

# ***PILING AND DIAPHRAGM WALLING***

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# Piling and Diaphragm Walling

## 1601 General

- 1 Piling and diaphragm walling shall be carried out as described in Appendix 16/1 and shall comply with the requirements of this Series.
- 2 Unless otherwise described in Appendix 16/1, concrete, reinforcement and prestressing tendons for piling shall comply with the 1700 Series and steelwork for piling shall comply with the 1800 Series.
- 3 The Contractor shall report immediately to the Engineer any circumstance which indicates that in the Contractor's opinion the ground conditions differ from those expected from his interpretation of the ground investigation reports.
- 4 Piles shall be installed within the following maximum permitted tolerances:  

Position:	75 mm in either direction at finished level of pile head
Verticality:	1 in 75 deviation from the vertical
Rake:	1 in 25 deviation from the specified rake

No method of forcible correction will be permitted.
- 5 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 programme of his proposed sequence and timing for driving or boring piles having regard to the avoidance of damage to adjacent piles or unfilled pile excavations. Slip coating shall be used as indicated in Appendix 16/1 or as instructed by the Engineer. Piling shall not commence until approval by the Engineer has been obtained.

## 1602 Precast Concrete Piles

### General

- 1 After a pile has been cast, it shall be indelibly marked to show the date of casting, identification number, length and where appropriate the prestressing force applied.

### Storing and Handling

- 2 Piles shall be stacked on firm ground in groups of the same length. Packings of uniform thickness shall be provided between piles at the lifting points.

### Driving

- 3 Piles shall not be driven until the concrete has achieved the specified characteristic strength. Unless otherwise described in Appendix 16/1, concrete shall not be stressed until it has reached the age at which two test cubes taken from it have attained the prescribed transfer strength. The test cubes shall be made and tested in compliance with BS 1881 : Part 108 and 116 respectively and shall be cured in similar conditions to the concrete to which they relate in a manner approved by the Engineer. The Engineer shall be notified 24 hours before the commencement of pile driving on the Site.
- 4 Piles shall be driven either to the approved set or prescribed depth and in the sequence of driving approved by the Engineer. The set shall be taken in the presence of the Engineer unless permission to the contrary has been obtained in writing.
- 5 Each pile shall be driven continuously, unless otherwise agreed by the Engineer, until the required set or prescribed depth has been reached.

### Lengthening of Piles

- 6 Unless another method is agreed by the Engineer, reinforced concrete piles shall be lengthened where required by stripping concrete from the main or splicing reinforcement for a distance of 40 times its diameter and tying additional reinforcement securely in position. Welding of reinforcement or mechanical splices complying with the 1700 Series may be permitted. Prestressed concrete piles shall only be lengthened by a method agreed by the Engineer. Driving shall not be resumed until the cube strength of the concrete in the extension of the pile is at least equal to the specified characteristic strength and the approval of the Engineer to recommence driving has been obtained. Test cubes shall be made and tested in compliance with BS 1881 : Part 108 and 116 respectively and shall be cured in similar conditions to the concrete to which they relate, in a manner approved by the Engineer.

### Removal of Surplus Length

- 7 Any length of pile surplus to that required in the Contract shall be cut off and removed. The Contractor shall obtain the written permission of the Engineer before cutting off this surplus by an agreed method.

### Risen Piles

- 8 When a pile has risen as a result of driving adjacent piles, the Contractor shall submit to the Engineer his proposals for the remedial work and shall carry out remedial work as agreed by the Engineer.

## 1603 Cast-in-place Piles

### General

- 1 This Clause does not apply to cast-in-place piles constructed by the continuous flight auger method. The Contractor shall carry out the work in accordance with a method statement which has been submitted to and approved by the Engineer. This method statement shall include as appropriate, under-reaming or driving, the length or set to be obtained, details of the constituent materials of any drilling fluid used for stabilisation, the method of inspection, details of the concrete mix, the minimum time between the completion of one pile and the commencement of the next, and the pattern of construction.

### Drilling Fluid

- 2 When the use of drilling fluid has been approved by the Engineer for maintaining the stability of a boring, the level of the fluid in the boring shall be such as to achieve stability. An adequate temporary casing shall be used in conjunction with this method to ensure stability of the strata near ground level until concrete has been placed. The fluid level shall be maintained at a level not less than 1 m above the level of external groundwater.
- 3 Bentonite, as supplied to the Site and before mixing, shall comply with the specification of the Engineering Equipment and Material Users Association, Drilling Fluid Materials, Publication No. 163, Bentonite. A certificate shall be obtained by the Contractor from the manufacturer showing the properties of each consignment of bentonite delivered to the Site. This certificate shall be made available to the Engineer on request. The properties to be given by the manufacturer are the apparent viscosity range (in centipoises) and the gel strength range (N/m<sup>2</sup>) for solids in water.
- 4 Where the use of bentonite is approved it shall be mixed thoroughly with clean fresh water to make a suspension which will maintain the stability of the boring/excavation for the period necessary to place concrete and to complete construction. The temperature of the water

used in mixing the drilling fluid, and of the fluid when supplied to the boring/excavation shall be not lower than 5°C. Where saline or chemically contaminated groundwater occurs, special precautions shall be taken to modify the drilling fluid or prehydrate the bentonite in fresh water so as to render it suitable in all respects for the construction of the Works.

- 5 In the event of a rapid or sustained loss of drilling fluid from the pile boring, the boring shall be backfilled without delay and the instructions of the Engineer shall be obtained before excavation at that location is resumed.
- 6 Pumping from a boring other than under controlled concrete placement shall not be permitted without the approval of the Engineer.
- 7 On completion of boring, all loose, disturbed or remoulded soil shall be removed from the bottom of the boring.

### Driven Cast-in-place Piles

- 8 Casings of driven cast-in-place piles shall be installed to the approved set or prescribed depth, and in the sequence of driving approved by the Engineer unless otherwise agreed in writing.
- 9 Each casing of driven cast-in-place piles shall be driven continuously unless otherwise agreed by the Engineer, until the approved set or prescribed depth has been reached.
- 10 Where described in Appendix 16/1, the Contractor shall demonstrate that the final set obtained in driving the casings is maintained after a minimum period of 24 hours.
- 11 Levels shall be taken immediately after the final set is obtained and before concreting each pile. When a pile has risen as a result of driving adjacent piles the Contractor shall submit to the Engineer his proposals for remedial work and shall carry out remedial work as agreed by the Engineer.
- 12 Where a permanent casing is to be made from a series of short sections it shall be designed and installed so as to produce a continuous watertight shaft. The dimensions and quality of the casing shall be adequate to withstand the stresses caused by handling and installation without damage or distortion.

### Bored Cast-in-place Piles

- 13 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 as required in Appendix 16/1.
- 14 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. The Contractor shall take all precautions necessary to prevent the ingress of surface water or foreign matter. Temporary casing or drilling fluid shall be provided where necessary to ensure stability of the pile boring during boring, placing of reinforcement and concreting operations.
- 15 Before concreting, any permanent casings shall be clean and undamaged.

### Reinforcement

- 16 Reinforcement shall be maintained in its correct position during concreting of the pile. Where it is made up into cages, they shall be sufficiently rigid to enable them to be handled without damage. The welding of reinforcement to form a rigid cage will be permitted subject to the approval of details by the Engineer. Welding shall be performed to the requirements of the 1700 Series.

### Concreting

- 17 Immediately after the boring has been completed, the Engineer's 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. In a boring which contains water or drilling fluid the concrete shall be placed by tremie by an approved method.
- 18 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.
- 19 The top of the pile shall be brought above the required finished level of the pile head by an amount sufficient to ensure a sound pile and the surplus removed to ensure satisfactory bonding of the pile head to the structure.

### Withdrawal of Casings and Linings

- 20 When casings and linings are withdrawn as concreting proceeds, a sufficient head of concrete shall be maintained to prevent the entry of groundwater or 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.

### Drilling Fluid and Soils Tests

- 21 The frequency of testing drilling fluid and the method and procedure of sampling shall be proposed by the Contractor to suit his method of construction 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. For average soil conditions the results shall generally be within the ranges stated in Table 16/1.
- 22 When required in Appendix 1/5, the Contractor shall take from the pile boring undisturbed soil samples in compliance with BS 5930. Such samples shall be tested as stated in Appendix 1/5.

## 1604 Steel Piles

### Tolerances

- 1 For rolled sections the deviation from straightness shall be within the tolerances specified in BS 4. For proprietary sections made up from rolled sections and sheet piles, the deviation from straightness shall not exceed 1/1000 of the length of pile. For tubular piles the deviation from straightness shall not exceed 1/600 of a length not exceeding 10 m. When two or more such lengths are joined, the deviation from straightness shall not exceed 1/1000 of the complete length unless otherwise agreed by the Engineer.
- 2 For a tubular pile where the loads will be carried by the wall of the pile, the external dimensions at any section on the circumference shall not differ from the theoretical dimensions by more than -1% to +1%. The rolling or manufacturing tolerances shall be such that the actual weight of any section does not differ from the theoretical weight by more than -2½% to +5%.

**Table 16/1: Tests for Drilling Fluids**

Property to be measured	Range of results at 20°C	Test method from the American Petroleum Institute (API) Publication RP13B
Density	Less than 1.10 g/ml	Mud Density Balance
Fluid Loss	Less than 40 ml	30 minute test
Viscosity	30-90 seconds or less than 20 cP	Marsh Cone method Fann Viscometer
Shear Strength (10 minute gel strength)	1.4 – 10 N/m <sup>2</sup> or 4 – 40 N/m <sup>2</sup>	Shearometer Fann Viscometer
Sand Content	Less than 5%	Screen
pH	9.5 – 12	pH indicator paper strips or electrical pH meter

**Note:**

Where the Fann Viscometer is used, the fluid sample should be screened by a 300 micron sieve before testing.

**Storage and Handling**

- 3 Where piles are to be stored, they shall be placed on sufficient supports on firm ground to avoid damage. For sheet piles, care shall be taken to prevent damage to, or obstructions entering, the interlocking clutches. Packings of uniform thickness shall be provided between pile groups.
- 4 Each pile shall be indelibly marked to show its identification number, grade of steel and length.

**Driving**

- 5 Piles previously driven shall not be used, except with the approval of the Engineer, in the Permanent Works.
- 6 All sheet piling before driving shall be pitched and supported as a panel of piles, unless another method is agreed by the Engineer. The piles shall be guided and held in position by temporary gates with each pile properly interlocked with its neighbour. Piles shall not by-pass one another in place of interlocking.
- 7 Where sheet piles are driven in panels, the end piles to each panel shall be driven in advance of the general run of piles. After allowing for initial penetration, no pile in the panel shall be driven more than 1 m in advance of the toe level of the panel in general, throughout the sequence of driving, unless otherwise agreed by the Engineer.

- 8 The Engineer shall be notified 24 hours before the commencement of driving. Piles shall be driven to the required set or prescribed depth and in the sequence of driving agreed by the Engineer. The set shall be taken in the presence of the Engineer unless permission to the contrary has been obtained in writing.
- 9 Driving of bearing piles or panels of sheet piles shall be continuous, unless otherwise agreed by the Engineer, until the required set or prescribed depth has been reached.

**Lengthening of Piles**

- 10 Subject to the Engineer's agreement, the Contractor may provide each pile in more than one length. Full penetration butt welds complying with the 1800 Series shall be used for all joining and lengthening. All piles shall be from the same rolling to facilitate welding. Sections to be jointed shall be maintained in true alignment and position. After welding, the affected areas shall be thoroughly cleaned and protected in the same way as adjacent surfaces.
- 11 Longitudinal seam welds and spiral seam welds of lengths of tubular piles forming a completed pile shall wherever possible be evenly staggered, but if, in order to obtain a satisfactory match of the ends of piles or the specified straightness, the longitudinal seam and spiral seams are brought into close proximity at the joint then they shall be staggered by at least 100 mm.



### Surplus Length of Piles

- 12 Any length of pile surplus to that required in the Contract shall be cut off and removed.

### Risen Piles

- 13 When a pile has risen as a result of driving adjacent piles, the Contractor shall submit to the Engineer his proposals for remedial work and shall carry out remedial work as agreed by the Engineer.

## 1605 Proof Loading of Piles

### General

- 1 Piles selected by the Engineer shall be tested by proof loading and the Contractor shall give the Engineer at least 24 hours' notice of the commencement of the test.
- 2 The test load shall be applied by a method agreed by the Engineer.

### Trial Piles

- 3 Trial piles, where required in Appendix 16/1, shall be constructed and tested in advance of the main piling operations. Main piles shall not be constructed until the test results of the trial piles have been accepted and the Engineer has given his approval for the main piling operations to proceed.

### Main Piles

- 4 Test piles shall be main piles selected by the Engineer for test loading, by one of the methods described in sub-Clauses 1605.8 and 9, as required in Appendix 16/1, and shall be tested after the pile has attained its characteristic strength.
- 5 Main piles shall not be used as reaction piles without the approval of the Engineer.

### Measuring Devices

- 6 Load measuring devices shall be calibrated before and after each series of tests, whenever adjustments or replacements are made to the devices and at the intervals recommended by the manufacturer of the equipment. Pressure gauges and hydraulic jacks shall be calibrated together. Certificates of calibration from a testing laboratory accredited by ILAB for such calibration shall be supplied to the Engineer.

- 7 The Contractor's proposed method of measuring the movement of pile heads shall be submitted to the Engineer for his agreement.

### Maintained Proof Loading

- 8 For a Maintained Load Test:

- (i) Each increment of load shall be measured within an accuracy of 2%. Movements shall be measured within an accuracy of 0.25 mm. An independent reference frame or wire shall be set up to permit measurement of pile movement. Dial gauges shall be accurate to within 0.1 mm. Overall movements shall be checked by optical or any other levelling method by reference to an external datum.
- (ii) The value of the test load and the number of increments in which it is to be applied shall be as shown on the Drawings.
- (iii) The load after each increment shall be kept constant until the rate of movement is reducing and does not exceed 0.25 mm per hour, measured over a minimum of 15 minutes, unless otherwise agreed by the Engineer.
- (iv) The amount of movement shall be recorded before the next increase of load.
- (v) The load shown on the Drawings as being equal to the working load of the pile shall be maintained for a period of not less than 12 hours and the total movement recorded before proceeding in increments to the full test load.
- (vi) The full test load shall be maintained for not less than 24 hours and the total movement recorded.
- (vii) The load shall be reduced in stages equal to those in which it was applied, unless otherwise shown on the Drawings.
- (viii) The load after each reduction shall be kept constant until the rate of recovery is reducing and does not exceed 0.25 mm per hour.
- (ix) The amount of recovery shall be recorded before the next decrease in load.
- (x) For any period when the load is constant, time and movement shall be recorded immediately on reaching the load and at 15 minute intervals for 1 hour; 30 minute intervals between 1 hour and 4 hours; and at 1 hour intervals between 4 hours and 48 hours; after the application of the increment of load.

- (xi) The movement of the pile under the full test load and the recovery of the pile after its subsequent removal shall be within the limits shown on the Drawings.

#### Constant Rate Proof Loading

**9** For a Constant Rate of Penetration or Constant Rate of Uplift Test:

- (i) The rate of loading shall be such that a constant rate of movement is maintained throughout the test.
- (ii) The rate of movement of the pile shall be agreed with the Engineer before the start of the test.
- (iii) Each increment of test load shall be measured within an accuracy of 2%. Movements shall be measured within an accuracy of 0.25 mm.
- (iv) Readings of load, movement and time shall be made simultaneously at regular intervals and agreed with the Engineer.
- (v) Loading shall be continued until one of the following results is obtained:
  - (a) The test load is reached.
  - (b) A constant or reducing load has been recorded for an interval of movement of 10 mm.
  - (c) A total movement of the pile base equal to 10% of the base diameter, has been reached.
- (vi) The load shall then be reduced in 5 approximately equal stages to zero load, and movement at each load stage including zero load shall be recorded.

#### Pile Proof Loading Records

**10** The Contractor shall, within 24 hours of the completion of the test, submit to the Engineer a complete record of each pile test, including:

- (i) For a Maintained Load Test:
  - (a) A graph of load and movement plotted respectively above and below a common base line of time.
  - (b) A graph of movement and recovery plotted vertically below a horizontal axis of load.
- (ii) For a Constant Rate of Penetration or Constant Rate of Uplift Test:
  - (a) The maximum load reached.
  - (b) A graph of load against movement.

**11** The Contractor shall, within seven working days of the completion of the test, submit to the Engineer, in writing, a complete schedule of data as listed below:

- (i) Copy of the installation details submitted to the Engineer in accordance with Clause 1606 Table 16/2 Piling Records;
- (ii) Date and time of commencement of test;
- (iii) Position relative to adjacent piles (working and reaction piles);
- (iv) Ground level at pile position at commencement of test;
- (v) Pile head level at which test load is applied;
- (vi) Angle of rake;
- (vii) Whether a compression or tension test;
- (viii) Date and time of casting concrete capping and cube test results;
- (ix) Weight of kentledge;
- (x) Ground anchorage or reaction pile details;
- (xi) Jack capacity;
- (xii) Method of load and movement measurement, and temperature corrections where applicable;
- (xiii) Weather conditions including temperature, during test.

Note: All levels shall be to Ordnance Datum and the 24-hour clock shall be used.

#### Reinstatement

**12** On completion of the testing of trial piles and main piles, pile caps and other temporary works shall be cut off and removed from the Site and the area reinstated, all to the satisfaction of the Engineer.

## 1606 Pile Records

- 1 A record of all piles installed shall be kept by the Contractor and a signed copy of the record of the work done each day shall be given to the Engineer within 24 hours.
- 2 The record shall consist of the information listed in Table 16/2.
- 3 On completion of piling, the Contractor shall deliver to the Engineer a schedule recording the final toe levels of all piles relative to Ordnance Datum.

**Table 16/2: Piling Records**

All Piles	Driven Precast Concrete Piles and Steel Piles
Date.	Cross-sectional dimensions.
Contract identification.	Total length of preformed pile.
Pile identification.	Driven length of preformed pile.
Pile type.	Time of commencement and completion of driving or redriving.
Working load.	Sequence of driving in groups.
Ground level at commencement of operations.	Final set.
Working platform level.	Sections and joints used.
Pile toe level.	Type, weight, drop and mechanical condition of hammer used.
Details of any obstructions, delays or other interruptions to the sequence of work, including times.	Number, type and condition of the packing on the pile head.
Finished level of pile head.	Type and condition of the dolly in the helmet.
Ground heave.	For a single acting hammer, the final drop.
	For a double acting hammer, the final frequency of blows.
	The sets taken at intervals during the last 3 m of driving, (if required in Appendix 16/1).
	Details of any interruption in driving.
	Details of redriving.



**Table 16/2: Piling Records (continuation)**

Driven Cast-in-place Concrete Piles	Bored Cast-in-place Concrete Piles
<p>Cross-section dimensions of driving tube (temporary casing).  Cross-sectional dimensions of completed pile.  Length of permanent casing.  Length of finished pile excluding any enlarged base.</p> <p>Time of commencement and completion of driving or redriving.</p> <p>Type, weight, drop and mechanical condition of hammer used.  Number, type and condition of the packing on the pile head.  Type and condition of the dolly in the helmet.  For a single acting hammer, the final drop.  For a double acting hammer, the final frequency of blows.  The sets taken at intervals during the last 3 m of driving, (if required in Appendix 16/1).  Details of any interruption in driving.  Details of redriving.  Method of placing concrete.  Concrete mix details:  Grade of concrete;  Nominal maximum aggregate size;  Cement content;  Type and quantity of admixtures;  Water/cement ratio.  Measured slumps.  Batch times.  Time of commencement of concrete pour.  Time of completion of concrete pour.  Volume of concrete placed in enlarged base.  Volume of concrete placed in pile shaft.  Reinforcement details:  Number, type and size of main reinforcing bars;</p> <p>Type, size and pitch or spacing of helical binding or link bars;  Length of individual reinforcement cages;  Total reinforced length of pile.</p>	<p>Diameter of completed pile.  Diameter of any enlarged base.  Length of temporary casing.  Length of permanent casing.  Length of finished pile including any enlarged base.  Type of boring.  Time of commencement of boring.  Time of completion of boring.  Details of soil strata penetrated.  Details of soil samples taken and in situ tests carried out.  Details of any interruption in boring.  Standing groundwater level and water strikes during boring.  Method of placing concrete.  Concrete mix details:  Grade of concrete;  Nominal maximum aggregate size;  Cement content;  Type and quantity of admixtures;  Water/cement ratio.  Measured slumps.  Batch times.  Time of commencement of concrete pour.  Time of completion of concrete pour.</p> <p>Volume of concrete placed in enlarged base.  Volume of concrete placed in pile shaft.</p> <p>Reinforcement details:  Number, type and size of main reinforcing bars;  Type, size and pitch or spacing of helical binding or link bars;  Length of individual reinforcement cages;  Total reinforced length of pile.</p>

**Notes:**

1. All levels shall be to Ordnance Datum.
2. The 24-hour clock shall be used.
3. For any pile not completed in the working day the date shall be entered in the records together with the times of commencement and completion.
4. For driving operations not using a piling hammer, equivalent information to that required on type, weight, drop, etc, of hammer packing and dolly shall be provided.
5. The final set of each pile shall be recorded as the penetration in mm per 10 blows or the number of blows required to produce a penetration of 25 mm.

## 1607 Diaphragm Wall Construction

### General

- 1 The Contractor shall submit for the Engineer's agreement, his proposals for the construction of diaphragm walls and trench guide walls including the method and sequence of operations and, where required in Appendix 16/1, drawings showing full details of wall panel sizes, recesses and arrangement of reinforcement. The wall panel lengths shall not exceed 4.5 m unless otherwise agreed by the Engineer and the trench shall be stabilized with drilling fluid.
- 2 Trench guide walls shall be stable and of sufficient height to maintain the required head of drilling fluid. They shall be founded at a depth sufficient to prevent erosion of the surrounding soil through turbulence of the drilling fluid.

### Drilling Fluid

- 3 The supply and use of drilling fluid shall comply with sub-Clauses 1603.3 and 4.
- 4 During construction, the level of drilling fluid in the trench shall be maintained within the guide walls and at a level not less than 1.0 m above the level of surrounding groundwater. In the event of a sudden loss of drilling fluid the trench shall be backfilled without delay and the instructions of the Engineer shall be obtained before excavation at that location is resumed.
- 5 All reasonable steps shall be taken to prevent spillage of drilling fluid on the Site. Discarded drilling fluid which has been pumped from the trench shall be removed promptly from the Site in watertight containers.

### Testing of Drilling Fluid

- 6 Three samples of drilling fluid shall be taken from the excavation before concreting any panel, using equipment and a method to be agreed by the Engineer. The samples shall be taken from a layer between 50 mm and 250 mm from the base of the trench. Should the density of any one of these samples fail to comply with Table 16/1, the Contractor shall replace the drilling fluid in the trench with material of the required density by extraction from the base of the trench and replenishment at the top. The sampling and replenishment procedure shall be repeated until compliance is achieved.

### Tolerances

- 7 The wall face to be exposed, and the ends of panels shall be vertical within a tolerance of 1 in 80. At no point shall the wall thickness be less than that shown on the Drawings.

### Reinforcement

- 8 Reinforcement shall be made up into cages which shall be sufficiently rigid to be handled without damage. The cages shall be clearly marked to indicate correct orientation for proper insertion into the trench. Welding of reinforcement to form a rigid cage will be permitted subject to the approval of details by the Engineer. Welding shall be performed to the requirements of the 1700 Series.

### Concreting

- 9 Stop ends, inserted before placing concrete in a panel, shall be clean and have a smooth regular surface. They shall be adequately restrained to prevent movement during concreting. The removal of vertical stop ends shall be completed without damaging the concrete placed against them.
- 10 Concrete for diaphragm walls shall be placed continuously by use of a tremie. The concreting of any panel shall be completed within such time that the concrete above the foot of the tremie remains workable. Compaction of the concrete shall be by gravity only. The concrete pour level shall allow for trimming to sound concrete at the finished levels shown on the Drawings.

### Diaphragm Wall Records

- 11 A record of all diaphragm wall panels constructed shall be kept by the Contractor and a copy of the record of work done each day shall be given to the Engineer within 24 hours. The record shall consist of the following information:
  - (i) Panel numbers;
  - (ii) Levels of the top and bottom of the guide walls;
  - (iii) Top level of the wall as cast;
  - (iv) Depth of base of panel from top of guide wall;
  - (v) Date panel excavated;
  - (vi) Date panel concreted;
  - (vii) Length of panel;

- (viii) Thickness of wall;
- (ix) Strata log;
- (x) Concrete mix details;
- (xi) Volume of concrete used;
- (xii) Details of any obstructions encountered and time spent in overcoming them;
- (xiii) Details of any loss of drilling fluid.

*Note: All levels shall be to Ordnance Datum and the 24-hour clock shall be used.*

- 12 On completion of the construction of each diaphragm wall, the Contractor shall deliver to the Engineer a schedule recording the levels of the top and bottom of each panel to Ordnance Datum.

## 1608 Drilling Fluid Tests

- 1 Tests on drilling fluid shall be carried out in compliance with sub-Clause 1603.21.
- 2 The tests shall be carried out until a consistent working pattern has been established, account being taken of the mixing process, any blending of freshly mixed drilling fluid and previously used drilling fluid and any process which may be used to remove impurities from previously used drilling fluid. When the results show consistent behaviour, the tests for shear strength and pH value may be discontinued. Tests to determine density and viscosity shall be carried out as agreed with the Engineer. In the event of a change in the established working pattern, tests for shear strength and pH value shall be reintroduced for a period as required by the Engineer.

