

SECTION 20600 EARTHWORKS

20601 Scope of Works

This section shall consists of various earth works as follows

- Clearing and Grubbing
- Removal of Topsoil
- Common Excavation
- Structural Excavation
- Backfill to Structures
- Embarkment
- Sub-Grade Preparation

20602 Clearing and Grubbing

20602.1

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of the Clearing and Grubbing to all required areas of the Site.
- b) Clearing and Grubbing shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Clearing and Grubbing shall be executed by the Contractor to all required areas. Methods and Workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Clearing and Grubbing shall include the removal from ground surfaces and grubbing up of roots and miscellaneous foundations of all dense vegetation, bushes, trees, hedges, fences, obstructions and the like together with the removal and disposal off the Site and off the Project Area, of all materials and waste arising therefrom, all as indicated on the Drawings or as instructed by the Engineer and as specified herein.
- e) All materials arising from Clearing and Grubbing shall remain the property of the Employer. Clearing and Grubbing materials generally shall be disposed of by burning and/or transported and deposited by the Contractor to locations on the Site or within the Project Area.
- f) Where instructed by the Engineer that materials are not required to be retained by the Employer, materials shall be removed by the Contractor from the Site and from the Project Area to a disposal area to be selected by the Contractor, at the expense of the Contractor.

20602.2 Construction Requirements

- a) In areas where clearing and grubbing is instructed by the Engineer, the Contractor shall clear the ground surface of all trees, stumps, logs, brush, undergrowth, hedges, fences, structures, debris and rubbish of any nature, including the removal of stumps, roots, road areas, slabs and structural foundations where affected by the Works. Due care must be taken not to

damage trees and existing structures outside the limits of the working area or identified as to remain.

- b) Where necessary, and as directed by the Engineer, voids resulting from clearing and grubbing operations shall be filled with suitable compacted material at the Contractor's expense.

**20603
Removal of
Topsoil**

20603.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Removal of Topsoil to all required areas of the Site.
- b) Removal of Topsoil shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Removal of Topsoil shall be executed by the Contractor to all required areas. Methods and workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Removal of Topsoil shall include excavation to remove the top organic layer, hauling to designated locations and stockpiling or removing as instructed, to permit construction of the Works, all as indicated on the Drawings or as instructed by the Engineer and as specified herein.
- e) All materials arising from Removal of Topsoil shall remain the property of the Employer and the Engineer will direct the Contractor where the permanent remaining surplus of materials are to be transported and deposited. Materials generally shall be set aside for re-use on the Works, or transported and deposited by the Contractor to locations on the Site or within the Project Area.
- f) Where instructed by the Engineer that materials are not required to be retained by the Employer, materials shall be removed by the Contractor from the Site and from the Project Area to a disposal area to be selected by the Contractor, at the expense of the Contractor.
- g) The Contractor shall carry out surveys together with the Engineer after the completion of the following Works:
- Clearing and Grubbing (where so instructed)
 - The removal of topsoil
 - Common Excavation Works

20603.2 Construction Requirements

- a) In general, topsoil shall be removed by the Contractor under embankments, land reclamation areas, buildings, paving and structures as directed by the Engineer.
- b) Topsoil so removed shall be kept separate from other excavated material, and the Contractor is to take all necessary measures to avoid contamination of the topsoil with other excavated material or debris.

- c) Topsoil removal shall generally be to depths of between 200 to 500 mm.
- d) If topsoil is not found at the ground surface or is less than 200 mm deep, the Contractor shall notify the Engineer and request instructions.
- e) Where the topsoil is considered by the Engineer to exist below the instructed depth then the Contractor shall remove such material to a further depth as directed by the Engineer.

**20604
Common
Excavation**

20604.1 Scope of Works

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Common Excavation to all required areas of the Site.
- b) Common Excavation shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Common Excavation shall be executed by the Contractor to all required areas. Methods and workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Common excavation shall include supports to sides or additional excavation to form sloped sides, working space, disposal of all water (including surface water and groundwater), segregation of material suitable for backfilling or embankment, all necessary handling, stockpiling, disposal, shaping and trimming completed excavation in accordance with the locations, lines, levels, grades and dimensions shown on the Drawings and as specified herein.
- e) Common excavation includes general excavation to reduce levels.
- f) All materials arising from Common Excavation shall remain the property of the Employer and the Engineer will direct the Contractor where the permanent remaining surplus of materials are to be transported and deposited. Materials generally shall be set aside for re-use, or transported and deposited by the Contractor to locations on the Site or within the Project Area.
- g) Where instructed by the Engineer that materials are not required to be retained by the Employer, materials shall be removed by the Contractor from the Site and from the Project Area to a disposal area to be selected by the Contractor, at the expense of the Contractor.

20604.2 Construction Methods

- a) Common Excavation
 - Common excavation shall not start until topsoil has been removed from the work area in accordance with Section 20603.
 - The working methods and equipment used for Common Excavation shall take into account the nature of soils to be encountered, and the presence of the ground water table.
 - Excavation shall be performed carefully to avoid overbreak or

unnecessary disturbance of adjacent surfaces. Any overbreak or disturbance caused by excavation operations shall be backfilled and restored by the Contractor at his expense and as directed by the Engineer.

- When unsuitable material is excavated below embankments or below normal sub-grade level the void so formed shall be backfilled with suitable material, compacted in 20cm layers to 90% of its maximum dry density to the approval of the Engineer.
- Slopes in excavations shall be formed and maintained to prevent the formation of standing water. All excavations shall be finished to reasonably smooth and uniform surfaces.
- Water from excavations shall not be permitted to flow directly into the new drains or other construction work.
- Water pumping at all low points shall be provided continuously until the permanent drainage systems are finished and connected to the existing drainage network.
- Temporary drains shall be built as excavation progresses.
- Effective temporary decantation basins shall be installed before the water is drained into recently completed or existing drainage systems.
- The drainage network for the water coming from the work area, whether on or outside the Site, shall be permanently protected against pollution, maintained and kept clean until the end of work.
- The Contractor shall divert as required all ditches, field drains, foul drains, sewer, water and electrical mains, ducts, etc. wherever encountered during the progress of the work. Where such diversions are temporary the Contractor shall subsequently reinstate them to the Engineer's approval.
- Existing ditches shall not be filled until diversion ditches have been excavated, or without the Engineer's permission.
- The Contractor shall organize each section of the earthworks rationally so as to eliminate prolonged exposure of sub grades and bottoms of excavations during bad weather.

b) Re-use of Suitable Material

- Suitable material arising from the common excavation shall be used as backfill to structures or in the embankment works.
- Suitable material is defined as common excavation material that complies with the Sections 20606 or 20607.
- Where the excavation reveals a combination of suitable and unsuitable materials, the Contractor, unless otherwise instructed by the Engineer, shall carry out the excavation in such a manner that the suitable material is excavated separately for use in the Works without being contaminated by the unsuitable material.
- Material that becomes unsuitable as result of incorrect handling or construction methods or contamination by the Contractor shall be disposed of, and replaced at the expense of the Contractor.

c) Disposal of Unsuitable or Surplus Common Excavation Material

- All other excavated materials, either within or beneath the design

excavation limits, that do not meet the specification for embankment material or are liable, in the opinion of the Engineer, to be detrimental to the permanent works shall be designated "unsuitable material".

- Unsuitable materials shall also include soils which:
 - contain salty and gypsiferous soil, containing more than 10% of soluble salts, or
 - contain unacceptable quantities of peat, roots or organic matter, or have a low natural density less than 800kg/m³, or
 - are highly expansive, or
 - have hazardous chemical or physical properties, or
 - contain clay of liquid limit exceeding 70 and/or plasticity index exceeding 45, or
 - have a moisture content greater than the maximum permitted for such materials in the contact unless otherwise permitted by the Engineer.
- Unsuitable or surplus material, shall only be removed from the Site or the Project Area following the written instruction of the Engineer.

d) **Work in Canals and Waterways**

- The Contractor shall ensure that all temporary restrictions or diversions of canals or watercourses are safe, cause no interference to water flows and comply with the regulations of relevant authorities.
- Suitable cofferdams shall be used. The Contractor shall submit calculations and drawings for these temporary works to the Engineer.
- The internal dimensions shall be such as to allow sufficient clearance for excavation operations and the construction of temporary and permanent Works within.

e) **Quality Control and Construction Tolerances**

The dimensional tolerance for finished lines, grades and formations after excavation shall be ± 5 cm of dimensions shown on the Drawings.

20605

**Structural
Excavation**

20605.1 Scope of Works

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Structural Excavation to all required areas of the Site.
- b) Structural Excavation shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Structural Excavation shall include supports to sides or additional excavation to form sloped sides, working space, disposal of all water (including surface water and groundwater), segregation of material suitable for backfilling or embankment, all necessary handling, stockpiling, disposal, shaping and trimming completed excavation in accordance with the locations, lines, levels, grades and dimensions shown on the Drawings and as specified herein.
- d) Structural Excavation is defined as particular excavation, commencing after Common Excavation for below ground structures including foundations,

bases, retaining walls, ditches, culverts and the like.

- e) Prior to commencement of Structural Excavation, the Contractor shall obtain the Engineer's written instructions regarding work area and depth limits, and approval for the equipment and materials to be used and the method of work execution.
- f) All materials arising from Structural Excavation shall remain the property of the Employer and the Engineer will direct the Contractor where the permanent remaining surplus of materials are to be transported and deposited. Materials generally shall be set aside for re-use, or transported and deposited by the Contractor to locations on the Site or within the Project Area.
- g) Where instructed by the Engineer that materials are not required to be retained by the Employer, materials shall be removed by the Contractor from the Site and from the Project Area to a disposal area to be selected by the Contractor, at the expense of the Contractor.

20605.2 Construction Methods

a) **Structural Excavation**

Structural Excavation shall be in accordance with Section 20604.2

b) **Re-use of suitable material**

Re-use of suitable material shall be in accordance with Section 20604.2

c) **Disposal of Unsuitable or Surplus Structural Excavation Material**

Disposal of Unsuitable or Surplus Structural excavation material shall be in accordance with Section 20604.2

d) **General**

- Construction works adjacent to an existing road or rail line or structure shall be planned in such a way as to ensure the safety of existing facilities and the new construction works. All necessary temporary works and diversions provided by the Contractor shall be adequate for their purpose and comply with relevant regulations of the affected authorities.
- Depending on the soil conditions, ground water levels and the proximity of existing facilities and structures, structural excavation may be open by cut methods or require the use of timber planking and strutting or unbraced or braced sheet piles. The Contractor shall be completely responsible for the selection of method and for the stability of excavations and supports to sides.
- The Contractor shall provide, install and maintain adequate dewatering equipment and methods to ensure that all excavations are free of water and that pumping operations will not damage the foundation soils, temporary works or freshly poured concrete.
- Excavation to final grade shall not be made until just before the foundation construction is to start. When the material at final grade level is deemed by the Engineer to be soft or otherwise unsuitable the Contractor shall remove the unsuitable material and replace it with granular backfill as specified in Section 20606. The granular backfill

shall be placed and correctly compacted in 15cm layers up to the required foundation level.

- If, in the opinion of the Engineer, the foundation material is unsuitable as a result of the Contractor's work methods then any removal of unsuitable material and replacement with granular fill shall be at the Contractor's expense.

**20606
Backfill to
Structures**

20606.1 Scope of Works

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Backfill to Structures to all required areas of the Site.
- b) Backfill to Structures shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Backfill to Structures shall be executed by the Contractor to all required areas, for which the Contractor is responsible for Design. Materials, methods and workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Backfill to Structures shall include the supply (or production), hauling, all necessary handling, placing and compaction of suitable material from excavation works or granular backfill adjacent to structures, in accordance with the locations, lines, levels, grades and dimensions shown on the Drawings and as specified herein.
- e) Prior to commencement of Backfill to Structures, the Contractor shall obtain the Engineer's approval for the equipment and materials to be used and the method of work execution.

20606.2 Materials

- a) Suitable Common or Structural Excavation Material or Material from borrow pits.
 - Suitable material from Common or Structural excavation or from the Contractor's borrow pits, meeting the required characteristics for Embankment material and as further detailed in Table No. 20600 - 2, shall be used for backfill to structures as directed.
 - These materials shall be designated as Common Backfill.
- b) Granular Backfill
 - This material shall be well graded crushed stone or gravel with a maximum nominal size of 50mm.
 - The material shall meet the requirements of Table 20600 - 3, and the following particle grading requirements:

Table No. 20600-1: Gradation for Granular Backfill

Sieve Size		Percentage by Weight Passing
Standard (mm)	Alternative US Standard	
50	2 inch	100
0.425	No.40	25 – 90
0.075	No.200	0 – 10

The granular material shall have a Plasticity Index of not more than 6.

20606.3 Construction Methods

- a) Materials for backfilling structures shall not be placed, spread or compacted when it is raining, and no compaction shall be carried out if the moisture content of the material is outside the specified limits.
- b) The thickness of each layer of backfill from different sources shall be determined by trials, depending on placement location and the type of compaction equipment to be used.

However, the maximum compacted thickness of any material used for backfill to structures shall not exceed 15cm.
- c) All backfill material shall be compacted to 95% of its standard maximum dry density.

20606.4 Quality Control and Testing

- a) Common Backfill shall be tested as instructed by the Engineer and comply with the requirements of Table No. 20600-2.
- b) Granular Backfill shall be tested as instructed by the Engineer and comply with the requirements of Table No. 20600-3.

Table No. 20600-2: Characteristics for Common Backfill

Test Item	Test Method	Frequency	Standard Value
Maximum particle size	AASHTO T 27	As directed by the Engineer	Not greater than 75mm
Plasticity Index	AASHTO T 90	As directed by the Engineer	Not more than 10
Density-Moisture Relationship	AASHTO T180	For each source or change of material	
Field Moisture Content	AASHTO T 191	One test for each completed layer of backfill	Within the range -3% to +1% of OMC
Field Density	AASHTO T 191	One test for each completed layer of backfill	Not less than 95% of Maximum Dry Density

Table No. 20600-3: Characteristics for Granular Backfill

Test Item	Test Method	Frequency	Standard Value
Maximum particle size	AASHTO T 27	As directed by the Engineer	Not greater than 50mm
Plasticity Index	AASHTO T 90	As directed by the Engineer	Not more than 6
Density-Moisture Relationship	AASHTO T180	For each source or change of material	
Field Moisture Content	AASHTO T 191	One test for each completed layer of backfill	Within the range -3% to +1% of OMC
Field Density	AASHTO T 191	One test for each completed layer of backfill	Not less than 95% of Maximum dry Density

**20607
Embankment**

20607.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Embankment to all required areas of the Site.
- b) Embankment shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Embankment shall be executed by the Contractor to all required areas, for which the Contractor is responsible for Design. Materials, methods and workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Embankment shall include road embankment and land reclamation over the required area of the Site, using suitable materials arising from Common or Structural Excavation or suitable materials selected and imported by the Contractor from off the Site.
- e) Embankment construction shall include for any necessary preparation of original ground below formation level, selecting and obtaining materials, hauling and handling, depositing, spreading, shaping and compacting in accordance with the requirements of location, elevation and grade designated in the Drawings and as specified herein.
- f) Prior to commencement of the Embankment work, the Contractor shall obtain the Engineer's approval for the equipment and materials to be used and the methods of work execution.

20607.2 Materials

- a) Embankment core material shall be a well graded material with a smooth and continuous grading curve, free of deleterious material, organic matter and excessive water and comply with the requirements of Table No. 20600-4.

Table No. 20600-4: Characteristics and Testing of Embankment Material

Test Item	Test Method	Frequency	Standard Value
Maximum particle size	AASHTO T 27	As directed by the Engineer	Not greater than 75mm
Plasticity Index	AASHTO T 90	For each source or change of material.	Not more than 10
Density-Moisture Relationship	AASHTO T180	For each source or change of material.	
Laboratory CBR	AASHTO T 193	As directed by the Engineer or for each source or change of material.	More than 10% when compacted to 95% of MDD
Field CBR	AASHTO 193 (Penetration Test)	As directed by the Engineer	
Field Moisture Content	AASHTO T 191	Once a day or for each completed layer of embankment.	Within the range -3% to +1% of OMC
Field Density	AASHTO T 191	Once a day or for each completed layer of embankment.	Not less than 95% of Maximum Dry Density

- b) Cohesive slope protection material shall be of such gradation that not less than 25% of particles are of clay size (i.e. less than 0.002mm). The material shall be well graded gravelly or sandy clay or clay of medium plasticity, and shall have a plasticity index of not less than 10 as determined by AASHTO T90.

20607.3 Construction Equipment and Methods

- a) Embankment construction shall not start until all clearing and grubbing and topsoil removal has been completed over the entire length or section of embankment proposed by the Contractor, to be constructed in a particular operation.
- b) Where the ground level after topsoil removal, is less than 50cm from the embankment formation level, or the roadway is in cutting, then the original material for 50cm below the road carriageway shall either be:
- conditioned and compacted, if deemed suitable, to achieve 95% of the material's Maximum Dry Density determined in accordance with AASHTO T 180, or
 - removed if deemed unsuitable and replaced with suitable material. The new suitable material shall be conditioned and compacted to achieve 95% of the material's Maximum dry Density determined in accordance with ASSHTO T 180.
- c) Where necessary the existing ground is to be benched, as indicated on the

Drawings or instructed by the Engineer, before embankment material is placed.

- d) Embankment material, generally, shall be placed and spread immediately on the prepared surface upon arrival at the work location. Stockpiling of embankment material will not be permitted, especially during the rainy season.
 - e) In placing embankment material over or against porous drainage material care shall be taken to avoid mixing of the two materials. In the case of vertical porous drains this shall be achieved by forming sharply defined surfaces with temporary forms that shall be gradually withdrawn as placing of the embankment fill and porous drain is carried out.
 - f) Embankment fill material shall be spread in horizontal layers not exceeding a compacted thickness of 20cm. The fill material shall be conditioned as necessary to achieve the required moisture content before compaction operations commence.
 - For dry material the nature of the conditioning shall be to add sufficient water and mix it uniformly into the fill material by discing, plowing or scarifying or other methods approved by the Engineer.
 - For material with a moisture content in excess of that required, the material shall be worked by adequately aerating the material, by scarifying or forming windrows or other approved methods, until the correct moisture content is achieved.
- Once embankment fill material is at the correct moisture content the surface shall be graded level before compaction operations commence.
- g) Hauling and levelling equipment shall be routed and distributed over fill areas in such a manner as to reduce rutting and uneven compaction.
 - h) Compaction equipment shall be capable of achieving the required compaction without having any detrimental affects on the fill material. The equipment shall be carefully controlled to ensure that all areas are uniformly compacted for their full width and depth.
 - i) Embankment material shall be compacted to 95% of the Maximum Dry Density determined in accordance with AASHTO T 180.
 - j) Successive layers of material will not be placed until the underlying layers have been tested for compliance with the specified quality requirements.
 - k) Embankment construction at structures shall be so controlled as to prevent displacement or overturning of structures or excessive pressure being exerted on them.
 - l) As the embankment height is increased the outer edges of fill layers should be located, wherever possible, to coincide with any benching required in the slope. The Contractor will be required to cut, form and shape all benching shown on the Drawings or as required by the Engineer to ensure stability of the cohesive slope protection material.
 - m) During construction, and until all pavement and permanent drainage works

have been completed, the embankment surfaces shall be suitably cambered and graded to drain rainwater through suitable side ditches or gutters to avoid erosion.

- n) Cohesive Slope Protection Material shall be placed as soon as practicable after the embankment core has been completed to prevent erosion.

20607.4 Compaction Trials

- a) Before the Contractor commences the placing, spreading and compacting of embankment material, trial sections shall be prepared, using the relevant material and Contractor's proposed equipment and work methods, to demonstrate, to the satisfaction of the Engineer, that the Specification will be complied with in all respects.
- b) Trial sections shall be of a suitable size, but not less than 500m².
- c) Trial sections of embankment fill material will be subject to testing by the Contractor, as directed by the Engineer, for moisture content, density, field CBR, construction tolerances, visual inspection and any other tests specified herein.
- d) If the Contractor's proposed equipment and work methods do not produce finished material that complies with the Specification then suitable amendments shall be made and new trial sections prepared.
- e) If, during the Contract, the materials or methods of working are changed, for whatever reason, the Contractor shall prepare and test further trial sections to show that any amendments comply with the Specification.

20607.5 Control of Traffic on Completed Surfaces

- a) Only traffic necessary for the placing, spreading, compaction, testing and supervision of the embankment fill material shall be permitted in the working area until shaping and compaction is substantially complete.
- b) At all times the Contractor shall be responsible for controlling traffic to avoid or eliminate damage to or deterioration of the embankment materials and surfaces. The Contractor shall be responsible for making good, rectifying or replacing any material that is considered to be unsuitable for use in the Works due to vehicular damage.

20607.6 Construction Tolerances

- a) The finished levels and grades of embankment shall not be more than 10mm below or more than 20mm above those specified or indicated on the drawings.
- b) Finished embankment slope surfaces shall not vary from the profile shown on the Drawings by more than 100mm.

20607.7 Quality Control and Testing

- a) Regular testing methods and their frequency during construction for the embankment material shall be as detailed in Table 20600-4.
- b) Alignment, levels and grades shall be checked regularly by surveying.

- c) All holes made in completed work by cores or other tests shall be filled with the specified material by the Contractor and compacted to the density and surface tolerance requirements of the Specification.

**20608
Sub-Grade
Preparation**

20608.1 Scope of Work

- a) The work under this Section to be carried out by the Contractor, consists of the design of relevant portions and the execution and completion of Sub-Grade Preparation to all required areas of the Site.
- b) Sub-Grade Preparation shall be executed by the Contractor to all required areas of the Engineers Design as indicated on the Drawings.
- c) Sub-Grade Preparation shall be executed by the Contractor to all required areas, for which the Contractor is responsible for Design. Materials, methods and workmanship for this Contractor designed portion shall be at least the same as indicated on the Drawings for other areas and as specified herein.
- d) Sub-Grade Preparation shall include for any necessary preparation of the formation level for paved surfaces, including conditioning, trimming, levelling and compacting surfaces, removing and replacing unsuitable or damaged material, all in accordance with the requirements of location, elevation and grade designated in the Drawings and as specified herein.
- e) Prior to commencement of the Sub-Grade work, the Contractor shall obtain the Engineer's approval for the equipment and materials to be used and the methods of work execution.
- f) Dependant upon the actual CBR value of the Sub-grade, the Engineer may instruct modification of the pavement sub-base and base.

20608.2 Construction Method

- a) Sub-grade to roads and yards shall be prepared after the excavation and removal of embankment surcharge, which shall be measured to surface of subgrade level.
- b) Sub-grades shall be conditioned, worked and compacted to required density and depth with surface accurately finished to required level and profile.
- c) For maximum compaction the moisture content of sub-grades shall be carefully controlled.
- d) The Contractor shall submit results of CBR tests for the Engineer's review and shall obtain approval of the Engineer prior to proceeding with pavement construction.
- e) The Contractor shall maintain the sub-grade free of storm water and ground water by furnishing pumps or dewatering equipment.

20608.3 Quality and Workmanship Standards

- a) Quality Standards - Refer to Section 20607
- b) Workmanship Standards - Refer to Section 20607

SECTION 20700 CAISSON QUAY WALLS

- 20701**
Scope of Work
- The caisson quay construction included in this section covers the construction, launching, positioning, bedding, seating, filling and back filling.
- The Contractor may select, subject to the approval of the Engineer, the method of construction, launching and placing of the reinforced concrete caissons required for – 14.0m CD. Caisson quay walls. A full method statement, including calculations and drawings will be required covering all aspects of the caisson construction, launching and placing. The method statement shall be presented to the Engineer for approval within four weeks of the issue of the Notice to Proceed.
- 20702**
Excavation for Quay Foundation
- Excavation for the caissons shall be carried out in accordance with Section 20400 of this Specification. The levels and dimensions of the insitu foundations indicated on the Drawings have been based on the estimated depths required to achieve a minimum insitu foundation Standard Penetration Test value of not less than $N = 30$. The indicated levels and dimensions may be amended by the Engineer during the excavation and dredging work based on the results of insitu inspection and testing of the excavated surface.
- 20703**
Equipment for Testing Quay Foundation
- The Contractor shall constantly keep at least one set of machinery, equipment, vessel, workers and technical staff available so that Standard Penetration Tests may be carried out at any location and at any time on the caisson or blockwork foundations in accordance as directed by the Engineer and shall immediately present the test results to the Engineer for assessment of the condition of the foundation.
- 20704**
Acceptance Criteria for Quay Foundation
- Inspection testing and sounding of the dredged surface shall be conducted immediately before placement of Graded Rock Base. Reinspection shall be made if the Contractor fails to place the Graded Rock Base within the time specified after the initial inspection as directed by the Engineer.
- The Contractor shall provide all equipment, vessels and workers required for surveying and sounding for inspection of the dredged surface as required by the Engineer.
- The Contractor shall establish by inspection that no loose soils remain on the sea bed after the completion of the dredging which are below the relative density or consistency specified elsewhere or as shown on the Drawings. Divers shall be used whenever necessary.
- 20705**
Rock Mound for Caisson Foundation
- The reinforced concrete caissons quay walls are to be placed on a graded compacted rock foundation as shown on the Drawings.
- The methods of transportation, placement, compaction and leveling of the graded rock mound shall be subject to the approval of the Engineer. Rock shall be placed until the Engineer has approved the previously prepared excavation of the seabed for the caisson quay wall.
- Rock Mound**
- The rock mound shall be evenly graded crushed stone ranging in size from 10 kg to 250 kg and rock quality shall be in accordance with Section 20200. Before placing the rock mound, the Contractor shall carry out compaction tests to determine any variation necessary in the grading proposed, to achieve the minimum voids content of the in place compacted rock mound.
- The upper surface of rock mound shall be placed and leveled to a nominal 250mm below the specified level of the underside of the caissons or to such other level as the Engineer may direct from time to time as the effects of compaction are recorded.

**20706
Compaction of
Rock Mound**

After leveling the base layer and its approval by the Engineer, the Contractor shall carry out tamping of the surface to compact the graded rock base.

Compaction requirements commence from a point 1m seaward of the front toe and extends to a point 1m landward of the back toe of each caisson as placed.

Either submerge vibrators or drop-hammer type compactors may be used for tamping works. The Contractor shall submit his proposals for compaction for the approval of the Engineer. A suitable Compactor specification is as follows:

- | | | |
|----|-----------------------------|---|
| a) | Compactor type: | drop-hammer |
| b) | Weigh of ram in air: | 5 tonnes |
| c) | Ground contact area of ram: | 0.64 sq. m |
| d) | Free fall of ram in water: | 3.0m |
| e) | Blow rate: | 3 blows/min. |
| f) | Ancillary: | Diesel engine driven winch and construction pontoon |
| g) | Capacity per hour: | 10 sq m./hr. |
| h) | No. of passes: | 2 minimum 25 percent overlap per blow |

Where a vibratory type compactor is used it shall have a compactor effect no less than that of the specified drop-hammer.

**20707
Seating Layer
and Surface
Leveling**

After the completion of the compaction of the rock base to the approval of the Engineer, a seating layer of compacted crushed rock, of nominal thickness 250mm shall be spread, leveled and compacted on the rock mound, extending at least 1 meter both seaward and landward of the width of the caisson or block base. The seating layer shall consist of evenly crushed rock ranging in size from 50mm to 150mm. The surface shall be leveled to an accuracy of +0,000 to -50mm to the required level of the underside of the caisson or blockwork base sheets.

**20708
Tolerances of
Rock Mound**

The top surface of the graded rock base shall be within a tolerance of ± 150 mm in level after compaction

The top surface of the seating layer shall be within a tolerance of +0,0 to -50mm

**20709
Seating Asphalt
Mat and Surface
Leveling**

After completion of the specified compaction work a seating Asphalt Mat. Shall be leveled by divers. The surface shall be leveled to an accuracy of ± 25 mm to the specified level, which is the required level of the underside of the caisson.

**20710
Concrete for
Caissons**

20710.1 Materials of Caisson

The requirements for concrete, reinforcement bars, formwork, etc. used in the construction of the reinforced concrete caissons shall be in accordance with SECTION 20300 of this Specification or as modified herein.

20710.2 Insulation Between Caisson and Casting Base

Insulation materials such as waterproof paper shall be placed between the bottom plane of each caisson and the casting base to prevent adhesion between the surfaces and to facilitate separation of the caisson from the base for launching and floatation.

20710.3 Placing of Concrete in the Side Wall

Placing of concrete in the side walls of each caisson shall be limited to 3.0m per lift. Concrete shall be placed evenly over the entire perimeter so that the height of the concrete surface may rise equally over the entire side walls and partition walls, to enable the surface of the fresh concrete to be leveled off in case of a stoppage in the concreting process.

An approved debonding membrane shall be placed between the bottom plane of each caisson and the casting base to prevent adhesion between the surfaces and to facilitate separation of the caisson from the base for launching.

20710.4 Prevention of Segregation of Concrete

The Contractor shall pay particular attention to the prevention of segregation of concrete when conveying and placing concrete for caissons. The Contractor shall adopt methods approved by the Engineer.

20710.5 Placing of Concrete

Placing of concrete shall be made evenly over the entire perimeter so that the height of the concrete surface may rise equally over the entire side walls and partition walls, so that the surface of the fresh concrete can be leveled off in case of a stoppage in the concreting process.

20710.6 Temporary Platforms for Concreting each Lift of Side Walls

The contractor shall provide temporary platforms for concreting each lift of concrete for side walls and partition walls of caisson.

20710.7 Limit in the Use of Diagonal Chutes

Concrete shall not be placed through a diagonal chute directly into the form. The concrete that flows out of a chute shall be received on steel plate, and then shall be carefully placed in the form to avoid segregation of the concrete materials.

20710.8 Limit in the Use of Concrete Pump

If the Contractor desires to carry out concreting of caisson using concrete pumps, the Contractor shall apply to the Engineer in advance for his approval, which shall be given only at the discretion of the Engineer.

20710.9 Compaction of Concrete

Internal vibrator shall be used generally for compacting concrete. Form vibrator shall be used for thin walls and the like where the use of internal vibrator may be restricted.

Concrete shall be thoroughly compacted immediately after being placed so that concrete can be fully filled around reinforcement steel bars and every corner of the forms. It is desirable that manual compaction using long bars is jointly applied with other methods for the production of watertight concrete walls of the caissons.

20710.10 Joints in the Concrete

At every construction joint laitance shall be removed and the concrete surface roughened, cleaned and sufficiently moistened before the next lift or panel of concrete is cast against it. When necessary a bed of mortar of the same proportions as the cement mortar for the concrete being cast and of a thickness to be agreed with the Engineer shall be placed on the moistened surface of the set concrete to allow complete bonding of new and old concrete.

20710.11 Concrete in Hot Weather

At the concrete mixing plant, the aggregate shall be shaded from direct sunlight with appropriate covers. The water tank shall be of such construction that the water temperature is maintained as low as possible. In addition, form surfaces shall be thoroughly sprayed with water prior to placing of concrete. The Contractor shall obtain approval of the Engineer for his measures for controlling temperature and evaporation of water from concrete.

The maximum temperature of the concrete in the moment of placing shall be as

specified in 20312.6 and it shall be at the contractors own expense to keep the temperature at or below the valves there specified.

20710.12 Removals of Forms

The Contractor shall obtain the approval of the Engineer regarding the timing and procedures for removal of concreting forms.

20710.13 Inspection of Arrangement of Reinforcement Bars

In each stage of the caisson construction process the Contractor shall not place concrete until the Engineer has inspected and approved the fixed reinforcement bars.

20710.14 Test on Caisson Concrete

Test on concrete used in caisson construction shall be conducted in accordance with the provision of Section 20300 Concret.

The specified slumps shall be $10\text{cm} \pm 2.5\text{cm}$. The number of test samples shall be as directed by the Engineer.

20710.15 Construction after Launching

If the Contractor prefers not to construct the entire height of caissons in the yards but to cast the upper lifts after launching, he shall present his construction plan to the Engineer for his prior approval.

For placing concrete when partially completed caissons are afloat the construction methods shall be such that the joint surfaces are not contaminated by sea water.

20711

**Formwork for
Caisson
Concrete**

The caisson concrete formwork grade shall conform with the specification for SECTION 20307. Contractor shall obtain the approval of the Engineer for the concrete finish to be formed on the top surface of the footing not later than eight (8) weeks prior to starting the formwork.

207012

**Surface Finish
of Top Surfaces**

The top surfaces of the caisson concrete shall be finished in Type U.2 Wood Trowel Finish outlined in SECTION 20309 of this specification.

20713

**Tolerances for
Caisson
Construction**

Caissons shall be constructed within the following tolerances:

- a) Tolerance in wall thickness: $\pm 10\text{mm}$
- b) Tolerance in length, width and height: $+30\text{mm}$, -10mm
- c) Deviation from verticality of walls measured at right angles to underside of caisson base shall be not greater than 25mm over the full height of wall
- d) Deviation in plane of cross walls measured at right angles to front face of caisson shall be as follows, measured over the full width of caissons:
 - External (end) walls not greater than 25mm
 - Internal walls not greater than 50mm .

20714

**Temporary
Mooring and
Storage**

If the Contractor intends to moor caissons in the vicinity of the Site or afloat elsewhere, he shall be responsible for obtaining all necessary approvals prior to seeking the approval of the Engineer and shall exercise particular care with regard to safety requirements.

If the Contractor intends to ground the caissons temporarily after flotation and later refloat them for towing and placing in their permanent locations in the works, he shall prepare a plan concerning the area of the temporary grounding showing the proposed preparation of the seabed, period of temporary grounding, the means of sinking, refloating, protection and security of the caissons for the approval of the

- Engineer.
- 20715 Towing** The Contractor shall obtain the approval of the Engineer for the method of towing of caissons, and details of all support craft etc. Due care shall be taken of all other moved craft and the passage of other vessels in the vicinity of the towing operations.
- 20716 Survey Control for Placing Caissons**
- 20716.1 Survey Platforms**
The Contractor shall establish two rigid steel survey platforms on the line of each seaward force of the caisson structures, clear of the working zone. The platform shall be filled with a secure working area approximately 2m × 2m, access ladders and safety rails all to the approval of the Engineer.
Due allowance shall be taken of the likely sea state conditions during the caisson installation period.
The survey platform shall be relocated or removed by the Contractor at anytime upon direction by the Engineer.
- 20716.2 Face Line**
After levelling of the graded rock base by divers, the Contractor shall survey the face line and shall present the results to the Engineer for his approval, indicating the compacted zone relative to the face line.
- 20717 Installation of Caissons**
For sinking of the caissons in their respective locations, each caisson shall be filled with water, the difference in water level in each chamber shall not exceed 1.0m.
At least two divers shall be available for the installation of each caisson. The grounding area shall be inspected for obstructions before placing each caisson.
The required accuracy of installation of the caissons is as follows:
- | | | |
|----|-------------------------|--------|
| a) | Space between caissons: | +100mm |
| b) | Face line: | ±50mm |
| c) | Top level of Caisson | ±100mm |
- Should these tolerance be exceed, the Contractor will refloat the caisson and take all necessary remedial actions as directed by the Engineer, prior to its repositioning.
- 20718 Fill for Caissons** Filling of the caissons shall be promptly carried out after installation of each caisson and the sand fill shall be distributed evenly in each chamber. The method and sequence of filling and compacting operations shall be subject to the Engineer approval.
- 20719 Joints Between Caissons**
After the installation of caissons and before the commencement of backfilling works, sand release protection sheet shall be installed at every joint between caissons as shown on the Drawings and in a manner approved by the Engineer.
Material for the sand release protection sheet to be used in the Work shall be of laminated soft polyvinyl chloride (PVC) and shall have sufficient strength, elasticity and rigidity against pulling and tearing force complying with the requirements in Section 20200.
Sand release protection sheet have 1.0 m width and shall be carefully installed in such way that both sides are firmly fixed to each caisson but allowing for at least 10 cm movement of the caisson in any direction after its installation. The installation method including fixing of the sand release protection sheet to caisson shall be submitted to the Engineer for approval prior to the commencement of work.
- 20720 Rock Backfill Behind Caissons** The graded rock fill behind the caissons shall be Back filling material as defined in Section 20200 and shall be placed to the lines and levels as shown on the Drawings.

20721
Survey
Monitoring of
Caissons

It is possible that settlement may occur in each caisson to a limited extent, causing slight forward movement and tilting as construction works progress. The Contractor shall survey the following items once a day from the date of installation of each caisson, plot the figures on graphs to a time base of days, and submit them to the Engineer within 24 hours of each survey.

Level survey of four corners of each caisson

Survey of movement of the face line at both ends of each caisson

20722
Face Line of
Cope Concrete

The shape of the cope concrete placed insitu for each caisson shall be modified to compensate for the settlement and forward tilt. In particular the correction to the joint of the cope concrete with the front face of caissons shall ensure that the face line of the quay is finished straight. The details will be directed by the Engineer. Cope concrete shall not be placed until caisson movement has ceased or has decreased to a rate acceptable to the Engineer.

20723
Expansion
Joints in Cope
Concrete

21121.1

Expansion joints shall be installed in the concrete cope at the locations and according to the dimensions shown on the Drawings or as directed by the Engineer.

The expansion joint filler shall be as approved bitumen impregnated compressible material. The joint filler shall be extended to within 50mm of the faces of the cope and be sealed with an approved resilient, oil resistant synthetic rubber.

20724
Placing Armour
Rock

The sea bed in front of the caissons shall be lined with Armour Rock as shown in the Drawings and specified in Section 20200.

This work shall be carried out by divers and using cranes. Particular attention is required to the level tolerance of the finished top surface.

Tolerance of the finished top surface level of the rock lining shall be +100mm, -200mm.

The armour rock used for the lining must be uniform in thickness.

SECTION 20800 PILING AND STRUCTURAL STEEL WORK

20801
Scope of work The scope of work covered by this section of the Specification includes the supply, fabrication, protection treatment, delivery and erection of all Structural Steelwork required for the Works, including:

- a) Steel piling
- b) Steel catwalks
- c) All temporary or permanent steel bracing and supports
- d) Other miscellaneous steel work

Included also is the supply of all bolts, purlins, girts, bracing and steel sections, etc, necessary for the satisfactory performance of the complete works.

20802
Materials

20802.1 Materials for Piles

Material to be used in the manufacture of the piles shall comply with the requirements of JIS G 3444 and JIS A 5525, ASTM A 512-96, A-513 and ASTM A 252 or equivalent standard.

The chemical composition, mechanical properties and types of pipe piles to be used are specified in Section 20204 of this Specification.

20802.2 Structural Steel

Structural Steel shapes and plates shall comply with SS-400 Hot Rolled Section of JIS G 3101 or ASTM A35 and A283 or approved equivalents.

The chemical composition and mechanical properties of hot-rolled steel shall comply with the standards as shown in Section 20204.

If the Contractor is unable to obtain steel of the sections specified he may submit alternative proposals to the Engineer for approval.

20802.3 Bolts and nuts

Bolts and nuts shall conform to the requirements of JIS G 3101, JIS B 1180, JIS B 1181, JIS B 0205, JIS B 1256 or ASTM A-325M, ASTM F-436. or approved equivalents.

20803
Splicing of Piles

Splicing of piles shall, in principle, be made on land before driving except for the case of unforeseen seabed configuration where splicing may be made in situ on partly driven piles. All butt welds shall have a backing plate bonded to the pile profile. The butting faces of the piles shall be trimmed to profile and the surfaces prepared for welding, and welded with a full strength butt weld.

When piles are spliced in-situ, the Contractor shall ensure that the extension is lined up accurately with the partially driven pile and that all steel parts are kept at proper temperatures. If welding is to be carried out in adverse weather condition, adequate shelter shall be provided for the work.

Splicing of piles in yard before driving shall be made in such a manner that the joints of piles are always located within the fill material behind the caissons.

**20804
Notice of Pile
Fabrication**

All piles shall be numbered sequentially in the order in which they are welded, and a record of these numbers, the date welded, the name of the operator and the results of testing shall be kept. These records shall be submitted to the Engineer as soon as possible after completion of welding.

**20805
Final Pile Set**

The piles shall be driven in to solid rock to a set approved by the Engineer based on the Hiley Formula or other formulas and sufficient to enable the piles to carry their working load with a minimum factor of safety of 3.

In determining the set, the weight of material inside the pile, and any pile helmets used for driving, shall be included in the total driven weight of the pile.

If diesel pile hammers are used, the manufacturer's rated energy of the blow shall be used.

The Contractor shall record on the pile driving chart the number of blows for every 50cm of pile penetration and the magnitude of rebound for at least 20 blows in the final stage of pile driving and submit the record to the Engineer.

The final set is expected to be attained when the penetration of pile becomes close to 2mm for each blow at this site. However, the Engineer may change the value of penetration for final set after several piles have been driven. Under no circumstances shall additional blows be given when the penetration of pile becomes less than 2mm per blow.

**20806
Handling and
Protection of
Piles**

Transport, lifting and pitching of piles shall be carried out in such a way as to ensure that the pile is not damaged.

Padded cradles or supports in yards and barges, etc., shall be provided and padded slings or straps used with slinging or pitching to prevent damage to the piles. The Contractor shall prevent mooring wires or ropes from floating equipment from damaging the piles.

The Engineer has the authority to reject any damaged pile and it shall be replaced by the Contractor at no additional cost.

**20807
Pile Lengths**

The overall pile lengths shown on the Drawings are for guidance only. The Contractor shall make his own assessment of the pile lengths required on the basis of the borehole information provided in the documents, and on the basis of experience gained at the Site.

The pile length measured for payment will be the distance along the pile between the toe level of the pile as driven and the cut off level specified on the Drawings. No payment will be made to the Contractor for extending piles which have proved to be too short to reach solid rock nor for extending piles as part of his method of working, and the Contractor shall allow for all such work in his rates for piles and pile driving. Pile cut offs shall be the property of the Contractor, and shall be re-used or disposed of off Site as necessary.

**20808
Plant and
Driving**

The Contractor shall provide temporary but rigid guides to ensure accurate driving of piles. He shall also provide any necessary framing, cranes, pontoons and other plant and equipment required in connection with piling operations.

All pile driving plant shall be approved by the Engineer before it is used on the Site. The Contractor shall provide the Engineer with the characteristics of all pile

hammers that he proposes to use which will be of adequate weight and suitable design to drive the piles to achieve the specified bearing capacity at the required penetration. The head of the piles shall be protected by a steel driving cap. If required, the heads of the piles are to be suitably strengthened.

If a single acting drop hammer is used for driving, the drop shall be limited to 1.2m. All piles shall be pitched accurately to line and level shown on the Drawings. The maximum deviation of any pile from the vertical shall not be greater than 1 in 75.

The Contractor is required to submit details of his proposals for the temporary works required by him to achieve pile driving of the accuracy required to the Engineer at least 4 weeks before he proposes to start pile driving operations.

20809

Obstructions

In locations where piles are driven and "hand-up" on boulder or obstruction at a level above the rock level occurs, and there is insufficient penetration to support the pile, it will be necessary to drive the pile through the obstruction by using the pile as a casing and drilling or chiseling inside to clear the obstruction and driving the pile to the required set.

20810

**Notice of Piling
Operations**

The Contractor shall give due and reasonable notice of his intention to drive piles so that the Engineer may make arrangements for inspection if he so requires.

20811

**Level of Pile
Toes**

The toes of piles shall be driven to depths which are judged by the Engineer to be sufficient for supporting the design working load. In general, the toes of piles shall be driven to solid rock.

20812

Driving Records

The contractor shall keep records of the driving, elastic compression and the set of piles as instructed by the Engineer and these records shall be submitted daily or weekly as required by the Engineer.

The following records shall be kept:

Pile number

Toe level

Cap level

Ground level

Tide level

Length of lower section

Length of upper section

Hammmer type and weight

Helmet weight

Hammer driving energy

Elastic compression at 1.0m penetration

Details of cap

Cushion (Dolly) and of any pile head packing used

Final set (series of 3 checks over 10 blows)

Measurement of "out of position" N-S and E-W

Measurement of verticality

Detailed records of set and elastic compression from the time when the rock surface is reached and any other such records as the Engineer may direct.

**20813
Marking of Piles**

Each pile shall be clearly marked at the head in white, with its number and overall length and is to be marked in 1.0m divisions over the visible length of the pile as pitched closer divisions are to be provided as necessary to facilitate the making of piling records.

**20814
Temporary
Bracing of Piles**

Temporary after driving, each pile shall be adequately supported until incorporated into the completed structure as described in Chapter 9.

The Contractor is required to submit details of how he intends to brace the piles to the Engineer for approval at least 4 weeks before he proposes to start pile driving operations.

**20815
Damaged Piles**

Piles lost or damaged due to transporting, handling, pitching and driving shall be replaced or repaired at the Contractor's expense.

**20816
Correction of
Out of Position
or Out of Plumb
Piles**

Piles deviating by more than the specified tolerances shall be accepted only if satisfactory modifications can be made to the crane beam structure to allow for the deviations.

Piles rejected may be extracted and re-driven if undamaged. If a pile is damaged, the damaged portion may be cut off and a new section welded on according to the specified methods. Piles which are badly damaged and cannot be repaired to the satisfaction of the Engineer shall be clearly marked **REJECTED**, removed from the Site and a replacement pile driven in accordance with the specification.

Where rejected piles cannot be extracted or the Contractor chooses not to extract, then a compensating pile or piles shall be driven at the Contractor's expense. Proposals for compensating piles shall be prepared by the Contractor for the approval of the Engineer before driving.

The costs of complying with this clause including replacement or additional piles and modifications to the crane beam or other rectification works shall be borne by the Contractor.

**20817
Welding**

20817.1 General

Welding of mild steel shall be done by the electrical arc welding and shall comply with the requirements of JIS Z 3801 and JIS Z 3841 or ASTM A-252.

All welding works shall be carried out by qualified welders only who shall have at least six months of experience including two consecutive months immediately before the works.

The contractor shall submit to the Engineer for his approval a roster of all the welders employed in the welding work showing their names, job experiences and other details.

Arc welding plant, equipment and accessories shall be used in accordance with the requirements of JIS C 9301.

20817.2 Cutting and Welding

Steel materials shall be cut accurately by the oxyacetylene process. Extra care shall be exercised in the cutting of long or deformed materials to ensure that no deformation develops.

The procedure of welding shall be approved by the Engineer before the work commences.

Splicing of steel pipe piles shall be done by welding at the welding yard on the Site and the welding shall be done by the semi-automatic method described in JIS Z 3605 and shall comply with the Drawings.

Before welding, all the surfaces to be welded and the adjacent area shall be thoroughly cleaned of rust, paint, slag and dirt and wiped dry.

During welding, the materials to be welded shall be firmly held together in correct position by means of jig or tack welding. The tack welding shall be limited to the minimum possible extent.

Welds in butt-welding shall be cut carefully and accurately and the gap between roots of the members shall be maintained precisely as shown on the Drawings.

During Welding, the welding current and speed shall be such that V-welds will be completely gorged with deposited sealing beads of weld metal. Care must be taken to prevent insufficient deposition or weld metal, inclusion of slag into weld, irregularity of the craters, and cracks.

The Contractor shall be responsible for making good all unsatisfactory welds including air bubbles, overlaps, undercuts, excess or shortage of the throat thickness or size.

No welding work shall be done in the rain or storm except the underwater welding system. Welding may be carried out with the approval of the Engineer where adequate protective measures are taken against the effects of such weather conditions.

20817.3 Finishing of Surface

The completed member shall be free of all scars, grooves, random arc strikes, burrs and any other imperfections induced by handling. Repair welding of any kinds shall be done on a surface ground smooth and free of defects. Repair welds shall be not less than 5 cm in length, including random arc strikes. All welds shall blend smoothly into edges of joint members. If, in the opinion of the Engineer, welded joints contain geometric irregularities contributing to stress concentrations or notch

effect due to improper weld deposition, the Contractor shall eliminate the conditions by grinding.

Over-welding shall not be permitted to correct such conditions. If additional welding is considered to assist in such operation, it shall be done with the Engineer's approval.

20817.4 Inspection of Welding

Welding shall be inspected or witnessed by the Engineer or his authorized representatives in accordance with the requirements of JIS Z 3146. Such inspection or witnessing shall include, but not be limited to, visual inspection, ultrasonic testing, and radiographic testing.

Regardless of any other methods of inspection used, all welding shall be subjected to visual inspection. Visual inspection shall include checking the fit-up of joints to be welded to see that they are in proper alignment and conform to the requirements of the welding procedures in respect of such factors as groove angle, root face and root opening.

The Engineer may order any welded seams to be examined and tested by approved radiographic method or ultrasonic method when he considers such tests area necessary. If do ordered, the Contractor shall provide or make arrangements for the supply and operation of all necessary equipment at no extra cost.

208218

Cathodic Protection of Particular Piles

The Contractor shall supply and install aluminium alloy anodes on the surface of the steel tube piles to be driven for the berths. The type and manufacture of the aluminium alloy anodes shall be subject to approval of the Engineer.

The anodes shall have a life expectancy of 20 years.

The steel pipe piles at the passenger berth shall be provided with a galvanic anode protection system against corrosion using aluminium alloy anodes as shown on drawing.

- 1) Scope of corrosion protection by cathodic protection system from the bottom (-1.20m) of petrolatum lining system to the tip of steel pipe pile (-26.8m--27.5m).
- 2) Scope of corrosion protection by petrolatum lining system from the bottom of coping to -1.200m of level.
- 3) Method of cathodic protection system sacrificial anode system by using aluminum alloy anode
- 4) Design life: 20 years
- 5) Protective current density

Non-coated area in rubble rock : 0.75A/m²

Non-coated area in sea water : 0.15A/m²

Non-coated area in sea mud : 0.02A/m²

6) Protective current density

Sea Water : 25ohm-cm

Soil : 150ohm-cm

TABLE 20800.1 PROTECTED AREA

	NON-COATED AREA IN RUBBLE ROCK	NON-COATED AREA IN SEA WATER	NON-COATED AREA IN SEA MUD	TOTAL
BREASTING DOLPHIN (2 UNITS)	42.84 m ² /UNIT x 2 UNITS=85.68 m ²	85.67 m ² /UNIT x 2 UNITS =171.34 m ²	234.88 m ² /UNIT x 2 UNITS =469.76 m ²	726.78 m ²
PIER-1 (1 UNIT)	192.69 m ²	64.64 m ²	429.93 m ²	687.26 m ²
PIER-2 (1 UNIT)	291.31 m ²	119.58 m ²	711.03 m ²	1121.92 m ²

TABLE 20800.2 REQUIRED PROTECTIVE CURRENT

	NON-COATED AREA IN RUBBLE ROCK	NON-COATED AREA IN SEA WATER	NON-COATED AREA IN SEA MUD	TOTAL
BREASTING DOLPHIN (2 UNITS)	3.22A/UNIT x 2 UNITS=6.44A	12.86A/UNIT x 2 UNITS =25.72A	47.A/UNIT x 2 UNITS =25.72A	41.56A
PIER-1 (1 UNIT)	14.47A	9.70A	8.6A	32.77A
PIER-2 (1 UNIT)	21.87A	17.95A	14.22A	54.04A

- 7) Protected area & Required protective current
- 8) Effect of cathodic protection : -0.81V or negative measured by Ag/AgCl Reference electrode
- 9) Anodes Specification Type : 3.0A x 20 years & 3.5A x 20 years

Material Composition (mass %) Aluminum Alloy

Zn	:	1.0 ~ 3.5
In	:	0.015 ~ 0.03
Sn	:	0.005 ~ 0.010
Mg	:	1.0 ~ 3.0
Si	:	0.11 ~ 0.7
Fe	:	Max. 0.1
Cu	:	Max. 0.004
Al	:	Balance

Performance Potential -1.05V or negative (SCE)

Capacity More than 2600 A.Hr/kg

(By Japan Society of Corrosion Engineering (JSCE) Santandad JSCE S-9301

Consumption Rate Less than 3.369kg/A-year

Size (170+210) x 190 x 1050 mm (230+250)x240x 790 mm

Net mass 101 kg 121.7kg

Output Current 3.0A 3.5A

Desing life 20 years 20years

The submerged "Anode" shall be installed on the pile by means of underwater welding after the pile has been driven. Two steel channel fittings shall be provided for each anode to fit the anode to the curved surface of the crane foundation pile.

The fitting shall be welded to the core at each end of the anode.

20819

**For Protection
of Heads of
Particular Piles**

The heads of the steel pipe piles at the passenger berth shall be provided with cylinder sleeves for corrosion protection and the gap between the inside wall of cylinder and the surface of the pile shall be filled with, as shown on Drawings.

Steel piles area to be protected against corrosion by the installation of a multi-layer system or polyethylene-coated heavy duty corrosion resistant sheet which shall be subjected to the approval of the Engincer.

All the steel piles shall be wrapped with a multi-layer system in lieu of the reinforced concrete sleeves. The coated surface of the pile shall be cleaned of all marine growth, mud etc. by brushing and water jetting and shall be primed with a petrolatum based paste formulated for use under water.

Priming shall be followed by a spiral application of petrolatum impregnated non-woven synthetic tape. Application shall start at the lowest point and each turn of the tape shall overlap the preceding turn by at least 55% to ensure a double thickness of tape throughout. The tape shall be applied under tension and shall be smoothed by hand into close contact with the pile surface joints between successive rolls of tape shall be overlapped by at least 150 mm.

The petrolatum based tape shall be protected from abrasion and damage by a bitumen-rubber impregnated synthetic tape applied in the same way and with the same sized overlaps as specified for the petrolatum tape. At the commencement of each new roll the wrapping should be very tightly banded with a non-rotting strapping. Intermediate banding should be applied upon the completion of wrapping so that each pile is banded at not more than 500 mm centers throughout its wrapped length.

20820

**Protective
Coating of Steel**

20820.1 General

Protective coating described in this Clause relates to steel members which will be

Members used for the berth structure.

20820.2 Cleaning

Before painting, steel members shall be thoroughly cleaned of rust by sand blasting or wire brushed as instructed by the Engineer.

All surfaces to be painted shall be prepared in accordance with the manufacturer's instructions and as specified herein.

Welds shall be cleaned of all slag and all spatters shall be removed from adjacent areas.

20820.3 Painting

After the Engineer's inspections of cleaning, the exterior surfaces of steel members shall be painted with the anticorrosive paints as shown in Table 20800.3.

Table 20800.3 Anticorrosive Paints

	Undercoat	Finishing Coat
Type of Paint	Zinc-rich Based	Epoxy resin based
Number of Coat	1	2

The paints shall be applied in 3 coats (each thickness of 0.1 mm) and total dry film thickness of coating shall be a minimum of 0.3 mm.

The samples of paint shall be presented together with the name of manufacturers to the engineer for approval before the works. The hue of the final coat shall be as instructed by the engineers

SECTION 20900 CONTAINER CRANE BEAM

20901 General

The reinforced concrete container crane beam supports the landward rail of the container crane and spans between the steel pipe foundation piles specified in Section 20800 and shown in the Drawings.

20902 Adjustment of Cap Level of Steel Pipe Piles

The steel pipe piles installed as specified in Section 20800 shall be cut to the level as specified on the Drawings. Tolerance for the cut off level shall be ± 20 mm.

20903 Removal of Temporary Bracing

The temporary bracing materials specified in Section 20800 shall be removed when instructed by the Engineer, such which instructions will be given only after completion of reclamation in the area to an agreed level.

20904 Inside Filling of Steel Pipe Piles and Preparation of Pile Head

The Contractor shall fill inside the steel pipe piles with sand up to the height specified on the Drawings. The quality of the sand shall be in conformity with Section 20200 Filling Sand.

The Contractor shall place inside the steel pipe piles the reinforcing bars as indicated on the Drawings and shall thereafter, place the concrete inside the steel pipe piles at the time the concrete is placed in the crane beam using the same concrete to ensure the integrity of the inside of pipe and the crane beam.

The Contractor shall weld a steel plate to the head of each steel pipe pile which shall be fixed to the lower portion of reinforcing bars by welding. The welding shall be as specified in Section 20200 to the satisfaction of the Engineer.

20905 Excavation for Crane Beam

The general level of reclamation for a width of 2 m on each side of the crane beam shall be +2.3 m at the time of filling.

The Contractor shall excavate to a depth of +2.3 m over the full width of 2 m on each side of the crane beam and shall compact the exposed surface using a power operated hand-rammer or other appropriate compacting equipment to be approved by the Engineer.

Any reduction in level due to compaction shall be made up in approved fill material and the surface again compacted. Alternatively the Contractor may at his own expense substitute and place additional thickness of binding concrete to compensate for the loss due to compaction.

For purposes of payment the level of fill before excavation for the crane beam shall be taken as + 2.3 m.

The surface of the compacted sand fill shall be leveled to a tolerance of ± 25 mm.

After leveling, the lean mix leveling concrete Grade S6 of 50 mm in thickness shall be placed over the position of the crane beam to provide a level clean surface for casting the crane beam concrete.

20906 Formwork for Crane Beam

The grade of the formwork referred to in this Chapter shall be in conformity with the specifications for Class F.2 Finish of Section 20300.

The grade of formwork for crane rail pits and tie-down anchor pits shall be for Class

F.3 Finish.

The Contractor shall provide drain holes for rail pits and tie-down anchor pits at the locations shown on the Drawings at the time of shuttering.

The Contractor shall submit a drawing of formwork indicating details of fixing anchor bolts for the container crane rails for the approval of the Engineer no later than four (4) weeks prior to starting the formwork of this Chapter.

**20907
Grade of
Reinforcement
Steel Bars**

The steel bars used for work in this Chapter shall be SD 345 of JIS G 3112 or ASTM A-6/6M Hot Rolled Steel Bars Grade 250 (deformed).

**20908
Concrete Work
for Crane Beam**

The concrete used for the reinforced concrete beam shall be in conformity with the Class S1 Concrete Mix Table in Section 20300 of this specification. The Contractor shall have at the site set and fix Socket block, crane anchoring frame, end stopper and jack up plates in the specified positions prior to the start of placing concrete.

**20909
Unformed
Surface Finish
of Crane Beam
Concrete**

The top surface of the crane beam concrete shall be finished in accordance with Type U.3 steel trowel finish of Section 20300 of this specification.

**20910
Expansion
Joints for Crane
Beam**

The joint filler specified in Section 20200 shall be used for the expansion joints shown in the crane beam drawing. The thickness of the specified bituminous fibre is 10 mm.

**20911
Compaction of
Sand Fill
Around Crane
Beam**

The sand fill of a thickness of 2.3 m on both sides of crane beam shall be compacted for a width of 2 m on each side and for the length of crane beam filled with sand.

SECTION 21000 REVETMENT WORKS

- 21001**
Scope of Works The works covered under this section of the Specification shall include, but shall not be limited to the construction of the following:
Revetment in the port area (West and East), as show in the Drawings.
- 21002**
Inspection Rock Quantity Measurement of rock of any type used in the construction of rock mound revetment shall be net based on the approved surveyed level of the sea bed prior to commencing these works and the levels indicated on the drawings, the Contractor will be deemed to have allowed in his rates for any additional rock required to form the revetments and armour stone due to looses of any kind.
- 21003**
Payment Payments shall be based on the net volume measured between the initial approved seabed survey and the finished levels approved by the Engineer on completion of contract, within the specified tolerances and according to the Bill of Quantities. The rates for supplying and placing the material shall also include all sampling, testing and weighing when required, selecting, grading and stock piling if necessary, all labor, including divers and plant required for depositing, spreading and positioning of the material as indicated in the drawings all necessary surveys, before, during and after placement.
- 21004**
Existing Sea Bed and Foundation Soft soil layers of material are to be removed before construction of revetments. The Contractor shall carefully examine the existing seabed condition and assess for himself the additional quantity of rock required to allow the loss due to consolidation or displacement.
- 21005**
Sand Replacement
21005.1 Grade
After soft soil removal has been completed sand shall be placed in the manner approved by the Engineer. The materials which will be incorporated into this work shall be subject to the Engineer approval. The grade of the sand shall be $\phi=30^\circ$, $\gamma=1.8$ t/m³.
21005.2 Tolerance
The tolerance of levels shall be +/- 100 mm.
- 21006**
Rubble Mound
21006.1 Grade
Rubble mound shall be placed to the lines and levels as indicated on the drawings, rubble which will be incorporated to this work shall be subject to the Engineers approval according to section 20311. The grade of the rubble shall be 10 – 250 kg/pc
21006.2 Tolerance of levels
The tolerance of levels shall be +/-150 mm.
- 21007**
Armour Stone
21007.1 Grade
Rock shall conform to the required specification 20311 and shall be approved by the Engineer. The stability of stone slopes and their resistance to attack by currents depends on the effective interlocking of placed stones. The method for placing the armour stone in the revetments shall be approved by the Engineer prior to any placement, rocks placed directly in geotextile sheet shall be placed in such a manner that the geotextile is not ruptured. The layers of stone shall be such as to maintain the outer profile of the revetments. The Grade of the stone shall be as follows: East Revetments 1.5 t/pc West Revetment 1.0 t/pc
21007.2 Tolerance of Levels
The tolerance of levels shall be +/- 250 mm.
- 21008**
Geotextile Sheet
21008.1 Properties
Geotextile sheet shall be used as shown in the drawings. The properties of the filter fabric shall be in accordance to the specification Section 20200 approved by the

Engineer. The filter fabric shall be such that it will retain the sand material in its place but will permit the free drainage of water through the filter. All details and specifications of the geotextile sheet (filter fabric) shall be subject to approval by the Engineer.

21008.2 Payment

Payment for supply and laying of the geotextile sheet shall be based on the net area of the material in contact with the rock or sand fill without allowance for overlap in any direction. The rate shall include for all necessary stitching, nailing, or pinning to ensure effective lapping and to fix the geotextile in the required position underwater or otherwise to the approval of the Engineer.

**21009
Coping
Concrete**

21009.1 Grade

Coping concrete shall be of S2 type according to Section 20300 and shall be placed to the lines and levels as indicated on the drawings. The joints shall be elastomeric type. The Contractor shall provide an expansion joint at intervals of 20mm in the longitudinal direction.

21009.2 Tolerance of Levels

The tolerance of coping concrete shall be +/- 50mm.

SECTION 21100 CONCRETE BLOCK WORK

21101 General

The Contractor shall submit in advance to the Engineer for his approval a method of manufacturing and installation of precast concrete block.

21102 Dimension and Materials

21102.1 [Precast Concrete Block Revetment (Transitional Part)]

The following three types of precast concrete block shall be manufactured as shown in the drawing.

- Type A: 2,000 (D) x 3,500 (W) x 2,000 (H)
- Type B: 3,500 (D) x 2,500 (W) x 2000 (H)
- Type C: 2,500 (D) x 3,000 (W) x 2,000 (H)

- a) The concrete to be used for manufacturing of Concrete Block for revetment shall be equivalent to Class S2 as shown in the concrete mix table of specification Section 20300.
- b) The lifting bar shall comply with specification Section 20200 and shall be SR 295.

21102.2 [Precast Concrete Stacking Plate (Stacking Plate)]

The following five types of precast concrete stacking plate shall be manufactured as shown on the drawing.

- Type A: 2.00 m (L) x 1.00 m (W) x 0.20m (T)
- Type B: 2.00 m (L) x 0.55 m (W) x 0.20m (T)
- Type C: 1.00 m (L) x 0.70 m (W) x 0.20m (T)
- Type D: 1.00 m (L) x 1.000 m (W) x 0.20m (T)
- Type E: 1.00 m (L) x 0.7 m (W) x 0.20m (T)

- a) The concrete to be used for manufacturing of stacking plate shall be equivalent to Class S3 as shown in the concrete mix table of the specification Section 20300.
- b) The reinforcing bar shall comply with the Specification Section 20200 and shall be SD-295.

SECTION 21200 ASPHALT CONCRETE PAVEMENT

21201 The type of asphalt concrete pavement to be provided for the project shall be as shown in the following table.

General

TABLE 21200.1 ASPHALT PAVEMENT OF MAIN ROAD AND FEEDER ROAD

Total Thickness	Surface course	Binder course	Base course (CBR 80)	Subbase course (CBR 30)	Design CBR of subgrade
450 mm	25 mm	25 mm	100 mm	300 mm	CBR = 7

21202 The pavements shall consists of a crusher-run aggregate subbase with CBR 30, a base course cement treatment with CBR 80 and asphalt concrete comprising two layers, one binder course and one surface course.

Composition of Asphalt Concrete Pavement

21203 The term subgrade referred to herein means the soil layer 1.5 meter in thickness immediately below the subbase, whether or not the pavement is provided on soil fill material or on existing ground after removal of topsoil and unsuitable soils.

Definition of Subgrade

21204 Compaction shall be carried out by means of compaction equipment as approved by the Engineer to ensure uniform compaction over the entire area. Where the required CBR value cannot be obtained the Contractor shall excavate to a depth as directed by the Engineer, refill with suitable materials and compact to the required density in layer of thickness approved by the Engineer. When suitable material cannot be obtained, the Contractor shall increase the total thickness of the pavement to achieve the required stability at his own cost.

Compaction of Subgrade

CBR tests shall be conducted once in every 500 m² for each compacted layer of soil and if the results are unsatisfactory, two additional tests shall be conducted in the vicinity of the original site. If both tests satisfy the specification, the area represented by the tests shall be accepted. If either or both the additional tests fail, then the Contractor shall carry out such remedial works as the Engineer may direct.

21205 The subgrade shall be finished to within ± 50 mm of the levels, determined by subtracting the thickness of pavement from the level of pavement surface, indicated on the drawings after removing debris from the surface of the subgrade.

Finish of Subgrade

The subgrade shall be prepared and completed for at least 50 m ahead of the placing of subbase source material. Notwithstanding any earlier approval by the Engineer of subgrade, any damage to or deteriorating of subgrade shall be made good before any subbased is laid. If any settlement of the subgrade occurs prior to commencement of subbase preparation, the Contractor shall at his expense rework the subgrade to conform to the specified level and compaction and shall obtain Engineer's approval.

Before the construction of subbase, the earthwork, ditches, drains etc. for the related

area shall be completed.

21206

**Structures
Adjacent to
Pavement**

All drains, manholes, curbs, foundations of structures etc. adjacent to the pavement shall be completed to the satisfaction of the Engineer before the subbase is laid.

Small areas around the completed structures shall be compacted by hand or power-operated hand rammer so that a density of not less than 95% of the maximum dry density as stipulated in JIS A 1210, and ASTM D-698-91 is achieved throughout.

Attention shall be paid to the compaction of filling material placed on each side of open drainage or service trenches, etc. within a distance three times greater than width, so that 100% maximum density may be achieved throughout.

21207

**Construction of
Subbase**

The materials for subbase shall be spread uniformly with such equipment as bulldozers, graders, aggregate spreaders, etc. approved by the Engineer to obtain a maximum thickness of 200 mm for one layer after compaction. Any damage of deterioration to underlying areas, caused by water, construction operations or the like, shall be rectified to the specified quality according the instruction of the Engineer and at the Contractor's expense, before the granular sub-base course is placed thereon.

Care shall be taken to prevent contamination by deleterious substance, and segregation of the material.

Where the required thickness of material is 150 mm or less it shall be spread and compacted in one layer. Where the required thickness is more than 150mm the material shall be spread and compacted in two or more layers of approximately equal, but each layer is not to exceed 150 mm compacted thickness.

Immediately after each layer is spread and shaped satisfactorily, the layer shall be thoroughly compacted with compaction equipment approved by the Engineer.

Rolling operations shall begin at the lowest level of cross section and progress towards the highest level.

Each layer shall be compacted to achieve a CBR of 30 or higher and the dry density shall not be less than 95% of the Maximum Dry Density as determined by JIS A 1210 Test No. 12 or ASTM D-698-91, at a moisture content $\pm 1\%$ Optimum.

Subbase materials which do not contain sufficient moisture in accordance with the requirements of this clause shall be sprinkled with water as directed by the Engineer.

Subbase materials containing excess moisture shall be dried prior to or during compaction. Drying of wet materials shall be performed by methods approved by the Engineer.

If the underlying material is soft or yielding the compaction operation shall be stopped and the defect in the underlying material rectified as directed by the Engineer.

Along curbs, headers and walls and other places not accessible to large compaction plant the granular sub-base and base material shall be thoroughly compacted to comply with the Specification by using approved tampers, pedestrian rollers or the

like.

During the construction of subbase the Contractor shall ensure that the subbase already spread and rolled is properly drained.

21208

**Finished
Subbase**

The finished subbase shall not vary more than ± 4 cm above or below the planned level of pavement indicated on the drawing, minus the total thickness of surface (binder course and surface course) and the base course. The subbase which does conform to the above requirements shall be reworked, watered and thoroughly recompact to conform to the Specifications.

At the junction of subbase layer of different thickness because of different pavement types or where the thickness has been changed by order of the Engineer, the bottom surface of such subbase shall be formed by an even slope of 1 : 5

21209

**Cement
Stabilization for
Base Course**

21209.1 General

- a) Cement Stabilization shall be a mixture of Portland Cement, sand, water and retarder.
- b) Water shall be free of oil, acid, salt, organic materials or other deleterious substance which may have an adverse effect on the quality of the work.

Sea water or brackish water shall not be used for mixing concrete.

- c) Aggregate shall consists of hard, durable and dense crushed natural rock, free of any dirt, organic matter or other objectionable material.

Sieve Designation (mm)	Percentage by Weight Passing Sieve (%)
50	100
40	95-100
20	50-100
2.5	20-60
0.075	0-15

- d) The design parameters shall be:
Minimum 7-day compressive strength of 2.0 N/mm²
- e) The Contractor shall provide a trial mix report showing that cement stabilization made from it will satisfy the requirements of the Contract when placed, or in accordance with the Engineer's directions.
- f) At least 21 days prior to the production of the mixture, the Contractor shall submit, for the Engineer's approval, a mix design and a report showing the results of applicable tests.

The completed cement treatment base shall be a uniform mixture, free from loose or segregated area, of uniform density and moisture content, and finished to a smooth surface suitable for the placing of a subsequent base or surface course. The Contractor shall satisfy the above conditions and rework the treated base as necessary to meet the above requirements.

21209.2 Weather Constraints

The placing of cement-stabilization base course will not be permitted when the weather is misty or when rain is falling.

21209.3 Mixing

- a) The sand and cement specified in the mix design shall be mixed with suitable equipment until a uniformly graded mixture is obtained. During the mixing, sufficient water shall be added to provide the optimum moisture content for compaction.
- b) Prior to production of cement treatment macadam, the mixing method shall be submitted to the Engineer for approval.

The time taken from starting to put water into the mixer until compaction is completed, shall not exceed 60 minutes.

Unless otherwise stipulated, a retarding agent may be used to permit an initial setting time of 2 hours. Retarder shall be added to the water to form a solution and mixed uniformly with the mixture. The same retardant used in the laboratory mix design shall be used for this work.

21210

Test for Subbase and Base Course

Before or during the paving works, the Engineer may inspect and carry out tests, where necessary, to ensure that the required compaction is maintained on the subbase and the base. The Contractor shall not proceed with the subsequent stages of the work without the written approval of the Engineer of the previous stages.

The Contractor shall provide all equipment and devices necessary for the tests given below, and carry out the tests in the presence of the Engineer.

- a) Tests on moisture contents and density
- b) Measurement of density in-situ
- c) CBR tests

These tests shall be conducted in accordance with JIS A 1203, JIS A 1214 and JIS A 1211, ASTM D-698-91, D1883-94, D2216-92 at least once in every 250 m² of subbase and base in the area to be paved.

When the Engineer has doubt as to the quality of materials being used for subbase or base course, he may instruct the Contractor to conduct the following tests. In such case, the Contractor shall carry out the tests in accordance with JIS A 1204, JIS A 1205 and JIS A 1206 D422-63(1990), D4318-95a at his own expense.

- a) Mechanical analysis
- b) Plasticity Index test

21211

**Prime Coating
and Tack
Coating
Material**

Prime coating and tack coating shall be applied to base and binder course of asphalt concrete, respectively, to provide better bonding or binder course and surface course.

The bituminous material of both the prime and the tack coating shall be asphalt emulsion, cutback asphalt or other materials approved by the Engineer. The cutback asphalt used as bituminous material of prime coating shall be Type MC-70 specified by the Japan Road Association (to be referred to as JRA hereinafter) or the equivalent and the asphalt emulsion shall be Type PR-3 specified by JIS K 2208 or the equivalent. The cutback asphalt to be used as bituminous material of tack coating shall be Type RC-70 specified by JRA or the equivalent. The asphalt emulsion of tack coating shall be Type PK4 specified by JIS K 2208, ASTM D977-97 or the equivalent standard.

The asphalt emulsion of more than 60 days after manufacturing shall not be used.

The Contractor shall submit certificates of quality for both the prime coating and the tack coating for the approval of the Engineer prior to their use.

21212

**Amount of
Prime Coating
and Tack
Coating to be
Applied**

The amount of prime coating to be applied shall be of the order of 1.0 liter/m² to 1.5 liters/m². However, the Contractor shall make a thorough study of the condition of the base and the working condition and shall determine the optimum amount which makes the prime coating exhibit its inherent characteristics and which would not cause bleeding or rutting. The amount of tack coating to be applied shall be of the order of 0.6 liters/m²; The amount of both the prime coating and the tack coating to be applied shall be approved by the Engineer prior to their use.

21213

**Application of
Prime Coating
and Tack
Coating**

21213.1 Prime Coating

Prior to the application of prime coating, the surface of the base shall be properly dried, leveled and cleaned of loose stones, rubbish and other foreign materials.

Where the surface of the base is excessively dry, a small quantity of water shall be sprinkled over the entire surface prior to coating. In this case, the bituminous material shall not be applied until the water on the surface of the base dries up.

A proper viscosity shall be given to the primer under normal temperature or by heating it if necessary. The primer shall be sprayed evenly by means of distributors or sprayers approved by the Engineer.

Where the amount of primer is not sufficient after penetration, additional amount of primer shall be applied and where the primer has been applied in excess, an appropriate amount of sand shall be sprinkled to absorb the excess.

When vehicles are to be allowed on the coated base due to unavoidable reasons after the spraying of the primer, a layer of coarse sand shall be spread over the surface for protection. Any prime coating damaged by the traffic shall be made good forthwith by spraying another coating. Any loose sand on the primer shall be completely removed prior to the paving of the base.

The application of prime coating shall be stopped immediately when it rains. The portion of prime coating affected by the rain shall be made good with another

coating as directed by the Engineer

21213.2 Tack Coating

Prior to the application on tack coating, the surface of binder course shall be dried and swept thoroughly and cleaned of all loose dirt and other foreign materials. In applying, attention shall be paid to the proper temperature of tack coating and the specified amount of tack coating shall be sprayed uniformly with distributors or sprayers approved by the Engineer. The amount of tack coating separating the specified amount shall, if determined to be deleterious, be removed as directed by the Engineer and the portion of the binder course shall be given another coating.

The tack coating shall be protected from damage in a manner approved by the Engineer until it is completely cured and stabilized.

Application of tack coating shall be stopped immediately when it rains. Any tack coating damaged by traffic shall be made good by spraying another coating as directed by the Engineer.

21214

**Application of
 Course
 Aggregate and
 Fine Aggregate**

21214.1 Coarse Aggregate

- a) Coarse aggregate shall consists of clean, sound, durable, angular particles produced from crushed stone or gravel, free of any dirt, organic matter, chemical contaminants or other deleterious substance and meeting the requirements specified herein.
- b) Dirty or dusty coarse aggregate containing more than 2% fines passing the 0.075mm (No. 200) sieve shall not be used in the Works. The Contractor should allow for improving the quality of dirty or dusty coarse aggregate by the use of suitable washing facilities.
- c) The physical characteristics of the coarse aggregate shall comply with the values as follows.

Characteristic	Allowable Value
Dry Specific gravity in accordance with AASHTO T 85	more than 2.45
Water absorption in accordance with AASHTO T 85	less than 3.0%
Loss by abrasion in accordance with AASHO T 96	less than 40%
Amount of loss (soundness) in accordance with AASHTO T104	less than 12%
Flatness	less than 10%

- d) Coarse aggregate shall also be tested for the presence of clay balls and other friable particles and, when tested in accordance with AASHTO T 112, these

shall not be greater than 0.25% by weight.

21214.2 Fine Aggregates

- a) Fine aggregate shall comply with the requirements below and shall consist of one or more natural sharp sands or crushed stone or gravel screenings or suitable combinations thereof.
- b) Fine aggregate shall be composed of clean, durable particles, free of dust and clay balls or other deleterious material. If natural sands have more than 8% fines passing the 0.075mm (No.200) sieve or have a sand equivalent value less than 50, as determined by AASHTO T 176, they shall not be used in the Works.
- c) Stone screenings shall be produced from rock or gravels from material meeting the quality requirements for coarse aggregate contained herein.
- d) The physical characteristics of the fine aggregate shall comply with the values as follows.

Characteristic	Allowable Value
Dry specific gravity in accordance with AASHTO T 84	more than 2.45
Water absorption in accordance with AASHTO T 84	less than 3.0%
Loss by abrasion in accordance with AASHTO T96	less than 40%
Amount of loss (soundness) in accordance with AASHTO T 104	less than 12%
Flatness	less than 10%

- e) The fine aggregate including any blended filler shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 when tested in accordance with AASHTO T 89 and T90.

21214.3 Filler

- a) Filler shall consist of limestone dust, Portland cement or other non-plastic mineral material free from any deleterious matter and comply with AASHTO M-17.
- b) Filler shall be free from lumps and comply with the values as follows.

	Sieve Size	Percentage by Weight Passing
Gradation	0.600mm (No.30)	100
	0.150mm (No.100)	90-100
	0.075mm (No. 200)	70-100
Water Content	Less than 1%	

- c) Lime may be used as a filler, if required to meet the gradation requirements. If lime is used the maximum allowable proportion shall be 1.0% by weight of the total asphalt concrete mix.

21215

Asphalt Mixture and Mix Design

Hot asphalt mix shall be used for both binder course and surface course. Coarse graded asphalt concrete shall be used for binder course and dense graded asphalt concrete shall be used for surface course.

Aggregates used for those asphalt mixtures shall meet the standard of max. particle size and grain size distribution shown in Table 21400.2 and shall be approved by the Engineer prior to their use.

TABLE 21200.2 STANDARD MIX FORMULA OF ASPHALT CONCRETE

		Coarse graded asphalt concrete	Dense grade asphalt concrete		Open graded asphalt concrete
Max. particle size (mm)		20	20	13	13
Weight percent passing sieve	25	100	100		
	20	90 - 100	95 - 100	100	95 - 100
	13	70 - 90	75 - 90	95 - 100	65 - 90
	5	35 - 55	45 - 65	55 - 70	25 - 45
	2.5	20 - 35	35 - 50	35 - 50	14 - 25
	0.6	11 - 23	18 - 30	18 - 30	7 - 15
	0.3	5 - 16	10 - 21	10 - 21	3 - 10
	0.15	4 - 12	6 - 16	6 - 16	2 - 7
	0.074	2 - 7	4 - 8	4 - 8	0 - 5

Prior to the manufacture of hot asphalt mixture, the Contractor shall make a laboratory mix design according to standard Marshall methods as specified in ASTM. D1 559-60T shown in Table 15.22/T2. In the laboratory mix design, the amount of asphalt shall be determined so as to prevent rutting of the pavement especially in the Container Yard.

The method and mix proportion of laboratory mix design shall be approved by the Engineer.

TABLE 21200.3 CRITERIA FOR ACCEPTABILITY OF MIX BASED ON MARSHALL METHOD

	Asphalt Concrete Type		
	Coarse graded	Dense graded	Open graded
Max. particle size (mm)	20	20 13	13
Number of blows	50		
Voids (%)	3 - 7	3 - 6	20 - 25
Voids filled (5)	65 - 85	70 - 75	-

Marshall stability, min. (kg)	500	500	350
Flow value (1/100 cm)	20	-	40

The job formula shall be such that the mixture made in the mixing plant based on the laboratory design mix shall satisfy the Marshall test values and shall be approved by the Engineer.

If the asphalt mixture made in the mixing plant is determined not to conform to the standard value shown in Table 21200.2 after placement in the works, the Contractor shall modify the mix formula when directed by the Engineer at no additional cost.

21216

Mixing Plant

The asphalt mixing plant shall be designed and adjusted to produce the required amount of mixture of uniform grade and shall, in principle, be more than 500 kg in the capacity of mixer.

The plant shall, in principle, be a batch mix plant and shall be equipped with all functions required. The type of plant and the capacity of each equipment of the plant shall be approved by the Engineer prior to the operation.

21217

Mixing Operation

Prior to the commencement of mixing operation, the Contractor shall obtain the approval of the Engineer as to the conformity of asphalt mix materials to the specified requirement.

The Contractor shall determine the weighing value for each hot bin to match the grain size of job mix.

The asphalt material shall be heated to the specified temperature in kettles or tanks so designed as to avoid local overheating and provide a continuous supply of the asphalt material to the mixture at a uniform temperature at all times.

Asphalt cement shall be heated to a temperature between 135°C and 160°C based on the instruction of the Engineer. The temperature variation shall be within +15°C of the approved temperature.

The mineral aggregates shall be heated to a temperature between 150°C and 170°C.

When a batch mixer is used, aggregate and filler shall be placed and mixed in the mixer for five seconds or more and then asphalt shall be poured into the mixer and mixing shall continue for more than 30 seconds until the uniform mixture is obtained.

The mixing time for batch mixer shall be determined after trial mixing in consultation with the Engineer.

The standard temperature of mixture when discharged from the mixer shall be determined in consultation with the Engineer.

The variation shall be limited to within +25°C of the approved temperature.

21218

Transportation

The mixture shall be transported from mixing plant to the place of use by truck.

The trucks hauling the mixtures shall have tight, clean and smooth metal beds; and to

of Mixture

prevent mixtures from adhering to the bed, beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other materials approved by the Engineer. Each truck shall have a suitable cover to protect mixture from adverse weather and an insulated bed to maintain at specified temperature. During transportation each load shall be securely covered with a canvas sheet, or similar waterproof material.

The mixture shall be delivered on the road at a temperature within the absolute limits of 140°C and 159°C even allowing for tolerances.

21219

Principal paving equipment, including asphalt finishers for spreading and levelling the hot mix and compacting, shall be approved by the Engineer.

**Paving
Equipment**

Prior to paving operations, the number, condition, wear and tear of parts, and availability of spares of the equipment and tools shall be examined so that no delays of work shall be caused by any unsatisfactory equipment during the execution of the works.

21220

**Placing and
Spreading of
Mixture**

Immediately before placing the mixture, the existing underlying course shall be cleaned of loose or deleterious material using a power sweeper equipped with a blower supplemented with hand brooms if necessary, or removed by other means as directed by the Engineer.

No asphalt mixtures shall be placed on the base or binder course where the prime coating or tack coating has not been cured and stabilized sufficiently.

Asphalt mixture shall not be placed when the underlying surface is not completely dry and in rainy weather. When the cutback asphalt is used for prime coating, the asphalt mixture shall not be placed within 24 hours unless approved by the Engineer.

When placing, the temperature of the mixture shall fall within the range of 120°C to 150°C. Where the Engineer considers it acceptable to mix and deliver asphalt concrete even under the weather condition being cold or warm, the Contractor will be directed so to do.

Hauling the mixture over the materials already placed shall not be permitted until the materials are thoroughly compacted as specified and allowed to cool to atmospheric temperature. Upon arrival, the mixture shall be dumped into an approved bituminous paver and immediately spread to full width required and struck off in a uniform layer of such depth that, when work is completed, it will have required thickness and will conform to grade and surface contour required.

Paver spreading shall be regulated to eliminate pulling and tearing of bituminous material. The mixture shall be placed in strips not less than 3 meters wide.

To ensure proper drainage, spreading shall begin along pavement centerline on a crowned section or on high side of pavement.

After the first strip of width is compacted, the second width shall be placed, finished, and compacted in the same manner as the first width. After the second strip is placed and rolled, a 5-meter straight edge shall be placed across longitudinal joint approved by the Engineer to determine if the surface conforms to grade and contour requirements.

Where the new pavement joins the pavement of existing road, the asphalt mixture shall be so placed and spread as to form a slope of less than 5%.

21221

**Compacting of
Mixture**

After spreading, mixture shall be thoroughly and uniformly compacted with power rollers as directed by the Engineer. Rolling shall begin as soon after spreading as mixture bears roller without undue displacement or hair cracking and shall start at the center of first spread and continue toward either edge. On subsequent strips laid, rolling shall start on edge adjacent to previously laid material and continue toward opposite edge.

Speed of roller shall, at all times, be slow to avoid displacement of hot mixture. Any displacement occurring as a result of reversing direction of roller, or from any other cause, shall be corrected at once by rakes and applying fresh mixture where needed.

Sufficient rollers shall be furnished and operated to handle plant output and rolling shall continue until all roller marks are eliminated, surface is of uniform texture and true to grade and cross section, and a density of at least 98 percent of specified laboratory density is obtained.

Field density tests shall be made at least twice a day.

To prevent adhesion of mixture to roller, wheels shall be kept properly moistened, but excessive water shall not be permitted.

In areas not accessible to roller, mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to surrounding areas.

Skin patching shall not be permitted.

21222

**Finish of
Surface**

The finished surface of the asphalt concrete surfacing shall not depart more than 6 mm from the levels and profile shown on the drawings or as directed by the Engineer.

21223

**Protection of
Pavement**

Sections of the newly finished work shall be protected from traffic of any kind until the mixture has cooled to 50°C. Traffic shall not normally be permitted on the newly laid surface for less than 6 hours after the completion of the pavement.

21224

Tolerance

The tolerance for all geometrical properties of pavement shall be as shown in Table 21400.4. For the thickness of each pavement component, the average of 10 measured values shall be within the limits shown by bracket in the Table.

Measurement of evenness shall be made with a legged direct-read flatness meter or a profile meter approved by the Engineer.

TABLE 21200.4 FREQUENCY OF INSPECTION AND TOLERANCE FOR GEOMETRICAL PROPERTIES OF FINISHED PAVEMENT

Pavement Component		Quality	Frequency of Tolerance Inspection	Tolerance
Subbase		Grade	every 20 m	± 4 cm
		Thickness	every 20 m	- 4.5 cm (-1.5 cm)
		Width	every 40 m	- 5 cm
Mechanically Stabilized Base		Thickness	every 20 m	- 2.5 cm (-0.8 cm)
		Width	every 100 m	- 5 cm
Binder and Surface	Hot asphalt Mix	Thickness: Surface	every 1,000 m ²	- 0.7 cm (-0.2 cm)
		Thickness: Binder	every 1,000 m ²	- 0.9 cm (-0.3 cm)
		Width	every 100 m	- 2.5 cm
		Evenness	throughout the length of every lane	2.4 mm or less

Note: Figures in parenthesis are the average of 10 measured