HSCC (INDIA) LIMITED

(A Subsidiary of NBCC (India) Limited)
(A GOVERNMENT OF INDIA ENTERPRISE)
E-6A, Sector-01, Noida-201301

Dated: 01/03/2019

AMENDMENT No. - III

Project Name : "Construction of ADVANCED NEUROSCIENCES CENTRE and their Maintenance during Defect Liability Period at PGIMER, Chandigarh on Comprehensive Design, Engineering, Procurement and Construction (EPC) basis"

Tender / NIT No.- HSCC/PGIMER/ANSC/CHANDIGARH/2019/ dated : 31/01/2019

This has reference to subject work, the following Amendment may be noted, which shall be treated as a part of the contract to be uploaded along with tender/ bid:

(i) Reply to pre-bid queries raised by bidders during pre -bid meeting held on 12.02.2019 at HSCC, Head Office, Noida:

Sr.No	Description/ Item	Ref. Vol./ Clause No.	Bidders Queries/ Request	HSCC Reply/ Clarification
1	Tender drawings		Beign a Design & Build project request to provide all tender drawings in Autocad format	Tender drawings already uploded on HSCC e-tender portal.
2	Soil Investigation report		Request to provide the soil investigation report	Refer Clause 11.1 (d) of SCC. Copy of soil investigation report is enclosed for reference only.
3	Mobilization advance	Volume-1 NIT Page No.10	Request to provide the 10% Interest free Mobilization advance	Shall be as per tender condition.
4	Basic rates		Request to provide the Basic rates for major material like Cement,R/f steel,Tiles etc.	it's a EPC basis works, Bidders has to workout at their own.
5	Drawings		Request to provide the Plumbing layout, ESS / HVAC Building, STP/EPT/UGT, Electrical single line diagram(SLD) drawings in Auto-Cad format	Required tender drwaings has already been uploded on HSCC e-tender portal. However, SLD will be provide only successful bidder.
6	Approvals Required	Vol.-III (SCC)	Request to Omit the scope of approvals from contractor scope.	Refer Clasue no.11.2 "Approvals Required" of Vol.-III (SCC), which is self explainetary.
7	DG/Transformer Location		Request to confirm the location of DG,Transformer/Substation,Main LT Panel room	Refer Master Plan
8	Scope of power supply		Please confirm the scope of Power Supply from State Electrical Board Substation to Project site Substation	Power supply to sub station in the premises will be provided by state electricity borad through client and supply from sub-station onward to the projcet site (neuroscience block) will be in the scope of EPC contrcator and as per DBR.

9	2.0 "Minimum Eligibility Criteria" : A. Work Experience	Vol.-I (NIT&PQ) Page No-3	(i) The above project is on Design, Engineering, Procurement and construction (EPC) of RCC framed structure building including civil works, external and internal electrical works , external & internal plumbing works, STP, ETP, fire fighting works , HVAC works, horticulture, landscaping and external development etc. The project consists of three basements plus G+ 6 structures. (ii) The additional qualifying criteria is with a project of costing not less than 40% of the estimated cost of project comprising of any multistoried RCC framed structure with minimum five storey's including foundation, finishing etc i e. similar as per the scope of work of Neurosciences centre mentioned above in bold letters. (iii) Please confirm that the basement will be considered as a storey as per CPWD guidelines and also as per NIT wherein only the mummty and machine room will not be counted as a storey. (iv) Apart from above an additional requirement of completion of construction of 150 bedded hospital works (without any specific value or percentage wrt estimate and without any specific requirement of Electro-mechanical services etc in line with the scope of work of NIT) is also required. It is requested that when the value of work of similar jobs as per NIT requirement and experience of composite work with all Electro mechanical services with minimum 5 floors is getting fulfilled above as per item 2, this additional requirement of Hospital will help only in getting the restricted participation of bidders. In view of above we request you to kindly amend the qualifying criteria of the project to have maximum participation with experience in line with the scope of work of the NIT.	Shall be as per tender condition.
10	Escalation		The tender document does not provide Escalation / Price Adjustment on the entire work. We do hereby submit in this regard that the work in question is Gi very nigh magnitude in terms of its cost & volume. The completion period as per NIT is also 22 months which has been fixed according to the volume and cost of the work. Hence, taking care of any further increase in the rates of building materials, labour elements and Petrol — Oil — Lubricants during the entire construction period, which may be causing adverse effect on the construction / progress of the work, should not at all be ignored. We, therefore, request to kindly allow price index based escalation which will be to some extent, consolating factor in expediting the construction and timely completion of the work.	No Escalation is paybale as per tender condition.
11	Deviation/ Variation Limit		The clause provided in the tender in respect of the Deviation Limit is self contradictory as per Memorandum (Annexure-l) sheets provided in the DNIT. It is, therefore, requested to kindly allow deviation limit as provided in one of the Memorandum / Annexue-1 Sheet and make it part of NIT	Plus or Minus 2% variation in area to be deemed included in the quoted price, any further increase/decrease in area beyond vatiation limit of 2% shall be considred on pro-rata basis for payment. Any structure without RCC roof or light structure shall be dealt on pro-rata basis or on actual basis.

12	Barricading	Site Barrication Sl.No. 2, (Vol.-III)- SCC	Item No. 2 of Special Conditions of Contract: Height of 18 M High barricading seems to be misprint, as generally the height of barricading is not more than 18 Feet. Kindly review and issue suitable corrigendum.	**Shall be read as :** During construction as mentioned above of the building shall be done with **1.8 M** High barricading to separate the building under construction with Completed building. The barricading of **1.8 meter** height along from road side and outer boundary the periphery of the project site shall be constructed by contractor as per direction by Engineer-in-charge.
13	Estimated value of Project		It is submitted that we have visited the site and noted that due to site conditions and location of existing building in the near vicinity of the site it will require shoring for excavating of sites while excavating for earth in the three basements which will involve additional expenditure amounting to Rs.10-12 Crores which may please be included in the estimate.	The tender is an EPC contract, Bidder has to quote accordingly.
14	Eligibility Criteria		As per NIT of Tender Document, the bidder must have executed One work either part of (i) above or a separate one costing not less than 40% of Estimated Cost of Project Comprising "Construction of any multistoried RCC framed structure minimum five storeys Machine Room and Ivlurnty shall not be counted as a storey including Foundation, Finishing works, Internal water supply, Sanitary Installations and Internal Electrical Installations, Fire Fighting works and Centralized HVAC works all executed under one composite agreement", It is requested that- > The Condition of Centralized HVAC work may be relaxed to individual AC's. › The HVAC works executed for own Office Building may be considered for that purpose.	Shall be as per tender condtition.
15	Time Period		It is requested that the Overall Time Period of the Project may please be Enhanced, as it involves the Most time consuming Activity of "Approvals from various Statutory Authorities", that takes a time period of about 4 - 6 Months.	Shall be as per tender condtition.
16	Charges for taking Approval from various Authorities.		Please Clarify, who shall borne the Fees / Charges incurred during the various Statutory Approvals / Permissions / Planning Permits / NOC's / Occupancy Certificate / Completion Certificate from various Statutory / Local / Govt. Agencies	No reimbursement shall be made for any payment on account of statutory clearances from various authorities.
17	CLU Charges		Please Clarify whether any CLU Charges shall be applicable for this Project & if (any) who shall bear such charges to the concerned Authorities.	Not applicable
18	Basic Rates of Items		Due to being a Lump Sum EPC contract, it is requested that the Basic Rates of various Finishing Items including, Internal & External electrical works, Internal & External plumbing works, STP, ETP, Fire Fighting works, HVAC works, Horticulture, Landscaping and External Development etc. as per scope of work may please be Freezed , so that the Department does not find any Difficulty in comparing the Rates of various Bidders for the subject Work.	it's a EPC basis works, Bidders has to workout at their own.
19	HVAC		Please Clarify whether the Air Conditioning to be provided in the Buildings shall be Centralized AC.	Centralized AC, Refer HVAC DBR

20	Undertaking for Financial Assistance		Please Clarify that whether the Undertaking for Financial Assistance placed at page no. 139 of Clauses of Contract is to be enclosed with Tender Document. The same has not been mentioned in the List of Documents to be Submitted as Mentioned as page no. 7 & 8 of N1T of Tender.	Refer Cl.No.23.4 "Financial Assistance to the contractor" which is stands deleted
21	Recovery Rates of Work Force,		In GCC of Tender Document, it is mentioned that Recovery of Z 20,000/- Per Person Per Month shall be made by HSCC for the workforce Supplied to Contractor, Whereas it has be shown as not applicable in the NIT of Tender Document, Please Clarify.	Shall be as per tender condtition.
22	Drawings, Layout Plans		Please provide the various Drawings of Floor Plans, Elevations, Site Layouts etc., of the subject work, in AutoCAD format.	Required tender drwaings has already been uploded on HSCC e-tender portal. However, SLD will be provide only successful bidder.
23	List of Approved Makes		Please provide the List of Approved makes of following items of works:- i) Internal & External Electrical Works ii) HVAC Works	Refer "DBR, Technical Specification & approved make list"
24	Rate of GST		It is understood that being a Govt Project, GST @ 12% of Gross Amount shall be Applicable to the subject work. Please Clarify	Applicable GST shall be applicable as per concerned authority.
25	Permission for Boring		Please clarify whether Boring is Allowed with in the Campus of the Proposed Building,	Boring may be carried out as per prevailing rules at chandigarh.
26	Land for Site Office, Site Store, Batching Plant, Labour Hutments		Please Clarify whether the land for making site Office, Site Store, Botching Plant and Labour Hutments shall be provided at the site by Client.	labour camp is not allowed at site. Space for other construction actvity infrastructure will be provided at site as per availability of space. However, contractor have no claim in case of non availability of the space.
27	Labour Cess		It is understood that Payment of Labour Cess to be Deposited along with the Submission / Approval of Detailed Drawings of the Project shall be borne by HSCC/ Client. Please Clarify,	Labour Cess is applicable to be born and deposition by EPC contractor.
28	Schedule of stage payment	Vol.-III (SCC)	10% amount of Project value is being withheld for Testing commissioning and handing over. This adding security deposit becomes 12.5% and will badly effect the cash flow In project. Kindly consider.	Shall be as per tender condtition.
29	Defect Liability period	Vol.-I (NIT&PQ), Page No.10	Start of Defect Liability period may please be considered after taking over the works by HSCC instead of Client.	Shall be as per tender condtition.
30	HVAC Works	DBR. Head 12.1 Chillers	We request you to kindly accept GB- Stamping on Condenser and evaporator. As we have supplied chillers with GB stamping in PGIMER Chandigarh.	ASME/ GB stamping acceptable.
31	HVAC Works	DBR. Head 2.3.2 Material of Construction	We wish to clarify that chillers with aututube cleaining system are asked in tender in that case marine boxes are not required. request to clarify.	Marine Boxes not required. ATB not required on chiller.
32			Moment of construction material etc. shall be allowed during any time or there shall be restricted moment?	Movement of material shall be as per local administration.

33	GRIHA		As per GRIHA guidelines about 700 trees are to be planted for this project. Whether they shall be planted in this campus or land shall be provided anywhere outside?	Shall be as per scope of work and tender condition.
34	GRIHA		For GRIHA 5 star rating, water, electricity and waste management is to be done. Also roof top panels will be required. Whether the cost of the same should be loaded in the price? Whether PPC cement! fly ash shall be allowed for concreting purposes as per GRIHA guidelines.	Shall be as per scope of work and tender condition.
35			Whether we can start the excavation immediately after allotment of work while the drawing preparation is in process?	Shall be as per scope of work and tender condition.
36			Allotment of project/ finalization of drawings should be done keeping in view the impending monsoon season. If any of the above clashes with the monsoon season sufficient time extension may be granted for that.	Shall be as per scope of work and tender condition.
37	Completion Period		What if there is delay in approval of drawings at clients end? It is requested that the start date of the project may be considered from the date the drawings are approved. It is also requested that the total time period for this project may be considered as 30 months instead of 22 months.	Shall be as per tender condition.
38	Environmental Clearance	Vol.-III (SCC)	We understand that environmental clearance for this project shall be obtained by you. P1 clarify?	Refer Cl.No. 11.2 of Vol.-III (SCC) under sub head "Approvals Required" which is self explanatory.
39	Eligibility Criteria	Vol.-I (NIT&PQ)	We request you to kindly consider a Hospital Project where 240 beds out of 350 beds are in full operation and minor work in progress.	Shall be as per tender condition.
(iii) Contrcator has to arrange for cutting of earmarked trees existing at site for which approval will be provided by client. The EPC contarctor to be numbered of these cut trees and stacked properly at specified laocation as per direction by Engineer –in –charge/ HSCC at thier own cost.				
(iv) Shifting of Services: During construction if any existing service line like as sever, water, fire, electricity line, telephone line, internet line is found to fouling with the building then the same shall be shifted/ relocated by the contractor at thier own cost as per direction of Engineer –in –charge/ HSCC.				

(iv) The bidders may also note the following amendments in the Tender Documents issued :

Sl.No.	Clause Ref./ Item No.	Vol. Ref.	Existing Provision	Modified Provision
(a)	1. (in table- 1st Column) Milestone Internal	Vol.-III (SCC),	at Sl.No.6 : Completion of all brick work & all Internal plaster, fixing of doors & Windows frames at Sl.No.7 :Completion of all Sanitary Piping, Internal Plumbing Piping & Electrical Conduiting and HVAC ducting works.	**Shall be read as:** at Sl.No.6 : Completion of all brick work & Electrical Conduiting and all Internal plaster, fixing of doors & Windows frames. at Sl.No.7 :Completion of all Sanitary Piping, Internal Plumbing Piping and HVAC ducting works.
(b)	16 (B) Mile Stone (in table- 3rd Column) "Acitivity to be completed"	Vol.-III (SCC)	at Sl.No.6 : Completion of all brick work & all Internal plaster, fixing of doors & Windows frames at Sl.No.7 :Completion of all Sanitary Piping, Internal Plumbing Piping & Electrical Conduiting and HVAC ducting works.	**Shall be read as:** at Sl.No.6 : Completion of all brick work & Electrical Conduiting and all Internal plaster, fixing of doors & Windows frames. at Sl.No.7 :Completion of all Sanitary Piping, Internal Plumbing Piping and HVAC ducting works.
(c)	Cl.No.23.1 under sub-head "Payments"	Vol.-II (GCC) Page No.54	All running payments shall be regarded as payments by way of advance against the final payment only and not as payments for work actually done and completed and/or accepted by HSCC …..	**Shall be read as:** All running payments shall be made as per "Schedule of Stage Payment" (Annexure-A) of Vol.-III (SCC) by way of advance against the final payment only and not as payments for work actually done and completed and/or accepted by HSCC.....
(d)	Cl.No.12 (Order of Precedence of Documents)	Vol.-III SCC	vi. Technical Specifications vii. Design Basis Report (DBR)	Design Basis Report (DBR) and Technical Specification are to be read in conjuction, in case of contradiction Design Basis Report (DBR) will prevail.
(e)	Cl.No.11.1(a) under sub-head "Scope of Work"	Vol.-III SCC	(a) The concept Plan shall be provided by Consultant to the contractor. The Contractor shall design and prepare detailed working drawings for all works like Architecture, Finishing, Structural and services design eg. Electrical, Lift Plumbing, HVAC works, Fire Fighting, Horticulture, landscaping and external development etc. The contractor shall prepare all coordinated drawings for all services and make all necessary co-ordination for satisfactory execution of all works/activities in time bound manner. Develop various 3 D views and model of the buildings. The Contractor will appoint a competent architect having adequate experience in planning and design of hospitals and medical college. The architect will develop detail design and drawings based on concept drawing and BOQ of the tender.	**Shall be read as:** (a) The concept Plan shall be provided by Consultant to the contractor. The Contractor shall design and prepare detailed working drawings for all works like Architecture, Finishing, Structural and services design eg. Electrical, Lift Plumbing, HVAC works, Fire Fighting, Horticulture, landscaping and external development etc. The contractor shall prepare all coordinated drawings for all services and make all necessary co-ordination for satisfactory execution of all works/activities in time bound manner. Develop various 3 D views and model of the buildings. The Contractor will appoint a competent architect having adequate experience in planning and design of hospitals and medical college. The architect will develop detail design and drawings based on concept drawing.
(f)	Cl.No. 5	Vol.-III SCC	Bidders are required to use standard software like MS project for project management, ensuring successful commissioning of project. Bidder will also implement contract management and project management through standard mutually agreed software etc. and will also provide customized dashboard in HSCC in format approved by HSCC for facilitating project monitoring.	Bidders are required to use standard software like "Primavera" /Ms-Project/ latest technology for project management, ensuring successful commissioning of project. Bidder will also implement contract management and project management through standard mutually agreed software etc. and will also provide customized dashboard in HSCC in format approved by HSCC for facilitating project monitoring.

(g)	Cl.No. 6 & Cl.No.7.	Vol.-III SCC	6. One IT engineer & Biomedical Engineers shall be deployed by bidder for this project up to end of defect liability period. 7. 3 years warranty/CMC (3 years warranty and (CMC) support for complete equipment systems with back to back similar warranty CMC support commitment OEM for major components of MGPS and MOT systems.	**Shall be read as:** 6. Stands "Deleted" 7.Stands "Deleted"
(h)	HVAC Works	DBR & Tech. Specs.	Existing Provision	Modified Provision
(i)			Specifications AC Page- 5 –(14.1) specifies Defect liability period as 60 months & clause 15 at page- 5 where Defect liability period is mentioned as 12 months.	Defect liability period will be 12 Months.
(ii)			At specifications AC Page -7 –{23(iii)}	Rates shall include CMC of HVAC system during DLP.
(iii)			At specifications AC Page- 12- (i) District cooling has been considered for Hospital, library, Administration, Medical college, medical lab …	Shall be read as **'Centralised HVAC system for Neuroscience Block.'** In place of "district cooling with primary, variable secondary for Hospital block and variable tertiary for Library & Admin, Medical college, Medical labs"
(iv)			At specifications AC Page -12 –(i) chiller refrigerant is taken as 134a/1233zd.	Refrigerant shall be R134a. ASME/GB stamping for condenser and evaporator.
(v)			At specifications AC Page- 23 –(vi) AHU panel 40 mm thick & DBR at page- 15 (2.4) which says 25 mm thick	Panel thickness shall be read as 25 mm in DBR.
(vi)			At specifications AC Page- 14- 2.2 6 row cooling coil	6 row cooling coil shall be 3+3 combination.
(viii)			At specifications AC Page -12- (v)	ATB is removed from Chillers.
(ix)			At specifications AC Page- 6 – (2.3.1)(iii)	Marine water boxes deleted.
(x)			At specifications AC Page -72 –(2.2.2)/2.2.3	Duct Insulation shall be Nitrile rubber class 'O' only (Option B).
(xi)	HVAC Works: Approved Makes List	HVAC Tech. Specifications at AC Page - 85 to 89	List of Approved Makes & Manufacturers: (10) Carrier/Caryaire/Systemair/VTS/ Flaktwood/ Waves/Edgtech (11) Nicotra/ Comefri/ Flakt/ Kruger/VTS/Systemair (12) Danfoss/ Siemens/ VTS /FUJI/ ABB/ Schneider (31) Siemens/ Kirloskar/ ABB/ Crompton Greaves (35) Steelgrip or equivalent as approved by engineer in-charge. (59) Audco/ Advance/ Honeywell (73) Thermadyne/ Spectrum/ Dynafilter /AAF/ klenzoid (78) K-flex /Vidoflex/ Armacell/ Aeroflex	**Shall be amended as under:** List of Approved Makes & Manufacturers: 10) Carrier/Caryaire/Systemair/Flaktwood/Edgtech (11) Nicotra/ Comefri/ Flakt/ Kruger/Systemair (12) Danfoss/ Siemens/FUJI/ ABB/ Schneider (31) Siemens/ Kirloskar/ ABB/ Crompton Greaves/**Marathon** (35) Steelgrip/Kinjan or equivalent as approved by engineer in-charge. (59) Audco/ Advance/ **L&T** (73) Thermadyne/ Spectrum/ Klenzoid / **Camfil Air** (78) K-flex / Armacell/ Aeroflex

All others terms and conditions of tender shall remain same.

Prospective bidders are advised to regularly scan through HSCC e-tender portal http://www.tenderwizard.com/HSCC and HSCC website http://www.hsccltd.co.in as corrigendum/amendments etc., if any, will be notified on this portal only and separate advertisement will not be made for this.

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DGM (C), HSCC (India) Ltd.

CONTENTS

1. INTRODUCTION

The present report deals with the Geotechnical field and lab investigations conducted for GEOTECHNICAL INVESTIGATION FOR PROPOSED ADVANCED NEUROSCIENCE CENTRE AT POST GRADUATE INSTITUTE OF MEDICAL EDUCATION AND RESEARCH, CHANDIGARH. The work was taken in hand on Behest of HSCC (INDIA) LIMITED.

The objective of the report is restricted to the factual information to be collected during the investigation period along with laboratory tests results and so as to obtain sequence & extent of soil so as to arrive at design parameters for the foundations from the recommended safe bearing capacity of foundation soil.

2. SCOPE OF WORK

2.1. Reconnaissance / field trip for studying the general topography and geology of the area/ terrain

2.2. The field Geo tech investigations consisted of 2 nos. bore hole/trial pits up to maximum depth of 25.0 m or refusal below N.S.L whichever is earlier as per IS code.

2.3. Conducting SPT/DCPT in the bore-hole/trial pits at regular intervals and collecting disturbed/undisturbed soil samples from the bores hole at regular intervals as per Indian code of practice.

2.4. Conducting Bore holes/Trial Pit Tests and Collection of Disturbed & Undisturbed Sample & Preparation of Test Reports.

2.5. Recording of water table level in the bore holes at the time of boring (if encountered).

2.6. Conducting laboratory tests on the samples collected and thereby determining various index and engineering properties and summarizing the detail of soil classification.

2.7. A comprehensive Geotechnical investigation report embodying all the above information

along with tables of Field / Lab tests results and bearing capacity computations.

3. DETAILS OF FIELD WORK

3.1. BORING/TRIAL PITS OPERATION & SAMPLING

100/200 mm dia hole was advanced at the location by manual means 100/200 mm nominal dia flush steel casing was advanced with the boring and the full length of the bore hole was encased at each bore location.

3.2. DISTURBED AND UNDISTURBED SAMPLE

Disturbed and undisturbed soil samples were obtained depending upon the nature of soil from different depths in the bore hole. The undisturbed samples were collected in sampling tubes. The ends of the tubes are sealed with molten wax to prevent evaporation. These samples were subsequently tested in the laboratory so as to determine the various index and engineering proportion of various sub soil strata met in the bore holes.

3.3. STANDARD PENETRATION TESTS (SPT)

3.3.1. Standard Penetration Test was performed in the borehole. The standard split spoon sampler, attached to a string of drill rods was lowered to the bottom of the hole and allowed to rest under self weight. The drill rods were connected to driving assembly which consisted of a hoisting equipments, a drive weight (Hammer) of 63.5 Kg, and a guide to ensure a 75 cm free fall of hammer on an anvil. The number of hammer blows that were required to penetrate the sampler through three runs of 150 mm each were recorded. Initial driving of 150 mm was disregarded and the number of blows required to drive the sampler through the remaining 300 mm is called BLOW COUNT or PENETRATION NUMBER,N. At the end of the test, the sampler was withdrawn and the soil extracted for subsequent testing in the laboratory . If the penetration was less than 30 cm for 50 blows, it is considered as refusal and the actual penetration was recorded.

3.4. DYNAMIC CONE PENETRATION TEST

3.4.1. Dynamic Cone penetration Tests is carried out in open pits up at required depth at suitable intervals by driving a standard cone of outside diameter 50 mm and having an apex angle of 60^0 attached to a string of drill rods using a hammer weighing 63.5 kg falling freely through a height of 75.0 cm. The total number of blows required for the 30.0 cm penetration is termed Cone penetration Resistance or 'N_{cd}' value. . N_{cd}value is correlated with SPT value, N as under:

$$N_{cd} = 1.5\ N$$

3.4.2. Refusal is deemed to have met if under 35 blows, penetration achieved is less than 10 cms. The above correlation is meant for sandy soils. In boulder deposit / rocky strata evaluation of strength and compressibility characteristics by using elaborate tests is uneconomical for a type of structure proposed to be constructed at site. As a conservative approach, the above correlation can be used such strata to arrive at a safe value of 'N' that takes care of the highly erratic vibrations of properties such strata. Once value of 'N' based on least N_{cd}value is known, then bearing capacity analysis can be performed as done in case of Sandy deposits.

3.5. CORRECTION OF 'N'- VALUES

In case of sandy/cohesion-less soil, the observed SPT values, designated as 'N', are to be corrected to account for the following two effects:

a) Correction due to effect of overburden pressure,

$$N_N = C_N \times N$$

C_N' is overburden pressure correction and is calculated as $C_N = 0.77 \log_{10}(200/\sigma_0)$.

b) Correction due to submerge effect (in case of fine sand and silt),

$$N_c = 15 + (N_N - 15)/2, \text{ provided } N_N > 15. \text{ Else } N_C = N_N$$

Where ' N_c' is the final corrected value.

4. GROUND WATER TABLE

Determination of Ground water Table and water depth from Existing Ground level was done

using Steel tape with weigh. The depth of Ground water table was determined as per procedure laid in IS 6935-1973. At the time of Soil Investigation at site, ground water table was not encountered upto the explored depth from Existing Ground Level.

5. OBSERVATION AND DISCUSSIONS

From the field borehole logs, the laboratory test result and the visual examination of soil samples indicates the following type of strata in the bore holes.

5.1. SOIL CLASSIFICATION & GENERAL NATURE OF THE SOIL STRATA:

Classification and identification is the pre–requisite of any site investigation report. The sub soil strata are classified on the basis of lab tests as per IS: 1498 -1978. The classification on the soil samples were obtained from the % age of grain size distribution of gravel sand silt and clay in different layers of deposit met at site. The classification soil groups are given in the data sheets attached.

6. LABORATORY TESTS

6.1. Index Properties [As per SP 36 (Part-I)-1987] :

All the relevant classification on the samples obtained from the four bore holes were carried out in the laboratory. The index properties obtained from such classification tests at different depths in the bore holes are reported in the bore hole log sheets.

6.2. UNDISTURBED SOIL SAMPLES:

Undisturbed soil sample collected in field have been tested in laboratory and preparation of sample for the under mentioned tests have been done in accordance with I.S.2720-(Part-I)-1983.

1. Sieve analysis test as per I.S. Specification No. 2720 --(Part-IV).
2. Atterberg limit test (L.L. & P.I.) as per I.S. Specification No. 2720 --(Part-II).
3. Natural moisture content as per I.S. Specification No.2720 – (Part-IV).
4. Particle size analysis test as per I.S. Specification No. 2720-(Part-VI).

5. Wet density test as per I.S. Specification No 2720- (Part-VI).
6. Dry density test as per I.S. Specification No. 2720- (Part-VI)
7. Specific Gravity test as per I.S. Specification No-2720-(Part-III)-Sec.2.
8. Triaxial compression test and determination of shear parameter (C & Ø as per I.S. XII) & I.S. 2720 – (part – XIII).
9. Direct Shear Test and Determination of Shear Parameter.
10. Consolidation test conducted as per I.S Specification No. 2720- (Part-XV).

6.3. DISTURBED SOIL SAMPLES:

Disturbed Soil samples have been prepared in accordance with I.S. Specification No. 2720-(Part-I)- 1983 and tested as follows:-

1. Sieve analysis test as per I.S. Specification No. 2720- (Part- IV).
2. Atterberg limit test (L.L..& P.I..) as per I.S. Specification No. 2720 --(Part-II).
3. Particle size analysis test as per I.S. Specification No. 2720-(Part-VI).

Calculation of bearing capacity is governed generally by I.S. Specification No. 8009-(Part-I)- 1976, I.S.No.2720- (Part – II)- 1980, I.S. No 6403-1981, I.S. 1904-1978 and I.S. 1080-1985 and other relevant I.S. Codes as well as based on assessment and latest developments.

Test results are shown in the respective borehole data sheets.

7. FOUNDATION PARAMETERS

Allowable Bearing capacity values are based on the following parameters

Table 1: Foundation Parameters

S No.	Type of Footing	Foundation Size	Foundation Depth
1.	Isolated Footing	2.0 x 2.0 m	1.50 m,2.0 m & 3.0 m
		3.0 x 2.0 m	
2.	Raft Footing	15.0 X 10.0 m	3.0 m, 4.0 m & 5.0 m

8. ESTIMATION OF ALLOWABLE BEARING CAPACITY

A foundation can fail by two modes i.e.

i) Shear failure.

ii) Excessive settlement.

Shear failure being catastrophic, an adequate factor of safety is applied to ultimate bearing capacity that can initiate this type of failure. BIS recommends a value of FOS = 2.5 to obtain the net safe bearing capacity q_{ns} by using the physical characteristics of the foundation and relevant shear strength parameters of soil.

Settlement analysis a net loading intensity q_n is obtained by using the physical characteristics of the foundation and the relevant compressibility characteristics of the Underlying soil. The value so obtained ensures that the foundation shall not settle more than that which is permissible as per BIS recommendations. The permissible settlement depends upon the type of superstructure and the nature of supporting strata.

The lesser of these computed values i.e. q_{ns} or q_n is adopted as the allowable bearing capacity for proportioning the foundation of superstructures

9. COMPUTATION OF ALLOWABLE BEARING CAPACITY

SHEAR FAILURE ANALYSIS

Net Ultimate bearing capacity for general shear failure,

$$q_{nu} = c\,N_c\,S_c\,D_c + q\,(N_q-1)\,S_qD_q + \tfrac{1}{2}\,B\,\gamma\,N_\gamma S_\gamma D_\gamma\,W' \qquad \text{--------(1)}$$

Net Ultimate bearing capacity for local shear failure,

$$q_{nu} = 2/3\,c\,N_cS_cD_c + q\,(N'_q-1)\,S_qD_q + \tfrac{1}{2}\,B\,\gamma\,N'_\gamma S_\gamma D_\gamma\,W' \qquad \text{--------(2)}$$

Shape factors,

For Strip Footing:

$S_c = 1$; $S_q = 1$; $S_\gamma = 1$

For Rectangle Footing:

$S_c = 1+0.2\,B/L$; $S_q = 1+0.2\,B/L$; $S_\gamma = 1-0.4\,B/L$

For Square Footing:

$S_c = 1.3$; $S_q = 1.2$; $S_\gamma = 0.8$

For Circular Footing:

$S_c = 1.3$; $S_q = 1.2$; $S_\gamma = 0.6$

Depth factors,

$d_c = 1 + 0.2 \times D/B \tan(45 + \Phi/2)$; $d_q = d_y = 1 + 0.1 \times D/B \tan(45 + \Phi/2)$

(For Cohesive soil, $\Phi = 0$)

Inclination Factors,

$i_c = 1.0$; $i_q = 1.0$; $i_Y = 1.0$

SETTLEMENT ANALYSIS

As per BIS recommendation permissible settlement for isolated footing is 50 mm and for raft foundation is 75 mm respectively. Because of the erratic and pronounced variations of the compressibility characteristics of supporting strata, even slight differential settlement can cause distress to superstructure. As such differential settlement should be kept as low as possible. Depending upon the ability of the strata to absorb settlements, maximum permissible settlement is conservatively chosen so that resultant differential settlements do not cause distress to the superstructure. Based upon the feedback of field observations and using engineering judgment based on experience, an allowable value of 50 mm & 75 mm is being adopted for isolated and raft footing respectively in the present analysis.

Max. Settlement in cohesion less soil is calculated from IS 8009(Part I):1976, from fig. 9

Settlement in cohesive soils:

$$\Delta = \frac{H \times C_C}{1+e_0} \times \log\left(\frac{\sigma_0+\Delta\sigma}{\sigma_0}\right) \times \lambda_{wf} \times D_{wf} \quad \text{----------} \quad (3)$$

Where;

H = thickness of soil layer (m)

C_c = Compression index

e_o = Initial void ratio

σ_0 = effective overburden pressure (t/sq.m)

$\Delta\sigma'$ = net increase in pressure at center of soil layer

ISOLATED FOOTING (2.0 M x 2.0 M)

Depth of Footing, D = 1.5 m, 2.0 m & 3.0 m

Width of Footing, B = 2.0 m

Density, γ = 2.30 t/m^3

Angle of shearing Resistance, Φ = 25.40^0

Mobilizing Angle of shearing Resistance, Φ' = 17.57^0

Bearing Capacity Factors :

Nc = 12.96; Nq = 5.20; N_γ = 4.06

Table 2: Shape & Depth Factor

Depth of Footing	Shape Factors			Depth Factors			Surcharge (YxD),q (t/m^2)
	S_c	S_q	S_γ	D_c	D_q	D_γ	
1.50 m	1.30	1.20	0.80	1.237	1.119	1.119	3.45
2.00 m	1.30	1.20	0.80	1.316	1.158	1.158	4.60
3.00 m	1.30	1.20	0.80	1.474	1.237	1.237	6.90

Calculation of bearing capacity from local shear failure

Substituting values in equation, $q_{nu} = 2/3\ c\ N_cS_cD_c + q\ (N'_q\text{-}1)\ S_qD_q + ½\ B\ \gamma\ N'_\gamma S_\gamma D_\gamma\ W'$

$q_{ns} = q_{nu}/ FOS = q_{nu}/ 2.5$

Table 3: Safe bearing capacity in Shear Criteria

Foundation Size	Depth of Foundation	Net Ultimate Bearing Capacity, q_{nu}	*Net Safe Bearing Capacity, q_{ns}*
Isolated footing (2.0 m x 2.0 m)	1.50 m	27.81 t/m^2	**11.1 t/m^2**
	2.00 m	35.51 t/m^2	**14.2 t/m^2**
	3.00 m	52.28 t/m^2	**20.9 t/m^2**

SETTLEMENT ANALYSIS

Net Settlement from safe bearing capacity from Settlement criteria may be calculated from Equation No. 3

$H_{1.5}$ = 3000 mm; $H_{2.0}$ = 3000 mm; $H_{3.0}$ = 4000 mm; C_c = 0.207;

e_0 = 0.96 ;Rigidity factor, λ_{yf} = 1.0 ; Depth Factor = 1.0

Table 4: Settlement in Cohesive soil

Depth of Footing	Avg. N-Value	σ_0 (t/m^2)	$\Delta\sigma$ (t/m^2)	Settlement in Cohesive Soil, Δ_1 (mm)	Settlement in Cohesion less Soil, Δ_2 (mm)	Net settlement Δ (mm)
1.50 m	18.0	11.5	1.47	16.6	16x11.1/10x1.0/4.0=4.5	21.0
2.00 m	18.0	12.65	1.88	19.0	16X14.2/10x1.0/4.0= 5.7	24.7
3.00 m	21.0	16.1	2.32	24.7	-	24.7

Net Settlement, Δ< 50 mm, Hence safe

ISOLATED FOOTING (3.0 M x 2.0 M)

Depth of Footing, D = 1.5 m, 2.0 m & 3.0 m

Width of Footing, B = 2.0 m

Density, γ = 2.30 t/m^3

Angle of shearing Resistance, Φ = 25.40^0

Mobilizing Angle of shearing Resistance, Φ' = 17.57^0

Bearing Capacity Factors :

Nc = 12.96; Nq = 5.20; N_γ = 4.06

Table 5: Shape & Depth Factor

Depth of Footing	Shape Factors			Depth Factors			Surcharge (YxD), q (t/m^2)
	S_c	S_q	S_γ	D_c	D_q	D_γ	
1.50 m	1.13	1.13	0.73	1.237	1.119	1.119	3.45
2.00 m	1.13	1.13	0.73	1.316	1.158	1.158	4.60
3.00 m	1.13	1.13	0.73	1.474	1.237	1.237	6.90

Calculation of bearing capacity from local shear failure

Substituting values in equation, $q_{nu} = 2/3\ c\ N_c S_c D_c + q\ (N'_q-1)\ S_q D_q + ½\ B\ \gamma\ N'_\gamma S_\gamma D_\gamma\ W'$

$q_{ns} = q_{nu}/ FOS = q_{nu}/ 2.5$

Table 6: Safe bearing capacity in Shear Criteria

Foundation Size	Depth of Foundation	Net Ultimate Bearing Capacity, q_{nu}	*Net Safe Bearing Capacity, q_{ns}*
Isolated footing (3.0 m x 2.0 m)	1.50 m	26.00 t/m^2	**10.4 t/m^2**
	2.00 m	33.26 t/m^2	**13.3 t/m^2**
	3.00 m	49.08 t/m^2	**19.6 t/m^2**

SETTLEMENT ANALYSIS

Net Settlement from safe bearing capacity from Settlement criteria may be calculated from Equation No. 3

$H_{1.5}$ = 3000 mm; $H_{2.0}$ = 3000 mm; $H_{3.0}$ = 4000 mm; C_c = 0.207;

e_0 = 0.96 ;Rigidity factor, λ_{yf} = 1.0 ; Depth Factor = 1.0

Table 7: Settlement in Cohesive soil

Depth of Footing	Avg. N-	σ_0 (t/m^2)	$\Delta\sigma$ (t/m^2)	Settlement in Cohesive Soil,	Settlement in Cohesion less Soil, Δ_2 (mm)	Net settlemen

	Value			Δ_1 (mm)		t Δ (mm)
1.50 m	18.0	12.65	1.16	16.0	16x10.4/10x1.0/4.0=4.2	20.2
2.00 m	18.0	13.80	1.48	18.7	16X13.3/10x1.0/4.0= 5.3	24.0
3.00 m	21.0	16.1	2.18	23.3	-	23.3

Net Settlement, Δ< 50 mm, Hence safe

RAFT FOOTING (15.0 M x 10.0 M)

Depth of Footing, D = 3.00 m, 4.00 m & 5.00 m

Width of Footing, B = 10.0 m

Density, γ = 2.30 t/m^3

Cohesion,c =6.40 t/m^2

Bearing Capacity Factors:

Nc = 5.14; Nq = 1.00; N_γ = 0.00

Table 8: Shape & Depth Factor

Depth of Footing	Shape Factors			Depth Factors			Surcharge (YxD), q (t/m^2)
	S_c	S_q	S_γ	D_c	D_q	D_γ	
3.00 m	1.13	1.13	0.73	1.060	1.030	1.030	6.90
4.00 m	1.13	1.13	0.73	1.080	1.040	1.040	9.20
5.00 m	1.13	1.13	0.73	1.100	1.050	1.050	11.50

Calculation of bearing capacity from local shear failure

Substituting values in equation, q_{nu} = 2/3 c $N_cS_cD_c$ + q (N'_q-1) S_qD_q + ½ B γ $N'_\gamma S_\gamma D_\gamma$ W'

q_{ns} = q_{nu}/ FOS = q_{nu}/ 2.5

Table 9: Safe bearing capacity in Shear Criteria

Foundation Size	Depth of Foundation	Net Ultimate Bearing Capacity, q_{nu}	*Net Safe Bearing Capacity, q_{ns}*	*Reduced Safe Bearing Capacity, q_{ns}*
Isolated footing (15.0 m x 10.0 m)	3.00 m	28.87 t/m^2	**11.5 t/m^2**	**11.0 t/m^2**
	4.00 m	29.42 t/m^2	**11.8 t/m^2**	**11.8 t/m^2**
	5.00 m	29.96 t/m^2	**12.0 t/m^2**	**12.0 t/m^2**

SETTLEMENT ANALYSIS

Net Settlement from safe bearing capacity from Settlement criteria may be calculated from Equation No. 3

$H_{3.0}$ = 6000 mm; $H_{4.0}$ = 5000 mm; $H_{5.0}$ = 4000 mm ; C_c = 0.207 ;

e_0 = 0.96 ; Rigidity factor, λ_{yf} = 1.0 ; Depth Factor = 1.0

Table 10: Settlement in Cohesive soil

Depth of Footing	Avg. N-value	σ_0 (t/m^2)	Δσ (t/m^2)	Settlement in Cohesive Soil, Δ_1	Settlement in Cohesion less Soil, Δ_2 (mm)	Settlement, Δ (mm)

				(mm)		
3.00 m	24.0	18.4	4.89	64.8	13x11.0/10x14.0/20=10.0	74.8
4.00 m	24.0	19.55	5.6	57.7	13x11.8/10x15.0/20=11.5	69.2
5.00 m	24.0	20.7	6.12	47.5	13x12.0/10x16.0/20=12.5	60.0

Net Settlement, Δ< 75 mm, Hence safe

10.RECOMMENDATIONS

Recommended bearing capacity for different types of foundation may be assumed as follow:

Table 11: Recommendations

S.No	Type of foundation	At 2.0 m depth		At 3.0 m depth		At 3.0 m depth	
		$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)	$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)	$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)
1.	**Isolated Footing**	**10.4**	13.85	**13.3**	17.90	**19.6**	26.50

S.No	Type of foundation	At 3.0 m depth		At 4.0 m depth		At 5.0 m depth	
		$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)	$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)	$(q_a)_{net}$ (t/m^2)	$(q_a)_{gross}$ (t/m^2)
2.	**Raft Footing**	**11.0**	17.90	**11.8**	21.00	**12.0**	23.5

NOTE:

1. The area under investigation falls under seismic zone-IV as per India seismic code.
2. It is also suggested that the backfilling of the foundation soil should be well compacted inlayer at optimum moisture content to achieve at least 95% of proctor density, followed by suitable plinth protection & effective drainage system.
3. For any other size and depth of footing bearing capacity of soil can be calculated from the data provided.

LIST OF I.S. CODES

FIELD INVESTIGATION:

1.	IS : 1498 – 1970	:	Classification and Identification of soils for general engineering purpose (First Revision).
2.	IS : 1892 – 1979	:	Code of practice for sub surface investigation for foundations (First Revision).
3.	IS : 2131 – 1981	:	Method of Standard Penetration Tests for soils.
4.	IS : 2132 – 1986	:	Code of practice for thin walled tube sampling of soils (Second Revision).
5.	IS : 4968 – 1976 (Part – 3)	:	Method of sub surface sounding for soils : Static cone penetration test.

LABORATORY TESTS:

1.	IS 2720 – 1983 (Part – 1)	:	Methods of test for soils : Preparation of dry soil sample for various tests (Second Revision).
2.	IS : 2720 – 1980 (Part – 2)	:	Method of test for soils : Determination of water content (Second Revision).
3.	IS : 2720 – 1980 (Part – 3) (Section – 1)	:	Method of test for soils : Determination of Specific Gravity : Fine Grained Soils.
4.	IS : 2720 – 1980 (Part – 3) (Section – 2)	:	Method of test for soils : Determination of Specific Gravity : Fine, Medium, Coarse Grained Soils (First Edition).
5.	IS : 2720 – 1985 (Part – 4)	:	Method of test for soils : Grain Size Analysis.
6.	IS : 2720 – 1985 (Part – 5)	:	Method of test for soils : Determination of liquid & plastic limit (Second Revision).
7.	IS : 2720 – 1986 (Part – 15)	:	Method of test for soils : Determination of consolidation properties (First Revision).
8.	IS : 2809 – 1972	:	Method of test for soils : Glossary of terms & symbols relating to soil engineering.

FOUNDATION CONSTRUCTION:

1.	IS : 1080 – 1986	:	Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (Second Revision).
2.	IS : 1904 – 1986	:	Code of practice for design and construction of foundation in soils : General requirements.
3.	IS : 1080 – 1986	:	Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (Second Revision).
4.	IS 6403 – 1981	:	Code of practice for determination of bearing capacity of shallow foundations.
5.	IS 8009 – 1976 (Part – 1)	:	Code of practice for calculations of settlements of foundations : shallow foundations subject to symmetrical static vertical loads.

NOTATIONS USED

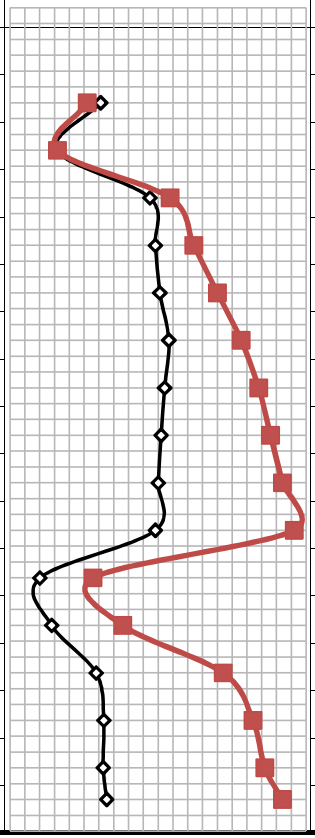
N	=	Observed SPT value
C_N	=	Correction factor
N_N	=	Corrected SPT values
γ	=	Bulk unit weight
γ'	=	Submerged unit weight
γ_d	=	Dry unit weight
γ_{sat}	=	Saturated unit weight
G	=	Specific gravity of soil
W_L	=	Liquid limit
W_P	=	Plastic limit
I_P	=	Plasticity index
Q_u	=	Unconfined compressive strength
C_u	=	Undrained shear strength
C	=	Effective cohesional parameter
Ø	=	Effective angle of shearing resistance
$Ø_m$	=	Mobilized angle of shearing resistance
N Ø	=	Flow value Tan^2 (45 + Ø / 2)
GSF	=	General shear failure
LSF	=	Local shear failure
C_c	=	Compression index
B	=	Width of foundation
L	=	Length of foundation

D	=	Depth of foundation
q	=	Effective surcharge
N_γ, N_q, &N_c	=	Bearing capacity factors
S_γ, S_q, & S_c	=	Shape factors
d_γ, d_q, & d_c	=	Depth factors
S.S.W.L.	=	Sub soil water level
W'	=	W.T. correction factor
H	=	Thickness of clayey layer
σ'_o	=	Original effective overburden pressure
$\Delta\sigma$	=	Vertical stress increment
e_o	=	Original void ratio
w	=	Water content
H_t	=	Thickness of sandy layer
B_t	=	Top width of sandy layer
$\Delta\sigma_t$	=	Stress increment at the top of a sandy layer
D_f	=	Depth factor
L_{yf}	=	Lateral yield factor
R_f	=	Rigidity factor
q_{nf}	=	Net ultimate bearing capacity
q_{ns}	=	Net safe bearing capacity against shear failure
q_n	=	Net foundation loading intensity for a given settlement
q_a	=	Allowable bearing capacity

S_o	=	Settlement due to a net unit foundation loading intensity
S_{ob}	=	Settlement due to a net unit foundation loading intensity under submerged conditions (1Kg / cm^2)
WT	=	Water table
S_t	=	Total settlement
S_a	=	Maximum allowable settlement
GW	=	Well graded gravels
GP	=	Poorly graded gravels
GM	=	Silty gravels
GC	=	Clayey gravels
SW	=	Well graded sands
SP	=	Poorly graded sands
SM	=	Silty sands
SC	=	Clayey sands
ML	=	Silt of low compressibility
CL	=	Clay of low plasticity
MI	=	Silt of medium compressibility
CI	=	Clay of medium plasticity
MH	=	Silt of high compressibility
CH	=	Clay of high plasticity
M (NP)	=	Non plastic silt
ML-CL	=	Mixture of ML and CL

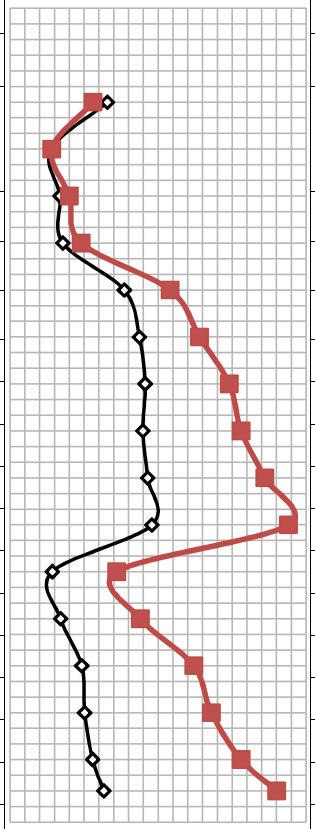
PROJECT :- Geotechnical investigation for proposed Advanced Neuroscience Centre at Post Graduate Institute of Medical Education and Research, Chandigarh | **Page no. 19**

Client :- HSCC (India) Limited | **Water table depth** | Not Encountered

Sample			SUB SOIL PROFILE				Atterbergs Limit						Density					
BHL NO	DEPTH FROM N.S.L. (m)	TYPE OF SAMPLE	DESCRIPTION OF STRATA	OBSERVED VALUE	CORRECTED VALUE	Depth v/s SPT N-value Graph	Gravel (%)	Sand (%)	Silt & clay(%)	% LIQUID LIMIT	% PLASTIC LIMIT	% PLASTIC INDEX	BULK DENSITY (gms/cc)	DRY DENSITY (g/cc)	% MOISTURE CONTENT	Cohesion, C	Angle of Shearing Resistance, Φ	Sp. GRAVITY
1	0.75	DS	Loose Filled up Land	-	-		0.0	46.6	53.4	NP	NP	NP			4.5	-	-	-
	1.50	DS		-	-		0.0	42.9	57.1	NP	NP	NP			4.1	-	-	-
	3.00	DS	Medium Dense Silty Sand with	18.0	20.3		51.1	45.6	3.3	NP	NP	NP	2.35	2.24	4.7	-	25.4	2.55
	4.50	UDS	Medium Consistency Silty Clay of	13.0	12.9		0.0	2.6	97.4	33.8	19.3	14.5			4.7	6.2	-	-
	6.00	UDS		32.0	28.6		0.0	5.6	94.4	31.8	27.0	4.8	2.22	2.12	4.9	-	-	2.46
	7.50	DS	Dense Silty Sand with Gravels	36.0	29.5		37.0	61.4	1.6	NP	NP	NP			5.1	-	-	-
	9.00	DS		40.0	30.3		22.4	75.4	2.2	NP	NP	NP	2.32	2.20	5.4	-	-	2.53
	10.50	DS		44.0	31.8		18.2	79.3	2.6	NP	NP	NP			5.4	-	-	-
	12.00	DS		47.0	31.1		12.1	84.2	3.7	NP	NP	NP	2.30	2.18	5.7	-	-	2.52
	13.50	DS		49.0	30.5		25.2	72.4	2.4	NP	NP	NP			5.9	-	-	-
	15.00	DS		51.0	30.0		45.2	52.3	2.6	NP	NP	NP	2.32	2.19	6.1	-	-	2.51
	16.50	DS		53.0	29.5		64.8	33.7	1.5	NP	NP	NP			6.4	-	-	-
	18.00	UDS	Stiff Silty Clay of Medium Plasticity	19.0	10.0		0.0	15.2	84.8	29.1	17.0	12.2	2.25	2.11	6.4	-	-	2.44
	19.50	UDS		24.0	12.0		0.0	13.6	86.4	-	-	-			6.6	-	-	-
	21.00	DS	Medium Dense Silty Sand	41.0	19.5		0.0	69.3	30.7	NP	NP	NP	2.07	1.94	6.7	-	-	2.49
	22.50	DS		46.0	20.8		0.0	70.3	29.7	NP	NP	NP			6.9	-	-	-
	24.00	DS		48.0	20.7		0.0	73.5	26.5	NP	NP	NP	2.02	1.89	6.7	-	-	2.51
	25.00	DS		51.0	21.3		0.0	84.7	15.3	NP	NP	NP			7.0	-	-	-

PROJECT :- Geotechnical investigation for proposed Advanced Neuroscience Centre at Post Graduate Institute of Medical Education and Research, Chandigarh | **Page no. 20**

Client :- HSCC (India) Limited | **Water table depth** | Not Encountered

Sample			SUB SOIL PROFILE				Atterbergs Limit						Density					
BHL NO	DEPTH FROM N.S.L. (m)	TYPE OF SAMPLE	DESCRIPTION OF STRATA	OBSERVED VALUE	CORRECTED VALUE	Depth v/s SPT N-value Graph	Gravel (%)	Sand (%)	Silt & clay(%)	% LIQUID LIMIT	% PLASTIC LIMIT	% PLASTIC INDEX	BULK DENSITY (gms/cc)	DRY DENSITY (g/cc)	% MOISTURE CONTENT	Cohesion, C	Angle of Shearing Resistance, Φ	Sp. GRAVITY
2	**0.75**	DS	Loose Filled up Land	-	-		0.0	27.0	73.0		-	-	-	-	3.4	-	-	-
	1.50	DS		-	-		0.0	23.9	76.1		-	-	-	-	3.9	-	-	-
	3.00	DS	Medium Dense Silty Sand with Gravels	19.0	21.4		63.9	35.1	1.0	NP	NP	NP	2.34	2.25	4.1	-	-	2.59
	4.50	UDS	Medium Consistency Silty Clay of Medium Plasticity	12.0	11.9		0.0	7.2	92.8	31.9	18.7	13.2	2.24	2.15	4.4	-	-	-
	6.00	UDS		15.0	13.4		0.0	10.2	89.8	-	-	-			4.8	-	-	2.44
	7.50	UDS		17.0	13.9		0.0	8.1	91.9	30.4	18.2	12.2	2.22	2.11	5.0	-	-	-
	9.00	DS	Dense Silty Sand with Gravels	32.0	24.3		27.9	65.7	6.4	NP	NP	NP			5.1	-	-	2.56
	10.50	DS		37.0	26.8		20.8	75.1	4.1	NP	NP	NP	2.32	2.20	5.4	-	-	-
	12.00	DS		42.0	27.8		22.1	74.7	3.2	NP	NP	NP			5.7	-	-	2.56
	13.50	DS		44.0	27.4		20.5	75.2	4.3	NP	NP	NP	2.30	2.18	5.7	-	-	-
	15.00	DS		48.0	28.2		14.2	81.9	3.9	NP	NP	NP			5.9	-	-	2.54
	16.50	DS		52.0	28.9		8.7	82.0	9.2	NP	NP	NP	2.24	2.11	6.1	-	-	-
	18.00	UDS	Stiff Silty Clay of Medium Plasticity	23.0	12.1		0.0	15.1	84.9	29.1	17.1	12.0	2.23	2.10	6.2	-	-	2.43
	19.50	UDS		27.0	13.5		0.0	17.1	82.9	-	-	-			6.4	-	-	-
	21.00	DS	Medium Dense Silty Sand with Gravels	36.0	17.1		15.2	80.7	4.1	NP	NP	NP	2.27	2.13	6.6	-	-	2.54
	22.50	DS		39.0	17.6		19.2	75.9	4.9	NP	NP	NP			6.7	-	-	-
	24.00	DS		44.0	18.9		27.4	66.5	6.1	NP	NP	NP	2.29	2.15	6.7	-	-	2.56
	25.00	DS		50.0	20.8		32.1	65.4	2.5	NP	NP	NP			7.2	-	-	-

LOCATION PLAN