

Special Specifications

Part II

**Pile Foundations
Specifications**

Pile Foundations

P/1- Description

P/1-1 All pile foundations shall be board cast-in-place concrete, all shall be constructed as indicated on the drawings and in compliance with these specifications, to B.S.8004 requirements, to M.P.W & H and concerned municipal authorities regulations.

P/2- Materials

P/2.1 The materials for the manufacture of the reinforced concrete shall be and in accordance to with B.S.8110 and as per M.P.W & H and concerned municipal authorities.

P/2.2 The temporary steel casings and the permanent casings or liners shall be cylindrical, if the diameter indicated on the drawings and shall be of sufficient strength to maintain shape and location during boring and placement of concrete. The casings shall be sufficiently watertight to exclude ground water during placing of concrete.

P/2.3 In case drilling mud is used, bentonite, as supplied to the site and prior to mixing shall be in accordance with specification DFCEP 4 of the Oil Companies Materials Association.

P/3- Ground Conditions

P/3.1 Soil investigations report for the site will be provided to tenderers.

The Contractor shall report immediately to the Engineer any circumstances which indicates that in t he Contractor's opinion the ground conditions differ from those reported in or which could have been inferred from the site investigation reports or trial pile results.

P/4- Tolerances**P/4.1 Setting out**

Setting out of the main grid line shall be carried out by the Contractor. The installation of marker pins at pile positions as required by the Engineer shall be accurate to 75mm in any direction.

P/4.2 Vertically

At the commencement of installation, the equipment governing the alignment of the bored pile, shall be made vertical to a tolerance of within 1 to 100. The maximum permitted deviation of the finished pile from the vertical is 1 in 75.

P/5- Piling Method and Programme

P/5.1 The Contractor shall supply for approval all relevant details of the method of piling and the plant he proposes to use. Any alternative method to that specified shall be subject to approval.

P/5.2 The Contractor shall inform the Engineer each day of the intended programme of piling for the following day and shall give adequate notice of his intention to work outside normal hours and Public Holidays.

P/5.3 The Contractor shall submit to the Engineer his proposed sequence and timing for boring piles, having regard to the avoidance of damage to adjacent piles.

P/5.4 Any proposals by the Contractor for ground treatment of any nature or for temporary lowering of the water table by well pointing or any other method shall be subject to the approval of the Engineer. The Contractor shall however remain fully responsible for any effects of such ground treatment or control of the level of water tables upon the existing roads, buildings and structures in the vicinity of works.

P/5.5 Any proposals by the Contractor for underpinning, needling and shoring of existing structures in the vicinity of works shall be carefully designed by the Contractor and be subject to the approval of the Engineer.

P/6- Piling Records

P/6.1 The Contractor shall keep records for the installation of each pile and shall submit two signed copies of these records to the Engineer not later than noon of the next working day after the pile was installed. The signed record will form a record of the work.

P/7- Damage to Adjacent Services and Structures

P/7.1 If damage will be, or is likely to be, caused to mains, services adjacent structures, the Contractor shall submit to the Engineer his proposals for making surveys, monitoring movements or vibrations, and minimizing avoiding such damage.

P/7.2 The Contractor shall carry out the work in such a manner and such times so as to minimize noise and disturbance.

P/8- Concrete for Piles

P/8.1 Concrete for piles shall be class 30 or as shown on the drawings and shall be in accordance with BS 8110 requirements and to the following requirements.

P/8.2 When a designed mix is specified the Contractor shall be responsible for selecting the mix properties to achieve the required strength and workability.

P/8.3 The concrete shall have sufficient workability to enable it to be placed and compacted by the methods used in forming the Piles.

P/8.4 For piles exposed to potentially aggressive ground or groundwater, approved measures shall be taken to ensure durability. Reference should be made to Building Research Establishment Design 363 published in the U.K. relating to sulphate attack.

P/8.5 The cement content in any mix shall not be less than 400 kg/CU.m.

- P/8.6 All concrete aggregates, cement and water shall be sampled and tested as frequently as deemed necessary by the Engineer as per specification. All test samples shall be supplied by the Contractor at his own expense.
- P/8.7 Trial mix shall be prepared for concrete in accordance with BS 5328, showing that the proposed mix proportions and manufacture will produce a concrete of the strength and quality required, having adequate workability for compaction by the method to be used in placing.
- P/8.8 The Contractor shall keep a detailed record of the results or all tests on concrete and concrete materials. Each test shall be clearly identified with the piles to which it relates.

P/9- Reinforcement for Piles

- P/9.1 The reinforcement for the piles to be epoxy coated high tensile deformed steel bars and shall conform to the requirement of BS 4449.
- P/9.2 Reinforcement in the form of a cage shall be assembled with additional support such as spreader forks and lacing, necessary to form a cage which can be lifted and placed without permanent distortion. Intersecting bars shall be fixed together by approved means. Hoops, links or helical reinforcement shall fit closely around the main longitudinal bars and be bound to them by approved wire, the ends of which shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in position to specified projection of reinforcement above the final cut-off level.
- P/9.3 The cover to all reinforcement in cast-in-place piles shall be not less than 75mm unless otherwise approved by the Engineer. Spacers shall be designed and manufactured using durable material which will not lead to corrosion of the reinforcement or spalling of the concrete cover.
- P/9.4 The number of laps in longitudinal steel bars shall be kept to a minimum. Joints in reinforcement shall be such that the full strength of each bar is effective across the joint and shall be made so that there is no detrimental displacement of the reinforcement during the construction of the pile. The lap length shall not be less than 50 times the bars diameter.

P/9.5 The min. vertical reinforcement is 0.8 % of pile cross section and minimum stirrups to be spiral of 8 mm diameter @ 150 mm c/c.

P/9.6 Vertical reinforcement to be for the full pile length.

P/10-Boring for piles

P/10.1 Prior to boring the Contactor shall the casing position for each pile during and immediately after placing the casing, and agree it with the Engineer.

P/10.2 Where the open bore is unstable, temporary casing, or bentonite suspension may be used to support the wall of the bore prior to concreting.

P/10.3 Piles shall not be bored so close to other piles which have recently been cast and which contain workable or unset concrete that a flow of concrete could be induced from or damage caused to any of the piles.

P/10.4 Temporary casings shall be free from significant distortion. They shall be of uniform cross-section throughout each continuous length. During concreting they shall be free from internal projections and encrusted concrete which might adversely affect the proper formation or piles.

P/10.5 Where piles are bored under water or bentonite suspension in an unlined state, the insertion of full-length loosely fitting casing to the bottom of the bore prior to placing concrete will not be permitted.

P/10.6 Where boring takes place through unstable water bearing strata, the process of excavation and the depth of temporary casing employed shall be such that soil from outside the area of the pile is not drawn into the pile section and cavities are not created outside the temporary casing as it is advanced.

P/10.7 Where the use of drilling fluid is specified or approved for maintaining the stability of a bore, an adequate temporary casing of all shall be used in conjunction with the method so as to ensure stability of the strata near ground level until concrete has been placed. During construction the level of drilling fluid in the pile excavation shall be maintained within the cased or stable bore so

that it is not less than 1.0m above the level of external standing groundwater at all times.

In the event of rapid loss of drilling fluid from a pile excavation, the bore shall be backfilled without delay and the instruction of the Engineer shall be obtained before boring at that location is resumed.

P/10.8 All reasonable steps shall be taken to prevent the spillage of bentonite suspension on the Site in areas outside the immediate vicinity of boring. Discarded bentonite shall be removed from the Site without undue delay. Any disposal of the bentonite shall comply with the regulations of concerned Municipal authorities.

P/10.9 Completion of boring and where inspection of dry pile bore indicates the necessity, loose disturbed or softened soil shall be removed from the bore. Where pile bores contain water or drilling fluid, a cleaning process shall be employed before concrete is placed. Large debris/or accumulated sediment shall be removed using appropriate approved methods, which shall be designed to clean while at the same time minimizing ground disturbance below the pile bases. Water or drilling fluid shall be maintained at such levels throughout and following the cleaning operation that stability of the bore is preserved.

P/11-Drilling Fluid

P/11.1 Bentonite, as supplied to the Site and Prior to mixing, shall be in accordance with specification DFCEP 4 of the Oil Companies Materials Association.

P/11.2 Where saline or chemically contaminated groundwater occurs, special precautions shall be taken to modify the bentonite suspension or prehydrate the bentonite in fresh water so as to render it suitable in all respects for the construction of piles.

P/12-Placing Concrete

- P/12.1 The method of placing and workability of the concrete shall be such that a continuous monolithic concrete shaft of the full cross-section is formed.
- P/12.2 The concrete shall be placed without such interruption as would allow the previously placed batch to have hardened. The method of placing shall be approved.
- P/12.3 The Contractor shall take all precautions in the design of the mix and placing of concrete to avoid arching of the concrete in temporary casing. No soil liquid or other foreign matter which would adversely affect the performance of the piles shall be permitted to contaminate the concrete.
- P/12.4 Slump measured at the time of discharge into the pile bore shall be in accordance with the standard shown in table 1.

The concrete shall be of the workability approved when in its final position and shall remain sufficiently workable for all pile construction procedures to be safely completed.

Table 1

Piling Mix Workability	Slump		Typical Conditions of Use
	Minimum mm	Range mm	
I	75	75 - 150	Placed into water free permanently lined bore of 600mm dia, or over where casing level lies below temporary casing ; reinforcement widely spaced, leaving ample room for free movement of concrete between bars.
II	100	100 - 200	Where reinforcement is not spaced widely; where cut-off level of concrete is within temporary casing; where pile bore is water-free and the diameter is less than 600mm.
III	150	150 or more	Where concrete is to be placed by tremie under water or drilling mud or by pumping

- P/12.5 Internal Vibrators shall not be used to compact concrete.
- P/12.6 Approved measures shall be taken to ensure that the structural strength of concrete placed in all piles is not impaired through grout loss, segregation or bleeding. Concrete shall be directed vertically into the center of each vertical pile so that grout is not lost from the initial discharge.
- P/12.7 Before placing concrete, measures shall be taken to ensure that there is to accumulation of silt or other material at the base of the baring, and the Contractor shall ensure that heavily contaminated bentonite suspension, which could impair the free flow of concrete from the tremie pipe, has not accumulated in the bottom of the hole.
- P/12.8 Concrete to be places under water or drilling fluid shall be placed by tremie and shall not into the water or drilling fluid. Pumping of concrete may be approved where appropriate.
- P/12.9 The hopper and pipe of the tremie shall be clean and watertight throughout. The pipe shall extend to the base of the bore and a sliding plug or barrier shall be placed in the pipe to prevent direct contact between the first charge of concrete in the tremie and the water or drilling fluid. The pipe shall at all times penetrate the concrete which has previously been placed and shall not be withdrawn from the concrete until completion of concreting. A sufficient quantity of concrete shall be maintained within the pipe of ensure that the pressure from it exceeds that from the water drilling fluid. The Internal diameter of the pipe of the tremie shall be not less than 150mm for concrete made with 20mm aggregate. It shall be so designed that external projections are minimized, allowing the tremie to pass within reinforcing cages without causing damage. The internal face of the pipe of the tremie shall be free from projections.
- P/12.11 No concrete shall be placed until all driving within a radius of 4.5 meters has been completed, not until all the shells for any one cluster have been completely driven. If this cannot be done, all driving within above limits shall be discontinued until the concrete in the last pile cast, has been set for at least seven days.
- P/12.12 Unless designated as basement piles all piles shall be placed with their tops at least 1 meter above pile cut-off level in their

respective pile caps. All bore holes, except for basement piles or unless otherwise specified, shall be filled with concrete to the top of the hole so that the Engineer can be assured that all the bentonite has been displaced by the concrete.

P/13-Extraction of Casing

P/13.1 Temporary casings shall be extracted while the concrete within them remains sufficiently workable to ensure that the concrete is not lifted. During extraction the motion of the casing shall be maintained in an axial direction relative to the pile.

P/13.2 When the casing is being extracted, a sufficient quantity of concrete shall be maintained within it to ensure that pressure from external water, drilling fluid or soil is exceeded and that the pile is neither reduced in section nor contaminated.

P/13.3 The concrete level within a temporary casing shall be topped up where necessary during the course of casing extraction in such a way that the case of the casing is always below the concrete surface under the casting of the pile has been completed.

P/13.4 Adequate precautions shall be taken in all cases where excess heads of water or drilling fluid could occur as the casing is withdrawn because of the displacement of water or fluid by the concrete as it flows into its final position against the walls of the pipe bore. Where two or more discontinuous lengths of casing (double casing) are used in the construction the proposed method of working shall be approved by the Engineer.

P/13.5 For piles cast in dry bores using temporary casing and without the use of a permanent lining, pile heads shall be cast to a level above the specified cut-off so that, after trimming, a sound concrete connection with the pile can be made. No pile shall be cast with its head below standing water level unless approved measures are taken to prevent inflow of water causing segregation of the concrete as temporary casing is extracted; and where applicable, the standing water level for each pile shall be agreed with the Engineer, and this level is to be treated as the cut-off for the purpose of calculating tolerance.

P/13.6 For piles cast in dry bores within the permanent lining tubes or permanent casings, or where their cut-off levels are in stable ground below the base of any casing used, pile heads shall be cast

to a level above the specified cut-off so that, after trimming, a sound concrete connection with the pile can be made.

P/13.7 For piles cast under water or drilling fluid, the pile heads shall be cast to a level above the specified cut-off so that, after trimming to remove all debris and contaminated concrete, a sound concrete connection with the pile can be made.

P/13.8 During extraction of temporary casings, where circumstances are such that newly placed unset concrete is brought into contact with external groundwater, precautions shall be taken to ensure that the internal concrete pressure at all levels within the pile exceeds the external ground water pressure.

P/14-Temporary Backfilling

P/14.1 After each pile has been cast, any empty bore remaining shall be protected and shall be carefully backfilled as soon as possible with the approved materials.

P/15- Disposal of Excavated Material

P/15.1 Disposal material shall be carried out by the Contractor as necessary to facilitate the works and to the satisfaction of the Engineer.

P/16-Cutting off Pile Heads

P/16.1 When cutting off and trimming piles to the specified cut-off level, the Contractor shall take care to avoid shattering or otherwise damaging the rest of the pile. Any cracked or defective concrete shall be cut away and the pile to be repaired in an approved manner to provide full and sound section at the cut-off level .

P/17-Integrity Testing of piles

P/17.1 Where integrity-testing is called for but the method is not specified, the method to be adopted shall be approved by the Engineer and shall be one of the following:

- I. Sonic Method
- II. Vibration Method
- III. Sonic Logging

- P/17.2 In the cast-in-place concrete piles, integrity test shall not be carried out until 7 days or more have elapsed since pile-casting unless otherwise approved.
- P/17.3 Where the method of testing requires the positioning of sensing equipment on the pile head, the head shall be clean, free from water, laitance, loose concrete, over spilled concrete and blinding concrete, and readily accessible for the purpose of testing.
- P/17.4 The testing shall be carried out by an approved specialist firm.
- P/17.5 The interpretation, of tests shall be carried out by competent persons and the full test results and finding shall normally be given to the Engineer within 10 days of the completion of each phase of testing. Full details of the ground conditions and construction method shall be made available to the specialist firm when required in order to facilitate interpretation of the tests.

P/18-Loading Tests

- P/18.1 Each test pile and working pile to be tested shall be loaded axially to 2.0 times and 1.5 times the working load respectively as specified on the drawings. The tests shall not be commenced until the concrete has reached 90% of its testing strength and shall be maintained on the pile as per specification or for such further period as the Engineer may direct.
- P/18.2 Loading tests shall be carried out at the date ordered on individual piles selected by the Engineer.
- P/18.3 Piles selected by the Engineer shall be tested in accordance with the B.S.8004 and Concerned municipal authorities regulations.
- P/18.4 The Contractor shall keep detailed records in collaboration with the Engineer of the settlement and recovery of the pile as the increment of load are applied and removed respectively.
- P/18.5 The Contractor shall provide the Engineer with two copies of his records of each test.
- P/18.6 If the tests indicate that, in the opinion of the Engineer, the piles are unsatisfactory for the working load, the Contractor shall at his

own expense replace the tested pile in a suitable position and if necessary support to be given to the structure to be carried.

P/18.7 The Contractor shall bear the cost of any additional work made necessary as a result of the unsatisfactory pile or piles. The Contractor shall also satisfy the Engineer that any piles constructed prior and subsequent to the results of the tests being known are capable of carrying the specified working load. Further tests shall be carried out, if required by the Engineer, and any piles deemed to be unsatisfactory by the Engineer shall be replaced or augmented by further piles. No extra cost will be accepted or extension of time granted in connection with the foregoing work.

P/18.8 The Contractor shall state in his proposals the measures he intends to take if the ultimate load of any pile falls to each the required value under the loading test, with regard to lengthening, rendering and retesting of the test pile, and also the provision of additional piling to augment or replace the tested pile. No extra cost will be accepted or extension of time granted in connection with the foregoing work.

P/19-Failure of Pile

P/19.1 A pile shall be considered to have failed when any of the following conditions apply.

- On completion of a load test, the residual settlement after rebound-exceeds 6mm.
- The test load as specified in the contract shall not have been achieved.
- The maximum settlement exceeds 10% of the least lateral Dimension of the pile under ultimate load.

P/20-Protection of Piling from Chemical Attack

P/20.1 All piles shall have protective sleeve for a minimum, depth 3m below the cut-off level of the pile. This sleeve shall be plastic or

metal bedded in mastic to form a fully water-proofed seal to the concrete.

P/21-Clearance of Work

P/21.1 Upon the completion of the works the Contractor shall clear away and remove from the Site all constructional plant, equipment, surplus materials, rubbish etc., and leave the whole of the site and works clean and in perfect condition to the satisfaction of the Engineer.