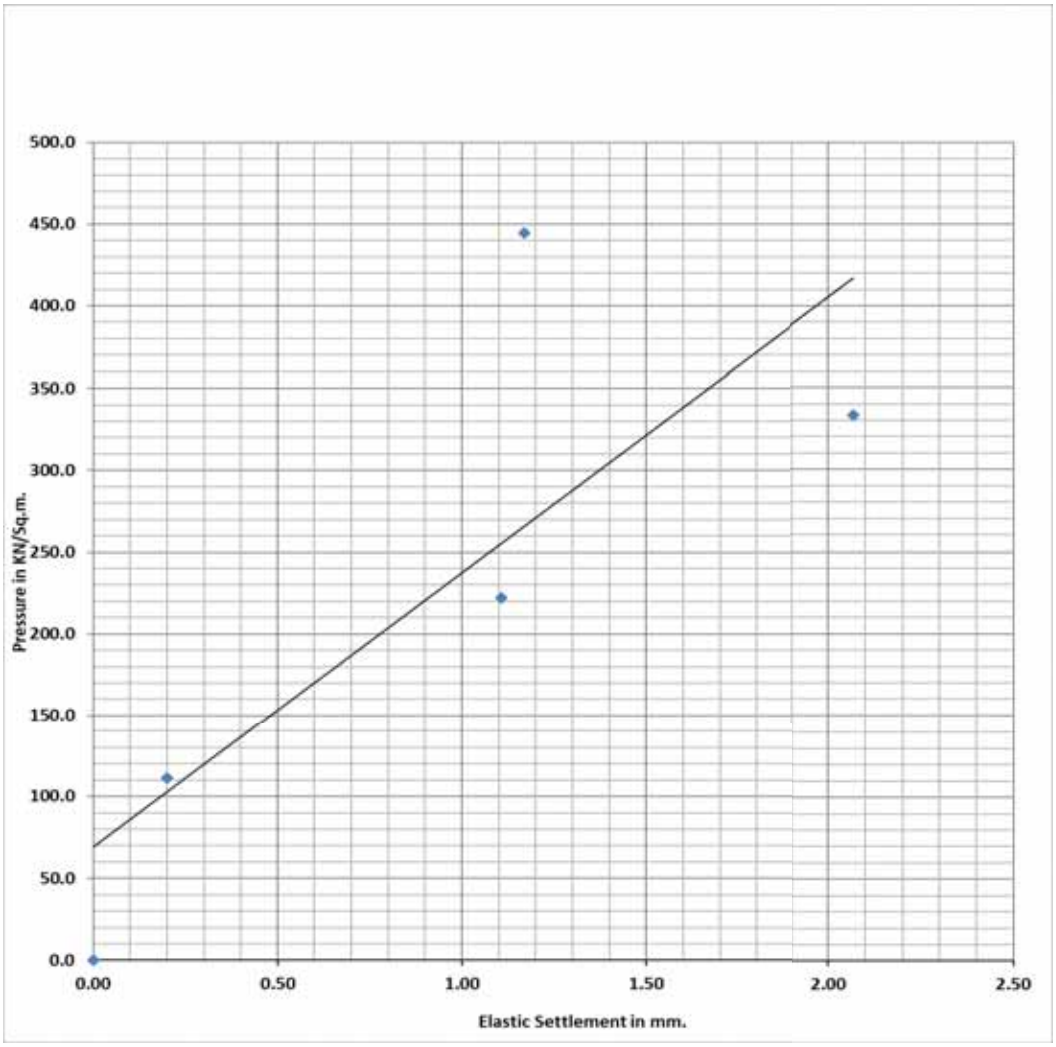
TEST NO 18

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	0.941
0.00	0.741
222.2	3.251
0.00	2.143
333.3	5.680
0.00	3.612
444.4	8.150
0.00	6.980



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.200
222.2	1.108
333.3	2.068
444.4	1.170



Thus, for 4 m^2 base area

$$C_u = 16.8 \times 10^4 \times \sqrt{0.09/4} = 2.52 \times 10^4 \text{ Kn/m}^3$$

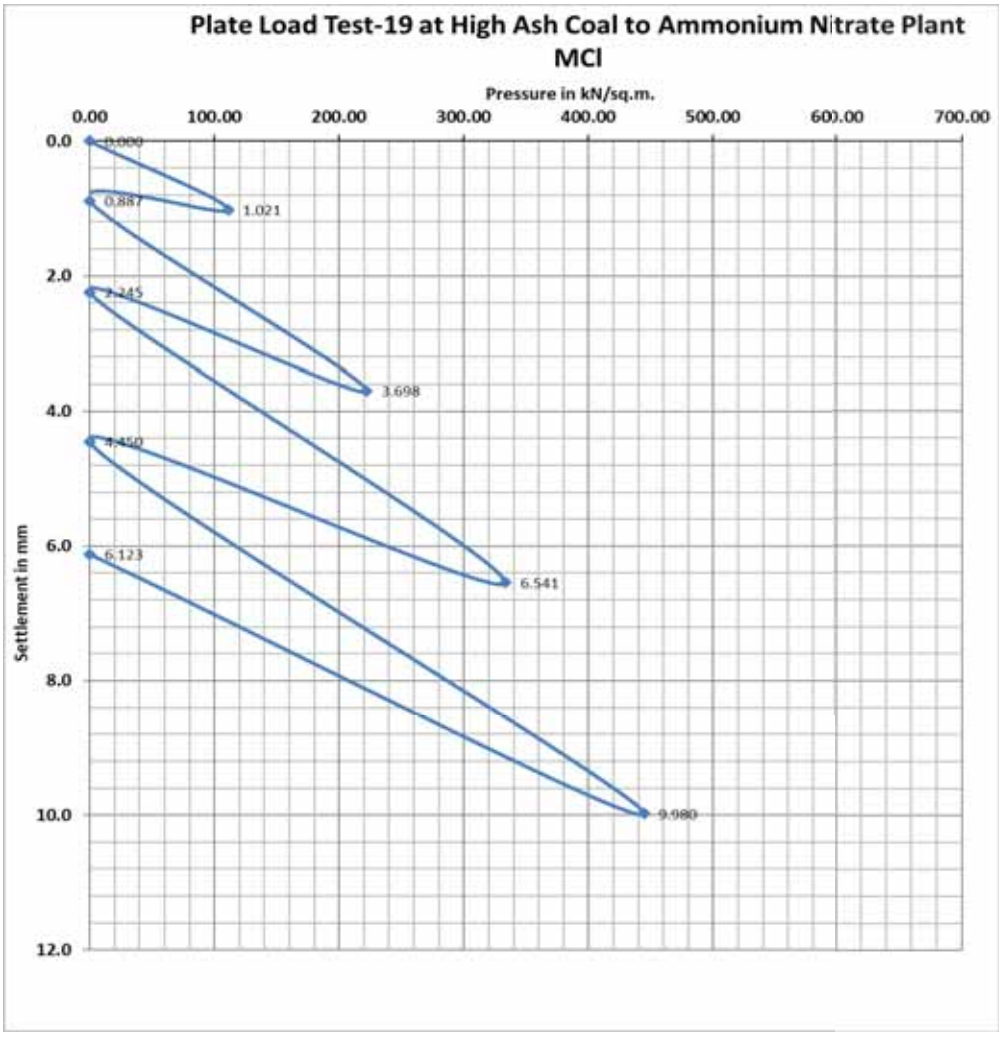
$$C_t = 0.5 \times C_u = 0.5 \times 2.52 \times 10^4 \text{ Kn/m}^3$$
$$= 1.26 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.52 \times 10^4 \text{ Kn/m}^3$$
$$= 4.35 \times 10^4 \text{ Kn/m}^3$$

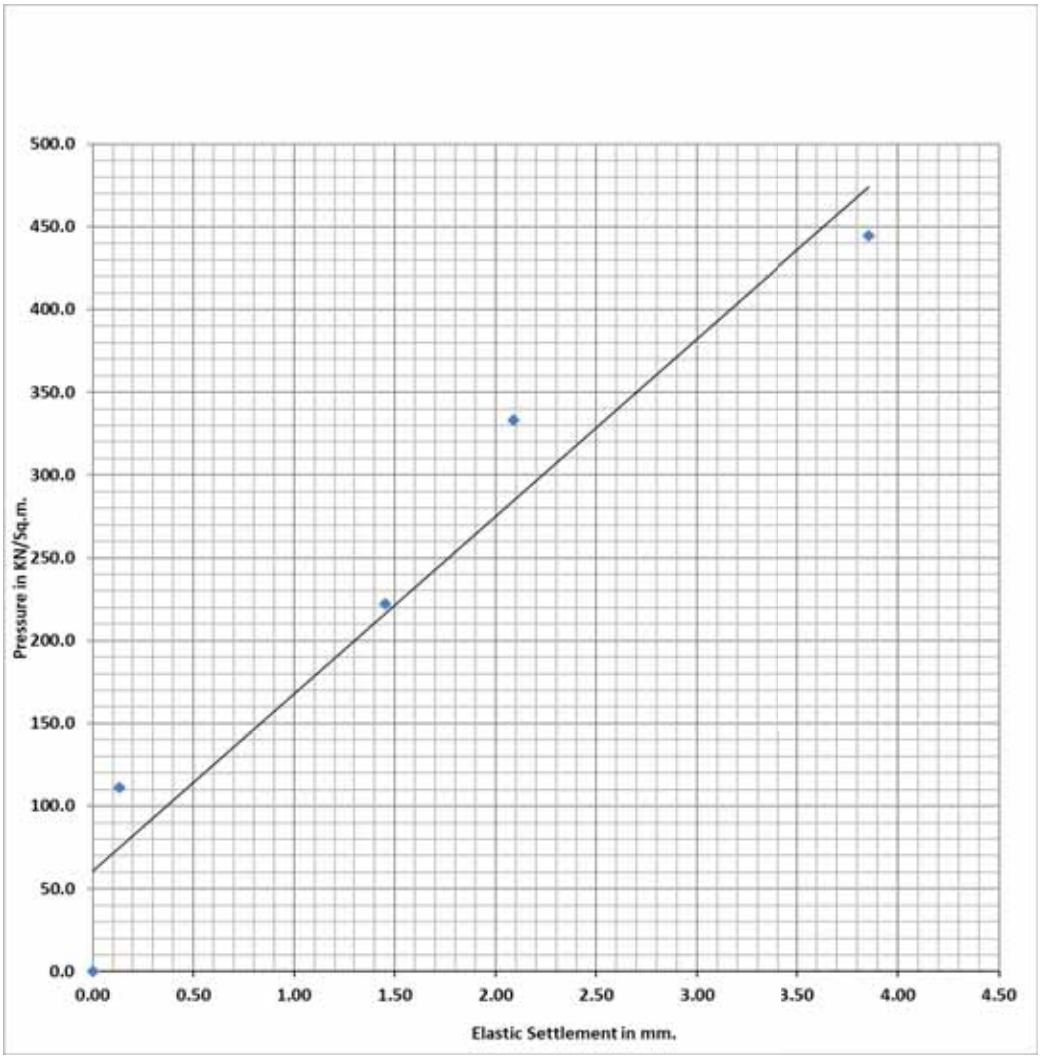
TEST NO 19

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.021
0.00	0.887
222.2	3.698
0.00	2.245
333.3	6.541
0.00	4.450
444.4	9.980
0.00	6.123



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.134
222.2	1.453
333.3	2.091
444.4	3.857



Thus, for 4 m^2 base area

$$C_u = 10.7 \times 10^4 \times \sqrt{0.09/4} = 1.60 \times 10^4 \text{ Kn/m}^3$$

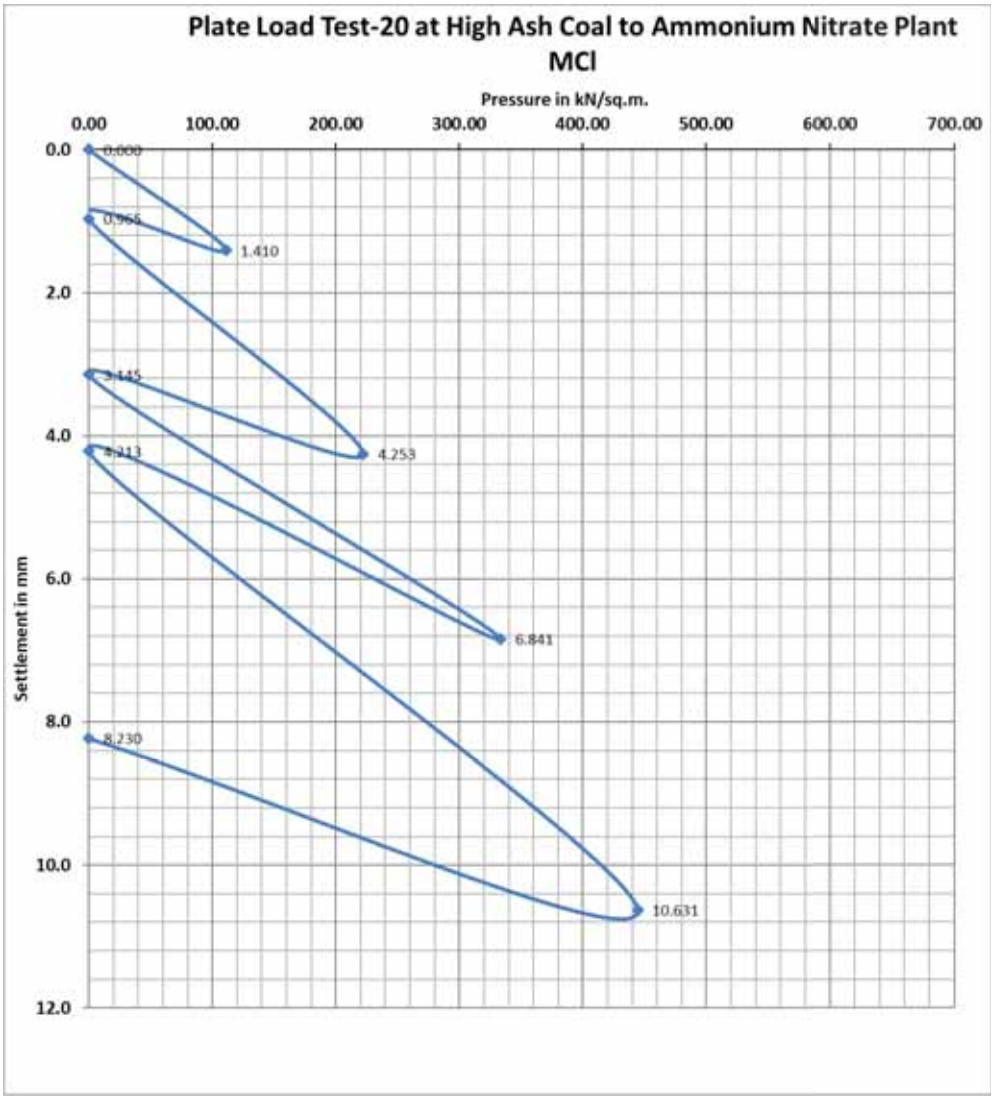
$$C_t = 0.5 \times C_u = 0.5 \times 1.60 \times 10^4 \text{ Kn/m}^3$$
$$= 8.02 \times 10^3 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 1.60 \times 10^4 \text{ Kn/m}^3$$
$$= 2.76 \times 10^4 \text{ Kn/m}^3$$

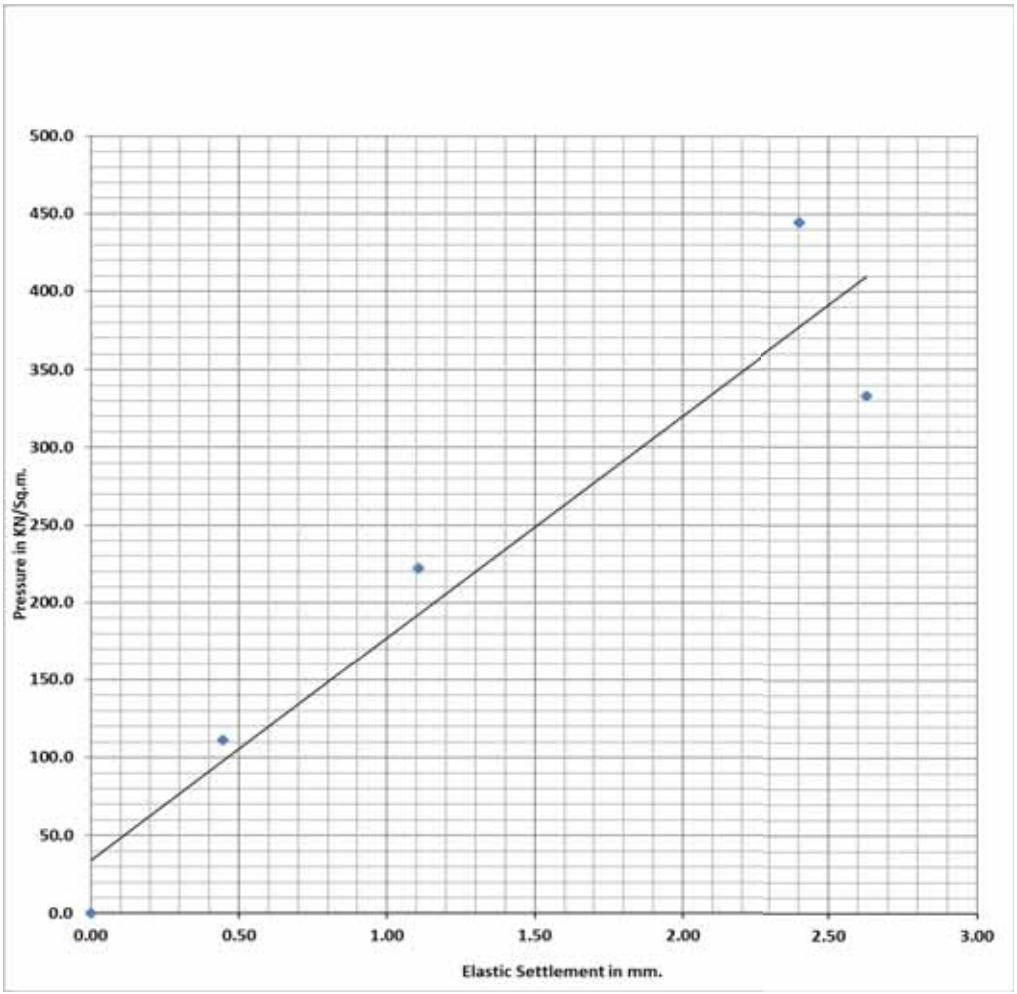
TEST NO 20

LOAD SETTLEMENT CURVE FOR CYCLIC PLATE LOAD TEST

Pressure (Kn/m^2)	Settlement (mm)
111.1	1.410
0.00	0.965
222.2	4.253
0.00	3.145
333.3	6.841
0.00	4.213
444.4	10.631
0.00	8.230



Pressure (Kn/m^2)	Elastic Settlement (mm)
111.1	0.445
222.2	1.108
333.3	2.628
444.4	2.401



Thus, for 4 m^2 base area

$$C_u = 14.2 \times 10^4 \times \sqrt{0.09/4} = 2.13 \times 10^4 \text{ Kn/m}^3$$

$$C_t = 0.5 \times C_u = 0.5 \times 2.13 \times 10^4 \text{ Kn/m}^3$$
$$= 1.06 \times 10^4 \text{ Kn/m}^3$$

$$C_q = 1.73 \times C_u = 1.73 \times 2.13 \times 10^4 \text{ Kn/m}^3$$
$$= 3.68 \times 10^4 \text{ Kn/m}^3$$

IN-SITU PLATE LOAD TEST

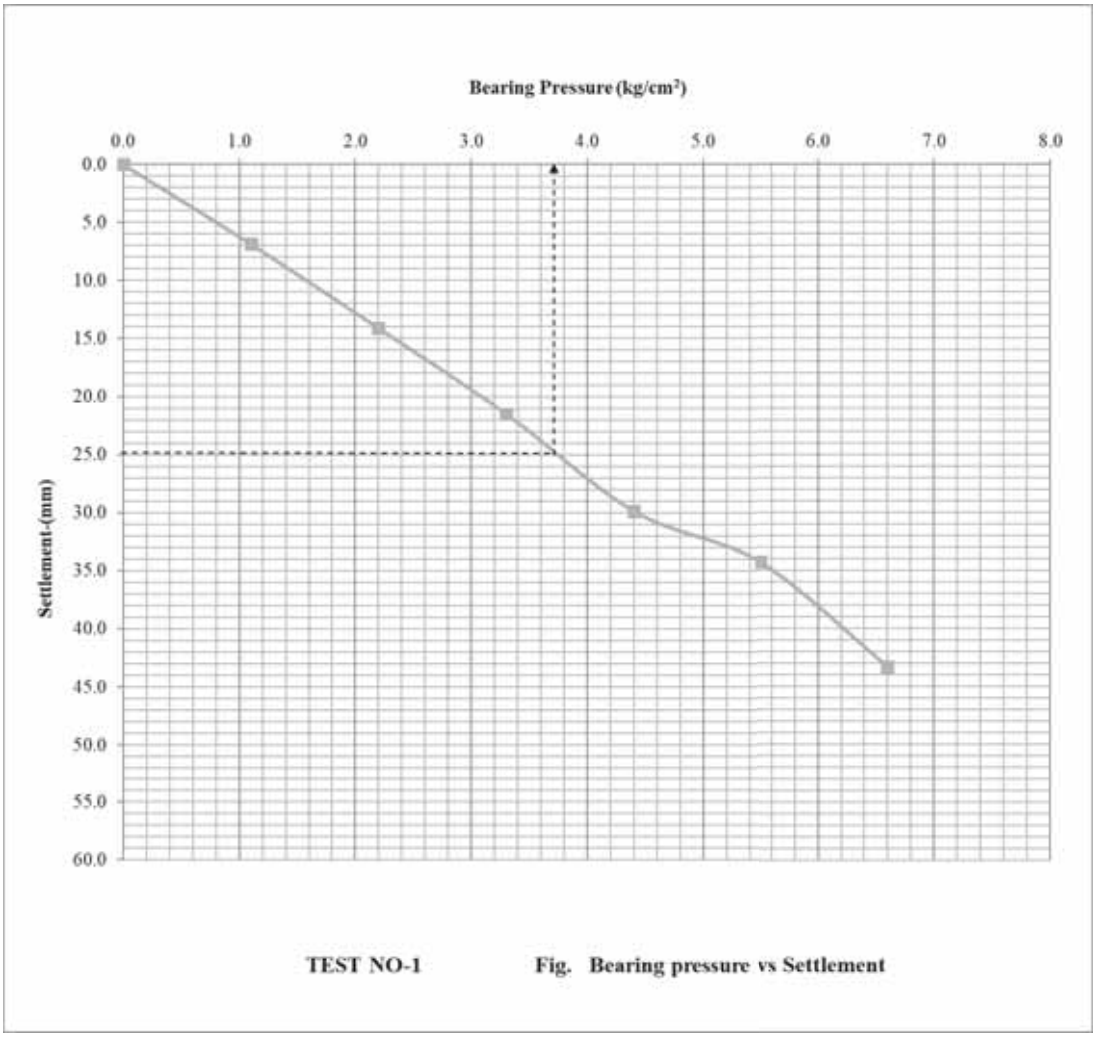
Test No 1

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.270	6.86
2.20	4.660	14.10
3.30	7.105	21.48
4.40	9.875	29.86
5.50	11.350	34.30
6.60	14.320	43.31

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-1 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.7 kg/cm^2.

Net safe bearing capacity = 36.41 t/m^2

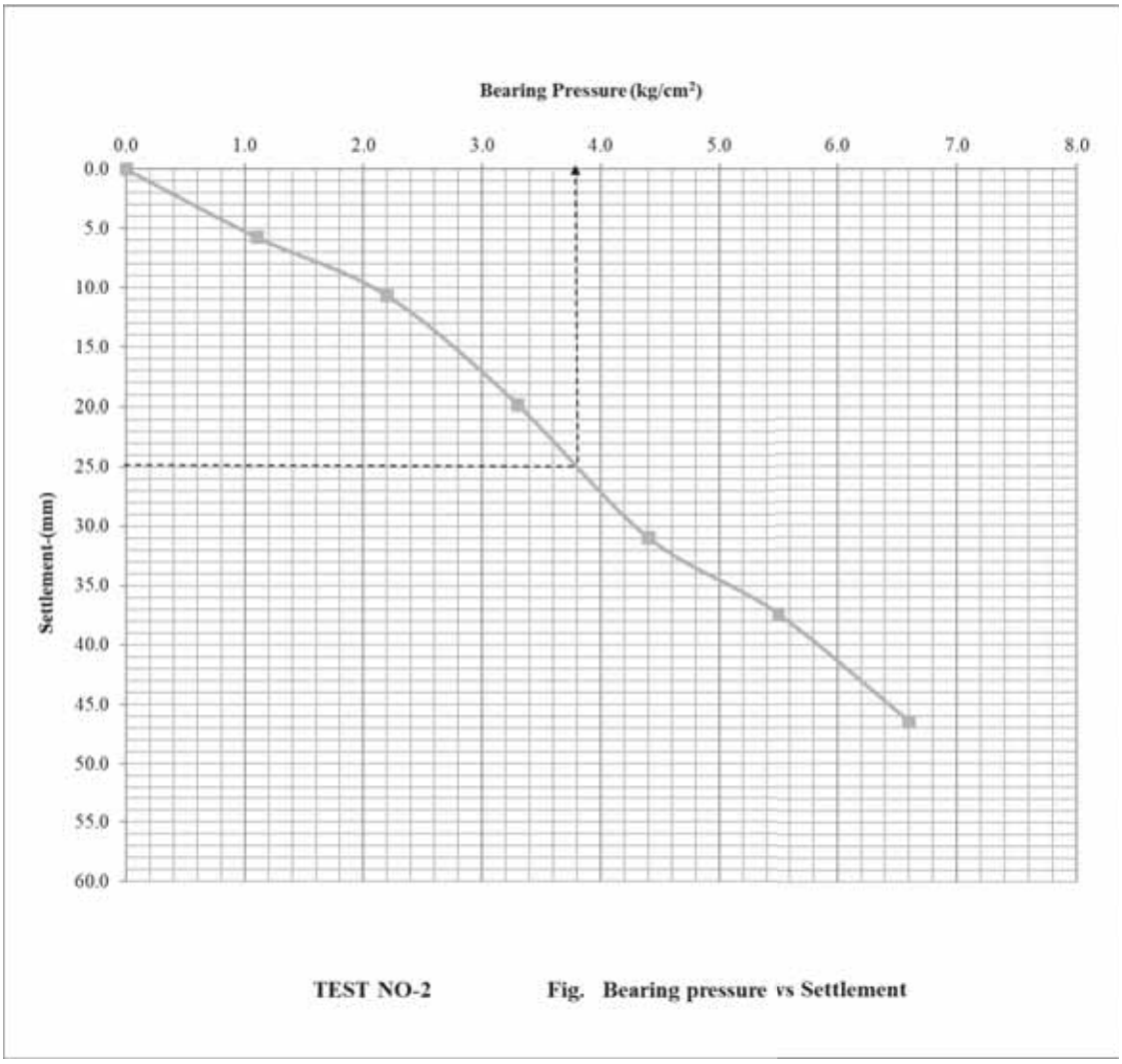
Test No 2

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.893	5.72
2.20	3.526	10.66
3.30	6.546	19.80
4.40	10.230	30.94
5.50	12.363	37.38
6.60	15.360	46.45

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-2 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.8 kg/cm^2.

Net safe bearing capacity = 37.39 t/m^2

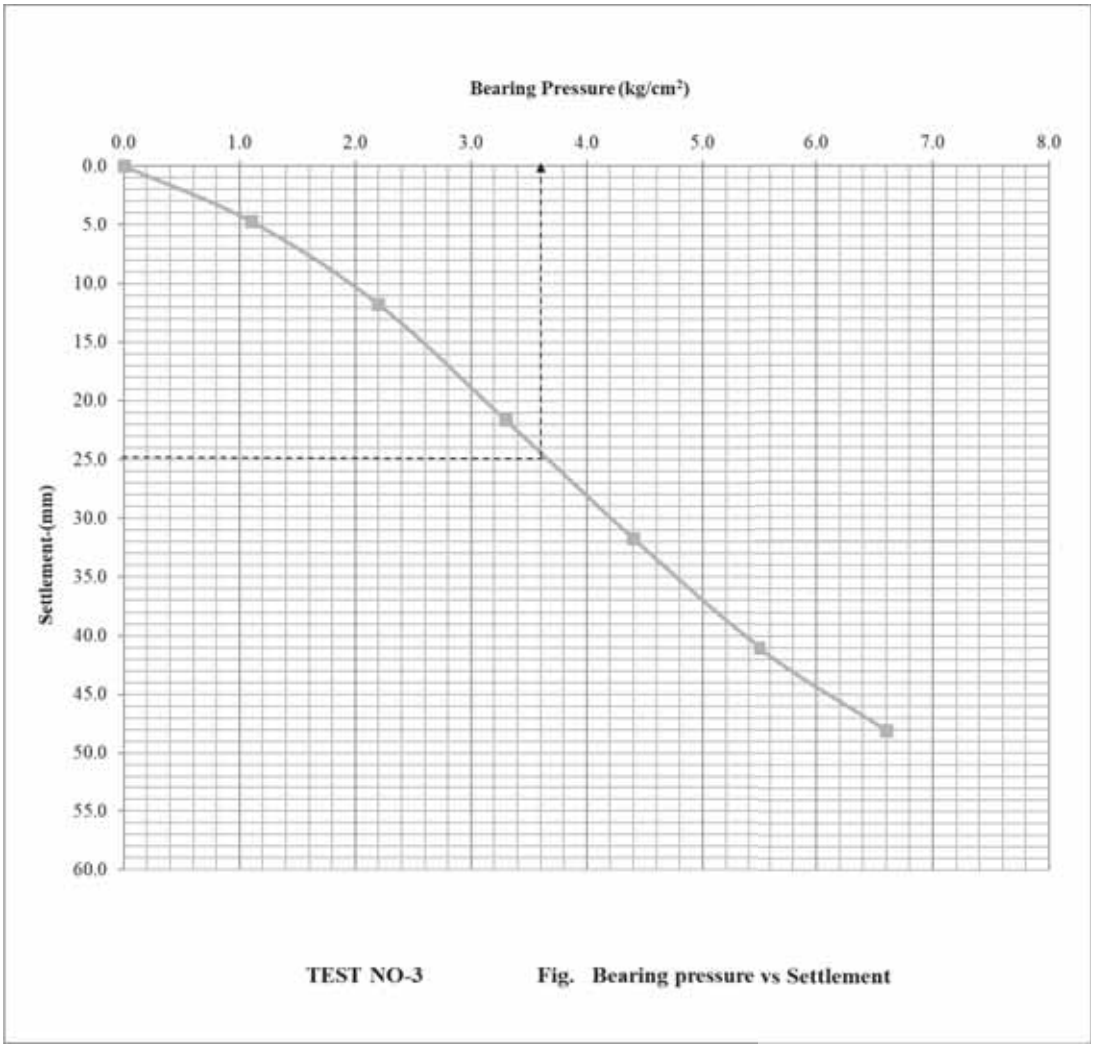
Test No 3

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.560	4.71
2.20	3.890	11.76
3.30	7.152	21.63
4.40	10.481	31.70
5.50	13.561	41.01
6.60	15.890	48.06

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-3 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.6 kg/cm^2.

Net safe bearing capacity = 35.43 t/m^2

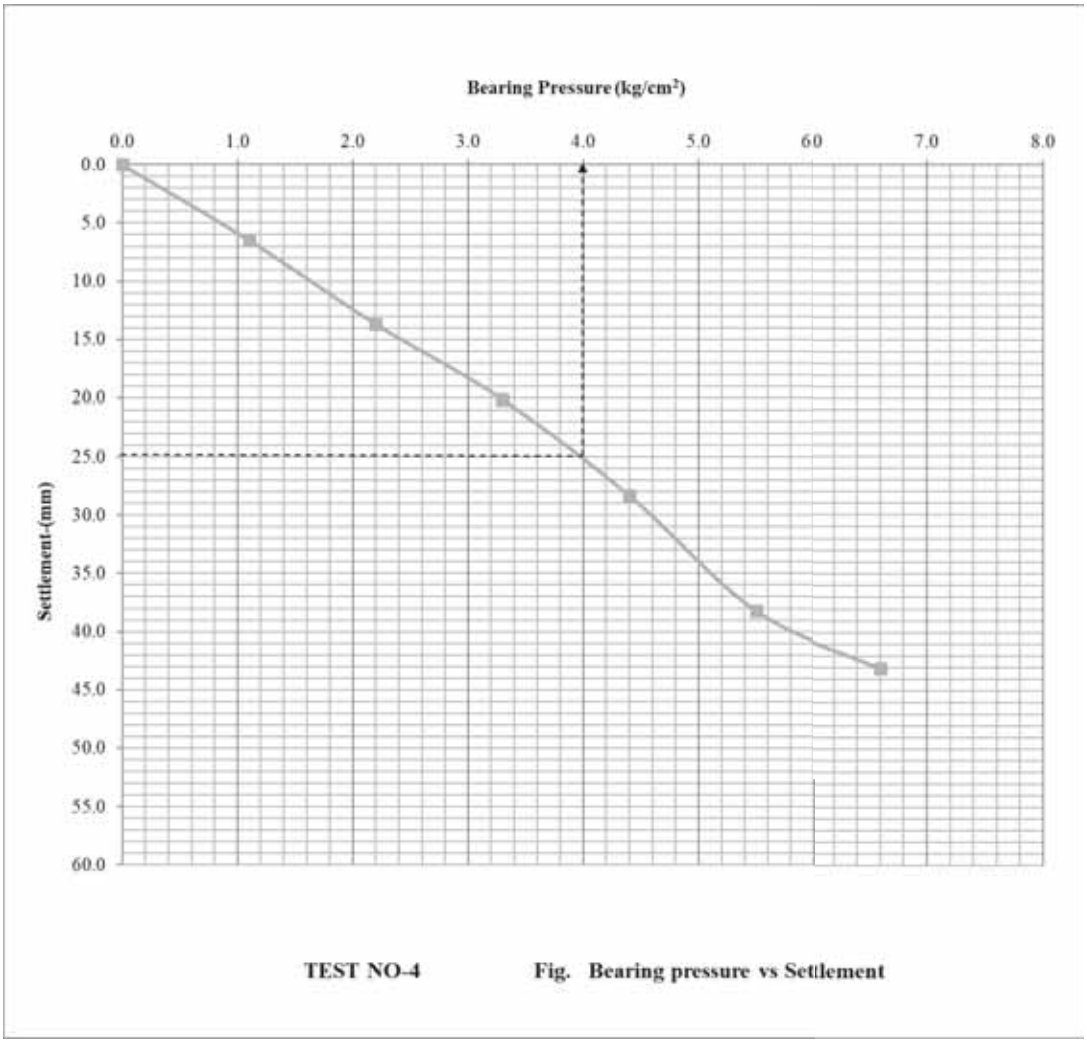
Test No 4

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.140	6.47
2.20	4.523	13.67
3.30	6.651	20.11
4.40	9.361	28.31
5.50	12.630	38.20
6.60	14.250	43.10

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-4 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 4.0 kg/cm^2.

Net safe bearing capacity = 39.36 t/m^2

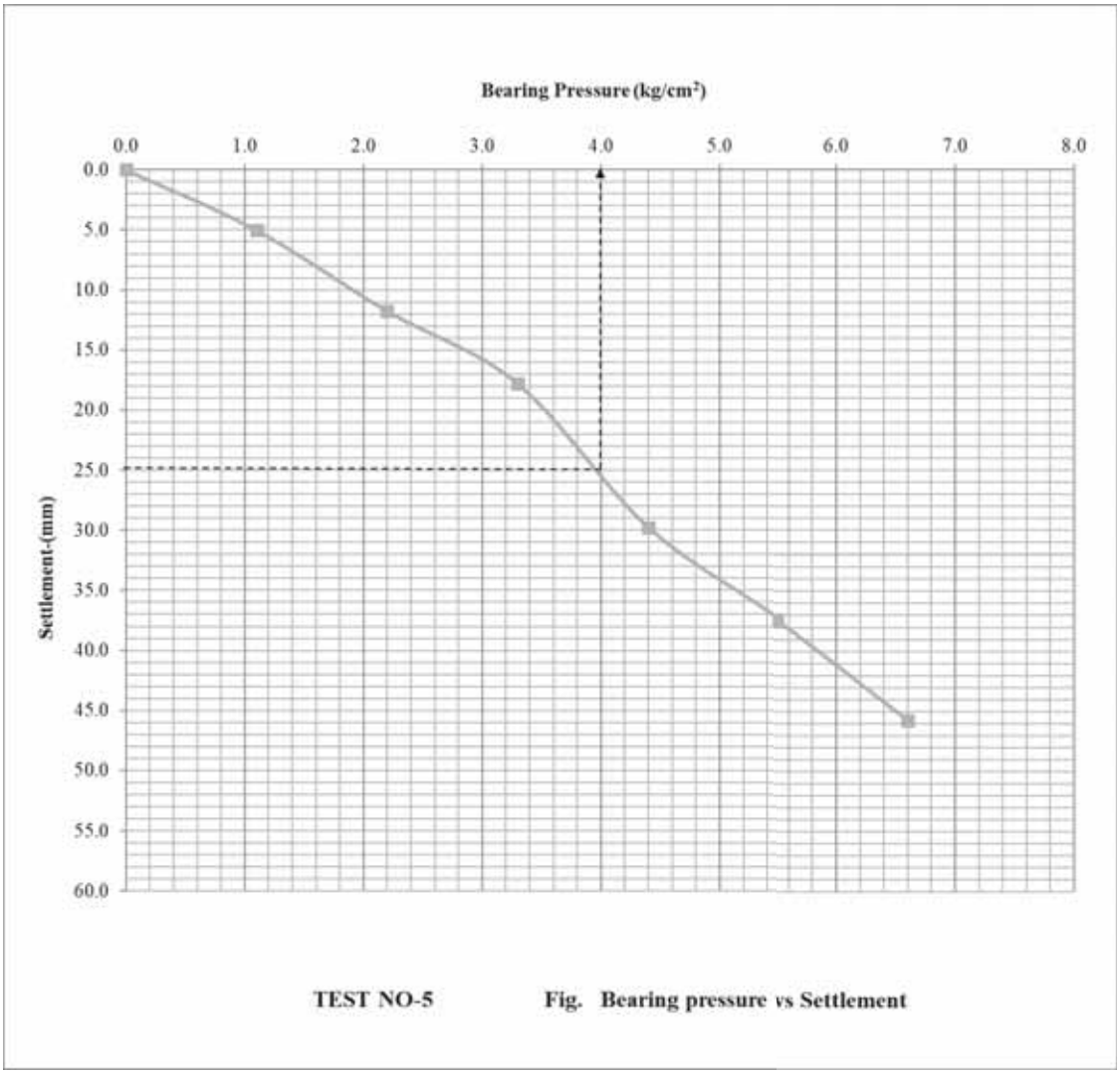
Test No 5

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.664	5.03
2.20	3.891	11.76
3.30	5.891	17.81
4.40	9.840	29.76
5.50	12.361	37.38
6.60	15.123	45.73

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-5 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 4.0 kg/cm^2.

Net safe bearing capacity = 39.36 t/m^2

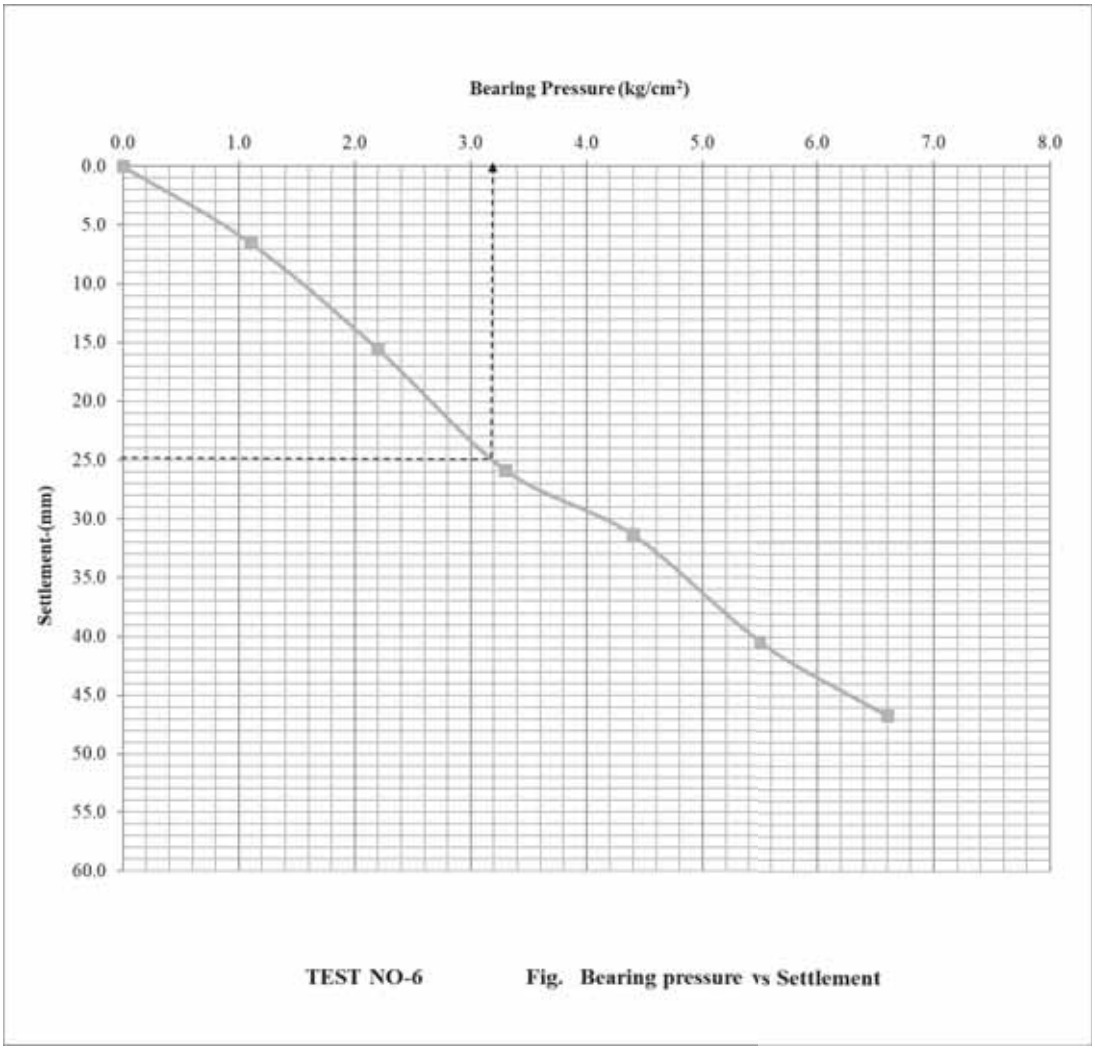
Test No 6

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.154	6.51
2.20	5.146	15.56
3.30	8.541	25.83
4.40	10.361	31.33
5.50	13.361	40.40
6.60	15.441	46.70

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-6 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.2 kg/cm^2.

Net safe bearing capacity = 31.49 t/m^2

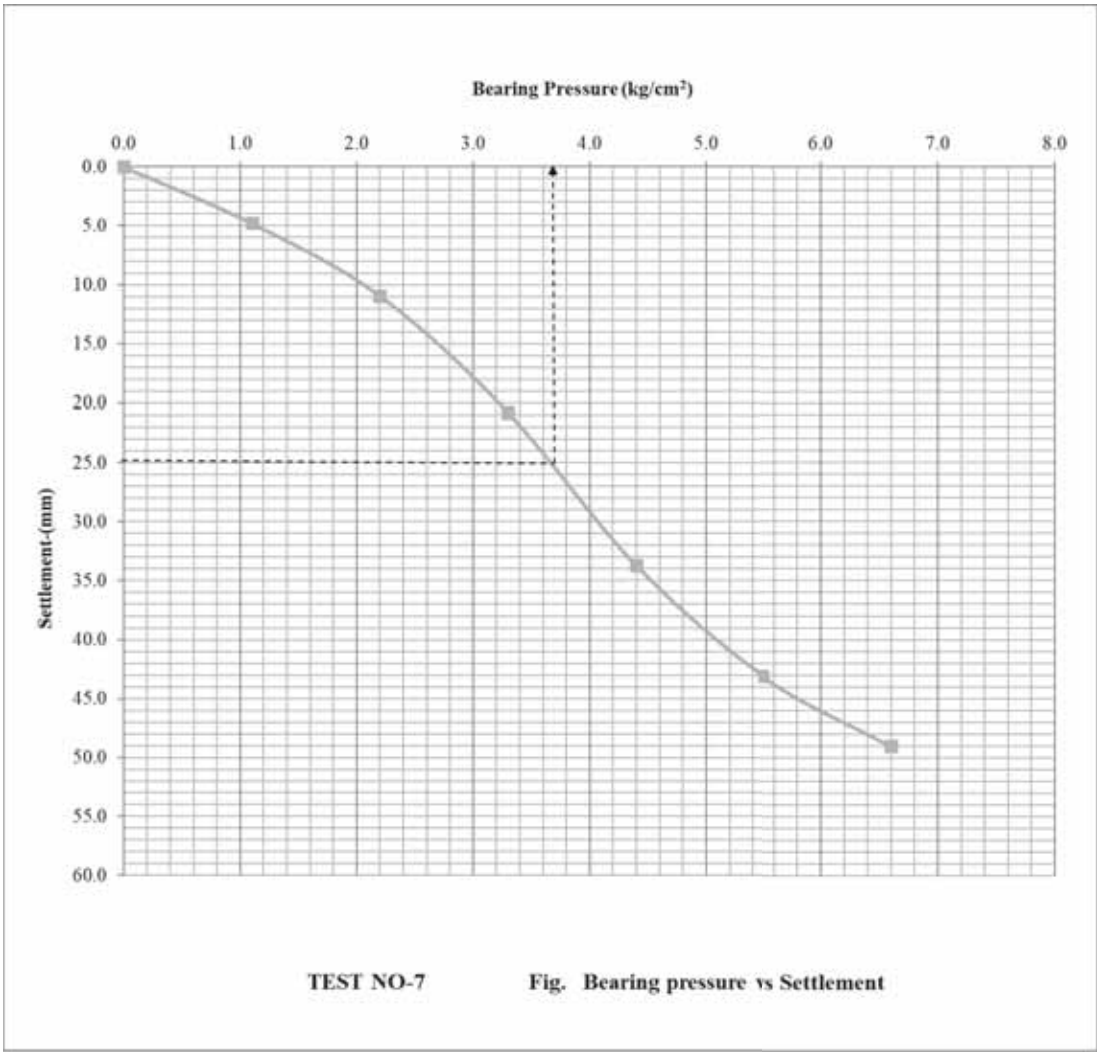
Test No 7

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.584	4.79
2.20	3.614	10.93
3.30	6.871	20.78
4.40	11.140	33.69
5.50	14.251	43.10
6.60	16.210	49.02

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-7 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.7 kg/cm^2.

Net safe bearing capacity = 36.41 t/m^2

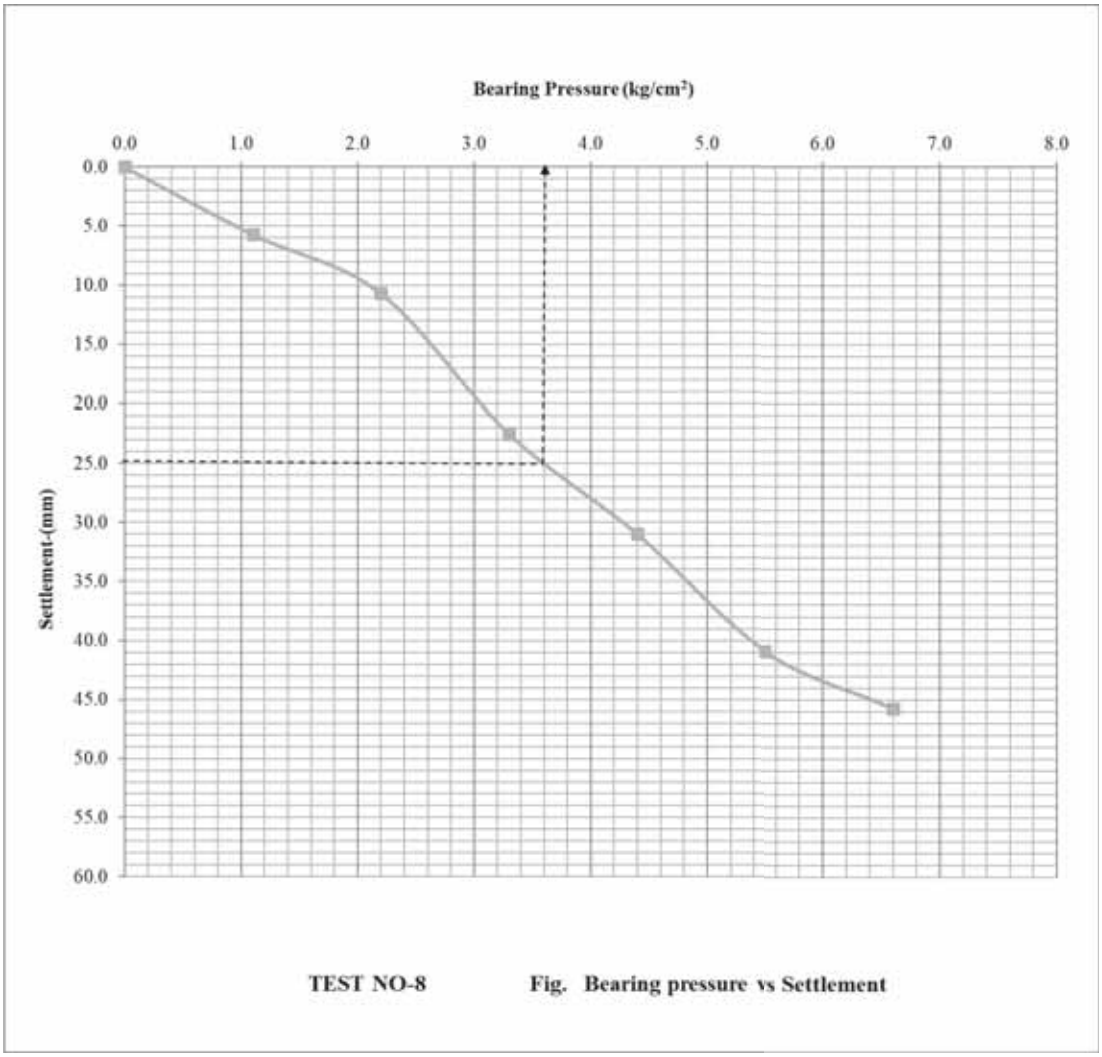
Test No 8

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.891	5.71
2.20	3.541	10.71
3.30	7.451	22.53
4.40	10.251	31.00
5.50	13.520	40.89
6.60	15.120	45.73

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-8 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.6 kg/cm^2.

Net safe bearing capacity = 35.43 t/m^2

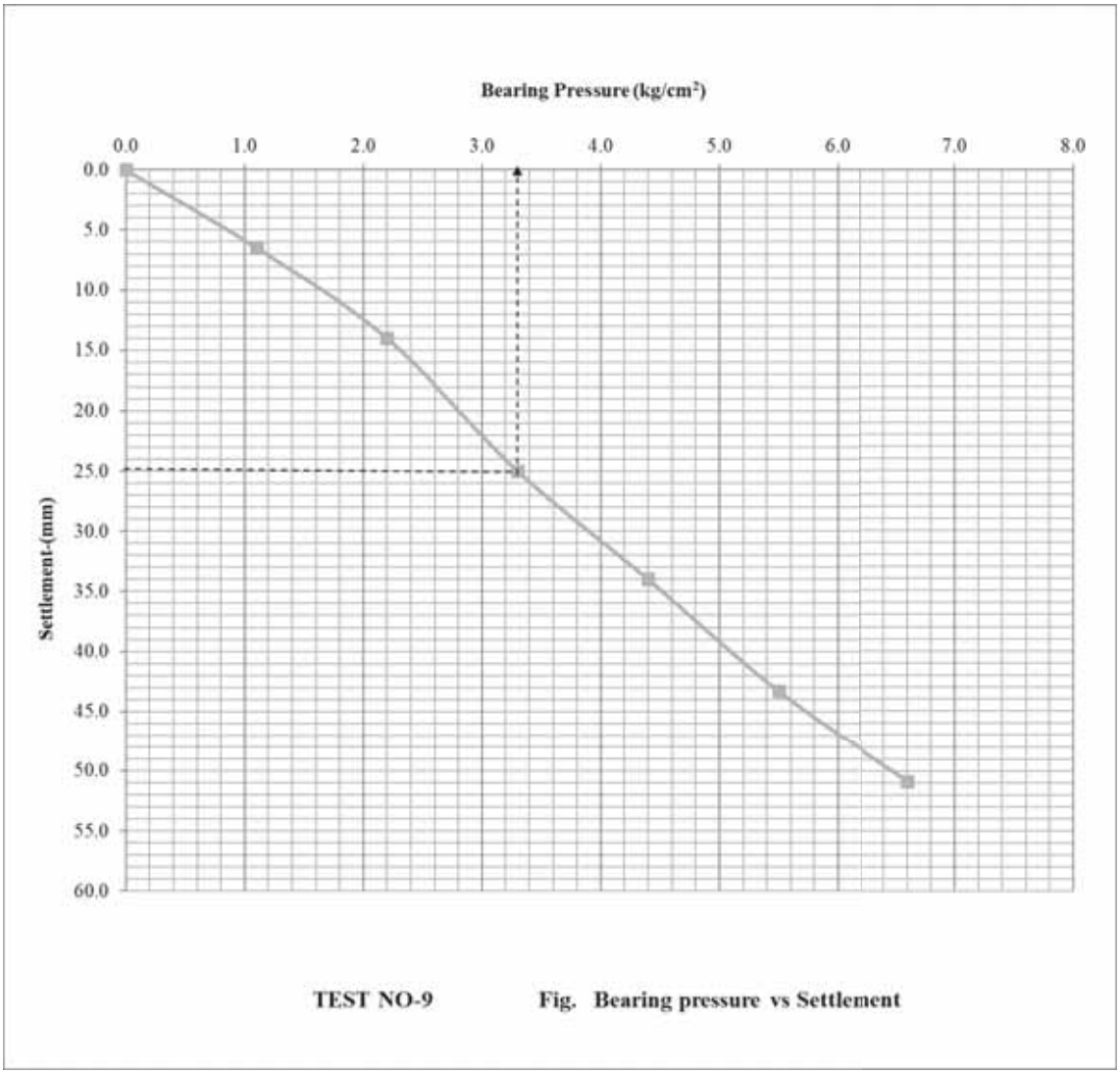
Test No 9

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.145	6.48
2.20	4.631	14.00
3.30	8.261	24.98
4.40	11.240	34.00
5.50	14.321	43.32
6.60	16.810	50.84

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-9 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.3 kg/cm^2.

Net safe bearing capacity = 32.47 t/m^2

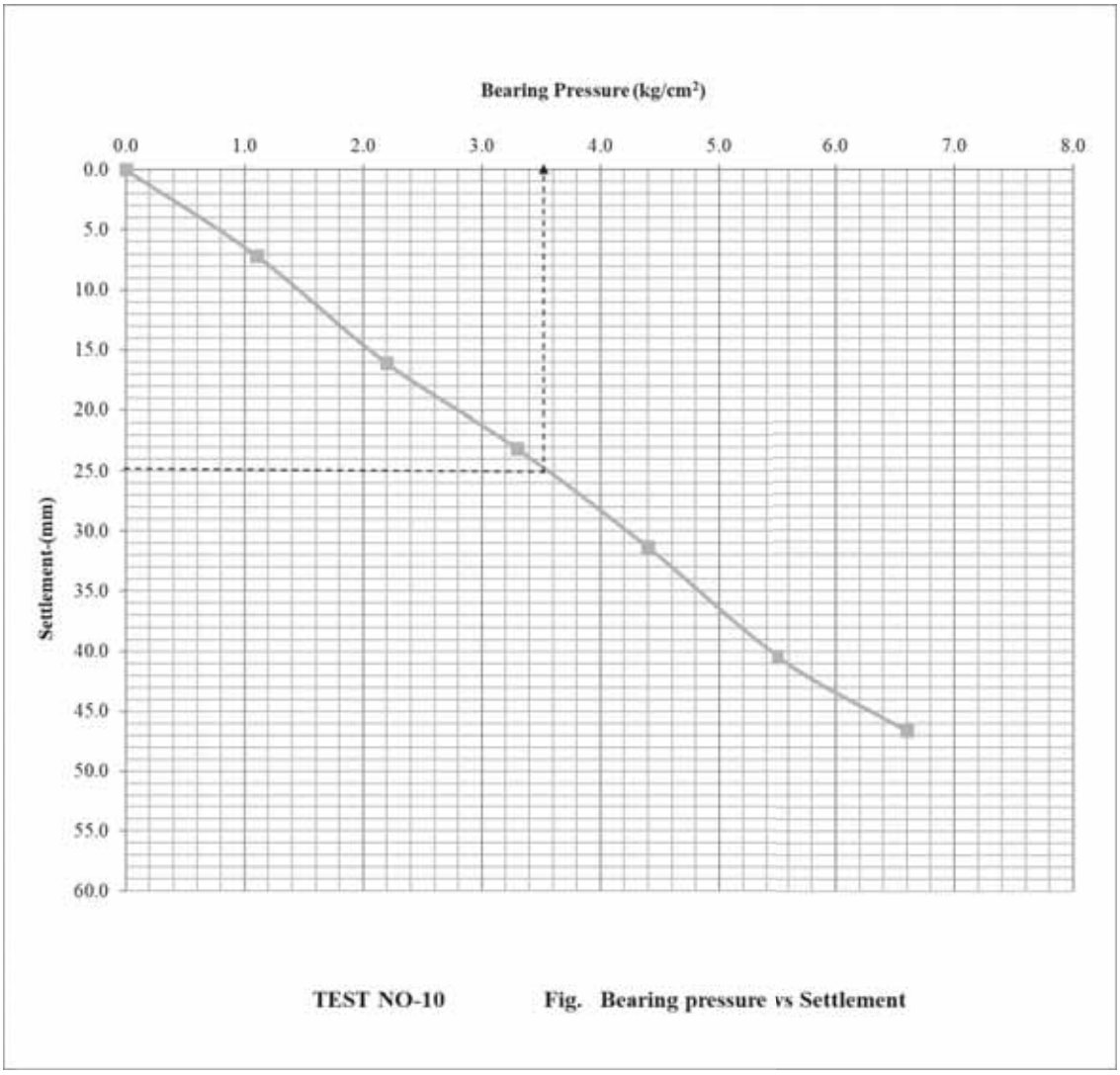
Test No 10

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.361	7.14
2.20	5.321	16.10
3.30	7.651	23.14
4.40	10.360	31.33
5.50	13.365	40.40
6.60	15.420	46.63

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-10 Fig. Bearing pressure *vs* Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.5 kg/cm^2.

Net safe bearing capacity = 34.44 t/m^2

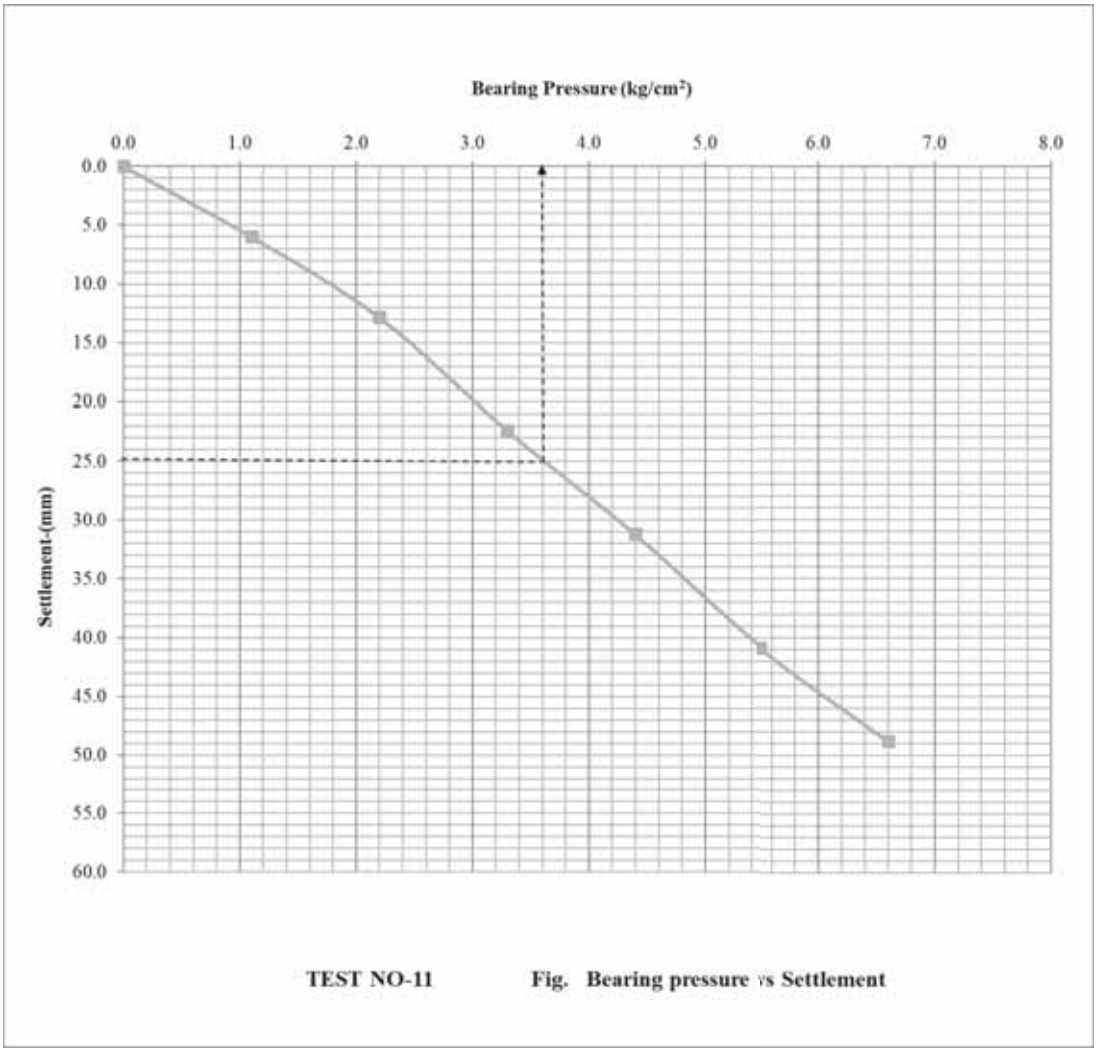
Test No 11

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.980	6.00
2.20	4.250	12.85
3.30	7.410	22.41
4.40	10.320	31.21
5.50	13.520	40.89
6.60	16.140	48.81

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-11 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.6 kg/cm^2.

Net safe bearing capacity = 35.43 t/m^2

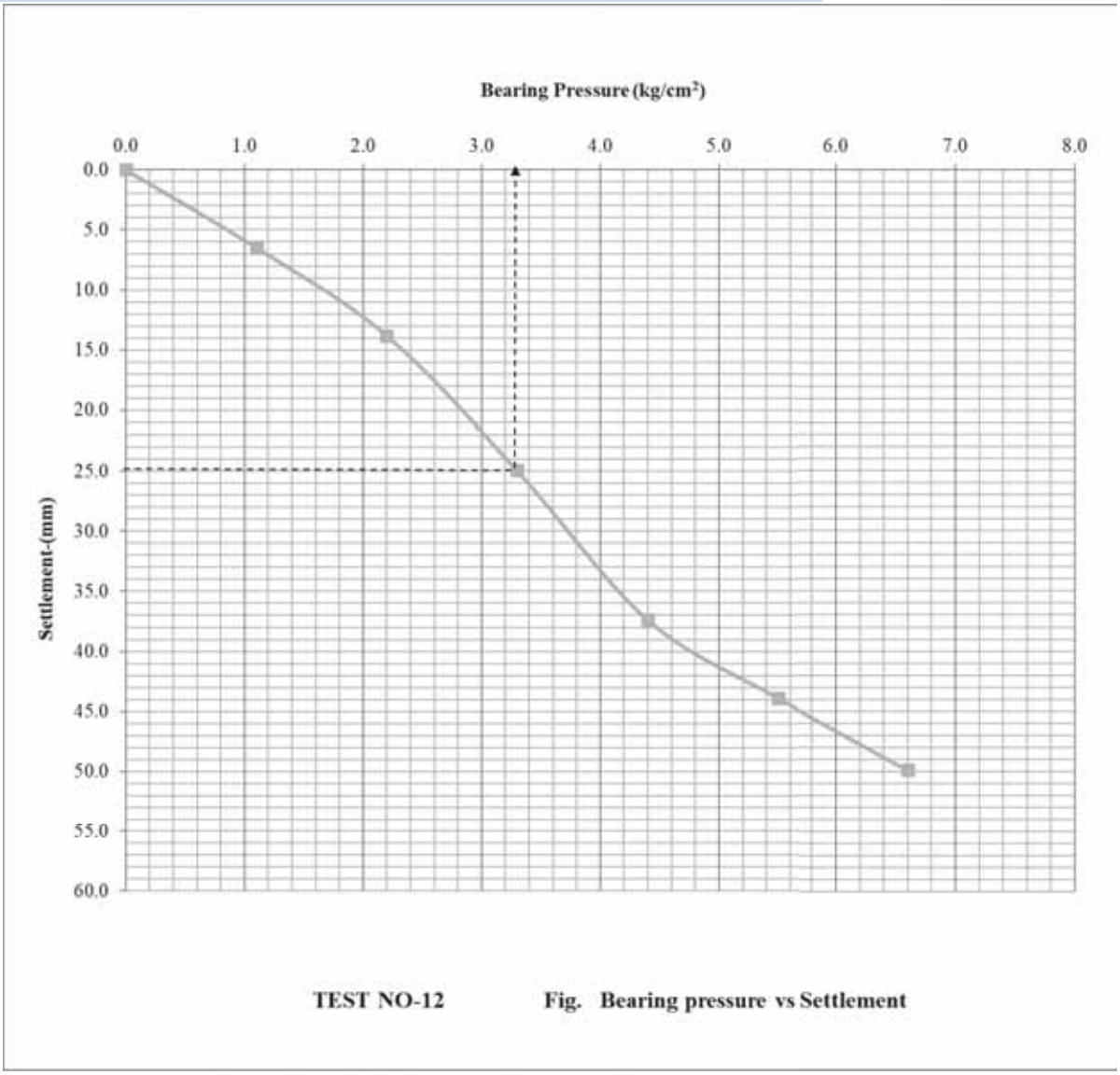
Test No 12

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.140	6.47
2.20	4.560	13.80
3.30	8.250	24.96
4.40	12.361	37.38
5.50	14.510	43.88
6.60	16.500	49.90

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-12 **Fig. Bearing pressure vs Settlement**

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.3 kg/cm^2.

Net safe bearing capacity = 32.47 t/m^2

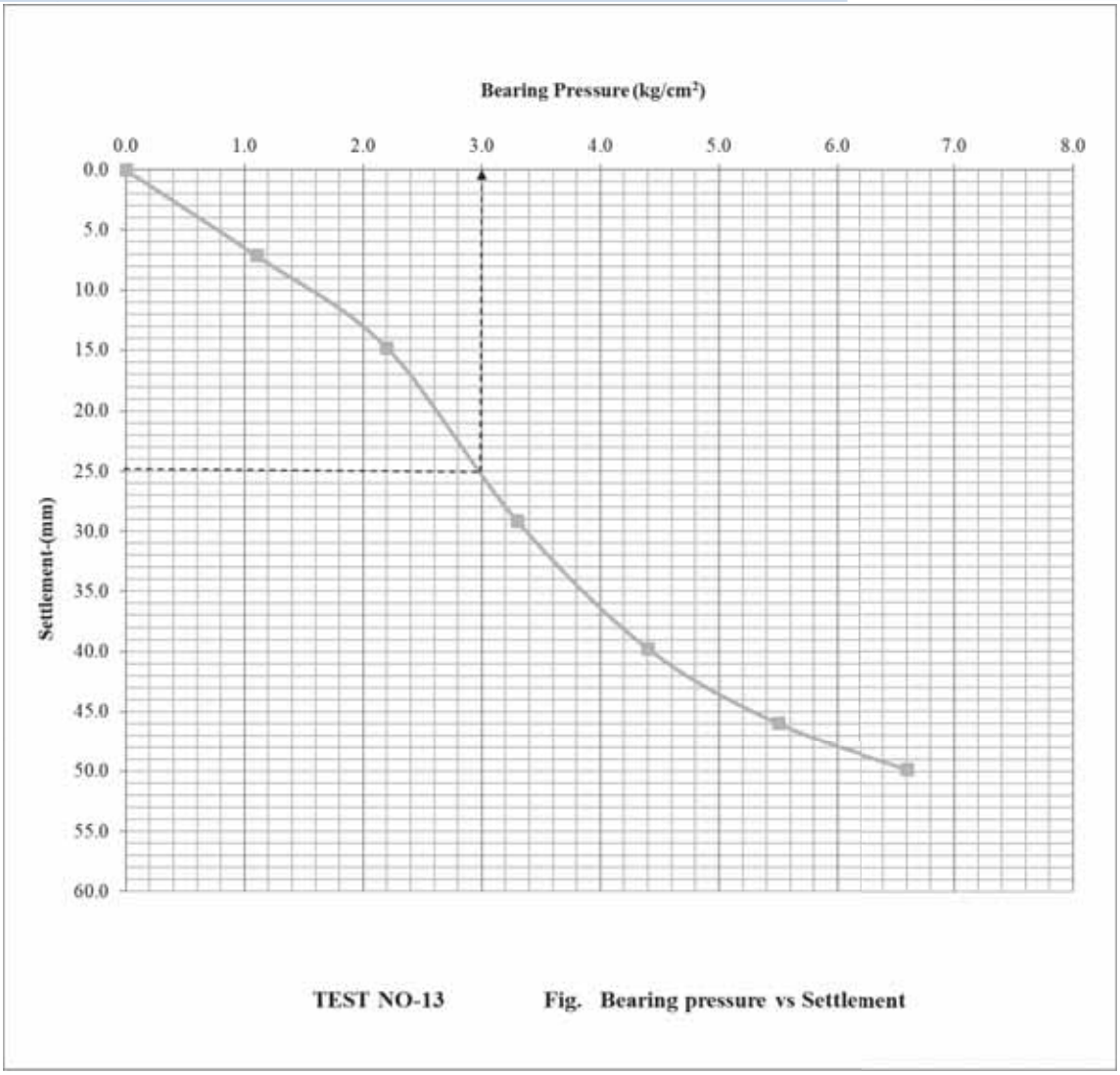
Test No 13

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.360	7.13
2.20	4.890	14.79
3.30	9.631	29.12
4.40	13.140	39.74
5.50	15.200	45.97
6.60	16.470	49.81

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-13 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.0 kg/cm^2.

Net safe bearing capacity = 29.52 t/m^2

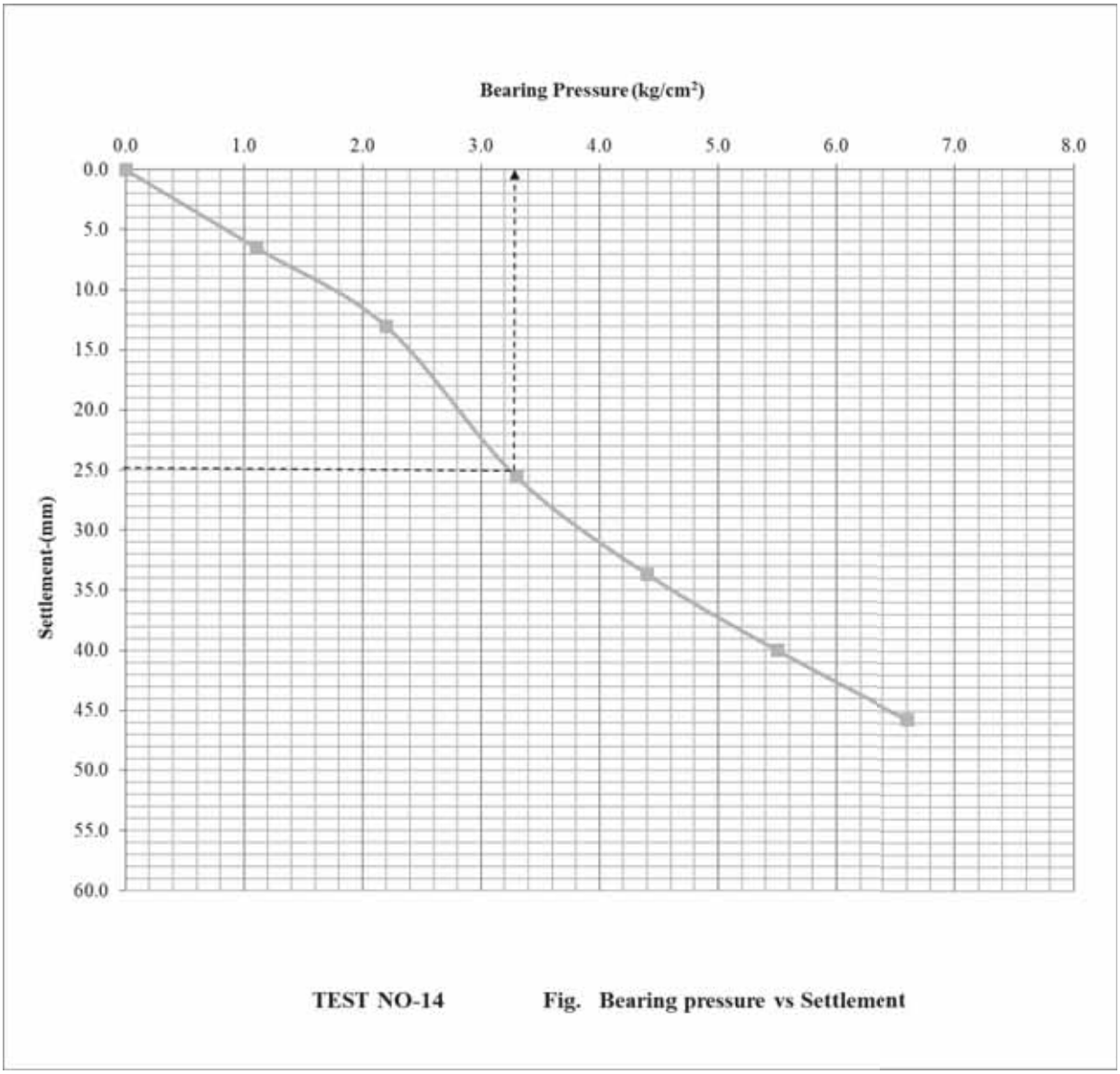
Test No 14

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.140	6.47
2.20	4.310	13.03
3.30	8.450	25.55
4.40	11.120	33.63
5.50	13.220	39.98
6.60	15.110	45.70

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-14 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.3 kg/cm^2.

Net safe bearing capacity = 32.47 t/m^2

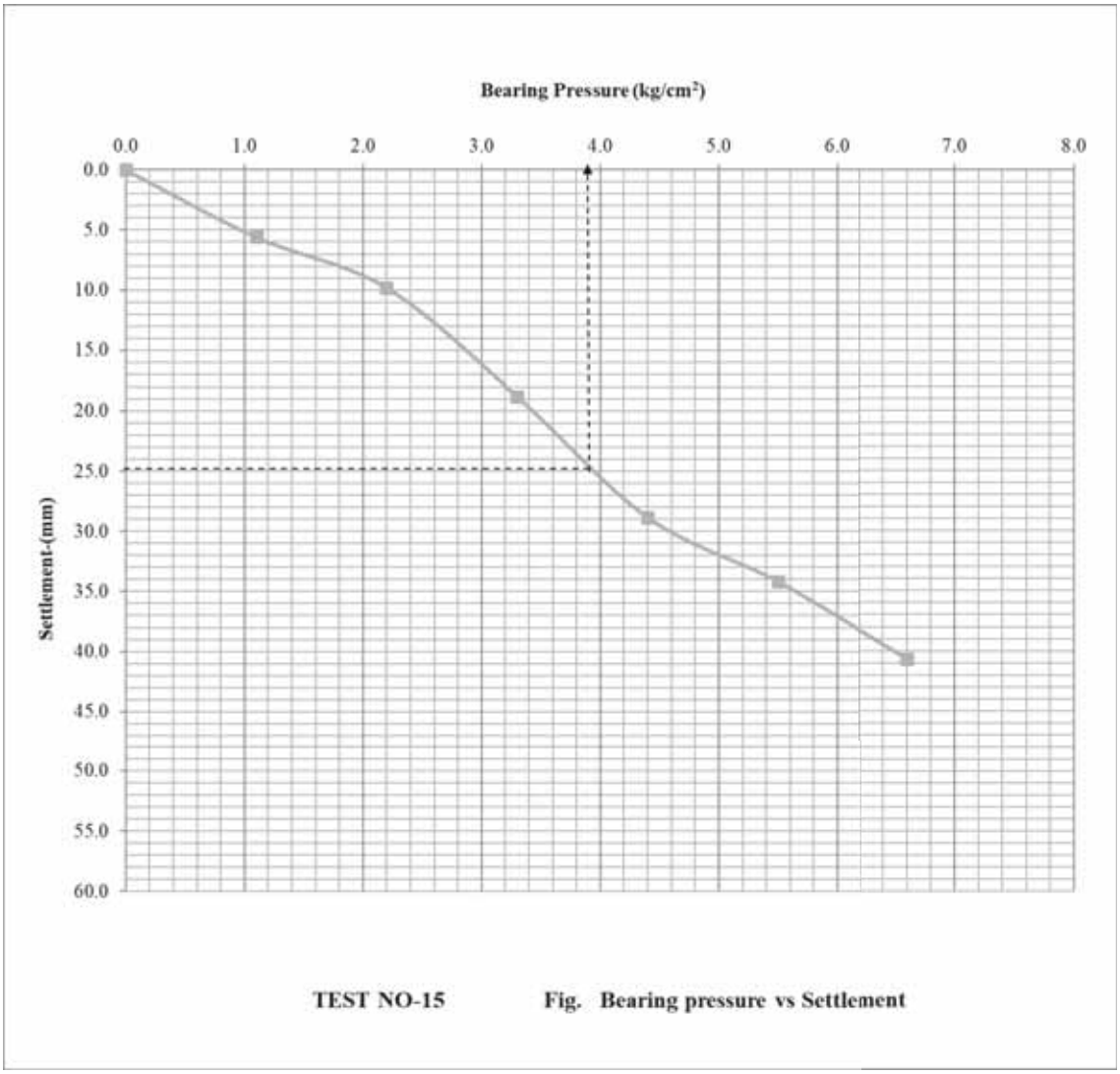
Test No 15

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.850	5.60
2.20	3.250	9.82
3.30	6.220	18.81
4.40	9.540	28.85
5.50	11.310	34.20
6.60	13.450	40.68

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-15 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.9 kg/cm^2.

Net safe bearing capacity = 38.38 t/m^2

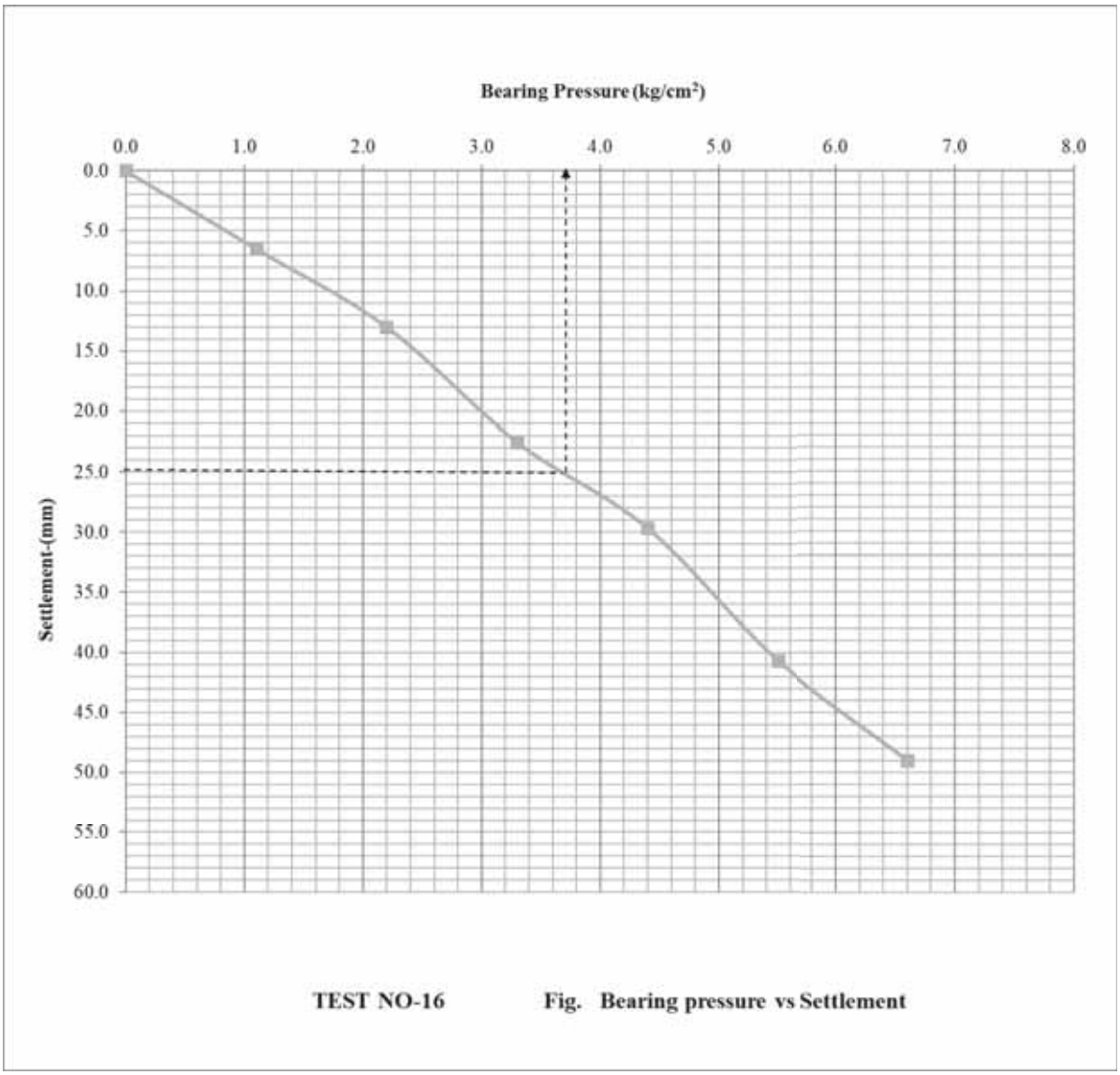
Test No 16

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.150	6.50
2.20	4.300	13.00
3.30	7.450	22.53
4.40	9.810	29.67
5.50	13.450	40.68
6.60	16.200	48.99

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-16 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.7 kg/cm^2.

Net safe bearing capacity = 36.41 t/m^2

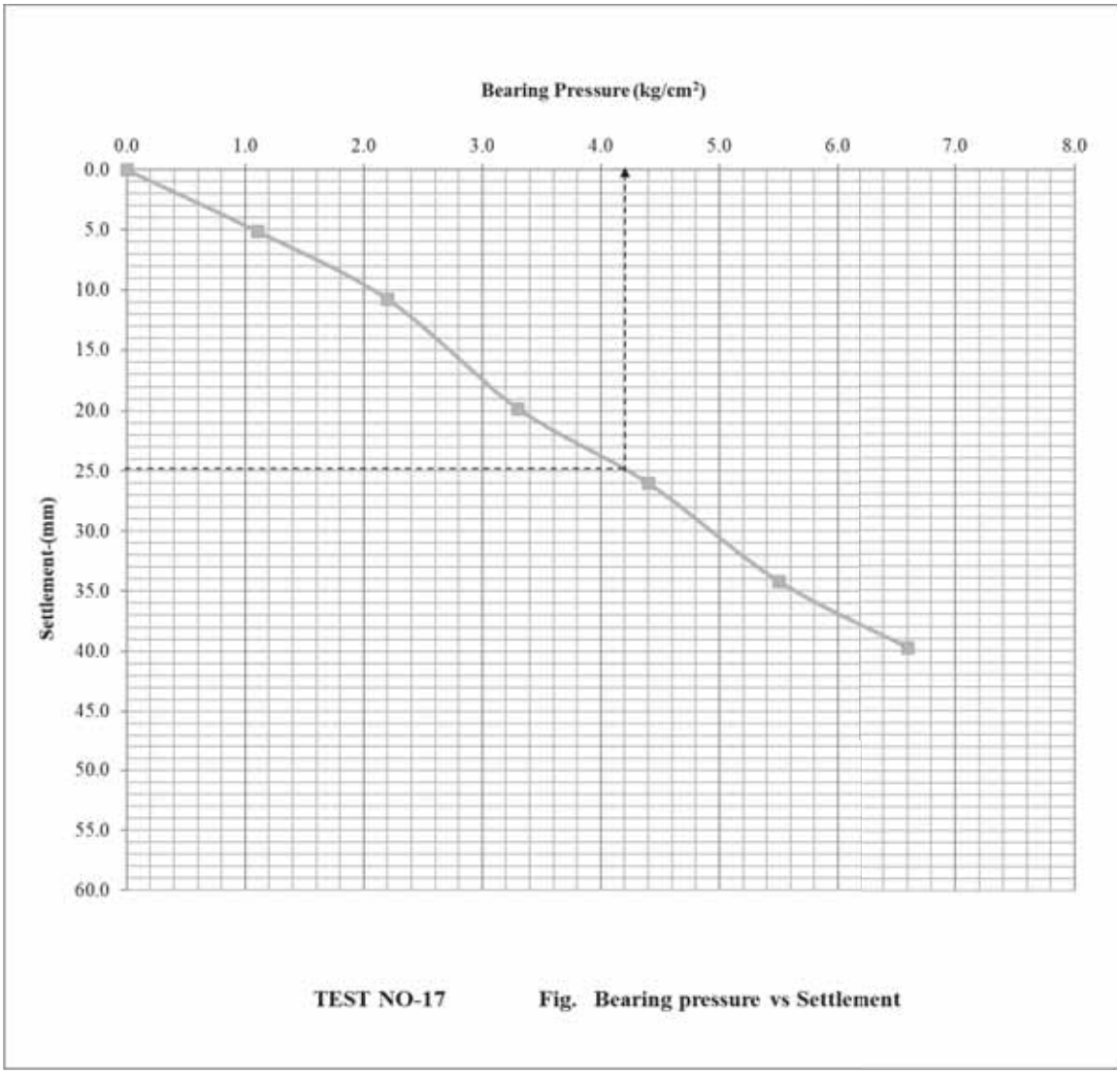
Test No 17

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	1.689	5.10
2.20	3.561	10.77
3.30	6.540	19.78
4.40	8.600	26.01
5.50	11.300	34.17
6.60	13.140	39.74

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-17 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 4.2 kg/cm^2.

Net safe bearing capacity = 41.33 t/m^2

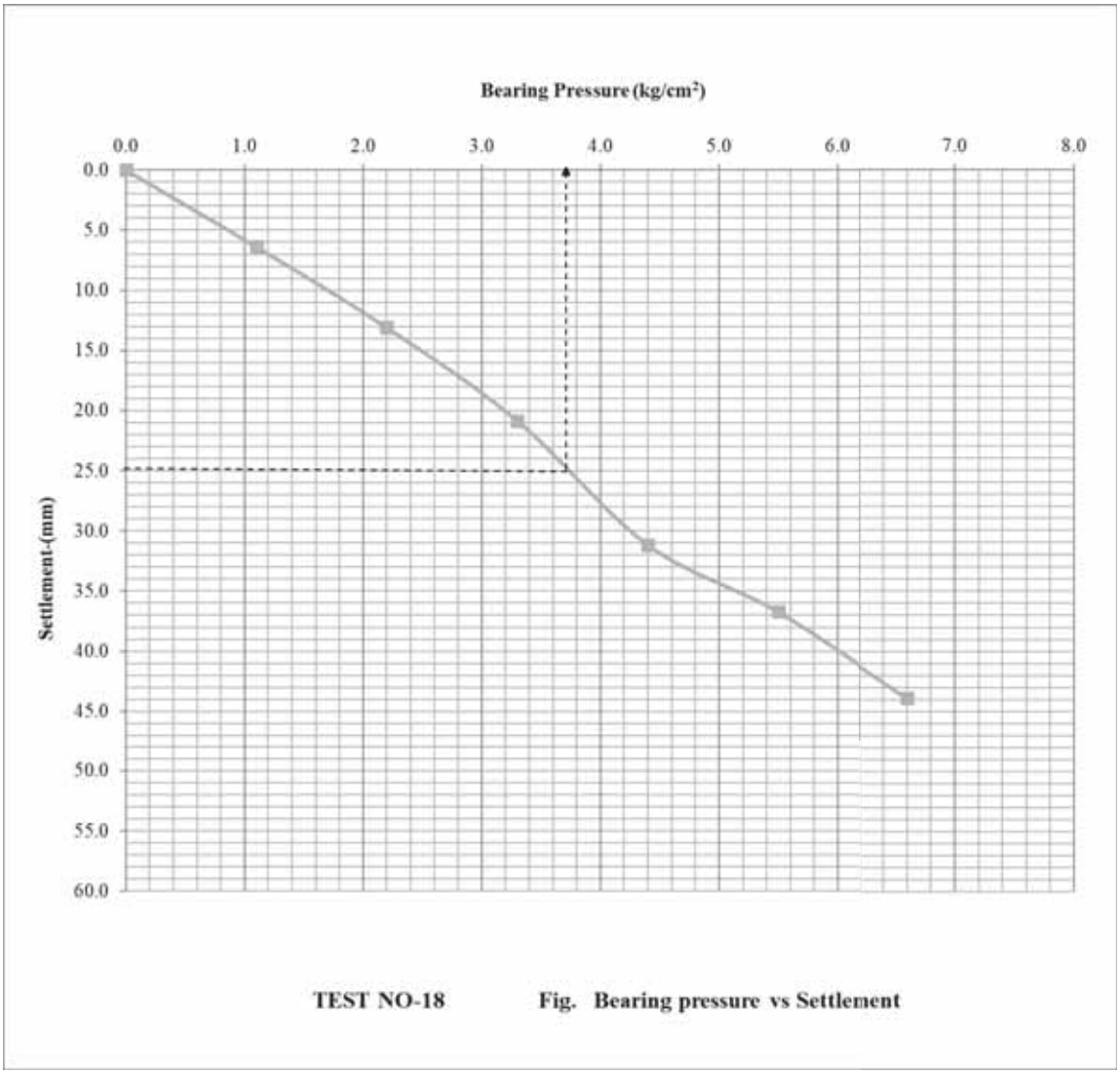
Test No 18

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.110	6.38
2.20	4.320	13.10
3.30	6.890	20.84
4.40	10.300	31.15
5.50	12.145	36.73
6.60	14.520	43.91

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-18 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.7 kg/cm^2.

Net safe bearing capacity = 36.41 t/m^2

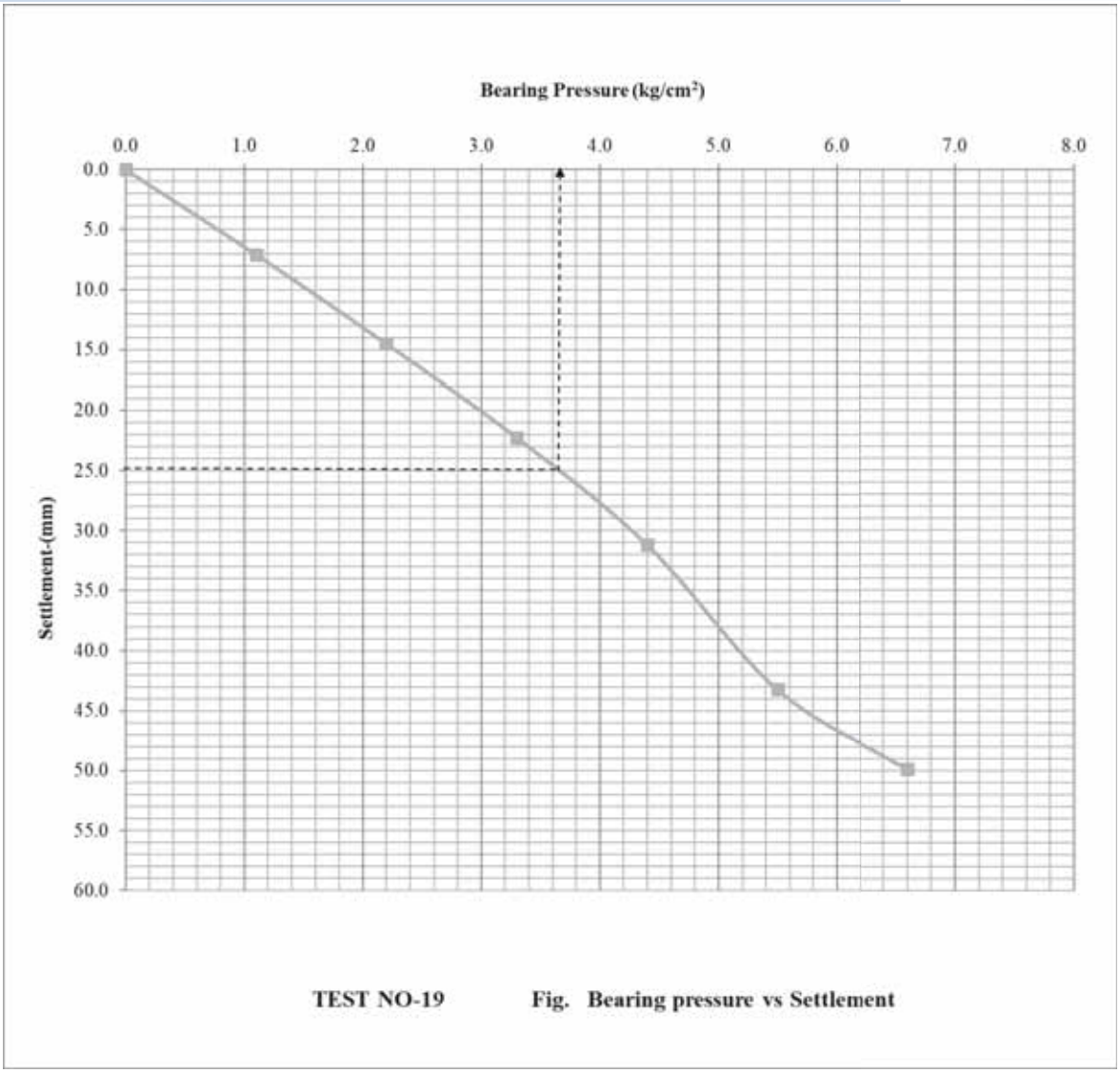
Test No 19

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	2.340	7.07
2.20	4.800	14.51
3.30	7.360	22.26
4.40	10.310	31.18
5.50	14.300	43.25
6.60	16.500	49.90

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-19 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

Hence, for 25mm settlement of foundation the safe bearing capacity is 3.65 kg/cm^2.

Net safe bearing capacity = 35.92 t/m^2

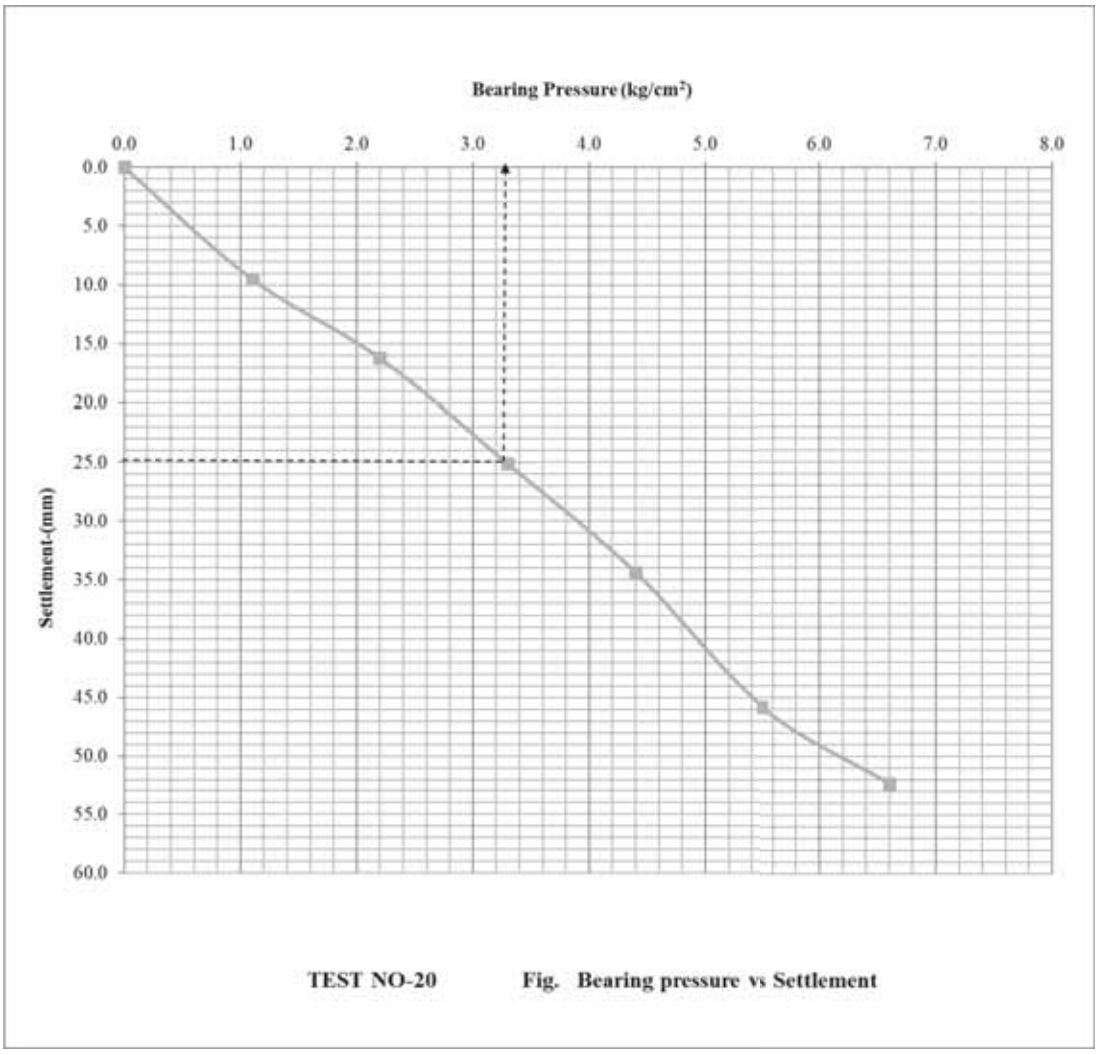
Test No 20

Pressure (Kg/Cm^2)	Settlement of plate (mm)	Settlement of foundation (mm)
1.10	3.140	9.49
2.20	5.360	16.21
3.30	8.310	25.13
4.40	11.360	34.35
5.50	15.140	45.79
6.60	17.300	52.32

The extrapolation of bearing capacity value is carried out as per IS: 1888-1982 & IS 8009 (Part -1) -1976:

$$S_f = S_p \left[\frac{B\left(b_p + 0.3\right)}{b_p\left(B + 0.3\right)} \right]^2$$

S_f: Permissible settlement value for foundation
S_p: Settlement observed for plate size
B_f: Width of foundation
B_p: Size of plate



TEST NO-20 Fig. Bearing pressure vs Settlement

The safe Bearing capacity is calculated based on Load Vs Settlement of the Plate Load Tests.

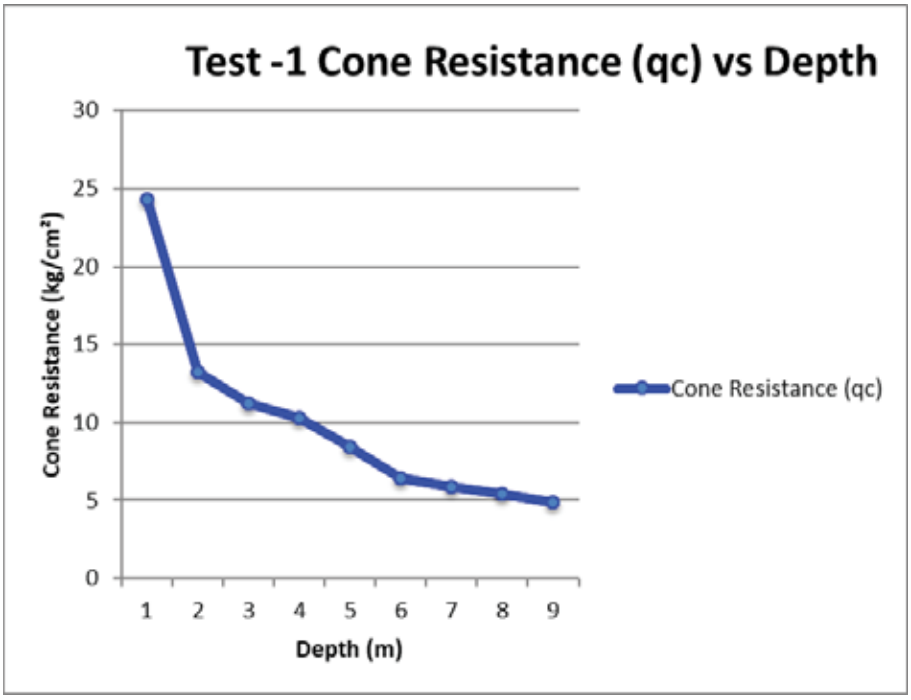
Hence, for 25mm settlement of foundation the safe bearing capacity is 3.3 kg/cm^2.

Net safe bearing capacity = 32.47 t/m^2

STATIC CONE PENETRATION TEST

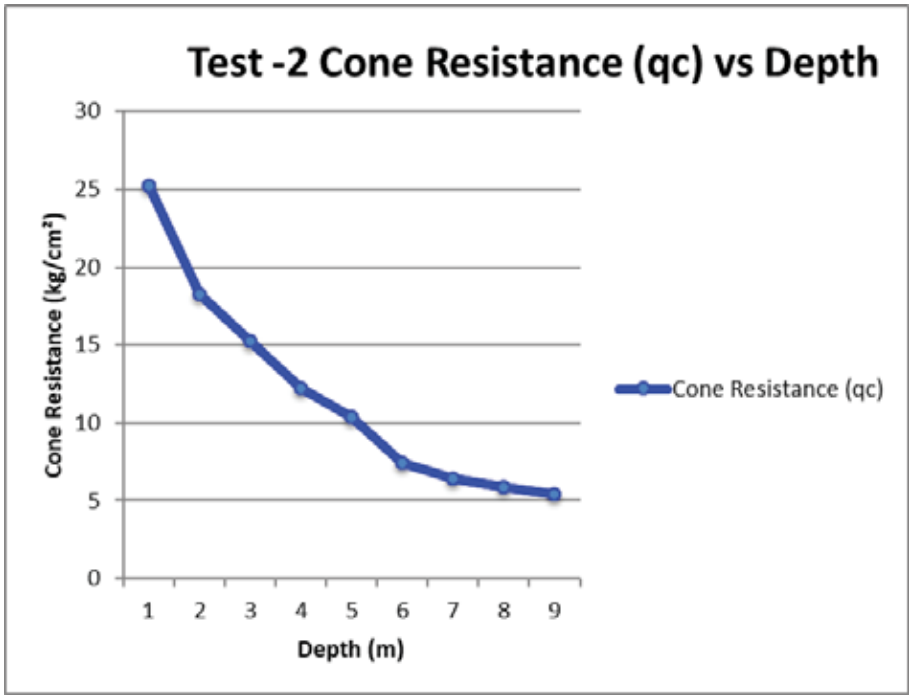
Test No.1

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	24.0	0.26	24.26
0.40	13.0	0.26	13.26
0.60	11.0	0.26	11.26
0.80	10.0	0.26	10.26
1.00	8.0	0.41	8.41
1.20	6.0	0.41	6.41
1.40	5.5	0.41	5.91
1.60	5.0	0.41	5.41
1.80	4.5	0.41	4.91



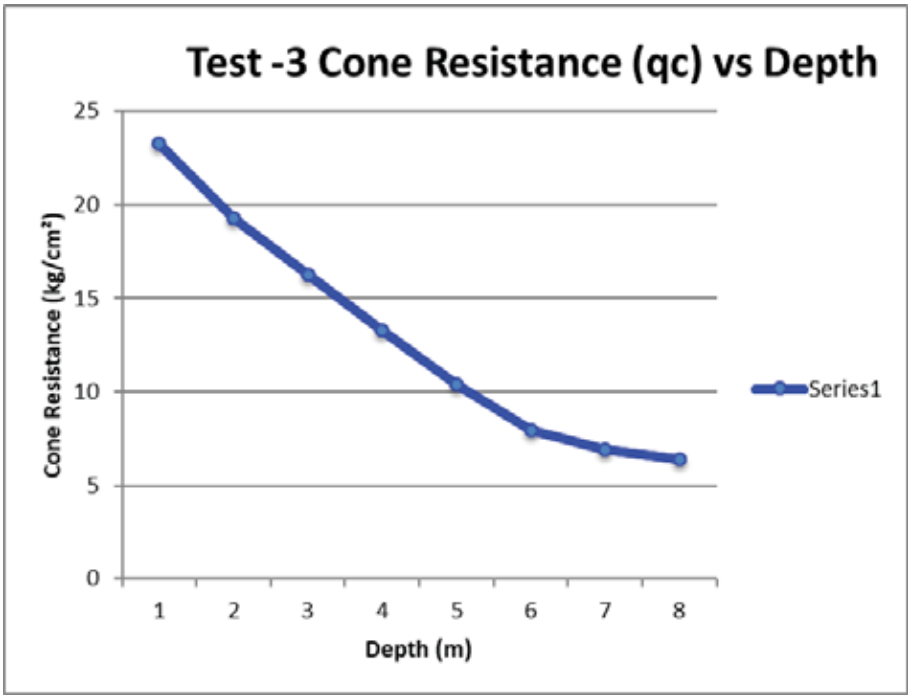
Test No.2

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	25.0	0.26	25.26
0.40	18.0	0.26	18.26
0.60	15.0	0.26	15.26
0.80	12.0	0.26	12.26
1.00	10.0	0.41	10.41
1.20	7.0	0.41	7.41
1.40	6.0	0.41	6.41
1.60	5.5	0.41	5.91
1.80	5.0	0.41	5.41



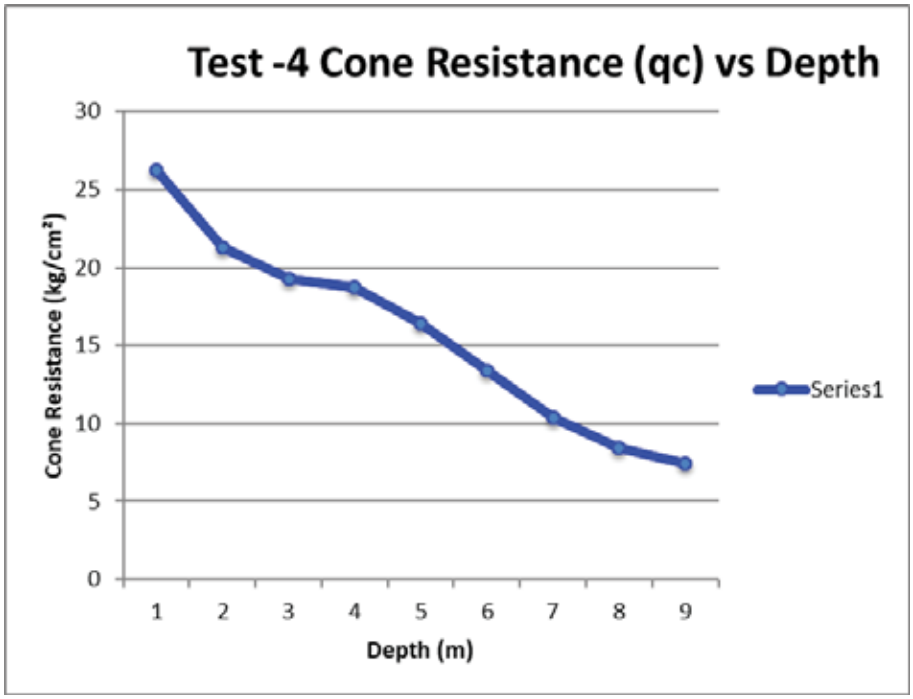
Test No.3

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	23.0	0.26	23.26
0.40	19.0	0.26	19.26
0.60	16.0	0.26	16.26
0.80	13.0	0.26	13.26
1.00	10.0	0.41	10.41
1.20	7.5	0.41	7.91
1.40	6.5	0.41	6.91
1.60	6.0	0.41	6.41



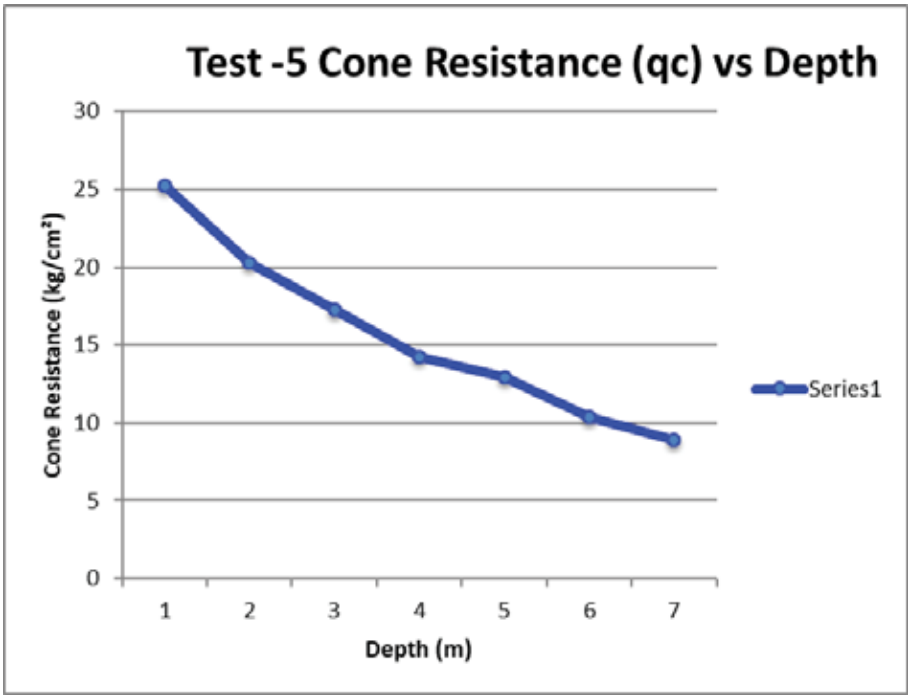
Test No.4

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	26.0	0.26	26.26
0.40	21.0	0.26	21.26
0.60	19.0	0.26	19.26
0.80	18.5	0.26	18.76
1.00	16.0	0.41	16.41
1.20	13.0	0.41	13.41
1.40	10.0	0.41	10.41
1.60	8.0	0.41	8.41
1.80	7.0	0.41	7.41



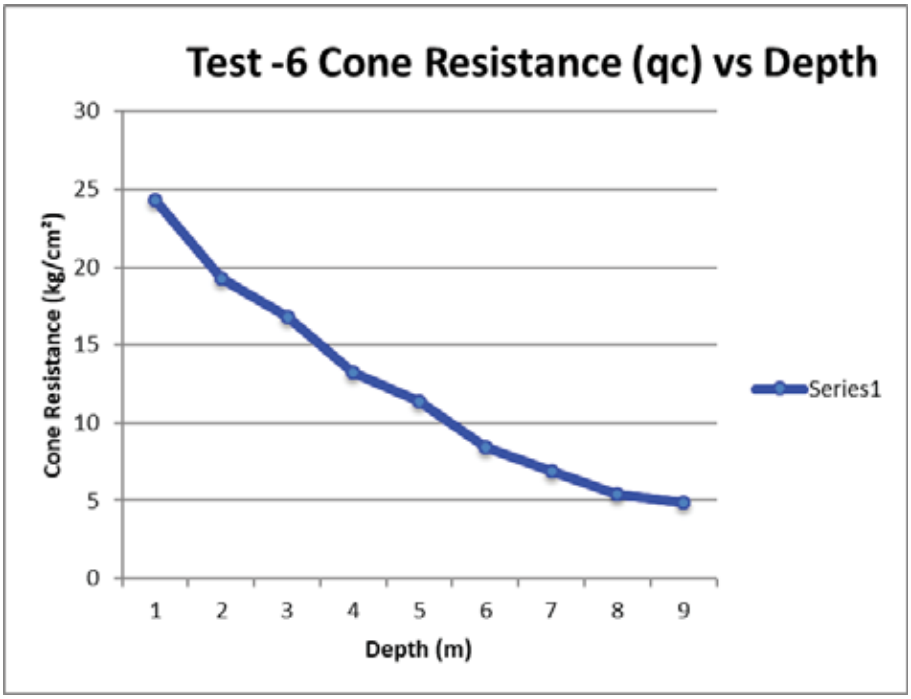
Test No.5

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	25.0	0.26	25.26
0.40	20.0	0.26	20.26
0.60	17.0	0.26	17.26
0.80	14.0	0.26	14.26
1.00	12.5	0.41	12.91
1.20	10.0	0.41	10.41
1.40	8.5	0.41	8.91
1.60	8.0	0.41	8.41



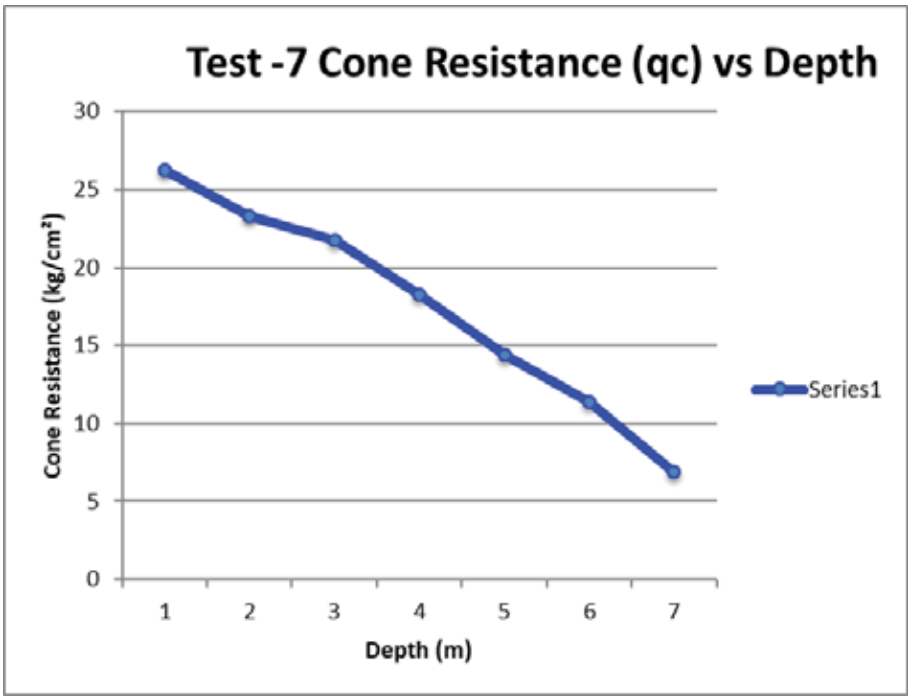
Test No.6

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	24.0	0.26	24.26
0.40	19.0	0.26	19.26
0.60	16.5	0.26	16.76
0.80	13.0	0.26	13.26
1.00	11.0	0.41	11.41
1.20	8.0	0.41	8.41
1.40	6.5	0.41	6.91
1.60	5.0	0.41	5.41
1.80	4.5	0.41	4.91



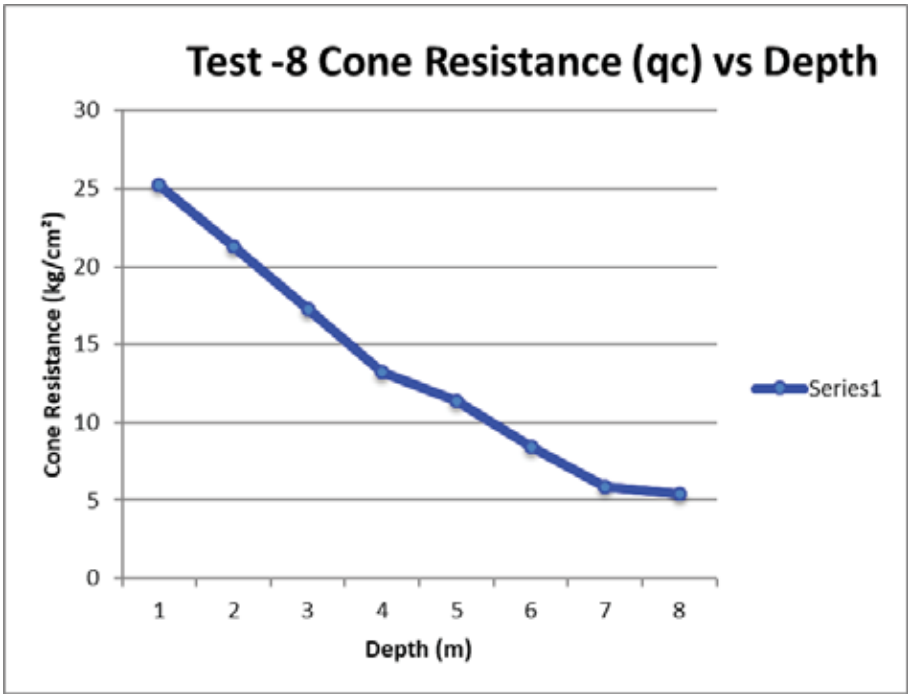
Test No.7

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	26.0	0.26	26.26
0.40	23.0	0.26	23.26
0.60	21.5	0.26	21.76
0.80	18.0	0.26	18.26
1.00	14.0	0.41	14.41
1.20	11.0	0.41	11.41
1.40	6.5	0.41	6.91



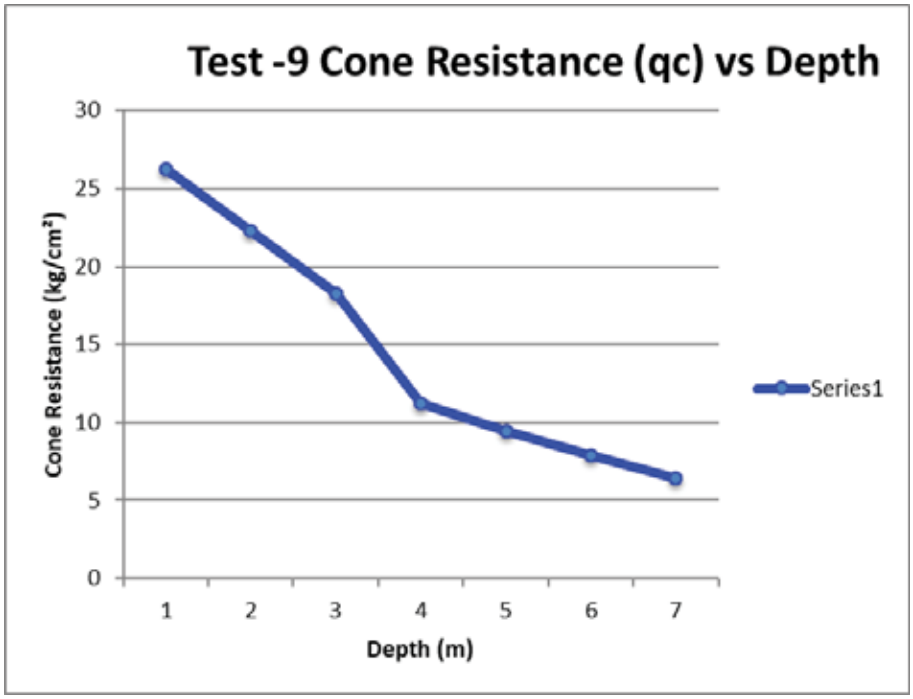
Test No.8

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	25.0	0.26	25.26
0.40	21.0	0.26	21.26
0.60	17.0	0.26	17.26
0.80	13.0	0.26	13.26
1.00	11.0	0.41	11.41
1.20	8.0	0.41	8.41
1.40	5.5	0.41	5.91
1.60	5.0	0.41	5.41



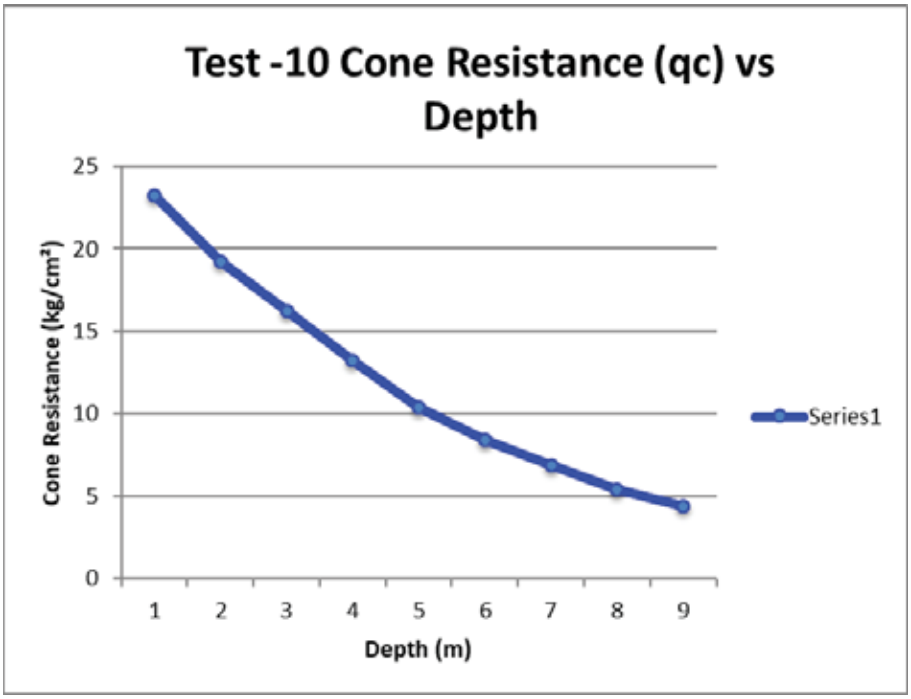
Test No.9

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	26.0	0.26	26.26
0.40	22.0	0.26	22.26
0.60	18.0	0.26	18.26
0.80	11.0	0.26	11.26
1.00	9.0	0.41	9.41
1.20	7.5	0.41	7.91
1.40	6.0	0.41	6.41



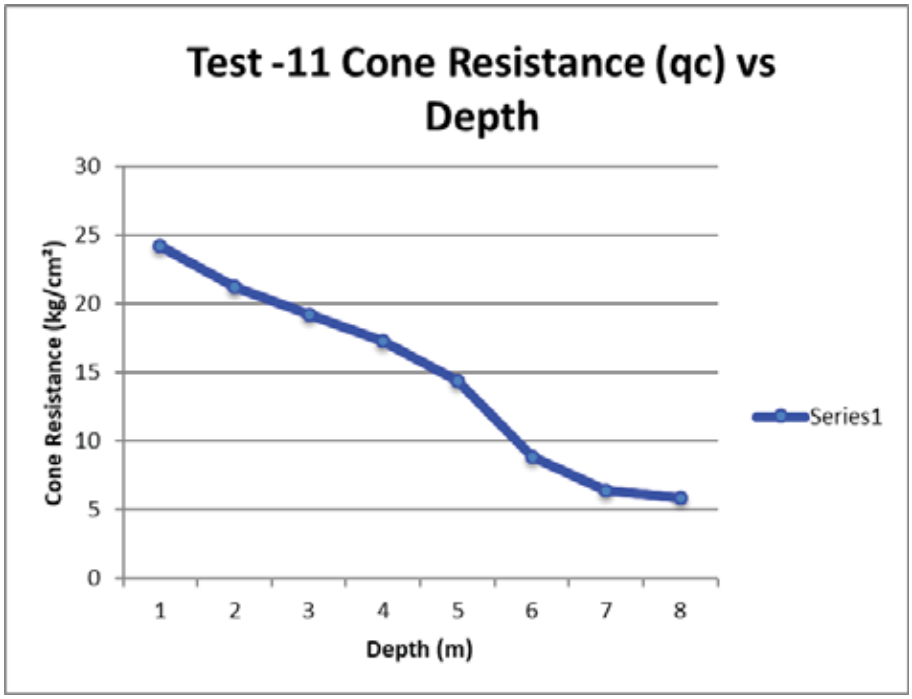
Test No.10

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	23.0	0.26	23.26
0.40	19.0	0.26	19.26
0.60	16.0	0.26	16.26
0.80	13.0	0.26	13.26
1.00	10.0	0.41	10.41
1.20	8.0	0.41	8.41
1.40	6.5	0.41	6.91
1.60	5.0	0.41	5.41
1.80	4.0	0.41	4.41



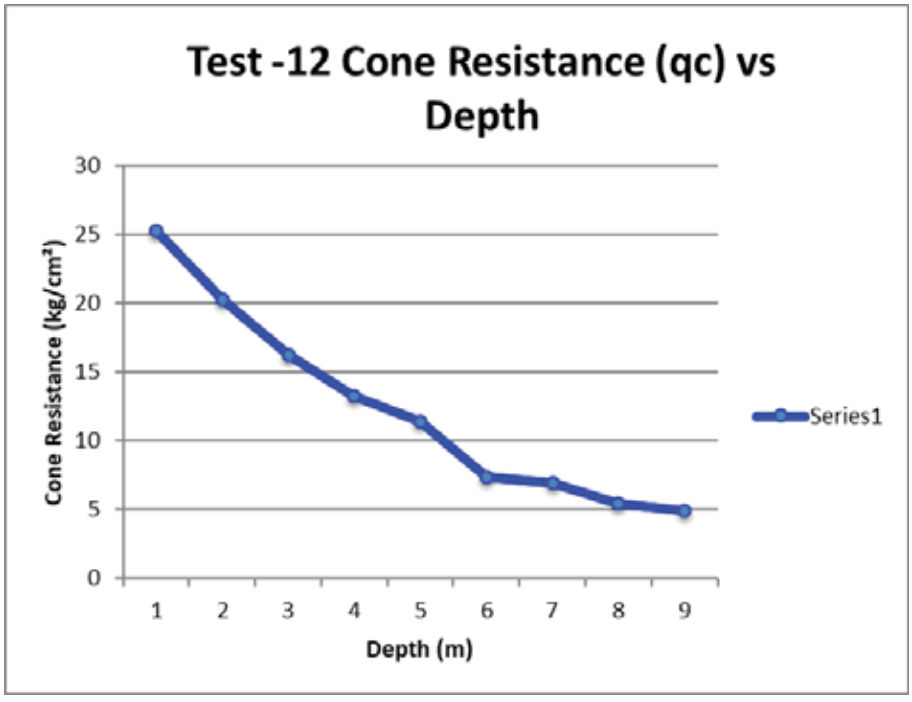
Test No.11

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	24.0	0.26	24.26
0.40	21.0	0.26	21.26
0.60	19.0	0.26	19.26
0.80	17.0	0.26	17.26
1.00	14.0	0.41	14.41
1.20	8.5	0.41	8.91
1.40	6.0	0.41	6.41
1.60	5.5	0.41	5.91



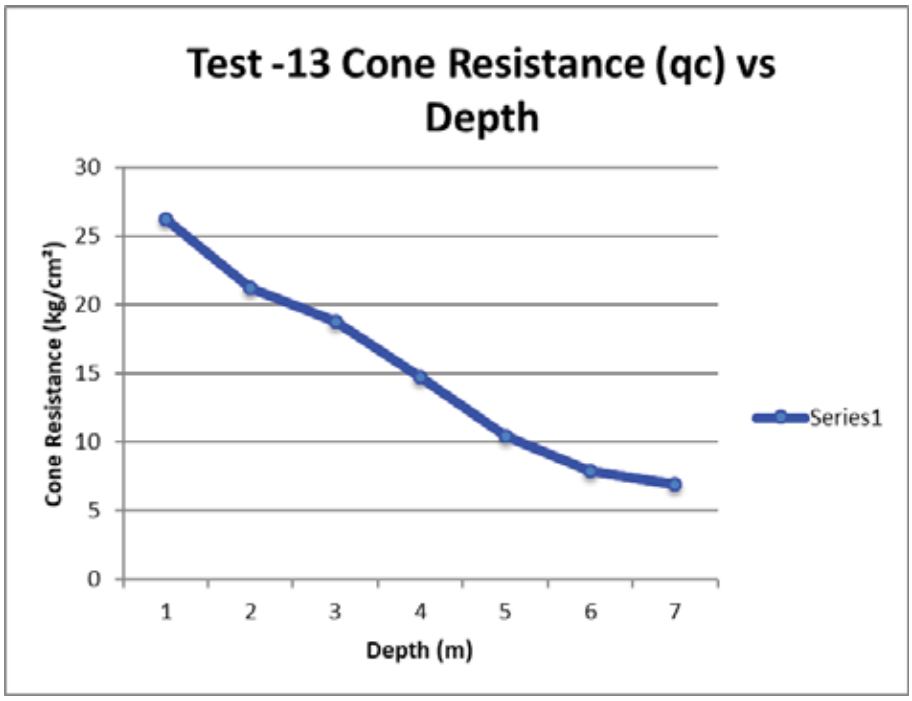
Test No.12

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	25.0	0.26	25.26
0.40	20.0	0.26	20.26
0.60	16.0	0.26	16.26
0.80	13.0	0.26	13.26
1.00	11.0	0.41	11.41
1.20	7.0	0.41	7.41
1.40	6.5	0.41	6.91
1.60	5.0	0.41	5.41
1.80	4.5	0.41	4.91



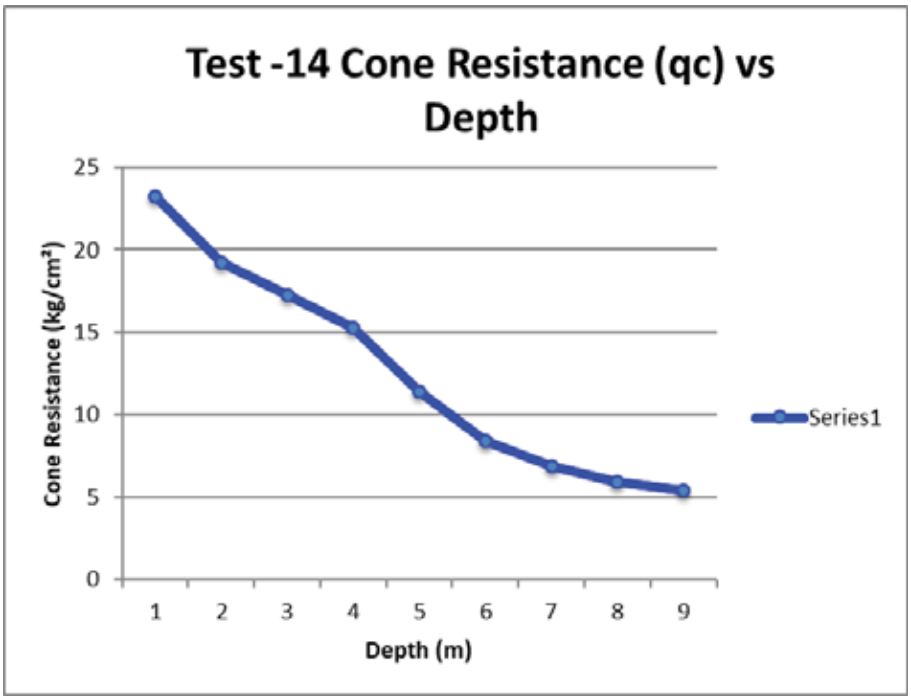
Test No.13

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	26.0	0.26	26.26
0.40	21.0	0.26	21.26
0.60	18.5	0.26	18.76
0.80	14.5	0.26	14.76
1.00	10.0	0.41	10.41
1.20	7.5	0.41	7.91
1.40	6.5	0.41	6.91



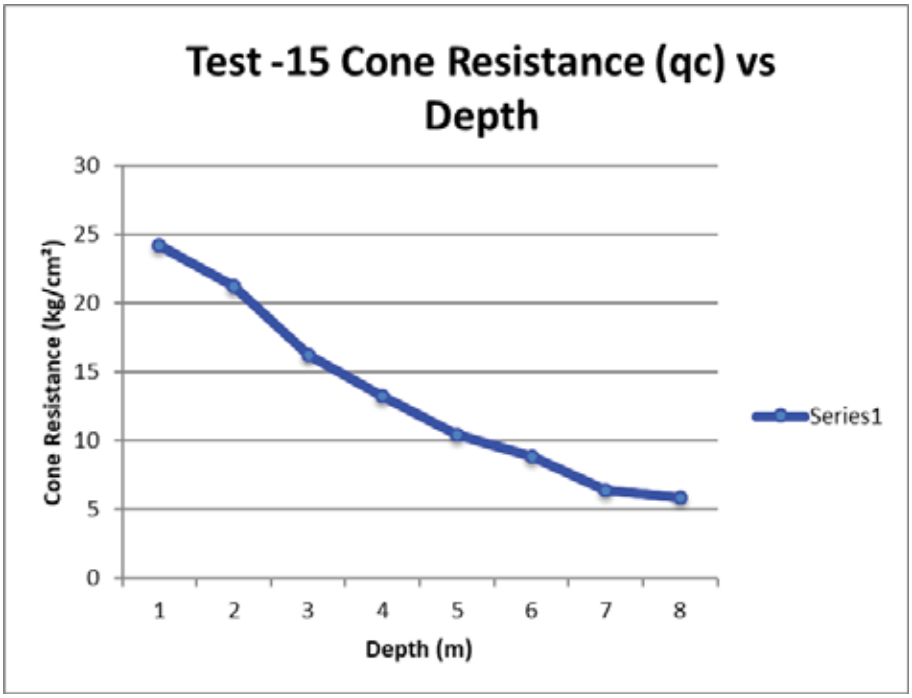
Test No.14

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	23.0	0.26	23.26
0.40	19.0	0.26	19.26
0.60	17.0	0.26	17.26
0.80	15.0	0.26	15.26
1.00	11.0	0.41	11.41
1.20	8.0	0.41	8.41
1.40	6.5	0.41	6.91
1.60	5.5	0.41	5.91
1.80	5.0	0.41	5.41



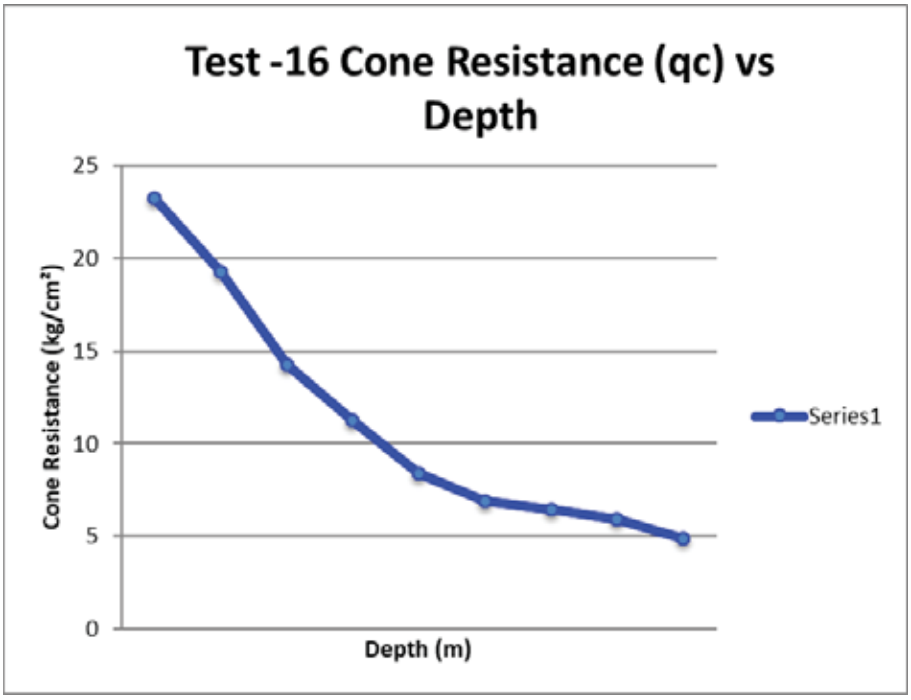
Test No.15

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	24.0	0.26	24.26
0.40	21.0	0.26	21.26
0.60	16.0	0.26	16.26
0.80	13.0	0.26	13.26
1.00	10.0	0.41	10.41
1.20	8.5	0.41	8.91
1.40	6.0	0.41	6.41
1.60	5.5	0.41	5.91



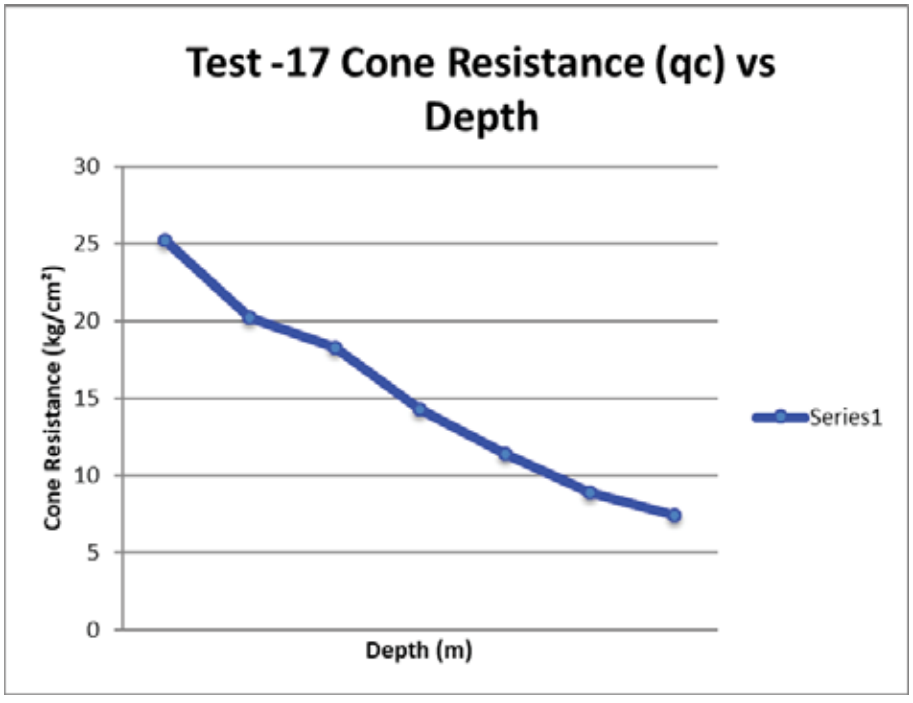
Test No.16

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	23.0	0.26	23.26
0.40	19.0	0.26	19.26
0.60	14.0	0.26	14.26
0.80	11.0	0.26	11.26
1.00	8.0	0.41	8.41
1.20	6.5	0.41	6.91
1.40	6.0	0.41	6.41
1.60	5.5	0.41	5.91
1.80	4.5	0.41	4.91



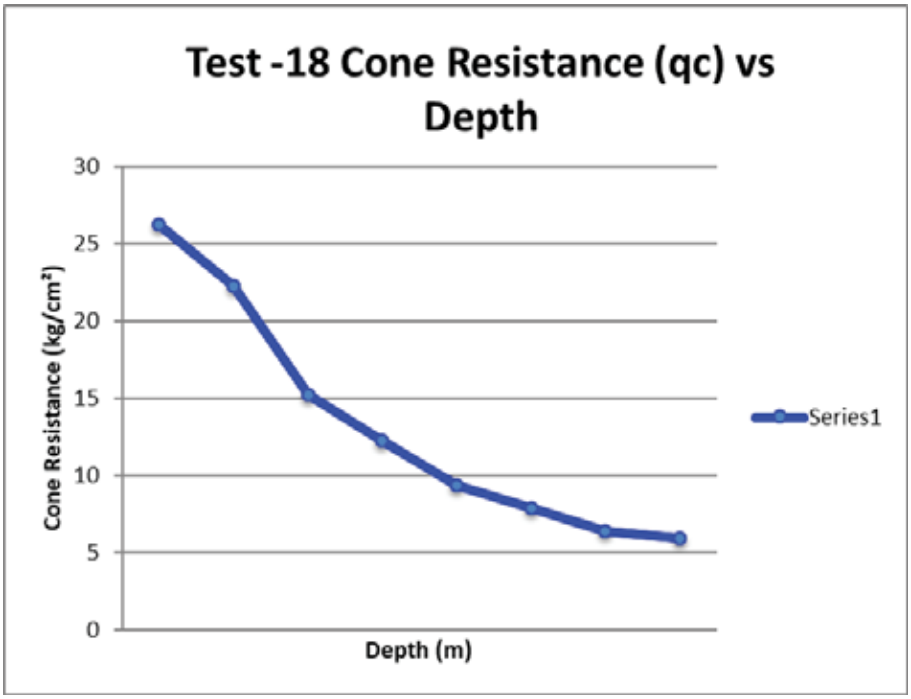
Test No.17

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	25.0	0.26	25.26
0.40	20.0	0.26	20.26
0.60	18.0	0.26	18.26
0.80	14.0	0.26	14.26
1.00	11.0	0.41	11.41
1.20	8.5	0.41	8.91
1.40	7.0	0.41	7.41



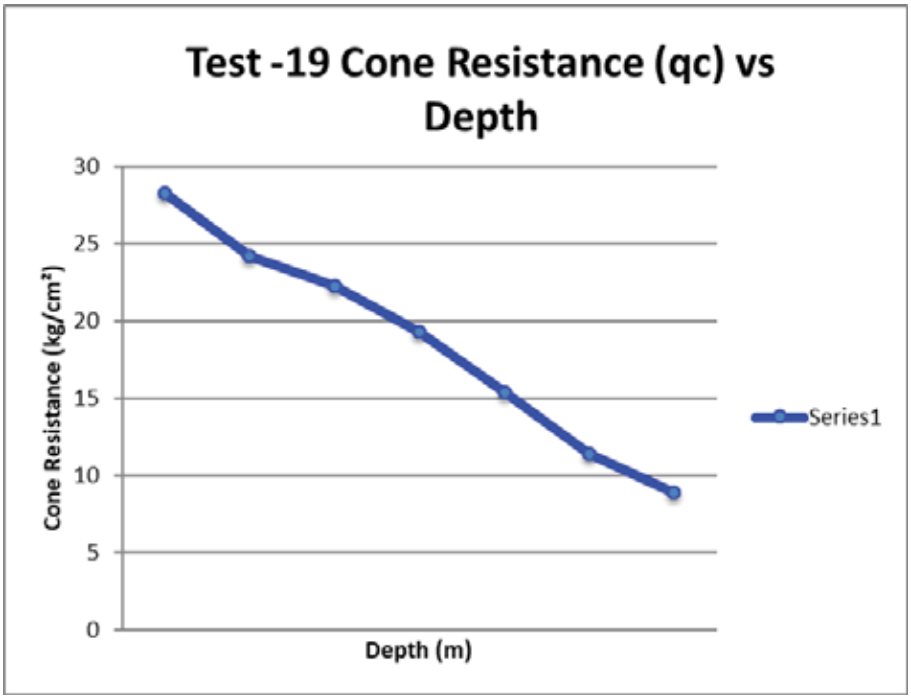
Test No.18

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	26.0	0.26	26.26
0.40	22.0	0.26	22.26
0.60	15.0	0.26	15.26
0.80	12.0	0.26	12.26
1.00	9.0	0.41	9.41
1.20	7.5	0.41	7.91
1.40	6.0	0.41	6.41
1.60	5.5	0.41	5.91



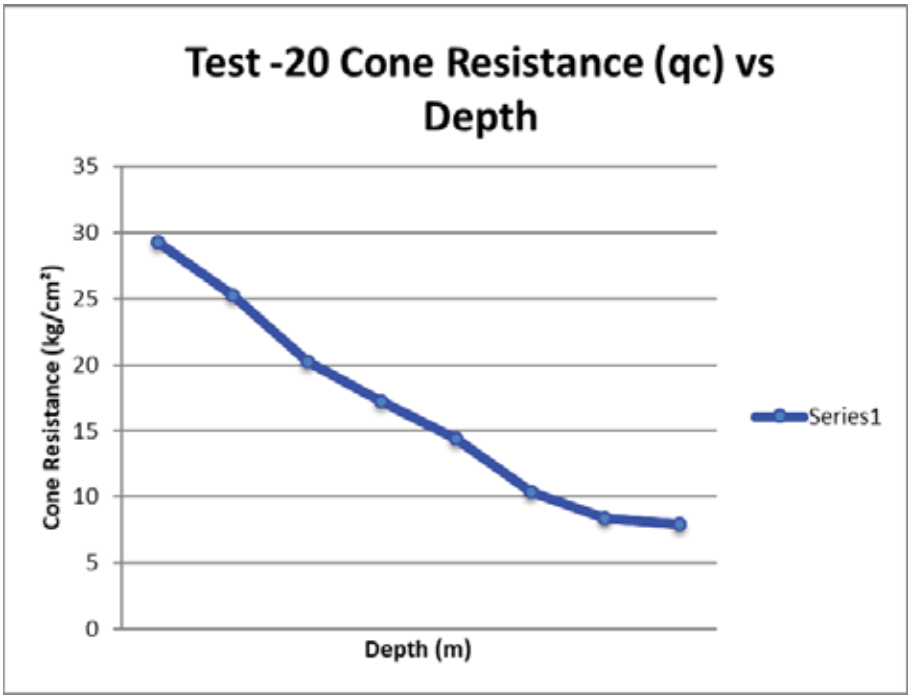
Test No.19

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	28.0	0.26	28.26
0.40	24.0	0.26	24.26
0.60	22.0	0.26	22.26
0.80	19.0	0.26	19.26
1.00	15.0	0.41	15.41
1.20	11.0	0.41	11.41
1.40	8.5	0.41	8.91



Test No.20

Depth (m)	Gauge Reading (kg/cm²)	Cone Resistance (qc) (kg/cm²)	Corrected Value Cone Penetration Resistance (q_c) (kg/cm²)
0.20	29.0	0.26	29.26
0.40	25.0	0.26	25.26
0.60	20.0	0.26	20.26
0.80	17.0	0.26	17.26
1.00	14.0	0.41	14.41
1.20	10.0	0.41	10.41
1.40	8.0	0.41	8.41
1.60	7.5	0.41	7.91



MODULUS OF SUB GRADE REACTION

BH-1

Pressure (Kg/Cm^2)	Settlement (mm)
1.10	2.270
2.20	4.660
3.30	7.105
4.40	9.875
5.50	11.350
6.60	14.320

Modulus of subgrade reaction for 30 cm dia of plate @ 3kg/cm^2

$$K_{30} = \frac{\text{Pressure}}{\text{Deflection}} = \frac{3.30 \text{ kg/cm}^2}{0.71 \text{ cm}}$$

= 4.64 kg/cm^3

As per IRC, modulus of subgrade reaction is always reports corresponding to 75 cm dia of plate

K x a = Constant

K_{30} X 4.64 = K_{75} X 75

K_{75} = 1.85 kg/cm^3

S.no	Location	K_{30} (Kg/cm^3) (Uncorrected)	K_{75} (Kg/cm^3) (Corrected)
1.	BH-1	4.64	1.85
2.	BH-2	5.04	2.01
3.	BH-3	4.61	1.84
4.	BH-4	4.92	1.96
5.	BH-5	5.60	2.24
6.	BH-6	3.84	1.54
7.	BH-7	4.80	1.92
8.	BH-8	4.42	1.77
9.	BH-9	3.99	1.59
10.	BH-10	4.31	1.72
11.	BH-11	4.45	1.78
12.	BH-12	4.00	1.60
13	BH-13	3.42	1.37
14.	BH-14	3.90	1.56
15.	BH-15	5.30	2.12
16.	BH-16	4.42	1.77
17.	BH-17	5.04	2.01
18.	BH-18	4.78	1.91
19.	BH-19	4.48	1.79
20.	BH-20	3.97	1.58

Note: -

1. That subgrade reaction k_s of cohessionless soil increases with increasing footing size for all type of foundations.

2. Subgrade reaction k_s of cohessionless soil under rectangular plate is higher than that under square than that under circular one (at same equivalent area).

*****End of Report*****

S.NO.	TEST/PARAMETER	CORDINATES		DEPTH(m)
		LAT.	LONG.	
	BOREHOLES			
1	BH-1	21.725104	83.833402	30.0
2	BH-2	21.721031	83.834808	20.0
3	BH-3	21.766634	83.835488	30.0
4	BH-4	21.713973	83.834726	20.0
5	BH-5	21.712446	83.837253	30.0
6	BH-6	21.712645	83.839753	20.0
7	BH-7	21.717341	83.844997	30.0
8	BH-8	21.72123	83.846282	20.0
9	BH-9	21-721425	83.841483	30.0
10	BH-10	21.721929	83.837365	20.0
11	BH-11	21.720298	83.840088	30.0
12	BH-12	21.719279	83.843628	20.0
13	BH-13	21.720612	83.844458	30.0
14	BH-14	21.71732	83.839511	20.0
15	BH-15	21.717358	83.836308	30.0
16	BH-16	21.717343	83.84322	20.0
17	BH-17	21.714997	83.838778	30.0
18	BH-18	21.714578	83.842636	20.0
19	BH-19	21.712797	83.840401	30.0
20	BH-20	21.712947	83.83711	20.0
	ERT			
1	ERT-1	21.721889	83.837827	Ground level
2	ERT-2	21.717287	83.83939	
3	ERT-3	21.714932	83.838814	
4	ERT-4	21.715549	83.842771	
5	ERT-5	21.717402	83.843206	
	PLT			
1	PLT-1	21.722055	83.837041	2.0
2	PLT-2	21.722295	83.843338	2.0
3	PLT-3	21.714779	83.838898	2.0
4	PLT-4	21.71362	83.834586	2.0
5	PLT-5	21.713438	83.839522	2.0
6	PLT-6	21.714596	83.839959	2.0
7	PLT-7	21.714424	83.842096	2.0
8	PLT-8	21.713832	83.843505	2.0
9	PLT-9	21.715937	83.84401	2.0
10	PLT-10	21.721727	83.844731	2.0
11	PLT-11	21.72238	83.844452	2.0
12	PLT-12	21.719668	83.83452	2.0
13	PLT-13	21.720921	83.838186	2.0
14	PLT-14	21.721397	83.836382	2.0
15	PLT-15	21.719291	83.837574	2.0
16	PLT-16	21.71934	83.837527	2.0
17	PLT-17	21.716453	83.838378	2.0

18	PLT-18	21.716602	83.841682	2.0
19	PLT-19	21.71951	83.838746	2.0
20	PLT-20	21.719696	83.836613	2.0
	CPLT			
1	CPLT-1	21.721397	83.838191	2.0
2	CPLT-2	21.718286	83.843338	2.0
3	CPLT-3	21.712721	83.836816	2.0
4	CPLT-4	21.725043	83.833446	2.0
5	CPLT-5	21.713748	83.840508	2.0
6	CPLT-6	21.716692	83.838991	2.0
7	CPLT-7	21.714646	83.841536	2.0
8	CPLT-8	21.716566	83.843202	2.0
9	CPLT-9	21.717457	83.843488	2.0
10	CPLT-10	21.721557	83.846233	2.0
11	CPLT-11	21.712828	83.835582	2.0
12	CPLT-12	21.719161	83.834984	2.0
13	CPLT-13	21.722301	83.83609	2.0
14	CPLT-14	21.719827	83.838402	2.0
15	CPLT-15	21.718444	83.840274	2.0
16	CPLT-16	21.71654	83.840619	2.0
17	CPLT-17	21.715742	83.838225	2.0
18	CPLT-18	21.71883	83.839436	2.0
19	CPLT-19	21.718993	83.836958	2.0
20	CPLT-20	21.720698	83.836313	2.0
	SCPT			
1	SCPT-1	21.717406	83.843281	1.80
2	SCPT-2	21.7182	83.842672	1.80
3	SCPT-3	21.717197	83.839686	1.60
4	SCPT-4	21.720095	83.840233	1.80
5	SCPT-5	21.721368	83.837651	1.60
6	SCPT-6	21.722266	83.83601	1.80
7	SCPT-7	21.724947	83.833443	1.40
8	SCPT-8	21.720621	83.836349	1.60
9	SCPT-9	21.719576	83.836692	1.40
10	SCPT-10	21.718805	83.836972	1.80
11	SCPT-11	21.719268	83.835507	1.60
12	SCPT-12	21.717365	83.844789	1.80
13	SCPT-13	21.719487	83.843374	1.40
14	SCPT-14	21.722185	83.843137	1.80
15	SCPT-15	21.72229	83.844386	1.60
16	SCPT-16	21.721446	83.846252	1.80
17	SCPT-17	21.716246	83.843384	1.40
18	SCPT-18	21.715959	83.844099	1.60
19	SCPT-19	21.715385	83.842728	1.40
20	SCPT-20	21.714499	83.842822	1.60

BOUNDARY CORNER POINTS

SL NO.	EASTING	NORTHING
1	793109.852	2405091.480
2	793228.780	2405080.480
3	793337.719	2405048.861
4	793592.871	2404921.976
5	793853.473	2404912.549
6	793955.443	2404942.747
7	793992.847	2404968.121
8	794051.219	2404986.020
9	794046.213	2404880.810
10	794387.399	2404857.565
11	794382.042	2404750.616
12	794477.489	2404729.714
13	794527.227	2404739.839
14	794540.474	2404786.966
15	794598.448	2404773.523
16	794583.437	2404742.082
17	794583.182	2404701.589
18	794558.660	2404677.253
19	794540.275	2404674.787
20	794519.976	2404638.065
21	794518.219	2404625.522
22	794494.913	2404615.971
23	794484.929	2404604.167
24	794389.843	2404591.779
25	794389.914	2404377.848
26	794380.016	2404306.829
27	794383.192	2404109.092
28	794315.712	2404044.152
29	794191.326	2404033.216
30	794199.212	2403862.158
31	794201.558	2403835.485
32	794082.748	794082.748
33	793940.217	2403714.040
34	793808.307	2403561.467
35	793634.826	2403595.770
36	793380.140	2403761.545
37	793339.215	2403771.478
38	793201.199	2403859.559
39	793225.534	2403929.278
40	793293.788	2404202.085
41	793245.880	2404347.897
42	793254.722	2404385.459
43	793240.404	2404617.414
44	793130.085	2404876.975
45	793108.547	2404993.275

ALL BENCH MARK DETAILS

SL NO.	X	Y	Z(RL)
TBM1	795143.524	2402807.668	215.458
TBM2	793744.218	2404237.606	220.372
TBM3	793086.236	2405098.268	224.865
TBM4	793082.212	2405099.380	224.433
TBM5	793813.508	2404775.934	220.992
TBM6	793814.840	2404764.286	220.871
TBM9	794234.472	2403837.624	212.918
TBM10	794228.568	2403826.886	212.897
TBM11	793719.602	2403667.155	211.430
TBM12	793720.624	2403669.028	211.427

NOTES :-

- All Dimensions are in Meter
- Reference Control Point (RL):- MCL 9 & MCL 10 (as provided by MCL)
- Proposed Plant Area :- 348.229 Acres
- Total Surveyed Area :- 415 Acres
- True North & Grid Noth are same
- Grid Interval :- 1. For Spot Level-5m 2. For Plan-100m
- No. of Trees- 1850
- Reference Co-ordinates established as per UTM :-

MCP 9 Near ROB X=794823.295 Y=2404570.992 Z=224.508 (RL)

MCP 10 Near ROB X=794916.404 Y=2405364.251 Z=233.994 (RL)

LEGENDS FOR PLAN

Cement Concrete Road		Transformer	
Bitumin Road		KM Stone	
Mud Road		Temple	
Structure		Well	
Shed		Water Tank	
Rail Track		Tube Well	
Boundary Wall	CW	Tower	
Property Line		Hospital	
Pond		School	
Culvert		Solar Light	
Tree		Contour	
Gate		Bench Mark	
Electric Pole			

PROJECT	**PROPOSED AMMONIUM NITRATE PLANT**
CLIENT	BHARAT COAL GASIFICATION AND CHEMICALS LIMITED (BCGCL)
Paper Size A0	TOPOGRAPHICAL & CONTOUR SURVEY WORK FOR HIGH ASH COAL-TO-AMMONIUM NITRATE PLANT BASED ON INDIGENOUS COAL GASIFICATION TECHNOLOGY: MAHANADI COALFIELDS LIMITED
S C A L E :-	

CHECKED BY			DRAWING NO.	REV
	Salonee	Laxmipriya	PICS/PDIL/01	0

PUSSHNEY INFRASTRUCTURE & CONSULTANCY SERVICES PVT.LTD.
394/4181, Laxminagar, Patia, Odisha-751031
Ph-9437192043,8895968943,9938879043
Mail ID- picspltd@gmail.com

Induced Draft Cooling Towers (IDCT) for 2000 TPD BCGCL COAL TO AMMONIUMNITRATE - LSTK 1

BHEL REPLIES TO CLARIFICATIONS

Sl No	Reference			CLARIFICATION	BHEL REPLY
	Section	Chapter / Cl. No	Page No.		
1	General	Existing site conditions	-	Please confirm that the designated site for subject cooling tower is free of any obstacles / existing structures / service lines (both overground and undferground). If not so, then it is the responsibility of BHEL / Owner to arrange for re-routing / demolition of the same, before handing over clear graded site to cooling tower contractor, with adequate clearances. Please confirm.	Handing over of graded land without any encumbrances is in the scope of M/s. BCGCL.
2	Technical specification for IDCT / Book 2 of 2	Soil investigation report	36 / 217	Reference of bore holes BH-1 to BH-20 are available for the project, however, reference of bore hole(s) pertaining to the cooling tower location is not mentioned. Please clarify the same.	Raw bore log data of IDCT area, from field investigation, is provided as per Annexure-P1.
3	Technical specification for IDCT / Book 2 of 2	Soil investigation report	-	Please confirm the Natural Ground Level (NGL) in the cooling tower area.	Refer the plot plan & contour levels already furnished.
4	Technical specification for IDCT / Book 2 of 2	cl.-3.11	15 of 217	There is a reference of "Annexure-G for Moisture Compatible Corrosion Resistant Coating System", which seems to be missing in the tender specification. Please furnish the same.	Annexure-G enclosed in specification.

	Induced Draft Cooling Towers (IDCT) for 2000 TPD BCGCL COAL TO AMMONIUMNITRATE - LSTK 1 **BHEL REPLIES TO CLARIFICATIONS**		
	CLARIFICATION	**BHEL Reply**	
1	This is a large IDCT that requires a Geotechnical report to enable us understand/determine the foundation requirements. Please provide whatever soil/bore log data in the IDCT area or at least in its vicinity to help us understand the type of foundation possible. Presently, there is no correlation between the Bore Log data and the IDCT location. Also, please let us know whether the Net SBC given on Page 739 of 920 of Tender Binder applies to the IDCT package. In case the IDCT is in either rocky or marshy area, please provide the appropriate bore log data with SBC recommendations.	Raw bore log data of IDCT area, from the ongoing field investigation is enclosed in Annexure-P1.	

Cooling Tower (IDCT) for 2000 TPD BCGCL Coal to Ammonium Nitrate – LSTK1, Jharsuguda, Odisha."

BHEL REPLIES TO CLARIFICATIONS

Sl. No.	Reference Clause of Tender Document	Existing Provision	CLARIFICATION	BHEL Reply
1.	Geotechnical Report	Bore Log Data for IDCT	6. This is a large IDCT that requires a Geotechnical report to enable us understand/ determine the foundation requirements. Please provide whatever soil/bore log data in the IDCT area or at least in its vicinity to help us understand the type of foundation possible. Presently, there is no correlation between the Bore Log data and the IDCT location.	Raw bore log data of IDCT area, from field investigation, is provided as per Annexure-P1.

Following drawings / documents / details are added in Specification.

a)	Annexure-P1 : Raw bore log data of IDCT area, from field investigation, is also attached.
b)	Annexure – G (Specification for high performance moisture compatible corrosion resistant coating system) is attached.
c)	Annexure – H (Wind & Seismic Data) is attached.

Annexure-P1 : Raw bore log data of IDCT area, from field investigation

FIELD BORELOG SHEET

NAME OF PROJECT	: Geotechnical Investigation work for BCGCL's 2000 TPD Coal to Ammonium Nitrate Project, Lakhanpur, Odisha	BOREHOLE NO. & LOCATION	: BH-20	BORING TYPE	: Rotary/Hydraulic
NAME OF CLIENT	: Bharat Heavy Electricals Limited (BHEL)	DATE OF START	:	DRILLING BIT	: Diamond
GROUND ELEVATION	:	DATE OF END	:	BH DIA. IN SOIL	: 150 mm
EASTING	: E 266	CASING DEPTH (m)	: 4 mtr	BH DIA. IN ROCK	: 76 mm
NORTHING	: N 825	WATER TABLE (m)	: 2.5 mtr	STANDARD	: IS 4464 : 1985

TOTAL DRILLING DEPTH (m) FROM	TO	DRILL RUN (m)	DESCRIPTION OF STRATA	TYPE OF SAMPLE DS/SPT/ UDS/CORE	SAMPLE NO.	STANDARD PENETRATION TEST 15	30	45	N	CORE RECOVERY LENGTH	CR (%)	RQD LENGTH	RQD (%)	REMARK
0.0	1.5	1.5	Reddish yellow	SPT		13	14	17	31					
1.5	3.0	1.5	Sandy clay	SPT		15	18	22	40					
3.0	4.5	1.5	"	SPT		25	28	30	58					
4.5	6.0	1.5	"	SPT		27	50/7cm							
6.0	7.5	1.5	Yallowish claystone	CS	1/6	-	-	-	-	77	51	61	41	
7.5	9.0	1.5	"	CS	7/10		-	-	-	75	50	66	44	
9.0	10.5	1.5	greyish black SS	CS	11/13		-	-	-	42	28	24	16	
10.5	12.0	1.5	"	CS	14/25		-	-	-	86	57	44	29	
12.0	13.5	1.5	"	CS	26/29		-	-	-	131	87	131	87	
13.5	15.0	1.5	"	CS	30/42		-	-	-	148	99	94	63	
15.0	16.5	1.5	"	CS	43/52		-	-	-	131	87	91	61	
16.5	18.0	1.5	"	CS	53/77		-	-	-	133	89	-	-	
18.0	19.5	1.5	"	CS	78/97		-	-	-	110	73	-	-	
19.5	21.0	1.5	"	CS	98/112		-	-	-	85	57	-	-	

Note: Borehole terminated at 21.0 mtrs.

ABBREVIATIONS :-
UDS : Undisturbed Sample
DS : Disturbed Sample
SPT : Standard Penetration Test

CR : Core Recovery
RQD : Rock Quality Designation
sp : Small Pieces

J. Pandey
Sr. geologist

Idam Consortium Pvt Ltd

BHEL

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

ANNEXURE-G

SPECIFICATION FOR HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore – 560012

SPECIFICATION FOR HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM

a) Providing & applying High Performance Moisture Compatible Corrosion Resistant Coating System manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.I.R. affiliate Institute), Tamil Nadu, Pin - 630 003.

b) The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing residual tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

c) The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

d) The coating system shall conform to the following:

PROPERTIES OF PAINT

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70%
Specific Gravity (ASTM-D-1475)	1.25 ± 0.1
Dry Film Thickness (ASTM-D-1186)	160 ± 10 µm per coat
Coverage	4 - 4.5 sq.m / ltr
Touch Dry	2 hours
Recoating	24 hours

PROPERTIES OF COATING

Salt Spray (ASTM-B 117)	2000 hours
Resistance to Sea Water (Carried out up to 6 months)	Passes
Coating Resistance (Carried out up to 6 months)	$10^9\ \Omega.cm^2$
Adhesion (ASTM-D 4541)	4.5 N/sq.mm
Flexibility (ASTM-D 522) Elongation	1/8" passes 33%
Impact (ASTM G 14-04)	45 cm passes

e) Paint material & its application method shall be obtained from any manufacturer who has been granted License by CECRI, Karaikudi for the technical know-how for **High Performance Moisture Compatible Corrosion Resistant Coating System**. The application method of coating shall be got duly approved from CECRI, Karaikudi.

TECHNICAL SPECIFICATION FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS FOR
INDUCED DRAFT COOLING TOWER

ANNEXURE-H

WIND & SEISMIC DATA

SPECIFICATION NO. IS-1-25-2002/TS/IDCT

Bharat Heavy Electricals Limited
Industrial Systems Group
Post Box # 1249, IISc Post,
Prof. CNR Rao Circle, Malleswaram,
Bangalore – 560012

1.0 WIND LOADS

Wind loads shall generally be as per IS-875 (Part-3) except for switchyard structures and transmission towers for which IS: 802 shall be applicable. Basic wind speed shall be as per the Code which is 44 m/s. Wind force on structural elements shall be calculated using design wind pressure multiplied by elements frontal area, normal to wind direction multiplied by force coefficient as per Table 26, IS 875 Part-3.

In calculation of wind force frictional drag shall be considered where applicable.

All structures shall be designed for static & dynamic wind forces in accordance with IS:875 (Part-3) and as specified in this document. Design parameters to be adopted are given below in Table

Basic Wind Speed, $\mathbf{V_b}$	44 m/s	*as per IS 875*
Terrain Category	Cat-2	*as per IS 875*
Risk Coefficient, $\mathbf{k_1}$	1.07	*as per IS 875*
Risk Coefficient, $\mathbf{k_2}$	Varies	*as per IS 875 Cl 6.3.2.2*
Topography Factor, $\mathbf{k_3}$	1.00	*as per Cl 6.3.3, IS 875 (Part-3):2015*
Cyclonic factor, $\mathbf{k_4}$	1.00	*as per Cl 6.3.4, IS 875 (Part-3):2015*
Wind directionality factor, $\mathbf{k_d}$	Varies	*as per IS 875 Cl 7.2.1*
Area Averaging factor, $\mathbf{k_a}$	Varies	*as per IS 875 Cl 7.2.2 Table 4*
Combination factor, $\mathbf{k_c}$	Varies	*as per IS 875 Cl 7.3.3.13*

2.0 SEISMIC LOADS

All structures and equipment shall be designed for seismic forces. Project site at Jharsuguda comes under Seismic Zone-3, type of soil – hard, as IS:1893 (2015/2016). Following damping factors to be considered for design of structures:

DAMPING FACTORS	
Steel structures	5%
Reinforced concrete structures	5%
Reinforced concrete stacks	3%
Steel stacks	2%

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

2.1 METHOD OF ANALYSIS

Since most structures in a LSTK-1 are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893.