



F.No: IIT-D/Bldg Proj/Geotechnical survey/Phase-II/201/2014

Dated : 30/5/2014

NOTICE INVITING QUOTATION(REVISED)

Sealed item rate quotations are invited for the following work on behalf of Registrar , IIT-Delhi from the specialized agencies for the following work so as to reach the office of undersigned up to 3PM on 6/6/2014 Quotations shall be opened on the same day at 3:30 PM, in the office of the GM(P), Service Block, IIT-D Campus, G.B.Pant Polytechnic extension, Okhla Phase-III New Delhi-110020 in presence of the intending bidders who so wish to attend.

Name of Work : **Geotechnical survey works of Phase-II at IIT-Delhi.**
Estimated Cost : **Rs 5.4 lacs**
EMD : **Rs 10,800/-(Ten thousand eight hundred only) in form of DD payable in favour of "IIT Delhi Collections."**

TERMS AND CONDITIONS:-

1. The work shall be carried out as per this NIQ(revised) including the revised BOQ, the clarifications at Annexure A , the drawing and specifications/ CPWD specifications.
2. Any damage done to the equipment/building during execution of work shall be on the part of contractor.
3. No T&P shall be issued to the contractor.
4. Contractor shall make his own arrangement for water and power. The agency should see the site conditions before submitting the tender and no extra on any such account shall be payable.
5. Locations of the boreholes are indicated tentatively as per plan and are subject to change as per building location etc.
6. Time allowed : 21 days.
7. Schedule of quantity : As per Revised BOQ
8. Payment shall be made as per actual quantities of executed works .
9. Security deposit @ 5% which shall be refunded after 6 months.
10. Clause-12 of G.C.C is applicable for E.I/S.I/Deviation etc.
11. Contractor must visit site before quoting and fully satisfy himself of the site conditions.
12. Eligibility Criteria: The agencies with office preferably in Delhi /NCR, must have satisfactorily executed in Government Departments/PSU/reputed MNC/Pvt Cos -three similar works each of value 40% of estimated cost or two works each of 60% of estimated cost or one work of 80% of estimated cost during last 5 years and preferably empanelled with Govt bodies. The said certificates along with the EMD be enclosed in Envelope-A. The applications not supported with requisite experience certificates shall not be entertained .The priced bill of quantities kept in Envelope-B ,all duly signed by the authorized signatory of the firms .
13. Conditional offers will not be accepted. The offer shall remain valid for 90days.
14. IIT-D reserves the right to accept or reject any tender in part or whole without assigning any reasons thereof.
15. This information can also be downloaded from <http://www.iitd.ac.in/tenders> .
16. All works described in the BOQ shall be assumed to be included in the price quoted for the survey work pertaining to making own arrangements for water tankers, electricity ,pump sets etc as observed for test bores in all kinds of hard rock/soil etc and nothing extra shall be payable on any account.

GM(P)

CC: Registrar,
Director
Notice Board

REVISED BOQ FOR GEOTECHNICAL INVESTIGATION AT IIIT DELHI FOR PHASE II CONSTRUCTION					
S.NO.	DESCRIPTION	UNIT	QTY.	RATE	AMOUNT
1	SOIL INVESTIGATION				
1.1	Drilling of 150 mm diameter bore hole in all types of soils as per depth indicated below or refusal strata which ever is earlier as per instructions of the Project In Charge. Refusal defined as and when 'N' value is 100 or more for 30 cm or part penetrati				
a.	Conducting standard penetration test (SPT) in the boreholes at 1.5m intervals in depth or every change of strata which ever is earlier as per IS 2131-1981.				
b	Electrical Resistivitytest Test				
c	Collecting disturbed soil sample from the location of conducting the SPT.				
d	Collecting undisturbed samples at 3m intervals or change of strata which ever occurs earlier.				
e	Analysis for liquifaction potential for Earthquake as per Zone – IV of IS: 1893-2002 (Part –1)				
f	Recording the Ground Water Table if observed upto exploration depth, as per IS : 6395:1973.				
g	Conducting all necessary laboratory tests on samples collected for their different engineering properties. Following tests will be carried out:				
g1	Grain size analysis of soil samples.				
g2	Liquid limit & plastic limit.				
g3	Specific gravity, Natural density & moisture content.				
g4	Shear tests – tri axial tests as per strata.				
g5	Consolidation tests if the strata is compressible.				
g6	Unconfined compression test for cohesive soils.				
g7	Chemical analysis of ground water extract, pH value of water also.				
g8	Chemical analysis of soil extracts at various depths in the boreholes from the point of view of chemical attacks on the structure & foundation, pH value of soil also.				
	Preamble: 1 bore holes of 15 m depth & 1 bore holes of 10 m depth				
a)	For Depth up to 15m	RM	Rate only		
b)	For Depth up to 10m	RM	Rate only		
1.2	Drilling of 150 mm diameter bore hole in all types of rocks (ordinary/ Hard rock) as per depth indicated below or refusal strata which ever is earlier as per instructions of the Project In Charge. Refusal defined as and when 'N' value is 100 or more for 30 cm or part penetrati				

S.NO.	DESCRIPTION	UNIT	QTY.	RATE	AMOUNT
a.	Conducting standard penetration test (SPT) in the boreholes at 1.5m intervals in depth or every change of strata which ever is earlier as per IS 2131-1981.				
b	Electrical Resistivitytest Test				
c	Collecting disturbed rock sample from the location of conducting the SPT.				
d	Collecting undisturbed samples at 3m intervals or change of strata which ever occurs earlier.				
e	Analysis for liquifaction potential for Earthquake as per Zone – IV of IS: 1893-2002 (Part –1)				
f	Recording the Ground Water Table if observed upto exploration depth, as per IS : 6395:1973.				
g	Conducting all necessary laboratory tests on samples collected for their different engineering properties. Following tests will be carried out:				
g1	Grain size analysis of soil samples.				
g2	Liquid limit & plastic limit.				
g3	Specific gravity, Natural density & moisture content.				
g4	Shear tests – tri axial tests as per strata.				
g5	Consolidation tests if the strata is compressible.				
g6	Unconfined compression test for cohesive rocks.				
g7	Chemical analysis of ground water extract, pH value of water also.				
g8	Chemical analysis of rock extracts at various depths in the boreholes from the point of view of chemical attacks on the structure & foundation, pH value of soil/ rocks also.				
	Preamble: 2 bore holes of 15 m depth & 6 bore holes of 10 m depth				
a)	For Depth up to15m	RM	30		
b)	For Depth up to 10m	RM	60		

S.NO.	DESCRIPTION	UNIT	QTY.	RATE	AMOUNT
1.3	Preparing & submitting Comprehensive soil/ rock investigation report (Six copies) for the project based on following observations:				
a.	Void ratio, permeability, Atterberg limits, water content, co-efficient of consolidation (by Oedometer), stress-strain modulus (by stress-strain curves from triaxial tests).				
b.	Foundation analysis & recommendations with supporting calculations regarding foundation system, depth of foundation.				
c.	Modulus of vertical sub-grade reaction to be used for raft foundation (based on empirical formulae).				
d.	Net safe bearing capacity & suggested founding levels for open foundations (Net safe bearing capacity at a depth of 3m,4m,5m & 6m below the existing ground level or at required depth).				
e.	Plotting of a compiled sub-surface profile along the depth in both plan directions.				
f.	Estimation of safe side slopes for excavation.				
g.	Suitability of excavated material as back fill.				
h.	Field CBR Value (based on empirical formula)				
i.	To check for liquefaction potential.				
j.	Any other pertinent information relating to foundation design considered necessary.	L.S.	1		
1.4	Transportation of equipment / Mobilization / Dematerialization of equipment, etc. for soil investigation.	L.S.	1		
TOTAL (Rs.)					
NOTE	Rates to be inclusive of all taxes duties etc complete for the works and clarifications at Annexure A				

CLARIFICATIONS TO QUERIES FROM AGENCIES

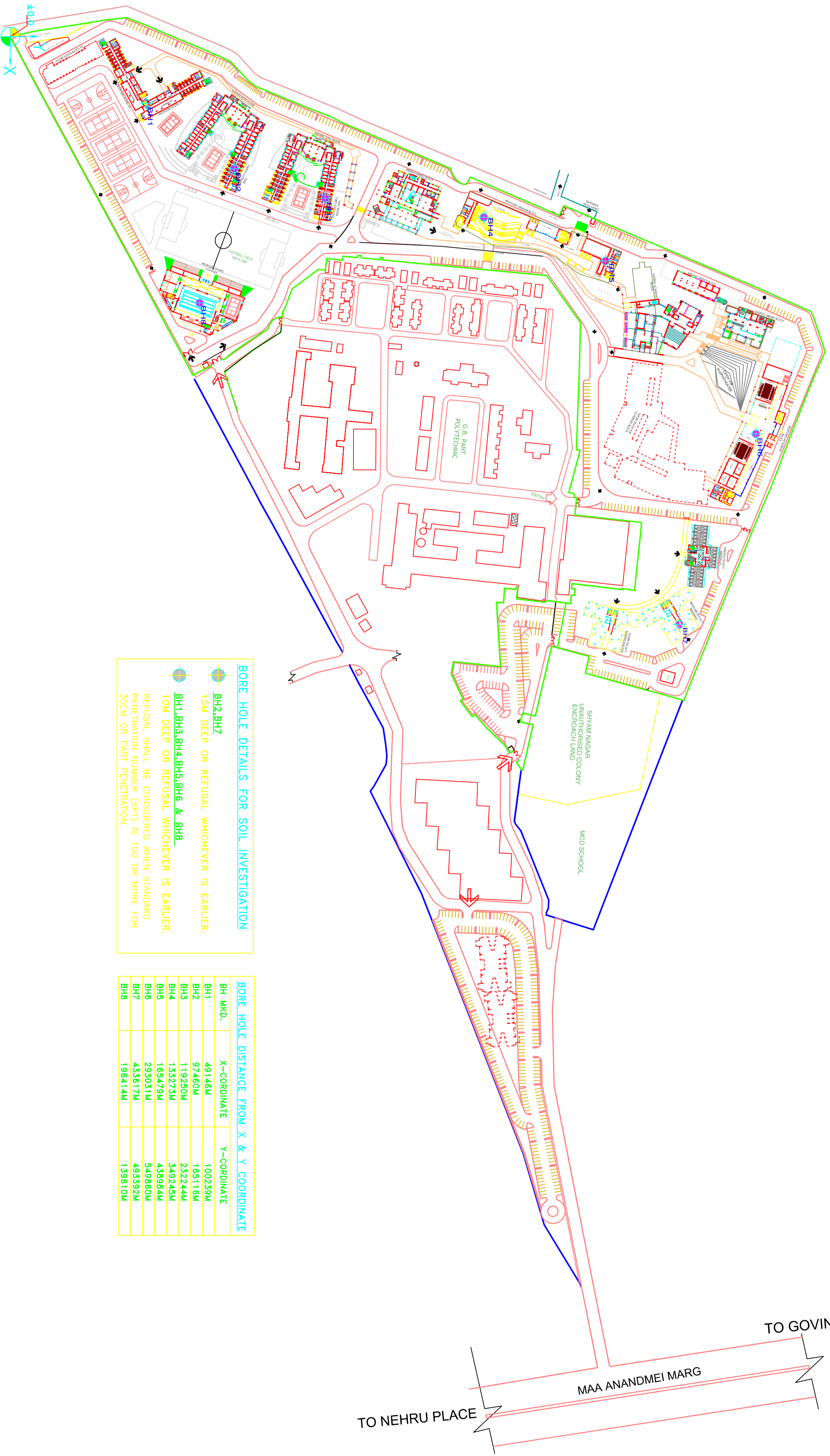
1. CBR VALUE BY EMPLOYING Empirical approach is acceptable.
2. Specifications relating Earth Resistivity for your reference are as under:

2.1 Electrical Resistivity Test:

The contractor shall also conduct Electrical Resistivity test indicating the test location coordinates and test ground elevation. The spacing of Electrodes shall be 0.5m. The results of Resistance in ohms and Average Resistivity in Ohm-meter shall be recorded in the standard format shown below:

Spacing of electrodes(m)	Resistance in ohms	Resistance in ohms	Resistance in ohms	Resistance in ohms	Avg Resistivity(Ohm meter) P=2KSR where K =3.14159	Avg Resistivity (Ohm meter) P=2KSR where K =3.14159	Avg Resistivity(Ohm meter) P=2KSR where K =3.14159	Avg Resistivity(Ohm meter) P=2KSR where K =3.14159	Avg Resistivity(Ohm meter) P=2KSR where K =3.14159
	N-S	E-W	NE-SW	NW-SE	N-S	E-W	NE-SW	NW-SE	

The Earth Resistivity shall be iterated for 4 locations at the periphery of Proposed Units of Buildings.



BORE HOLE DETAILS FOR SOIL INVESTIGATION

- BH2, BH7**
1.5M DEEP OR REFUSAL WHICHEVER IS EARLIER.
- BH1, BH3, BH4, BH5, BH6 & BH8**
1.0M DEEP OR REFUSAL WHICHEVER IS EARLIER.

REFUSAL SHALL BE CONSIDERED WHEN STANDARD PENETRATION NUMBER (SPN) IS 100 OR MORE FOR 30CM OR PART PENETRATION.

BORE HOLE DISTANCE FROM X & Y COORDINATE

BH MKD.	X-COORDINATE	Y-COORDINATE
BH1	491.46M	1002.33M
BH2	97.460M	1651.16M
BH3	1192.50M	2322.44M
BH4	1332.73M	3492.45M
BH5	1654.79M	4369.84M
BH6	2930.31M	5498.60M
BH7	4336.17M	4933.92M
BH8	1964.14M	1396.10M

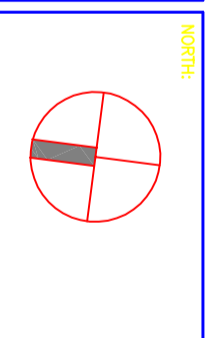
TO NEHRU PLACE

MAA ANANDMEI MARG

TO GOVINDPURI

CLIENT: **INDRAPRASTHA INSTITUTE of INFORMATION TECHNOLOGY DELHI**

DWG TITLE: **SITE PLAN (BORE HOLE LOCATIONS)**



STRUCTURAL CONSULTANTS:
MEHRO CONSULTANTS
 Structural Engineering Division
 4-1/2E, Seelampur, East, New Delhi-110029
 Tel: 91-11-46028052, 91-11-26184466,
 91-11-26172156, Fax: 91-11-46028053
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architecture
 • master planning
 • urban design
 • interior design
 • project management

SPECIFICATION FOR GEOTECHNICAL INVESTIGATIONS

1.0 SCOPE

- 1.1 This specification covers the work required for geotechnical investigation and preparation of a detailed report. The work shall include mobilization of necessary equipment providing necessary engineering supervisors and technical personnel, skilled and unskilled labour and such other services as required, to carry out field investigations and tests, laboratory tests and analysis and interpretation of data and results, preparation of a detailed geotechnical report including recommendations.

2.0 CODES AND STANDARDS

- 2.1 All work shall be carried out strictly in accordance with the specifications. Where not specified, the latest edition of the applicable code of practice or procedure as laid down by the Bureau of Indian Standards (BIS) shall be followed unless indicated other wise. Some of the relevant standards issued by BIS are listed below. In case of any discrepancy between these specifications and BIS these specifications shall govern.

IS : 1080	-	Code of practice for design and construction of simple spread foundations.
IS : 1498	-	Classification and identification of soil for general engineering purpose.
IS : 1888	-	Method of load tests on soils.
IS : 1892	-	Code of practice for site investigation for foundations.
IS : 1904	-	Code of practice for structural safety of buildings : foundations.
IS : 2911	-	(Part I to Part IV and all Sections) Code of practice for design and construction of piles.
IS : 2131	-	Method of standard penetration test for soils.
IS : 2132	-	Code of practice for thin walled tube sampling of soils.
IS : 2720	-	(Part I onwards) – Method of test for soils.
IS : 2809	-	Glossary of terms and symbols relating to soil engineering.
IS : 2810	-	Glossary of terms and symbols relating to soil dynamics.
IS : 2950	-	Code of practice for design and construction of raft foundations.
IS : 2974	-	(Part I to Part V) – Code of practice for design and construction of machine foundations.
IS : 4078	-	Code of practice for indexing and storage of drill cores.
IS : 4332	-	(Part I to Part X) – methods of test for stabilized soils.
IS : 4434	-	Code of practice for in-situ vane shear test for soils.

- IS : 4464 - Code of practice for presentation of drilling information and core description in foundation investigation.
- IS : 4968 - (Part III) – Method of sub-surface sounding.
- IS : 5249 - Method of test for determination of in-situ dynamic properties of soils.
- IS : 5529 - (part I and Part II) – Code of practice for in-situ permeability.
- IS : 6403 - Code of practice for determination of allowable bearing pressure on shallow foundations.
- IS : 8009 - (Part I and Part II) code of practice for calculation of settlements of foundations.
- IS : 9214 - Method of determination of modulus of subgrade reaction (K value) of soils in field.
- IS : 9221 - Method for determination of modulus of elasticity and poisson's ratio of rocks materials in uniaxial compression.
- IS : 10042 - Code of practice for site investigations for foundation in gravel-boulder deposit.
- IS : 10108 - Code of practice for sampling of soils by thin wall sampler with stationary piston.
- IS : 11550 - Code of practice for field instrumentation of swelling pressure in expansive soil.

3.0 PURPOSE

3.1 The purpose, in brief, of the proposed geotechnical investigations is:

- i) To determine type of substrata and their characteristics up to the specified depths.
- ii) To assess the general suitability of the site for the proposed works.
- iii) To enable an adequate and economic design to be prepared, including the design of temporary works.
- iv) To plan the best method of construction, to foresee and provide against difficulties and delays that may arise during construction due to ground and other local conditions.
- v) To determine the changes that may arise in the ground and environmental conditions, either naturally or as a result of the proposed works, and the effect of such changes on adjacent works and on the environment in general..

3.2 All the tests that are considered necessary for this purpose shall be conducted. Any additional tests/works, changes in the number and type of specified tests, revision in the

diameter and/or depth of boreholes, samples to be collected, etc. shall be carried out as required by Consultant.

4.0 CALIBRATION OF EQUIPMENT

4.1 The contractor shall ensure that all the equipment/instruments are properly calibrated at the start of the work to reflect factual values.

5.0 PERSONNEL FOR GEOTECHNICAL INVESTIGATION AND REPORT

5.1 It is essential that personnel involved in the work of geotechnical investigation and report should have appropriate specialized knowledge and experience.

5.2 Field work shall be supervised on full time basis by a suitably qualified and experienced civil/geotechnical engineer and/or engineering geologist.

5.3 All field works shall further be supervised and executed by suitably trained foremen and personnel.

5.4 The laboratory work shall be under the direct control of suitably qualified and experienced engineer/supervisor. Laboratory technicians should have received training and have skill and experience in the type of tests they are carrying out.

5.5 The report shall be prepared by a suitably qualified and experienced geotechnical engineer.

6.0 FIELD WORK

6.1 General

6.1.1 The contractor shall have on site all required survey instruments to carry out the work accurately according to specifications and drawings. All the specified locations for boreholes and field tests shall be set out at site by the contractor from two established reference grid lines which will be shown to him by the engineer or as indicated in the drawing. If required, the contractor shall set out the base lines and the locations of boreholes and field tests with reference to the property line as indicated by the engineer or as indicated on the drawing. At each location of boreholes, plate load tests and other field tests, the contractor shall establish the ground prior to commencing of the operations.

6.2 Boring

6.2.1 Boring in soil

6.2.1.1 Method of boring

Boring in soil strata shall be carried out by shell and anger, or percussion tools. Also rigs shall be capable of boring to required depth. Casing and/or bentonite mud slurry may be used to avoid caving. However, for those boreholes where water samples are to be collected for chemical analysis or field permeability tests are to be conducted, bentonite / mud slurry shall not be used.

In boring particularly through cohesionless and soft to medium stiff clay strata, the contractor shall take every precaution to avoid unnecessary disturbance to the soil including ensuring that:

- i) The net hydraulic head at the bottom of borehole is zero or slightly on positive side within the borehole;
- ii) Close- fitting tools such as bailer shall be withdrawn slowly to avoid suction pressure.

6.2.1.2 Diameter of Boreholes

The diameter of the boreholes shall be such as to permit collection of undisturbed samples of 90 to 100 mm diameter. However, the diameter shall not exceed 150mm unless approved by the engineer during the award of the work.

6.2.1.3 Casing in Boreholes

Where a borehole is being cased, the bottom of the casing shall always be maintained within 150mm of the bottom of the borehole, till a stratum is reached where a casing is not required. However, the casing shall never be in advance of the bottom of the borehole during undisturbed sampling, standard penetration tests, and other in-situ tests.

6.2.1.4 Obstructions while boring

If any obstruction to normal boring is encountered in any borehole, this obstruction shall be overcome by drilling and / or by chiseling. Chiseling will normally be paid at the contract rate for boring in soil at appropriate depths, unless a separate rate has been provided for in the contract.

6.2.2 Drilling in rock

6.2.2.1 In rock strata, boring shall be done by using a rotary cutting tool tipped with diamonds and equipped to recover cores. The use of tungsten carbide (TC) bits shall be permitted.

6.2.2.2 Drill hole size shall generally be NX. .

6.2.2.3 Core barrels shall normally be double-tube ball-bearing, swivel type, with the core lifter located in the lower end of the inner barrel.

6.2.2.4 Drilling shall be carried out in such a manner that maximum core is recovered. This requires close surveillance of wash water, drilling pressures, lengths of runs etc. The drill bit shall be withdrawn and the core removed as often as may be necessary to secure the maximum possible amount of core. Contractor shall ensure that drilling is carried out with necessary skill and expertise.

6.2.2.5 Coring runs shall be limited to a maximum length of 3.0M. When less than 50% of the core is recovered from a run or when a geological features is to be accurately determined, the length of the run shall be reduced to 0.3M unless ,indicated by the Consultant.

6.2.2.6 The core shall be removed from the drill hole immediately if blocking of the bit or grinding of the core is apparent, regardless of the length of run which has been made.

- 6.2.2.7 The contractor shall not use drilling mud or any lubricant in the drillhole other than water.
- 6.2.2.8 The ease or difficulty of drilling at different depths shall be carefully noted and recorded during drilling. The returning drill water shall be kept constantly under observation and its character, such as, its clarity or its turbidity, its colour, etc. shall be recorded.
- 6.2.2.9 For each run, core recovery and rock quality designation (RQD) shall be noted carefully immediately after cores are taken out of the barrel.
- 6.2.2.10 Each and every core piece shall be serially and sequentially numbered from top downwards as soon as the core pieces are removed from the core barrel. The serial number shall be painted with good quality enamel paint.
- 6.2.2.11 All core pieces shall be placed in core boxes in serial order in correct sequence from top downwards. Core boxes shall be made according to specifications laid down in IS: 4078.

6.3 Borehole Depth

All boreholes shall be sunk to depths shown on the drawing

6.4 Sampling

6.4.1 The contractor shall take samples and cores r. This operation shall include the provision of all necessary equipment, tubes and containers and materials..

6.4.2 Undisturbed soil sampling in boreholes.

6.4.2.1 Frequency

Generally, undisturbed soil samples (UDS) shall be obtained at every 3.0M interval and at every identifiable change of soil formation.

6.4.2.2 Sampler size

The sampler shall be minimum 90mm diameter and generally 450mm long.

6.4.3 Types of samplers

6.4.3.1 Thin walled open drive sampler

Generally open drive sampler shall be permitted for sampling in cohesive strata. These samplers shall be made of seamless steel or aluminium tube. Area ratio of sampler shall not exceed 25 per cent for 100mm diameter sampler, and 15 per cent for 75mm dia sampler. The cutting edge of the cutting shoe (or edge) of the sampler shall be tapered at an angle not exceeding 20 degrees and inside clearance ratio shall generally be limited to 0.5 to 1.5 percent. Samplers with low clearance ratio shall be used in soft strata and those with high clearance ratio shall be used in stiff strata.

The sample tube and cutting shoe (or edge) shall be free from rust, pitting, burring or any other defect. The use of oil inside the sampler shall be limited to the minimum practicable.

One end of sample tube shall be marked "top" and this end shall be kept uppermost during sampling.

The adaptor head to be used with sample tube shall be fitted with a ball valve to permit the exit of air or water during driving or jacking.

6.4.3.3.2 Stationary piston sampler

In fine grained strata with no or little cohesion such as in silty soils piston sampler shall be used. Requirements of the piston sampler are same as those of open drive sampler.

6.4.3.3.3 Sand sampler

If undisturbed samples are specified to be recovered from sandy strata particularly below ground water table special sand samplers shall be used. A compressed air sampler (Bishop 1948) or similar sampler would be acceptable.

6.4.3.3.4 Samplers for continuous sampling

When specified continuous sampling shall be obtained to depths specified. For this purpose, the delft continuous sampler may be used.

6.4.3.4 Procedure for sampling

Before sampling operation, the contractor shall clean the bottom of borehole very carefully and every care shall be taken to avoid disturbance of material to be sampled. For sampling, the sampler shall be lowered to the bottom of borehole without impact, and pressed into the soil in a single continuous movement at a sufficiently slow rate to permit the check valve to pass the water in the tube without creating excess back-pressure. The open drive sampler may also be driven into the soil. The sampler shall never be pushed or driven to its full length. After penetration to the required depth, the sampler shall be freed from the soil by being rotated by one full turn. The sampler shall then be withdrawn smoothly so as to cause the minimum disturbance to the sample. The total length of the sample shall be measured and recorded and, if any of the soil has fallen out of the bottom of the tube, this fact shall also be recorded.

6.4.4 Undisturbed soil samples from test pits and other sources:

6.4.4.1 The Contractor may be required to collect undisturbed soil samples from trial pits, excavations etc..

6.4.4.2 Samples to be collected may be core samples or block samples, as required by Consultant.

6.4.4.3 Core samples shall generally be obtained by jacking a this-walled open drive sampler of around 100mm diameter into the stratum. Sample tube may also be driven if approved by Consultant Sample tubes shall be held steady during jacking/driving and a suitable frame shall be used for guiding inclined samplers.

6.4.5 Disturbed soil samples

6.4.5.1 In all boreholes, unless continuous undisturbed soil sampling is in operation, disturbed soil samples shall be taken at every 1.5M interval and at significant change of stratum. Materials from cutting shoe of undisturbed samplers and from split spoon sampler used for standard penetration tests shall be taken as disturbed samples. These samples shall

be placed without delay in air-tight glass jars of not less than 0.4 kg nominal size or adequately sealed polythene bags and each sample shall fill the jar or bag as possible. Payment for disturbed samplers and from the cutting edges of undisturbed samplers and from split spoon sampler is presumed to be included in the rate of collecting undisturbed samples and conducting standard penetration test.

In certain cases bulk disturbed samples may be required to be collected from boreholes and trial pits. Bulk disturbed samples from boreholes are to be collected if the material in the ground includes gravel or cobble sized particles. Such samples shall be representative. Unless specified, the large sample should be minimum of 3 kg when collected from boreholes, and of 10 kg when collected from trial pits. All large samples shall be sealed into heavy duty polythene bags immediately after they are collected.

6.4.6 Water samples

Water samples shall be collected from boreholes. Water samples shall be collected before the addition of water to the hole. If this is not possible, then, prior to collection of water sample, water level in the borehole shall be lowered by about 0.5M and the water level in the borehole then allowed to rise by water seeping through the walls of the borehole. The water sample shall then be collected. Care shall be taken to see that water sample is not contaminated by surface water or rain water.

If specified, ground water sample shall also be collected from trial pits.

If there are any wells within the area investigated and if specified, water samples shall also be collected from wells.

The water sample shall be collected in an air tight, scrupulously clean glass or inert plastic bottle or jerry can. The bottle/can shall be rinsed three times with water being sampled, before filling. The quantity of each water sample collected shall be about 1 litre.

Water samples shall be tested as soon as possible after sampling for sulphate (as S03) and chloride contents and its Ph, and for other cations and anions.

6.4.7 Sealing and labeling of samples

6.4.7.1 Immediately after taking an undisturbed sample in a tube, the cutting shoe and the adaptor head shall be removed along with the disturbed material which they contain. The visible ends of the sample shall each be trimmed off any wet disturbed soil. The ends shall then be coated alternately with four layers of just molten microcrystalline wax or other similar material approved by the engineer. More molten wax shall then be added to give a total thickness of not less than 25mm. Any space remaining at the ends of the sample tube shall be solidly filled with damp sawdust or other material approved by engineer, and ends of the sample tube shall be covered with tight fitting caps preferably screw caps.

6.4.7.2 Block samples shall also be coated with a succession of layers of microcrystalline wax. These samples should be packed in a suitable material and placed in a strong case. Large samples shall be provided with a tight fitting formwork or packed in a rigid cement or resin bag so as to prevent fissures opening up under the self weight of the sample.

6.4.7.3 The contractor shall assign a reference number to each soil and water sample taken from the borehole. This number shall be unique for that borehole and shall be in order of depth below the ground level.

6.4.7.4 All samples shall be clearly labeled indicating job number, borehole number, sample number, date of sampling, brief description of sample, type of sample, elevation of sample etc. and in case of undisturbed samples, the top / bottom of samples shall also be clearly labeled. Each such label shall be pasted on the container and another shall also be within the container.

6.4.8 Transporting and storing of samples

6.4.8.1 The contractor shall properly store all the samples at site till they are transported to his laboratory for testing. Sampling tubes containing undisturbed soil samples shall not be exposed to direct sun and shall be kept in a shade covered with wet gunny bags. These tubes shall be transported in specially fabricated wooden boxes with hinged covers. To minimize disturbance during shipment, saw-duct or similar other resilient material shall be used while packing into the wooden boxes.

6.4.8.2 The rock cores obtained by drilling shall be carefully removed from the core barrel and placed in a properly constructed wooden core boxes with hinged wooden covers as specified above. The cores shall be placed segregated accurately by labeled wooden blocks 25mm thick. No box shall contain more than 6M of core. Depths of all runs shall be marked on the portions with paint.

6.4.8.3 The contractor shall transport all samples to his testing laboratory as quickly as possible and test the samples. All unused and excess samples after testing shall be retained and properly stored by the contractor for three months after the end of submission of the report.

6.4.8.4 The unit rates quoted by the contractor for sampling are deemed to account for sealing, labeling, transporting, storing etc. as specified.

6.4.8.5 The contractor may be directed by the engineer to deliver some of the samples to a laboratory other than his own, and in such cases, the contractor shall be paid only for the extra cost of shipment, if any, incurred by him.

6.5 Specific observations during boring

Observations to be made by the contractor during boring shall include but not be limited to the following:

6.5.1 Sequence and thickness of different strata

Visual description and thickness of each stratum shall be observed. The description shall include but not necessarily be limited to soil type, consistency colour etc..

6.5.2 Groundwater table

The depth at which ground water is struck during boring shall be carefully noted and the depth of water table shall be ascertained subsequently in the completed borehole by daily observing the depth for the next six to seven days. Depth of groundwater shall also be observed in wells, if wells exist in the vicinity.

6.5.3 Loss or Make of drilling fluid

The 'Loss' or 'Make' of drilling fluid if observed during the boring shall be noted and brought to the attention of the engineer. Attempts shall be made to detect joints, fissures, artesian conditions, etc.

6.5.4 Presence of Lime, Mica etc..

Soil and rock samples shall be examined for presence of lime, mica etc. and shall be recorded if observed.

The contractor's rate for boring shall be deemed to include these and all other relevant observations.

6.6 Test in a Borehole

6.6.1 Standard penetration test (SPT)

6.6.1.1 Unless directed otherwise by the Engineer, the Contractor shall carry out standard penetration test in a borehole generally at 3M intervals and at every noticeable change of strata and as per the procedure in IS:2131 . The first test shall generally begin at 1.0 to 1.5M depth, unless UDS is collected at that depth. Generally SPT and UDS shall be conducted alternatively at 1.5M intervals. If UDS cannot be collected, this shall be replaced by the SPT.

6.6.1.2 For conducting the test, the bottom of borehole shall be cleaned properly and the spoon shall be properly and centrally seated in position in the borehole. It is necessary to ensure that drive hammer is of specified weight and has a specified free fall. It shall be ensured that energy of the falling weight is not reduced by friction between the drive weight and guides or between rope and which drum. Only BIS recommended standard connecting rods shall be used for the test.

6.6.1.3 In case the blow count of SPT in soil (including the number of blows for seating) exceeds 120, the corresponding penetration shall be recorded and this particular test at that depth stopped. If the total penetration is more than the seating penetration of 15cm, then the break-up of blow count for 15cm seating penetration and for remaining portion of penetration shall also be given.

6.6.1.4 A standard penetration tests shall also be conducted in weathered/soft rock with rock quality designation (RQD) less than 25%. In such a case, test shall be conducted at every 1.5M interval, unless specified otherwise, with the first test at a depth of 0.5M below the elevation at which weathered/soft rock is encountered. The procedure for the test shall be same as that in soil except that penetration corresponding to 20 to 120 blows shall be noted. Also, if the total penetration is more than the seating penetration of 15cm, then the break up of blow count for 15cm, seating penetration and for remaining portion of penetration shall also be given.

6.6.1.5 If required, standard penetration tests shall also be conducted in rock where RQD exceeds 25% and is up to 100%. The test shall be conducted at every 3.0M interval, unless specified otherwise, with the first test at a depth of about 0.5M below the elevation at which this rock is encountered. The procedure for the test shall be the same as that in soil except that penetration corresponding to 20 and 100 blows shall be noted. In case the total penetration exceeds 15cm, then the break up of blow count for 15cm seating penetration and for the remaining portion of penetration shall also be given.

6.6.1.6 The samples from the split spoon sampler shall be maintained.

6.6.2 Vane Shear Test (VST)

6.6.2.1 The contractor shall carryout field vane shear test in boreholes as per procedure IS: 4434.

6.6.2.2 At each location, vane shear test shall be conducted in two stages. In the first stage, the test shall be done in undisturbed soil and in the second stage, the test shall be conducted on the remoulded soil as per standard practice. For payment purpose both these stages of the test shall be considered as a single test.

6.6.3 Permeability test

6.6.3.1 Test in overburden

The Contractor shall carryout field permeability tests in overburden, at specified depths, as variable head (rising or falling head) and/or constant head test.

This test shall not be conducted in that portion of borehole in which bentonite or drilling mud has been circulated.

If external water is to be added to borehole as in constant head test, only clear water shall be used.

6.6.3.2 Test in Rock : Packer Test

Permeability test in rock, at depths specified, shall be carried out as a packer test. Single or double packer, as required, shall be used. Preference shall be given to single packer type of test. Hence at different depths, the tests shall be conducted progressively as the drill hole is advanced.

The type of packer to be used shall be such as to give a tight fit. The difference between the borehole and packer diameter shall not exceed 6mm.

The maximum pressure to be applied in a test should equal to standard head of 100m above the groundwater level, unless approved otherwise by Engineer. This value of maximum pressure may be reduced if it is likely to cause uplift of the ground or to break the seal of the packer in weak rock. The test shall be conducted as a series of tests, at a given depth, at different pressures. A series of 3 tests is desirable with the maximum pressure applied in three equal increments and then reduced with decrements of the same amount.

6.6.4 Static Cone Penetration Test

This test shall be conducted as per IS: 4968 Part III at locations and to depths as indicated on the drawings. The core shall have an apex angle of 60 degree with base area of 10 sq.cm. The cone assembly and method of testing shall such as to permit measurement of end resistance and frictional resistance. Wherever possible, an electric cone with load cell measuring device within the cone assembly to eliminate effect of rod friction and to provide automatic continuous recording of end resistance shall be used.

6.6.5 Bearing test

6.6.6 Vertical Load Test

Vertical load test shall be conducted either on a plate or on concrete foundation block as specified. These tests shall be conducted at locations and at depth as indicated on the drawing or as indicated by Consultant.. The test procedure shall be in accordance with IS: 1888.

For a plate bearing test, the test plate shall be of mild steel and shall be square or circular. The test plate shall be 600mm width/diameter. The test plate shall be plane and level and in no case less than 25mm thick. A series of concentrically placed smaller plates of 450mm and 300mm width/diameter (for 600mm test plate) and each of 25mm thickness shall be used to reduce the upward deflection of the free edges of the plate resting on the soil.

The test pit at test level shall be at least five times the width of the test plate. The pit shall be logged at all four corners as it is excavated and freshly cut encountered, pocket penetrometer tests shall be generously conducted and values (with test location within the pit) recorded. If necessary, sides of the test pits shall be adequately shored. The shoring shall be arranged in such a manner that working of the test is not hampered.

Initially, the pit shall be excavated to a depth of 300mm above the proposed test level. Thereafter, the kentledge and all other accessories outside the pit pertaining to and necessary for conducting the test shall be set up. On completion of such set up, the final 300mm shall be excavated from within the pit, taking adequate care so as not to disturb the kentledge.

An easy access to the bottom of the pit shall be provided and the ground under test shall be protected from rain and sun both during excavation and testing. The bottom of pit at test level shall be undisturbed, planar and free from any crumbs of fine, loose debris. The test plate shall be set on a suitable approved bedding material shall normally consist of cement mortar or plaster of Paris.

If the test level is below the groundwater level, the test may be conducted with water level in the pit at groundwater level or contractor may be required to lower the water level in the pit to test level or to a depth at least three times the width / diameter of the test plate measured from the test level and maintain it throughout the duration of the test. The actual option to be adopted shall be as indicated by Consultant.. For test below ground water level, even if the test is to be conducted with water level in the pit at groundwater level, the pit shall be dewatered to its bottom, unless specified otherwise, while seating the plate. Any dewatering involved for the test will be considered as part of the test.

The test load shall be so applied that it reaches the soil in a static manner. The loading may be applied directly by kentledge or jacking against a reaction system provided by means of kentledge, tension piles or ground anchors. Where kentledge is used it shall be supported on a properly designed frame or gantry such that there is no possibility of the load tilting or collapsing. The foundations of this frame or gantry should be sufficiently far away from the test plate so as not to affect its behaviour to any significant extent. Where tension piles or ground anchors are used, they shall be located a minimum distance of three times the plate width / diameter from the center of the plate to the center of the pile/anchor. The displacement of the plate shall be related to a fixed datum. This may consist of a reference beam (datum bar) supported by two foundations positioned outside the zones of influence of either the loaded area or the reaction

support area. The deflection measuring equipment must be set up in such a way that any tilting of the plate will not cause errors in the measurements. Dial gauges may be used. The least count of the dial gauges shall be at least 0.02mm. At least two but preferably four dial gauges shall be used and shall be placed at diagonally opposite corners.

The reference bars for the strain gauges shall be adequately rigid and on firm supports. The supports for the reference bars shall be so located that they are beyond the zone of influence of the loaded plate (600mm from plate edge for a 600mm size square plate) and the zone of influence of kentledge supports. The bars shall be adequately stiffened and placed on supports in a manner such that any effect due to ambient temperature variations are minimized. The reference bars and strain gauges shall not be exposed to direct sun and the pit shall be protected by tarpaulin sheets while the test is in progress.

The maximum load for the test shall correspond to settlement of test plate not less than 40mm or shear failure in subsoil or four times the design intensity of loading whichever is earlier. Final load shall be reached in not less than ten equal increments. Unloading may, however, be in higher decrements with total number not less than four. At each load increment settlement shall be observed accurate to 0.02 mm at an intervals of 1, 5, 10, 15, 25, 35, 50 and 60 minutes and thereafter at hourly intervals. In case of clayey soils, the time settlement curve shall be plotted at each load stage and load increased to the next stage either when the curve indicates that the settlement has exceeded 90 percent of the probable ultimate settlement at that stage or at the end of the 24 hours period. For soils other than clayey soil, each load increment shall be kept for not less than one hour or up to a time when the rate of settlement gets appreciably reduced (to a value of 0.02 mm/min). the next increment of load shall then be applied and the observations repeated. As noted earlier unloading shall be done in equal decrements with total number not less than four and with time gap not less than half an hour in between decrement.

If a load test on a concrete block is specified, it shall be conducted similar to plate bearing test. However, loading on the block shall commence only 21 days after the block is cast. The block shall be adequately reinforced.

6.6.7 Cyclic Vertical Loading Test

This test shall be conducted as vertical loading test as specified in Clause 6.8.1 herein above except that each load increment, after it is maintained for sufficient period as noted in Clause 6.8.1, shall be reduced to zero. The readings for rebound shall also be taken till the rate of rebound is less than 0.02 mm per minute. However, there should be a gap of not less than 10minutes between unloading and reloading.

6.6.8 Lateral and Inclined Loading Test

These tests are carried out similar to vertical loading test except that they are carried out at specified orientation as indicted by Consultant..

6.6.9 California Bearing Ratio (CBR) Test

The California Bearing Ratio test shall be carried out as per IS: 2720 part (XXXI) . The load may be applied through a screw jack using the weight of a vehicle as jacking resistance and deflections may be measured by dial gauges carried on a bridge with independent foundations resting on the ground, well clear off the test point. Depth of test shall be either the ground surface or as specified by Consultant.

A circular area of about 300mm shall be trimmed flat to required elevation, special care being taken for the central area on which the plunger will bear. A thin layer of fine sand may be used to seat the plate on which the surcharge weights rest, but the use of sand to seat the plunger itself shall be totally avoided. If it is impossible to trim the soil sufficiently to obtain good seating of the plunger, a thin layer of plaster of Paris shall be used, care being taken to remove any plaster extending beyond the area of the plunger. Initially a seating load of 50N shall be applied and maintained on the plunger. Thereafter, clean fine sand shall be laid and spread over the surface to be covered by the surcharge annular weight. Surcharge weight shall be as specified by Consultant..

Immediately after conducting the CBR test, a field density test shall be conducted from the level at which the CBR test was conducted by either 'Sand replacement' or 'core cutter' method . The test shall be conducted about 200mm away from the CBR test located and it shall be ensured that moisture conditions are similar. Field dry density and field moisture content values shall be reported along with the CBR curves and test result.

6.7 Trial Pit

If specified the Contractor shall excavate trial pits of size as specified in BOQ. Relevant tests specified in these excavations shall also be carried out. Whether specified or not, in every trial pit, including those excavated for loading tests, tests by pocket penetrometer shall be generously carried out at different depths in different strata in cohesive soils only.

6.8 Backfilling of Boreholes and pits

Unless specified, the Contractor shall backfill the boreholes and pits. Boreholes shall be backfilled by bentonite-cement grout. The cement and bentonite for the grout shall be in the ratio 1 to 1 by weight, and shall be made into a slurry with no more water than is necessary for placing the slurry in the borehole. If there is standing water in the borehole, the borehole shall be dewatered first before placing the mix. The pits shall be backfilled with proper ramming using the excavated material..

7.0 GENERAL

All laboratory tests shall be performed by qualified and experienced personnel, familiar with and having access to equipment and facilities for the accurate determination of data necessary, for requirements under this specification.

7.1 Standards and procedures for testing

Laboratory tests shall be carried out in accordance with the procedures described in the relevant BIS codes of practice and guidelines and/or other specific requirements indicated by Consultant

8.0 REPORT

8.1 General

The report shall generally contain geological history of the site, all detailed boreholes, summarized test data, observations, conclusions and recommendations. Actual field and laboratory observations, calculations of test results, supporting calculations for the recommendations made, etc. shall also be presented as appendices to the report.

8.2 Plot Plan

A plot plan, showing locations of all tests viz. boreholes, trial pits, bearing tests, static cone penetration tests, etc; properly drawn and dimensioned with reference to the established grid lines, shall be presented in the report.

8.3 Boreholes

True cross sections of boreholes or trial pits shall be presented. These cross-sections shall include all the relevant details such as reduced levels of the ground/bed surface, location coordinates of the borehole/ trial pit, and thickness and full classification of each of the strata encountered. The various tests conducted and samples recovered from every soil and rock stratum shall be clearly shown against that stratum. Observations of water table and any peculiar conditions such as artesian conditions, sand blow, etc. shall also be indicated.

8.4 Groundwater

All available data on ground water conditions shall be presented separately and shall be identified by borehole number.

8.5 Test Results

Results of all the tests, field as well as the laboratory, shall be summarized separately test wise. All relevant graphs, charts diagrams shall be submitted with the report.

8.6 Recommendations:

8.7 The recommendations shall be based on observations and test results and shall encompass theoretical as well as practical considerations for foundations for type of structure envisaged.

8.8 Recommended type of foundations.

8.9 Allowable or safe bearing capacities in different strata for shallow foundations indicating relevant design criteria adopted ,methods of analysis adopted

8.10 For pile foundations, type of piles recommended with reasons for the same; length, diameter, allowable capacity (both lateral and vertical) of individual and groups of piles.

8.10.1 Estimate of magnitude and rate of settlement of the proposed foundations.

8.10.2 Negative skin friction, if any magnitude of estimated negative skin friction. Methods to minimize or eliminate negative skin friction.

8.10.3 Comments on chemical nature of subsoil and groundwater with due regards to potential deleterious effects on concrete, steel and other substructure materials and recommended measures to overcome deleterious effects, if any.

8.10.4 Recommendations for subsoil treatment such as sand drains or stone columns, if any needed, giving reasons for such treatment, available and recommended method (s) of treatment. Mention shall be made of studies / trials to be carried out, if any, prior to selection of a method / methods of treatment.

8.10.5 Recommendations regarding any special construction procedure / precaution to be adopted / taken, method of dewatering, if any required etc..

8.10.6 Recommended side slopes for cutting and embankment, if any.