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7. PILE WORKS

7.1 GENERAL

The work shall consist of performing all operations in connection with furnishing, driving, cutting off and load testing of RCC Cast-In-Situ and Precast Concrete piles to obtain the specified bearing value, complete in place and strictly in accordance with these Specifications and as shown on the Drawings.

The kind and type of piles shall be as shown on the Drawings and/or as specified and shall not be changed, except with the approval of the Designer.

7.2 RCC CAST-IN-SITU PILES

7.2.1 SCOPE OF WORK

All works to be performed under these Specifications shall be carried out at the proposed locations shown on the Drawings and shall include but not be limited to the following:

a) Construction of bored & cast in-situ RC test piles for pile load tests (Test Pile).
b) Performance of load tests on piles.
c) Construction of bored & cast in-situ RC piles for various structures under contract (working piles).
d) Performance of proof load tests on the working piles selected by the Engineer-in-Charge.
e) Keeping complete record of all the operations performed during boring, construction and load testing of the piles stated above.

7.2.2 GENERAL REQUIREMENTS

The general requirements for RC piles shall be as follows:

a) Type, Diameter and Length of Piles:
   i) Bored cast & in-situ reinforced concrete (RC) piles using Ordinary Portland Cement (OPC) or Sulphate Resisting Cement (SRC) as specified shall be constructed as shown on the Drawings.
   ii) Piles diameter, type and length shall be as shown on the Drawings.
   iii) Unless the approval of designer, the contractor cannot change the position, the number, diameter and length of pile.
b) Tolerances in Location and Plumbness

   Following construction tolerances shall be maintained:
   i) The drilled shaft shall be within 3 inches of the plan position in the horizontal plane at the plan elevation for the top of the shaft.
   ii) The vertical alignment of the shaft excavation shall not vary from the plan alignment by more than ¼ inch per foot of depth.
   iii) After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.
   iv) When casing is used, its outside diameter shall not be less than the shaft diameter shown on the plans. When casing is not used, the minimum diameter of the drilled shaft shall be the diameter shown on the plans for diameters 24 inches or less, and not more than 1 inch less than the diameter shown on the plans for diameters greater than 24 inches.
   v) The bearing area of bells shall be excavated to the plan bearing area as a minimum. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the equipment used.

vi) The top elevation of the shaft shall be within 1 inch of the plan top of shaft elevation.

vii) The bottom of the shaft excavation shall be normal to the axis of the shaft within ¾ inch per foot of shaft diameter.

c) Cutting of Pile Heads:

Pile heads shall be cut to the levels shown on the Drawings and the cut shall be level, smooth, and horizontal. Due care shall be taken to protect the edges and reinforcement. No extra payment shall be made for this work. Pile cut off levels shall be shown on the shop drawings to be submitted by the Contractor for approval of the Engineer-in-Charge.

d) Order of work:

The order in which construction and load testing of piles shall be carried out will be decided by the Engineer-in-Charge, who will have the discretion to alter the same during the course of the work.

e) Plant:

The Contractor shall keep on the site sufficient plant to meet all requirements of the work. The plant shall be in satisfactory operating condition and capable of efficiently performing the work as per these Specifications.

f) Supervisory Staff:

The Contractor shall have at site at all times, only qualified, experienced and thoroughly competent persons, who shall conduct and supervise drilling, pile construction and load testing operations. Since the construction of piles requires special knowledge and utmost care, the Contractor shall have at least one qualified and experienced Engineer-In-charge specialized in this field of work who shall be present full time during execution. The Contractor shall remove from the site any employee who does not in the opinion of the Engineer-in-Charge, meet these requirements.

g) Site Conditions:

The Contractor is responsible for any damage to the existing superstructures, sub-structures utility lines caused due to piling work. The contractor shall ensure that pile construction works shall not interfere with the work of the other Contractors working in the area.

Where approval has been given to the Contractor for carrying out concreting operations at night or in places sunshine hours are limited, the Contractor shall provide adequate lighting at all points where mixing, transporting, placing of concrete is in progress.

When concrete is to be manufactured, transported and placed in hot weather, specific precautions as required by the Engineer-in-Charge shall be observed in accordance with the provisions of sub-sections 5.3.2.5(f) and 5.3.4(c).

h) Quality Assurance:

Quality of concrete for piles shall comply with Section5 – Plain & Reinforced Concrete.

The materials, used in pile construction (cement, aggregates, steel reinforcement etc.) shall conform to the requirements of relevant Sections of technical provisions.

Standards and Codes of Practice:

The latest edition of International Standards and codes such as American, British or German etc., shall be used. All materials and workmanship shall, unless otherwise specified, comply with these standards and codes.

The Contractor shall make available at the site for the use of the Engineer-in-Charge, one copy of each of all relevant Standards & Codes used and quoted in the documents and Drawings at his own expense. No additional cost will be paid to the contractor for this.

7.2.3 SUBMITTALS

The Contractor shall be required to make following submittals:

1) Method Statement:
The Contractor shall submit to the Engineer-in-Charge before start of piling work a detailed description of the equipment, materials and procedures that will be used. The description shall include equipment specifications, loading capacities, protective devices, test apparatus, detailed installation procedures, test procedures and other documents ordered by the Engineer-in-Charge. Contractor's construction procedures shall be type-written and shall include charts and diagrams as applicable and necessary, to fully explain the subject procedures, methods and equipment operation in order to allow effective review by the Engineer-in-Charge. The method statement shall be submitted to the Engineer at least 2 weeks prior to commence the work.

2) Survey and Location:
The Contractor shall carry out a levelling survey and provide excavated ground elevations for each pile location. The elevations shall be given with respect to a permanent Bench Mark. The locations of piles shall be established by the Contractor as per shop drawings as approved by the Engineer-in-Charge. Establishing the pile locationsaccurately in the field shall be the sole responsibility of the Contractor.

3) Protective Measures:
The Contractor shall submit to the Engineer-in-Charge procedures for the following:
   a) Both hot and cold weather concreting procedures shall be submitted to the Engineer-in-Charge by the Contractor regardless of the need for the immediate implementation of such procedures. Procedures shall include insulation, enclosures and the like, finishing procedures and timing and duration of curing shall be described.
   b) Protection of concrete against damage due to mechanical contact and construction operations,
   c) Proposal regarding necessary facilities for drainage of the excavated areas, It shall be the Contractor's sole responsibility to keep the site free of ponding water during rain and duringboring and construction of piles.

4) Placement Schedule:
The Contractor shall submit a placement schedule for review prior to start of concrete placement operations. Daily concrete pour schedules shall be submitted 24 hours in advance of planned pours.

5) Testing Programme:
The Contractor shall submit test programme for all specified requirements along with the testing schedule.

6) Test Reports:
The Contractor shall submit test reports showing the results of required tests and compliance with specified standards and codes. Test reports shall be certified by the Contractor at the testing agency approved by the Engineer-in-Charge.

7) Samples:
The Contactor shall submit to the Engineer-in-Charge for acceptance prior to purchase, fabrication or delivery samples of materials or products where required by the Engineer-in-Charge.
Substitute products, materials or fixtures proposed by the Contractor shall be submitted as samples to the Engineer-in-Charge for his information about materials.

8) Shop Drawings:
The Contractor shall submit for Engineer-in-Charge a review and acceptance detailed shop drawings showing layout, arrangement, dimensions locations of piles, pile diameters and lengths, pile marks and details of construction showing reinforcement of the piles. The drawing shall also indicate the cut off level, tip elevation of each pile and all other necessary details required for completion of the construction work or required by the Engineer-in-Charge. Shop drawings shall be submitted to the Engineer-in-Charge for his acceptance and approval.

7.2.4 PRODUCTS

The products and materials shall meet the following requirements.

1. General:
All materials used in the Works shall be subjected to inspection and testing as and when directed by the Engineer-in-Charge.
Should the Engineer-in-Charge decide not to carry out tests on a material or materials himself or under his direction, the Contractor shall, whenever required, obtain from the Manufacturer and submit to the Engineer-in-Charge the certificates, showing that tests of materials having been carried out in accordance with the requirements of this Specification. Engineer-in-charge can verify the test reports in his own presence or his representative.
Before ordering any materials proposed to be used in the execution of the Works, the Contractor shall submit to the Engineer-in-Charge for his written approval the name(s) and address(es) of the firm(s) from which he proposes to order the material(s).
If the Engineer-in-Charge is in doubt about the quality of the delivered materials, the Contractor shall demonstrate through the relevant tests that the quality of the materials fully satisfies the requirements of this Specification.

2. Concrete:
Concrete for bored & cast-in-situ pilesincluding their caps, shall be in accordance with the requirements specified in the Section 5 - Plain Reinforced Concrete using Ordinary Portland Cement (OPC) or Sulphate Resisting Cement (SRC) as specified.In addition to meeting the strength requirements, the concrete for bored & cast in-place piles shall have adequate workability for the method of placing employed in the casting of piles and the consistency will meet the requirement as stipulated in the Section as above.
The concrete shall be supplied in sufficient quantity to ensure that the concreting of each cast in-place pile proceeds without interruption.The concrete shall be of class as specified in accordance with the Specifications and Drawings.
3. Concrete Aggregates:
Coarse and fine aggregates used for concrete under these Specifications shall be furnished by the contractor in accordance with the provisions of and in complete conformity with the requirements of the Specifications in Section 5 – Plain & Reinforced Concrete.
4. Reinforcing Steel:
Reinforcing steel shall conform to the requirements set forth in Sub-section 5.4 – “Concrete Reinforcement” of the Section 5 – Plain & Reinforced Concrete. All placing shall be in accordance with the Drawings furnished or as approved by the Engineer-in-Charge.
5. Drilling Fluid:
The drilling fluid used for all types of drilling shall be clean water, free from suspended sediments. The Contractor may be allowed to use bentonite slurry, barite slurry, loss circulation material as drilling fluid with the prior approval of the Engineer-in-Charge.
6. Casingof Holes:
Casing of holes shall be according to the provisions given below:
a) The hole shall be cased up-to its bottom.
b) The casing shall be made of cylindrical steel pipes of inside diameter equal to the pile

diameter and shall have sufficient strength so as to maintain position and shape during drilling operations. Casing used during concreting should be free from internal projections and encrusted concrete which might prevent the proper formation of piles. It shall also be free from distortion and shall be of uniform cross-section throughout.

c) The casing may be omitted only where it can be shown to the satisfaction of the Engineer-in-Charge that lowering of reinforcement cage and concreting operations will not cause caving of the bore hole.

d) It shall be the Contractor's responsibility to pull out the casing from the holes at the time of concreting of piles. No extra payment shall be made for pulling out the casing or for leaving the casing inside the hole.

7.2.5 EXECUTION

The procedures for execution shall be as follows:

1) Drilling:

Drilling shall be performed as described below:

a) General:

i) Before starting the piling work, the contractor shall complete clearing, levelling and setting out of the site. Any obstacles shall be removed, as directed by the Engineer-in-Charge. If the presence of existing underground utilities is known or suspected, the Contractor shall carry out such diversion or protection of these as directed by the Engineer-in-Charge.

ii) All excavations shall be carried out as nearly as possible to the exact dimensions of the pile foundations to minimize backfilling.

iii) All surplus excavated material from excavations not required for back filling shall, if considered unsuitable by the Engineer-in-Charge, be disposed of as directed.

iv) All installation procedures shall be subject to the Engineer-in-Charge's approval. No pile boring shall take place within 48 hours of the concreting of any pile which is within a radius of 10 feet (3.05 meters).

v) The sequence of work shall be proposed by the Contractor and as approved by the Engineer-in-Charge. The test piles shall be constructed and load-tested prior to the start of main piling. Additionally, proof load tests shall also be carried out on working piles during construction of piles. The piles for proof load tests shall be selected by the Engineer-in-Charge.

b) Method of Drilling:

The drilling of holes for piling shall be done by straight or reverse rotary rig or any other suitable method proposed by the Contractor, subject to approval of the Engineer-in-Charge. Regardless of the method used for drilling holes, the following specifications shall be adhered to by the Contractor.

i) After completion of drilling operations the bore holelength shall be checked and recorded.

ii) The deviation from the vertical shall not exceed 0.5 degree (1 in 114) on any section of the length for the holes.

iii) Drilling operations shall be carried out in such a way as to avoid any disturbance of the soil especially at the bottom of the hole. (i.e., sand boiling).

c) Stabilizing the Holes:

The Contractor shall ensure at all times that the hole does not collapse during and after boring. The Contractor may use bentonite slurry or any other drilling method with written approval of the Engineer-in-Charge. When bentonite slurry is used strict compliance with Sub-section-f herein below shall be ensured. The nominal diameter of pile is defined as the minimum cross-section of unlined portion of borehole. The possible enlargement of the pile shaft during boring, placement and compaction of the concrete, shall not be taken for measurement and for increase in the admissible load. It may also be noted that no extra payment shall be made for

using bentonite slurry or adopting alternative drilling method(s) for advancing the boreholes in satisfactory manner.

d) Removal of Mud:
The excavated material from boreholes shall be disposed of by the Contractor under instructions of the Engineer-in-Charge at no extra cost.

e) Clean out and Control at the Bottom of the Piles:
After the bore has reached its final penetration as stipulated on the Drawings and as may be additionally ordered by the Engineer-in-Charge, on the basis of data obtained in the field, and after it has been completely cleaned of all earth and otherwise made ready to receive the reinforcement and thereafter the concrete, the Contractor shall so inform the Engineer-in-Charge. All disturbed soil and loose materials shall be pumped out in such a manner that after cleanout operation, the bottom of borehole remains horizontal and in undisturbed condition. The clean out pumping arrangement shall be such that the lower end of the pump can be moved all over the cross-section by a routine operation. The suction of the pump shall be adjustable. At the end of clean-out operations, a break shall be made for a period of at least five minutes, then pumping shall be resumed and shall continue until the bottom of hole is cleaned. The Engineer-in-Charge shall check the actual bore penetration achieved, the cleanliness of the boreholes and the amounts and directions, if any, by which the borehole is out of position and/or out of plumb and having satisfied himself on these and on any other points which he may consider relevant, shall sign pour slip for the borehole authorizing the Contractor to proceed with the placing of reinforcement. The Contractor shall under no circumstances proceed with the placing of reinforcement in the boreholes or with the subsequent concreting without having first obtained the written authority signed separately for each and every borehole.

f) Bentonite Slurry:
Where the use of bentonite slurry is approved for the purpose of maintaining the stability of the walls and base of bore, the Contractor's proposals in accordance with clause (v) herein below shall include details of the slurry. These shall include inter-alia.

- The source of the bentonite
- The constitution of the slurry
- Specific gravity, viscosity, shear strength and pH value of slurry.
- The methods of mixing, storing, placing, removal and recirculating the slurry, and
- The provision of stand-by equipment.

i) Tests shall be carried out to ensure that the proposed constitution of the slurry is compatible with the ground water: Proposals for the constitution and physical properties of the slurry shall include average, minimum and maximum values. The specific gravity of the slurry shall not be less than one and one tenth (1:1/10) in any case at any time. The Contractor shall use additives where necessary to ensure the satisfactory functioning of the slurry.

ii) A manufacturer's certificate showing the properties of the bentonite powder shall be delivered to the Engineer-in-Charge for each consignment delivered to site: Independent tests shall be carried out at laboratory approved by the Engineer-in-Charge on samples of bentonite frequently.

iii) The Contractor shall carry out tests at site during the course of the piling to check the physical properties of the bentonite slurry in the works. These tests shall include, inter-alia, density, viscosity, shear strength and pH tests. The test apparatus and

testmethods shall be proposed by Contractor as recommended by manufacturer and as approved by the Engineer-in-Charge.

iv) The frequency of tests shall be that which the Contractor considers necessary to ensure that the bentonite slurry is in accordance with his proposals and as such other times as the Engineer-in-Charge may direct.

v) Should the physical properties of any bentonite slurry deviate outside the agreed limits, such slurry shall be replaced, irrespective of the number of times it has been used by new bentonite slurry of correct physical properties. Adequate time shall be allowed for proper hydration to take place consistent with the method of mixing, before using slurry in the works.

vi) The Contractor shall control the bentonite slurry so that it does not cause a nuisance either on the site or adjacent waterway or other area. After use it shall be disposed of in a manner approved by the Engineer-in-Charge.

vii) The level of the slurry in the bentonite shall be maintained so that internal fluid pressure always exceeds the external water pressure.

viii) If chiselling is used when boring through hard strata or to overcome obstructions, the stability of the excavation shall be maintained by methods acceptable to the Engineer-in-Charge.

2) Concreting:

Concreting of piles shall be done as given herein below:

a) Placing of Steel Reinforcement:

The cage of reinforcement shall be assembled on the ground and securely tied by means of binding wire in such a manneras to form a rigid cage. It shall be lowered in the bore hole carefully keeping the cage concentric with the bore hole. Adequate concrete spacers shall be provided around the cage to ensure the required concrete cover to be available on all sides of the cage. Concrete spacer blocks specially pre-cast for this purpose shall be securely attached to the reinforcement at a suitable spacing and each quarter point so as to ensure that the concrete cover stipulated on the drawings is maintained throughout and that the reinforcement cage is not displaced in the casing during the course of subsequent concreting operations. In addition concrete spacer blocks shall be located immediately below and immediately above the lap at 4 points spaced around the cage. Particular care shall be taken to ensure that none of the spacer blocks move out of position to the inside of the reinforcement cage due to spacer blocks or lapped reinforcement or any other reasons which might interfere with concrete placement. Depth of the hole shall be measured just before and after the lowering of cage. In case it is found that the soil has caved into the hole during the lowering of the cage, the contractor shall be required to adequately clean the hole to the satisfaction of the Engineer-in-Charge, before the start of concreting at his own cost.

b) Composition of Concrete:

Composition of concrete shall be as specified.

c) Batching of Concrete:

Batching of concrete shall be in accordance with the provisions of Section 5 – Plain & Reinforced Concrete.

d) Mixing of Concrete:

Mixing of concrete shall be done in accordance with the provisions of Section 5 – Plain & Reinforced Concrete.

e) Conveying:

Concrete shall be conveyed from mixer to piles as rapidly as practicable by methods which will prevent segregation or loss of ingredients, as specified in Section 5 – Plain & Reinforced

Concrete. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no vertical drop greater than 5 feet. Belt conveyers, chutes, or other similar equipment will not be permitted for conveying concrete except where the use of such equipment is approved in writing by the Engineer-in-Charge, in advance of any use.

g) Placing:

i) General

Once the bore hole has reached the required depth and the reinforcement cage properly installed, and such depth has been checked and recorded concreting operations shall be carried out. Approval of the Engineer-in-Charge shall be obtained before starting any concrete pour. Concrete pouring will not be permitted when in the opinion of the Engineer-in-Charge weather conditions prevent proper placement. Unless otherwise approved concrete pouring shall be performed only in the presence of a duly authorized representative of the Engineer-in-Charge.

ii) Mixing-Placing Interval:

Concrete shall be placed within thirty minutes, after it has been mixed.

iii) Placing Temperature:

Concrete shall be delivered to the piles at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of 90°F (32°C) or lower than 41 of (5°C).

iv) Placing Method

Pouring of concrete shall be done by an efficient tremie technique. The method and equipment used shall be subject to the prior approval of the Engineer-in-Charge. The tremie pipes shall have to be large enough with due regard to the size of the aggregate. For 3/4 inches (19.5 mm) aggregate, the tremie pipe shall be of diameter not less than 6 inches (15 mm) and for larger aggregate, larger diameter tremie pipes shall be used. The hopper and tremie pipe shall have to be a closed system embedded in the placed concrete, through which water cannot pass. When concrete is deposited by tremie, the tremie seal shall be effected in a manner which will not produce undue turbulence in the water around the pipe. The discharge end shall be kept submerged continuously in the concrete and the shaft kept full of concrete to a point well above the water surface. The tremie shall not be moved horizontally during a placing operation. The rate of placing concrete in the borehole shall be neither less than 30 feet (9.15 meters) per hour and nor more than 50 feet (15.24 meters) per hour.

When a casing is used, it shall be lifted up-to height less than the height of casing already filled in with concrete. The bottom of casing shall stop to an elevation of 5 feet (1.52 meters) lower than the top of the concrete. Particular care shall be taken in order to avoid earth slide inside the hole.

During the progress of pouring, the Contractor will ensure that a stand by equipment is available in order to cope with plant break down if encountered.

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The Contractor shall not be permitted to place concrete while it is raining. Should it rain while the concrete placement is already in progress, the Contractor shall carry on with proper and sufficient precautions, the concrete placement operation until the pile is completed and shall cover the concrete already placed and under setting condition with polythene or similar impervious sheets. No additional payment shall be made for any such emergency and protection works.

All tremie tubes shall be scrupulously cleaned after use for subsequent concreting.Concrete in piles shall be continued up-to two feet above cut off levels as shown on the Drawings and shall be broken down to cut-off levels prior to placement of pile caps. The contractor shall break

back the concrete in the top portion of the piles to the final elevation which will be 3 inches above the bottom of the pile cap and at the same time exposing the length of pile reinforcement required for lapping and binding with the pile cap. The contractor shall also establish and record the actual co-ordinates of the centres of the broken-off pile tops with respect to theoretical centre line of each pile cap as shown on the Drawings and the tolerance in this respect shall not exceed 2 inches (50 mm) in any direction. No separate payment will be made for manufacturing, placing and breaking of this part of concrete.

v) Protection and Curing

As each pile cap is completed, the projected length shall be immediately and carefully protected from any condition that will damage or adversely affect the hardening of concrete. Concrete shall be cured for 28 continuous days by an approved method.

vi) Stripping and Finishing

Any cracked or defective concrete in the head of the completed pile shall be cut away and made goodwith new concrete well bonded into the old. The reinforcement in the pile shall be exposed for a sufficient distance to permit it to be adequately bonded to the pile cap. This shall be done carefully to avoid shattering or otherwise damaging the rest of the piles. The reinforcement shall then be cleaned and bent to form an anchorage into the concrete of the super-structure as directed by the Engineer-in-Charge.

Where a temporary casing is used, the top of the pile shall be brought up sufficiently above the required finished level to allow for slumping on withdrawal of the casing and to permit all laitance and weak concrete to be removed.Particular attention shall be paid to the compaction of the concrete in the top 3 feet (0.91 meters) or so of the pile.

vii) Damaged Piles

Should any pile be damaged or not conforming to the requirements of this Specification the Contractor shall be responsible for repairing or replacing the pile to the requirements and satisfaction of the Engineer-in-Charge without cost to the Employer.

Should the Engineer-in-Charge doubt the efficiency of any pile so repaired, he may order the Contractor to construct additional piles, at points selected by him without cost to the Employer. The Engineer-in-Charge may direct the Contractor to proof load test the doubtful pile.Any piles that are damaged or imperfect and thus rejected by the Engineer-in-Charge shall be removed and discarded.

When the rejected pile is withdrawn, the space shall be filled solid with gravel or broken stone without extra payment therefore.Debris from pile cut-offs and damaged piles shall not be buried in required fill under slabs at grade or in required embankments but shall be disposed of by the Contractor off the site of the work.Piles which, in the opinion of the Engineer-in-Charge, are defective in any way shall be rejected and replaced by the Contractor without any extra cost.

viii) Safety Precautions

Before commencing piling operations, reference shall be made to Pakistan statutory safety requirements. In addition, the safety precautions in British Standard CP 2004 shall be strictly followed.The presence of the gas mains, electric cables, water mains and other services that may be damaged and cause injuries shall be investigated before work is commenced. The site shall be kept clear of dangerous obstructions.

High tension overhead power lines shall not be approached nearer than 15 feet (4.57 meters) because of the danger of sparking.A safety supervisor shall be appointed on site, the supervisor being qualified in accordance with the statutory regulations. First-aid boxes in the

charge of a responsible person shall be kept at all the locations.Fencing shall be provided to prevent free access to the site and all open pits and boreholes shall be covered.

If lighting by electricity is provided, it is preferable that the voltage for trailing cables shall not exceed 60 V. Electrical installations shall be properly earthed. Cables shall be protected from accidental damage and kept clear of movable equipment plugs and socket connections shall be of water- proof type.Safety helmets and safety footwear shall always be worn by all workers. Piling sites are often wet and use of rubber boots shall be essential.

All boring and concreting equipments shall be cleaned regularly.Helmets, driving caps, etc., shall be inspected regularly for damage or fracture.If cast in-place piles are finished below ground level, proper covers shall be provided to prevent workmen from falling into the holes.

7.2.6 LOADING TESTS ON PILES

The procedure for loading test on piles shall be as given below:

a) Pile load tests shall be conducted to failure on test piles prior to commence actual piling work. The number and location of test piles shall be given by the Engineer-in-Charge in thefield. Test piles shall be constructed 'first, cured for 28 days and then load tested for load carrying capacity by the procedure specified in ASTM D1143.
   Proofload tests shall be conducted on selected working piles during and after execution of piling work of the constructed piles. The number of proof load tests, selection of proof load test pile, and magnitude of load shall be decided by the Engineer-in-Charge. The proof load should be 150% of design load.In case of failure of a working pile it shall be considered as a damaged pile to be replaced by another pile at no extra cost to the Employer.
b) The Contractor shall be responsible for bringing all equipment and supplies to the site for satisfactory performance of the test according to ASTM D1143, or any other method approved by the Engineer-in-Charge.
c) The Contractor shall submit to the Engineer-in-Charge an up-to-date calibration certificate from a laboratory approved by the Engineer-in-Charge, showing correctness of the gauge and/or load cell to be used with the hydraulic jacks.
d) The apparatus shall be calibrated as per requirements of ASTM D1143. The Contractor shall submit to the Engineer-in-Charge details of calibration within 7 days prior to commencing testing for his review and approval.
e) The pile head shall be cut-off or built up to the necessary elevation and shall be capped appropriately to produce a horizontal bearing surface.
f) Care shall be taken to ensure that the center of gravity of the kentledge is on the axis of the pile and that the load applied by the jack is coaxial with the pile.
g) Settlement of pile head shall be recorded using dial gauges and precise levelling in accordance with ASTM D1143.
h) The record of pile load test shall be kept on an approved format as given in Forms-1 to 3 of these specifications. The Contractor shall prepare load-time settlement curves for each such load test. Two copies of the relevant field data and the graphs shall be supplied to the Engineer-in-Charge within 48 hours of the completion of the test.

7.2.7 RECORD AND REPORT

The following tests, records and reports shall be prepared by the Contractor at his own expense.

1) Records:

The Contractor shall keep accurate records of all the works accomplished under this Section. All such records shall be preserved in good condition and order by the Contractor until they are

delivered and accepted by the Engineer-in-Charge. The Engineer-in-Charge shall have the right to examine such records at any time prior to their delivery to him.

The following information shall be included in the records for each pile.

a) Pile number and elevation of top of bore hole and top of pile.
b) Type of rig used and a brief description of drilling operations.
c) Type of soil encountered in the hole with values of cohesion and angle of internal friction.
d) SPT resistance values (N-values)
e) Date and depth of bore when drilling operations were performed and piles constructed.
f) Total depth of each bore hole.
g) Size and length of casing, if used.
h) Quantity of concrete and steel used for the construction of each pile.
i) Quantity of constituents for each batch of mix, water cement ratio and the result of all quality control tests.
j) Date and time of load testing of piles, load and settlements readings during the loading and unloading of the test piles (For test piles only).
k) Graph of time-load-settlement relationship for test (For test piles only).
l) Remarks concerning any unusual occurrence during drilling, concreting and load testing of piles.

2) The presence of Engineer-in-Charge's representative or the keeping of separate records by his representative shall not relieve the Contractor of the responsibility for the work specified in this clause. Payment will not be made for any work for which records have not been furnished by the Contractor

3) Reports:

Reports of each pile construction and pile load test shall be communicated to the Engineer-in-Charge as follows:

a) Oral reports as the work proceeds.
b) A report in duplicate not later than 48 hour after the completion of each hole, concreting of piles and load testing of piles. Performa record of piling work for pile load test record is enclosed as Form-2 and Form-3.
c) Daily record for bored piles on the format shown in Form-1.
d) Five copies of the final report of the works within one month of completion of the last pile.

4) The final report shall include:

a) Layout showing the "As-built" arrangement of piles, their exact locations, dimensions, length, reinforcements, cut off elevation and the location of test piles.
b) A tabulation of the loads and settlement readings during the loading and unloading of the test piles
c) A graphic representation of the test results in the form of time-load-settlement curves.

7.3 PRECAST CONCRETE PILES

7.3.1 GENERAL

The general requirements of Precast concrete piles shall comply with sub-section 7.2.2 unless otherwise specified hereof and approved by the Engineer-in-Charge. The submittals shall comply with Sub-section 7.2.3 and products for production of reinforced concrete piles shall comply with Sub-section 7.2.4 Sub-paras (1) to (4).

7.3.2 MANUFACTURE

The concrete and reinforcing steel for manufacture of precast piles shall be produced and placed according to the applicable provisions of Section 5 – Plain & Reinforced Concrete.

All concrete load bearing plies shall be manufactured in accordance with the details shown on the drawings or as directed by the Engineer-in-charge in writing. The plies shall be cast on level, and tight platforms shall be constructed to prevent settlement during the casting and curing operations; All concrete shall be thoroughly compacted by adequate vibration, spading and roding during the placing operation, and shall be thoroughly worked around the reinforcement and Into the corners of the forms. Vibrations shall be applied uniformly over the entire length of the pile and shall be of sufficient duration to ensure a thorough compaction. Pick-up points and date of casting shall be distinctly marked on each pile.Unless otherwise specified. or directed by the Engineer-In-charge in writing the dimensions of the plies shall be as shown on the approved drawings.

7.3.3 PILE SHOES

Pile shoes when required shall be of the design as called for on the Drawings or directed by the Engineer-in-Charge.

7.3.4 STORAGE AND HANDLING

Storage and handling of the plies shall be executed In a way that does notsubject them to over-stress, spalling or other Injuries. Piles shall remain undisturbed after casting and shall not be subjected to handling till the specified curing period ends. They shall be lifted by means of a suitable bridle or slings attached to them at the marked pick-up points. Piles which are over-stressed or otherwise Injured during curing or handling shall be removed away from the site of work by the contractor at his own expense.

7.3.5 PLACING OF PILES

Plies shall be driven as accurately as practicable in the correct location, true to line both laterally and longitudinally and to the vertical line as indicated on the drawing. A lateral deviation from the correct location at the cut-off elevation of not more than 3 inches shall be permitted. A variation in slope of not more than 2 Inches per 10 feet of longitudinal axis shall only be permitted. The correct relative position of piles shall be maintained by the use of template or by other approved means. Any pile driven out of correct locations shall be pulled out and re-driven by the contractor at no additional cost. No lateral force of any nature or magnitude shall be permitted to pull a pile into correct position or vertical alignment.

7.3.6 DRIVING OF PILES

7.3.6.1 PILE LENGTH

The criteria for pile length and bearing capacity will be determined by the Engineer according to the results from test piles and load tests. The piles shall be driven to such depths, that the bearing loads indicated on the Drawings are obtained.

The criterion for pile length may be one of the following:

1. Piles in sand and gravel shall be driven to a bearing value determined by use of the pile driving formula or as decided by the Engineer-in-Charge.
2. Piles in clay shall be driven to the depth ordered by the Engineer-in-Charge. However, the bearing value shall be controlled by the pile driving formula if called for by the Engineer-in-Charge.
3. Piles shall be driven to refusal on rock or hard layer when so ordered by the Engineer-in-Charge.

   The Contractor shall be responsible for correct pile lengths and bearing capacities according to the criteria given by the Engineer-in-Charge.

7.3.6.2 PILE DRIVING

Plies shall be driven by means of a steam hammer or an air hammer of a size and type suitable for the work, as approved by the Engineer-In-charge. The weight of the moving parts of the

hammer shall not be less than 8000 pounds, unless otherwise authorized by the Engineer-In-charge. The hammer shall be operated at all times at the steam or air pressure and at the speed recommended by the manufacturer. Boiler or compressor capacity shall be sufficient to operate the hammer continuously at full rated speed. Duringdriving, piles shall be protected by a cushion and cap approved by the Engineer-In-charge. Pile drivers shall have firmly supported leads extending to the lowest point the hammer must reach to drive the piles to cut-off elevation without the use of a follower. Each pile shall be driven continuously and without voluntary Interruption till the required depth of penetration has been attained. Deviation from this procedure shall be permitted by the Engineer-In-charge only in case the driving is stopped by causes which could not reasonably have been anticipated. Water Jet shall be allowed to be used to assist driving only when specifically authorized by the Engineer-in-charge, who shall grant such permission only where satisfactory driving cannot be obtained otherwise. Where jetting is authorized, the Jetting equipment shall be of a type and capacity approved by the Engineer-In-charge. The lowest 3 feet shall however, be always driven without jetting. Unless otherwise authorized by the Engineer-in-charge no pile shall be driven within 100 feet of concrete less than seven days old. Unless otherwise specified or directed by the Engineer-in-charge all pile tops shall be driven to cut-off elevation.

7.3.6.3 PILE DRIVING FORMULAS

Pile driving formulas may be used to determine the number of blows of hammer per unit of pile penetration needed to obtain the specified bearing capacity for piles driven in the sub-soils at the site. Piles shall be driven to a final resistance as indicated on the plans determined by the following formula:

For Drop Hammer

Qall = WH/[6(S+2.5)]

For single-acting steam or air hammers and for diesel hammers having unrestricted rebound of rams.

Qall = WH/[6(S+2.5)] (Use when driven weights are smaller than striking weights)

Qall = WH/[6{S+0.25(WD/WS)}] (Use when driven weights are larger than striking weights)

For double-acting steam or air hammers and for diesel hammers having enclosed rams.

Qall = E[6(S+2.5)] (Use when driven weights are smaller than striking weights)

Qall = E[6{S+0.25(WD/WS)}] (Use when driven weights are larger than striking weights)

In the above formulas:

Qall = Allowable pile load in Kilograms.

W = Weight of striking parts of hammer in Kilograms.

H = The height of fall in centimetres for steam and the observed average height of fall in centimetres of blows used to determine penetration for diesel hammers with unrestricted rebound of hammer.

S = Average net penetration per blow in centimetres for the last 10 to 20 blows of steam, air, or diesel hammer, or for the last 15 centimetres of driving for a drop hammer.

E = The actual energy delivered by hammer per blow in Kilogram centimeter

WD = Driven weights in Kilogram

Note: Ratio of driven weights to striking weights should not exceed three.

WS = Weight of striking parts in Kilograms.

Modifications of basic pile driving formula:

a) For piles driven to and seated in rock as high capacity end-bearing piles: Drive to refusal (approximately four(4) to five(5) blows for the last 0.625 centimetres of

driving). Re-drive open end pipe piles repeatedly until resistance for refusal is reached within two and half (2.5) centimetres of additional penetration.

b) For piles driven through stiff compressible materials unsuitable for pile bearing to an underlying bearing stratum:
Add blows attained before reaching bearing stratum to required blows attained in bearing stratum.

c) For piles into limited thin bearing stratum:
Drive to predetermined tip elevation, and determine allowable load by load test.
The bearing power as determined by the appropriate formula in the foregoing list will be considered effective only when it is less than the crushing strength of the pile. Other recognized formula for determining pile bearing power may be used when given in special specification. However, it shall be understood that the relative merits and reliability of any of the pile formula can be judged only on the basis of comparisons with the results of load tests.

7.3.7 DAMAGED AND MISPLACED PILES

Any pile which is cracked or broken because of internal defects or by improper handling or driving or which Is otherwise Injured so as to Impair it for Its intended use or any pile driven out of proper location shall be removed and replaced by the contractor at his own expense. The Engineer-in-charge may require the contractor to pull out certain selected plies (up to a maximum of 2 per cent of the total number of the plies driven subject to a minimum of 2 plies) for test and Inspection to determine their condition. Any pile so pulled out and found to be damaged to such an extent as, In the opinion of the Engineer-In-charge, would Impair Its usefulness In the completed structure, shall be removed from the site of the work, and the contractor shall furnish and drive a new pile to replace the damaged one. Piles pulled out and found to be in a sound and satisfactory condition shall be re-driven and in such a case payment for both theinitial driving, pulling out and re-driving shall be made to the Contractor.

7.3.8 CUT-OFF

A pile which cannot be driven to the required depth of penetration because of an underground obstruction shall be pulled out, the obstruction removed, and the pile re-driven - all at the contractor's expense. If for any reasons It Is not possible to drive a pile to the required depth of penetration, the Engineer-in-charge shall determine, whether an acceptable friction bearing capacity has been attained and, if so, shall permit the contractor to cut the pile off perpendicular to the axis of the pile at the cut off, elevation as shown on the drawing. Otherwise, the contractor shall continue to drive the pile or pull out and re-drive the pile In order to obtain the required depth of penetration.

The cut-off method shall be used in a way that does not damage the portion of the pile to be left In place nor the pile reinforcement.Tops of piles shall be embedded in the concrete footing as shown on the Drawings.Concrete piles shall, when approved by the Engineer-in-Charge, be cut off at such a level that at least five (5) cm of undamaged pile can be embedded in the structure above. If a pile is damaged below this level, the Contractor shall repair the pile to the satisfaction of the Engineer-in-Charge. The longitudinal reinforcement of the piles shall be embedded in the structure above to a length equal to at least (40) times the diameter of the main reinforcing bars. The distance from the side of any pile to the nearest edge of the footing shall not be less than twenty (20) cm.

When the cut off elevation for a pre-cast concrete pile, or for a cast-in-place concrete pile is below the elevation of the bottom of the pile cap, the pile may be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete construction.

7.3.9 SPLICING

Piles should be lengthened when so required, by splicing after getting approval of the Engineer-in-charge. For this purpose the longitudinal reinforcement of the pile shall be exposed for a length equal to at least 50 diameters of the bars. If necessary, the concrete shall be cut away to accomplish this. Bars of the same size and of a length sufficient for the required extension shall be fastened to the exposed bars and transverse reinforcement as shown on the drawing for the pile head; concrete cuts shall be made perpendicular to the axis of the pile; and all concrete shall be removed above the elevation of the 50 diameter length cut. Bars shall, be lapped for the full length of the bars exposed. Alternatively the splicing can be done by welding the reinforcement bars if approved by the Engineer-in-charge. In such cases only enough concrete shall be removed to provide adequate working space for the welding operation.

When reinforcement has been properly placed by lapping or welding the top of the pile shall be roughened and the necessary formwork placed. Immediately before pouring concrete, the top ofthe concrete shall be thoroughly wetted and covered with a thin coat of neat cement mortar. Concrete of the same quality as that used to cast the pile shall then be placed finished and cured as specified for all piles, except that forms shall remain in place for at least 72 hours after placing the concrete. Driving of a spliced pile shall not be resumed till it is approved by the Engineer-in-Charge.

7.3.10 LOADING TESTS OF PILES

The loading tests on Piles shall comply with the requirements of Sub-section 7.2.6.

The Contractor shall keep accurate records of all the works accomplished under this Section. All such records shall be preserved in good condition and order by the Contractor until they are delivered and accepted by the Engineer-in-Charge. The Engineer-in-Charge shall have the right to examine such records at any time prior to their delivery to him.

The following information shall be included in the records.

a) Pile number, location and elevation of top of pile.
b) Total depth of pile
c) Quantity of concrete and steel used for the construction of each pile
d) Quantity of constituents for each batch of mix, water cement ratio and the result of all quality control tests.
e) Date and time of load testing of piles, load and settlements readings during the loading and unloading of the test piles (For test piles only).
f) Graph of time-load-settlement relationship for test (For test piles only).
g) Remarks concerning any unusual occurrence during load testing of piles.

Items (a) to (d) shall be reported on a format approved by the Engineer-in-Charge. The items (e) to (g) should be reported on forms.

The presence of Engineer-in-Charge's representative or the keeping of separate records by his representative shall not relieve the Contractor of the responsibility for the work specified in this clause. Payment shall not be made for any work for which records have not been furnished by the Contractor.

7.4 MEASUREMENT AND PAYMENT

7.4.1 COMPOSITE RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

7.4.2 LABOUR RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

7.4.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR are measured in the above mentioned criteria;
   Item No.: 7-1 to 7-2, 7-8 and 7-14
2. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following items of CSR are measured according to this criteria;
   Item No.: 7-4 to 7-7, 7-9 and 7-15 to 7-16
3. For bulk items, the quantity of work shall be measured in units of weight i.e. Tonne or Tons. Following items of CSR are measured according to this criteria;
   Item No.: 7-10 to 7-13
4. For bulk items, the quantity of work shall be measured in units of weight i.e. Kilogram or Pound. Following items of CSR are measured according to this criteria;
   Item No.: 7-3