

TABLE OF CONTENTS

SECTION TS 14. PILES DRIVEN CONCRETE

14.1	GENERAL.....	TS 14-1
14.2	MANUFACTURE.....	TS 14-1
14.2.1	Supply by Contractor.....	TS 14-1
14.2.2	Dimensions.....	TS 14-1
14.2.3	Specifications.....	TS 14-1
14.2.4	Designation and Strength of Piles.....	TS 14-2
14.2.5	Pile Shoes.....	TS 14-2
14.2.6	Marking.....	TS 14-2
14.3	HANDLING, TRANSPORT AND STORAGE.....	TS 14-3
14.3.1	General.....	TS 14-3
14.3.2	Handling.....	TS 14-3
14.3.3	Transport.....	TS 14-3
14.3.4	Storage.....	TS 14-3
14.4	DRIVING OF PILES.....	TS 14-4
14.4.1	General.....	TS 14-4
14.4.2	Minimum Age of Piles Before Driving.....	TS 14-4
14.4.3	Test Piles.....	TS 14-4
14.4.4	Driving Procedure.....	TS 14-4
14.4.5	Pile capacity.....	TS 14-5
14.4.6	Severe Driving.....	TS 14-5
14.4.7	Acceptance of Driven Piles (other than Test Piles).....	TS 14-5
14.4.8	Driving Precast Prestressed Concrete Sheet Piles.....	TS 14-5
14.5	CUTTING OFF AND STRIPPING OF PILE HEAD.....	TS 14-5
14.6	EXTENSIONS OF PILES.....	TS 14-6
14.6.1	General.....	TS 14-6
14.6.2	Splicing Piles by Lapping of Steel.....	TS 14-6
14.6.3	Splicing by Welding of Steel.....	TS 14-6
14.6.4	Splicing with Precast Lengths of Pile.....	TS 14-6
14.6.5	Pile Extensions in Reinforced Concrete.....	TS 14-7
14.6.6	Pile Extensions which are not Driven.....	TS 14-7
14.6.7	Pile Extensions of Prestressed Concrete Piles.....	TS 14-7
14.6.8	Miscellaneous Works Associated with Piling.....	TS 14-7

14.6.8.1 Concrete Filling	TS 14-7
14.6.8.2 Pile Head Treatment	TS 14-7
14.6.8.3 Sand Filling.....	TS 14-8
14.7 MEASUREMENT AND PAYMENT.....	TS 14-8
14.7.1 Prestressed Concrete Test Piling	TS 14-8
14.7.2 Prestressed Concrete Piles	TS 14-9
14.7.3 Prestressed Concrete Sheet Piles.....	TS 14-10
14.7.4 Miscellaneous Works Associated with Piling	TS 14-10

SECTION TS 14. PILES DRIVEN CONCRETE

14.1 GENERAL

This Section covers the driving of precast reinforced or prestressed concrete piles.

The manufacture, handling, transport and storage of precast concrete piles shall be generally in accordance with the requirements of Section TS 4 of this Specification.

The general principles of driving piles shall be in accordance with the requirements of Section TS 13 of this Specification.

14.2 MANUFACTURE

14.2.1 Supply by Contractor

Unless otherwise shown on the Drawings or in the Special Specifications, all piles shall be supplied by the Contractor and the provisions of this Specification shall apply.

14.2.2 Dimensions

Piles shall be manufactured to the dimensions shown on the Drawings.

If a test pile is ordered, only the test pile shall be manufactured to the length shown on the Drawings. After driving the test pile, all other piles shall be manufactured to the lengths, sectional dimensions, and with reinforcement to conform to the toe levels authorised by the Engineer.

If no test piles are shown on the Drawings, or specified, all piles may be cast to lengths to suit the levels shown on the Drawings. As the work proceeds and further information is obtained the Engineer may amend the toe levels, and the dimensions of all piles required to piles not already cast shall be amended accordingly. If any additional length is required to piles already cast, the Engineer will determine at what stage such extensions are to be made.

Where the authorised length of piles is more than 1.5 metres in excess of the length shown on the Drawings, the Engineer may direct that reinforcement of a larger diameter, and/or a greater number of bars, and/or a larger size of pile than shown on the Drawings, shall be used.

The Contractor may propose to use high early strength cement, to employ steam curing, or to give special treatment to piles. Details of such proposals shall be submitted in writing to the Engineer, and his consent obtained before the special construction method is introduced. Once obtained no alteration shall be made unless consented to by the Engineer. No extra payment will be allowed for any such special type of construction.

A completed pile shall be straight within a tolerance of 0.06 percent of its length.

14.2.3 Specifications

Piles manufactured (together with any extensions) shall comply with the requirements of:

Section TS 3 – Concrete

Section TS 4 – Precast Concrete

Section TS 5-- Prestressed Concrete

Section TS 6 -- Pretensioned Prestressed Concrete

14.2.4 Designation and Strength of Piles

Precast Prestressed Concrete Cylindrical Piles

Precast, prestressed Concrete Cylindrical Piles furnished under this contract shall comply with the type of pile designated shown on the Drawings. For the purposes of this contract the designations shall have the minimum strengths as shown in the following table.

Outside Diameter (mm)	600	500	500	450	450	400	350
Piles Type Designation	A	A	A	A	A	A	A
Cracking Bending Moment (tf.m)	17.0	10.5	15.0	7.5	11.0	5.5	3.5
Concrete Compressive Strength (kgf/cm ²)	500	500	500	500	500	500	500
Effective Prestress (kgf/cm ²)	40.0	40.0	80.0	40.0	80.0	40.0	40.0

Precast Prestressed Concrete Sheet Piles

All materials and workmanship shall comply with the general requirements specified in sections TS 3, 4, 5 and 6.

Concrete shall be Class A-1 in accordance with Section TS 3 of this Specification.

Prestressing tendons shall comply with the requirements of Section TS 5 of this Specification.

Piles shall measure 500 mm x 220 mm in cross section with male and female shaping of the edges to permit jointing between adjacent installed piles and shall be manufactured to the required lengths as shown on the Drawings.

The bending moment capacity shall be equal or greater than 5.90 tf.m (cracking bending moment).

14.2.5 Pile Shoes

The shoe as shown on the Drawings shall be firmly bonded to the pile, located centrally and in line with the pile axis. Manufacture of the pile shoe shall be in accordance with the manufacturer's recommendations and to the Engineer's approval.

14.2.6 Marking

Each pile segment shall have on its side, within 300 mm from the head, the length of pile, the date of casting and identification number. The marking shall be in indelible paint which is not injurious to the concrete, and the letters shall be at least 75 mm high. Alternatively, the markings may be cast into the concrete not deeper than 5 mm if consented to by the Engineer.

In addition, commencing at 5 metres from the toe, and thereafter at every metre up to the head, each pile shall be marked by a lightly-scribed line across the full width of one face of the pile or a minimum of one third of the circumference, and square to its length. Just above each line, on the side further from the toe, the distance of each such line from the toe shall be lightly scribed.

14.3 HANDLING, TRANSPORT AND STORAGE

14.3.1 General

Handling, transport and storage of piles shall be in accordance with the requirements of Section TS 4 of this Specification except as modified below.

14.3.2 Handling

a. General

Piles shall be lifted by means of a suitable bridle or slings using lifting points located at the one-fifth point of their length unless otherwise shown on the Drawings or directed by the Engineer.

In no case shall piles be moved by dragging across the ground.

The method of support for piles being pitched shall be subject to the consent of the Engineer.

b. Reinforced Concrete Piles

The entire length of each pile shall be supported during curing and shall not be lifted or handled until the concrete has attained sufficient strength to support the weight of the pile without damage.

c. Prestressed Piles

Prestressed piles shall not be handled or lifted until fully stressed.

The entire length of each pile shall be supported and remain stationary, and the pile shall not be handled, until after the specified curing period has expired, that is at least seven days for concrete made with normal cement and moisture cured, or otherwise as directed by the Engineer for special methods of manufacture and/or curing. Piles shall be handled and supported at the one-fifth points of their length, except that piles up to 10 meters long may be lifted at a point one third of the length of the pile from the end.

14.3.3 Transport

During transport piles shall be supported at lifting points as consented to by the Engineer.

Timber packers shall be used between the sides of individual piles to prevent contact.

14.3.4 Storage

For the stacking of piles, heavy sill logs shall be well bedded and flattened to give a bearing width not less than 200 mm and minimum clearance of 300 mm above ground. Piles may be stacked on top of each other up to six layers with the consent of the Engineer.

Each layer shall be separated from the next layer by timber bearers, each 100 mm wide and 75 mm high. The bearers shall be placed centrally above the still logs, and above one another, so that no additional bending is induced in any pile in the stack. The bearers shall support the piles over their full width.

Piles when stacked shall be supported at lifting points as consented to by the Engineer.

14.4 DRIVING OF PILES

14.4.1 General

Piles shall be driven generally in accordance with the requirements of Section TS 13 of this Specification except as modified below.

Only piles which have been inspected and passed by the Engineer shall be driven. Any pile which shows any defect which, in the opinion of the Engineer, would affect the driveability or durability of the pile will be rejected and shall not be used anywhere in the work.

14.4.2 Minimum Age of Piles Before Driving

Piles shall not be driven until the least 14 days after the specified 28 days strength has been achieved and in no case shall piles be driven until the least 21 days after casting.

These minimum ages before driving shall also apply to any concrete extensions and splices.

14.4.3 Test Piles

When shown on the Drawings or in the Special Specifications or ordered by the Engineer, test piles shall be driven at locations designated by the Engineer and, if accepted, may form part of the permanent works.

The Contractor shall not cast the remaining piles until the test piles have been driven. Following the driving of the piles the Engineer will determine any variations to the casting lengths obtained from the Contract Levels shown on the Drawings and shall not notify the Contractor of such variations in writing.

Where piles are manufactured by a specialised and reputable pile manufacturer, approved by the Engineer, the Contractor may, at his own risk, order remaining pile segments without awaiting driving of test piles.

14.4.4 Driving Procedure

To prevent damage to the pile from the tension caused by shock wave action, driving shall commence by tapping the pile very lightly with blows of the order of 0.2 to 0.3 metre-tonne intensity (that is with a driving energy between 2 to 3 kilojoules), so that the penetration does not exceed 50 mm per blow, or such figure as may be directed by the Engineer. The driving energy shall be increased gradually as the resistance to the movement of the pile increases, until the full energy specified in Section TS 13 can be applied without producing a penetration exceeding 50 mm per blow.

To avoid damage by bending the piles shall be driven from a fixed frame having sufficient rigidity to ensure accuracy of driving and freedom from bending of the pile under all conditions of tides, stream flow, hammer action or other disturbances which may occur during the driving.

The force of the hammer shall be directed centrally and axially into the head of pile.

The Contractor shall ensure that no torsional stresses are induced into the pile by any restraint against rotation about the vertical axis within the helmet.

14.4.5 Pile capacity

The capacity of driven piles shall be calculated in accordance with the requirements of Section TS 13 of this Specification.

14.4.6 Severe Driving

Unless otherwise consented to by Engineer, severe driving where the average penetration per blow is less than that for nominal refusal shall not be permitted.

14.4.7 Acceptance of Driven Piles (other than Test Piles)

The "permissible set" is the criterion for accepting driven piles (other than test piles) when the finished toe level is at or lower than amended toe levels.

When "nominal refusal" or "permissible set" is achieved before the toe of the pile reaches the amended to levels, the Engineer may authorise the acceptance of the pile provided adequate penetration below the existing surface has been achieved.

Piles which contain additional bonding bars cast into the head end must be driven until a minimum length equal to one and a half times the bond length of these bars remains in the pile below the level to the which the pile is stripped back. The pile shall not be cut off without this bond length remaining unless written consent is obtained from the Engineer.

14.4.8 Driving Precast Prestressed Concrete Sheet Piles

Prestressed concrete sheet piles be pitched and driven accurately in the positions shown on the Drawings and to the required depths as directed by the Engineer.

The piles shall be pitched inside a braced template and carefully aligned and positioned before driving. The piles shall then be driven to the required penetration in such a manner as to ensure that the vertically of the piles is maintained. In the event of any misalignment developed during driving, the Contractor shall take appropriate action to correct the condition during driving.

Piles driven in excess of 10 mm, per meter of pile length or damaged during driving may be rejected, if, in the opinion of the Engineer, the improperly aligned or damaged pile adversely affects the structure. The Contractor shall propose the corrective measures to be taken for approval by the Engineer. All corrective measures shall be at the Contractor's own expense. Rejected piles shall be expected, re-driven or placed or cut-off at all a level approved by the Engineer.

14.5 CUTTING OFF AND STRIPPING OF PILE HEAD

After driving the excess portion of the pile shall be cut off and the top section remaining shall be stripped over the length as shown on the Drawings to expose longitudinal reinforcement for bonding into the pile cap. The concrete in the pile head after stripping shall be embedded into the pile cap the distance shown on the Drawings.

In order to prevent spalling of the adjacent concrete stripping of a pile shall be preceded by cutting a circumferential notch, approximately 30 mm deep, at the level above which the concrete is to be removed.

The Contractor shall ensure that longitudinal reinforcement and prestressing strands are not damaged in any way during the stripping operations.

Explosives shall not be used except with the consent of the Engineer.

Where cut-off elevation is above the level of the head of the pile it shall be extended in accordance with Clause 14.6.6 below.

When a pile is cut off and stripped and the projecting steel is longer than is required for joining to the structure, the Engineer will direct whether the steel is to be cut off or bent. No extra payment will be made for cutting off or bending.

14.6 EXTENSIONS OF PILES

14.6.1 General

Should a pile fail to achieve the specified set after being driven to the limit of its cast length it shall continue to be driven as far as practicable by first extending the leaders and then using a suitable dolly as specified in Section TS 13.

14.6.2 Splicing Piles by Lapping of Steel

Unless otherwise specified the end of the pile shall be stripped to expose the longitudinal reinforcing steel for a length equal to:

- 40 diameters of the steel for deformed bars up to U 24 grade (2400 kg/cm²)
- 50 diameters of the steel for deformed bars above U 24 grade (2400 kg/cm²)
- 50 diameters of the steel for plain bars
- 60 diameters of the steel for prestressing strand or wire

Where bars or strands of different diameters are used the stripped length shall be equal to the longest of the individual requirements.

Reinforcement similar to that used in the original end of the pile shall then be spliced to the projecting steel, spiral steel being for two complete turns and the straight steel for a length as specified above.

14.6.3 Splicing by Welding of Steel

Splicing of steel by welding shall only be used with the express consent of the Engineer.

The concrete at the top of the pile shall be cut away, leaving the reinforcing steel exposed for such length as may be required for the splice as directed by the Engineer.

Welds shall fully develop the strength of the bars, all bars being fully butt welded, or joined by means of lapped bar filled welded joints.

No welding shall approach closer than 150 mm to a concrete surface.

In the case of fillet welds fillets not less than 6 mm shall generally be used, and the lapped length on each end of each bar to be spliced shall not be less than twelve diameters of the spliced bar, or six diameters if two splice bars and four lines of fillet weld are used for each pile bar spiced.

All welding shall be in accordance with procedures and by welders approved by the Engineer.

14.6.4 Splicing with Precast Lengths of Pile

If consented to by the Engineer, lengthening of piles may be carried out by splicing on a length of precast pile, prior to driving, during driving or after driving ceases. Splices may be made in concrete, epoxy mortar or epoxy with a suitable steel sleeve.

Details of the proposed splice shall be submitted to the Engineer and his consent obtained prior to the splice being made and/or prior to the commencement of driving.

14.6.5 Pile Extensions in Reinforced Concrete

The extended reinforcement shall provide an ultimate flexural strength of the pile equivalent to that of the original pile.

The extended bars shall be secured in position and held by circumferential ties or spirals consisting of 6.4 mm wire at 150 mm pitch or equivalent. In the case of reinforced concrete piles, should any pile need to be driven after it has been extended, the tie reinforcement at the end of the pile shall be similar to that at the driving end of the original pile.

Unless otherwise directed by the Engineer in writing the extension shall be formed to the same cross sectional profile and fillet concrete of the same strength as that specified for the original pile.

14.6.6 Pile Extensions which are not Driven

In the case of extensions to piles already fully driven, the necessary length of steel for bonding to work above the pile shown on the Drawings shall project above the extended portion of the pile.

14.6.7 Pile Extensions of Prestressed Concrete Piles

Extensions of prestressed concrete piles will be permitted only where a recognised standard proprietary welded steel splice recommended by the manufacturer and approved by the Engineer, is used conforming to the requirements of Japanese Standard JIS A 7201 (Standard Practice for Execution of Spun Concrete Piles)

With the consent of the Engineer, and only after driving has been completed, extensions may be made in accordance with Clause 14.6.6 above.

Welding of tendons will not be permitted and tendons must be adequately protected during any welding operations adjacent to them.

14.6.8 Miscellaneous Works Associated with Piling

14.6.8.1 Concrete Filling

Where shown on the Drawings, the Contractor shall fill concrete into the hollow cores of precast prestressed concrete piles after driving as shown on the Drawings or as directed by the Engineer. Concrete shall be type D in accordance with the requirements of Section TS 3, Concrete Works.

14.6.8.2 Pile Head Treatment

Where shown on the Drawings reinforced concrete shall be placed in the upper portion of prestressed concrete piles for the purposes of tying into pile caps. Materials shall be Concrete type C1 and steel reinforcement shall be deformed reinforcing bars in accordance with Section TS 3 of the Technical Specification. Refer to Section TS 3 for measurement and payment of this item.

14.6.8.3 Sand Filling

Where shown on the Drawings or directed by the Engineer the Contractor shall fill sand into the hollow core of precast prestressed concrete piles after driving as shown.. Filling and compaction of sand shall be performed with the appropriate equipment approved by the Engineer.

(Note this item is deleted from this contract)

14.7 MEASUREMENT AND PAYMENT

14.7.1 Prestressed Concrete Test Piling

This clause refers to the precast, prestressed concrete piles for test piling as described in Section TS 14 and other referenced sections of the Technical Specification.

Measurement for payment, of each test pile size, shall be based on the total number of linear metres supplied, marked accordingly, and placed in storage at the site of the works and accepted by the Engineer.

The measurement for payment shall be made for such piles whether driven or used only as undriven extensions, in linear metres (m), measured along the pile axis from the pile toe, as actually driven, to the head of the pile prior to stripping back for joining into the pile cap.

Apart from partial payments for certain materials delivered to site, as provided for below, payment shall not be made for test piles until they have been driven, test loaded and accepted in accordance with the Drawings and this Technical Specification or as directed by the Engineer.

Payment will be made at the rates entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs. In particular rates for test piles shall be deemed to include, but not be limited to, the following:

- 1) Supplying precast prestressed concrete piles, taking delivery and handling
- 2) Preparing, handling and pitching precast prestressed concrete piles
- 3) Driving precast prestressed concrete piles including pre-boring and the like
- 4) Driving additional pile lengths
- 5) Dollying piles below ground or water level
- 6) Moving pile frames to re-test piles or re-drive lengthened piles
- 7) Test loading of piles
- 8) Test loading of piles
- 9) Cutting off and stripping of pile heads and incorporation into cap
- 10) Extension of pile
- 11) Splicing of pile including welding consumables and equipment
- 12) Any excavation, dewatering and the like

No payment shall be made for lengthening of test piles carried out by the Contractor to make up test piles from shorter lengths than the lengths shown on the Drawings or directed by the Engineer or for any lengthening of test piles which is carried out by the Contractor for his own convenience.

For the purposes on payment for materials on site, payment may be made at 50 % of the rates entered in the priced Bill of Quantities following delivery and the Engineer deeming the piles acceptable. The remaining 50% may be paid following testing and acceptance by the Engineer.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.1.1	PC Pile for Test Piling, dia 600 mm Type A	m
D.1.3	PC Pile for Test Piling, dia 450 mm Type A	m
D.1.5	PC Pile for Test Piling, dia 400 mm Type A	m
D.2.1	PC Pile for Test Piling, dia 600 mm Type A	m
D.2.3	PC Pile for Test Piling, dia 350 mm Type A	m
D.3.1	PC Pile for Test Piling, dia 500 mm Type A	m

14.7.2 Prestressed Concrete Piles

This clause refers to the precast, prestressed concrete piles as described in Section TS 14 and other referenced sections of the Technical Specification.

Measurement for payment, of each pile size, shall be based on the lengths of piles as instructed in writing by the Engineer.

The measurement for payment shall be made for such piles whether driven or used only as undriven extensions, in linear metres (m), measured along the pile axis from the pile toe, as actually driven, to the head of the pile prior to stripping back for joining into the pile cap.

Apart from partial payments for certain materials delivered to site, as provided for below, payment shall not be made for test piles until they have been driven, and accepted in accordance with the Drawings and this Technical Specification or as directed by the Engineer.

Payment will be made at the rates entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs. In particular rates for test piles shall be deemed to include, but not be limited to, the following:

- 1) Supplying precast prestressed concrete piles, taking delivery and handling
- 2) Preparing, handling and pitching precast prestressed concrete piles
- 3) Driving precast prestressed concrete piles including pre-boring and the like
- 4) Driving additional pile lengths
- 5) Dollying piles below ground or water level
- 6) Moving pile frames to re-test piles or re-drive lengthened piles
- 7) Extension of pile
- 8) Splicing of pile including welding consumables and equipment
- 9) Any excavation, dewatering and the like

No payment shall be made for lengthening of piles carried out by the Contractor to make up piles from shorter lengths than the lengths shown on the Drawings or directed by the Engineer or for any lengthening of piles which is carried out by the Contractor for his own convenience.

For the purposes on payment for materials on site, payment may be made at 50 % of the rates entered in the priced Bill of Quantities following delivery and the Engineer deeming the piles acceptable. The remaining 50% may be paid following driving and acceptance by the Engineer.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.1.2	Furnishing and Driving PC Piles, dia 600 mm Type A	m
D.2.2	Furnishing and Driving PC Piles, dia 600 mm Type A	m
D.3.2	Furnishing and Driving PC Piles, dia 500 mm Type A	m
D.1.4	Furnishing and Driving PC Piles, dia 450 mm Type A	m
D.1.6	Furnishing and Driving PC Piles, Dia 400 mm Type A	m
D.2.4	Furnishing and Driving PC Piles, dia 350 mm Type A	m

14.7.3 Prestressed Concrete Sheet Piles

Measurement shall be made of the length of prestressed concrete sheet piles in place and accepted by the Engineer.

Payment for prestressed concrete sheet piles will be made at the rate entered in the priced Bill of Quantities which shall be full compensation for materials, labour, tools, equipment including furnishing, handling, pitching, driving and cutting and all other items for completing the work in accordance with the specification.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.1.10	Furnishing and Driving PC Sheet Pile (Prestressed Concrete K 500, t = 220 mm, w = 500 mm)	m
D.2.6	Furnishing and Driving PC Sheet Pile (Prestressed Concrete K 500, t = 220 mm, w = 500 mm)	m

14.7.4 Miscellaneous Works Associated with Piling

Concrete Filling

Measurement will be made of the volume of concrete filling placed in the hollow core of concrete piles in accordance with the Drawings and the Specification.

Payment will be made at the rate entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of the work.

Cutting Pile Head

Measurement will be made of the volume of concrete cut away for the purpose of cutting the pile head to the required elevation and for exposing the reinforcement for tying-in to pile cap.

Payment will be made at the rate entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of the work.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
D.1.7	Concrete Filling in Pile Holes, Concrete Type D	m ³
D.1.8	Cutting Pile Head	m ³
D.2.7	Cutting Pile Head	m ³
D.3.3	Cutting Pile Head	m ³

TABLE OF CONTENTS

SECTION TS 15. STEEL SHEET PILES

15.1 GENERAL.....	TS 15-1
15.2 MATERIALS.....	TS 15-1
15.3 HANDLING, TRANSPORT AND STORAGE.....	TS 15-1
15.4 DRIVING OF PILES.....	TS 15-1
15.4.1 General.....	TS 15-1
15.4.2 Test Piles.....	TS 15-1
15.4.3 Driving Steel Sheet Piles.....	TS 15-1
15.5 MEASUREMENT AND PAYMENT	TS 15-2

SECTION TS 15. STEEL SHEET PILES

15.1 GENERAL

This Section covers the supply and driving of steel sheet piles

The handling and driving of steel sheet piles shall be in accordance with the requirements of Section TS 13 of this Specification except as modified hereunder.

The steel sheet piles to be furnished and driven in this contract are for seepage control and are not required to be driven to criteria based on bearing capacity.

15.2 MATERIALS

Steel sheet pile shall be of U-shape type with a yield point strength of 30 kgf/mm² or more as specified in JIS A5528 or equivalent approved by the Engineer. Type and sectional properties of steel sheet pile shall be as tabulated below. The material used for sheet pile shall be Type II as shown on the Drawings or directed by the Engineer.

Type of Steel Sheet Pile

Type	Width (mm)	Height (mm)	Thickness (mm)	Section Modules (cm ³)
Type I	400	85	8.0	88
Type II	400	100	10.5	152
Type III	400	125	13.0	223
Type IV	400	170	15.5	362
Type V	400	200	24.3	520

All piles shall be supplied by the Contractor

15.3 HANDLING, TRANSPORT AND STORAGE

Handling, transport and storage shall be as specified in Section TS 13

15.4 DRIVING OF PILES

15.4.1 General

Piles shall be driven generally in accordance with the requirements of Section TS 13 of this Specification except as modified below.

Only piles which have been inspected and passed by the Engineer shall be driven. Any pile which shows any defect which, in the opinion of the Engineer, would affect the driveability or durability of the pile will be rejected and shall not be used anywhere in the work.

15.4.2 Test Piles

Test piles are not required for steel sheet piles.

15.4.3 Driving Steel Sheet Piles

Steel sheet piles be pitched and driven accurately in the positions shown on the Drawings and to the required depths as directed by the Engineer.

The piles shall be pitched inside a braced template and carefully aligned and positioned before driving. Particular care shall be taken to ensure the interlocking

of adjacent sheet piles. The piles shall then be driven to the required penetration in such a manner as to ensure that the vertically of the piles is maintained. In the event of any misalignment developed during driving, the Contractor shall take appropriate action to correct the condition during driving.

Piles driven in excess of 10 mm, per meter of pile length or damaged during driving may be rejected, if, in the opinion of the Engineer, the improperly aligned or damaged pile adversely affects the structure. The Contractor shall propose the corrective measures to be taken for approval by the Engineer. All corrective measures shall be at the Contractor's own expense. Rejected piles shall be expected, re-driven or placed or cut-off at all a level approved by the Engineer.

Pile shall be extended by full penetration butt welds in accordance with clause 13.4.7 of the Technical Specification.

15.5 MEASUREMENT AND PAYMENT

Measurement shall be made of the length of steel sheet piles in place and accepted by the Engineer. The length measured shall include the length of any portion cut off as the result of the specified length of pile not being driven to the toe elevation as shown on the Drawings following a directive of the Engineer to cease driving for whatsoever reason.

Payment for steel sheet piles will be made at the rate entered in the priced Bill of Quantities which shall be full compensation for materials, labour, tools, equipment including furnishing, handling, pitching, driving and cutting and all other items for completing the work in accordance with the specification.

Pay Item No.	Description	Unit of Measurement
D.1.9	Furnishing and Driving Steel Sheet Pile Type 11	m
D.2.5	Furnishing and Driving Steel Sheet Pile Type 11	m

TABLE OF CONTENTS

SECTION TS 16. TIMBER PILES

16.1 GENERAL.....	TS 16-1
16.2 MATERIALS.....	TS 16-1
16.2 HANDLING.....	TS 16-1
16.3 DRIVING	TS 16-1
16.4 MEASUREMENT AND PAYMENT	TS 16-1

SECTION TS 16. TIMBER PILES

16.1 GENERAL

This section covers the requirements for timber log piles to be driven as part of foundations in various parts of the Works.

16.2 MATERIALS

Timber piles shall be cylindrical logs cut from timber with recognised qualities of durability and suitability for installation as piles in wet conditions. The Contractor shall propose timber of a type or species for the Engineer's approval prior to procuring timber pile material. Logs shall be straight to a tolerance of 20 mm over their full length and shall be free of branches. The diameter of the thinnest part of any pile shall not be less than 150 mm and not shorter than the length specified on the drawings. All logs shall be treated with creosote using a method subject to the Engineer's approval. Any log not complying with the above requirements shall be removed from the site.

16.2 HANDLING

Timber piles shall be kept in neat stacks on site until ready for use. Handling shall be conducted in such a manner so as not to damage the integrity and strength of the piles.

16.3 DRIVING

Timber piles shall be pitched and driven accurately in the position and at the location shown on the Drawings and to the required depths as directed by the Engineer. During driving operations, timber pile heads shall be protected and held in position by use of a combination creation-driving head and pilot.

Timber piles shall be fresh-head and square and, when directed by the Engineer, the pile heads shall be protected by means of heavy steel or wrought iron rings. The driving head shall closely fit the top of the timber pile and shall extend down the sides of the pile at least 75 mm. During driving operations, each pile shall be restrained from lateral movement and the pile shall be kept moving by continuous operation of the hammer. If the specified penetration has not yet been reached when the energy required to continue driving is endangering the pile integrity the driving may be discontinued with the approval of the Engineer. Piles driven materially out of line and position as indicated on the Drawing shall be pulled and replaced. Deviations in the excess of 200 mm out of position and 2 percent out of plumbness or batter indicated on the Drawings shall be cause for rejection.

Cutting off and trimming of timber piles shall be done at the designated elevations. Splicing of timber piles shall not be permitted except when approved by the Engineer in writing. Piles inaccurately cut off shall be replaced. The sawn heads of all treated piles which are not embedded in concrete shall be brush-coated with 3 applications of hot creosote and covered with hot roofing pitch. The sawn heads of all treated piles to be encased in concrete need not to be treated further.

16.4 MEASUREMENT AND PAYMENT

A count shall be made of the number of timber piles in place and installed in accordance with the specification then that total multiplied by the nominal length of pile specified on the Drawings.

Payment for timber piles will be made at the rate entered in the priced Bill of Quantities which shall be full compensation for materials, labour, tools, equipment including furnishing, handling, pitching, driving and cutting and all other items for completing the work in accordance with the Specification.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
F.1.6	Furnishing and Driving Log Pile, Dia 150 mm, L=2.0 m	m

TABLE OF CONTENTS

SECTION TS 17. STONE MASONRY

17.1	GENERAL.....	TS 17-1
17.2	MATERIALS	TS 17-1
17.2.1	Stone.....	TS 17-1
17.2.2	Mortar.....	TS 17-1
17.3	CONSTRUCTION.....	TS 17-2
17.3.1	Wet Stone Masonry Walls	TS 17-2
17.3.1.1	General.....	TS 17-2
17.3.1.2	Selection and Placing	TS 17-2
17.3.1.3	Beds and Joints	TS 17-2
17.3.1.4	Headers	TS 17-2
17.3.1.5	Backing.....	TS 17-2
17.3.1.6	Pointing.....	TS 17-3
17.3.1.7	Plastering.....	TS 17-3
17.3.1.8	Coping	TS 17-3
17.3.1.9	Weep Holes	TS 17-3
17.3.1.10	Cleaning Exposed Faces.....	TS 17-3
17.3.1.11	Curing	TS 17-3
17.3.2	Wet Stone Masonry for Revetment Facing.....	TS 17-3
17.3.2.1	General.....	TS 17-3
17.3.2.2	Preparation	TS 17-4
17.3.2.3	Selection and Placing	TS 17-4
17.3.2.4	Beds and Joints	TS 17-4
17.3.2.5	Pointing.....	TS 17-4
17.3.2.6	Weep Holes	TS 17-4
17.3.2.7	Cleaning Exposed Faces.....	TS 17-4
17.3.2.8	Curing.....	TS 17-4
17.3.3	Stone Facing	TS 17-5
17.3.3.1	General.....	TS 17-5
17.3.3.2	Preparation	TS 17-5
17.3.3.3	Selection and Placement	TS 17-5
17.3.4	Rip Rap	TS 17-5
17.3.4.1	General.....	TS 17-5
17.3.4.2	Preparation	TS 17-5
17.3.4.3	Selection and Placement	TS 17-5
17.4	MEASUREMENT AND PAYMENT	TS 17-5

SECTION TS 17. STONE MASONRY

17.1 GENERAL

This section covers the general and specific requirements for the construction of the following type of masonry work:

- Wet stone masonry in flood walls, revetment construction of various types, retaining walls, ground sills, channels, dikes, drainage structures, stairways and other structures included in the Works and in places where shown on the Drawings or directed in writing by the Engineer.
- Stone facing in revetments.
- Rip Rap.

17.2 MATERIALS

17.2.1 Stone

Stone for all classes of masonry shall be clean, hard, and durable. Adobe blocks shall not be used unless specified or consented to by the Engineer.

Samples of stone proposed for use in masonry construction shall be submitted to the Engineer for his consent.

Stones shall be of the sizes shown on the Drawings or appropriate for the particular application. Unless otherwise shown on the Drawings, stones shall have thickness of not less than 150 mm, widths of not less than one and a half times their respective thicknesses, and lengths of not less than one and a half times their respective widths. Each stone shall be free of depressions and projections that would prevent it from being properly bedded.

Stone to be used in wet stone masonry revetments shall be regular in size and their thickness shall be approximately 200 mm.

Stone shall be dressed to remove any thin or weak portions. Face stone shall be dressed to provide bed and joints lines that do not vary more than 20 mm from true lines and to ensure the meeting of bed and joints lines without the rounding of the corners of the stones in excess of 30 mm in radius. Bed surfaces of face stones shall be normal to the faces of the stones for 80 mm and from this point may depart from a normal plane by an angle which is not to exceed 50 mm in 300 mm.

Face stones shall be pitched to line along all beds and joints. The maximum projections of rock faces beyond the pitch lines shall not be more than 50 mm.

Stones shall increase in thickness from bottom to top of wall.

17.2.2 Mortar

Cement mortar shall be composed of one part of cement to three parts of fine aggregate by volume, or such other proportions as shall be directed by the Engineer, or as shown on the Drawings mixed with water so that the water-cement ratio does not exceed 0.45 by weight.

Hydrated lime may be added in an amount not exceeding ten (10) percent of the cement by weight. The hydrated lime shall comply with the requirements for type "N" lime in ASTM C 207 "Hydrated Lime".

17.3 CONSTRUCTION

17.3.1 Wet Stone Masonry Walls

17.3.1.1 General

This clause refers to the construction of wet stone masonry walls including, but not limited to, retaining walls, parapet walls, flood walls and leaning walls.

17.3.1.2 Selection and Placing

When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the Engineer before any stone is placed.

Care shall be taken to prevent the bunching of small stones or stones of the same size large stones shall be used for the bottom courses and large, selected stones shall be used in the corners.

All stones shall be cleaned thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joint shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set.

The stones shall be so handled as not to jar or displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by two men. Rolling or turning stones on the walls will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

17.3.1.3 Beds and Joints

Beds for face stones may vary from 20 mm and to 50 mm in thickness. They shall not extend in an unbroken line through more than five stones. Joints may vary from 20 mm to 50 mm in thickness. They shall not extend in unbroken line through than two stones. They may be at angles with the vertical from 0 to 45 degrees. Face stone shall bond at least 150 mm longitudinally and 50 mm vertically. At no place shall corners of four stones be adjacent to each other.

Beds for vertical faced walls shall be level, and battered walls may vary from level to normal to the batter line of the face of the wall.

17.3.1.4 Headers

Headers shall be distributed uniformly throughout the walls of structures so as to form at least one fifth of the exposed faces. They shall be of such lengths as to extend from the front face of the wall into the backing at least 300 mm. When a wall is 450 mm or less in thickness, the headers shall extend entirely from front to back face.

17.3.1.5 Backing

The backing shall be built with greater than 75 percent of stones having a minimum dimension of 200 mm. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

17.3.1.6 Pointing

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least 3 days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

17.3.1.7 Plastering

Plaster, if called for, shall be of the same mix proportions as for mortar. Before plastering commences the surface to be plastered shall be cleaned of any dirt, grease, organic matter or any other deleterious substance. The surface shall then be wet with water. Plaster shall be applied so as to firmly key into the surface being treated. The finished surface shall be uniform in texture and regular in appearance. Flat surface shall be flat to a tolerance of 10 mm measured with a 2 m long straight edge.

17.3.1.8 Coping

Copings, if called for, shall be as shown on the Drawings. Where copings are not called for, the top of the wall shall be finished with stones wide enough to cover the top of the wall from 450 mm to 1 metre in length, and of random heights, with a minimum height of 150 mm. Stone shall be laid in such a manner that the top course is an integral part of the wall. The tops of the top courses of stone shall be pitched to line in both vertical and horizontal planes.

17.3.1.9 Weep Holes

All walls and abutments shall be provided with weep holes. Unless otherwise shown on the Drawings or directed by the Engineer, the weep holes shall be placed at the lowest points where free outlets for water can be obtained and shall be spaced not more than 2 metres centre to centre.

Weep holes shall be constructed in accordance with the requirements of Section 18 of the Technical Specification, Weep Holes.

17.3.1.10 Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all faces stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

17.3.1.11 Curing

The masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

17.3.2 Wet Stone Masonry for Revetment Facing

17.3.2.1 General

This clause refers to the use of wet stone masonry for surface protection construction in revetments or where otherwise required to complete the Works.

17.3.2.2 Preparation

The gravel bed shall be completed to the approval of the Engineer prior to placing wet stone masonry.

All concrete work around the perimeter of the intended wet stone masonry work shall be completed to the satisfaction of the Engineer prior to commencing wet stone masonry.

17.3.2.3 Selection and Placing

All stones shall be cleaned thoroughly and wetted immediately before being set, and the gravel bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joint shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the revetment face in which the stones are set and the pattern shall be regular.

The stones shall be so handled as not to jar or displace the stones already set.

17.3.2.4 Beds and Joints

Beds for stones may vary from 20 mm and to 50 mm in thickness. At no place shall corners of four stones be adjacent to each other.

17.3.2.5 Pointing

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into gaps between stones with a pointing tool. Stones shall be proud of the pointed mortar by approximately 30 mm. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least 3 days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.

17.3.2.6 Weep Holes

Weep holes shall be constructed at the locations as shown on the Drawings or as directed by the Engineer in accordance with the requirements of Section 18, Weep Holes.

17.3.2.7 Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all faces stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

17.3.2.8 Curing

The masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

17.3.3 Stone Facing

17.3.3.1 General

This clause refers to the construction of dry stone masonry (i.e. stone masonry without mortar) in revetments.

17.3.3.2 Preparation

All surfaces on which stone facing is to be placed shall be completed to the satisfaction of the Engineer prior to placing stone facing.

17.3.3.3 Selection and Placement

Stones of size 250 mm to 400 mm in maximum dimension in accordance with clause 10.2.1 shall be selected for use.

Stones shall be carefully placed such they are stable, closely interlock with adjacent stones and are arranged such that they comply with the lines, levels and profiles of the stone facing as shown on the Drawings to a tolerance of + or - 30 mm.

17.3.4 Rip Rap

17.3.4.1 General

This clause refers to the construction of rip rap for protection works as shown on the Drawings or directed by the Engineer.

17.3.4.2 Preparation

Where applicable, surfaces on which rip rap is to be placed shall be completed to the satisfaction of the Engineer prior to placing rip rap.

17.3.4.3 Selection and Placement

Stones of size 250 mm to 400 mm in maximum dimension shall be selected for use.

Stones shall be carefully placed such they are stable, closely interlock with adjacent stones and are arranged such that they comply with the lines, levels and profiles of the stone facing as shown on the Drawings to a tolerance of + or - 100 mm. Particular care shall be taken not to damage structures (e.g. sheet piling or existing structures) when placing rip rap. Any such damage caused shall be rectified by the Contractor at his expense.

17.4 MEASUREMENT AND PAYMENT

Wet Stone Masonry

Measurement will be made of the volume of stone masonry complete in place and accepted. Projections extending beyond the faces of the walls will not be included. In computing the quantity for payment, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No deductions shall be made for weep holes, drain pipe, pipe, or other openings of less than 0.01 square metres in area.

Payment will be made at the rate entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of stone masonry.

Pointing

Measurement will be made of the area of the surface of wet stone masonry in which the mortar has been pointed and accepted. The area measured will be the gross area which includes stone and pointed mortar. No deduction shall be made for the areas occupied by stone, weep holes or openings less than 0.01 square metres.

Payment will be made at the unit price entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of pointing.

Plastering

Measurement will be made of the area of the surface of wet stone masonry or Floodwall which has been plastered and accepted. No deduction shall be made for the areas occupied by stone, weep holes or openings less than 0.01 square metres.

Payment will be made at the unit price entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion plastering.

Stone Facing

Measurement will be made of the volume of Stone Facing complete, in place and accepted. Projections beyond the lines and profiles shown on the Drawings shall not be measured.

Payment will be made at the unit price entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of stone facing.

Rip Rap

Measurement will be made of the volume of Rip Rap complete, in place and accepted. Projections beyond the lines and profiles shown on the Drawings shall not be measured.

Payment will be made at the unit price entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of rip rap.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
F.1.1	Wet Stone Masonry on Side Slope 1:2 and 1:1.5	m ³
F.1.2	Wet Stone Masonry for Gravity Type Wall in Downstream Channel	m ³
F.1.3	Wet Stone Masonry for Leaning Wall for Connecting Channel of Semarang River and Left Irrigation Channel	m ³
K.1.7	Wet Stone Masonry for Channel Revetment and Wall	m ³
L.2.11	Wet Stone Masonry	m ³
F.1.5	Cement Mortar Pointing on Riverside Surface of Wet Stone Masonry	m ²
L.2.12	Cement Mortar Pointing on Surface of Masonry	m ²
K.1.10	Cement Mortar Pointing on Surface of Masonry	m ²

TABLE OF CONTENTS

SECTION TS 18. GABIONS AND MATTRESSES

18.1	GENERAL.....	TS 18-1
18.2	MATERIAL REQUIREMENTS.....	TS 18-1
18.2.1	Gabion Wire Mesh Baskets.....	TS 18-1
18.2.2	Stone Fill.....	TS 18-2
18.2.3	Palm Fibre.....	TS 18-2
18.2.4	Geotextile Filter Cloth.....	TS 18-2
18.3	CONSTRUCTION.....	TS 18-2
18.4	MEASUREMENT AND PAYMENT.....	TS 18-3

SECTION TS 18. GABIONS AND MATTRESSES

18.1 GENERAL

This section of the Technical Specification covers the requirements for Gabions and Gabion Mattresses (also known as reno mattresses).

Gabions shall be flexible galvanised wire boxes of the size stated in the Drawings, fabricated of wire mesh of the type and size, and selvedged as specified as specified below. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabion plus 100 mm except in the case of reno mattresses where the diaphragms shall have a maximum spacing of 600mm.

18.2 MATERIAL REQUIREMENTS

18.2.1 Gabion Wire Mesh Baskets

Wire

Wire used in the fabrication of gabions and in the wiring operations during construction shall conform to AASHTO M 279 (ASTM A 116) having a tensile strength of not less than 350 MPa (3500kg/cm²). The minimum weight of zinc coating shall be 250 g/m².

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns around a mandrel of four times the diameter of the wire, it shall not crack to such an extent that any zinc can be removed by rubbing with the bare fingers.

Where shown in the Drawings or shown in the Bill of Quantities, wire, galvanized as specified above, shall be coated with PVC in accordance with the manufacturer's recommendations.

Manufacture

The mesh shall be hexagonal woven mesh wherein the joints are formed by twisting each pair of wires through three half turns. The diameter of the wire shall be as shown on the drawings but not less than 3 mm for body wire, 3.9 mm for perimeter wire and 2.4 mm for tying and connecting wire.

The undisturbed size of the mesh shall be as shown on the drawings but shall not be greater than 80 mm by 100 mm. The tightness of the twisted joints shall be such that a force of not less than 1.75 kN pulling on one wire is required to separate it from the other wire when each wire is prevented from turning and the wires and the applied force are in the same plane.

The wire mesh shall have elastic properties sufficient to permit elongation of the mesh equivalent to a minimum of 10% of the length of the section of mesh under test without reducing the gauge or tensile strength of individual wire strands to values less than those for a similar wire one gauge smaller in diameter.

All edges of the gabions, diaphragms and end-panels except as stated below shall be selvedged with a wire of which the diameter is 25% greater than that of the wire used to form the mesh. Where the selvedge is not woven integrally with the mesh but has to be fastened to the cut ends of the mesh, it shall be attached by binding the cut ends of the mesh, so that a force of not less than 8.5 kN applied in the same plane as the mesh, at a point on the selvedge of a mesh sample of length one (1) metre is required to separate it from the mesh.

The diaphragms and end-panels shall be selvaged on the top and vertical sides only. The end panels shall be attached by twisting the cut ends of the mesh at the bottom of the panel about the selvedge on the base of the gabions. Similarly, the diaphragms shall be attached by twisting the cut ends of the mesh to the twisted joints of the mesh of the gabions. In each case the force required to separate the panels from the base shall not be less than that required to break the mesh over the same length.

Sufficient binding and connecting wire shall be supplied with the gabions to perform all the wiring operations to be carried out in the construction of the gabion work as stated below. The diameter of the binding wire shall not be less than 2.20 mm.

Tolerances

A tolerance on the diameters of all wire of + or - 2.5 % shall be permitted. The length of the gabions is subject to a tolerance of + or - 3 % and the width of gabions to a tolerance of + or - 25 mm. All other gabion dimensions are subject to a tolerance of + or - 3% of the sizes shown on the Drawings.

18.2.2 Stone Fill

Stone fill material shall consist of hard, durable stone of minimum dimension 100 mm and maximum dimension of 250 mm.

18.2.3 Palm Fibre

Material shall be palm fibre comprising a dense matrix of interwoven fibrous material and shall be approved for use by the Engineer prior to placement.

18.2.4 Geotextile Filter Cloth

Geotextile filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 gm/m² and shall comply with AASHTO M 288 'Geotextiles used for Subsurface Drainage Purposes'.

18.3 CONSTRUCTION

Gabions and Gabion Mattresses

Prior to constructing gabions the bed on which they are to be placed shall be cut to the lines and profiles as shown on the Drawings.

Where shown on the Drawings palm fibre filter material shall be placed on the prepared bed. Palm fibre shall be spread uniformly such that there are no gaps and shall have a minimum uncompressed thickness of fifty (50) mm. All palm fibre sealing shall be Approved by the Engineer before being covered with other materials.

Where shown on the Drawings geotextile cloth shall be placed on the prepared bed. Geotextile cloth shall be lapped by a minimum of 300 mm where joints are necessary and shall extend 300 mm beyond the outside the lines of gabions to be constructed on top of the geotextile cloth.

The placement of the gabion boxes shall be carried out in an orderly manner so that a face of incomplete work is maintained.

At least two rows of empty boxes shall be wired together at the face of uncompleted work prior to filling the box closest to the completed work. Prior to filling any box, one end or side of the box shall be secured to completed works or to stakes driven into the ground at the corners or in any other approved manner

and the opposite end, side or corner shall be stretched with crow bars and secured to and bottom in a suitable manner.

Stone fill material shall be placed carefully in order to ensure that it is tightly packed with a minimum of voids. The boxes shall be filled to between 25 mm and 50 mm above their tops. The top layer of material shall consist of selected small stone not less than 100 mm minimum dimension.

Where shown on the Drawings soil filling, as describe in Clause 2.5.10 shall be place on top of the completed gabion mattresses and watered in such that soil fills the voids between the stone fill. The process shall be repeated until no further soil penetrates the voids and a uniform layer of soil remains on the surface of the gabions.

Gabion Cylinders

Prior to constructing cylindrical gabions the bed and batter slopes on which they are to be placed shall be cut to the lines and profiles as shown on the Drawings.

Wire mesh shall be laid out in place ensuring that the log piles, previously driven penetrate the wire mesh to ensure anchorage.

Stone filling shall be placed and the gabions assembled and completed in accordance with the manufacture's recommendations.

Soil filling, as describe in Clause 2.5.10 shall be place on top of the completed cylindrical gabions and watered in such that soil fills the voids between adjacent cylindrical gabions and the voids between the stone fill. The process shall be repeated until no further soil penetrates the voids and a uniform layer of soil remains on the surface of the cylindrical gabions.

18.4 MEASUREMENT AND PAYMENT

Gabion Mattresses

Measurement shall be made of the volume of gabion mattresses in place and accepted by the Engineer.

Payment shall be made at the unit prices entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

For pay item D.4.9 the unit price shall also include the cost of providing and placing soil filling as shown in the Drawings and described in the Specification.

Gabion Cylinders

Measurement shall be made of the volume of gabion cylinders in place and accepted by the Engineer.

Payment shall be made at the unit prices entered it the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

Payment for soil filling around the gabion cylinders shall be made in accordance with clause 2.7.3.2.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
F.2.4	Gabion Mattress; 3.0mx1.5mx0.5m (Galvanised and PVC Coated)	m ³
F.2.5	Gabion Mattress, 2.0mx1.0mx0.3m (Galvanised and PVC Coated)	m ³
F.2.6	Geotextile Filter Cloth	m ²
F.2.7	Palm Fibre	m ²
F.2.8	Gabion Cylinder Dia. 500 mm (Galvanised and PVC Coated)	m ³

TABLE OF CONTENTS

SECTION TS 19. WEEP HOLES

19.1 SCOPE	TS 19-1
19.2 MATERIAL.....	TS 19-1
19.3 CONSTRUCTION.....	TS 19-1
19.4 MEASUREMENT AND PAYMENT	TS 19-1

SECTION TS 19. WEEP HOLES

19.1 SCOPE

This section of the Technical Specification covers the general and specific requirements of Weep Holes. It shall apply wherever Weep Holes are used in the Works, such as in revetments, wall, wet stone masonry or other applications, as shown on the Drawings or specified in this and other Technical Specification clauses.

19.2 MATERIAL

Pipe:

Material for weep holes shall be 50 mm nominal diameter, black, Unplasticised Poly-Vinyl-Chloride (uPVC) conforming to the requirements of JIS K 6741. Pipe for weep holes shall be approved in writing by the Engineer before any purchase orders are placed.

Palm Fibre:

Palm fibre shall be fresh palm fibre to the Engineer's approval.

Filter Cloth

Filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 gm/m² and shall comply with ASTHMA M 288 'Geotextiles used for Subsurface Drainage Purposes'.

19.3 CONSTRUCTION

Pipes for weep holes shall be cut to the required lengths as shown on the Drawings and the inner end shall be surrounded by a ball of palm fibre not less than 150 mm diameter wrapped in filter cloth. The filter cloth shall be tied firmly to the pipe with nylon twine so as to ensure that all water which will enter the pipes must pass through the filter cloth and palm fibre filters.

Assembled units shall be placed in the work at the levels, positions and slopes shown on the Drawings taking care to ensure that filter constructed as described above remains intact and that the exposed ends on the face of the work are flush with the face of the structure through which the weep hole passes. Gravel backfill shall be carefully hand placed around inner ends of the filters ensuring that the filter remains intact.

19.4 MEASUREMENT AND PAYMENT

Measurement will be made of the number of weep holes of the various lengths completed in accordance with the Drawings, the Specification and to the approval of the Engineer.

Payment will be made at the unit price entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
E.4.12	Weep Hole, Dia.50mm including Filter Cloth	Nos.
F.1.4	Weep Hole, Dia.50mm including Filter Cloth	Nos.
K.1.9	Weep Hole, Dia.50mm including Filter Cloth	Nos.

TABLE OF CONTENTS

SECTION TS 20. ROADS AND PAVEMENTS

20.1	GENERAL.....	TS 20-1
20.2	PREPARATION OF SUBGRADE	TS 20-1
	20.2.1 General.....	TS 20-1
	20.2.2 Testing and Preparation	TS 20-1
20.3	SUB-BASE COURSE	TS 20-1
	20.3.1 Materials	TS 20-1
	20.3.2 Placing and Spreading.....	TS 20-2
	20.3.3 Compacting the Sub-base	TS 20-2
	20.3.4 Tolerances.....	TS 20-3
20.4	BASE COURSE	TS 20-3
	20.4.1 Materials	TS 20-3
	20.4.2 Spreading and Compacting	TS 20-4
	20.4.3 Tolerances	TS 20-4
20.5	BITUMINOUS PRIME COAT	TS 20-5
	20.5.1 General.....	TS 20-5
	20.5.2 Material for Prime Coat.....	TS 20-5
	20.5.3 Surface Preparation before Prime Coating	TS 20-5
	20.5.4 Equipment for Prime Coating.....	TS 20-5
	20.5.5 Application of Prime Coat	TS 20-5
20.6	ASPHALT TREATMENT BASE	TS 20-6
	20.6.1 General.....	TS 20-6
	20.6.2 Materials	TS 20-6
	20.6.3 Preparation of Sub-base.....	TS 20-8
	20.6.4 Preparation of the Bituminous Mixture.....	TS 20-8
	20.6.5 Transportation and Delivery of the Mixture	TS 20-8
	20.6.6 Spreading	TS 20-9
	20.6.7 Compaction of the Mixture	TS 20-10
	20.6.8 Trimming and Clean-up	TS 20-10
	20.6.9 Completion Test.....	TS 20-10
20.7	BITUMINOUS SURFACE COURSE	TS 20-11
	20.7.1 Aggregates for Bituminous Surface Course.....	TS 20-11
	20.7.2 Preparatory Works.....	TS 20-12
	20.7.3 Equipment.....	TS 20-12
	20.7.4 Job Mix Formula	TS 20-13
	20.7.5 Preparation and Composition of the Mixture.....	TS 20-13
	20.7.6 Spreading and Compacting	TS 20-14
	20.7.7 Requirements for the Mixture.....	TS 20-14
	20.7.8 Spreading and Compacting	TS 20-15
	20.7.9 Required Density	TS 20-15
	20.7.10 Tolerances	TS 20-15
20.8	MEASUREMENT AND PAYMENT	TS 20-15

SECTION TS 20. ROADS AND PAVEMENTS

20.1 GENERAL

This section covers the construction of bituminous pavements to be constructed on the bridges of the Simongan Weir and the complete road pavement to be constructed for the approach roads to the Simongan Weir.

20.2 PREPARATION OF SUBGRADE

20.2.1 General

This clause specifies the requirements of the preparation of the surface on which the approach roads are to be constructed.

20.2.2 Testing and Preparation

Where sub-base is to be placed on a subgrade of natural material (i.e. not on embankment), the Contractor shall check and visually inspect the subgrade for soft spots which shall be removed and replaced with suitable approved, compacted granular material. The Contractor shall check the in-situ density of the subgrade to ensure that it complies with the acceptance criteria shown below.

The acceptance criteria for the subgrade shall be :

- i) No visible soft areas and;
- ii) No discernible movement during rolling with a 6 to 8 ton roller and;
- iii) Compaction 90% of the maximum dry density determined according to AASHTO T 99.

No measurement or additional payment shall be made for the testing and preparation of subgrade described herein and the cost of complying with this clause shall be deemed to be included in the rate for sub-base.

20.3 SUB-BASE COURSE

20.3.1 Materials

(a) Aggregates for sub-base shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matters. The composite material shall be free from organic matters and lumps or balls of clay, and shall be of such nature that can be compacted readily to form a firm, stable sub-base.

(b) Materials for sub-base shall conform to the requirements Class C sub-base as specified on the Drawings or directed by the Engineer. All sub-base materials shall be free from lumps of dirt, organic matter, shale or any other deleterious matter and shall be of such quality that it will bind readily to form a firm, stable sub-base.

"Class C sub-base" shall consist of well-graded sand and gravel conforming to the following requirements:

Grading Requirements of Sub-Base Course Class C

AASHTO Designation No.	Percentage Passing by Weight
1 1/2 inch	100
No. 10 (2 mm)	80 max.
No. 200 (0.074 mm)	15 max.
Sand Equivalent (AASHTO T176)	25 min.
Loss by Abrasion of particles retained in ASTM No. 12 sieve (AASHTO T96)	40% max.
Maximum Dry Density (AASHTO T180)	2.0 g/cm ³ min.

20.3.2 Placing and Spreading

- (a) Sub-base material shall be placed as a uniform mixture on the prepared subgrade in a quantity which will provide the required compacted thickness. When more than one layer of sub-base material base is required, each layer shall be shaped and compacted before the succeeding layer is placed. When uniformly mixed, the sub-base material shall be spread to the required thickness as shown on the Drawings or as directed by the Engineer.
- (b) Sub-base material shall be distributed in a continuous uniform layer or windrow of such size that, when spread and compacted, the finished layer shall be equal to or slightly greater than the nominal thickness of sub-base shown on the Drawings.
- (c) When hauling is done over previously placed sub-base material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimize rutting or uneven compaction.
- (d) Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, sub-base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.
- (e) The moisture content of sub-base material shall be adjusted before compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the required compaction.

20.3.3 Compacting the Sub-base

- (a) Immediately after each layer of the sub-base has been spread, the full width shall be compacted by approved compaction equipment. Compaction shall progress gradually from the sides to the center, parallel to the centerline of the road, and shall continue until the whole surface has been compacted. All irregularities or depressions that develop shall be corrected by loosening material at these places and adding or removing material until the surface is smooth and uniform. At all places not accessible to the compaction equipment, the sub-base material shall be compacted thoroughly with approved tampers or compactors.
- (b) Each layer of the sub-base shall be compacted to a density of at least one hundred percent (100%) of the maximum dry density determined in accordance with AASHTO T180, Method D. In-situ density of the

compacted sub-base shall be measured in accordance with AASHTO T191 at the location directed by the Engineer.

20.3.4 Tolerances

Tolerances for the sub-base course shall be as specified in the following table:

Tolerances for Sub-Base Course:

Feature	Tolerance
Permitted variation from thickness of layer	± 20 mm
Permitted variation from design level of surface	+ 10 mm - 20 mm
Permitted surface irregularity measured by 3-m straightedge	20 mm
Permitted variation from design crossfall or camber	± 0.3%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%

20.4 BASE COURSE

This item comprises the supply and placement of granular base course material in accordance with the following:

20.4.1 Materials

Aggregate for base course shall consist of hard, durable particles or fragments of stone or gravel crushed to the size and of the quality requirements of this Clause. It shall be clean and free from organic matters, lumps or balls of clay and other deleterious substances. The material shall be of such nature that it can be compacted readily to form a firm, stable base.

All base course aggregate shall conform to the following physical requirements:

Physical Requirements of Base Course Material

(i) Toughness (ASTM D3)	6 min.
(ii) Loss by Sodium Sulphate Soundness Test (AASHTO T104)	10% max.
(iii) Loss by Magnesium Sulphate Soundness Test (AASHTO T104)	12% max.
(iv) Loss by Abrasion after 100 revolutions (AASHTO T96)	10% max.
(v) Loss by Abrasion after 500 revolutions (AASHTO T96)	40% max.
(vi) Thin and elongated pieces, by weight (pieces larger 1 inch., with thickness less than 1/5 of length)	5% max.
(vii) Soft fragments (AASHTO T189)	5% max.
(viii) Clay lumps (AASHTO T112)	0.25% max.

Aggregate for base course shall conform to the requirements of Class A as specified herein. Crushed gravel or rock fragments for base course Class shall consist of the product obtained by crushing gravel or rock, which, if directed by the Engineer, has first been screened in such a manner that when the aggregate is produced from gravel, not less than eighty percent (80%) by weight of the coarse aggregate shall be of particles having at least one fractured face.

Class A base course material shall be crushed rock or crushed gravel conforming to the following grading requirements:

Grading Requirements for Base Course Class A

AASHTO Designation No.	Percentage Passing by Weight
2 1/2 inch	100
2 inch	90 - 100
1 1/2 inch	35 - 70
1 inch	0 - 15
1/2 inch	0 - 5

Blending material for Class A base shall be quarry screenings or natural sand of suitable binding quality as approved by the Engineer. Blending material shall be free from foreign or organic matter, dirt, shale and clay lumps or other deleterious matter and shall conform to the following requirements:

Grading Requirements of Blending Materials for Base Course Class A

AASHTO Designation No.	Percentage Passing by Weight
3/8 inch	100
No. 4 (5 mm)	85 - 100
No. 100 (0.15 mm)	10 - 30
Plasticity Index (AASHTO T90)	6 max.
Sand Equivalent (AASHTO T176)	30 min.

The percentage of crushed aggregate composed of elements having at least one fractured face shall be at least eighty percent (80%) by weight of the material retained on sieve No. 4.

20.4.2 Spreading and Compacting

The coarse and fine components of the base course material shall be mixed in proportions as directed by the Engineer

Base course material shall be spread and compacted in the same manner as specified above for Sub-base Course.

20.4.3 Tolerances

Tolerance for the base course shall be as specified in the following table.

Tolerances for Base Course

Feature	Tolerance
Permitted variation from thickness of layer	± 10 mm
Permitted variation from design level of surface	+ 5 mm- 10 mm
Permitted surface irregularity measured by 3-m straightedge	5 mm
Permitted variation from design crossfall or camber	± 0.2%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%