DEENDAYAL PORT AUTHORITY

ISO 9001-2015 & 14001:2015 Certified

Email : kptprojectdivision@gmail.com
Mobile No.: +91 9724301528
Website: www.deendayalport.gov.in

Office of the Executive Engineer(P)
Administrative Office, Room No.105
Annexe Building, Post box No.50,
Gandhidham Kutch

No. CE/Project/ **Dated: 15/07/2025**

To, M/s._____

Expression of Interest

Sub: Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla, Deendayal Port Authority.

Sir,
Deendayal Port Authority (DPA) is an autonomous organization under the administrative control of Ministry of Ports, Shipping and Waterways.

DPA intends to appoint an agency for Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla. The Scope of Work (Stage wise) is attached herewith as Annexure-II. The format for submission of soil report is attached herewith as Annexure-III. The location for Bore Holes is attached herewith as Annexure-IV. The Bill of Quantities is attached herewith as Annexure-V.

Interested firms should send their Expression of Interest for "Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla, Deendayal Port Authority." as per Annexure – I. Your Expression of interest should be submitted through email to the id: kptprojectdivision@gmail.com or hard copy to the following address on or before 23.07.2025 by 17:30 Hrs.

Address: -
Office of Executive Engineer (P),
Room no. 105, A.O. Building (Annex),
Deendayal Port Authority
Gandhidham (Kutch) 370 201, Gujarat
M: +91- 9724301528

Encl. As above

-SD-
Executive Engineer (P)
Deendayal Port Authority

Annexure I

BUDGETARY OFFER

[LOCATION, DATE]

To,
Executive Engineer (P),
Deendayal Port Authority.

SUB: Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla, Deendayal Port Authority.

Sir,

The Budgetary offer for the subject work in accordance to your EOI request letter dated <date……, is given as under:

Sr.No.	Description of Item	Lump sum rate in figure	Lump Sum rate in words
1	Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla. i.e. Field Tests, Laboratory tests, Preparation of Soil investigation report; as per the Scope of Work (Annexure-II), Location (Annexure- III), format (Annexure-IV) BOQ (Annexure-V).		

Note: The budgetary offer is inclusive of all taxes, duties for performing the work & exclusive of GST.

Signature [In full and initials]:

Name & Title of Signatory:

Name of Agency:

Annexure II

Name of the Work: "Conducting Soil Test and submission of Report for SIPC plot no. 51 at Kandla".

➢ Scope of work:

a. The subsurface investigation shall be carried out generally in accordance with this specification and to the satisfaction of the Engineer.

b. The soil investigation work shall be generally carried out in accordance with IS 1892. The extent of work shall be defined in different sections of this specifications. On completion of sub-surface explorations, a detailed report containing the information as given in Annexure-3 shall be submitted.

c. The geotechnical investigation is aimed to the establishment of the geotechnical properties of the soil, including bearing capacity, deformability, aggressiveness, dynamic parameters, presence of cavities and slopes not only for the excavations but also for the required backfilling.

1. Existing buried facilities detection:

a. Prior to commencement of the field tests, the CONTRACTOR shall investigate and ascertain that no service lines (Power and telecom) or pipes lie beneath the area where bore holes are carried out. In case of any doubt, at first manual excavations to a minimum depth of 2 m shall be performed to investigate the presence of service lines and bring such matters to the notice of Engineer-in-charge. Where such services or underground structures are thought to exist in the immediate vicinity of the position of a borehole, a trial pit shall be dug and taken to such a depth that it is reasonably certain all-underground services and structures have been uncovered, after which normal boring may proceed.

b. CONTRACTOR shall take all reasonable precautions to avoid damage to underground services such as sewers, drains, pipes, cables and all underground structures and shall be wholly responsible for any damage caused to these services. Any damage caused to existing utilities while executing the work shall be the CONTRACTOR responsibility and shall be repaired at no cost to the DPA. If during investigation work, any obstruction such as foundations, trenches, cables, underground piping, etc. is met during excavation, the same shall be brought to the notice of Engineer in-charge immediately and suitable modified locations shall be established in due consultation with DPA.

c. CONTRACTOR shall carry out all activities in a systematic and sequential manner to have minimum hurdles, disturbances, or obstructions to on-going plant functional activities.

d. CONTRACTOR should use geophysical technique in order to detect buried facilities prior to commencement each geotechnical field test and shall inform to DPA for approval in order to proceed with the rest of geotechnical work.

2. Field Work:

a. DPA shall provide locations of soil borings and other field tests before the start of work. Borings or other field tests may be relocated by DPA after the start of work if needed. CONTRACTOR shall locate by field survey (plan and elevation) the soil borings and field tests and provide the records of the survey to DPA. Locations and elevations shall be based on the plant grid system and plant datum respectively. CONTRACTOR shall establish access for the drilling rig and other necessary equipment to all locations with minimal disturbance to the existing vegetation.

b. CONTRACTOR shall confirm in writing compliance with this Specification and related documentation. If any initial fieldwork and / or laboratory testing indicates a need of

modification in the geotechnical investigation scope of work, CONTRACTOR shall immediately notify this fact to DPA. In no case shall this Specification be used to supersede and / or delete applicable norms, codes and regulations. In all cases CONTRACTOR shall inform DPA of any deviation from the requirements in this document, which is considered to be mandatory in order to comply with regulations.

c. Starting from this Specification, CONTRACTOR shall provide a Technical and Commercial Proposal to develop the field works (personnel and equipment), laboratory testing, geophysical survey and office works. The geotechnical CONTRACTOR shall provide in his offer a Work Schedule including permits, mobilization, field works, laboratory testing and office works, and the Bill of Quantities dully filled with unit prices and estimated number of laboratory tests.

d. CONTRACTOR shall visit the site prior to starting works and take into account all duties and implications derived by access and operational conditions in the areas of survey work. All tests shall be performed as per guideline of relevant standards. For arriving at dynamic soil properties, Cross-hole Seismic wave propagation tests shall be carried out. Electrical Resistivity Test shall be carried out at locations as shown in Attachments.

   CONTRACTOR shall carry out geophysical investigation to reinforce data obtained from other field investigations.

e. The scope shall include but not limited to,

   i. Supply of all tools and equipment required for soil investigation.

   ii. Supply of all manpower required for soil investigation.

   iii. Co-ordination & management.

   iv. Obtaining all necessary work permits and authorizations.

   v. Follow all HSE requirements.

   vi. Supply of construction water required for borehole drilling.

   vii. CONTRACTOR is responsible to make clean and bring the Site to original condition after satisfactory completion of work. All boreholes to be backfilled with approved material as and when directed by the Engineer.

   viii. All excavation or boring should be barricaded during work.

   ix. Off-site testing shall be carried out in a well-established recognized appropriate laboratory.

   x. Any other facilities required for successful execution of work as per scope. The extent of work shall be in accordance with the Bill of Quantities and as mark-up shown in Annexure-1.

3. Subsurface Investigations

Borings shall be carried out in accordance with the specifications given below.

a. Mud-Rotary Drilling:

Mud-rotary drilling with bentonite slurry shall be carried out as per the standard method. Care shall be exercised in thoroughly cleaning the hole prior to recovering undisturbed sample and carrying out in-situ test. In the case of hard strata rock samples shall be collected for laboratory testing. Augers must be helical or post hole type and can be operated manually or by power.

The diameter of the hole shall be 150 mm.

Casing shall be used up to the explored depth of investigation. When boring through soft cohesive soils and cohesionless soils above the water table, no water should be added.

Always keep the water level in the casing at or above the water table when boring through cohesionless soils that are below the water table.

It may be necessary to soak the borehole in stiff cohesive soil before making any progress. While boring, care must be taken to minimize disturbance to the deposits beneath the borehole's bottom.

At specified depths from the borehole, undisturbed samples must be taken to conduct in situ tests. While carrying out these operations, the borehole must be kept clean and free of foreign matter.

The water table in the borehole must be carefully recorded and reported.

The following techniques will be used to determine the water table. Method (a) is best suited for permeable soil, while methods (b) and (c) are appropriate for both permeable and impermeable soils. The engineer will specify the appropriate procedure to be used.

After adequately lowering the water level through bailing, the water table in the borehole should be allowed to stabilize. The sides and bottom of the borehole must always be kept stable.

The borehole will be filled with water and then bailed out to various depths. To determine whether the water level is rising or falling, observations must be made at each depth. The water table depth is defined as the depth at which neither a rise nor a fall is seen. This will be determined by taking three consecutive readings of the water level every two hours.

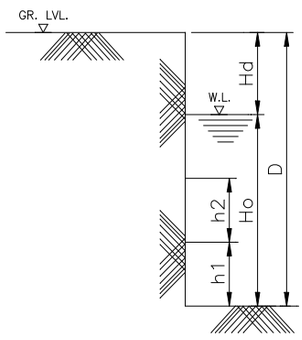
Hvorslev Method (Ref. Foundation Design - by W.C. Teng).

The water level will be lowered by bailing (to D below ground level), and then allowed to rise. It is necessary to record water rise at suitable equal intervals of time. If h1 and h2 represent two consecutive increases in the borehole's water level during the same time interval, then "Ho" the distance between the actual water table and the lowered water level, can be determined as follows:

$$Ho = \frac{h_1^2}{h_1 - h_2}$$

The water table depth Hd from ground level shall be determined as under:

$$Hd = D - Ho$$



Three sets of observations shall be made and the average value of Hd is determined. Immediately on completion of borehole, Record of Boring shall be prepared and submitted to the Engineer in triplicate.

b. Percussion Boring:

Percussion Boring shall be carried out in accordance with IS 1892. This method of boring shall be adopted for drilling boreholes containing boulders and gravel.

c. Backfilling of boreholes:

On completion of boreholes, back filling shall be carried out with an approved material as and when directed by the Engineer.

4. In-situ Tests: -

a. Standard Penetration Test

The test shall be performed on undisturbed soil by driving the split spoon sampler by means of 63.5 kg weight with 75 cm free fall. The number of blows required to affect each 15 cm of penetration shall be recorded. The first 15 cm drive shall be considered as a seating drive. The penetration resistance shall be for the last 30 cm of penetration. The procedure of standard penetration test shall be as per IS:2131.

The samples obtained in the split spoon sampler shall be labelled and preserved for identification tests in the laboratory.

First SPT shall be taken 0.5m below existing ground level. These tests shall be carried out at intervals of 1.50 m within continuous stratum or at every change of stratum whichever is less. The tests shall be terminated at SPT value of greater than 50 or after reaching minimum borehole depth as defined, whichever occurs earlier, subject to refusal not occurring.

Fully automated trip hammer shall be used. Vendor shall furnish the calibration certificate of the hammer to know the energy transfer efficient. Certificate shall not be more than 90 days old.

b. Static Piezo Cone Penetration Test:

These tests shall be conducted using a 20-tons capacity power operated hydraulic machine using 35.7 mm diameter steel cone with 60 degrees apex angle attached to rods protected by mantle tubes. By pushing the electric piezo cone into the ground by hydraulic machine the cone resistance and skin friction along the depth is to be recorded at regular depth intervals. The data shall be represented in graphical plot of cone resistance versus the depth. A correlation shall be established between cone resistance values and SPT “N” values. The procedure of the test shall be as per IS:4968 (Part III).

The test shall be terminated at refusal or at depth specified in the investigation drawing whichever occurs first. The test should be terminated when refusal has reached (qc> 50 MPa, fs > 1 MPa, inclination > 15 degrees).

The CPT equipment shall be used to conduct pore pressure dissipation tests by interrupting the penetration of the cone and measuring the decrease of the excess pore pressure with time. The procedure shall be as per ASTM D5778.

c. Electrical Resistivity Tests:

The IS:3043 Code of Practice for Earthing shall be followed when measuring the soil resistivity. During the execution of the work, the location of the tests must be indicated. Wenner's four electrode method with a four terminal megger will be used for field investigation. This technique involves driving four electrodes into the ground at equal intervals in a straight line. The vertical variations may be detected by repeating the tests at given locations in a chosen direction with S number of different electrode spacings, preferably in the steps 2, 5,10,15, 25 and 50 meters or more.

Depth of burial of electrodes in ground = 1 m

Spacing between successive electrodes = 20 m

Soil Resistivity in Ohm-meter	=	p
Megger Reading in Ohms	=	R
Pi	=	3.1416

When spacing of successive electrodes is at least 20 times more than depth of burial the following equation may be used:

P	=	2.Pi. S.R.

Correction factors shall be applied if applicable at each test location. The tests shall be carried out in E-W, N-S, NE-SW and NW-SE directions. Results shall be furnished in tabulation form indicating mark-up location of test pits in plot plan.

d. Thermal Resistivity Tests:

Thermal resistivity tests must be carried out in accordance with IEEE Std 442-2017.

e. Crosshole Seismic Test:

Crosshole Seismic test shall be carried out as described in IS 13372 (Part-1):1992 to determine the design parameters of soil/rock required for designing of dynamically loaded foundations.

f. Vane Shear Test:

The Vane shear test shall be carried out for determination of the shear strength of saturated clays, especially of the 'soft' to 'medium' consistency. The test shall be especially carried out for determining the shear strength of sensitive soils which are highly susceptible to sample disturbances.

The Vane shear test consists of pushing a four-blocked vane in the soil and rotating it till a cylindrical surface in the soil fails by shearing. The torque required to cause this failure is measured and this torque is converted to a unit shearing resistance of the cylindrical surface. The apparatus and procedure for tests shall be as per IS:4434.

g. Seismic Refraction Test:

Seismic refraction profiles shall be carried out to determine excavability and the thickness of soil above the bedrock. Devices should be used consisting of implantations of 12 or 24 geophones, spaced about 5 meters, so setting implantations of 60 m or 120 m respectively. For 12 geophones be made a minimum of 5 shots equidistant (one center, two inside and two outside about 2.5 m from both ends geophones), and in the case of 24 geophones be made a minimum of 7 shots equidistant (one center, four inside and two outside about 2.5 m of ends geophones).

In case of multiple seismic deployments arranged adjacent to configure seismic profile, overlap at least the last two geophones previous implementation with the first two of the following to reduce the loss of information, although preference is given mainly to the use of long implants. The surveys shall be made in accordance with IS 15681 or project specific standard.

h. Trial Pits:

Trial pits shall be performed at site to carry out and verify the soil sample. Trial pits shall be of minimum 1.5m x 1.5m size at base and depth up to 1.5m to permit easy access for visual examination of the walls of the pit and to facilitate sampling and in-situ testing operations. If shoring is required, preparations must be made to guarantee the stability of pit walls. If the pit is excavated below the water table, dewatering arrangements must be made.

To prevent substantial moisture variations in the subsoil, in-situ tests must be carried out and undisturbed samples must be obtained immediately or until they reach the specified depths. After conduction of tests and examination, the pits shall be filled with the excavated soil unless otherwise specified by the Engineer.

i. Samplings:

The choice of sampling tools, the methods of sampling and the procedure for taking samples shall be in accordance with IS:1892 and IS:2132.

j. Disturbed soil samples:

Disturbed soil samples must be obtained while boring at the frequency specified in (l). Disturbed samples should be carefully preserved for mechanical analysis and index property tests.

k. Undisturbed soil samples:

In order to obtain undisturbed soil samples, samplers must conform to IS: 2132. Samples with a diameter of less than 65 mm normally aren't permitted for use. Thick-walled samplers may be used in very hard and dense soils, with the engineer's approval. In very soft or soft clays, a piston sampler of approved design must be used. Undisturbed soil samples must be obtained while boring at the frequency specified in (l).

l. Frequency of sampling

Disturbed and undisturbed soil samples must be collected from boreholes at every stratum change and at intervals of not more than 1.5m within a continuous stratum. These samples need to be labelled correctly and preserved in suitable airtight containers for laboratory testing.

m. Rock samples:

I. Disturbed rock samples:

The sludge from 'Shell and Auger Borings,' 'Percussion Borings,' and 'Rotary Borings' shall be collected. It must be recovered from circulating water by settling in a trough. These rock samples will be preserved. The rock type can be determined by examining the sludge's composition.

II. Undisturbed rock samples:

According to code IS: 1892, Cores of rock shall be taken by means of rotary drills fitted with a coring bit with core retainer, if warranted.

n. Ground water samples:

Water samples must be collected prior to the addition of water to the Borehole. If this is not possible, water must be bailed or pumped out of the borehole so that fresh ground water can flow in. Care shall be taken in avoiding any contamination with surface water or bentonite mud. Water samples must be collected in a five-litter glass container, labelled, preserved, and sent to a laboratory for chemical analysis.

o. Borehole termination criteria:

The boring shall be carried out in all types of deposits including boulders or gravelly strata and hard rock by any of the suitable methods given in this specification.

Boring shall be carried out to a depth as specified in investigation (see Annexure-IV) below ground unless hard rock is met with early. Bore hole shall be terminated at 5 m into weathered rock or 3 m into hard rock, whichever occurs earlier, enough to have the guarantee that their thickness is representative and is not a layer of negligible thickness or the transmitted tension by structure will not affect at that depth. The Boring shall be terminated until one of the following occurs:

1. A total of 50 blows have been applied during any one of the three increments.
2. A total of 100 blows have been applied.

3. There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

If unsuitable material or soft soil is encountered near the end of bore hole, the borehole depth shall be further extended to firm strata. The final depth of each borehole depends on the observation during drilling. However, the minimum depth should cover the stress bulb from future foundation. Any changes in drilled length shall be informed to DPA for approval. Recommended locations of various field tests are marked-up in Annexure-IV.

5. Laboratory testing:

Necessary laboratory tests shall be conducted on selected disturbed and undisturbed samples as required to arrive at the soil properties. All tests shall be performed as per IS:2720 (relevant parts) and as per the direction of the Engineer. The results of the Laboratory tests shall be submitted in the proforma giving the complete results of the lab tests. The following tests shall be performed, to determine design parameter to decide the soil foundation system and to identify soil and ground water characteristics.

- Shear strength- Angle of internal friction, Cohesion.
- Compressibility.
- Consolidation.
- Natural moisture content of each stratum.
- Density of each stratum, void ratio, specific gravity.
- Atterberg limits of each stratum
- Classification of soils based on grain sizes (sieve analysis and hydrometer analysis)
- Chemical properties of soil, water and special type of cement requirement, if any.
- Unconfined compression test.
- Triaxial test (drained and undrained).
- Shear parameters by Direct Shear Test.
- Test for volume change and expansive pressure (zero to saturation moisture content).
- Test for C.B.R.
- Proctor test at foundation and grade level.
- Recommended method of soil improvement, if any.

Annexure-III

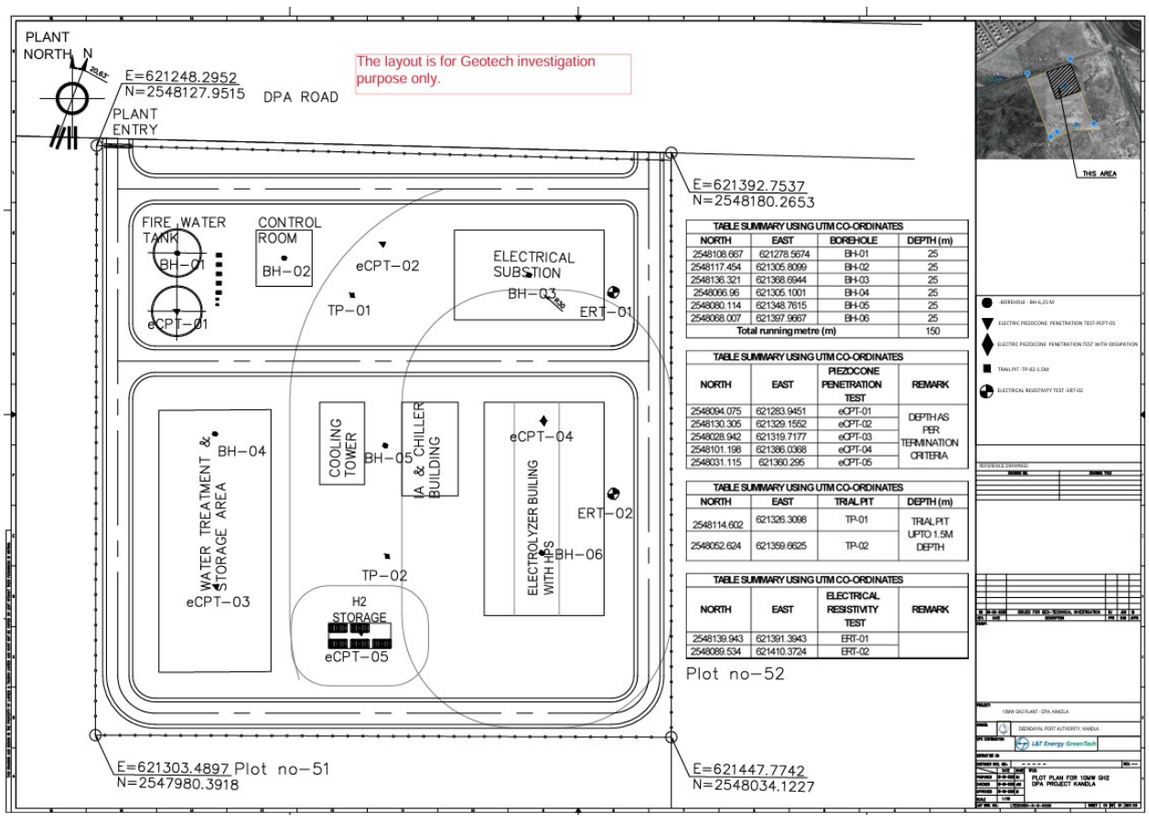


TABLE SUMMARY USING UTM CO-ORDINATES			
NORTH	EAST	BOREHOLE	DEPTH (m)
2548108.667	621278.5674	BH-01	25
2548117.454	621305.8099	BH-02	25
2548136.321	621368.6944	BH-03	25
2548066.96	621305.1001	BH-04	25
2548080.114	621348.7615	BH-05	25
2548068.007	621397.9687	BH-06	25
Total running metre (m)			150

TABLE SUMMARY USING UTM CO-ORDINATES			
NORTH	EAST	PIEZOCONE PENETRATION TEST	REMARK
2548094.075	621283.9451	eCPT-01	DEPTH AS PER TERMINATION CRITERIA
2548130.305	621329.1552	eCPT-02	
2548028.942	621319.7177	eCPT-03	
2548101.198	621386.0368	eCPT-04	
2548031.115	621360.295	eCPT-05	

TABLE SUMMARY USING UTM CO-ORDINATES			
NORTH	EAST	TRIAL PIT	DEPTH (m)
2548114.602	621326.3098	TP-01	TRIAL PIT UPTO 1.5M DEPTH
2548052.624	621359.6625	TP-02	

TABLE SUMMARY USING UTM CO-ORDINATES			
NORTH	EAST	ELECTRICAL RESISTIVITY TEST	REMARK
2548139.943	621391.3943	ERT-01	
2548089.534	621410.3724	ERT-02	

Annexure-IV

The final geo-technical report shall include information and recommendations marked (3) in the following list:

A4-1 **Introduction**

—— A4-1.1 Purpose and scope of investigation

—— A4-1.2 Abstract of findings and recommendations

A4-2 **Site Conditions**

—— A4-2.1 Site geology, general description

—— A4-2.2 Potential geologic hazards

—— A4-2.3 Site surface description

—— A4-2.4 Site topography, general description

—— A4-2.5 Description of above ground obstructions

A4-3 **Surface Conditions**

—— A4-3.1 Stratigraphy

—— A4-3.2 Subsurface material properties, general description

—— A4-3.3 Groundwater elevations and expected variations

—— A4-3.4 Description of underground obstructions encountered or otherwise identified.

A4-4 **Field Investigation**

—— A4-4.1 Summary of operations

—— A4-4.2 Description of sampling procedures

—— A4-4.3 Description of field tests

—— A4-4.4 Logs of borings, pits, etc. containing:

- A4-4.4.1 Complete description and thickness of all strata, including near-surface materials such as paving, base course, topsoil, fill etc.
- A4-4.4.2 Locations referenced to plant coordinate system.
- A4-4.4.3 Ground surface elevations referenced to plant datum, if available; if not, then referenced to MSL (mean sea level)
- A4-4.4.4 Standard penetration test values in blows per 300 mm increment
- A4-4.4.5 Results of all field tests

—— A4-4.5 Location plan, containing as a minimum

- A4-4.5.1 Scale plan with locations of borings, pits, etc.
- A4-4.5.2 Include plant coordinate system
- A4-4.5.3 Location showing sudden change in depth of hard strata (example – presence of stone quarry in the past)

A4-5 **Laboratory Tests**

—— A4-5.1 Description of tests

—— A4-5.2 Test results

A4-6 **Foundation Recommendations**

—— A4-6.1 Type(s) of foundation recommended

—— A4-6.2 Basis of selecting recommended foundation type(s)

—— A4-6.3 Recommendations for foundation type(s) selected

—— A4-6.4 Soil strength parameters used in determining design capacities

A4-7 **Shallow Foundation Recommendations**

—— A4-7.1 Spread footing: Depth below grade, size and shape restrictions

—— A4-7.2 Mat foundations: Depth below grade, modulus of subgrade reaction

—— A4-7.3 Tank foundations: Recommendations and restrictions, excavation and backfill, ring wall or mat considerations, extended water tests.

—— A4-7.4 Vibratory equipment foundations: Dynamic shear modulus, Poisson's ratio, other considerations

A4-7.4.1 Based on correlations from published literature

A4-7.4.2 Based on in-situ testing

—— A4-7.5 Ultimate and allowable net soil bearing capacity

A4-7.5.1 As a function of the shape and size of foundation, depth of embedment, and soil strength.

A4-7.5.2 Any increase in net allowable bearing capacity for hydrotest loads, and short term loads such as wind and earthquake.

—— A4-7.6 Foundation settlement

A4-7.6.1 As a function of loading, shape and size of foundations, and compressibility of sub-soils

A4-7.6.2 Immediate settlement during construction

A4-7.6.3 Long term settlement

A4-7.6.4 Time rate of settlement

A4-7.6.5 Adjacent foundation settlement

A4-7.6.6 Differential settlement for tanks

A4-7.6.6.1 Along the perimeter

A4-7.6.6.2 Centre of tank to perimeter

A4-7.6.6.3 Slope of tank bottom after anticipated settlement

A4-7.6.6.4 Limitations or recommendations for hydrotest procedures to minimize differential settlement

A4-7.6.6.5 Anticipated settlement and rebound during hydrotest and specific measurements during hydrotest.

A4-8 **Deep Foundation Recommendations**

—— A4-8.1 Type of pile and basis for recommendation

—— A4-8.2 Ultimate and allowable axial compression capacity through end bearing and skin friction for various diameters.

A4-8.2.1 Capacity v/s length

A4-8.2.2 Any increase in capacity for hydrotest loads, or for short term loads such as wind and earthquake.

—— A4-8.3 Minimum and maximum tip elevations, when applicable

—— A4-8.4 Ultimate and allowable axial uplift capacity for various diameters

A4-8.4.1 Uplift capacity v/s length

A4-8.4.2 Any increase in capacity for hydrotest loads or for short term loads such as wind and earthquake.

A4-8.5 Allowable lateral capacity for various diameters

A4-8.5.1 Applied lateral loading v/s deflection of pile head

A4-8.5.2 Pile moment v/s depth

A4-8.5.3 P-Y curves

A4-8.5.4 Recommendations for generation of P-Y curves and required parameters (cohesion, friction angle, E).

A4-8.5.5 Recommendations for ground improvement techniques for enhancing the lateral capacity of the piles

A4-8.5.6 Sample calculation of pile capacity

—— A4-8.6 Down drag considerations

—— A4-8.7 Spacing, group action, and use of batter piles

—— A4-8.8 Settlement considerations

—— A4-8.9 Vibratory equipment foundations, spring constants in each direction for recommended pile type

—— A4-8.10 Driven pile installation considerations

A4-8.10.1 Driving criteria, including refusal criteria

A4-8.10.2 Wave equation analysis

A4-8.10.3 Pre-drilling requirements / restrictions

A4-8.10.4 Potential problems and recommended solutions

A4-8.10.5 Pile installation near existing facilities

—— A4-8.11 Bored/ drilled pile installation considerations

A4-8.11.1 Installation equipment requirements

A4-8.11.2 Casing / slurry considerations

A4-8.11.3 Installation criteria and recommendations

A4-8.11.4 Potential problems and recommended solutions

—— A4-8.12 Load test requirements, procedures, and acceptance criteria

A4-9 **Earth Pressures**

—— A4-9.1 Active earth pressure, at-rest earth pressure

—— A4-9.2 Ultimate and allowable passive soil resistance for on site soils, and recommended fill and backfill material.

—— A4-9.3 Groundwater considerations-uplift parameters

- A4-9.4 Drainage requirements

A4-10 **Soil Properties**

- A4-10.1 Coefficient of friction or adhesion values between soil and concrete
- A4-10.2 Unit weight of soil
- A4-10.3 Cohesion and angle of internal friction
- A4-10.4 Chemical analysis and other properties of soil and groundwater at depths of proposed structural elements and utilities, as follows:
  - A4-10.4.1 pH value
  - A4-10.4.2 Electrical conductivity (laboratory determination)
  - A4-10.4.3 Chloride ion (Cl) concentration
  - A4-10.4.4 Sulphate ion (SO_4) concentration
  - A4-10.4.5 Electrical resistivity of soil (field determination)
- A4-10.5 Recommendations on harmful sulphate and chloride attack on concrete. Recommendations on environmental exposure conditions for concrete below ground as per Table 3, IS:456. Recommendations on types of cement, reinforcing steel, coatings etc.
- A4-10.6 Recommendation on corrosive effects of soil on carbon steel pipes.
- A4-10.7 Permeability
  - A4-10.7.1 Laboratory determination
  - A4-10.7.2 In situ determination

A4-11 **Rigid and Flexible Pavements**

- A4-11.1 Natural soil and fill, subgrade suitability
- A4-11.2 Recommended California bearing ratio value for pavement design
  - A4-11.2.1 Based on correlations from published literature
  - A4-11.2.2 Based on laboratory testing
  - A4-11.2.3 Based on in-situ testing
- A4-11.3 Recommended modulus of subgrade reaction for slab design
- A4-11.4 Treatment for improving subgrade, if required
- A4-11.5 Base course, sub-base course, and shoulder recommendations
- A4-11.6 Surfacing recommendations
- A4-11.7 Base, sub-base, and subgrade drainage recommendations
- A4-11.8 Complete pavement system design

A4-12 **Other Considerations, discuss and provide recommendations for:**

- A4-12.1 Swelling potential of soils, including depth of zone of soil moisture content fluctuation
- A4-12.2 Liquefaction potential of soils
- A4-12.3 Collapsible or dispersive soils
- A4-12.4 Frost susceptibility of soils, frost depth
- A4-12.5 Effects of proposed construction on existing facilities or adjacent property

A4-13 **Excavation Considerations**

- A4-13.1 Allowable excavation slope inclinations, temporary and permanent
- A4-13.2 Groundwater control
    - A4-13.2.1 Recommended dewatering method
    - A4-13.2.2 Temporary and permanent groundwater control
    - A4-13.2.3 Flow quantities
- A4-13.3 Foundation subgrades
    - A4-13.3.1 Heave control
    - A4-13.3.2 Protection/preserving integrity of subgrade
- A4-13.4 Effects on existing facilities
- A4-13.5 Potential excavation problems
- A4-13.6 Rock excavation
    - A4-13.6.1 Rock quality designation (RQD).
    - A4-13.6.2 Definition of rock for contract documents
    - A4-13.6.3 Rock quantity estimate guidance
- A4-13.7 Pressure diagrams for shoring design
- A4-13.8 Applicability of specialized shoring/stabilization procedures

A4-14 **Earthwork**

- A4-14.1 Topsoil: Thickness for stripping; definition for contract documents
- A4-14.2 Suitability soils at the site for use in compacted fills
- A4-14.3 Special preparations or other requirements for use of on-site material
- A4-14.4 Availability of imported fill
- A4-14.5 Subgrade preparation
- A4-14.6 Recommended compaction criteria and moisture content control
- A4-14.7 Potential compaction difficulties and recommended solutions

A4-15 **Dykes and Embankments**

- A4-15.1 Recommended slope inclination
- A4-15.2 Slope stability analysis
- A4-15.3 Settlement
- A4-15.4 Seepage analysis
- A4-15.5 Erosion protection of slopes
- A4-15.6 Foundation and subgrade preparation
- A4-15.7 Fill material: Type, compaction, and moisture content control.
- A4-15.8 Filling/diversion/protection of existing wells, ponds, lakes, rivulets, and the like.

Annexure-V

Bill of quantity

Item No.	Description	Unit	Qty	Remarks
A) Field Tests				
1.	Mobilization and demobilisation of equipment and personnel needed for investigations to site (including accommodation etc.)	Lump sum		
2	Setting up bore hole positions including surveying	Nos.	4	
3a	Drilling of 150 mm diameter bore hole and sampling of disturbed and undisturbed in all types of strata including boulders, gravels, soft integrated rock but excluding hard rock boreholes and back filling with approved material as specified up to depth of 10 m	m	40	Drilling for cross hole test is included in this item. And conducting test cost is to be considered in the respective item
3b	Drilling of 150 mm diameter bore hole and sampling of disturbed and undisturbed in all types of strata including boulders, gravels, soft integrated rock but excluding hard rock boreholes and back filling with approved material as specified up to depth of 10-20m	m	40	
3c	Drilling of 150 mm diameter bore hole and sampling of disturbed and undisturbed in all types of strata including boulders, gravels, soft integrated rock but excluding hard rock boreholes and back filling with approved material as specified up to depth of 20-30 m	m	0	
4	Conducting SPT in boreholes *(SPT is to be performed as per IS 2131)*	Nos.	56	SPT numbers for cross hole logs included in this item
5	Conducting Cross hole seismic test *(IS 13372)*	Nos	-	
6	Conducting Vane shear test *(IS 4434)*	Nos	-	
7	Piezo Cone Penetration Test (PCPT). *(Tests to be performed till as per IS 4968 and ASTM D5778)*	Nos.	3	
8	Piezo cone pore pressure dissipation test	Nos	0	
9	Conducting Soil Electrical Resistivity Test *(IS 3043)*	Nos.	2	
10	Conducting Soil Thermal Resistivity Test	Nos.	-	
11	Piezometric water level monitoring per borehole, including installation of PVC slotted tube, gravel, bentonite.	Nos	-	
12	Trial Pit size of 1.5m x 1.5m at bottom of pit, including in-situ density testing. *(Maximum Depth of Trial Pit is 1.5 m. However, depth can be reduced if Hard Strata / Rock is encountered)*	Nos.	2	

Item No.	Description	Unit	Qty	Remarks
B) Laboratory Tests				
I)	**Testing on Soil Samples**			
1.	Grain size analysis	Nos.	25	
2.	Natural moisture content	Nos.	25	
3.	Specific Gravity	Nos.	25	
4.	Atterberg Limits	Nos.	25	
5.	Hydrometer Analysis	Nos.	25	
6.	Bulk and Dry Density	Nos.	25	
7.	Chemical Analysis of soil & water (pH, Chlorides and sulphates)	Nos.	4	
8.	Direct Shear Test	Nos.	25	
9.	Triaxial Test (UU)	Nos.	6	
10.	Unconfined Compression Test (UCS)	Nos.	6	
11.	Consolidation Test	Nos.	6	
12	Permeability test	Nos.	-	
13	CBR Test	Nos.	2	
14	Collapse potential of soils	Nos.	-	
15	Swelling potential of soils	Nos.	-	
II)	**Testing on Rock Samples**			
1	Point Load Index Test	Nos.	-	
2	Uniaxial Compression Strength Test	Nos.	-	
3	Water Absorption Test	Nos.	-	
***Note:** Indicated lab test quantities are tentative. They can be increased or decreased depending on soil strata encountered during field investigation.*				
C) Preparation of Soil investigation Report				
1.	Draft geotechnical report	Nos.	1	
2	Final report submission of geotechnical investigations report in pdf format including native files in Word, Excel, and Auto Cad layouts.			