TECHNICAL SPECIFICATION
1. Introduction

1.1 Information about the site:
Establishment of RGCB Bio Innovation Center at Akkulam in Thiruvananthapuram District, Kerala State Phase. I – Construction of Research Block with Animal Research Facility, Hostel Buildings, Civil & Related MEP works including site development and connected Infrastructure (Composite Contract)- Piling works. All tenders are advised to visit the site and collect necessary information from site with prior approval from EPIL prior to submission of the tender.

1.2 SCOPE OF WORK
The scope of work as per the present scope of contract is as follows:

a. Pile, pile caps, grade beams, tie beams and all concrete works upto plinth level including column base at plinth level.

b. Brick works upto plinth level.

c. Anti-termite treatment, plinth filling, floor PCC at plinth level.

GENERAL TECHNICAL SPECIFICATION:

2.0 GENERAL SPECIFICATION

2.1 The work in general shall be carried out as per CPWD specifications, 1996 (volume I to VI) (updated with correction slips issued up to last date of submission of tender) and text of revised CPWD specifications for cement mortar, cement concrete and RCC works, 2002 unless otherwise specified in the nomenclature of the individual item or in the particular specifications for civil works and CPWD specifications, 1994 for Electrical works (Internal) and 1995 for Electrical works (External) (updated with correction slips issued up to last date of submission of tender).

2.2 For the items not covered under the specifications as stated above, the work shall be done as per relevant IS Codes.

2.3 For the items not covered under any of the specifications stated above, the work shall be executed as per Manufacturer’s specifications/ General Engineering Practice and / or as per direction of Engineer in Charge.

2.4 ADDITIONAL PARTICULAR SPECIFICATION
In the absence of any definite provisions or any particular issue in the aforesaid specification, reference to be made to the latest codes and specifications of BIS, IRC, BS, ASTM, AASHTO and CAN/CAS in that order. Where even these are silent, the construction and completion of
works shall conform to sound Engineering practice as approved by Engineer in Charge. In case of any dispute arises out of the interpretation of the above, the decision of the Engineer in charge shall be final and binding on the contractor.

Where ever reference is made in the contract to specific standard codes to be met by the materials, plants and other supplies to be furnished and work performed and tested, the latest edition or revision of the relevant codes in effect shall apply, unless otherwise explicitly stated in the contract. Where such standards and codes are national, or related to a particular country of region, other internationally recognized standards which ensure a substantially equal or higher performance than the standards and codes specified will be accepted subject to the Engineer in charge prior review and written approval. Differences between standards must be fully described in writing by the contractor and submitted to the Engineer in Charge at least 15 days prior to the date when contractor desires the Engineer in Charge's approval. If the Engineer in Charge determines that such proposed deviation do not ensure substantially equal performance, the contractor shall comply with the standards specified in the documents.

2.5 Bored Cast – in – situ piles

Bored Cast – in – situ RCC piles of diameter and length as specified in the schedule of quantities are proposed to be installed. The cut off level for piles may be considered at a level of approximately 1.5m-2.0m below average ground level of the site for the purpose of the tendering. The contractor shall however have to execute the work as per the final "good for construction" drawings.

length of pile for payment shall be measured up to bottom of pile cap only and nothing extra shall be paid for empty boring of the concrete above the C.O.L. and whatever extra is required technically and as per I.S. 2911 (Part I/see 2) shall be included in the rates quoted for relevant items of piling work.

Before tendering the contractor shall inspect the site of work and thoroughly acquaint himself with the site condition. He shall also study the soil test report to understand characteristics of various soil strata.

Any filling dressing up or excavation required for easy movement of the piling rigs and all precautions necessary for the safety of the works, tools and adjoining structures shall have to be undertaken by the contractor at his own cost. All cost incurred for shifting of rigs, machinery etc. from one location to another shall have to be born by the contractor within the rates quoted by him.

The contractor shall be responsible for the accurate setting out of the works.
All piles shall be bored Cast – in – situ type and installed by the using DMC techniques. High quality sodium based Bentonite as per IS specification shall be used. Concreting by Tremie Technique, using minimum 150mm I.D. Tremie pipes to construct a sound continuous RCC shaft for each pile shall have to ensure.

Crawler mounted telescopic boom hydraulic pilling Rig using for piling operation along with bentonite solution of suitable consistency for stabilizing the hole.

The Bentonite used shall be of high quality sodium based montmorillonite as per specification

a) The liquid limit of Bentonite when tested in accordance with IS 2720 (part IV) 1965, shall be more than 350%.

b) The sand contend of the Bentonite power shall not be greater than 7%

c) The Bentonite slurry should be made by mixing it with fresh water using pump for circulation. The density of the fresh Bentonite solution after 24 hours maturing should be about 1.12 gm/cc.

d) The Marsh Viscosity of fresh slurry when tested by a standard marsh cone should be about 37 seconds.

e) The swelling index as measured by the swelled volume after 12 hrs. in abandon quantity of water shall be at least 2 times its dry volume.

f) The pH value of the Bentonite suspension shall be less than 11.5 but not less 8.5

Fresh Bentonite powder brought at site shall be tested for properties enumerated in IS2911Part I/sec 2 and any stock not meeting this standard shall be taken away, replaced by acceptable stock all as per the direction of EPI/RGCB/Architect. The contaminated slurry shall be suitably processed by appropriate means (Sp. Gr. of the slurry not to exceed 1.12 before re – circulation into the pile bore during progress of boring.

The Bentonite processing unit with settling tanks of required capacities shall be made adequately planned and constructed based on good engineering practice before starting the job. The consistency of the Bentonite slurry used shall be such as to ensure the stability of hole during boring and till completion of concreting. The Bentonite powder and the slurry made shall be tested at regular intervals and records maintained in the field registered.

The pile bore shall be then be flushed and cleaned through the tremie set using fresh bentonite slurry for a period of not less than 10 minutes or till the slurry from the hole has a specific gravity less than 1.20 and/or Marsh cone value less than 45.

After lowering the reinforcement cage a tremie set (I.D not less than 150mm dia) shall be lower so as to reach the bottom of the bore – hole.
Concreting shall be commenced immediately on completion of flushing. The tremie hopper shall have a minimum capacity of 0.75m³ and it shall be filled up fully using a stopper. The batch of concrete shall discharged in one go to ensure a minimum 1.5m embedment of the tip (bottom) of tremie within the concrete. This minimum embedment shall be maintained till end of the concreting operation by correct monitoring of tremie pipe cutting in stages. This complete concreting operation shall be preferably completed within 5/6 hours.

Concreting of grade M30 designed mix as per relevant IS codes/CPWD and with cement consumption not less than as stipulates in IS codes/CPWD and having a slump consistent with method of concreting but not less than 150mm shall have to be used. If higher quantity of Cement than minimum is necessary to achieve the desired strength and workability, the same shall have to be used without any extra claim.

The removal of Bentonite muck and bored soil from the site shall be responsibility of the contractor at his own cost to the location as specified by the EPI/RGCB/Architect.

All work shall be as per IS 2911 part /Section 2-1987.

On completion of piling in specific areas the top weak concrete of the pile shaft shall be broken down to the specified cut-off level to expose sound concrete shaft. The pile reinforcement shall project above cut off-level.

All plant, machinery, tools and tackles, collar casing labours etc. required for the completion of the work as per the technical specification and good Engineering practice, within the schedule time of completion, shall have to be provided by the contractor at his own cost.

Pile should be installed as accurately as possible as per the drawings. For vertical piles a deviation of more than 1.5% shall not be permitted. Also a pile should not deviate more than 75mm or D/10, which ever is less for the pile having diameter more than 600mm. In case of piles deviating beyond this limits any additional piles that have to be taken to makeup the deficiencies to be provided by the contractor at his own cost.

**TEST OF PILE**
Routine vertical and lateral load test has to be carried out in single pile to ascertain the capacities of piles and their behaviors. Test shall be carried out as per the requirement of IS 2911, part IV and test result shall be submitted with all details and graphs. Pile for testing be selected by the EPI/RGCB/Architect. The scheme of pile test shall be submitted by the contractor for approved of the EPI/RGCB/Architect prior to making arrangement for tests on selected piles. This approval shall however, shall not relieve the contractor from the responsibility of conducting the test safely and in a technically sound manner.

Initial vertical load test shall be carried out in single pile to ascertain the capacities of piles and their behaviors. Test shall be carried out as per the requirements of IS 2911 (Part IV) and the test results shall be submitted with all details and graphs. The scheme of pile test shall be submitted by the contractor for approval of the EPI/RGCB/Architect prior to making arrangement for tests on selected piles. This approval however shall not relieve the contractor from the responsibility of the test safety and in a technically sound manner.

Specification for Bored Cast – in – situ Concrete Piles

Codes and standards:
IS 2911 (Part I/ Section 2 ) 1979: Bored Cast – in – situ Concrete Piles.
IS 2911 (Part IV) 1985: Load test on piles.

Materials:
Cement : Cement shall conform to IS 8112 or IS 12269 (Grade 43 or 53) or IS 1489 (part 1) ( PPC)
Steel : Thermo-Mechanically Treated bars of Fe 500D Steel shall conform to IS 1786
Bentonite : Bentonite shall conform to Appendix ‘A’ of IS 2911 (Part I/Section 2) 1979
Concrete: Concrete of grade M30 as stipulated in I.S. 456 and I.S. 2911 (Part I/sec. 2) 1979 latest revision, with minimum cement content of concrete and degree of workability will be in very high category, measurement of workability by determination of flow ( IS: 9103) may be used, slump greater than 180mm should not be used for piling. Design of Concrete mix to be done and to be got approved by EPI/RGCB/ARCHITECT.
Specified characteristic compressive strength of 150mm cube at 28 days will be 30 N/sq mm.
Concrete is to be tested as per I.S. code 516-1959 (latest Revision).
Contractor should ensure uniform grade and quality of Concrete for the entire project.

**Workmanship**

**Control of pile Installation:**
The pile shall bored Cast – in – situ RCC Piles capable of being test for bearing capacity after 28 days of casting. Bored Cast – in – situ Piles shall be adopted by suitable choice of installation techniques e.g. using casing and/or drilling mud, manner of concreting i.e. by direct pouring and placing by buckets or by using tremie method and choice of boring tools in order to achieve a satisfactory installation of piles in the site.

**Construction of Piles:**

**Boring:**
Boring may be done by graving the earth or by reverse or direct mud circulation technique. In general the hole shall be kept cased with a lead in tube to prevent ingress of soil. In soils, which are liable to flow, the bottom of casing shall be kept low enough in advance of the boring tools to prevent the entry of the soil into the casing, thus preventing the formation of cavities and settlements in adjoining grounds.
Alternatively, the inflow of ground water and soil shall be controlled by the use of a head of drilling mud e.g. Bentonite suspension.
Wash sample/bailer sample of soil shall be collected for inspection during progress of boring mud soil samples of the founding strata shall be carefully collected and stored for inspection.
The depth of boring shall be determined by sounding and in case of uncased bore diameter of the bore at different depth shall be determined by pantograph or other suitable means as directed by EPI/RGCB/Architect. After completion of boring the holes shall be cleaned by airlift method of flushing with fresh drilling fluid.

**Lowering of reinforcement Cage:**
On satisfactory completion of boring the Reinforcement cage shall be lowered inside the bore holes with sufficient number of cement conc. cover block attached with the lateral links.
The Reinforcement cage should go down into the bore hole and in no case, the cage shall be hammered for lowering. During concreting the Reinforcement cage shall be kept hung by suitable arrangement from the top of the bore hole and not allowed to stand on its own weight on the bottom of the bore holes.
Concreting:

In case a hole is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the holes shall, whenever directed, be determined by suitable slurry samples in a first few piles and at suitable intervals of piles and recorded. Consistency of the drilling mud suspension shall be controlled throughout the boring and Concreting operation in order to keep the holes stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud. The Concreting operation shall not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by Tremie method in such cases. The slurry shall be maintained at 1.5m above the ground water level.

The Concreting of piles shall commence immediately after the completion of boring. Should a bore hole, which is not cased, be left unconcreted for more than two hours, it shall be cleaned thoroughly before placing concrete to the satisfaction of EPI/RGCB/Architect.

The bottom of the bore holes shall be cleaned of all accumulated sand, muck and loose materials by controlled air lift flushing with fresh drilling fluid. The tremie pipe shall extend to the bottom of the bore hole at the start and shall be jointed in sections and fitted with the hopper for receiving the concrete pore at the top of the bore hole. The first charge of concrete shall be pored in the hopper, the bottom opening of which temporarily remains closed by a steel plate placed on top of the opening. The hopper shall have adequate capacity to receive concrete sufficient enough to displace the drilling mud within the tremie pipe and from the bottom of the bore hole. After the hopper is filled up the steel plate shall be quickly removed to allow the concrete to rush into the bore hole and fill it up from the bottom by displacing the drilling fluid from the tremie pipe and the bottom of the bore hole. As concreting progresses the tremie pipe shall be removed in sections ensuring every time that the bottom of the tremie pipe remains embedded in side the concrete for at least 1m. The placing of concrete shall be done in one continuous operation and the tremie pipe shall be held concentric with the bore. The level of concrete shall be checked at frequent intervals to maintain a sufficient head of concrete above the discharge end of tremie pipe. It shall be ensured that sufficient number of mixes are pored to expel the first mix of concrete contaminated with Bentonite such that good concrete is obtained up to 15cm above the cut off level. At all stages of Concreting, care shall be taken to prevent voids and segregation of concrete.

The top of concrete in a pile shall be brought above the cut-off level to permit removal of laitance and weak concrete before capping and to ensure Concrete at the cut-off.
level for the proper embedment into the pile cap. When Concrete is placed by tremie method, Concrete shall be cast to the piling platform level to permit overflow of Concrete for visual inspection or to a minimum of 1 mt. above the cut-off level. In the circumstances the cut-off level is below the ground water level the need to maintain a pressure on the unset Concrete equal to or greater than water pressure than should be observed and accordingly the length of extra Concrete above the cut-off level shall be determined.

Withdrawal of Casting:
Extraction of casing shall be done in such a manner that no necking or shearing of the Concrete in the shaft takes place.

Sequence of Piling:
Sequence of piling shall be such that there is no damage caused to the concrete recently laid in the adjacent pile. Construction of piles shall be done in accordance with the priority of construction of various building. Sequence of piling shall be decided by the EPI/RGCB/Architect.

Finishing of Pile Heads:
The top level of concrete in the pile shall be brought up sufficient above the required level or cut-off level to allow for slumping or withdrawal of casing tube, and also to have a minimum allowance above cut-off-level for removal of all laitance and weak concrete at the cut-off-level. Any defective concrete at the head of the completed pile shall be cut out and made good with new concrete bonded to the old concrete. Manual chipping of the pile heads may be permitted after three days of pile casting. Pneumatic tools for chippings shall not be used before 7 days after pile casting.

Consumption of Concrete in Piling:
After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially casted. If the actual quantity is found to be considerably less, special investigation shall be conducted and appropriate measures to be taken.

Replacement of Defective Bored Piles:
Defective piles shall be removed or left in place without affecting the performance of adjacent piles or capping above an additional pile / more than one piles (as required in considering structural aspect) shall be provided to replace them, as directed by EPI/RGCB/Architect, the cost of replacement and / or provision of additional piles, and
additional cost of providing larger size of pile caps and grade / plinth beams as directed shall be borne by the contractor at no extra cost to the employer.

In case of defective boring, the defective bore hole shall be filled up with sand consolidation / concrete (filling material to be decided by the Engineer in charge which will be binding to the contractor) and the position of boring for that pile to be shifted as per direction, if required fro structural aspect position of more than one pile may be shifted due to that defective boring, and additional cost of providing larger size of pile caps and grade / plinth beams as directed shall be borne by the contractor at no extra cost to the employer.

Deviation for designed location/alignment /load capacity of piles:
Any deviation from the designed location, alignment or load capacity of any pile shall be noted and adequate measures taken by the contractor well before the concreting of the pile cap and grade / plinth beam, if the deviation are beyond the permissible limit.

**Basic properties of Drilling mud (Bentonite):**

**Properties:**
Drilling mud shall be used to keep the sides of borehole stabilized. The drilling mud shall have Thixotrophic properties, i.e. gel forming properties. The drilling mud shall have such properties as to permit formation of filter cake on the inside surface of the bore holes, the thickness of which will depend on the nature of sub-soil deposits. Sodium based Bentonite have ideal properties suitable for use as drilling mud.

**Specification:**
The Bentonite suspension use for piling work shall satisfy the following requirements:

a) The liquid limit of Bentonite when tested in accordance with IS: 2720 (Part- V) shall be more than 300% and less than 450%.

b) The sand contained of the Bentonite powder shall not be greater than 7%.

c) Bentonite solution shall made by mixing it with fresh water using pump for re-circulation. The density of the Bentonite solution shall be about 1.12 maximum.

d) The marsh cone viscosity value when tested by a marsh cone shall be about 37 sec.

e) The swelling index as measured by the swelled volume after 12 hrs. in abundant quantity of water shall be at least 2 times its dry volume.

f) The pH value of the Bentonite suspension shall be less than 11.5 but not less than 8.5.

**Loss of Bentonite :**
In the event of a sudden loss Bentonite suspension during boring, the bore hole shall be backfill without delay and instructions of the EPI/RGCB/Architect shall be obtained.

**Removal of Bored Muck:**

All reasonable steps shall be taken to prevent spillage of Bentonite suspension on the site away from the immediate vicinity of the pile. Discarded Bentonite suspension which has been pumped from the boring shall be removed from the site by the contractor at no extra cost to the employer.

**Testing of Concrete:**

Concrete shall be tested to ascertain its cube strength at 7 days and 28 days. The number of piles for which tests cubes are to be taken would be as follows:

<table>
<thead>
<tr>
<th>Pile group</th>
<th>Number of piles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 4</td>
<td>1</td>
</tr>
<tr>
<td>5 to 8</td>
<td>2</td>
</tr>
<tr>
<td>Above 8</td>
<td>Every fourth pile</td>
</tr>
</tbody>
</table>

Six cubes shall be taken in accordance with IS: 1199 for testing a set of 3 cubes after 7 days and the second set of three cubes after 28 days. The method of testing Concrete cubes shall be in accordance with IS: 516 and the strength requirements of Concrete shall be as specified in IS: 456.

**Procedure for routine load tests on piles:**

Loading shall be carried out up to one and a half (1.5) times the safe load or up to the load at which the total settlement attains a value of 12mm for single piles, which ever is earlier.

The pile head shall be chipped of carefully till sound concrete is met. The projecting reinforcement shall be cut off and the top surface finished smooth and leveled with plaster of paris when required. AMS bearing plate shall be placed on the head of the pile for the jack to rest.

The test shall be carried out by applying a series of downward incremental loads on the test pile. The loading shall be done by reaction from the kentledge of adequate capacity for the full test load. Test pit shall be excavated by open excavation through all types of soils to required depth. The base of the pit shall be minimum 3m X 3m size with adequate side slope and provision for shoring and dewatering etc. The excavated materials shall be
dumped sufficiently away from the edge of the excavation so as not to endanger the
stability of pit. After completion of the test, the pit shall be back filled as directed by
EPI/RGCB/Architect.

The hydraulic jack for transferring the load to the pile shall be capacity 25% in excess of
the final test load proposed to be applied and shall be provided with calibrated pressure
gauge. The contractor shall furnish to the EPI/RGCB/Architect necessary tests certifies
for each dial gauge from approved authority before putting into operation.

Before any load test is performed, the contractor shall obtain the approval of the set up
and the load frame from the EPI/RGCB/Architect. Care shall be taken to ensure that the
centre of gravity of Kentileedge is on the axis of pile and load applied by the jack is co –
axial with the pile.

The M.S plate of 5mm thick shall be set on the pile head such that its surface is perfectly
horizontal jack shall be inserted between the M.S. plate and the kentledge frame. The
dial gauge shall at equal distance around pile and shall be fixed to two numbers of
datum bars whose ends shall rest on immovable supports. The supports for the datum
bars with reference to which the settlement of the pile will be measured shall be at least
5D away clear from the piles, where D is the dia of pile subject to a minimum of 1.5m.

The test loads shall be applied in increments of about 20% of the assumed safe loads.
Each stage of loading shall be maintained till the rate of displacement of the pile top is
either 0.1mm in first 30 mins or 0.2mm in first one hour or till 2 h whichever occur first.
The test load shall be maintained for 24 hrs.

For each increment, application of load shall be smooth as far as possible. Time and
settlement observations shall be made at the commencement and completion of each
increment. Settlement observations shall be continued when each increment load is kept
constant at about 15 mins intervals. The load on the pile may be removed in one stage
by releasing the jack steadily after completion of the test and rebound observations
made for 2 hrs.

The safe load on single pile may be removed in one stage by releasing the jack steadily
after completion of the test and rebound observations made for 2 hrs.

The safe load on single pile shall be calculated as below.

a) Two thirds of the final load at which the total settlement attains a value of 12mm.
Unless it is specified that a total settlement different from 12mm is permissible in a given
case on the basis of nature and type of structure. In the later case, the safe load shall be
corresponding to actual total settlement permissible.

b) 50 percent of the final load at which the total displacement equal 10 percent of pile
diameter in case of uniform diameter pile.
Recording of data
Complete records of boring and Concreting process for each file shall be maintained by
the contractor and submitted daily in triplicate to the Engineer or his representative at
site for their record, one copy of which shall be counter signed by the
EPI/RGCB/Architect of his representative and return to the contractor. The following
recordings shall be maintained for each pile:
a) Details of piles
   i) Pile number and location
   ii) Existing ground level, cut-off-level and level of top of the casting
   iii) Nominal shaft and inside diameter of casing
   iv) Data and time of setting up of rig at the pile location.
   v) Data and time of start of boring.
   vi) Length of casing driven and depths bored vs time.
   vii) Description and thickness of various strata bored.
   viii) Details of any obstructions encountered (depth from existing ground level, thickness
        and time taken to penetrate through the same)
   ix) Chiseling depth and time.
   x) Final depth of boring (founding level).
   xi) Standard penetration test at the bottom of the bore hole, if any.
   xii) Date and time of completion of boring.
   xiii) Data and time of start and completion of flashing of the bore hole with fresh
       Bentonite fluid before Concreting.
   xvi) Time of lowering Reinforcement cage and tremie pipes with total length thereof.
   xv) Date and time of start of concreting
   xvi) Nos. of mixes poured. Level of concrete inside the bore hole and tremie pipes at
       various stages of concreting.
   xvii) Concrete grade, mix proportion, water cement ratio and slump test results.
   xviii) Empty boring length and concrete length below cut-off-level.
   xix) Results of tests on Bentonite slurry used.

b) Details of Instruments used
   I) Make and specification of jack, pressure gauge and dial gauge.
   II) Capacity of jack.
   III) Calibration of pressure and dial gauge.
   IV) Design load of piles, description of location and identification marks for testing.

c) Test recordings:
The readings for settlement and rebound shall be entered in the form given on the next page.

d) Failure of Test:
If the test fails to show the specified capacity, the cost of replacing the defective pile by a new pile / more than one pile (as required considering design aspect) and consequent additional cost of pile cap, plinth beam etc. as directed shall be entirely to the contractors account.
No payment for pile testing shall be made to the contractor for pile /piles which have failed in the test.

VERTICAL AND LATERAL LOAD TEST OF PILE:
Testing of pile will be strictly as per IS 2911 part (IV).

LIST OF DRAWINGS:

1. RGCB/ST/01
2. RGCB/MP/AD/01