



GEOTECHNICAL – CONSTRUCTION SPECIFICATION

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**SPECIFICATION
 FOR
 SECANT PILE WALLS**

Modifications subjects of this revision concern the following pages : **NIL**

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SECANT PILE WALLS SPECIFICATION

1.0 GENERAL

1.1 Works in accordance with Specifications

Piling shall conform in all respects with the principles contained in BS 8004.

Unless otherwise stated, concrete, reinforcement and formwork shall be in accordance with the requirements of the relevant specifications.

In the event that the provisions of other specification clauses cause ambiguity or conflict with the requirement of this Specification, the latter shall take precedence unless otherwise approved by the Engineer.

1.2 Setting Out

The Contractor shall prepare setting out drawings showing locations of each pile to be installed at site and submit to the Engineer for approval within 14 days prior to construction.

The Contractor shall be required to employ an approved Licensed Surveyor who will set up the positions of the piles as shown in the pile layout plans of the detailed design. The Contractor will be responsible for the accuracy of location and positioning of each pile. Any errors in setting out and any consequential loss to the Employer will be made good by the Contractor to the satisfaction of the Engineer.

The Contractor shall preserve the pegs set out by the Surveyor. Should any peg be displaced or lost it must be replaced by a Licensed Surveyor to the approval of the Engineer. Upon completion of all piling works, the Contractor shall produce as-built Drawings showing the positions of all piles as installed. The positions of piles shall be verified and endorsed by a Licensed Surveyor.

1.3 Tolerances

- (a) Position
At cut-off level, the maximum permitted deviation of the pile centre from the centre point shown on the setting out drawings shall be 25mm in any direction.
- (b) Verticality
The maximum permitted deviation of the finished pile from the vertical at any level is 1 in 200. The contractor shall demonstrate to the satisfaction of Engineer the pile verticality is within the allowable tolerance.
- (c) Correction
Should piles be installed outside these tolerances affecting the design and appearance of the structure, the Contractor shall propose and carry out immediate remedial measure to the approval of the Engineer at his own time and cost.

1.4 Person in Charge

The piling work is to be carried out by full time operators and supervisory staff who must be experienced in the installation of the proposed type of piles.



The Contractor shall submit to the Engineer for approval, written evidence to show that the persons who will be engaged in the works have had such experience.

1.5 Piling Equipment and Accessories

The equipment and accessories must be capable of safely, speedily and efficiently installing piles to the design requirements at the project site.

Sufficient units of equipment and accessories must be provided to keep to the agreed construction schedule.

1.6 Sequence of Installation of Working Piles

The Engineer reserves the absolute right and the Contractor shall recognise such right to direct the installation of working piles in any sequence the Engineer deems necessary for the satisfactory completion of the works.

1.7 Forcible Correction Not Permitted

Where piles have not been positioned within the specified limits no method of forcible correction will be permitted.

1.8 Rejected Piles

Any piling work rejected by the Engineer not properly constructed and installed in accordance with this Specification shall be replaced or rectified by the Contractor to the approval of the Engineer and this include reinstallation of piles, and the design and construction of a modified walls and also constructing of additional compensation piles.

1.9 Ground Conditions

No responsibility is accepted by the Engineer or Employer for any opinions or conclusions given in any factual or interpretative ground investigation reports. The Contractor shall report immediately to the Engineer any circumstance which indicates that in the Contractor's opinion the ground conditions differ from those reported in or which could have been inferred from the ground investigation reports or test results.

1.10 Guide Walls

Scalloped guide walls shall be used for all secant pile walls that form part of the permanent works of the structure but may be omitted for temporary works. In all cases, the Contractor shall demonstrate by experience, calculation and monitoring on site that adjacent piles will remain interlocked to the final excavation depth.

The design and construction of guide walls shall be the responsibility of the Contractor and shall take into account the actual site and ground conditions and the equipment to be used on site to ensure stability and avoid under-cutting as appropriate.

Guide walls shall be constructed in reinforced concrete or of other suitable materials. The minimum depth of guide wall shall be 0.5m and the minimum shoulder width shall be 0.3m for walls in reinforced concrete.



The finished internal face of guide wall closest to any subsequent main excavation shall be vertical to a tolerance of 1 in 200 and shall represent the reference line. There shall be no ridges on this face and the centre line of the guide wall shall not deviate from its specified position by more than +15mm/-15mm in any 3m along its length.

The clear distance between the inside faces of the guide wall shall be the maximum tool diameter plus 25mm, with a tolerance of +25mm/-0mm.

1.11 Records

A record of all piles installed shall be kept by the Contractor and a copy of the record (Hard & Scanned softcopy in PDF format) of the works done each day shall be given to the Engineer within 24 hours. The form of record shall first be approved by the Engineer before piling works commence. Any comment by the Engineer shall be incorporated into the record form.

All unexpected boring or installation conditions shall be noted in the records.

Two (2) bound sets of collated and certified (by the Contractor's P.E.) piling records of all piles shall be submitted by the Contractor to the Engineer after the completion of the piling works. A scanned softcopy of the above (in PDF format) shall also be submitted together to the Engineer.

2.0 BORED CAST-IN-PLACE SECANT PILES

2.1 General

The Contractor shall carry out the works in accordance with a method statement. This method statement shall include inter alia length of temporary casing, grouting or other methods to stop lost of drilling fluid or concrete or collapse of soil, details of the constituent materials of any drilling fluid used for stabilisation, the method of inspection, details of the concrete design mix, concreting method, the minimum time between the completion of one pile and the commencement of the next, and the pattern of construction.

Unless otherwise described in the Specifications, reinforcement and concrete shall comply with the requirements in relevant specifications. The Contractor shall ensure that damage does not occur to completed piles through his method of working. The Contractor shall submit to the Engineer a pile installation programme. The proposed sequence and timing of pile installation shall be such that the installation works shall not cause any damage to adjacent piles. Piling works shall not commence until approval of the Engineer has been obtained.

2.2 Tolerances

Tolerances shall be in accordance with the requirements in Clause 1.3 herein.

2.3 Concrete

(a) Trial Mix

The Contractor shall arrange to have a trial mix in the presence of the Engineer prior to the commencement of field work. The trial mix shall be carried out in accordance to the design mix submitted to the Engineer.

(b) Concrete for Piles

Unless otherwise stated, concrete used shall comply with relevant specifications and as



approved by the Engineer. The grade of concrete shall be as specified. Minimum grade of concrete is 35 (characteristic cube strength of 35 N/mm² at 28 days) with minimum cement content of 400kg per cubic meter of concrete, unless otherwise stated in the drawings. Concrete admixture shall only be used with the permission of the Engineer, and shall be used strictly in accordance with relevant specification.

The Engineer may permit the use of ready mixed concrete provided complete details of the mix proportions and workability have been submitted to him for prior approval. Such permission shall only be given for as long as the Engineer is satisfied that the concrete complies with relevant specification and the recommendations of M.S. 523. The Contractor shall ensure that the Engineer shall have access to the supplier's mixing plant at all times for inspection and checks on quality of concrete supplied. Each load shall be accompanied by a delivery note stamped with the time of mixing and stating the consignee and quantities of each material in the mix including water and additives.

(c) Concrete Testing

Close control of the mixing of the concrete shall be exercised and cube strength tests shall be carried out in accordance with M.S. 26. Unless the Engineer otherwise directs, a set of at least three 6" cubes shall be taken for every 10 cubic metres or every group of 10 batches of concrete used for the piling works. For the latter, the samples shall be taken from one single batch randomly selected from the group of batches. One cube of each set shall be tested at seven days and the remaining two at 28 days after casting. The test cubes shall be made from a representative batch of concrete as that used for the piling works and each cube shall be properly marked and identified with details relating the specimen to the borehole in which the concrete is used.

Test shall be carried out by approved lab. Test results shall be submitted to the Engineer within 48 hours after testing.

The Contractor shall not carry out the specified cube strength tests without prior notice to the Engineer. The tests must be witness by the Engineer or his representative. The contractor shall provide sufficient quantity of all necessary equipment at site to carry out these tests.

(d) Workability

Slump test shall be undertaken for every truck load of concrete. Slump measured at the time of discharge into pile shaft or at the time of discharge into the concrete pump hopper shall be in accordance with the standards shown below unless otherwise approved. A concrete pump shall not be used to place tremie concrete directly into the pile shaft.

Class of Slump (mm) Workability		Typical Conditions of Use
A	100 ± 25	Where concrete is to be placed in water-free shaft.
B	175 ± 25	Where concrete is to be placed by tremie method under drilling fluid.

The concrete for piles shall be as specified in the design requirement with suitably enriched cement content to permit a high slump mix. Alternatively, the Contractor may incorporate an approved set retarding additive into the mix to ensure extended workability of the concrete after placement. It is held that the Contractor has included these provisions in the unit rate for the pile.



(e) Failure of Concrete Cube Tests

If the concrete cubes as tested failed to satisfy the criteria as prescribed in the Specification, the Contractor shall undertake all necessary additional and consequential remedial/compensatory Work to the approval of the Engineer. The piles shall be rejected as in Clause 1.8 "Rejected Piles".

2.4 Pile Excavation

(a) Pile size and length

The Contractor shall carry out own tests along the proposed wall alignment to determine the bedrock level. Probing of bedrock shall be carried out along the proposed wall alignment at intervals to be agreed by the Engineer.

(b) Boring into recently cast piles

Piles shall not be bored into other piles which have recently been cast and which contain workable or partially set concrete that a flow of concrete or instability could be induced or damage caused to any installed piles.

(c) Stability of Boreholes for Secant Piles

It is held that the Contractor has allowed in the unit rate of the pile for the implementation of all necessary measures, including the provision of all materials, labour and plant, for maintaining the stability of the sides of boreholes during secant pile installation and successful completion of the piles. The Contractor shall submit his proposed methods for agreement prior to commencement of boring operations.

Irrespective of the presence of ground water, the sides of all borehole shall be kept intact and no loose material shall be permitted to fall into the bottom of the boreholes. The Contractor's boring equipment shall be able to sink a steel casing to support the sides of all boring.

If the sides of boreholes are found to be not stable, temporary steel casing shall be driven into stable stratum. The borehole shall be filled with drilling fluid to a level sufficiently to stabilise the boreholes. The Contractor shall also carry out necessary grouting or sealing using suitable materials to control and prevent collapse of the boreholes or lost of drilling fluid or lost of concrete during installation of secant piles.

If ground water is found in any hole in sufficient quantity or gushing out as to affect boring operations or excavations and removal of soil from the boreholes, or the sides of boreholes collapse, then a steel casing of appropriate size and length in conjunction with stabilising fluid or other alternatives of sufficient strength shall be used to support the sides of the borehole and permit boring operations to proceed smoothly and safely. The proposed drilling fluid mix must be submitted to the Engineer for approval.

Excavations shall not be exposed to the atmosphere longer than is necessary and shall be covered at all times when work is not in progress. Pile excavated shall be cast within 24 hours unless otherwise agreed by the Engineer.

In the event of a rapid loss of drilling fluid from the borehole excavation and caused instability of bore, the excavation shall be backfilled without delay or other appropriate and approved remedial measures taken by the Contractor like installing temporary casing prior to resuming boring at that location.



(d) Stability of bore by temporary casing method

Where the use of a temporary casing is required to maintain the stability of a bore, the bottom of casing shall be kept a minimum of 1 metre or more below the unstable strata to prevent the inflow of soil and the formation of cavities in the surrounding ground. The process of advancing the bore and the temporary casing shall be such that soil is not drawn into the bore from outside the area of the pile and cavities are not created outside the temporary casing.

Temporary casings shall be thin walled mild steel cylindrical casing, spirally welded or other similar construction. The dimensions and quality of the casing shall be adequate to withstand without damage or distortion all handling, construction and ground stresses to which they will be subjected, including preventing concrete from within the pile from displacing soft soil or soil squeezing in and displacing fresh concrete. The casings shall have an internal diameter not less than the specified pile diameter. They shall be free of significant distortion, of uniform cross-section throughout each continuous length and free from internal projections and encrusted concrete which might prevent the proper formation of piles. The joints of casings shall be reasonably watertight.

If temporary casings are damaged during installation in a manner which prevents the proper formation of the pile, such casings shall be withdrawn from the bore before concrete is placed, repaired if necessary, or other action taken as may be approved to continue the construction of the pile.

(e) Rock Coring

Rock coring shall mean coring of sound bedrock using a coring bucket or approved method. The use of chisel shall not be permitted unless otherwise approved by the Engineer. When approved, the chiselling shall not cause loosening or collapse of borehole. Coring of rock other than the two items specified below shall not be considered as coring in rock, and will only be considered as boring in soil.

- (i) Rock socket length
- (ii) Cavity roof

Coring of inclined rock surface, limestone pinnacles, cavities and soil below boulder/floater shall be considered as boring in soils.

Socket length shall be measured from the flattened horizontal bedrock surface. This flat horizontal surface shall be probed using kelly bar or steel bar at a minimum of five positions over the borehole to confirm sound bedrock for socketing.

(f) Spillage and Disposal

All reasonable steps shall be taken to prevent the spillage of drilling fluid on the site in areas outside the immediate vicinity of boring. Discarded drilling fluid shall be removed from the site without delay. In disposal of unwanted drilling fluid, the Contractor shall comply with government regulations and shall propose a proper disposal method to be approved by the Engineer.

(g) Inspection of Pile Excavation

Where practicable, all pile excavations shall be inspected for their full length before concreting. The Contractor shall provide all the apparatus necessary for the inspection.

Inspection shall be carried out either from the ground level or below ground level at the sole discretion of the Engineer prior to concrete being placed in the borehole. For such inspection to be carried out safely, the Contractor shall provide all facilities and



assistance to enable the said inspection to be done. In the course of inspection any loose or soft material in the borehole which is likely to affect the performance of the pile shall be removed to the satisfaction of the Engineer.

In the case of inspection from ground level, the base of the boring shall be inspected by approved method for wet hole and means of a light for dry hole to ensure that all loose, disturbed and/or remoulded soil is removed and that the sides of the boring will remain stable during the subsequent concreting operations. The verticality and position of the boring shall be checked to ensure that they meet the specified tolerances.

Inspection below ground level for dry hole method shall be carried out for piles with shafts of 760mm (2'6") diameter and above. For this purpose the Contractor shall, apart from providing other safety measures, also provide the required facilities such as an approved type of a steel safety cage with an air-line, lifting cable and hoist, gas detector, lights, etc. to enable descent into and ascent from the borehole to be carried out safely without any danger to life. In this regard the safety precautions described in CP 2011:1969 "Safety Precautions in the Construction of Large Diameter Boreholes for Piling and Other Purposes" shall generally be followed, unless otherwise directed by the Engineer.

(h) Pumping from Bored Hole

Pumping from boreholes may be carried out from time to time on a number of piles designated by the Engineer to verify the suitability of dry hole construction, or to investigate and rectify a cold joint in a pile shaft where concreting has been interrupted.

No pumping from a borehole shall be permitted unless a casing has been placed into the stable stratum which prevents further ingress of water of significant quantity from other strata into the borehole, or unless it can be shown that pumping will not have a detrimental effect on the surrounding soil or hamper the piling operation in any way.

(i) Cleaning Out

Upon completion of boring the excavation shall be cleaned of all loose, disturbed and or remoulded soil and sediment soil to expose a firm base of undisturbed material using a suitable and effective method to be approved by the Engineer.

(j) Continuity of Construction

A pile constructed in a stable soil without the use of temporary casing or other support shall be bored and concreted without prolonged delay to ensure that the soil characteristics are not significantly altered.

(k) Surface Water

All boreholes shall be protected from the possibility of any surface water entering the hole from time to time and until the hole is completed and ready to be concreted.

(l) Excavation Materials

Surplus earth resulting from piling operations shall be used where required or removed from site as directed by the Engineer.

2.5 Placement of Reinforcement

Reinforcement shall be free from rust and mud and not be placed until inspected and accepted.

Reinforcement cages shall be sufficiently rigid to ensure that they remain at their correct level



during the lifting and placing of the concrete and the extraction of temporary lining tubes. Reinforcement shall be maintained in its correct position during concreting of the pile. The minimum cover to all reinforcement shall not be less than 75mm.

Concrete spacer shall be provided at every 3m interval or closer, size and minimum yield strength of reinforcement shall be as specified in the Drawing. Details by which the Contractor plans to ensure the correct cover to and position of the reinforcement shall be approved by the Engineer.

The main longitudinal reinforcing bars in piles not exceeding 12 metres in length shall be in one continuous length unless otherwise specified. In piles longer than 12 metres and required to be reinforced throughout their full lengths when specified, joints with staggered laps of alternate bars will be permitted in main longitudinal bars at 12- metre nominal intervals unless otherwise specified in the Drawings. Joints in reinforcement shall comply with the specific requirements of BS8110 clause 3.12.8.

The Contractor shall submit for approval a method statement on the manner by which he intends to lower reinforcement cages into pile shafts. Where tack welding is carried out on pile reinforcement for the purpose of hoisting, such welding shall be located only within the top 100mm of each reinforcement cage. Where the top of a reinforcement cage being lowered is to be lapped to the next cage, as in the case of tension piles exceeding 12 metres in length, the Contractor shall provide adequate sacrificial steel to compensate any lapped reinforcement which has been tack welded, where such tack welding is the requirement of the Contractor for his hoisting operation. Sacrificial steel shall be of the same grade and size as that of the compensated bar.

If required by the Engineer, reinforcement cages shall be flushed with fresh water to remove accumulated salts or other deposits immediately prior to lowering into the pile shaft.

On completion of the pile, the reinforcement shall be located within a vertical tolerance of +150/-50mm (i.e. a maximum of 150mm high) on the level of the reinforcement projecting above the final cut-off level.

2.6 Concreting in Wet Hole

Immediately after the boring for the pile has been completed, approval to commence concreting shall be sought and, when this has been obtained, concreting shall start forthwith and continue without interruption. All concrete for cast-in-place piles shall be compacted to produce a dense homogeneous mass by a method agreed by the Engineer.

Concrete to be placed under drilling fluid shall be placed using a tremie concrete pipe in accordance with BS 8004, Clauses 7.4.5.4.2 and 8.2.2.3.4. Where discrepancies arise, the provisions of this specification shall take precedence.

Alternative methods of placing concrete such as the use of a drop bottom bucket or hose from a concrete pump will not be accepted by the Engineer. At no stage concrete be permitted to discharge freely into drilling fluid.

Before placing concrete, agreed measures shall be taken by the Contractor to ensure that there is no accumulation of contaminated drilling fluid, silt or other deleterious material at the base of the bore. Contaminated drilling fluid could impair the free flow of concrete from the tremie pipe and affecting the performance of the pile.

A sample of the drilling fluid shall be taken from the base of bore using an accepted sampling device. If the drilling fluid does not comply to the specification, concrete placement shall not proceed and the Contractor shall modify or replace the drilling fluid to meet the requirements of this specification.



The tremie concrete pipe shall consist of a series of metal pipes with internal diameter not less than 250mm. The receiving hopper shall have a capacity at least equal to that of the pipe it feeds. At all times, a sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from concrete exceeds that from the water or drilling fluid.

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 placed at the discharge outlet of the pipe to prevent direct contact between the first charge of concrete in the tremie pipe and drilling fluid. If the plug or barrier is sacrificial, it shall not be retained in the mass of the concrete.

The tremie pipe outlet shall be kept at least 1.5 metres below the surface of the concrete at all stages in the pour. The Contractor shall develop a system of level checks for the concrete and pipe outlet to ensure that this requirement is met. The tremie pipe shall be withdrawn upward gently below the concrete level, and shall not be given any violent movement either in dislodging the concrete within the pipe or for any other reason.

Concrete placement shall be halted should a delay or breakdown occur during the concreting operation which in the opinion of the Engineer, could cause a cold joint, entrapment of latency in the tremie concrete, or otherwise lead to defective concrete. Before the remainder of the pile shaft can be concreted, the pile shall be dewatered and the top surface of the tremie concrete cut back to sound concrete and cleaned of all laitance and weak concrete. The remainder of the pile shall either be cast by tremie or in the dry, as directed by the Engineer. If this remedial work can not be carried out due to construction difficulty, the Contractor will need to construct a replacement pile.

The concrete for each pile shall be from the same source. The Contractor is to ensure that the supply from whatever source (whether site-mixed or ready-mixed) is of sufficient quantity so that concrete for each pile shall be placed without such interruption.

All holes bored shall be concreted within the same day. In the event of rain, the Contractor is to provide adequate shelter to keep the hole dry and to concrete under cover.

The method of placing and the workability of concrete shall be such that a continuous monolithic concrete shaft of the full cross-section is formed. The method of placing shall be approved by the Engineer. The Contractor shall take all precautions in the design of the mix and the placement of concrete to avoid arching of the concrete in the pile shaft. No spoil, liquid or other deleterious matter shall be allowed to contaminate the concrete.

Temporary casings shall be extracted while the concrete within remains sufficiently workable to ensure that the concrete is not lifted and that the resultant pile is continuous and of full section. Temporary casings shall be extracted in not more than 2 hours after concreting has completed.

When casings and linings are withdrawn as concreting proceeds, a sufficient head of concrete shall be maintained to prevent the entry of ground water which may cause reduction of cross-section of the pile. No concrete shall be placed after the bottom of the casing or lining has been lifted above the top of the concrete. Concrete shall be placed continuously as the casing is extracted until the desired head of concrete is obtained.

Adequate precautions shall be taken in all cases where the withdrawal of casing could result in excess heads of water or drilling fluid. Excess pressure heads are caused by the displacement of water or fluid by concrete as the concrete flows into its final position against the wall of the shaft. Precautions such as the use of two or more discontinuous lengths of casing (double casing) shall be deemed an acceptable method of construction in this case.

In the event of the ground water level being higher than the required pile head cut-off level shown in the contract drawings, the Contractor shall submit his proposals for agreement prior to placing concrete. The pile head shall not be let below the ground water level unless adequate and agreed precautions are taken.



The top of the pile shall be brought above the required cut-off level by an amount sufficient to ensure a sound concrete at cut-off level and the surplus removed to ensure satisfactory bonding of the pile head to the structure.

The actual volume of concrete used for each pile must be measured with the calculated volume required. If the difference between these two volumes indicates a possible necking, the Contractor shall propose and carry out appropriate tests and measures to the approval of the Engineer to ensure the adequacy of the pile.

Backfilling of Empty Bore - On completion of concreting, the remaining empty bore shall be backfilled with suitable soil or lean concrete unless otherwise agreed by the Engineer.

Any consequences causing the pile rejected by the Engineer due to supply of concrete shall be on Contractor's own risk.

2.7 Stripping Pile Heads and Bonding

The piles shall be constructed to a sufficient height above the required cut-off levels ('overcast') to ensure that all concrete at and below cut-off level is homogeneous and free of laitance and deleterious matter. The Contractor shall be required to provide adequate reinforcement with sufficient length to project above cut-off levels so that the reinforcement can be properly bonded in the capping beam. After completion of piling, the Contractor shall excavate and cut back the piles as necessary to verify the cut-off levels and to give accurate details of the pile positions as compared with the positions indicated on the layout plans of the detailed design. Defective concrete in pile heads shall be cut away and made good with new concrete well bonded to the pile head. If the pile is undercast, it shall be built-up with new concrete and a permanent casing.

2.8 Drilling Fluid and Soil Tests

Minimum frequency of testing are as follows:

- 1) fresh drilling fluid
- 2) drilling fluid taken from the bottom of the pile before concreting
- 3) recycle drilling fluid taken from desanding machine
- 4) drilling fluid left in the bored hole for more than 12 hours

The frequency of testing drilling fluid and the method and procedure of sampling shall be proposed by the Contractor and agreed by the Engineer before the commencement of the work. The frequency may subsequently be varied with the approval of the Engineer. Control tests for density shall be carried out daily on the drilling fluid using suitable apparatus. The measuring device shall be calibrated to read within 0.01 g/ml. The results shall be within the ranges stated in Table 2.1.

All reasonable steps shall be taken to prevent the spillage of drilling fluid on the site. Discarded drilling fluid shall be removed from the site without delay and such removal shall comply with the regulations of the relevant Authorities.

If sand content is more than 5%, Contractor shall carried out desanding to screen out sand from the drilling fluid before concreting.



TABLE 2.1 - TESTS FOR BENTONITE DRILLING FLUIDS

Property	Units	Stages			Test Equipment
		Fresh	Ready for re-use	Before concreting	
Density	g/ml	< 1.10	< 1.25	< 1.15	Mud balance
Marsh viscosity (946 ml)	sec	32 to 50	32 to 60	32 to 50	Marsh funnel
Fluid loss (30 min)	ml	< 30	< 50	NA	Filter press
pH		7 to 11	7 to 12	NA	pH meter
Sand content	%	NA	NA	< 4	Sand content set

Tests for drilling fluid other than bentonite have to be approved before use.

2.9 Dry Hole Construction (If directed by the Engineer Only)

For the purpose of the tender, the boreholes for pile construction shall be assumed to be wet holes, where the tremie method of concreting shall be adopted.

However, during pile installation as directed by the Engineer, the Contractor shall be required to determine for a number of designated piles whether dry hole construction could be implemented. The accepted method for dry hole verification shall be to pump out all water in the hole, and observe the rate of water intrusion and to be decided by the Engineer.

Whenever practicable, concrete for bored piles may be placed into a clean, dry hole. All dry holes shall be inspected and approved by the Engineer prior to placing of concrete. All facilities, labour and material required for the inspection shall be provided by the Contractor.

Agreed measures shall be taken to avoid segregation and bleeding, and that the concrete at the bottom of the pile is not deficient in grout. The concrete shall be placed by tremie. The free fall of the concrete from the bottom of the tube shall not exceed 1.5 times the diameter of the pile. The concrete shall be placed as quickly as possible where the ground is liable to deteriorate on exposure.

2.10 Pile Acceptance Criteria

The target termination depth, required socket length, concrete strength and the required interlocking are as shown in the drawings. The actual termination depths and socket lengths shall be agreed with the Engineer based on review of the conditions encountered during boring and prior to commencement of concreting. Piles shall meet tolerance requirements as specified in Clause 1.3. Any defects of the secant pile walls shall be made good by the Contractor.

2.11 Casting Level

Concrete shall be finished not less than 300mm above the cut-off level ('overcast') to ensure that all concrete at and below cut-off level is homogeneous and free of laitance and deleterious matter. A thicker overcast may be required by the Engineer depending on site condition, and this shall be carried out. The overcast shall be chipped off to cut-off level later by the Contractor.



2.12 Defective Concrete

Defective concrete in the pile heads shall be cut away and made good with new concrete well bonded into the old concrete.

2.13 Piling Records

Submission of the record shall be in accordance with Clause 1.11 herein.

The record shall contain all information required by the Engineer including the following:

- Name of Supervisor
- Pile forming equipment including Rig No.
- Length, diameter, reference number and coordinate of the borehole
- Existing ground level
- Cut-off level, rock level, pile toe level
- Length of pile
- Log of material encountered and level of change in strata and where boring stops
- Speed of boring through soil or rock shall be recorded for every metre of drilling
- Depth bored and details of inclination or displacement of the pile during boring and date of inspection
- Length of reinforcement cage, reinforcement details
- Water table below ground level
- Levels where seepage occurs
- Results of tests on soils
- Results of tests on concrete cubes including slump test
- Length of temporary casing if used
- Date and actual volume of concrete placed in piles, time start and complete
- Concrete level after each truck of concrete
- Details of all inspections including base inspections
- Details of all obstructions, delays and other interruption
- Signature of the Resident Engineer or his representative
- Weather condition
- Method of casting (wet/dry tremie)
- Date and time boring start and complete and speed of drilling
- Type of stabilising fluid and results of fluid used
- Collapse of bore or loss of drilling fluid
- Cavities or slump zones encountered

2.14 Treatment of Cavities and Slump Zones

The specification for treatment of cavities and slump zones should be followed unless otherwise instructed by the Engineer.

3.0 SOFT PILES (ONLY APPLICABLE FOR HARD/SOFT SECANT PILE WALLS)

3.1 General

A hard/soft secant pile wall consists of overlapping piles. The primary (female) piles are cast first and consist of a soft pile mix, typically cement and bentonite or cement, bentonite and sand with a characteristic compressive strength of 1-3N/mm². They are unreinforced. The Contractor shall be responsible for the design of the self-hardening mix.



Before commencing the filling of the pile, the Contractor shall plan and reasonably demonstrate that a sufficient quantity of self-hardening mix is available to construct the pile in one continuous operation.

Removal of temporary casing, when used, shall be completed before the self-hardening mix within the casing loses its workability. No spoil, liquid or other foreign matter shall be allowed to contaminate the mix.

3.2 Workability of Self-Hardening Mix

Self-hardening mixes shall be coherent and of a workability such that when in its final position and after all constructional procedures in forming the pile have been completed it shall remain sufficient workable.

3.3 Placing Self-Hardening Mix

The self-hardening mix shall be placed using methods appropriate to the composition of the mix. These may include placing through a hopper attached to a length of tremie pipe and tremie methods in which case placement shall be in accordance with that in Section 2 above. Other self-hardening mixes using proprietary methods shall be set out by the Contractor in his method of construction.

3.4 Time Period for Excavation and Placing Self-Hardening Mix

The time period after a pile is excavated and before the self-hardening mix is placed shall not exceed 12 hours unless otherwise permitted. If temporary casing is used, this period shall start when excavation below the temporary casing commences.

4.0 BACKFILLING OF EMPTY BORE

Where concrete is not brought to the top of the piling platform, the empty pile bore shall be backfilled as soon as possible with suitable soil or lean concrete unless otherwise specified by the Engineer. Prior to backfilling, the bore shall be clearly marked and fenced off so as not to cause a safety hazard.

5.0 WATER RETENTION

The Contractor shall be responsible for the repair of any cracks, joint or defect of pile where on exposure of the wall visible running water leaks are found which would result in leakage of the walls.

6.0 SPECIAL CONSIDERATIONS FOR SECANT PILE WALLS

The hard/hard secant pile walls which consist of overlapping structural concrete piles constructed usually by high torque rotary piling equipment. Temporary support of the pile bore is provided by drill casing which generally extends over the full pile length and with drilling fluid. The secant pile wall is constructed in two stages. All piles constructed during Stage 1 are known as primary (female) piles. These are spaced at the specified primary secant pile spacing (in the drawings). All piles constructed during Stage 2 are known as secondary (male) piles. These are positioned between the primary piles and secant (i.e. overlap) with the primary piles.



The Contractor shall be responsible for the programme and sequence of construction which is dependent on the rate of gain of strength of primary piles and which affects the time within which secondary piles can be formed. The concrete mix may include additives to control the rate of gain of strength, particularly the primary piles. Where the Contractor considers that alternative proposals for the concrete mix are required then evidence of trial mixes should be provided.

For hard/soft secant pile walls, the soft piles are normally formed with a weak bentonite/cement mix which act as a void filler. The Contractor shall be responsible for the design of the self-hardening mix.

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