DIVISION 3 PORT FACILITIES

3.1 LAYOUT AND INSTALLATION OF MARKERS

3.1.1 GENERAL

1. Work under this contract shall be in accordance with Division 1, "General Requirements" of these Specifications and shall be applicable to this Section, herein referred to or not.

2. Applicable requirement under Section 2.2 "Surveys/Soundings, Soil Investigations, Installation of Markers, etc." shall apply to this section.

3.1.2 SCOPE OF WORK

This Section covers layout and setting of reference points.

3.1.3 SETTING OF REFERENCE POINTS

1. The Contractor shall establish new permanent benchmarks and monuments based on existing ones designated by the Engineer that can serve as reference points to delineate the technical description of the port zone and plan layout.

2. The Contractor shall submit field notes and computations regarding the above item 3.1.3.1 for reference of the Engineer.

3. Setting of reference points shall include the supply and installation of markers which the Contractor may require for the proper execution and completion of the project. The Contractor shall be solely responsible for the accuracy of setting surveyed points.

3.2 CONCRETE WORKS

3.2.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.2.1.1 SCOPE OF WORK

All works falling under this Section shall include reinforced concrete for all kinds and parts of any reinforced concrete structure.

3.2.1.2 GENERAL PROVISIONS

1. Full cooperation shall be given to the other trades to install embedded items. Suitable templates or instructions will be provided for setting, items shall have been inspected, and tests for concrete or other materials or for mechanical operations shall have been completed and approved.

2. The following publications of the issues listed below, but referred to thereafter by basic designation only, form as an integral part of this Specification to the extent indicated by the reference thereto:

   a. American Concrete Institute (ACI) Standards:

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 121R	Quality Management System for Concrete Construction
ACI 201.2R	Guide to Durable Concrete
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete
ACI 304.2R	Placing Concrete by Pumping Methods
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308R	Guide to Curing Concrete
ACI 309R	Guide for Consolidation of Concrete
ACI 311.4R	Guide for Concrete Inspection
ACI 318M	Metric Building Code Requirements for Structural Concrete and Commentary

ACI 347	Guide to Formwork for Concrete
ACI SP-15	Field Reference Manual: Standard Specifications for Structural Concrete with Selected ACI and ASTM References
ACI SP-2	ACI Manual of Concrete Inspection

b. American Society for Testing and Materials (ASTM) Publications:

ASTM A 185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A 966	Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C 1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C 1157	Standard Specification for Hydraulic Cement
ASTM C 1202	Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C 1218	Standard Specification for Water-Soluble Chloride in Mortar and Concrete
ASTM C 1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 131	Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 138	Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 227	Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 295	Petrographic Examination of Aggregates for Concrete
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 441	Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C 469	Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 597	Pulse Velocity Through Concrete
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 642	Density, Absorption, and Voids in Hardened Concrete
ASTM C 805	Rebound Number of Hardened Concrete
ASTM C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	Standard Specification for Elastomeric Joint Sealants
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C 1751	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Non-extruding and Resilient Bituminous Types).
ASTM D 1179	Fluoride Ion in Water
ASTM D 1190	Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1339	Sulfite Ion in Water
ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

ASTM D 1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Nitrite-Nitrate in Water
ASTM D 3867	Nitrite-Nitrate in Water
ASTM D 512	Chloride Ion in Water
ASTM D 516	Sulfate Ion in Water
ASTM E 329	Standard Specification for Agencies Engaged in the Testing and/ or Inspection of Materials Used in Construction

c. American Welding Society (AWS)

D 12	Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.

d. All other standards hereinafter indicated.

e. The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

3.2.1.3 SUBMITTALS

1. Refer to The Technical Specifications Division 1, "General Requirements".

2. Test Reports and Certificates shall be furnished in conformity with Division 1 and approval received before delivery of certified or tested materials to the Project Sites.

   a. Submit Test Reports for the following:

      1) Concrete mixture proportions

         Submit copies of test reports by independent test labs conforming to ASTM C 1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports shall be submitted along with the

concrete mixture proportions. Obtain approval before concrete placement. Fully describe the processes and methodology whereby mixture proportions were developed and tested and how proportions will be adjusted during progress of the work to achieve, as closely as possible, the designated levels of relevant properties.

2) Aggregates

Submit test results for aggregate quality in accordance with ASTM C 33. Where there is potential for alkali-silica reaction, provide results of tests conducted in accordance with ASTM C 227 or ASTM C 1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve.

3) Admixtures (if required to be used by field conditions subject to approval by the Design Engineer)

Submit test results in accordance with ASTM C 494 and ASTM C 1017 for concrete admixtures, ASTM C 260 for air-entraining agent, and manufacturer's literature and test reports for corrosion inhibitor and anti-washout admixture. Submitted data shall be based upon tests performed within 6 months of submittal.

4) Fiber-Reinforced Concrete (if required to be used by field conditions subject to approval by the Design Engineer)

Test to determine flexural toughness index I5 in accordance with ASTM C 1116.

5) Cement

Submit test results in accordance with ASTM C 150 Portland cement and/or ASTM C 595 and ASTM C 1157 for blended cement. Submit current mil data.

6) Water

Submit test results in accordance with ASTM D 512 and ASTM D 516.

7) Reinforcement and Protective Coating

Provide coating manufacturer's and coating applicator's test data sheets certifying that applied coating meets the requirements of ASTM A 934.

b. Submit Certificates for the following:

1) Curing concrete elements

Submit proposed materials and methods for curing concrete elements.

2) Form removal schedule

Submit proposed materials and methods for curing concrete elements.

3) Concrete placement and compaction

a) Submit technical literature for equipment and methods proposed for use in placing concrete. Include pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. No adjustments shall be made to the mixture design to facilitate pumping.

b) Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal shall include technical literature describing the equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

4) Mixture designs

Provide a detailed report of materials and methods used, test results, and the field test strength (fcr) for marine concrete required to meet durability requirements.

3. The Contractor shall submit shop drawings and erection drawings for formwork and scaffolding at least 14 days prior to commencing the work.

Each shop drawing and erection drawing shall bear the signature of a Contractor's qualified Engineer. Details of all proposed formwork to be prefabricated and formwork to produce special finishes shall be submitted to the Engineer for approval before any materials are ordered. If the Engineer so requires, samples of proposed formworks shall be constructed and concrete placed at the Contractor's expense so that the proposed methods and finished effect can be demonstrated.

The Contractor shall submit shop drawings showing reinforcing bar placing and bar lists for the Engineer's approval. Such shop drawings shall show also supplemental bars for forming, strengthening frames of bars of sufficient rigidity to withstand forces during placing concrete. If necessary, shaped steel may be added to improve rigidity of the frame of bar.

Such shop drawings shall clearly indicate bar sizes, spacing, location and quantities of reinforcement, mesh, chairs, spacers and other details to be as per ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

Details shall be prepared for placement of reinforcement where special conditions occur, including most congested areas and connection between precast concrete and concrete in-situ.

All shop drawings shall be reviewed by the Engineer within seven (7) days after receiving them.

At least two (2) days prior to pouring concrete, the Contractor shall submit to the Engineer a pouring permit for his inspection and approval.

4. Field Samples

   a. Slab Finish Sample

      Install minimum of 3m x 3m slab. Finish as required by Specification.

   b. Underwater Concrete Sample

      Place concrete in four 5 gallon buckets below water. Permanently mark as "7 days," "14 days," "28 days," and "Extra." Include date and station. Provide specimen sets at every 46 lineal meter of seawall with a minimum of one set per day of underwater concrete placement. Retrieve specimens at specified intervals. Extract 100 mm diameter by 250 mm core and test in accordance with ASTM C 39.

3.2.2 MATERIAL REQUIREMENTS

3.2.2.1 CEMENT

Unless otherwise specified in the Drawings, only one (1) brand of cement shall be used for any individual structure. In determining the approved mix, only Portland cement shall be used as the cementitious material.

1. Portland Cement: ASTM C 150

   Type I (for general use in construction)

2. High-Early Strength Portland Cement may be used for precast concrete. Cement Type III shall conform to ASTM C 150 with a tricalcium aluminate limited to 8 percent.

3.2.2.2 SYNTHETIC FIBROUS REINFORCEMENT (OPTIONAL)

Unless otherwise indicated on the Drawings or as required by the Design Engineer, synthetic fiber reinforcement shall conform to BS 5139 or ASTM C 1116.

Synthetic fiber reinforcement shall be 100% virgin polypropylene synthetic fiber with micro multi-filament design.

This material shall mainly be used in the following structures:

1. Suspended slabs
2. Plastering on walls of building structures
3. Concrete topping

3.2.2.3 ADMIXTURE (IF NECESSARY)

Unless otherwise required by field conditions, admixture may be used subject to the expressed approval of the Engineer. The cost of which shall already be included in the unit cost bid of the Contractor for the concrete.

1. Air Entraining Admixture shall conform to ASTM C 260.
2. Admixture other than air entraining agent shall conform to ASTM C 494.
3. Admixture containing chloride ions, or other ions producing deleterious effect shall not be used.

3.2.2.4 AGGREGATES

1. Crushed Coarse Aggregate

Conforming to ASTM C 33 and having nominal sizes passing 38.0 mm to 19.0 mm, 19.0 mm to 9.5 mm to No. 4 sieve. The material shall be well graded between the limits indicated and individually stockpiled. It shall be the Contractor's responsibility to blend the materials to meet the gradation requirements for various types of concrete as specified herein.

Nominal sizes for combined gradation shall be as follows:

ASTM Sieves	**Nominal Size of Coarse Aggregates % by Weight Passing**			
	40 mm	25 mm	19 mm	10 mm
50.0 mm (2")	100	-	-	-
38.0 mm (1 ½")	95-100	100	-	-
31.8 mm (1 ¼")	-	90-100	100	-
25.0 mm (1")	-	-	90-100	-
19.0 mm (3/4")	35-70	25-90	-	100
16.0 mm (5/8")	-	-	20-55	85-100
9.5 mm (3/8")	10-30	0-10	0-10	0-20
No. 4	0-5			

2. Fine Aggregate

ASTM C 33 except for gradation which has been revised to meet local conditions unless otherwise required by the Engineer, grading of find aggregate shall be as follows:

ASTM Sieves	**% by Weight Passing**
9.5 mm (3/8")	100
No. 4	90 - 100
No. 8	80 - 100
No. 16	50 - 90
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

a. Grading of fine aggregates shall be reasonably uniform and fineness modulus thereof shall not vary more than 0.2 from that of the representative sample in which mix proportions of concrete are based.

b. Due care shall be taken to prevent segregation.

3.2.2.5 WATER

The water used in concrete, mortar and grout shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities. Sea water shall not be used at any time.

3.2.2.6 ANCHORAGE ITEMS

Dowels for anchoring mechanical items to concrete shall be in conformity to manufacturer's standard and of types required to engage with the anchors to be provided and installed therein under other sections of these Specifications, and shall be subject to the approval of the Engineer.

3.2.2.7 CURING MATERIALS

1. Impervious Sheet Materials: ASTM C 171 type, optional, except that polyethylene film, if used, shall be white opaque.

2. Burlap of commercial quality, non-staining type, consisting of 2 layers minimum.

3. Membrane Forming Curing Compound: ASTM C 309; submit evidence that product conforms to specifications.

3.2.2.8 JOINTING MATERIALS

1. Sealant: Sealant shall be multi-component, polyurethane base compound, gray in color, self-leveling for horizontal joints, 2 part polythremdyne, terpolymer compound, gray in color; non-sag for vertical joints.

   Sealant shall be compatible with materials in contact and to perform satisfactorily under salt water and traffic conditions, and be capable of making joint watertight and allow movement 25% of the width of joint in any direction.

   Sealant shall be guaranteed against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion for a period of five years from the date of acceptance of work.

2. Joint backing shall be expanded extruded polyethylene, low density, oval in shape to fit the joints as indicated on the drawings and to be compatible with sealant.

3. Where required, primer shall be compatible with joint materials and installed in accordance with manufacturer's instructions.

4. Joint filler shall conform to ASTM D1751 (AASHTO M213) non-extruding, resilient bituminous type. Filler shall be furnished for each joint in single piece for depth and width required for joint, unless otherwise authorized by the Engineer. When more than one piece is authorized for a joint, abutting ends shall be fastened and hold securely to shape by stapling or other positive fastening.

3.2.2.9 EPOXY BONDING COMPOUND

ASTM C 881. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Class B if placement temperature is between 4 and 16°C; or Class C if placement temperature is above 16°C.

3.2.2.10 NEOPRENE BEARING PAD

Neoprene bearing pad shall be of 60 Durometer Hardness and of size as shown on drawings. It shall conform to AASHTO M 251.

3.2.2.11 REINFORCEMENT

Steel reinforcement, other than Steel for Prestressing, used in Reinforced Concrete, shall conform to ASTM as follows:

- ASTM Designation A615-Deformed Billet Steel Bars for Concrete Reinforcement. Minimum yield strength of 230 MPa (33,400 psi) for diameter of 6 mm to 10 mm and 276 MPa (40,000 psi) for diameter of 12 mm to 36 mm.

- Welded steel wire ASTM Designation A185, Fabric for Reinforcement of Concrete.

All bar reinforcement shall have deformed surfaces except that 6 mm bars may be plain.

3.2.2.12 TIE WIRE

Tie wire shall be plain, cold drawn annealed steel wire 1.6 mm diameter.

3.2.3 SAMPLES AND TESTING

1. Refer to Section 1.6.

2. Cement: Sampled either at the mill or at the site of work and tested by an independent commercial or government testing laboratory duly accredited by the Bureau of Research and Standards (BRS) of the DPWH, Department of Science and Technology (DOST) or the Department of Trade and Industry (DTI) at no additional cost to PPA. Certified copies of laboratory test reports shall be furnished for each lot of cement and shall include all test data, results, and certificates that the sampling and testing procedures are in conformance with the Specifications. No cement shall be used until notice has been given by the Engineer that the test results are satisfactory. Cement that has been stored, other than in bins at the mills, for more than 3 months after delivery to the Site shall be re-tested before use. Cement delivered at the Site and later found after test to be unsuitable shall not be incorporated into the permanent works.

3. Aggregates: Tested as prescribed in ASTM C 33

   At least 28 days prior to commencing the work, the Contractor shall inform the Engineer of the proposed source of aggregates and provide access for sampling.

   Gradation tests will be made on each sample without delay. All other aggregates tests required by these Specifications shall be made on the initial source samples, and shall be repeated whenever there is a change of source. The tests shall include an analysis of each grade of material and an analysis of the combined material representing the aggregate part of the mix.

4. Reinforcement: Certified copies of mill certificates shall accompany deliveries of steel bar reinforcement. If requested by the Engineer additional testing of the materials shall be made at the Contractor's expense.

5. Concrete Tests: For test purposes, provide three (3) sets of test specimens taken under the instruction of the Engineer from each 50 cu.m. or fraction thereof of each class of concrete placed. At least one (1) set of test specimen shall be provided for each class of concrete placed in each 8-hour shift. Each shall consist of two test specimens, and shall be made from a separate batch. Samples shall be secured in conformance with ASTM C 172. Tests specimens shall be made, cured, and packed for shipment in accordance with ASTM C 31. Cylinders will be tested by and at the expense of the Contractor in accordance with ASTM C 39. Test specimens will be evaluated separately by the Engineer, for meeting strength level requirements for

each with concrete quality of ACI 318. The standard age of test shall be 28 days, but 7 day tests may be used, with the permission of the Engineer, provided that the relation between the 7-day and 28-day strengths of the concrete is established by tests for the materials and proportions used. When samples fail to conform to the requirements for strengths, the Engineer shall have the right to order a change in the proportions of the concrete mix for the remaining portions of the work at no additional cost to the Engineer.

6. Test of Hardened Concrete in or Removed from the Structure: When the results of the strength tests of the concrete specimens indicates the concrete as placed does not meet the Specification requirements or where there are other evidences that the quality of concrete is below the specification requirement in the opinion of the Engineer, tests on cores of in-place concrete shall be made in conformance with ASTM C 42.

   Core specimens shall be obtained by the Contractor and shall be tested. Any deficiency shall be corrected or if the Contractor elects, he may submit a proposal for approval before the load test is made. If the proposal is approved, the load test shall be made by the Contractor and the test results evaluated by the Engineer in conformance with Chapter 20 of ACI 318. The cost of the load tests shall be borne by the Contractor. If any concrete shows evidence of failure during the load test, or fails the load test as evaluated, the deficiency be corrected in a manner approved by the Engineer at no additional cost to the Engineer.

7. Synthetic Fibrous Reinforcement: Tested for conformance to the referenced specifications under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the Project.

8. Admixtures/Additives: The admixtures/additives if approved shall be tested for conformance to the referenced specification under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the Project. The admixtures/additives shall be tested and those that have been in storage at the Project Site for longer than six (6) months shall not be used until proven by retest to be satisfactory.

   Five (5) liters of samples of any admixtures/additives proposed by the Contractor shall be submitted for testing at least 56 days in advance of use, , which shall require approval of the Engineer. Testing of admixtures/additives proposed by the Contractor including test mixing and cylinder test shall be at the Contractor's expense.

9. Jointing Materials and Curing Compound Samples: At least 28 days prior to commencing the work, the Contractor shall submit to the

Engineer for his approval samples of the following materials proposed for use together with manufacturer's certificate.

a. 10 kg of joint sealant
b. 1 m length of joint filler
c. 5 li of curing compound
d. 1 m length of joint backing

The Engineer shall deliver to the Contractor his assessment on the materials within seven (7) days after receiving them.

3.2.4 DELIVERY, STORAGE AND HANDLING OF MATERIALS

1. Cement: Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI 301 and ASTM A 934 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

   Immediately upon receipt at the Site, the cement shall be stored separately in a dry weathertight, properly ventilated structures with adequate provisions for prevention of absorption of moisture. Storage accommodations for concrete materials shall be subject to approval and shall afford easy access for inspection and identification of each shipment in accordance with test reports.

   Cement shall be delivered to the Site in bulk or in sound and properly sealed bags and while being loaded or unloaded and during transit to the concrete mixers whether conveyed in vehicles or in mechanical means, cement shall be protected from whether by effective coverings. Efficient screens shall be supplied and erected during heavy winds.

   If the cement is delivered in bulk, the Contractor shall provide, at his own cost, approved silos of adequate size and numbers to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately after it has been delivered to the Site. Approved precautions shall be taken into consideration during unloading to ensure that the resulting dust does not constitute a nuisance.

   If the cement is delivered in bags, the Contractor shall provide, at his own cost, perfectly waterproofed and well ventilated sheds having a floor of wood or concrete raised at least 0.5m above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of the work and each consignment shall be stacked

separately therein to permit easy access for inspection, testing and approval. Upon delivery, the cement shall at once be placed in these sheds and shall be used in the order in which it has been delivered.

Cement bags should not be stacked more than 13 bags high. All cement shall be used within two months of the date of manufacture. If delivery conditions render this impossible, the Engineer may permit cement to be used up to three (3) month after manufacturing, subject to such conditions including addition of extra cement as he shall stipulate.

2. Aggregate: All fine and coarse aggregate for concrete shall be stored on close fitting, steel or concrete stages design with drainage slopes or in bins of substantial construction in such a manner as to prevent segregation of sizes and to avoid the inclusion of dirt and other foreign materials in the concrete. All such bins shall be emptied and cleaned at intervals of every six (6) months or as required by the Engineer. Each size of aggregate shall be stored separately unless otherwise approved by the Engineer.

   Stockpiles of coarse aggregate shall be built in horizontal layers not exceeding 1.2 m in depth to minimize segregation.

3.2.5 FORMWORK

1. Forms: Designed, constructed, and maintained so as to insure that after removal of forms the finished concrete members will have true surfaces free of offset, waviness or bulges and will conform accurately to the indicated shapes, dimensions, lines, elevations and positions. Form surfaces that will be in contact with concrete shall be thoroughly cleaned before each use.

2. Design: Studs and wales shall be spaced to prevent deflection of form material. Forms and joints shall be sufficiently tight to prevent leakage of grout and cement paste during placing of concrete. Juncture of formwork panels shall occur at vertical control joints, and construction joints. Forms placed on successive units for continuous surfaces shall be fitted in accurate alignment to assure smooth completed surfaces free from irregularities and signs of discontinuity. Temporary opening shall be arranged to wall and where otherwise required to facilitate cleaning and inspection. Forms shall be readily removable without impact, shock, or damage to the concrete.

3. Form Ties: Factory fabricated, adjustable to permit tightening of the forms, removable or snap-off metal of design that will not allow form deflection and will not spall concrete upon removal. Bolts and rods that are to be completely withdrawn shall be coated with a non-staining

bond breaker. Ties shall be of the type which provide watertight concrete.

4. Chamfering: External corners that will be exposed shall be chamfered, beveled, or rounded by mouldings placed in the forms.

5. Coatings: Forms for exposed surfaces shall be coated with form oil or form-release agent before reinforcement is placed. The coating shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing of concrete. Surplus coating on form surfaces and coating on reinforcement steel and construction joints shall be removed before placing concrete.

6. Removal of Forms shall be done in a manner as to prevent injury to the concrete and to insure complete safety of the structure after the following conditions have been met. Where the structure as a whole is supported on shores, forms for beam and girder sides, and similar vertical structural members may be removed before expiration of curing period. Care shall be taken to avoid spalling the concrete surface or damaging concrete edges. Wood forms shall be completely removed.

   Minimum stripping and striking time shall be as follows unless otherwise approved by the Engineer.

   Vertical sides of beams, walls, and columns, lift not 12 hours exceeding 1.2 m

   Vertical sides of beams and walls, lift exceeding 1.2 m 36 hours

   Softlifts of main slabs and beams (props left under) 5 days

   Removal of props from beams and mains slabs and other work 10 days

7. Control Test: If the Contractor proposes to remove forms earlier than the period stated above, he shall be required to submit the results of control tests showing evidence that concrete has attained sufficient strength to permit removal of supporting forms. Cylinders required for control tests shall be provided in addition to those otherwise required by this Specification. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near the points as

practicable, the same protection from the elements during curing as is given to those portions of the structure which they represent, and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three fourths of the proposed period before removal of forms. Cylinders will be tested by and at the expense of the Contractor. Supporting forms or shoring shall not be removed until control test specimens have attained strength of at least 160 kg/sq cm. The newly unsupported portions of the structure shall not be subjected to heavy construction or material loading.

3.2.6 REINFORCEMENT

1. Reinforcement: Fabricated to shapes and dimensions shown and shall be placed where indicated. Reinforcement shall be free of loose or flaky rust and mill scale, or coating, and any other substance that would reduce or destroy the bond. Reinforcing steel reduced in section shall not be used. After any substantial delay in the work, previously placed reinforcing steel for future bonding shall be inspected and cleaned. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel or concrete. Bars with kinks or bends not shown in the drawings shall not be placed. The use of heat to bend or straighten reinforcing steel shall not be permitted. Bars shall be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements shall be approved before concrete is placed. In slabs, beams and girders, reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated. Unless otherwise shown in the drawings, laps or splices shall be 40 times the reinforcing bar diameter.

2. The nominal dimensions and unit weights of bars shall be in accordance with the following table:

Nominal Diameter (mm)	**Nominal Perimeter (mm)**	**Nominal Sectional Area (sq mm)**	**Unit Weight (kg/m)**
6	18.8	28.27	0.222
10	31.4	78.54	0.616
12	37.7	113.10	0.888
16	50.3	201.10	1.579
20	62.8	314.20	2.466
25	78.5	490.90	3.854
28	88.0	615.70	4.833
32	100.5	804.20	6.313
36	113.1	1017.60	7.991
40	125.7	1256.60	9.864
50	157.1	1963.50	15.413

3. Welding of reinforcing bars shall only be permitted where shown; all welding shown shall be performed in accordance with AWS D 12.1.

4. Exposed reinforcement bars, dowels and plates intended for bonding with future extensions shall be protected from corrosion.

5. Supports shall be provided in conformance with ACI 315 and ACI 318, unless otherwise indicated or specified.

6. Concrete Protection for Reinforcement

   a. The minimum concrete cover of reinforcement shall be as shown below unless otherwise indicated in the drawings.

   b. Tolerance for Concrete Cover of Reinforcing Steel other than Tendons.

Minimum Cover	Maximum Variation
7.5 cm or more (marine structures and concrete cast against and permanently exposed to earth) less than 7.5 cm (other structures)	9 mm 6 mm

3.2.7 CLASSES OF CONCRETE AND USAGE

1. Strength Requirement:

   a. Concrete of the various classes unless specified in other Sections or indicated on the Drawings or directed by the Engineer shall be proportioned and mixed to achieve the following strengths:

Class	Specified Compressive Strength - 28 days	
	Fc' = MPa	fc' = psi
A	35	5,000
B1	35	5,000
B2	25	3,500
C	21	3,000
D	17	2,500
E	41.4	6,000

b. In addition to the above, the maximum permissible water-cement ratio by weight shall not be greater than 0.55 unless otherwise permitted by the Engineer.

c. However, for projects located in remote areas where the concrete transit mixer (batching plant) is not available such that the 5,000 psi compressive strength is not attainable for Classes A and B1, the minimum compressive strength of 3,500 psi may be used.

2. Usage: Concrete of the various classes to be used shall be as follows:

a.	Class A concrete	:	Special cases for marine structures
b.	Class B1 concrete	:	Marine Structures (piles/RC for sheet piles and coping for sheet piles/retaining walls/wharf/pier deck), precast or in-situ concrete.
c.	Class B2 concrete	:	Concrete pavement for causeways and roads, stair landings and curbs
d.	Class C concrete	:	Building Works, Utility RC works
e.	Class D concrete	:	Concrete blocks, concrete slabs for buildings with no vehicle access.
f.	Class E concrete	:	Interlocking Concrete Block Pavement

3.2.8 PROPORTIONING OF CONCRETE MIXES

1. Trial design batches and testing to meet requirements of the classes of concrete specified shall be the responsibility of the Contractor. The design mix shall be of consistencies specified hereinafter in Paragraph 3.2.8.6. Tests for slump, unit weight, and air content shall be performed in the field under the presence of the Engineer.

2. Synthetic fibrous reinforcement shall conform to the recommended dosage of the manufacturer.

   Water reducing agents, set retarders or strength accelerators shall not be used in greater dosages than those recommended by the manufacturers.

3. Concrete Proportioning: Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregates shall be representative of those proposed for the Project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixes having proportions, consistencies and air content suitable for the work shall be made based on ACI Standard 211.1 using at least three different water-cement ratios which will produce a range of strength encompassing those required for the work. Trial mixes shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength.

4. Average Strength: For each portion of the structure, proportions shall be selected so that the maximum permitted water-cement ratio is not exceeded and so as to produce an average strength to exceed the specified strength fc' by the amount indicated below. Where production facility has a standard deviation record determined in accordance with ACI 214, based on 30 consecutive strength tests of similar mixture proportions as proposed it shall be used in selecting average strength.

   The average strength used as the basis for selecting proportions shall exceed the specified strength fc' by at least:

   a. 2.94 MPa if standard deviation is less than 1.96 MPa

   b. 3.92 MPa if standard deviation is 1.96 to 2.94 MPa

   c. 4.90 MPa if standard deviation is 2.94 to 3.92 MPa

   d. 5.88 MPa if standard deviation is 3.92 to 4.90 MPa

   e. If a standard deviation record is not available, proportions shall be selected to produce an average strength of at least 6.86 MPa greater than the specified strength.

5. Corrective additions to remedy deficiencies in aggregate gradation shall be used only on written approval of the Engineer.

6. Slump:Tests shall be made in conformance with ASTM C 143, and unless otherwise specified by the Engineer, slump shall be within the following limits:

Structural Element	Slump for Vibrated Concrete	
	Minimum	Maximum
Pavement Concrete	25 mm	50 mm
Precast Concrete	50 mm	70 mm
Lean Concrete	100 mm	200 mm
All other Concrete	50 mm	90 mm

7. Sampling: Provide suitable facilities and labor for obtaining representative samples of concrete for the Contractor's quality control and the Engineer's quality assurance testing. All necessary platforms, tools and equipment for obtaining samples shall be furnished by the Contractor.

3.2.9 MIXING CONCRETE

1. GENERAL

   a. Concrete shall be thoroughly mixed in a mixer of an approved size and type that will insure a uniform distribution of the materials throughout the mass.

   b. All concrete shall be mixed in mechanically operated mixers. Mixing plant and equipment for transporting and placing concrete shall be arranged with an ample auxiliary installation to provide a minimum supply of concrete in case of breakdown of machinery or in case the normal supply of concrete is disrupted. The auxiliary supply of concrete shall be sufficient to complete the casting of a section up to a construction joint that will meet the approval of the Engineer.

   c. Equipment having components made of aluminum or magnesium alloys, which would be in contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

   d. Concrete mixers shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the amount of water used.

   e. Materials shall be measured by weighing. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. The accuracy of all weighing devices except that for water shall be such that successive quantities can be measured to within one percent of the desired amounts. The water measuring device shall be accurate to plus or minus 0.5 percent. All measuring devices shall be subject to the approval of the Engineer. Scales and measuring devices shall be

tested at the expense of the Contractor as frequently as the Engineer may deem necessary to insure their accuracy.

f. Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cut-off shall not vary from the weight designated by the Engineer by more than one percent for cement, 1-½ percent for any size of aggregate, or one percent for the total aggregate in any batch.

g. Manual mixing of concrete shall not be permitted unless approved by the Engineer.

2. MIXING CONCRETE AT SITE

a. Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixers shall be restored or replaced when any part or section is worn 20 mm or more below the original height of the manufacturer's design. Mixers and agitators which have an accumulation of hard concrete or mortar shall not be used.

b. When bulk cement is used and the volume of the batch is 0.5 m^3 or more, the scale and weigh hopper for Portland cement shall be separate and distinct from the aggregate hopper or hoppers.

The discharge mechanism of the bulk cement weigh hopper shall be interlocked against opening before the full amount of cement is in the hopper. The discharging mechanism shall be interlocked against opening when the amount of cement in the hopper is underweight by more than one percent or overweight by more than 3 percent of the amount specified.

c. When the aggregates contain more water than the quantity necessary to produce a saturated surface dry condition, representative samples shall be taken and the moisture content determined for each kind of aggregate.

d. The batch shall be so charged into the mixer that some water enter in advance of cement and aggregates. All water shall be in the drum by the end of the first quarter of the specified mixing time.

e. Cement shall be batched and charged into the mixer by such means that it will not result in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or

hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

f. Where required, synthetic fibrous reinforcement shall be added directly to the concrete mixer after placing the sufficient amount of mixing water, cement and aggregates.

g. The entire contents of a batch mixer shall be removed from the drum before materials for a succeeding batch are place therein. The materials composing a batch except water shall be deposited simultaneously into the mixer.

h. All concrete shall be mixed for a period of not less that 3 minutes after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at the speed for which it has been designed.

i. Mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed.

j. The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand, and water to coat the inside of the drum without reducing the required mortar content of the mix. When mixing is to cease for a period of one hour or more, the mixer shall be thoroughly cleaned.

3. MIXING CONCRETE IN TRUCKS

a. Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to insure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured and charged into the drum at the proportioning plant. Except as subsequently provided, the truck mixer shall be equipped with a device by which the quantity of water added can be readily verified. The mixing water may be added directly to the batch, in which case a tank is not required. Truck mixers may be required to be provided with a means by which the mixing time can be readily verified by the Engineer.

b. The maximum size of batch in truck mixers shall not exceed the minimum rated capacity of the mixer as stated by the manufacture and stamped in metal on the mixer. Truck mixing shall, unless otherwise directed, be continued for not less than 100 revolutions

after all ingredients, including water, are in the drum. The mixing speed shall not be less than 4 rpm, nor more than 6 rpm.

c. Mixing shall begin within 30 minutes after the cement has been added either to the water or aggregate, but when cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above 32 °C, this limit shall be reduced to 15 minutes. The limitation in time between the introduction of the cement to the aggregate and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregate is sufficiently free from moisture, so that there will be no harmful effects on the cement.

d. When a truck mixer is used for transportation, the mixing time in stationary mixer may be reduced to 30 seconds and the mixing completed in a truck mixer. The mixing time in truck mixer shall be as specified for truck mixing.

3.2.10 JOINTS

1. No reinforcement, corner protection angles or other fixed metal items shall be run continuously through joints containing expansion-joint filler, through crack-control joints in slabs on grade and vertical surfaces.

2. Preformed Expansion Joint Filler

   a. Joints with Joint Sealant: At expansion joints in concrete slabs to be exposed, and at other joints indicated to receive joint sealant, preformed expansion-joint filler strips shall be installed at the proper level below the elevation with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a groove. When surface dry, the groove shall be cleaned of foreign matter, loose particles, and concrete protrusions, then filled flush approximately with joint sealant so as to be slightly concave after drying.

   b. Finish of concrete at joints: Edges of exposed concrete slabs along expansion joints shall be neatly finished with a slightly rounded edging tool.

   c. Construction Joints:

      Unless otherwise specified herein, all construction joints shall be subject to approval of the Engineer. Concrete shall be placed continuously so that the unit will be monolithic in construction. Fresh concrete may be placed against adjoining units, provided the set concrete is sufficiently hard not to be injured thereby. Joints not indicated shall be made and located in a manner not to

impair strength and appearance of the structure. Placement of concrete shall be at such rate that the surface of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon. Lifts shall terminate at such levels as are indicated or as to conform with structural requirements as directed. If horizontal construction joints are required, a strip of 25 mm square-edged lumber, beveled to facilitate removal shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed one hour after the concrete has been placed. Any irregularities in the joint line shall be leveled off with a wood float, and all laitance removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in sub-section 3.2.14, "Bonding."

Construction Joint which is not indicated in the Drawings shall be located as to least affect the strength of the structure. Such locations will be pointed out by the Engineer.

3.2.11 PREPARATION FOR PLACING

Hardened concrete, debris and foreign materials shall be removed from the interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position, and shall be inspected, and approved before placing concrete. Runways shall be provided for wheeled concrete-handling equipment. Such equipment shall not be wheeled over reinforcement nor shall runways be supported on reinforcement.

Notice of any concreting operations shall be served to the Engineer at least three (3) days ahead of each schedule.

3.2.12 PLACING CONCRETE

1. Handling Concrete: Concrete shall be handled from mixers and transported to place for final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients until the approved unit of work is completed. Placing will not be permitted when the sun, heat, wind or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Concrete shall be placed in the forms, as close as possible in final position, in uniform approximately horizontal layers not over 40 cm deep. Forms splashed with concrete and reinforcement splashed with concrete or form coating shall be cleaned in advance of placing subsequent lifts. Concrete shall not be allowed to drop freely more than 1.5 m in unexposed work nor more than 1.0 m in exposed work; where greater drops are required, tremie or other approved means

shall be employed. The discharge of the tremie shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 40 cm thick, and the spacing of the tremies shall be such that segregation does not occur. Concrete to be overlayed shall be screeded to the proper level to avoid excessive shimming or grouting. Conduits and pipes shall not be embedded in concrete unless specifically indicated.

2. Time Interval between Mixing and Placing: Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed in the forms within 30 minutes from the time ingredients are charged into the mixing drum. Concrete transported in truck mixers or truck agitators shall be delivered to the site of work, discharged in the forms within 45 minutes from the time ingredients are discharged into the mixing drum. Concrete shall be placed in the forms within 15 minutes after discharged from the mixer at the jobsite.

3. Hot Weather Requirements: The temperature of concrete during the period of mixing while in transport and/or during placing shall not be permitted to rise above 36 °C. Any batch of concrete which had reached a temperature greater than 36 °C at any time in the aforesaid period shall not be placed but shall be rejected, and shall not thereafter be used in any part of the permanent works.

    a. Control Procedures: Provide water cooler facilities and procedures to control or reduced the temperature of cement, aggregates and mixing handling equipment to such temperature that, at all times during mixing, transporting, handling and placing, the temperature of the concrete shall not be greater than 36 °C.

    b. Cold Joints and Shrinkage: Where cold joints tend to form or where surfaces set and dry too rapidly or plastic shrinkage cracks tend to appear, concrete shall be kept moist by fog sprays, or other approved means, applied shortly after placement, and before finishing.

    c. Supplementary Precautions: When the aforementioned precautions are not sufficient to satisfy the requirements herein above, they shall be supplemented by restricting work during evening or night. Procedure shall conform to American Concrete Institute Standard ACI 305.

4. Conveying Concrete by Chute, Conveyor or Pump: Concrete may be conveyed by chute, conveyor, or pump if approved in writing. In requesting approval, the Contractor shall submit his entire plan of operation from the time of discharge of concrete from the mixer to final placement in the forms, and the steps to be taken to prevent the formation of cold joints in case the transporting of concrete by chute,

conveyor or pump is disrupted. Conveyors and pumps shall be capable of expeditiously placing concrete at the rate most advantageous to good workmanship. Approval will not be given for chutes or conveyors requiring changes in the concrete materials or design mix for efficient operation.

a. Chutes and Conveyors: Chutes shall be of steel or steel lined wood, rounded in cross section rigid in construction, and protected from overflow. Conveyors shall be designed and operated and chute sections shall be set, to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients, loss of mortar, or change in slump. The discharged portion of each chute or conveyor shall be provided with a device to prevent segregation. The chute and conveyor shall be thoroughly cleaned before and after each run. Waste material and flushing water shall be discharged outside the forms.

b. Pumps shall be operated and maintained so that a continuous stream of concrete is delivered into the forms without air pockets, segregation or changes in slump. When pumping is completed, concrete remaining in the pipeline shall be ejected and wasted without contamination of concrete already placed. After each operation, equipment shall be thoroughly cleaned and the flushing water shall be splashed outside the forms.

5. Wall and Abutments

No load shall be placed upon finished walls, foundations or abutments until authorized by the Engineer. Minimum time before loading shall be 7 days.

6. Concrete Placing on Wharf Deck

When placing concrete on wharf decks, the Contractor shall:

- Ensure that rate of placing is sufficient to complete proposed placing, finishing and curing operations within the scheduled time; that experienced finishing machine operators and concrete finishers are provided to finish the deck; that curing equipment and finishing tools and equipment are at the site of work and in satisfactory condition for use.

- Immediately prior to placing, the Contractor shall place scaffolding and wedges and make necessary adjustments. Care shall be taken to ensure that settlement and deflection due to added weight of concrete will be minimal. The Contractor shall provide suitable means to readily permit measurement of settlement deflection as it occurs.

- Should any event occur which, in opinion of the Engineer, would prevent the concrete conforming to specified requirements, the Contractor shall discontinue placing of concrete until corrective measures are provided satisfactory to the Engineer. If satisfactory measures are not provided prior to initial set of concrete in affected areas, the Contractor shall discontinue placing concrete and install a bulkhead at a location determined by the Engineer. Concrete in place beyond bulkheads shall be removed. The Contractor shall limit the size of casting to that which can be finished before beginning of initial set.

3.2.13 COMPACTION

1. Immediately after placing, each layer of concrete shall be completed by internal concrete vibrators supplemented by hand-spading, rodding, and tamping. Tapping or other external vibration of forms will not be permitted unless specifically approved by the Engineer. Vibrators shall not be used to transport concrete inside the forms. Internal vibrators submerged in concrete shall maintain a speed of not less than 7,000 impulses per minute. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete.

2. Spare units shall be on hand as necessary to insure such adequacy. The duration of vibrating equipment shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into the lower courses that have begun to set. Vibrator shall be applied vertically at uniformly spaced points not further apart than the visible effectiveness of the machine.

3.2.14 EPOXY BONDING COMPOUND

Before depositing new concrete on or against concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned so as to expose the coarse aggregate and be free of laitance, coatings, foreign matter and loose particles. Forms shall be re-tightened. The cleaned surfaces shall be moistened, but shall be without free water when concrete is placed.

ASTM C 881. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Class B if placement temperature is between 4 to 16 °C; or Class C if placement temperature is above 16°C.

Apply a thin coat of compound to dry and clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is tacky. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.2.15 SETTING OF BASE PLATES

1. Preparation: After being plumbed and properly positioned, base plates shall be provided with full bearing with damp-pack bedding mortar, except where expansive grout is indicated. The space between the top of concrete or masonry bearing surfaces and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 13 mm for plates less than 30 cm wide. Concrete surfaces shall be rough, clean, free of oil, grease and laitance, and shall be damp. Metal surfaces shall be cleaned and free of oil, grease and rust.

2. Mortar: Damp-pack bedding mortar shall consist of one part Portland cement and 2.5 parts of fine aggregates, suitable to the work required, proportioned by weight and not more than 17 liters of water per bag of cement. The space between the top of the plate shall be packed with the bedding mortar by tamping or ramming with a bar or rod until the voids are completely filled.

3. Expansive Grout: Grout shall derive its expansive properties from the liberation of gas into the mixture during and after mixing. This includes typically, the chemical reaction of metallic aluminum with alkali hydroxides in solution which causes the evolution of hydrogen gas. Expansion of such materials may be expected to continue after the gas liberating mechanism has been exhausted or until the mixture has solidified to such an extent that the tendency for the evolving gas to expand is effectively registered by the stiffness of the grout.

    a. When tested as provided for herein, an expansive grout shall meet the following performance requirements:

Expansion, 28 days, %	0.4 (max) 0.03 (min)

    b. It will be the Contractor’s responsibility to supply the necessary manufacturer’s certificates.

3.2.16 FINISHES OF CONCRETE

Within 12 hours after the forms are removed, surface defects shall be remedied as specified herein. The Temperature of the concrete, ambient air and mortar during remedial work including curing shall be above 10 °C. Fine and loose material shall be removed. Honeycomb, aggregate

pockets, voids over 13 mm in diameter, and holes left by the rods or bolts shall be cut out to solid concrete, reamed, thoroughly wetted, brush-coated with neat cement grout, and filled with mortar. Mortar shall be a stiff mix of one part Portland cement to not more than 2 parts fine aggregate passing the No. 16 mesh sieve, with a minimum amount of water. The color of the mortar shall match the adjoining concrete color. Mortar shall be thoroughly compacted in place. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through the outside face. Holes which do not pass entirely through wall shall be packed full. Patchwork shall be finished flush and in the same plane as adjacent surfaces. Exposed patchwork shall be finished to match adjoining surfaces in texture and color. Patchwork shall be damp-cured for 72 hours. Dusting of finish surfaces with dry material or adding water to concrete surfaces will not be permitted.

3.2.17 CONCRETE FINISHING DETAILS

1. Concrete Paving: After concrete is placed and consolidated, slabs shall be screeded or struck off. No further finish is required.

2. Smooth Finish: Required only where specified; screed concrete and float to required level with no coarse aggregate visible. After surface moisture has disappeared and laitance has been removed, the surface shall be finished by float and steel trowel. Smooth finish shall consist of thoroughly wetting and then brush coating the surfaces with cement to not more than 2 parts fine aggregate passing the no. 30 mesh sieve and mixed with water to the consistency of thick paint.

3. Broom Finish: Required for paving, stair landings; the concrete shall be screeded and floated to required finish level with no coarse aggregate visible. After the surface moisture has disappeared and laitance has been removed, surface shall be float-finished to an even, smooth finish. The floated surfaces shall be broomed with a fiber bristle brush in a direction transverse to the direction of the main traffic.

4. Tolerance: Smooth and broom finished surfaces shall be true to plane with no deviation in excess of 3 mm in any direction when tested with a 3 m straightedge.

3.2.18 CURING

1. Concrete shall be protected against moisture loss, rapid temperature changes, mechanical injury from rain or flowing water, for a minimum period of time given below:

Types A, B1 and B2	7 days
Types C and D	5 days

2. Concrete shall be maintained in a moist condition throughout the specified curing period and until remedial work is started under sub-section 3.2.16, "Finishes of Concrete". Curing activities shall be started as soon as free water has disappeared from the surface of the concrete after placing and finishing. Formed under-surfaces shall be moist cured with forms in place for the full curing period or, if forms are removed prior to the end of the curing period, by other approved means. Curing shall be accomplished by any of the following methods or combination thereof, as approved.

3. Moist Curing: Unformed surfaces shall be covered with burlap or mats, wetted before placing and overlapped at least 15 cm. Burlap or mats shall be kept continually wet and in intimate contact with the surface. Where formed surfaces are cured, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on unformed surfaces, using suitable materials.

4. Impervious-sheet Curing: All surfaces shall be thoroughly wetted with a fine spray of water and be completely covered with waterproof paper, polyethylene sheeting or with polyethylene coated burlap having the burlap thoroughly water saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 30 cm and securely weighted down or shall be lapped not less than 10 cm and taped to form a continuous cover with completely close joints. Sheets shall be weighted to prevent displacement or billowing from winds. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

5. Membrane-forming Compound Curing: Before applying curing compound, tops of joints that are to receive sealant shall be tightly closed with temporary material to prevent entry of the compound and to prevent moisture loss during the curing period. The compound shall be applied on damp surfaces as soon as the moisture film has disappeared. The curing compound shall be applied by power spraying using a spray nozzle equipped with a wind guard. The compound shall be applied in a two-coat, continuous operation at a coverage of not more than 10 sq m per liter for each coat.

   When application is made by hand sprayers the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections. Surfaces subjected to rainfall within 3 hours after compound has been applied, or surfaces damaged by subsequent construction operations within the curing period, shall be immediately re-sprayed at the rate specified above. Membrane

forming curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Where membrane-forming curing compounds are permitted, permanently exposed surfaces shall be cured by use of non-pigmented membrane-forming curing compound containing a fugitive dye. Where non-pigmented type curing compounds are used, the concrete surface shall be shaded from the direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other causes of abrasion and contamination during the curing period.

3.2.19 UNDER WATER CONCRETE

1. Concrete placement under water, when unavoidable, shall be made in accordance with the following requirements and provided always with the Engineer's approval.

    a. Water cement ratio shall be within 50 percent.

    b. Weight of cement per one cubic meter shall be not less than 370 kg.

    c. Use of water reducing admixtures and/or admixtures that reduce concrete contamination by sea water shall be recommended.

    d. Slump shall be within the following limits:

Construction Method	Slump
Using tremie or concrete pump	Between 13 to 18 cm
Using bottom opening type box or buck	Between 10 to 13 cm

    e. Coverage of reinforcement shall be 10 cm or more.

    f. Concrete shall be placed under water in accordance with Sub-section 3.2.12 "Placing Concrete" unless otherwise mentioned below.

        1) Concrete shall be placed under calm weather conditions and current shall be within 3 m/min.

        2) Concrete shall be placed using tremies or concrete pumps or any other approved equipment.

3) Tremies shall be watertight and of size which can deliver concrete freely without any segregation or change in slump. Tremies shall be filled with concrete fully during placing.

4) Pipes of concrete pumps shall be watertight.

5) Tremies shall move carefully up to the designated height under continuous concrete placement operations so that concrete can spread uniformly.

6) Concrete shall not be agitated after placing in the forms in order to prevent laitance formation at the top of the works.

7) Successive concrete placement can be carried out only after all laitance has been removed from existing surfaces.

3.2.20 MEASUREMENT AND PAYMENT

3.2.20.1 MEASUREMENT

1. Concrete shall be measured by the cubic meters of various kind and classes of respective items of work required as shown in the Drawings or as specified and as installed and accepted in completed work.

   Volumes of concrete shall be reduced by the amount occupied by pipes, conduits, chases or other places with net cross section areas more than 100 cm^2 other than the following items:

   a. Reinforcing steel and anchor bolts.

   b. Space required for or occupied by expansion/construction joints, joint fillers, water stops, chamfers and like details of relatively small size.

   Setting out of the work to be paid for shall not be measured separately, the cost shall be deemed as part of and incidentals to the foundation works.

2. Formwork shall not be measured separately for payment. The cost is deemed as part and incidentals to the concrete works.

3. Reinforcing steel bars shall be measured in kilograms incorporated into work, computed from theoretical unit mass for sizes of bars multiplied by length of bars as shown on approved shop drawings except where specified otherwise.

No measurement shall be made for reinforcing steel in catch drains, catch basins, manholes and precast concrete. The cost will be included in the price for each item of work.

Separate measurement will not be made for:

a. Increase of bar sizes or decrease of bar spacing, unless approved in advance by the Engineer.

b. Increase in number of bars resulting from Contractor's constructing method.

c. Bar splicers added for Contractor's convenience or made necessary as a result of using bar lengths less than 10 meters.

d. Weight of quantity of tie wires, chairs, spacers or other accessory items necessary for erection of steel work.

e. Sleeves and work incidental to and necessary for installation of dowels for expansion/construction joints for slabs.

4. Cost of all testing and records to be made shall be deemed included in the unit cost of concrete.

3.2.20.2 PAYMENT

1. The quantities measured as provided above, shall be paid for at the contract unit price according to the class of concrete for the pay item shown in the Bill of Quantities. The unit price shall be considered to include all formwork including scaffolding, forms for construction and expansion joints, vapor barrier and sealant, form oil coating, synthetic fibrous reinforcement/admixtures where required, necessary accesses for pipes, conduits, sewer drains and the like and work required for placing concrete in the final position including material, batching, mixing, transporting, handling, placing, compacting, curing, protection and finishing of concrete surfaces.

2. The quantity of reinforcing steel bars to be paid for shall be measured (as in 3.2.21.1.3) by the weight of reinforcing steel bars supplied and installed completely and certified by the Engineer for payment. The cost shall constitute full compensation for furnishing materials, labor, equipment, tools, and incidentals necessary to complete reinforcing steel works as indicated in the Bill of Quantities.

3.3 PILING WORKS

3.3.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements", and shall apply to the Section, whether herein referred to or not.

3.3.1.1 SCOPE OF WORK

This section covers the technical requirements for the material, workmanship, fabrication, installation and testing of piling works, and shall form part of this Specification to the extent indicated by the reference thereto.

3.3.1.2 GENERAL PROVISIONS

The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

AWS D1.1	Structural Welding Code
ASTM D1143	Load Settlement Relation for Individual Vertical Piles under Static Axial Load

The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

3.3.1.3 COATING PROTECTION

Steel Pipe Pile Coating Protection, when required, shall be as specified in the drawing.

3.3.1.4 METHOD STATEMENT

Before the commencement of any piling works, the Contractor shall submit (allowing sufficient time for consideration) to the Engineer for approval a Safety Policy and a Method Statement which shall include the following information:

1. Program of Works detailing sequence and timing of individual portions of works.
2. Maximum proposed lead at any stage of driving between a pile and its neighbor and the limitations of same if hard driving is encountered.

3. Contingency plan in the event of encountering obstructions or reaching driving refusal to minimize disruption/delay especially when using pitch and drive methods.

3.3.2 MATERIAL REQUIREMENTS

3.3.2.1 PRECAST REINFORCED CONCRETE PILES (RC PILES)

Precast concrete for reinforced concrete piles and its reinforcement shall conform to the requirement of Section 3.2 “Concrete Works”.

1. Fabrication Yard and Equipment

   Reinforced concrete piles shall be products of approved manufacturers regularly engaged in pile production of the same size or larger for a period of three years or more. However, the Contractors may be allowed to manufacture RC piles upon presentation to the Engineer of proof that they have past experienced in manufacturing RC piles from their previous contracts having the same or bigger requirements.

   Before casting of piles is started, approval shall be obtained of the casting method, the casting yard and storage site and equipment. The Contractor shall provide all equipment necessary for the fabrication of piles. Special care shall be made for curing, handling and transport of piles.

2. Casting and Fabrication

   Piles shall be cast separately. The formwork for the piles shall have an even and solid bed and be constructed so that the piles can be easily removed from the form. The formwork and its placing shall be approved before casting of concrete. The formwork shall not be removed from its bed until the concrete has attained a compressive strength of at least 70% of its required 28 day strength.

   The pile shall not be removed from its casting bed until it has reached its full 28 day compressive strength. Piles shall be moist cured for a period of 28 days after casting.

   The Contractor shall determine the points where the piles will be supported during handling, transportation and storage. Care shall be taken to prevent piles from any damage during transportation. If the piles are placed in stacks, the supporting points at each layer shall be vertically over one another and the location of the supporting points shall be approved by the Engineer.

3. Formwork

   Forms shall conform to the applicable provisions in Section 3.2, "Concrete Works." Chamfers shall be provided at each corner of piles as indicated on the Drawings.

4. Marking

   After the concrete has hardened, the piles shall be marked in approved format in durable paint indicating:

   a. Serial Number, marked close to both ends
   b. Date of casting, marked as (a)
   c. Date of arrival, marked as (b)
   d. Length of pile, marked as (c)
   e. Position of lifting points as approved by the Engineer
   f. Meter marks in two faces, throughout the length

3.3.2.2 PRESTRESSED REINFORCED CONCRETE PILES (RC PILES)

Prestressed concrete piles shall be constructed in accordance with the normal practice employed for the particular system specified and as directed by the Engineer subject to the following clauses.

1. Prestressed concrete piles shall be of readymade products of approved fabricator regularly engaged in the production of prestressed concrete piles for a period of three years or more.

2. The design report, specification, handling manual and shop drawings of piles to be applied shall be submitted by the Contractor for the Engineer's approval.

3. If an alternative system of prestressing to that shown in the Drawings is proposed by the Contractor, full details, procedures and explanations shall be submitted in writing to the Engineer for his approval. When approved for the work, the provisions of this Specification and such other provisions as he may require shall be fully satisfied.

4. Concrete strength, wires/strands, bars to be used for prestressed concrete work shall be as specified in the Drawings.

5. The Contractor shall submit the casting method including prestressing, application of stress and casting schedule and shall obtain the approval of the Engineer before commencement of fabrication of the piles.

6. The Contractor shall arrange for the Engineer to have free access to the place of manufacture of the piles.

7. Casting of prestressed concrete piles shall be in a manner that there shall be no leakage of concrete or grout into the space to be occupied by the steel. The ducts shall be of the correct cross-section, the ends being formed out as shown on the Drawings or as required by the prestressing system in use. Adequate means, subject to the Engineer's approval, shall be employed to ensure that their location is maintained exactly throughout the concreting operations. Passage shall be provided in the locations indicated on the Drawings for the injection and escape of grout and the release of air.

   Piles shall be cast on a horizontal platform in approved steel moulds and details of the formwork and methods of concreting shall be as specified. The concreting of each pile shall be completed on one continuous operation and no interruption shall be permitted.

   The ends of the piles must be formed truly square to the axis of the pile.

8. Anchorages shall be made from steel of a suitable quality to withstand permanently the forces imposed upon them, and shall in general be in accordance with the normal practice of the proprietors of the prestressing system in use.

9. Application of stress, grouting of prestressing cables, protection of prestressing cable anchorages and other necessary steps to complete the prestressing process shall conform to the standard practice of the prestressing system in use or as directed by the Engineer.

   When the stress has been transferred to the pile, the pile shall exhibit no curvature in its length on any face greater than 3 millimeters deviation along a chord of 15 meters (1 in 500).

10. Precast prestressed units shall be lifted only by lifting holes near the ends of the units, or when not provided can be lifted by slings placed securely at corresponding points. Units shall be kept in the upright position at all times and shock shall be avoided. Any unit considered by the Engineer to have become sub-standard in any way shall be rejected and replaced by an acceptable unit.

11. Each prestressed member is to be uniquely and permanently marked to show its type, date of casting and reinforcement.

12. Forms shall conform to the applicable provisions in Section 3.2. Chamfer shall be provided at each corner of piles as shown on the Drawings.

13. The Contractor or approved manufacturer shall mark the casted piles in same manner discussed in Sub-section 3.3.2.1.4).

3.3.2.3 REINFORCED CONCRETE SHEET PILES

Same requirements for reinforced concrete piles shall be applied to reinforced concrete sheet piles.

3.3.2.4 STEEL PIPE OR TUBULAR PILES

1. Steel Pipe Piles

   Steel tubular piles required under this heading may either be fluted or plain, tapered or cylindrical, seamless or welded type or as indicated in the drawings conforming to the requirements of ASTM A 252 Grade 2, equal or better. Minimum shell thickness shall be as indicated in the drawings. Piles may be supplied knockdown in the sections then fabricated or welded to the required length in the field prior to driving.

   a. Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) Jacket as Protective Coating of Steel Piles

      Unless otherwise specified on the Drawings, the Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) Jacket (Heavy Duty Application) shall be used as protective coating for steel piles.

      (1) Material Requirements:

         (a) Petrolatum Paste

            - Petrolatum Paste is a soft paste containing water displacing, corrosion inhibiting and flow control additives with broad-spectrum biocides. It does not dry, harden or crack.

            - Applicable to badly corroded and fitted steel above and below water surface prior to the application of the marine piling tape. It fills pits and depressions on the steel pile surface and does not contain volatile organic components.

- Specially designed for underwater applications.

  Properties:

Flash point	=	180˚C (minimum)
Specific Gravity	=	+ 1.08

  Temperature Range:

For Application	=	0°C to 40°C
For Service	=	- 30°C to 55°C

(b) Petrolatum Marine Piling Tape

- Petrolatum Marine Piling Tape is a synthetic filament fabric coated with a neutral compound based on saturated petroleum hydrocarbons and inert mineral fillers with additional inhibitors and water displacing agents.
- It is primarily used for the protection of jetty piles particularly in the splash and inter-tidal zones.
- It is an anti-corrosion tape that can be applied to metal under water that adheres and remains attached to all cleaned, sound, wet or dry metal surfaces.

(c) High Density Polyethylene (HDPE) Jacket

- HDPE Jacket is a flexible plastic outer cover, new, seamless, non-rigid virgin material. The sheet shall be uniform throughout, free from dirt, oil and other foreign matter and free from cracks. This sheet shall conform to the following mechanical and physical properties:

Tensile Strength @ Break	=	187 kg/cm2
Elongation @ Break	=	610%
Thickness	=	2.00 mm
Tear Resistance	=	146 kg/cm^2

(2) Installation Procedure

(a) Surface Preparation

- Prior to the application of Petrolatum Paste, the Pile Surface should be thoroughly cleaned starting from the interface of the bottom of pile cap down to elev. – 3.00m (Splash Zone).

- All Marine growths, loose and flaking paint, adhering rust scale and deep pitting corrosion products should be removed by chipping hammers and/or hand power tools.

- Weld scars and protrusion of any kind (other than the welded seam on the pile) should be cut away and smoothened to removed sharp edges and sudden changes of profile.

(b) Petrolatum Paste

- Apply the petrolatum Paste by hand, brush, glove, rag or roller.

- Apply a thin uniform film over the entire surface to be wrapped with Petrolatum Marine Piling tape.

(c) Petrolatum Marine Piling Tape

- A minimum of two layers of marine piling tape should be wrapped around the surface of the steel piles along the splash zone.

(d) High Density Polyethylene (HDPE) Jacket

- A minimum of 50 mm overlap width is required along joints.

b. Other Protective Coating for Steel Piles

Unless otherwise specified on the drawings, when the steel pipe piles or tubular piles are extended aboveground surface or water surface, they shall be protected by two (2) coats of epoxy coal tar. If concrete jacket is required, a minimum thickness of 0.15m shall be used. These protections extend 1.00m below the water elevation on finished ground to the top of the exposed steel.

c. Exterior Surfaces

All exterior surfaces of pile shall be shop coated with red lead primer or as indicated in the drawings.

2. Concrete and Reinforcement Works

Concrete and reinforcement works (where required) for filler of steel pipe piles, concrete jacket and pile cap shall be in accordance with Section 3.2, “Concrete Works” where concrete compressive strength at 28 days shall be [35.0] MPa [5,000 psi].

Provide reinforced concrete filler for steel pipe piles from the top of piles up to 2.00 m below MLLW (Elevation 0.00). Concrete jacket (100 mm thick) shall be provided up to 1.00 meter below MLLW as indicated on the Drawings.

3. Welding Requirements

The welding material used for the production of steel piles by circumferential welding of steel pile or in the attachment of accessories shall have a tensile strength not less than the following standards.

JIS Z 3211 - Covered Electrodes for Mild Steel

JIS Z 3213 - Covered Electrodes for High Tensile Strength Steel

JIS Z 3312 - MAG Welding Solid Wires for Mild

JIS Z 3313 - Flux Cored Wives for Gas Shielded and self-shielded Metal Arc Welding of Mild Steel, High Strength Steel and Low Temperature Service Steel

JIS Z 3352 - Submerged Arc Welding Fluxes for Carbon Steel and Low Alloy Steel

The welder shall have a qualification specified in JIS Z 3801 Standard Qualification Procedure for Welding Technique or equivalent.

4. Splicing

The Contractor shall splice the pile as shown on the drawings or by other methods approved by the Engineer.

5. Tip Protection

The Contractor shall submit shop drawing and methods of pile tip protection to the Engineer for approval.

6. Marking

The pile shall be marked on durable paint indicating:

1. Serial Number, marked close to both ends
2. Date of Arrival, marked same as (i)
3. Length of pile, marked same as (i)
4. Meter marks in two faces, throughout the length

7. Workmanship

All piles shall be correctly finished free of cracks, surface flaws, laminations and all other defects. The repairs of minor defects by welding or otherwise will be permitted but such repairs shall only be done after obtaining the permission of the Engineer in writing. Detail of the defect and of the proposed method of repair shall be submitted to the Engineer at least 48 hours before it is desired to effect the repair.

8. Documents to be submitted

The following documents shall be submitted to the Engineer prior to the commencement of welding work of tubular steel piles:

1. Steel pipe (pile) manufacturing plan
   (steel pipe production plan, welding method, welding material, production location, production method, transportation, etc.)
2. Design plan
3. Manufacturing process
4. Shipment method and stacking plan
5. Steel pipe inspection certificate
6. Size inspection record
7. Radiographic test record

3.3.2.5 STEEL SHEET PILES

1. Quantities and Dimensions

Steel sheet piles shall be of the type indicated on the Drawings with continuous interlock. The sections and grade of steel shall be as shown on the Drawings or approved equivalent.

All steel sheet piles shall conform to ASTM A 328 or approved equivalent.

2. Quantities and Dimensions (Tie-Rods, Walings and Fittings)

All components of tie-rod assemblies to be supplied, assembled and installed by the Contractor shall be in accordance with the applicable requirements of the ASTM standards. The tie-rods shall have upset treaded ends and the minimum yield point shall be as shown on the drawings.

Structural Steel shapes for walings shall be supplied, fabricated, assembled and installed by the Contractor as shown on the Drawings. The structural steel shall conform to Section 3.15 “Steel and Metal Works”.

Bolts for assembly of structural steel walings and for connections or special sections shall conform to ASTM A 325 and ASTM A 307 or as specified on the Drawings.

3.3.2.6 TIMBER PILES

1. Material

The timber piles shall be straight and treated apitong or equivalent and creosoted with minimum butt diameter of and a minimum tip diameter of 200mm and a length as shown on the Drawings. The piles shall be free from ring shakes, unsound spots or knots and short bends. All knots shall be trimmed close to the body and the piles peeled soon after cutting. The piles shall have a uniform taper such that a line drawn from the center of the top to the center of the tip shall be within the body of the pile. No piles shall be driven without the acceptance of the Engineer.

2. Creosoting

Creosoting of piles shall be by the Pressure Process and in accordance with the Philippine Standard Association, Inc. Standard Specification for preservation of Timber Piles by pressure Process, (PHILSA 168:1978).

a. Conditioning

1)	Air Seasoning	-	Seasoning to a moisture content of 35% and below
2)	Streaming Temperature	-	118 C, maximum
	Duration	-	20 hours, maximum

3) Boultonizing Temperature - 110 C, maximum
Duration - 20 hours, maximum
Vacuum - 550 mm Hg, maximum

4) Heating in Preservative - 104 C, maximum
Duration - no time limit

b. Treatment

1) Pressure - 10.5 kg/cm², minimum
14 kg/cm², maximum
Duration - 3 hours, maximum

2) Expansion Bath Temperature -104 C, maximum
Duration - as required

3) Final Steaming Temperature -118 C, maximum

c. Retention

Creosote retention shall be 320 kg/m^3

d. Sampling Zone

Sampling zone shall be 0 to 75mm from the surface of each timber pile.

e. Determination of Penetration

All boring shall be taken between the butt and tip of each pile. Penetration of creosote preservative shall be 100% of the sapwood or not less than 25mm from the surface of the pile.

All holes made for determining penetration of preservative shall be filled with tight-fitting treated plugs.

3.3.3 GENERAL REQUIREMENTS

Pile Length: Pile lengths shown on the Drawings are for estimating purpose only and are based upon probable lengths remaining in place in the completed structure.

1. Test piles of length shown on the drawings shall be driven at such points as designated by the Engineer that they may be left in place, cut off, and become a part of the permanent structure. From their performance under driving, the Engineer will determine the lengths of piles required.

This pile shall be longer than ordinary piles shown in the pile schedule to provide for contingencies due to variations in soil behavior. Pile penetration observed per blow of the hammer shall be recorded. If refusal is observed while the required penetration is not yet obtained, the Contractor shall continue driving the pile with the aid of water jets. Water jets shall be carried out in all respect with rigorous control and not to detriment the surrounding ground or any part of the Works.

If necessary, test pile/s shall be spliced and redriven until the bearing power and penetration are acceptable to the Engineer.

2. Lengths of regular piles shall be computed by the Hiley Formula or other formulas accepted by the Engineer.

   The above shall not be construed to mean that driving may stop when such penetration as shown on the plans has been secured, but that driving shall continue in every case until the total penetration obtained is satisfactory to the Engineer, regardless of the fact that sufficient bearing capacity as determined by the formula may be obtained at a lesser depth.

3.3.4 TESTING OF MATERIALS

1. Reinforced Concrete Piles and Concrete Sheet Piles

   The requirements regarding testing of concrete and reinforcement used in reinforced concrete piles and sheet piles shall be in accordance with Section 3.2, “Concrete Works”.

   However, the Engineer may conduct the necessary testing at the approved fabricator’s casting yard whenever he considers necessary. Tests shall be carried out at the Contractor’s expense.

2. Steel Pipe Piles and Steel Sheet Piles

   The Contractor shall submit to the Engineer three (3) copies of test reports by the approved steel mill certifying that the steel pipe pile or steel sheet pile meets the requirements specified in these technical specifications.

3. Timber Piles

   The Contractor shall submit to the Engineer three (3) copies of the test reports certifying the timber pile meets the specified requirements in accordance with the Standard Specifications for preservation of Timber Piles by pressure Process.

3.3.5 STORAGE AND HANDLING

1. When raising or transporting piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Pile materials damaged in handling or driving shall be removed from the site and replaced by the Contractor at his expense.

   Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

   Before delivering steel pipe piles to the construction site, they shall be inspected as to external appearances, shapes, and dimensions in accordance with ASTM A 252, Grade 2 or its equivalent.

2. Piles may be stored in open air but on wooden sleepers to be placed in a manner so as not to cause excessive bending.

3. Piles shall be stacked on a stable yard and shall not be stacked more than three (3) tiers high.

3.3.6 PILE DRIVING

1. Uncapped pile heads shall be protected against damage by the use of appropriate pile driving caps and/or cushions to centralize the driving impact.

2. The pile headers shall be of sufficient rigidity and fixity to hold the pile firmly in position and true alignment during driving operations.

3. The procedure and the data for the hammer to be used in driving shall be submitted to the Engineer prior to starting the driving operation. The Engineer's approval of the pile driving equipment will not release the Contractor from the responsibility for the adequacy of selected equipment.

   A steam or diesel pile hammer shall be used for driving reinforced concrete and tubular steel piles. For timber piles a gravity or drop hammer may be allowed.

   When steam hammers are used, the energy delivered in the pile being driven shall not be less than 5,300 ft.-lbs. The total energy developed by the hammer shall not be less than 6,000 ft.-lbs. per blow. Self-powered or diesel hammers of corresponding energy may be used in lieu of steam hammer for the particular pile/s being driven. For gravity hammers, the weight of ram shall be at least 50% of the weight of the pile being driven but should not be less than 907 kg. (2,000 lbs) for piles weighing 1,814 kg. (4,000 lbs) or less.

The fall of hammer shall not exceed 6 m (19.18 ft) and shall be of uniform frequency to avoid injury to the piles.

Piles driven shall be held firmly in position in axial alignment with the hammer by means of leads of adequate length. Approved cushions shall be provided to the pile butts.

4. Piling shall commence from the interior outward as the lateral displacement of soil may influence driving and heaving of already driven piles.

5. Every effort shall be made to drive continuously without interruption.

6. The Contractor shall repair all damages to piles during driving. A minimum cut-off allowance, not less than 600 mm shall be provided for all corrections at in-place splices and at all the pile heads for removal after completion of the driving.

   Any pile damaged by improper driving or driven out of its proper location, or driven out of elevation fixed on the plans, shall be corrected correspondingly at the Contractor's expense by any of the following methods:

   a. Withdrawal of the pile and replacement by a new pile,
   b. Driving a second pile adjacent to the defective one, or
   c. Splicing an additional length

   The method to be adopted in each case shall be at the discretion of the Engineer.

7. The piles which have been uplifted after being driven shall be re-driven to the required penetration after completing other activities in the nearby areas. As heaving is anticipated, survey benchmarks should be established and elevations must be taken of the driven piles adjoining the piles being driven to avoid pile displacement affected by the swell rise of sub-soil structures.

8. Splicing of piles if any, shall be subject to the Engineer's approval. The Contractor may propose splicing procedures.

3.3.7 OBSTRUCTION

Where boulders or other obstructions make it impossible to drive certain piles in the location shown and to the required bearing strata, the Engineer may order additional pile or piles driven at other suitable location after consultation with the Structural Engineer.

3.3.8 PILE DRIVING RECORDS

3.3.8.1 R.C. PILES

Pile driving records shall be prepared for each pile on Form No. 001 attached at the end of this Section and shall be submitted to the Engineer two (2) signed typewritten copies daily. The records shall show the number of blows per 0.75 m. penetration from the pile tip, attain a depth of 5.0 m., the penetration under the last 10 blows, and the calculated safe load according to the Hiley Formula or other formula acceptable to the Engineer.

3.3.8.2 STEEL PIPE PILES

Driven Piles

1. Pile Details (for each pile)

    a. The date, start time and finish time of driving the pile.
    b. Date of casting and concrete quality.
    c. The location number, identification number, pile dimensions and specified rake.
    d. The seabed elevation.
    e. The pile toe elevation.
    f. Elevation of soil inside the pile upon completion of each driving operation, and hence the drawdown of the soil plug.
    g. Elevation of the pile head after driving.
    h. Actual length of the pile, cut-offs and extensions.
    i. Deviation of the pile from the true location, orientation and rake.
    j. Pile penetration (before and after driving).

2. Equipment Used

    a. The make, model, type, size and efficiency of hammer and its stroke and characteristics including rated energy and operating speed.
    b. Weight of hammer and ram.
    c. Type, thickness and condition of capblock and pile cushion.
    d. Weight and dimensions of drive cap and follower.
    e. For gravity and single-acting hammers: the height of drop
    f. For double-acting hammers: the frequency of lows.

3. Driving Details

   a. The number of blows per 250 mm penetration.
   b. The final set of mm/blow for the last ten blows and the actual stroke of the hammer.
   c. The results of the Pile Driving Analyzer and CAPWAP analysis showing total resistance, friction and tip resistance, maximum pile press and effective pile length.
   d. Unusual behavior of hammer or pile during driving.
   e. Details of interruption in driving, including "set up" time.
   f. Details of redriving.

   In case a pile in-situ, then the record shall also show the length of extension, time of welding, results of non-destructive tests on the weld, date and time of restarting pile driving and details of protective coating of the weld and adjacent area.

3.3.9 PERMISSIBLE TOLERANCE

1. Position error in plan : ± 100 mm

2. Cut-off elevation : + 10 mm

3.3.10 NOT PERMITTED

Pulling the head of the pile to attain the design position shall not be permitted.

3.3.11 MEASUREMENT AND PAYMENT

3.3.11.1 R.C. SHEET PILING

1. The quantity of precast R.C. sheet piles wall to be paid for shall be measured by the linear meter or a fraction thereof-cast in accord with the contract and as ordered, specified and accepted by the Engineer.

2. Driving of R.C. sheet piles which consist of regular and corner RC sheet piles including grouting of gap between piles, to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work, excluding pile length cut from driven piles to adjust to the cut-off elevations and as required and shown in the drawing.

3. In case of sheet piles not driven to full length due to unforeseen obstruction, the Contractor shall be compensated for the whole cost of driving the full length of piles without additional cost for the cutting of pile to meet the desired cut-off elevation.

4. Accessories

   a. Supply and installation of structure steel walings shall be measured by weight in kilograms of waling materials supplied and installed. The unit price shall include loading, transportation, unloading, storage, cutting connection, fabrication at the site, and installation of waling. The unit price shall also include bolts, nuts, and other fittings as shown on the drawings.

   b. Supply and installation of tie rods shall be measured per sets of each dimension of tie rods. The unit price shall include loading, transportation, unloading, fabrication, storage at the site, and installation of tie rods. The unit price shall also include fittings and joints as shown on the drawings. Temporary support of suspended tie rod shall be incidental to the work and shall not be measured separately.

5. Measurement and payment for concrete work for concrete coping and concrete anchor block shall be in accordance with Section 3.2, Concrete Works.

3.3.11.2 PRESTRESSED CONCRETE PILES AND PRECAST REINFORCED CONCRETE PILINGS WORKS

1. The quantity of Prestressed Concrete Piles and Precast R.C. piles, to be paid for shall be measured by the linear meter or a fraction thereof as ordered cast in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of Prestressed concrete piles and Precast R.C. piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. Chip-off/cut-off elevation: The quantity to be paid shall be the actual number per unit of driven piles chipped-off and cut-off to the desired elevation as shown on the drawings and approved by the Engineer. Payment shall include the cost of disposal, labor, tools, equipment and other incidental expenses necessary to complete the work.)

4. If splicing is necessary, cost of splicing shall not be paid separately but included under pay-item for driving of piles.

3.3.11.3 STEEL PIPE PILES AND STEEL SHEET PILES

1. The quantity of steel pipe piles and Steel sheet piles, to be paid for shall be measured by the linear meters or a fraction thereof as ordered in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of steel pipe piles and Steel sheet piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. There will not be any particular payment for cutting of steel pipe piles and steel sheet piles to adjust to desired cut-off elevation.

4. The cost is included in the driving price as specified above.

5. If splicing is necessary, cost of splicing shall not be paid separately but included under pay-item for driving of piles.

6. All concrete and reinforcement works shall not be paid separately but shall be included under concrete works of structures where concrete filled steel pipe piles shall be installed. No additional payment shall be made for any incidental works that may arise to comply with the requirements specified under Sub-section 3.3.2.4.2 since such expenses incurred shall be included under above-mentioned pay-item for concrete works.

3.3.11.4 TIMBER PILES

1. Timber piles shall be measured and paid for in lineal meter of materials shall be measured by the linear meters or a fraction thereof as ordered in accordance with the Contract and as specified and accepted by the Engineer.

2. Driving of steel pipe piles and Steel sheet piles to be paid for shall be measured by the linear meter or a fraction thereof placed in accord with the Contract and accepted in completed work up to desired cut-off elevation as shown on the drawings.

3. There will not be any particular payment for cutting of steel pipe piles and steel sheet piles to adjust to desired cut-off elevation.

4. The cost is included in the driving price as specified above and as shown on the Drawings and supplied and delivered on site.

3.3.11.5 TEST PILES

The supply and driving of test piles shall be measured per pile tested at the site and accepted by the engineer. Payment for test piles will be made at the contract unit price by the number of each test pile actually placed and accepted in the final position. The unit price will be full compensation for furnishing all materials, labor, tools, test, and other incidental expenses necessary to complete the work.

PILE RECORD

Sheet No. _____
Date _____

Ref. Elev. _____

Form No. 001 Job No. _____ Plant _____ Water Depth _____

HAMMER DATA PILE DATA

	Pile No.	Butt Dia	Tip Dia	Length	Ground Elev.	Cutoff Elev.	Final Tip Elev.

Make _____
Model _____
Energy _____
Blows/Min _____

DRIVING RECORD

Tip Elevation (m)	Depth of Penetration (m)	Total Blows	Blows per 30 cm	Length of Stroke (m)	Remarks

Note: Indicate by number in remarks column, thus 1, 2, etc. any important information e.g. jetting, delays, breakage, out of plumb, obstruction, etc.

Contractor : _____

3.4 CAUSEWAY

3.4.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.4.1.1 SCOPE OF WORK

This Specification covers the construction of the causeways for the Project. The works to be carried out shall be, but not limited to the following:

1. Supply and laying of core rocks
2. Supply and laying of secondary rock - one (1) or two (2) layers
3. Supply and laying of armour rock - one (1) or two (2) layers
4. Supply and laying of quarry run filler to fill the voids of top core rocks.
5. Placement of concrete curb
6. Construction of concrete pavement
7. Toe Protection

3.4.1.2 SETTING OUT WORKS

1. Topographic/Hydrographic Survey:

   Prior to commencement of the work, the Contractor shall conduct a topographic/hydrographic survey in conjunction with the Engineer's instructions. This survey shall form the basis for future quantity measurements.

2. The Contractor shall set out works and be solely responsible for accuracy of such setting out.

   Prior to placement of any material, the Contractor shall establish construction markers to clearly define the horizontal and vertical limits of works.

3. Applicable requirements under Section 2.3 shall apply to this Section.

3.4.2 MATERIAL REQUIREMENTS

1. Concrete work and reinforcement work (where required) for curbs shall be in accordance with Section 3.2, "Concrete Works", where concrete compressive strength (fc') = [25] MPa.

2. Concrete works for payment shall be in accordance with Division 5.0, "Roads and Pavements."

3. All rocks to be used shall be angular, hard, durable and not likely to disintegrate in seawater. Rock layers to be installed should more or less be 'global in shape", "angular in surface" and should avoid "river run rocks". Rocks that are sub-angular may be subject to the approval of the Engineer. Rounded or well rounded pieces will not be accepted.

4. All rocks shall have a minimum unit weight of 2,650 kg per cubic meter (specific gravity 2.65) of solid materials when measured dry.

5. Rocks with specific gravity higher than the above specified is preferable and will readily be accepted. But no adjustment (increase) in the contract price will be made on this account.

6. Rocks of the primary cover layer should be sound, durable and hard. It should b free from laminations, weak cleavages, and undesirable weathering, and should be of such character that it will not disintegrate from the action of the air, seawater, or in handling and placing. All stone should be angular quarry stone.

7. The greatest dimensions individual rock unit should be no greater than three times the least dimensions.

8. All rocks should conform to the following test designations: Apparent specific gravity, ASTM C-127 and abrasion, ASTM C-131.

9. Weight of the individual pieces of rock.

    a. Armour Rock

        Refer to the Drawings for the required sizes of the armour rocks for the 1st and 2nd layers.

    b. Core Rock

        Refer to the Drawings for the required sizes of the core rock.

        Core rock bedding shall be reasonably well graded in weight between the minimum and maximum sizes.

c. Quarry run filler shall consists of pieces of varied sizes of small rocks from quarry (minimum of 10% of the weight of core rocks) to fill the voids of top rocks prior to the placing of subbase course.

3.4.3 EXECUTION

1. Construction method of concrete pavement shall be in accordance with Division 5.0 "Roads and Pavements".

2. The core rock shall be placed at convenient height and width for each delivery of materials.

3. Armour rocks shall cover the sides and berm of the causeway.

4. Armour rock fillers shall not be less than one half (1/2) of the weight of the armour rock.

5. Armour rocks shall be placed with the longitudinal section perpendicular to the slope and longitudinal section of the causeway.

6. No cutting, spalling or coursing of the stones shall be allowed, but it is expected that the work shall be done in a workmanlike and skilled manner, which implies careful selection of stones.

7. The armour rock fillers shall be wedged firmly in between the facing of armour rocks so that the latter shall be in the stable position.

8. Armour rocks shall be placed individually by crane equipped with suitable bucket or by other means acceptable to the Engineer.

9. Secondary rocks of specified sizes and weights could be dumped along the size slopes of the structure after the core rock has been placed up to required elevation as shown on the Drawings. Utilizing a crane, the materials can be placed individually maintaining the alignment along the side slopes.

10. The rock causeway can be constructed by any method acceptable to the Engineer. Prior to the start of work, the Contractor shall submit to the Engineer for approval his method and sequence of construction. The Engineer approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the work.

11. Quarry run fillers shall be wedged firmly in between the facing of top core rocks at minimum depth of 300 mm below the neat line and elevation so that the latter shall be in stable position.

12. Permissible Tolerance

    a. Core Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.30 m

    b. Armour Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.20 m

3.4.4 QUARRY SITE AND ROCK QUANTITY

Refer to Section 3.5 of these Specifications.

3.4.5 MEASUREMENT AND PAYMENT

1. Quantities of core rocks, secondary rocks and armour rocks to be paid for shall each be measured in cubic meters. The volume to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10-meter intervals or closer, if necessary, immediately before placing the rock. The volume of the different classes of rocks shall then be computed based on the neat lines and elevations shown on the Drawings and on the foregoing data, with probable settlement as shown in the Drawings.

   Quarry run fillers shall not be measured separately as the payment for quarry run fillers shall be included under pay-item for top rocks.

2. Unless otherwise directed by the Engineer, measurement for settlement shall be done by providing a 28mm diameter x 6.0m round bar calibrated rod attached or welded to the center of a one (1) m x one (1) m steel plate at 6mm thick. Measurement device shall be installed at 20.0m interval prior to laying of 1st stage rock.

3. Measurement and payment for concrete and reinforcement works for the construction of R.C. Curb shall be in accordance with Section 3.2, "Concrete Works."

3.5 REVETMENT

3.5.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this Section, whether herein referred to or not.

3.5.1.1 SCOPE OF WORK

This Specification covers the construction of all revetments for the Project. The works to be carried out shall be, but not limited to the following:

1. Supply and laying of erosion protection mat (filter fabric) as shown in the drawings. Refer to Section 3.8 “Reclamation” of these Specifications.

2. Supply and laying of core rocks as shown in the drawings.

3. Supply and laying of secondary rocks as shown in the drawings.

4. Supply and laying of armour rock as shown in the drawings.

5. Casting of reinforced concrete curbs as shown in the drawings.

3.5.1.2 SURVEY AND SETTING OUT

1. Topographic/Hydrographic Surveys: Prior to commencement of the Work the Contractor shall conduct a topographic/hydrographic survey in conjunction with the Engineer instructions. This survey shall form the basis for future quantity measurements.

2. The Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal limits of Works.

3.5.2 MATERIAL REQUIREMENTS

1. Type of Revetment (as shown in the drawings).

2. Concrete curb shall be fabricated in accordance with Section 3.2 - Concrete Works. Use fc' = [25] MPa.

3. The weight of individual pieces may exceed the maximum specified in the drawings by up to 25 percent.

4. Rock works shall be in accordance with Section 3.4, “Causeway.”

3.5.3 EXECUTION

1. Revetments may be constructed by any method acceptable to the Engineer. Prior to start of work, the Contractor shall submit his method and sequence of construction for approval to the Engineer. The Engineer's approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the Work.

2. Core rocks shall be placed as uniformly as possible by controlled dumping or by other means acceptable to the Engineer.

3. Armour rocks and secondary rocks where required or as indicated in the Drawings shall be placed individually by a crane equipped with a suitable bucket or by other means acceptable to the Engineer.

4. Permissible Tolerance

   a. Core Rock:

      Alignment : plus or minus 0.30 m
      Elevation : plus 0.20 m

   b. Armour Rock:

      Alignment : plus or minus 0.30 m
      Elevation : plus 0.20 m

   c. Reinforced Concrete Curb

      Alignment : plus or minus 0.05 m
      Elevation : plus 0.05 m

3.5.4 QUARRY SITE AND ROCK QUANTITY

1. It is the Contractor's responsibility to make necessary surveys / investigations on quarry sites applicable to the Works, taking into consideration the nature of the rock works required under the Contract such as required quality, total quantity and daily required quantity, transportation method and route etc.,

2. The Contractor shall submit data on characteristics of proposed quarry sites together with the location of sites, test results of their products and samples for the approval of the Engineer.

3. When the Contractor intends to operate a quarry for the Works, the Contractor shall take all the responsibilities in connection with its operation including, but not limited to, obtaining all necessary permits and approvals, payment of safety measures or like (if any), provisions and maintenance of safety measures and temporary access roads, all of private and public roads and temporary jetties to be used to transport quarried materials and the compliance with all regulations etc. required by the authorities having jurisdiction over any part of the operation.

   Should any explosive be used in the quarry operations, the Contractor shall be responsible to meet laws and regulations, wherever applicable, established by the Local Government and Central Government Department concerned.

4. Despite the Engineer's previous approval of the natural rock and borrow pits, the Engineer reserves the right to suspend any operation in connection with the rock, if, in its opinion, such rock is not suitable for the work. In such case, the Contractor shall comply with the Engineer's instructions.

3.5.5 MEASUREMENT AND PAYMENT

1. Quantities of core rock, rubble, secondary rock, armour rock and rock fragments to be paid for shall each be measured in cubic meters. The volumes to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10 meter intervals or closer, if necessary, immediately before placing the rock. The volumes of the different classes of rock shall then be computed based on the neat lines and elevations shown on the drawings and on the foregoing data, with probable settlement as shown in the drawings.

2. Unless otherwise directed by the Engineer, measurement for settlement shall be done by providing a 28mm diameter x 6.0m round bar calibrated rod attached or welded to the center of a one (1) x one (1) m steel plate at 6mm thick. Measuring device shall be installed at 20.0m interval prior to laying of 1st stage rock.

3. Concrete works for reinforced concrete curb shall be measured and paid for by the length in linear meters of each type of curb along its front face at the finished grade elevation. Reinforcing steel bars for R.C. curb shall be measured in accordance with Section 3.2, “Concrete Works”.

3.6 DREDGING

3.6.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" shall apply to this Section whether herein specified or not.

3.6.1.1 SCOPE OF WORK

Dredging of the sea bed where required (where shown on the drawings).

3.6.1.2 GENERAL REQUIREMENTS

1. If dredged materials are to be used for reclamation, separate payment will not be made for dredging. These costs shall be considered as incidental to and part of the reclamation works.

2. A marine survey of the dredged area inside the port shall be carried out by the Contractor and monitored by the Engineer after dredging stages are completed. In the event the survey reveals that any finished area was under-dredged, the Contractor shall complete that portion of the dredging.

    a. Upon assumed completion of all the dredging operations inside the project area, the Contractor shall sweep the dredged areas within the limits stated in the specification to ensure that no shoals higher than the specified depth exist. The Contractor shall remove all shoals so discovered.

    b. The Contractor shall be responsible during the Work for all horizontal layouts and vertical profiling of the dredging work inside the port.

3.6.2 CHARACTERISTICS OF MATERIALS

Information regarding the characteristics of soils which may be encountered in the performance of this Contract is shown in the Tender Drawings for review.

3.6.3 INTERFERENCE WITH NAVIGATION

1. The Contractor shall familiarize himself with vessel movement and fishery activities in the area affected by dredging operations. The work shall be in a manner that will not impede navigation including movement of vessels at adjacent wharves or interfere with fishing operations.

2. The Contractor shall coordinate dredging works with Harbor Authorities, port users and other Contractors.

3.6.4 NATURE OF MATERIALS TO BE DREDGED

1. Refer to borehole logs as indicated in the drawings for characteristics of material to be dredged at each location. The data is made available for information only and the Engineer does not warrant its accuracy at any location other than the referenced borehole.

2. After examination, determine properties of materials to be dredged, the most suitable method and equipment to be employed including disposal of dredged spoil.

3.6.5 ASSISTANCE TO THE ENGINEER

On request of the Engineer, furnish use of such boats, equipment, labor and materials forming ordinary and usual part of dredging plant as may be reasonably necessary to inspect and supervise work.

3.6.6 EXECUTION

1. Dredging shall consist of all underwater excavation/removal of all materials.

2. The equipment to be used in dredging and filling operations is subject to approval by the Engineer.

3. Dredging shall be carried out only in the locations and in the order as approved by the Engineer, and only within limits shown on the drawings or as shown on drawings prepared by the Contractor and approved by the Engineer.

4. Approved dredged materials is to be deposited in areas allocated for port developments whereas dredged material, unsuitable for fill, shall be deposited in areas approved by the Engineer.

5. The dredging and the disposal of the dredged material including placing and operation of equipment and conveying pipes, and transportation of dredged material to disposal sites shall be done without interference with port operations.

6. Stones which may be encountered in the materials to be dredged, and having a smallest dimension of at least 300 mm may be buried in the seabed. No part of buried stones must extend above a level 500 mm below the dredging levels indicated. Stones smaller than those mentioned above may be left on the seabed of partly embedded provided that the stones are below the dredging levels indicated.

3.6.7 PREPARATION

1. The Contractor shall mark floating equipment with lights in accordance with International Regulations for Prevention of Collision at Sea and maintain a radio watch on board.

2. The Contractor shall place and maintain buoys, markers and lights required to define work and disposal areas.

3. The Contractor shall layout work from baseline established by the Engineer. He shall be responsible for accuracy of work relative to established baseline and shall provide and maintain equipment as normally required for accurate dredging control.

4. The Contractor shall establish and maintain tide gauges in order that proper depth of dredging can be determined. Locate gauges so as to be clearly visible.

5. The Contractor shall establish and maintain on-land targets for location and definition of designated dredge area limits. Targets to be suitable for control of dredging operations and locating soundings. Remove targets on completion of work.

3.6.8 DREDGING OF SLOPES FOR DYKES

1. Details on temporary slopes, dredged for the execution of Dykes, to be provided by the Contractor and shall be included in their construction method.

2. The work shall be measured and approved by the Engineer before any sand or stone material is placed unless directed otherwise by the Engineer.

3.6.9 DREDGING OF BASINS AND APPROACH CHANNEL

1. The lines shown on drawings indicate the boundaries of the dredging. Carry out dredging to a depth equal to or below the specified level, with a maximum permissible over-dredging of 400 mm below the specified level.

2. Cut side slopes between original seabed and dredged levels as shown on the drawings unless otherwise authorized in writing by the Engineer.

3. The Engineer shall verify that the dredging has been carried out as required. In general, the dredged depths shall be checked by Echo-Sounder recording. The survey pattern and method, and the Echo-Sounder type shall be approved by the Engineer. In areas where additional precision is required, the verification shall be carried out by

suspending a 6 to 10m long straight edge from a vessel, so that the underside of the straight edge is horizontal and level with the indicated dredging level. A sounding rod shall be connected to each end of the straight edge and shall extend vertically above the water surfaces in order to determine the vertical movements of the straight edge.

4. The vessel shall be moved slowly across the area in a manner which will ensure that the total area is covered by the straight edge. Areas where the straight edge cannot pass freely shall be marked and dredged and the check shall be repeated.

5. In case of excessive overdredging the Contractor shall backfill the overdredged areas and/or take all necessary measures as directed by the Engineer without cost to the Engineer.

3.6.10 DREDGING IN FRONT OF WATERFRONT STRUCTURE

1. In addition to the requirements of Sub-section 3.6.9, the following shall apply for dredging carried out in front of waterfront structure.

2. The maximum permissible overdredging is 200 mm.

3. Dredging may proceed unrestricted in accordance with Section 3.6.9 and provided that in the opinion of the Engineer, a stable, temporary slope to the edge of the strip is maintained.

4. The Contractor shall be fully responsible for the safety of the permanent structures in the temporary phases of construction. Temporary and permanent bench marks and reference points shall be established as directed by the Engineer for recording immediate and future movements of waterfront structures.

5. In case of excessive overdredging, the Contractor shall on his account backfill the overdredged areas and/or take all necessary measures as directed by the Engineer.

3.6.11 SPOILS FROM DREDGING

1. All dredged material, which in the opinion of the Engineer is unsuitable for fill, shall be dumped at the spoil area indicated on the drawings or into the open sea of depth of at least 20 m MLLW and at least 500m away from the project site.

2. Deposit dredged material suitable for fill in accordance with Sub-Section 3.8, "Reclamation."

3. All dredged material, which in the opinion of the Engineer, is suitable for fill but is in excess of the quantities required for the present project shall be deposited as directed by the Engineer.

3.6.12 ARTICLES OF VALUE

Disposal of all articles of value discovered on the site of the works shall be in accordance with appropriate provision of Conditions of Contract.

3.6.13 WRECKS

Should any wreck or obstruction be found, other than that caused by the Contractor, the Contractor is to comply with such instructions as the Engineer may issue regarding its removal.

3.6.14 MEASUREMENT AND PAYMENT

1. Before dredging in any location and in accordance with the approved schedule, the Contractor shall perform a new sounding survey over the area to be dredged and its adjoining areas in accordance with Division 1, "General Requirements."

2. On completion of dredging in any location, perform a sounding survey in accordance with General Requirements to verify compliance with Contract and as a basis for measurement of dredging quantities.

3. Do not disturb or displace rip-rap or armour protection during dredging. Reset or replace any disturb or displaced materials without additional compensation or time extension.

4. Only materials excavated above dredged line and within side slope specified or indicated in the drawings or authorized in writing by the Engineer will be measured for payment.

5. Dredging will be measured in cubic meters, in place measurement determined from approved soundings - taken before and after dredging.

6. Dredged volumes by section of work shall be considered for inspection and acceptance.

7. Supply all equipment and assistance needed for inspection and measurement by the Engineer. Cost of such assistance is incidental to dredging work and shall not be measured for payment.

8. Disposal is incidental to dredging work and will not be measured for payment.

9. No additional cost shall be charged to the Engineer where excavation of corals, bedrocks or hard materials has been encountered by the Contractor.

3.7 SAND REPLACEMENT

3.7.1 GENERAL

Works under these Contract shall be in accordance with Division I, "General Requirements" and shall apply to this Section, whether herein referred to or not.

3.7.1.1 APPLICATION

This section shall apply to the sand replacement work to be carried out under the Contract.

3.7.1.2 GENERAL PROVISION

1. The area, formation levels and slopes of the volume to be replaced shall be as indicated on the drawings. The Contractor shall replace existing marine soft clay with the specified materials, in other words backfilling of specified material into the empty space left after dredging operation or underwater excavation.

2. The provision of Sub-section 3.5.4, "Quarry Site and Rock Quantity" shall also apply to this Section.

3.7.2 MATERIAL REQUIREMENTS

Sand shall be well graded and with less than 20% of its weight or particles classified finer than sand. The sample and its sieving result shall be submitted to the Engineer for approval prior to commencement of the laying works.

Notwithstanding any or all of the requirements of these Specifications, the Engineer shall reject any sand which he considers to be unsuitable and the Contract shall remove such rejected sand from the Site and replaced it with an approved quality at no cost to the Employer.

3.7.3 BACKFILLING WORKS

1. The work methodology and sequence of replacement works shall be submitted to the Engineer for approval prior to the commencement of work.

2. The dredging depths and slope for the work shall be undertaken as shown on the drawings, prior to the commencement of backfilling.

3. No dredged slope and bottom shall be exposed longer than seven (7) calendar days before backfilling with the replacement material takes place.

4. Interim slope of fill shall not be greater than the slope indicated on the drawings to ensure stability of bottom layer against slope failure.

3.7.4 SURVEY WORKS

Prior to sand replacement, the Contractor shall perform a sounding survey over the area to be filled to provide a basis for measurement of fills. Sounding work shall be done in conjunction with and to the approval of the Engineer, in accordance with Section 2.3 of these specifications.

On completion of underwater fill in any one section, the Contractor shall perform a sounding survey over the filled area to verify that the fills have been placed to the section shown on the drawings.

Sand replacement shall be inspected and measured by the Engineer as the work proceeds. The Contractor shall attend such inspection and measurement operations and make records as he requires.

The Contractor shall supply all equipment and assistance needed for inspection and measurement and shall plot results on drawings for approval, as required by the Engineer.

Work covered before inspection and approval of drawings shall not be eligible for payment until satisfactory re-execution in accordance with this Section.

3.7.5 MEASUREMENT AND PAYMENT

Measurement and payment shall be made in cubic meters of material in-placed to the neat lines and elevations. Material outside the neat lines and elevations will not be measured for payment.

Unit Price shall constitute full payment for all labor, material and equipment and all incidental works necessary to complete the work.

3.8 RECLAMATION AND FILL

3.8.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this Section, whether or not referred to herein.

3.8.1.1 SCOPE OF WORK

The area to be reclaimed shall be as indicated on the Drawings.

The work includes furnishing of all labor, materials and equipment required to complete/finish the reclamation and filling the area in accordance with the Drawings and the Specifications.

The following major items of work are included:

1. Supply and fill of suitable materials to places required to form the land reclamation areas as shown in the drawings.

    a. Compaction of fill materials.

    b. Supply and placing of filter fabric.

2. The work may also include the construction of temporary dike or structure to enclose the reclamation material before the completion of a permanent waterfront bulkhead.

3. Soil Consolidation (if Necessary)

    The work shall include the soil consolidation by the use of prefabricated vertical drain to be carried out under this Contract.

The Contractor shall include in his unit prices allowances to cover all risks for any contingencies, except noted otherwise, that may arise during the execution of the works.

3.8.1.2 GENERAL REQUIREMENTS

The Contractor shall not commence filling any area until that area has been surveyed by the Contractor and the survey results are accepted by the Engineer.

The Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of such setting out the Contractor shall establish visible construction markers to clearly define horizontal limits of Works.

The Contractor shall keep all pavements and areas adjacent to and leading to/from the Site, clean and free from mud, dirt and debris.

The Contractor shall not interfere with shipping and navigation or other traffic during execution of the Works.

3.8.2 MATERIAL REQUIREMENTS

1. Filling Materials

   a. General

      All sources of filling materials shall be approved by the Engineer.

      Appropriate quantities of sample of all materials to be used in the Works shall be submitted for acceptance and approval by the Engineer thirty (30) days before the commencement of work.

      General filling shall consist of approved material from approved sources of suitable grading obtained from excavation, quarries or borrow pits, without excess fines, clay or silt, free from vegetation and organic matter.

      Sample of approved materials shall be kept/stored in the field for ready reference/comparison of the delivered materials.

      The Contractor shall insure that adequate quantities of required materials that comply with the specifications and quality approved by the engineer are available at all times.

   b. Fill Materials other than Dredged Materials

      Fill materials for reclamation purposes other than dredged materials shall be pit sand, quarry run, gravel or mine tailings. The fill material shall be of the same quality or better, as approved by the Engineer and called for in dredged material specification.

   c. Dredged Materials

      Hydraulic fill shall be well-graded gravel.

   d. Types of Filling Materials

      1) Selected Fill Materials

         The material shall not have high organic content and shall meet the following requirements:

(i) Not more than 10 percent by weight shall pass the No. 200 sieve (75 microns).
(ii) Maximum particles size shall not exceed 75 mm.
(iii) The fill materials shall be capable of being compacted in the manner and to the density of not less than 95%.
(iv) The material shall have a plasticity index of not more than 6 as determined by AASHTO T 90.

2) Sand and Gravel Fill:

The materials shall be composed of 50% sand and 50% gravel and shall be free from rocks, wood, scrap, vegetables, and refuse. The materials shall not have organic content and the maximum particle size shall not exceed 100mmm. Source of materials shall be river or mountain quarry.

2. Soil Consolidation: Prefabricated Vertical Drain

The Prefabricated Vertical Drain (PVD) shall be of newly manufactured materials and shall consist of a high density polyethylene core with a cuspated profile (to ensure high strength and drainage) enclosed in a non-woven spunbonded polypropylene or polyester fabric filter jacket. The jacket shall allow free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage.

The PVD shall be band-shaped with an aspect ratio (width divided by thickness) exceeding 50.

Refer to the table below for the required properties of the preferred product specifications:

Properties	*Unit*	*Test Method*	*FD5*
Core			
Structure	-	-	Cuspated Profile
Material	-	-	HDPE
Compressive Strength	kPa	ASTM D 1621	> 450
Drain			
Weight	g/m	-	70
Width	mm	-	100
Thickness	mm	-	5
Discharge Capacity, qw			
@ i = 1, 10 kPa	m^3/s	ASTM D 4716	90 x 10 –6
@ i = 1, 350 kPa	m^3/s	ASTM D 4716	60 x 10 –6
Tensile strength	kN/100mm	ASTM D 4595	2.2
Elongation at 1 kN	%	ASTM D 4595	< 10
Filter			
Structure	-	-	Non woven
Material	-	-	Spunbond
Tensile Strength	kN/m	ASTM D 4595	Polyester
Permeability	m/s	ASTM D 4595	5.5
Permittivity	s-1	ASTM D 4491	1.0 x 10 -4
Apparent Opening Size	microns	ASTM D 4751	0.5
			< 75
Packing Details			
Roll Length	m	-	200
Roll Diameter	m	-	1.2 ± 5%
20ft container	m	-	40,800
40ft container	m	-	86,800

3.8.3 EXECUTION

1. Reclamation and Fill

    a. General: The Contractor shall be responsible for all ancillary earthworks that are necessary for the reception of the fill material and including, all spout handling, temporary dike or shoring construction where necessary, temporary protection to dikes in the sea and drainage of excess water.

The arrangements of these ancillary earthworks shall be laid out in consultation with the Engineer and to the Engineer's satisfaction and care shall be taken to minimize the loss of fill.

b. Replacement, backfilling and reclamation may be done by any method acceptable to the Engineer. Prior to start of Work, the Contractor shall submit his method and sequence of performing the works to the Engineer for approval. However, the Engineer's approval of the method and sequence of construction shall not release the Contractor from the responsibility for the adequacy of labor and equipment.

c. The Engineer shall approve the type of material to be used as fill prior to its placement. If the material is rejected, such material shall be deposited into areas designated or as directed by the Engineer.

d. When suction dredges are used, discharge pipework shall be arranged in conjunction with the Engineer's instructions and shall be such that by means of operating valves, material can be deposited to several places without altering the pipework or interrupting dredging. Where necessary vehicle overpasses shall be constructed by the Contractor.

e. Reclamation of fill material shall be placed in horizontal layers not exceeding 200mm (8 inches), loose measurement, and shall be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Removal of water shall be accomplished through aeration by plowing, blading, dicing, or other methods satisfactory to the Engineer.

Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 600 mm in diameter will be permitted provided that when placed, they do not exceed 1200mm (48 inches) in height and provided they are carefully distributed, with the interstices filled with finer material to form a dense and compact mass.

Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. Lifts of material containing more than 25 mass percent of rock larger than 150mm in greatest dimension shall not be constructed above an elevation 300mm (12 inches) below the finished subgrade. The balance of the reclamation work shall be

composed of suitable material smoothed and placed in layers not exceeding 200mm (8 inches) in loose thickness and compacted as specified for embankments.

Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until the necessary compaction is compacted.

Hauling and leveling equipment shall be so routed and distributed over each layer of the fill in such a manner as to make use of compaction effort afforded thereby and to minimize rutting and uneven compaction.

f. Field Compaction Test

Field Density tests to determine the percent of compaction of the material shall be conducted at elevation + 1.60 from MLLW. Compaction of each layer thereafter shall continue until a field density of at least 98 percent of the maximum dry density in accordance with AASHTO T/180. Method D has been achieved. In place density determination shall be made in accordance with AASHTO T191.

g. Permissible Tolerance

Elevation: plus 5 cm

2. Soil Consolidation

a. General

Prefabricated Vertical Drains (PVD) are artificially created drainage paths which can be installed by one of several methods and which can have a variety of physical characteristics. A PVD can be defined as any prefabricated material or product having the following characteristics:

1) ability to be installed vertically into compressible subsurface soil strata under field conditions,

2) ability to permit pore water in the soil to seep into the drain, and

3) a means by which the collected pore water can be transmitted up and down the length of the drain.

For a particular project, the performance of the PVD will be influenced by the soil conditions, type of PVD, equipment and construction technique (i.e. contractor). The installation of PVD shall be carried out by the Specialist contractor.

b. Installation of Pre-fabricated Drain

1) Installation Equipment

a) Prefabricated Vertical Drains (PVD) shall be installed with approved modern equipment of a type which will cause minimum disturbances to the subsoil during the installation operation and maintain the mandrel in a vertical position.

b) PVD shall be installed using a mandrel or sleeve which shall be inserted (i.e. pushed or vibrated) into the soil. The mandrel or sleeve shall protect the drain material from tears cuts and abrasion during installation and shall be retracted after each drain is installed.

c) To minimize disturbance of the subsoil, the mandrel or sleeve shall have a maximum cross-sectional area of approximately 65 cm^2 the mandrel or sleeve shall be sufficiently stiff to prevent wobble or deflection during installation.

d) The mandrel or sleeve shall be provided with an anchor plate or similar arrangement at the bottom to prevent the soil from entering the bottom of the mandrel during the installation of the PVD and to anchor the drain tip at the required depth at the time of mandrel withdrawal. The dimensions of the anchor plate shall conform as closely as possible to the dimensions of the mandrel so as to minimize soil disturbance. The Engineer shall determine the acceptability of the anchorage system and procedure.

e) The mandrel or sleeve shall have visible external markings at maximum one (1) meter increments to enable measurement of penetration depth of PVD.

2) Installation Procedures

a) Prior to the commencement of the PVD installation, the Specialist Contractor shall submit full details on the materials equipment, sequence and method proposed for PVD installation to the Engineer for review and approval.

b) Approval by the Engineer of installation sequence and methods shall not relieve the Specialists contractor of its responsibility to install drains in accordance with the plans and specifications.

c) Prior to the installation of PVD, the Specialist Contractor shall demonstrate that its equipment, methods and materials produce a satisfactory installation in accordance with these specifications. The Specialist Contractor may be given instruction by the Engineer to carry out trial installation of PVD at designated locations.

d) PVD shall be clearly located, numbered and staked-out by the Specialist Contractor using a baseline and benchmark provided by the Engineer. The Specialist Contractor shall take all reasonable precautions to preserve the stakes and is responsible for any necessary re-staking. The as-built location of the PVD shall not vary by more than 250mm from the plan location designated on the drawings.

e) PVD shall be installed from the working platform to the depth shown on the drawings, or to such as directed by the Engineer. The Engineer may vary the depths, spacing or the number of drains to be installed and may revise the plan limits for this work as necessary.

f) Equipment for installing PVD shall be plumbed prior to installing such drain.

g) PVD shall be installed during a continuous push using static weight or vibration.

h) The installation shall be performed without any damage to the PVD during advancement or retraction of the mandrel. In no case will alternate raising or lowering of the mandrel during advancement be permitted. Raising of the mandrel will only be permitted after completion of a drain installation.

i) The completed PVD shall be cut off neatly 150mm above the working platform or as otherwise specified on the contract drawings.

j) Shown below is the detailed rig specifications

Base Machine	Crawler Crane (min. 50 metric ton)
Penetration Force	9 ton
Extraction Force	9 ton
Driving System	Mechanical System
Mandrel	120mm x 60mm x 10mm (thk)
Total Weight	43.5 ton
Maximum Depth	35.0 m
Height of PVD Rig	Approximately30m
PVD Productivity	4,000 m/day/rig

3) Splicing

a) Splicing of PVD material shall be done by stapling a workmanlike manner and so as to ensure structural and hydraulic continuity of the drain.

b) b) A maximum of one (1) splice per drain installed will be permitted without specific permission from the Engineer.

c) c) The jacket and core shall be overlapped a minimum of 150mm at any splice.

4) Obstruction

a) Where obstruction is encountered below the working platform which cannot be penetrated by the PVD installation equipment, the Specialist Contractor shall complete the drain from the elevation of the working platform to the obstruction and notify the Engineer. At the direction of the Engineer and under his review, the Specialist Contractor shall attempt to install a new drain within 500mm horizontally from the obstructed drain. A maximum of two attempts shall be made as directed by the Engineer. If the drain still cannot be installed to the design tip elevation, the drain location shall be abandoned and the installation equipment shall be moved to the next location, or other action shall be taken as directed by the Engineer.

b) If directed by the Engineer, the Specialist Contractor may use auguring, spudding, pre-boring or other methods to penetrate through the obstruction. The cost incurred by the Specialist Contractor to penetrate through the obstruction shall be compensated based on the contract unit price per linear meter.

5) Site Records

The Specialist Contractor shall provide competent personnel to continuously supervise and observe the installation of PVD, and furnish the Daily Record sheets to the Engineer each week. The Daily Record Sheets signed by the Specialist Contractor's representative and the Engineer shall contain the following information.

a) Date of installation

b) Type of PVD

c) Location of PVD (installation point)

d) Depth of length of PVD installed at each location

e) Details of obstruction, delays and any unusual ground conditions

6) Specialist Contractor

To insure the quality of services rendered the following conditions must be met by the Specialty Contractor:

a) The Specialty Contractor must be a Filipino owned company with at least 10 years of existence.

b) The Specialty Contractor must have already installed a total of at least 7 million linear meters of PVD in past completed projects.

c) The Specialty Contractor must have proven itself capable of installing at least 3 million meters within the duration of one year.

d) The Specialty Contractor's Project Supervisor must have at least 5 years experience in PVD installation.

e) The Specialty Contractor's Project Foreman must have at least 5 years experience in PVD installation.

3.8.4 GEOTEXTILE FABRIC

3.8.4.1 SCOPE

This work covers all the following requirements regarding the installation of geotextile (filter fabric) in accordance with the lines, grades, and dimensions shown on the Drawings.

3.8.4.2 GENERAL

The geotextile fabric shall meet the following requirements in full. If required, a sample of 1.0 m^2 shall be supplied to the Engineer for approval and retention for purposes of comparative testing against materials randomly sampled from the site.

1. PHYSICAL PROPERTIES

   a. The geotextile material shall be a nonwoven needle punched type comprising of needlepunched polypropylene fibers or its equivalent. The geotextile shall be manufactured from two (2) component geotextile layers with different diameter size fibers needlepunched together to provide a homogenous sheet.

   b. The design of the component layers shall be such that one layer shall exhibit proven constriction characteristics and one layer ensures construction survivability.

   c. The geotextile material shall be UV stabilized to ensure retention of minimum 70% original tensile strength after 90 days exposure to sunlight. The manufacturer shall submit test results to support this.

   d. The geotextile must be highly resistant to long term contact with damp cementitious substances or acid or alkali solutions in the pH range 2-13. The manufacturer shall submit test data to ensure resistance of the polymer.

   e. The minimum required porosity of the geotextile shall be >80%.

   f. The geotextile filter should satisfy the Filter Criteria" of $O_{98} < D_{15,}$ where O_{98} is the effective opening size of the geotextile which corresponds to the average diameter of a sand fraction 98% of which remains on the geotextiles filter during sieving.

2. MECHANICAL AND HYDRAULIC PROPERTIES

   The geotextile supplier is required to certify that the materials delivered to site will be proven to meet or exceed the following properties:

TECHNICAL PROPERTIES	UNIT	Minimum	TEST STANDARD
A. Physical Characteristics:			
Minimum Mass (per unit area)	(g/m^2)	600	ASTM D5261 ISO 9864
Thickness	mm	2kPa 4.5	ASTM D5199 ISO 9863
B. Mechanical Properties:			
Tensile Strength	kN/m	(md/cd) 30/30	ASTM D4595 ISO 10319
Tensile elongation	%	(md/cd) 90/40	ASTM D4595 ISO 10319
CBR Puncture Resistance	N	4,500	ASTM D6241 ISO 12236
Dynamic Drop Cone	(mm)	10	EN 918
C. Hydraulic Properties:			
Effective Opening Size (O_{90} Wet Sieving) (()$_{95}$ Dry apparent Opening)	(mm) (mm)	.08 < 0.075	ISO12956 ASTM D4751
Water Permeability: Permittivity	(s^{-1})	0.85	ASTM D4491

3.8.4.3 STORAGE AND INSTALLATION

1. The geotextile shall be delivered to site with an outer wrapper to protect it from exposure to the elements.
2. Installation of the geotextile shall be in accordance with the manufacturer's instructions.
3. The Engineer reserves the right to sample geotextile delivered to site for individual quality control testing at the contractor's expense. A material not meeting the manufacturer's certified values will be rejected from the site.
4. The geotextile shall be proven to resist dynamic puncture damage when subject to impact stress from stone armor (200-400 kg) dropped from a minimum height of 2.0 m and should be laid on at least 1-foot sand and/or gravel bedding. Geotextile failing to resist puncture shall not be accepted.
5. To facilitate site Quality Assurance, each roll of geotextile delivered to site shall be clearly labeled with brand name, grade, and production batch number and this information is required to be clearly printed at regular intervals along the entire length of each roll.
6. Geotextile overlaps shall be at least 1.0 m when installed underwater and 0.35 m for installation in dry conditions unless otherwise stated on the drawings. Alternatively, geotextile overlaps are to be heat-welded or sewn using appropriate polyester, polypropylene or other synthetic

thread and portable hand sewing equipment. Joint seams shall meet or exceed 80% of the fabric's tensile strength.

3.8.5 MEASUREMENT AND PAYMENT

1. The quantities of fill to be paid for shall be the volume in cubic meters of earthwork material compacted in place, after clearing, grubbing and stripping, and as accepted by the Engineer. The probable settlement indicated in the drawings may be considered for the calculation of the quantities to be paid (subject to Contractor justifications and the Engineer's approval). Compaction test shall be performed by an authorized approved testing laboratory. Cost of test shall be incidental to reclamation and shall not be measured for payment.

2. Filter fabrics to be paid for shall be measured by the actual surface area in square meters of geotextile filter fabric supplied, set in place and finished in accordance with the Specifications and accepted by the Engineer.

   All work performed and measured as provided shall be paid for at the contract unit price per square meter for filter fabric, which price shall include furnishing of labor, equipment, tools, materials, supplies and incidentals necessary to complete work.

3.9 MULTI-PURPOSE PIER/WHARF/TRESTLE

3.9.1 GENERAL

Work under this contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.9.1.1 SCOPE OF WORK

This Section includes the furnishing of all labor, materials, equipment and all incidentals for the construction of the multi-purpose pier and all its appurtenances. The works to be carried out shall be, but not limited to the following:

1. Driving of [___] mm and [___] mm diameter steel pipe piles
2. Driving of __ m x __ m pre-cast concrete piles
3. RC and steel pipe pile caps and beams
4. Concrete apron construction
5. Installation of accessories such as mooring bollards, bitts, cleats, fenders and timber pile dolphins.

3.9.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal / vertical of works.

3.9.2 MATERIALS REQUIREMENTS

1. Submittal

    a. Certified Laboratory Test Report

        Before delivery of materials, certified copies in triplicate of the reports of all tests required herein under materials shall be submitted for approval by the Engineer.

    b. Materials Samples

        Representative samples of all materials to be used when required by the Engineer shall be submitted before the delivery of the materials. Representative samples shall be accompanied by certified laboratory test reports.

2. Materials

    a. Precast/Reinforced Concrete (RC/PC) Piles
    b. Steel Pipe Piles
    c. Concrete (fc' = [35] MPa)
    d. Accessories

        1) Mooring Bollards, Bitts and Cleats - refer to material requirements in Section 3.14
        2) Rubber Fenders - refer to material requirements in Section 3.14
        3) Timber Pile Dolphins – refer to material requirements in Section 3.14

    e. Guardrail for trestle: Reinforced concrete guardrail shall have the dimensions as specified on the drawings. Concrete and reinforcement works shall conform with the requirements of Section 3.2, "Concrete Works" with concrete compressive strength of [__] MPa [(_____ psi)] for the pre-cast horizontal beams and for the cast in place columns. Apply non-shrink grout between joints as indicated on the Drawings in the proportions recommended by the manufacturer. The Contractor shall ensure that the grout fills all voids.

3.9.3 EXECUTION

1. Piling Works

    a. All piling works shall follow specification prescribed in Section 3.3.

    b. The pile length shall be as decided and directed by the Engineer based on the results of the boring investigations and test pile driving.

    c. Test piles which may form part of the structure as directed by the Engineer shall be driven to the required depth and “refusal."

2. Replacement of Bed Materials

    The method of dumping, placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to the Engineer’s approval.

3. Concrete Works

    All concrete works shall follow specifications prescribed in Section 3.2, "Concrete Works."

4. Shop Drawings

    The Contractor will submit shop drawings and erection drawings for formwork, falsework and the reinforcing bar lists for the Engineer’s review and approval in accordance with the applicable requirements in Section 3.2, “Concrete Works,” and Section 3.3, “Piling Works.”

5. Mooring Bollards, Bitts, Cleats, Rubber Dock Fenders and Timber Pile Dolphins

    a. All materials shall be installed at the location shown on the drawings in accordance with the approved manufacturer’s instructions and shop drawings.

    b. The Contractor shall submit the detailed construction method based on the manufacturer’s recommendations for the Engineer’s approval.

    c. The installation and testing procedure for the mooring bollards, bitts, cleats, rubber dock fenders and timber pile dolphins shall follow specifications prescribed in Section 3.14, “Mooring and Fender System.”

3.9.4 MEASUREMENT AND PAYMENT

1. Refer to specific sections of this specification for the method of measurement and payment of piles, concrete works, mooring and fender systems necessary for the construction of piers/wharves/trestles and their appurtenances. The unit price shall be considered to include all materials, fabrication, installation, painting and all other incidental work.

3.10 RO-RO RAMP

3.10.1 GENERAL

Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.10.1.1 SCOPE OF WORK

This Section includes furnishing of all labor, material, equipment and all incidentals for the construction of the Ro-Ro ramp and all its appurtenances. The works to be carried out shall be, but not limited to the following:

1. Driving of [__] m x [__] m precast concrete piles
2. Concrete Works (Section 3.2)
3. Installation of accessories

3.10.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of Works.

3.10.2 MATERIAL REQUIREMENTS

1. Precast/reinforced concrete (PC/RC) Piles
2. Concrete (f'c = [__] MPa)
3. Accessories : Fenders

    a. Rubber Fenders shall be V-type or equivalent with dimensions as shown on the drawings. Refer to Section 3.14, "Mooring and Fender System" for the material requirement of rubber fenders.

    Rubber Fenders shall be installed as shown in the drawings.

3.10.3 EXECUTION

1. Piling Works

    a. All piling works shall follow specifications prescribed in Section 3.3, “Piling Works.”

    b. The pile length shall be as decided and directed by the Engineer based on the results of boring investigations and test pile driving.

    c. Test piles which may form part of the structure as directed by the Engineer shall be driven to the required depth and “refusal.”

2. Replacement of Bed Materials

    The method of dumping and placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to the Engineer’s approval.

3. Concrete Works

    All concrete works shall follow specifications prescribed in Section 3.2, "Concrete Works."

4. Rubber Dock Fenders

    a. All materials shall be installed at the location shown on the drawing in accordance with the approved manufacturer’s instructions and shop drawings.

    b. The Contractor shall submit the detailed construction method based on the manufacturer’s recommendations for the Engineer’s approval.

    c. The installation and testing procedure for the Rubber Dock Fenders shall follow specifications prescribed in Section 3.14, “Mooring and Fender System.”

3.10.4 MEASUREMENT & PAYMENT

Refer to specific sections of this specification for the measurement and payment of piles, concrete works and rubber fenders necessary for the construction of Ro-Ro ramp and its appurtenances.

3.11 STAIR LANDINGS

3.11.1 GENERAL

Work under this Contract shall be in accordance with Division 1, "General Requirements" and shall apply to this section, whether herein referred to or not.

3.11.1.1 SCOPE OF WORK

This Section includes furnishing of all labor, material, equipment and all incidentals for the construction of the stair landings and all appurtenances. The works to be carried out shall be, but not limited the following:

1. In-situ R.C. stair landings (Concrete Works-Section 3.2).

2. Casting and installation of precast concrete block, dimensions as shown on the drawings.

3. Preparation of rock bedding for the installation of precast concrete block.

4. Installation of Mooring Rings.

3.11.1.2 SURVEY AND SETTING OUT

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of works.

3.11.2 MATERIAL REQUIREMENTS

1. Applicable requirements under Section 3.2, "Concrete Works" shall apply to this Section.

2. Concrete of the stair landing and precast concrete block shall be Class B2 concrete for marine structure with a compressive strength of fc' =[25] MPa [(3,500 psi)].

3. Mooring rings shall be 16 mm ø stainless steel plain bar.

3.11.3 EXECUTION

3.11.3.1 FABRICATION

1. Fabricated pre-cast concrete blocks shall be free from bends and twists. Where bends shall exist in any section along length of the block, it shall not exceed 5 mm permissible tolerance.

2. Concrete curing shall be done by covering with wet burlap for a period of not less than 21 days.

3. The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the specification and that the Contractor obtains the Engineer's approval to each supplier.

3.11.3.2 CONSTRUCTION REQUIREMENT

1. Rock bedding where the precast concrete block will be installed, shall be placed uniformly as possible and graded acceptably to the Engineer.

2. The top of precast concrete block shall be installed at 0.00 elevation referred to M.L.L.W datum with + 0.05 m tolerance.

3. The lowest step shall be at the top of the precast concrete block.

4. The dimension of the steps shall be 30 cm tread with a 20 cm riser.

5. No precast units shall be removed from the casting beds until the concrete samples representing them reach a strength not less than that specified as the minimum concrete strength at seven days for the class of concrete concerned. Similarly no units shall be set in place until the samples representing them reach a strength not less than that specified as the minimum concrete strength at twenty eight (28) days for the class of concrete concerned. All units shall be clearly marked with a serial number and date of casting.

6. The Contractor shall submit to the Engineer's approval full details of his proposed methods of handling pre-cast concrete works.

7. In-situ and precast concrete for the stair landings shall be cast and/or placed to the following tolerances:

   1) Lengths: $\pm$ 20 mm

   2) Cross Section (each direction, width and depth)
      Outward + 10 mm
      Inward - 5 mm

3.11.4 MEASUREMENT & PAYMENT

1. Measurement

   The quantity of stair landings shall be measured in cubic meter of in-situ concrete, in kg of reinforcing bars, in cubic meter of precast concrete blocks inclusive of reinforcing bars and in number of sets of mooring rings.

   Payment for the rock filler to be used in the preparation of rock bedding for precast concrete block shall be included under Pay-item for the Supply and Place of Armour Rock.

2. Payment

   Stair landings measured as provided above shall be paid at contract prices which prices and payment shall constitute full compensation for the furnishing of all labor, equipment and tools and materials and constructing complete as per drawings and specifications and accepted.

3.12 REPAIR AND REHABILITATION OF EXISTING PORT FACILITIES

3.12.1 DESCRIPTION

1. The work consists of furnishing all labor, materials, equipment and incidentals necessary to undertake rehabilitation of existing port facilities, in accordance with the Specification, the Drawings and to the approval of the Engineer.

2. The Contractor shall be deemed to have satisfied himself of the site conditions and to have included in his unit prices all risks that may arise during or in connection with the work.

3. This Section shall be read together with the Section on concrete works, piling, fender systems of these Specifications.

4. The location and position for repair and rehabilitation works shall be in accordance with the Drawings and as directed by the Engineer.

5. The Contractor shall submit his proposal of work methods for the approval of the Engineer prior to the commencement of the works.

3.12.2 MATERIAL REQUIREMENTS

1. All the materials to be used for the works described in this Section shall have the same strength as, or more than, that of the original materials which are to be repaired, unless otherwise specifically stated. The materials shall be approved by the Engineer before use.

2. Fill repair materials shall be non-shrinkage type of either concrete, cement mortar or epoxy mortar. The selection of materials as well as the mix design shall be approved by the Engineer.

3. Adhesive bond shall be of epoxy type especially manufactured for the purpose of the concrete repair. Its application shall be in accordance with the manufacturer's specifications.

4. Mortar for concrete lining and repair of existing damaged grouted riprap, shall consist of cement, sand and water conforming to the requirements given under Section 3.2, “Concrete Works,” mixed in the proportion of one part cement to two parts sand by volume, and sufficient water to obtain the required consistency.

5. Fiber Reinforced Plastic (FRP) are used for applications requiring high strength to weight ratio and resistance to deterioration, such as

   Pile jackets for steel, concrete and timber piling to reduce corrosion or erosion, for reinforcement and to prevent marine borer attack.

   FRP systems are composed of several distinct chemical and components, including various primers, chemicals and components, including various primers, putties and adhesives, as well as the fibres fabrics and epoxy saturants that eventually become the FRP materials.

TYPICAL DRY FIBER PROPERTIES

Tensile Strength	550,000 psi (3.79 GPA)
Tensile Modulus	33.5 x 10^6 psi (231 GPa)
Ultimate Elongation	1.5%
Density	0.065 lbs./in.^{3} (1.81 g/cm3)
Volumetric Fiber Content	68%

COMPOSITE GROSS LAMINATE PROPERTIES

PROPERTY	ASTM METHOD	TYPICAL TEST VALUE	DESIGN VALUE*
Ultimate tensile strength in primary fiber direction, psi	D-3039	326,000 psi (2.25 GPa)	293,400 psi (2.02 GPa)
Elongation at break	D-3039	1.3%	1.3%
Tensile Modulus, psi	D-3039	22.5 x 10^6 psi (155 GPa)	20.2 x 10^6 psi (139 GPa)
Ultimate tensile strength fiber, psi	D-3039	0	0
Layer Thickness		Varies	Varies

TYPICAL FIBER PROPERTIES

Tensile Strength	470,00 psi (3.24 GPa)
Tensile Modulus	10.5 x 10^6 psi (72.4 GPa)
Ultimate Elongation	4.5%
Density	0.092 lbs/in.^{3} (2.55g/cm^3)
Weight per sq. yd.	14.9 oz. (505 g/m^2)
Fiber Thickness	0.0075 in. (0.19 mm)

COMPOSITE GROSS LAMINATE PROPERTIES

PROPERTY	ASTM METHOD	TYPICAL TEST VALUE	DESIGN VALUE*
Ultimate tensile strength in primary fiber direction, psi	D-3039	83,400 psi (575 MPa) (2.17 kip/in.width)	66,720 psi (460 MPa) (1.7 kip/in. width)
Elongation at break	D-3039	2.2%	2.2%
Tensile Modulus,psi	D-3039	3.79 x 10^6 psi (26.1 GPa)	3.03 x 10^6 psi (20.9 GPa)
Ultimate tensile strength 90 degrees to primary fiber, psi	D-3039	3750 psi (25.8 MPa)	3,00 psi (20.7 MPa)
Laminate Thickness		0.026 in. (0.66 mm)	0.026 in. (0.66 mm)

EPOXY MATERIAL PROPERTIES

Curing Schedule 72 hours post cure at 140°F (60°C)		
PROPERTY	**ASTM METHOD**	**TYPICAL TEST VALUE***
Tg 140 ^{0}F (60 ^{0}C)		180^{0}F (82 ^{0}C)
Tensile Strength[1], psi	ASTM D-638 Type 1	10,500 psi (72.4 MPa)
Tensile Modulus ,psi		461, 000 psi (3.18 GPa)
Elongation Percent	ASTM D-638 Type 1	5.0%
Flexural Strength, psi	ASTM D-790	17,900 psi (123.4 MPa)
Flexural Modulus, psi	ASTM D-790	17,900 psi
Flexural Modulus, psi	ASTM D-790	452,000 psi (3.12 GPa)

6. Underwater Petrolatum Tape System with High Density Polyethylene (HDPE) jacket

   (a) Petrolatum Marine Piling Tape

   Petrolatum Marine Piling Tape is a synthetic filament fabric coated with a neutral compound based on saturated petroleum hydrocarbons and inert mineral fillers with additional inhibitors and water displacing agents.

   It is primarily used for the protection of jetty piles particularly in the splash and inter-tidal zones.

   It is an anti-corrosion tape that can be applied to metal under water that adheres and remains attached to all cleaned, sound, wet or dry metal surfaces.

   (b) Petrolatum Paste

   Petrolatum Paste is a soft paste containing water displacing, corrosion inhibiting and flow control additives with broad-spectrum biocides. It does not dry, harden or crack.

   Applicable to badly corroded and fitted steel above and below water surface prior to the application of the marine piling tape. It fills pits and depressions on the steel pile surface and does not contain volatile organic components.

Specially designed for underwater applications.

Properties:

Flash point	=	180^0C (minimum)
Specific Gravity	=	+ 1.08
Temperature Range:		
For Application	=	0°C to 40°C
For Service	=	- 30°C to 55°C

3.12.3 EXECUTION

1. Preparatory Work

   The Contractor shall verify the dimensions and locations of damaged portions of existing structures and confirm the type of repair works prior to the commencement of works.

   Within twenty eight (28) days from the commencement of the work, the Contractor shall submit to the Engineer for approval his detailed methodology and sequence of construction including the mix proportion and materials he proposes to use for the works.

   The Contractor shall carry out all the necessary preparatory works needed such as setting out, marking, temporary staging etc., prior to the commencement of such works.

   The Contractor shall also clean all the surfaces to be repaired by means of brushing, sand blasting or any other appropriate means for rust, dust, weathered materials or any other deteriorated part of structures.

2. Records of Repair Works

   The Contractor shall take photographs including underwater photographs for all the places to be repaired prior to the commencement of such works.

   These photographs shall be in the monthly reports with identification numbers for each location, namely bay number for slab, etc.

Photographs after repairing works shall be also taken at the same locations and from the same directions. The Contractor shall submit two (2) copies of color photos to the Engineer upon the completion of such works.

3. Rehabilitation of Concrete Slabs (For Causeways & Piers)

   a. Repair and rehabilitation works of concrete slabs shall be carried out according to the specified type of repair works as shown on the Drawings.

   b. The location and position of each type of repair and rehabilitation works of damaged slabs at existing piers and causeways, shall be in accordance with the drawings and as directed by the Engineer.

   c. Type of repair works:

Type	Application	Repair Method
SA/SB	Medium to wide crack at location directed by the Engineer.	Patching of mortar to level.
SC/SD	Spalled concrete without exposed rebars at location directed by the Engineer	Patching of mortar to level.
SE/SF	Spalled concrete with exposed rebars not more than 50% of the panel at location directed by the Engineer	Replacing of corroded rebars and injection of mortar.
SG	Spalled concrete with exposed rebars more than 50% of the panel and depth of spalled concrete more than 150 mm	Replacing concrete and rebars for entire slab panel.

   d. Particulars:

      1) The surface of the damaged part of the concrete shall be removed by chipping as indicated on the drawings, without damaging other parts, until fresh concrete appears.

      2) The exposed concrete shall be brushed clean and free from concrete debris. Heavily corroded rebars shall be replaced with the same size and quality as the original rebars.

3) Before casting new concrete, the old concrete shall be saturated by water sprays for at least 24 hours.

4) After applying epoxy bond onto the surface of the fresh concrete and rebars, temporary formwork shall be provided and fixed in position, if necessary, by either hole-in anchors or temporary supports.

5) The temporary form prefabricated on land with injection and exhaust pipes shall be rigid enough to support the cast concrete or mortar.

6) The non-shrink concrete or mortar shall be cast in by pumping through injection pipes.

4. Rehabilitation of Concrete Beam

a. Repair and rehabilitation works of concrete beams shall be performed following to the specified type of repair works as shown on the Drawings.

b. The location and position for each type of repair and rehabilitation works on damage beam at existing piers and wharf shall be in accordance with the Drawings and as directed by the Engineer.

c. Type of repair works.

Type	Application	Repair Method
BA/BB	Medium to wide crack at location directed by the Engineer.	Patching of mortar to level.
BC	Spalled concrete without exposed rebars at location directed by the Engineer.	Patching of mortar to level
BD	Spalled concrete with exposed rebars but at the side of beam at location directed by the Engineer	Replacement of corroded rebars and mortar injection.
BE	Spalled concrete with exposed rebars at the bottom of beam	Replacement of corroded rebars and mortar injection.

d. Particulars

Particular for this works are described in Sub-section 3.12.3.3, Urgent Rehabilitation of Concrete Slab, paragraph “d” 1 to 6.

5. Rehabilitation of Pile Cappings

a. Repair and rehabilitation works of pile cappings shall be applied to the following specified type of repair works as shown on the Drawings.

b. The location and position for each type of repair and rehabilitation works of damaged concrete pile cappings at existing piers and wharf shall be in accordance with the Drawings and as directed by the Engineer.

c. Type of repair works.

Type	Application	Repair Method
PA/PB	Fine to wide crack at location directed by the Engineer.	Patching of mortar to level.
PC	Spalled concrete without exposed rebars at location directed by the Engineer	Patching of mortar to level.
PD/PE	Spalled concrete with exposed rebars.	Pile jacket by injection of mortar.

d. Particulars:

Refer to Sub-section 3.12.3.3, Rehabilitation of Concrete Slab, paragraph “d”

6. Rehabilitation of Damaged Piles

Rehabilitation works shall be applied following to the specified grade of repair works for each pile as described in Sub-section 3.12.3.5.

7. Installation or Demolition of Bollards

    a. The specified existing bollards installed at the existing piers and wharf shall be removed from their existing positions in accordance with the Drawings or as directed by the Engineer.

    b. The removed bollards shall be stored in the Contractor's storage for re-use or dumped in the disposal area, as directed by the Engineer.

    c. The Contractor shall repair the concrete base after the removal of bollards.

    d. Strengthening of existing concrete slab and/or beam for installation of bollards, shall be undertaken if instructed by the Engineer.

8. Installation of Rubber Fenders

    a. Concrete base for installation of rubber fenders shall be provided to the existing marginal wharf in accordance with the Drawings.

    b. The face line of the rubber fenders after installation shall be straight for safe ship operation.

    c. Rubber fender shall be set as shown on the Drawings with anchor bolts as specified in Section 3.13 "Mooring and Fender System".

9. Replacement of Timber Fender Piles

    a. Existing fender piles shall be removed or cut at the design seabed elevation and then stored in the yard for re-used or dumped in the disposal area if instructed by the Engineer.

    b. Setting-out shall be made by the Contractor to maintain straight faceline as indicated on the Drawings.

10. Strengthening of Concrete Structures using FRP

    a. Only trained and certified Specialty Contractors should be used for strengthening of concrete structures using FRP.

    b. Concrete Preparation

        (1) Concrete substrate must be in a clean and sound condition.

            (a) Remove unsound concrete
            (b) Repair corroding reinforcing steel

(c) Patch large voids
(d) Inject large cracks

c. Surface Preparation

(1) The surface must be prepared to receive the FRP system.

(a) Level the concrete surfaces with epoxy putty
(b) Round sharp edges where required

d. Adhesive mixing

Well mixed resin is critically important, and manufacturer recommendations should be followed.

e. FRP Installation

FRPs are bonded to the surface of the concrete

(1) Pre-cured laminate and Strip System

Rigid FRP plates or strips are bonded to the surface of the concrete with an epoxy adhesive.

(2) Fabric System

Flexible fibre fabrics are bonded to the concrete using epoxy adhesives/saturants

For Dry lay-up Systems, Fabric is saturated during lay-up operation.

(3) Protective Coatings

Aesthetics, fireproofing, UV Radiation, or otherwise protective coatings are often applied to install FRP systems.

(4) Curing Conditions

The following must be carefully monitored and controlled during curing of the epoxy saturants/ adhesives.

11. Repair of Damaged Tape or Coating on Steel Piles

    a. Remove damaged tape or non-adhering coating. Remove corrosion materials. Apply thin coat of petrolatum paste. Begin the application of tape a minimum of 50 mm back from the damaged area utilizing the recommended overlap. Complete wrapping of repair area so that the tape overlaps at least 50 mm onto the original coating.

    b. When repairing petrolatum tape, the damaged area frequently can be repaired by applying a patch or full circumferential wrap. The new petrolatum tape can readily be pressed onto the old tape. Patches should only be installed on the top half of a pipe surface.

3.12.4 MEASUREMENT AND PAYMENT

1. Measurement

   All items for the repair and for the rehabilitation of the existing structure shall be measured based on actual quantities and on the item included in the bill of quantities. The Contractor shall measure the work at the presence of the Engineer and submit the unit for approval.

2. Payment

   All payments shall be done in quantity as mentioned above. All unit prices shall include (if under the Bill of Quantities there is no specific price applicable) excavation, clearing, chipping, materials with accessories, reinforcing bars, forms, scaffolding, backfilling and other related works to be carried out in the works specified.

3.13 MOORING AND FENDER SYSTEMS

3.13.1 GENERAL

3.13.1.1 SCOPE OF WORK

1. The work includes furnishing of all labor, materials and equipment to complete the installation of mooring bollards, bitts, cleats and fenders in new piers.

2. The work shall include the supply, transport, handling, storage and installation of fender systems in the newly constructed piers.

3. The work shall include the furnishing, driving, cutting off and binding of timber piles in clusters (dolphins) in the new trestles as shown on the drawings and in accordance with this specification.

4. The Contractor shall furnish and install the necessary fittings for a complete job as shown on the drawings and/or as specified.

   Supplementary parts necessary to complete and install each item of works shall be included whether or not shown or specified. The Contractor shall furnish to relevant trades all anchors, fastenings, inserts, fittings, fixtures or the like to be installed on or required for securing the works.

   The Contractor shall submit shop drawings of all fitting works prior to placing orders and commencement of any fabrication.

3.13.1.2 MOORING SYSTEM

1. Designated load capacity of mooring bollards, bitt and cleats shall be as shown on the drawings, and shall refer to the safe working load. The bollards shall be capable of withstanding a proof test load of 1.5 times the safe working load.

2. The following publications listed below shall form a part of these Specifications to the extent indicated by the reference thereto.

   Publication

   G 5101 SC 46, Carbon Steel
   G 3101 SS 41, Rolled Steel for General Structures
   JIS B0205 Standard M Screw
   JIS B1181 Hexagon Nut

3. Bollards at the new berth shall be installed at the edge of concrete decks of piers.

3.13.1.3 RUBBER FENDER SYSTEMS

1. Material for fender systems such as rubber fenders, anchor bolts and templates shall be supplied by the Contractor.

2. The Contractor shall install the fender system properly according to the drawings and the instructions prepared by the Engineer.

3. Performance Requirements

   The fenders shall be procured in accordance with the performance characteristics, under 45%-50% fender deflection, specified hereunder:

Type of Fender	Min. Energy Absorption (Ton-M)	Max. Reaction Force (Ton)
(1)	1.0	15
(2)	1.8	20
(3)	2.8	32

4. Types of Fenders

   Type (1) = 200 mm in height and 1000 mm in length
   Type (2) = 250 mm in height and 1500 mm in length
   Type (3) = 300 mm in height and 1500 mm in length

5. Manufacturing Rubber Main Body

   Rubber fenders shall be manufactured at the factories of approved makers.

   Basic manufacturing methods shall be as follows:

   - Shape of rubber main body: refer to the Drawings
   - Fabrication of rubber main body shall be completed at the factory
   - No connection of main body shall be permitted out of the factory
   - Steel plate shall be embedded in the deck sides of rubber main body.
   - The Contractor shall submit manufacturer's methods of manufacturing for approval by the Engineer.

3.13.1.4 TIMBER PILE DOLPHINS

1. Materials for timber pile dolphins such as creosoted apitong timber piles, connection wire rope, staples and protector shall be supplied by the Contractor subject to approval of the Engineer.

2. The Contractor shall install the dolphins properly according to the drawings and instructions prepared by the Engineer.

3. Related specification will be provided in Section 3.3, "Piling Works."

3.13.1.5 SUBMITTALS

1. Shop drawings and/or catalogues of mooring bollards, bitts, cleats and rubber fenders indicating size, weight and mounting requirements shall be submitted for approval of the Engineer.

2. No materials or fitting shall be ordered without prior approval of the Engineer.

3.13.2 MATERIAL REQUIREMENTS

3.13.2.1 MOORING SYSTEM

1. Mooring bollards, bitts and cleats shall be of the dimensions, weights, capacities and design in accordance with shop drawings approved by the Engineer and shall be fabricated by approved manufacturers with cast steel conforming to the following requirements or approved equivalent.

Part	Spec. (JIS or its equivalent)	Grade
Body	JIS G5101 3	Grade SC46
Anchor	JIS G3101 2	Grade SS41
Bolts	JIS B0205	M64-6
Nut	JIS B1181 1 Class 3	Grade 1 4T, N64-6
Washer	JIS B1256	Steel Bars
Foundation Plate	JIS G3101 2 or JIS G5101	Grade SS41 Grade 3 SC46

The size of the bolts, nuts and washers shall be in accordance with the specifications of the manufacturer. However, the length of the bolts shall be as indicated on the drawings. The anchor plate shall be connected to the holding down bolt with 12.5 mm weld, as shown on the drawings. All bolts, nuts, washers, etc. that are exposed shall be galvanized to the satisfaction of the Engineer. Provide lead cover for exposed threads of galvanized anchor bolts.

Samples of the bolts, nuts, washers and anchor plates shall be submitted to the Engineer for approval before being used in the Works.

a) The upper parts of bollards, bitts, and cleats not embedded in concrete shall be painted. The surface of bollards and bitts shall be cleaned thoroughly by wire brush or other means prior to painting to remove rust or any other contamination which may interfere with bond of paint to metal.

   The exposed surface shall be coated with rust proof paint and finishing paint, which shall be coal-tar epoxy of 120 micron thickness in accordance with JIS K5623 or the approved standard.

b) Alternative

The Contractor can submit to the Engineer's approval cleats, bitts or bollards different from these specifications but with the capacities indicated in the drawings.

c) Concrete foundations/base of bollards and bitts shall conform to the requirements of Section 3.2, "Concrete Works."

d) Visual Inspection

All bollards, bitts and cleats delivered to site shall be inspected by the Engineer for any signs of flaws or defects inimical to usage.

e) Mill Test Certificates

Two (2) copies of mill test reports shall be submitted certifying that materials meet the specified standards.

f) Tests and Inspection

Inspection of all materials and methods of fabrication shall be carried out by the Contractor. However, the Engineer reserves the right to inspect all facilities at any time during the manufacture to ensure that the materials and workmanship are in accordance with the specifications and the best workmanship.

3.13.2.2 RUBBER FENDER SYSTEM

1. Concrete with reinforcing bars on which the fenders are fixed shall conform to the requirements of Section 3.2, "Concrete Works."

2. Physical Properties

Material for rubber fenders will be one of the international accepted materials.

Test methods shall conform to JIS K6301 or equivalent.

The rubber material used for rubber fenders shall be a compound of natural rubber and synthetic rubber of high quality having sufficient resilience, anti-aging, weather and wear resistant property according to the following table.

	Property	Requirement	Test Method (JIS K6301)
Tension test (before aging)	Hardness (HS)	77 max.	Spring type Hardness type
	Tensile Strength (kg/cm^2)	160 min.	Test piece Dumbell No. 3
	Elongation (%)	350 min.	
Tension test (after aging)	Hardness	+8 max. from original value	Air heating 70 °C x 96 hrs.
	Tensile Strength (kg/cm^2)	not less than 80% of original value	
	Elongation	not less than 80% of original value	
Tear resistance (kg/cm^2)	Inner rubber	70 min.	Test piece
	Outer rubber	60 min.	
Compression Set (%)		30 max.	
Oil Resistance (volume change)	Industrial gasoline (%)	60 max. 20 max.	25 °C x 24 hrs.

3. Anchor

Anchor Bolts and connecting hardware shall be fabricated from type SUS 304 stainless steel to the required shapes and sizes as shown on the approved shop drawings, and conforming to JIS G 4303 or equivalent.

4. Testing

The Contractor shall be required to submit test certificates showing compliance to the above requirements. The test certificates should be certified by an independent inspection organization recommended by the Contractor and approved by the Engineer.

One fender of each type (1, 2 & 3) selected at random shall be tested for performance. The fender shall be compressed repeatedly three times to the minimum deflection at speed from 2 to 8 cm. per minute.

The load and deflection values shall be recorded with a precision of 0.5 mm. The results shall be plotted in the form of load-deflection-energy absorption curves. The average data obtained in the second and third test loadings shall be considered as performance values. The tests and reporting shall be carried by an approved laboratory and shall be supervised and certified by the independent inspection organization.

The performance shall satisfy the requirements indicated in Sub-section 3.13.1.3 paragraph 3.

If any of the tested fenders fail to satisfy the performance requirements, retesting shall be conducted on one piece for every 10 fenders of the same type. If the second sample still fails the test, all the remaining fenders of this type shall be tested.

5. Sampling of Specimen

The specimens of rubber shall be taken at the mixing stage directly from each batch of rubber compound for manufacturing of fenders. The specimens shall be tested for compliance with requirements as specified in paragraph b of this Sub-section.

6. Inspection for Dimension

The fenders shall be inspected by the independent inspection organization.

One fender out of five fenders of each type shall be inspected for compliance with dimensions.

Five percent (5%) of anchor bolts and fittings shall be selected at random and inspected. Materials for bolts and fittings to be covered by certified steel manufacturer's mill sheet shall be verified by the independent inspection organization.

7. Acceptance Tolerance

The acceptance tolerances shall be as stipulated in the following:

a. Fender Dimension

	Length	**Width**	**Height**	**Thickness**
Tolerance	+4% -2%	+4% -2%	+4% -2%	+8% -2%

b. Anchoring Bolt Holes in Fender

	Diameter of the Hole	Pitch of the Hole
Tolerance	+2 mm	+4 mm

c. Performance requirements shall conform to paragraph c of Sub-section 3.13.1.3

As basis for acceptance of all finished fenders supplied, a tolerance of +10% on the performance requirements indicated will be acceptable.

The cost of tests and inspection required herein are all for the Contractor's account.

8. Marking

All fender units shall be clearly numbered and marked. Each fender shall have the following marking:

a. Fender type and manufacturer's name or trademark

b. Production serial number

c. Date of manufacturing

d. Main dimensions (length, height)

e. Bill number in accordance with the project code specified in the Bill of Quantities.

9. Warranty

The Contractor shall guarantee the fenders against any defects that are attributable to faulty design and manufacture and shall also guarantee the performance of the fenders under normal working conditions. The guarantee shall be for a minimum period of 12 months from the date of the issuance of Taking-Over Certificate of the Works.

During the period of guarantee, repairs and replacement of defective fender units and/or material shall be carried by the Contractor at his own cost.

3.13.2.3 TIMBER PILE DOLPHINS

1. Timber piles shall be “Creosoted Apitong” (Dipterocarpus Grandiflorus) of the best grade. It shall be free from loose knots, splits, worn holes, decay, warp, ring separation or any deflects which will impair its strength or render it unfit for its intended use. Creosoted Timber Piles shall have the diameter and length shown on the drawings. No cracks will be permitted in any pile.

   Timber treatment shall consist of the forcing of creosote oil into the outer fiber of the timber by a heat and pressure process. The treatment shall be so regulated that the curing process will not induce excessive checking.

   The minimum penetration of the preservative with the surface of the timber shall be 20mm. The minimum retention of preservative per cubic meter of timber shall be 320 kg. By “Full Cell Process” for treated timber intended for marine use.

   The Engineer shall be notified at least ten (10) days in advance of the date that the treating process will be performed in order that the untreated timber, the treatment process and the finished treated timber may be inspected. The Engineer will inspect the timber prior to treatment to determine conformance with the specifications and suitability of conditions for treatment. He shall be permitted free access to the plant in order that temperatures, pressures and quantities and types of treatment materials used may be observed. Samples of the creosote oil shall be furnished as required for tests.

   After completion of the treatment, the timber shall be checked to determine penetration of treatment, amount of checking, quantity of free preservative remaining on the timber and any other visual evidence that the treatment has been performed in a satisfactory manner. The penetration of treatment shall be determined by boring a sufficient number of well distributed holes to determine the average penetration. All such holes shall be plugged with plugs approximately 2 mm larger in diameter than the bit used in boring the holes.

   If the penetration of preservative is less than the required amount, the entire charge, or such parts thereof as are determined by the Engineer to be unsatisfactory, shall be retreated. If after retreatment, the penetration is still insufficient, the retreated pieces shall be rejected.

   Any excessive checking caused by the treating process shall be cause for rejection of the pieces in which the excessive checking occurs.

The treating plant shall be equipped with adequate thermometers and pressure gages so that the process can be accurately controlled and a continuous record made of stages of the treating process. If requested by the Engineer, records shall be furnished showing the duration, maximum and minimum temperatures and pressures used during all stages of the process.

All timber which is to be stored on the job for any length of time prior to its use in the structure shall be nearly stacked in piles to prevent warping or distortion. Creosote treated timber shall be open-stacked and piled to prevent warping. The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish. Care shall be exercised in handling treated timber so as not to break or penetrate the treatment with any tool or handling equipment. Any piece of timber that has been damaged by the Contractor shall be replaced by him without extra compensation.

2. Connection wire shall be 6 x 9 galvanized wire rope with fiber core, 25 mm diameter, weight 1.98 kg/m, breaking load 27.6 tonnes (160 kg/mm^2).

3. Preservative shall be creosoted oil and shall conform to ASTM D-1760 “Standard Specification for Pressure Treatment of Timber Products.” Creosoted petroleum oil blend shall not be used for timber piles intended for marine use.

4. All staples, caps, bolts shall be of galvanized steel.

3.13.3 EXECUTION

3.13.3.1 MOORING SYSTEM

All bollards, bitts and cleats shall be installed at the locations shown on the drawings and in accordance with the approved manufacturer's recommendations and shop drawings, and as directed by the Engineer.

3.13.3.2 RUBBER FENDER SYSTEM

All fenders shall be installed at the locations shown on the drawings and in accordance with the approved manufacturer's recommendations and shop drawings.

3.13.3.3 TIMBER PILE DOLPHINS

All timber piles shall be installed at the location shown on the drawings and connected to each to form a cluster piles.

The timber pile should be driven to a penetration below seabed to a depth indicated on the drawings. This penetration may increased or decreased depending upon the nature of the material encountered and as directed by the Engineer.

Bind the piles as shown on the drawing to form a pile clusters with galvanized wire rope which should be secured to every pile in contact with galvanized staples and the ends of wire rope to be looped securely fastened. The top of the pile and wire rope after cutting and placing respectively shall be treated with two (2) thick coats of hot tar before placing of the metal cap. The top of the cap should be painted with one (1) coat of tar.

All works shall be carried out in accordance with the approved shop drawings. Pile driving shall conform to requirements of Section 3.3, "Piling Works."

3.13.4 MEASUREMENT AND PAYMENT

1. Measurement and payment of the quantities of bollards, bitts and cleats shall each be based on the number of sets of bollards, bitts and cleats completely installed (excluding concrete base/foundation) with anchor bolts and certified by the Engineer.

   Reinforced concrete base/foundation of mooring bollards and bitts to be installed on piers shall not be paid separately and such shall be included under pay-item for Concrete Works of pier.

   Separate measurement shall be made for reinforced concrete base/foundation of mooring bollards and bitts to be installed on structures other than pier which shall be paid for per cubic meters of concrete and per kilograms of reinforcing bars.

2. Measurement and payment of the quantities of rubber fender system shall be based on the number of sets of rubber fender systems completely installed with anchor bolts with necessary sleeves and certified by the Engineer.

3. The furnishing of creosoted timber piles for fender cluster/breasting dolphins to be paid for shall be measured by the number of pieces as ordered in accordance with the Contract and as specified and accepted by the Engineer.

   The installation of timber pile dolphins (with specified number of piles per cluster) shall be measured and paid for by the number of sets of timber pile dolphins placed in accordance with the Contract and accepted in completed work.

4. Payment stated above shall be full compensation for all labor, materials and equipment and all preparatory and incidental works necessary to complete the work.

3.14 STEEL AND METAL WORKS

3.14.1 GENERAL

3.14.1.1 SCOPE OF WORK

The work includes the furnishing of all labor, material and equipment required for performing all operations in the fabrication and installation of structural steel and miscellaneous metal work as specified and shown on the drawings.

Materials shall conform to the requirements hereinafter specified. Connections for which details are not indicated shall be designed in accordance with the American Institute of Steel Construction, Manual of Steel Construction, latest edition, and shall be welded or bolted, except as shown otherwise.

Bolted connections for structural steel work shall be made with high strength steel bolts. Holes shall be provided where necessary for securing other work to steel framing. Steel less than 4.75 mm thick shall be in accordance with the American Iron and Steel Institute's light gauge Steel Design Specification.

Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Miscellaneous bolts and anchors, supports, braces and connections necessary for completion of the work shall be provided.

3.14.1.2 STANDARDS INCLUDED IN THE SPECIFICATIONS

The following publications listed below form a part of these Specifications to the extent indicated by the reference thereto.

1. American Institute of Steel Construction (AISC) Publication:

   Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

2. American Society for Testing and Materials (ASTM) Publications:

   A-123 Zinc (Hot-Galvanized) Coating Products Fabricated from Rolled Pressed and Forged Steel Shapes, Plates, Bars and Strips

A-153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A-386 Zinc Coating (Hot-Dip) on Assembled Steel Products

3. American Welding Society (AWS) Publications:

   D1.1 Structural Welding Code

4. Japanese Industrial Standard (JIS) Publication:

   JIS B 1186 Sets of High Strength Hexagon Bolts, Hexagon Nuts, and Plain Washers for Friction Grip Joints

   JIS G 3101 Rolled Steel for General Structures

   JIS G 3444 Carbon Steel Tubes for General Structural Purposes

   JIS G 3445 Carbon Steel Tubes for General Structural Purposes

   JIS G 3452 Carbon Steel Pipes for Ordinary Piping

   JIS G 3454 Carbon Steel Pipes for Pressure Services

   JIS G 4303 Stainless Steel Bars

   JIS G 4313 Cold Rolled Stainless Steel Strip for Spring

   JIS G 4051 Carbon Steel for Machine Structural Use

3.14.1.3 STORAGE

Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids or other supports. Materials shall be kept free from dirt, grease and other foreign matter and shall be protected from corrosion.

3.14.1.4 SUBMITTALS

1. Shop Drawings

   The Contractor shall submit shop drawings for the whole of the steelwork to the Engineer for approval. All such drawings shall show the dimensions of all parts, method of construction, spacing of rivets, bolts, welding, sectional areas and all other details. Riveted or welded construction may be employed subject to approval and neatness of design. Where welds are used, either at works or on site, they shall wherever possible, be continued and returned around any meeting face to ensure that the joints are completely sealed against corrosion.

The details of connections on shop drawings shall be such as to minimize formation of pockets to hold condensation, water or dirt and a minimum gap between abutting angles and the like shall be provided wherever possible to eliminate any traps and facilitate maintenance painting.

No material shall be ordered nor fabrication commenced until such drawings are approved by the Engineer in writing.

The Contractor shall be responsible for all errors of detailing fabrication and for correct fitting of the structural members.

2. Erection Procedures

The Contractor shall submit work program and statement to illustrate the structural steel erection and temporary staying and bracing and to give clarification on data submitted by him should the Engineer requested the same. He shall also submit the data on welding equipment he proposes to use in the field, such data shall include the type, voltage and amperage of the said equipment and be subject to approval of the Engineer.

3. Proof of Compliance with the Specifications for Materials

The Contractor shall submit the following test results as a proof that the materials he will use complies with the requirement of the specifications.

a. Reports of ladle analysis for steel

1) Mill tests reports for main members
2) Fabrication's affidavit for secondary and detail members.

b. Reports of tensile properties and bed tests for:

1) Steel shapes
2) Steel bars
3) Steel plates

c. Certification of conformance for:

1) Structural steel tubing
2) Steel bar grating
3) Filler metals for welding

d. Reports of mechanical properties of headed stud type shear connectors.

e. Reports of mechanical tests for high strength threaded fasteners.

4. Manufacturer's Literature

The Contractor shall submit manufacturer's literature describing the type of welding studs and arc shields used.

5. Inspection Report

The Contractor shall likewise submit the result of inspection tests specified in this Sub-section 3.14.3.4.

3.14.2 MATERIAL REQUIREMENTS

All materials shall be of new stock, free from surface imperfections and shall conform to the applicable ASTM, JIS, AISC or other equivalent standards.

Structural steel plates, shapes, grating and bars shall conform to JIS G 3101 SS 41.

Structural carbon steel shall conform to ASTM designations A 36 or equivalent. Shapes of structural members shall be as given in AISC, Manual of Steel Construction or equivalent.

High strength structural bolts, nuts and washers shall conform to JIS B 1186 F 11T.

Electrodes for arc welding shall conform to American Welding Society Specification A5.1.

Chains and fittings for fender systems shall conform to JIS F 3303 "Electrical Welded Anchor Chain Cables". All chains and accessories shall be hot-dip galvanized.

3.14.3 EXECUTION

3.14.3.1 QUALIFICATION

1. Steel Fabricator

Steel Fabricators shall have a minimum of 5 years experience in fabrication of structural steel for projects of similar size. The Contractor shall submit a written description of fabrication ability including facilities, personnel and lists of similar completed projects,

including quality control capability and specifically the type and extent of quality control procedure which the fabricator intends to employ on this project.

2. Steel Erector

Steel Erectors shall have a minimum of 5 years experience in the erection of structural steel structures of similar size to the proposed structure. The Contractor shall submit a written description of structural steel erection ability including equipment, personnel and a list of completed projects.

3. Qualified Welders and Welding Procedures

Welders, tackers, welding procedures and operations shall be in accordance with AWS D1.1. The Contractor shall submit for the Engineer's approval the welding procedure, welder's qualifications and the test results of each type of welding to be performed.

Procedures shall be developed for welding all metals included in the work. The Contractor shall not start welding until procedures, welders, welding operator and tackers have been qualified as specified herein. The Contractor shall perform qualification testing by an approved testing laboratory, or by the Contractor if approved by the Engineer. Cost of such testing shall be borne by the Contractor.

The Contractor shall qualify each welder, welding operator and tacker assigned to work on this project by tests using equipment, positions, procedures, base metal and electrodes that will be encountered in their assignment. The Contractor shall furnish to the Engineer for approval certification that each welder, welding operator and tacker is qualified in accordance with the requirements of AWS D1.1 or approved equal.

3.14.3.2 WELDING

1. General

All welders, welding operators and tackers to be employed on the Works shall have been qualified by tests prescribed by the Structural Welding Code of American Welding Society (AWS D1).

Before the work is started the welding procedure of each type of joint shall be approved by the Engineer and the Contractor shall make such trial welds and tests as required for the proposed method.

2. Equipment

Machine welding shall be used wherever possible. All shop welds shall be carried out by qualified operators under proper supervision. The work shall be properly prepared for welding and the correct sequence adhered to.

All site welding shall be carried out by the electric arc process, with coated electrodes.

The welding plant shall be of modern design and with ample capacity to provide the required current to each welding point without appreciable fluctuations.

3. Welding Material

The Contractor shall employ only welding electrodes, welding wire and fluxes capable of producing satisfactory welds when used by qualified welders or welding operators using qualified welding procedures. Filler metals for welding may be any or combination of the following:

a. Shielding metal-arc welding: AWS A5.1 or A 5.5
b. AWS A 5.18 and Article 417 of AWS Building code
c. Flux core arc welding: AWS A5.2 and article 418 of AWS Building Code.

4. Welded Construction

Welded connection shall be permitted only where indicated on the approved shop drawings. Welded construction shall conform to the following:

a. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

b. Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more that 4.75 mm. If the separation is 1.6 mm or greater, the size of the filler welds shall be increased by the amount of the separation. The separation between facing surfaces of lap joints and the butt joints on a backing structure shall not exceed 1.6 mm. The fit of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.

c. Abutting parts to be butt welded shall be carefully aligned. Misalignments greater than 3.2 mm shall be corrected and in making the correction, the part shall not be drawn into a sharper slope than 2 degrees. Prior to welding, all parts shall be held securely in position by tack welds, clamps or other means.

d. The work shall be positioned for flat welding whenever practicable.

e. The technique of welding employed, the appearance and quality of welds made, and the methods used in correcting defective work shall conform to Section 4 - Workmanship, of the Standard Code for Arc and Gas Welding in Building Construction of the American Welding Society.

3.14.3.3 FABRICATION

The Contractor shall fabricate structural steel in the shop to the greatest extent possible for transporting in accordance with AISC Building Code with the modifications and additional requirements specified in this section.

Bolted or welded connections shall be provided whether constructed in the shop or in the field as shown on the drawings or as approved by the Engineer. High strength threaded fasteners for all bolted connections shall be used unless otherwise shown on the drawings or approved by the Engineer.

Connections shall be as shown on the drawings or as approved by the Engineer. Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Draw allowance shall be made for draw in all tension bracing.

All sharp edges and corners be ground to a minimum radius of 1 mm and all sharp irregularities, burrs, slag and spatters on welds shall be removed.

Bearing plates shall be provided under beams resting on concrete walls.

3.14.3.4 TEST AND INSPECTION

Welds shall be inspected visually. A min. 10% of all butt welds and a min. 5% of all fillet welds to be designated by the Engineer shall be examined by radiographic, liquid penetrant, magnetic particle or ultrasonic method, alone or in combination to determine conformance to the acceptance specified herein. All testing shall be performed by an approved testing agency performed in the presence of the Engineer. All tests shall be certified and submitted to the Engineer.

3.14.3.5 DELIVERY TO SITE

Anchor bolts and other anchorage devices which are to be embedded in cast-in-place concrete construction shall be delivered to site before the start of the said work.

The Contractor shall number in accordance with shop drawings the materials tested and approved by the Engineer before delivery to the site, and prepare a list showing number, size, quality and quantities of materials.

Material shall be transported in accordance with material list and transportation schedule approved by the Engineer.

Materials shall be protected to prevent damage during transportation. The Contractor shall package and label small parts such as bolts and rivets.

3.14.3.6 FIELD ERECTION

Steel erection shall conform to the requirements of these Specifications and to the applicable requirements of AISC, "Specification for the Design, Fabrication, and Erection of Structural Steel for Building" and the AISC "Code of Standard Practice for the Steel Building and Bridges".

The Contractor shall set and wedge or shim loose bearing plates and erect individual pieces not deviating from vertical level and alignment more than 1 in 500.

For the field assembly the Contractor shall:

1. Assemble structural steel frames accurately to the lines and elevations indicated and within the specified erection tolerance.

2. Align and adjust accurately various members forming parts of a complete frame of structure before fastening.

3. Fasten splices of compression members after the abutting surfaces have brought completely into contact.

4. Clean bearing surfaces in permanent contact of all rust and scale and surface coated with the required corrosion protection before members are assembled.

5. Provide splices only where indicated.

6. Provide bolted and welded field connections as specified in this Section.

7. Remove run-off tabs and grid surfaces where requested by the Engineer.

8. Clean weld spatter from contact surface.

Field correction of fabrication by gas cutting shall not be permitted on any major member of the structural framing without prior approval of the Engineer.

Structural steel members of high strength steel shall be marked to permit visual verification of the grade of steel used.

3.14.3.7 BOLTING

Bolts shall be driven accurately into the holes without damaging the thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.

Unfinished bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of the length that will extend entirely through but not more than 6.4 mm beyond the nuts. Bolts heads and nuts shall be drawn tight against the work with a suitable wrench not less than 80 mm long. Bolt heads shall be tapped with a hammer while the nut is being tightened. After having been finally tightened, nuts shall be locked.

Alternatively, bolts shall be tightened with a torque wrench to the appropriate torque for the bolt diameter.

3.14.3.8 GALVANIZING

Galvanizing, where called for, shall conform to the requirements of ASTM A 123. The required weight of the zinc coating for each type of material category with corresponding range of thickness is shown below in compliance with ASTM A 123.

Minimum Average Coating Thickness Grade by Material Category

Materials Category	All Specimens Tested (Steel Thickness Range (Measured), in. (mm)				
	<1/16 (<1.6)	1/16 to < 1/8 (1.6 to <3.2)	1/8 to <3/16 (3.2 to 4.8)	>3/16 to <1/14 (>4.8 to <6.4)	≥1/4 (≥6.4)
Structural Shapes & Plate	45	65	75	85	100
Strip & Bar	45	65	75	85	100
Pipe & Tubing	45	45	75	75	75
Wire	35	50	60	65	80

Coating Thickness Grade

Coating Grade	mils	Oz/ft^2	µm	g/m^2
35	1.4	0.8	35	245
45	1.8	1	45	320
50	2	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.4	1.5	65	460
75	3	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2	85	600
100	3.9	2.3	100	705

Conversion Factors
Mils = µm x 0.03937
Oz/ft2 = µm x 0.02316
g/m2 = = µm x 7.067

3.14.3.9 PAINTING

Shop paint for all structural steel shall be carried out in accordance with Sub-section 4.5.5, "Painting".

3.14.3.10 INSPECTION

1. Recommendation and procedures governing inspection are in general described in API RP 2A Section 7 - Inspection, and description in this Section.

2. Inspection by the Engineer does not relieve the Contractor of his responsibility to provide the necessary inspection of his own work, and that of his sub-contractors, to ensure compliance with Contract Drawings and Specifications.

3. All sub-contractors, used for steel fabrication work by the Contractor shall be subject to the approval of the Engineer prior to their start of any work for this project.

4. The fabrication and erection facilities, materials and quality workmanship of the Contractor and his sub-contractors shall be available for inspection by the Engineer at all times during the progress of work. The Engineer shall have the right to reject work not satisfying the requirements of their governing references as mentioned herein before.

3.14.4 MEASUREMENT AND PAYMENT

The unit price of structural steel shall be measured and paid for by the kilograms and shall include procurement, transportation, fabrication, painting, erection and all related works. The unit prices shall constitute full payments for all labor, materials, scaffoldings, etc. necessary for the successful completion of the work.

3.15 RUBBLE CONCRETE

3.15.1 GENERAL

Division 1, “General Requirements” contain provision and requirements essential to these specifications, and apply to this section, whether or not referred to herein.

3.15.1.1 SCOPE OFWORK

This section shall consist of the furnishing and placing of rubble concrete for breakwater and other structures called for on the drawings, constructed on the prepared foundation bed, in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on the drawings.

Rubble concrete shall be Class C concrete with stones embedded therein.

3.15.1.2 GENERAL REQUIREMENTS

Concrete works shall conform with the requirements of Section 3.2, “Concrete Works.”

3.15.1.3 SURVEY AND SETTING OUT

Contractor shall set out works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical limits of works.

Applicable requirements under Section 2.3, “Surveys, Soundings, Soil Investigations, Installation of Markers, etc.,” shall apply to his section.

3.15.2 MATERIAL REQUIREMENTS

3.15.2.1 STONES

Stones for rubble concrete shall consist of rocks as nearly rectangular in section as is practical. The stones shall be sound, tough, durable, dense, resistant to the action of air and water and suitable in all respects for the purpose intended.

Unless otherwise indicated on the drawings, stone for rubble concrete shall have a minimum weight of 5kg. to a maximum of 20kg. with at least 50 percent of the stones weighing more than 15 kg.

3.15.2.2 CONCRETE

Concrete shall be Class C, conforming to the requirements given under Section 3.2, “Concrete Works.”

3.15.2.3 FORMWORK

Formwork shall conform to the requirements given under Section 3.2, “Concrete Works.”

3.15.3 EXECUTION

All stones shall be cleaned thoroughly and wetted immediately before being set. Stones shall be laid firmly on prepared foundation bed starting from the base or bottom laying upslope. Concrete, 300 mm thick shall be laid first prior to placement of stones. Stones shall be carefully hand laid and thoroughly incorporated into the mass at least 300mm below the outside surface of the concrete. Horizontal and vertical spacing of stones shall not be less than 30 mm. Class C concrete shall be placed and spread to properly filled all the voids and up to the required sections, grades and elevations shown on the drawings. Finish surface of rubble concrete shall be smooth and no portion where stone is visible after completion of the works. Minimum covering of concrete shall be 300 mm all throughout.

3.15.4 MEASUREMENT AND PAYMENT

The quantities of rubble concrete to be measured for payment shall be the number of cubic meters of rubble concrete in place including preparation of foundation bed, in close conformity with the drawings and accepted by the Engineer.

The computation of the quantities will be based on the volume within the limiting dimensions designated on the drawings or as determined by the Engineer.

The quantities measured as provided above shall be paid for at the contract unit prices as shown in the Bill of Quantities, which price and payment shall be full compensation for the necessary excavation and preparation of the foundation bed, for furnishing and placing materials including all labor, equipment, tools and incidentals necessary to complete this item.

3.16 NAVIGATIONAL AID

3.16.1 SCOPE OF WORK

This Section covers the procurement and installation of light beacons and buoys for navigational aid including sinkers and reinforced concrete foundation. Unless otherwise instructed by PPA, the Contractor shall procure and install beacons at the location as indicated on the drawings.

The Buoy system shall be in accordance with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System B.

3.16.2 MATERIAL REQUIREMENTS

3.16.2.1 GENERAL DESCRIPTION

For reference and guidance, hereunder are the general descriptions of the light beacons to be procured and installed by the Contractor.

3.16.2.2 DESCRIPTION OF NAVIGATIONAL AIDS

Materials shall conform with the specified material or approved equivalent.

1. Light Buoy (Entrance Buoy) : Solar and Turbine (Wave Activator)

a. Buoy Data

1)	Main material	:	Steel plate
2)	Height overall	:	Approx. 8.9 m
3)	Focal plane height	:	Approx. 4.8 m

4)	Outside diameter of float	:	Approx. 2.6 m diameter
5)	Total weight	:	Approx. 5.5 tons
6)	Total buoyancy	:	Approx. 8.7 tons
7)	Reserved buoyancy	:	Approx.3.2 tons

b. Body

1)	Material	:	9 mm thick rolled steel plate
2)	Cathodic Protection	:	Anode plate
3)	Lifting eye	:	40mm steel plate (2 places)
4)	Mooring eye	:	40mm steel plate (2 places)
5)	Counter weight	:	Cast steel
6)	Bolts and Nuts	:	Stainless steel
7)	Buoy color	:	Starboard hand (RED) Port hand (GREEN)
8)	Rubber fender	:	Marine grade fender

c. Superstructure

1)	Material	:	Steel angle
2)	Bolts and nuts	:	Stainless steel
3)	Top mark	:	Steel

d. Mooring Equipment

1)	Main chain	:	32mm dia. Stud link chain with end link 30M x 1 pc JIS Grade 2
2)	Bridal chain	:	32mm dia. Stud link chain with end link 9M x 1 pc JIS Grade 2
3)	3 eyes piece	:	for 32mm dia. Chain x 1 pc
4)	Swivel piece	:	for 32mm dia. Chain x 1 pc
5)	Joining shackle	:	for 32mm dia. Chain x 6 pcs
6)	Anchor shackle	:	for 32mm dia. Chain x 1 pc
7)	Sinker (not to be supplied)	:	10 ton concrete sinker x 1 pc

e. Lighting Equipment

1)	Lantern	:	4 layer LED model
2)	Lens	:	Polycarbonate 4 layer type Fresnel lens

3)	Light color	:	Starboard hand (RED) Port hand (GREEN)
4)	LED load	:	12V 19.2W (RED colored light/ Green color)
5)	Flasher	:	Solid state system Pre-programmed with 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are filled adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	258 cd for Red light 265 cd for Green light
8)	Effective Range (T=0.74)	:	6.3 N.M. for Red 6.4 N.M. for Green
9)	Light Character	:	Fl 4 sec. (0.5+3.5 =4 sec)
10)	Protection for Stealing	:	Consideration must be taken for securing lantern to avoid loss after installation at sea.

f. Power Source

1)	Solar cell module	:	(12V, 26.2W) x 2 pcs Total output power 17.4V 52.4W
2)	Charging controller	:	Over voltage, over current and reverse current protection type
3)	Wave activated generator	:	maximum output power 12V 100W. Average output, power, more than 55W (in case wave height 40 cm and wave period sec)
4)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 3 pcs
5)	Battery life (without charge)	:	More than one month operation

6) Protection form theft : Consideration must be taken for securing power source to avoid loss after installation at sea.

g. GPS Synchronizer

GPS synchronizer can control for synchronize group flashing period.

1)	Model	:	(GPS receiving type)
2)	Receive frequency	:	1575 42 MHz
3)	Receiving channel	:	8 Channel
4)	Signal pulse voltage	:	5V +- 0.1V (p-p)
5)	Signal pulse time	:	2.0ms +- 0.5 ms
6)	Shape signal pulse	:	Rectangular shape
7)	Interval time of signal pulse	:	1 time every 2 hours
8)	Signal pulse accuracy	:	Within 3±3 ppm /sec.
9)	Power voltage	:	DC 12V
10)	Power consumption	:	0.125Ah / day 12V D.C. power supply

h. Lens Reflector

a.	Model	:	(equivalent area 10 square meter)
b.	Weight	:	Approx. 6.5 kg
c.	Main Material	:	F.R.P. resin

i. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Above water line			**Total 338 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	120 microns
Under water line			**Total 418 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	200 microns
Interior			**Total 36 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	1	18 microns

2. Light Buoy (Channel Buoy)

a. BUOY DATA

1)	Main material	:	Steel plate
2)	Height overall	:	Approx. 5.7 m
3)	Focal plane height	:	Approx. 3.0 m
4)	Outside diameter of float	:	Approx. 1.5 m diameter
5)	Total weight	:	Approx. 1.7 tons
6)	Total buoyancy	:	Approx. 2.7 tons
7)	Reserved buoyancy	:	Approx. 1.0 tons

b. BODY

1)	Material	:	4.5 mm thick rolled steel plate
2)	Cathodic Protection	:	Anode plate
3)	Lifting eye	:	steel plate (2 places)
4)	Mooring eye	:	steel plate (2 places)
5)	Counter weight	:	steel plate
6)	Bolts and Nuts	:	Stainless steel
7)	Buoy color	:	Starboard hand (RED) Port hand (GREEN) Hazard (YELLOW)
8)	Rubber fender	:	Marine grade fender

c. Superstructure

1)	Material	:	Steel angle
2)	Bolts and nuts	:	Stainless steel
3)	Top mark	:	Steel

d. Mooring Equipment

1)	Main chain	:	24mm dia. Stud link chain with end link 20M x 1 pc JIS Grade 2
2)	Bridal chain	:	24mm dia. Stud link chain with end link 4M x 2 pcs JIS Grade 2
3)	3 eyes piece	:	for 24mm dia. Chain x 1 pc
4)	Swivel piece	:	for 24mm dia. Chain x 1 pc
5)	Joining shackle	:	for 24mm dia. Chain x 6 pcs
6)	Anchor shackle	:	for 24mm dia. Chain x 1 pc
7)	Sinker (not to be supplied)	:	10 ton concrete sinker x 1 pc

e. Lighting Equipment

1)	Lantern	:	1 layer LED model
2)	Lens	:	Polycarbonate 1 layer type Fresnel lens
3)	Light color	:	Starboard hand (RED) Port hand (GREEN) Hazard (YELLOW)
4)	LED load	:	12V 4.8W (RED colored light/ Green color)
5)	Flasher	:	Solid state system Pre-programmed with 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are filled adjustable. At least 248 flashing characters should be pre-programmed.

6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	38 cd for Red light 48 cd for Green light 37 cd for Yellow light
8)	Effective Range (T=0.74)	:	4.0 N.M. for Red 4.8 N.M. for Green 4.0 N.M. for Yellow
9)	Light Character	:	Fl 4 sec. (0.5+3.5 =4 sec) for green and red
		:	Fl.5 sec. (0.5+4.5 = sec) for yellow
10)	Protection for Stealing	:	Consideration must be taken for securing lantern to avoid loss after installation at sea.

f. Power Source

1)	Solar cell module	:	(12V, 11.5W) x 1 pc Total output power 17.4V 11.5W
2)	Charging controller	:	reverse current protection type
3)	Wave activated generator	:	maximum output power 12V 100W. Average output, power, more than 55W (in case wave height 40 cm and wave period sec)
4)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
5)	Battery life (without charge)	:	More than one month operation
6)	Protection form theft	:	Consideration must be taken for securing power source to avoid loss after installation at sea.

g. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Above water line			**Total 338 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	120 microns
Under water line			**Total 418 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	2	200 microns
Final coat	Epoxy Topcoat	2	200 microns
Interior			**Total 36 microns**
Under coat	Epoxy zinc rich primer	1	18 microns
	Epoxy resin primer	1	18 microns

3. Light Beacon

a. Beacon Data

1) Main material : Mild Steel
2) Height overall : Approx. 3.3 m
3) Focal plane height : Approx. 3.2 m
4) Outside diameter of body : Approx. φ318.5 mm & φ 508mm
5) Total weight : Approx. 407 kg

b. Body

1) Material : 8.0 mm thick steel pipe
2) Bolts and nuts : Stainless steel
3) Buoy color : White

c. Superstructure

1) Material : Steel pipe
2) Bolts and nuts : Stainless steel

d. Lighting Equipment

1)	Lantern	:	(1 layer LED model)
2)	Lens	:	Polycarbonate Fresnel lens
3)	Light color	:	White
4)	LED load	:	12V 4.8W White color light
5)	Flasher	:	Solid state system Pre-programmed w/ 256 flashing characters. (248 pre-programmed 8 as specified by customer). And 256 flashing characters are field adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	40 cd for White
8)	Effective luminous intensity	:	28 cd for White
9)	Effective Range (T=0.74)	:	3.7 N Miles for White
10)	Light Character	:	Fl 4 sec. (0.5+3.5 = 4 sec) for white
		:	Fl.6 sec. (0.5+5.5 = 6 sec) for white

e. Power Source

1)	Solar cell module	:	12V, 11W) x 1 pc
2)	Charging controller	:	Over voltage charger
3)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
4)	Battery life (without charge)	:	Approx. 30 days operation

f. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Interior of battery box body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns
Exterior of body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns

4. Light Beacon

a. Beacon Data

1) Main material : Mild Steel
2) Height overall : Approx. 3.6 m
3) Focal plane height : Approx. 3.5 m
4) Outside diameter of body : Approx. φ216.3 mm
5) Total weight : Approx. 150 kg

b. Body

1) Material : 5.8 mm thick steel pipe
2) Bolts and nuts : Stainless steel
3) Buoy color : White

c. Superstructure

1) Material : Steel pipe
2) Bolts and nuts : Stainless steel

d. Lighting Equipment

1)	Lantern	:	(1 layer LED model)
2)	Lens	:	Polycarbonate Fresnel lens
3)	Light color	:	White
4)	LED load	:	12V 4.8W White color light
5)	Flasher	:	Solid state system Pre-programmed w/ 256 flashing characters (248 pre-programmed, 8 as specified by customer). And 256 flashing characters are field adjustable. At least 248 flashing characters should be pre-programmed.
6)	Sun Switch	:	Photo electric cell system
7)	Luminous intensity (fixed)	:	40 cd for White
8)	Effective luminous intensity	:	28 cd for White
9)	Effective Range (T=0.74)	:	3.7 N Miles for White
10)	Light Character	:	Fl.4 sec. (0.5+3.5 = 4 sec) for white
		:	Fl.6 sec. (0.5+5.5 = 6 sec) for white

e. Power Source

1)	Solar cell module	:	(12V, 11W) x 1 pc
2)	Charging controller	:	Over voltage charger
3)	Storage battery	:	Sealed lead acid battery (12V, 40Ah) x 1 pc
4)	Battery life (without charge)	:	Approx. 30days operation

f. Paint Schedule

Process	Kind of Paint	Number of Coat	Thickness
Interior of battery box body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns
Exterior of body			**Total more than 220 microns**
Under coat	Epoxy zinc rich primer	1	more than 25 microns
	Epoxy resin	2	more than 125 microns
Final coat	Polyurethane resin	1	more than 35 microns
	Polyurethane resin	2	more than 35 microns

3.16.3 EXECUTION

1. Prior to procurement of light beacons and bouys, the Contractor shall submit the manufacturer's catalogue, with detailed information of the product, for approval of the Engineer. The Contractor shall carry out detailed hydrographic survey in the vicinity of the place where light beacons and bouys are intended to be installed for Engineer's approval. The Contractor shall also secure permit/clearance to install the light beacons from the Philippine Coast Guard.

2. After installation, the actual location of light beacons as installed shall again be surveyed and the results thereof shall be submitted to the Engineer for approval.

3.16.4 MEASUREMENT AND PAYMENT

Measurement and payment of quantities of light beacon and bouys shall be based on the number of sets of light beacon completely installed including reinforced concrete base certified by PPA.

The work includes the furnishing of all labor, materials, and equipment required to install all navigational aids, in accordance with these Specifications and where shown on the Drawings and to the approval of the Engineer.

The Contractor shall satisfy himself and shall be deemed to have satisfied himself as to the nature of the sub-soil conditions, topographic and hydrographic conditions.

The Contractor shall be deemed to include in his unit prices allowances to cover all risks, except noted otherwise, for any contingencies that may arise during or in connection with the works.

3.17 PRECAST CONCRETE

3.17.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

Precast concrete to be used shall comply generally with the sections relating to concrete and reinforcement concrete and the following clauses, including those for prestressed concrete where applicable.

Concrete members so specified shall be fabricated as precast units with concrete for the specified class placed into a grout-tight mould. If so required, the mould shall be laid on the vibrating table and vibration applied while the concrete is placed.

Permanently exposed surfaces shall have a finish given by moulds of closely-jointed steel material. The surface shall be improved by carefully removing all fins and other projections. After inspection by the Engineer, any concrete surfaces which have been accepted but contain blemishes filled with a cement and fine aggregate paste matching the color of the concrete.

Surfaces which will subsequently received grout or concrete to complete a structural connection or other composite structural component of which the precast unit forms a part, shall be prepared for surfaces treatment as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened, by jetting with a fine spray of water or rushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impractical, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking shall be avoided.

The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the Specification and that the Contractor obtains the Engineer’s approval for each supplier.

The Contractor shall give to the Engineer full details of proposed methods of handling and stacking precast concrete units. The Engineer will examine these details and will either approve the methods or cite other modifications design to ensure that no excessive stresses are set up in the units. The finally approved methods shall be adhered to at all times and the

Contractor shall be deemed to have included in his rates for all measures required to handle and stack beams and units safely and without undue stressing.

3.17.2 CASTING BED AND MARKING

All precast units shall be cast on a suitably prepared level, unyielding paved area or on suitable platforms. A suitable serial number indicating the date of casting shall be impressed or painted on each unit or portions cast.

3.17.3 CONSTRUCTION JOINT

Every unit shall be cast in one continuous operation. Construction joints shall be avoided.

3.17.4 TOLERANCES FOR INDIVIDUAL UNITS

Precast concrete units shall be true to the size and dimensions shown on the Drawings within the following limits:

Lengths

up to 3 meters	± 6
More than 3 meters but less than 6 meters	± 9
6 meters or more	± 12

Cross Section (each direction)

up to 0.5 meters	± 6
More than 0.5 meters but less than 0.75 meters	± 9
0.75 meters or more	± 12

Straightness or bow (deviation from intended line)

up to 3 meters	± 6
More than 3 meters but less than 6 meters	± 9
6 meters or more	± 12

3.17.5 SQUARENESS

When measuring the squareness of a corner, the longer of the two adjacent sides shall be taken as the base line. The shorter side shall not vary in its distance from a perpendicular so that the difference in mm. between the greatest and shortest dimensions exceeds :

Lengths of short side

up to 1.2 meters	± 6
More than 1.2 meters but less than 3 meters	± 9
3 meters or more	± 12

3.17.6 TWIST

Any corner shall not be more than the tolerance stated in mm. from the plane containing the other three corners:

up to 0.7 meter wide and up to 6 meters in length	± 6
over to 0.7 meter wide and for any length	± 9

3.17.7 MEASUREMENT AND PAYMENT

1. Prices to be paid shall constitute full payment for all labor, materials, and equipment and all testing and incidental works necessary for the completion of the work.

2. Precast concrete shall be measured either by the number of each precast unit or by volume in cubic meter whichever is called in the Bill of Quantities. Payment shall include the cost of reinforcing steel bar needed for each precast units.

   No deduction shall be made for volume of concrete displaced by reinforcing steel, structural steel or steel piles.

3.18 PRESTRESSED CONCRETE

3.18.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.18.1.1 SCOPE OF WORK

The sections relating to concrete, reinforced concrete and precast concrete shall be read in conjunction with the following clauses.

The work shall consist of furnishing, transportation, storage and placing of prestressed concrete, stressed by pretensioning or post-tensioning method. It shall be in accordance with the Drawings and as specified herein Also the work shall be in accordance with Section 3.2, “Concrete Works” of these Specifications.

Unless otherwise ordered by the Engineer, the Contractor shall certify for the Engineer’s approval that a technician skilled in the required prestressing method will be available during its implementation to give aid and instruction in the use of prestressing equipment and installation of materials as maybe necessary to produce prestressed concrete.

3.18.1.2 DEFINITION

1. Post-tensioning is defined as any method of prestressing concrete in which tensioned reinforcement is stretched after the concrete has hardened.

2. Pretensioning is defined as any method of prestressing concrete in which the tensioned reinforcement is tensioned before the concrete is placed.

3. Prestressing reinforcement is defined as any reinforcement to which prestress is applied by post-tensioning or pre-tensioning method.

3.18.2 MATERIAL REQUIREMENTS

3.18.2.1 TYPES OF CONCRETE

The concrete shall be of the types as specified on the Drawings and at the time of prestressing shall have reached the specified strengths as determined by the test cylinders which have matured under the same conditions as the units to which the cylinders shall be marked conspicuously with the date of casting and other identification marks as directed by the Engineer.

3.18.2.2 PRESTRESSING STRAND

Prestressing strand to be used shall be high-tensile strand conforming to JIS G 353G, SWPR 19 (AASHTO M 203, “Steel Strand, Uncoated Seven-Wire for Prestressed Concrete” or ASTM A 416, “Steel Strand, Uncoated Seven-Wire for Prestressed Concrete”).

3.18.3 EXECUTION

3.18.3.1 GENERAL

Prestressed concrete structural members shall be constructed and placed in accordance with the requirements of Section 3.2, Concrete Works”.

3.18.3.2 PRESTRESSING METHODS

The methods of prestressing to be used shall be optional but shall be subject to all requirements herein after specified.

The Contractor, prior to casting any members to be prestressed shall submit in advance for approval of the Engineer complete details of the methods, materials and equipment proposed to be used in the prestressing operations. Such details shall outline the method and sequence of prestressing, complete specifications and details of the prestressing steel and anchoring devices proposed for use, anchoring stresses, type of sheath, and all data pertaining to the prestressing operations including the proposed arrangement of the prestressing units in the members pressure grouting materials and equipment.

3.18.3.3 PRESTRESSING EQUIPMENT

Hydraulic jacks shall be equipped with accurate pressure gauges. The Contractor may elect to substitute screw jacks or other types for hydraulic jacks. In which case, proving rings or other approved devices shall be used in connection with the jacks. All devices, whether hydraulic jack gauges or otherwise shall be calibrated so as to permit the stress in the prestressing steel to be computed at all times. A certified calibration curve shall accompany each device. Safety measures shall be taken by the Contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

3.18.3.4 CASTING YARD

The precasting of prestressed concrete structural members may be done at a location selected by the Contractor, subject of the approval of the Engineer

3.18.3.5 PLACING ENCLOSURES

Enclosures for prestressed reinforcement shall be accurately placed at locations shown on the Drawings or approved by the Engineer.

3.18.3.6 PLACING OF STEEL STRANDS

All steel strands units shall be accurately and firmly placed in the position shown on the drawings or as instructed by the Engineer.

Steel strands clearance from the forms shall be maintained by stays, blocks, ties or hangers approved by the Engineer. Blocks for holding units from contact with the forms shall be precast mortar blocks of approved shape and dimensions. Layers of units shall be separated by mortar blocks or other equally suitable devices. Wooden blocks shall not be left in the concrete.

Suitable horizontal and vertical spacers shall be provided if required to hold the wire and strand correctly in place in the sheath.

3.18.3.7 PLACING OF CONCRETE

Concrete shall be deposited in the forms only after the Engineer had inspected and approved the reinforcement, enclosures, anchorages, and prestressing steel. The concrete shall be vibrated internally or externally or both with care as ordered by the Engineer in such a manner as to avoid displacement of reinforcement, enclosures, or prestressing strand.

3.18.3.8 CONTRACTION/CONSTRUCTION JOINT

Concreting for single prestressed concrete units shall be done continuously without any contraction joint.

Construction joints shall not be allowed unless permitted by the Engineer in writing.

3.18.3.9 CURING

Concrete shall be adequately cured to prevent the harmful effects of drying and rapid change in temperature. Curing shall be done by methods approved by the Engineer. Proper care shall also be exercised to insure that fresh concrete will not be damaged by vibration, impact or lifting or loading.

Prestressed concrete slabs shall be adequately cured before the application of tensioning.

3.18.3.10 PRE-TENSIONING

The prestressing elements shall be accurately held in position and stressed by jacks. The Contractor shall record the jacking forced and the elongations produced. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to concrete, nor end anchorages released until the concrete has attained a compressive strength, as shown by cylinder tests, of at least 28 MPa. The elements shall be cut or released in such an order that lateral eccentricity or prestress will be a minimum.

3.18.3.11 POST-TENSIONING

Tensioning of the prestressing reinforcement shall not be commenced until tests on concrete cylinders, manufactured from the same concrete and cured under the same conditions has attained a compressive strength of at least 28 Mpa.

The steel strands shall be stressed by means of jacks to the required tension and the stressed transferred to the end anchorages. The tensioning process shall be conducted in a manner that the tension being applied and the elongation of the prestressing elements may be measured at all times.

To minimize possible irregularity in quality the tensioning operation shall be closely supervised for each group of strands to insure that tension applied will not go under the specified value.

During the tensioning operation the Contractor shall monitor the amount of tension and the elongation of strand to insure that they are proportional. The tension applied to the strand shall be measured by the load gauge and the elongation by approved method. The tensioning operation shall be re-executed if the relationship between the applied tension and the elongation vary from the allowed proportion. In the event that any abnormality is found after re-execution of tensioning the operation shall be suspended and the cause determined taking into account friction loss, deformation or slippage of anchors and other causes allowed by the Engineer. Where tension is applied to each piece of strand or group of strands, care shall be exercised so that no harmful stress is allowed to concentrate at any stage of operation. The tension to be applied at the end of strands shall be determined taking into account the change in tension applied to each group of strand due to elastic deformation of concrete.

3.18.3.12 GROUTING

Grouting shall be done in such a way that it will fill up the duct while the strands are well protected and concrete and strands are firmly bonded.

The grout shall be tested in accordance with the test methods for consistency, bleeding ratio, expansion ratio and concrete strength recommended by the Japan Society of the Civil Engineers or other equivalent standards of tests.

The test results shall comply with the following requirements:

- Consistency, Flow Time

  15-30 sec (JA funnel) or 6-12 sec (J funnel)
- Expansion ratio, Less than 10%
- 28 - day compressive strength more than 200 kg./cm^2.

The cement ratio of the grout shall less be than 45%.

All prestressing strands to be bonded shall be free of dirt, loose rust, grease, or other deleterious substances. Before grouting, the ducts shall be free of water, dirt or any other foreign substance. Cleaning may be done preferably by bombarding with compressed air until no water comes through the duct. The grout pump shall be capable of pumping grout gradually and without any air bubble. The duct shall be thoroughly cleaned and wet with water before commencing the grouting operation. Pouring of grout shall be done slowly, using the grout pump. The grout shall be filtered through suitable sieve before grouting. Sufficient pressure shall be used in grouting to force the grout completely through the duct, care being taken that rupturing of the ducts does not occur.

The grout mixer shall be of sufficient capacity and capable of mixing grout for a 5 minutes continuous grouting operation. Grout of uniform consistency shall be delivered through the outlets in sufficient amount. The outlets shall then be closed one by one along the direction of grouting. The grout shall be of fluid or thick paint consistency proportioned so that free water will not separate from the mix. Commercial plasticizers used in accordance with the manufacturer's recommendation may be used provided they contain no ingredients that are corrosive to steel.

3.18.3.13 PREMOLDED EXPANSION JOINT FILLER

Premolded expansion joint filler used for the wharf widening section, distance beam and the landside crane rail foundation beam shall be soft fiber strips impregnated with bitumen, conforming to Item 405-2.8,Standard Specifications for Highway and Bridges of the Department of Public Highways, revised 2004.

3.18.4 MEASUREMENT AND PAYMENT

1. The quantity of precast prestressed members to be measured shall be the actual number of members, of types installed in place, level completed and accepted before placement of any in-situ concrete.

2. The work measured as provided above shall be paid for at the unit rates entered into the Bill of Quantities.

3. The unit rates for precast prestressed members shall include for:

   a. Concrete, formwork, non-prestressed and prestressed reinforcement, enclosures for prestressing steel, anchorages, grouting curing plates, nuts and other such incidentals necessary to complete the work.

   b. Delivery and Settings: The payment shall be fully compensated for furnishing and placing of all materials including all labor, tools, equipment, testing and incidentals thereto.

3.19 PAINTING OF PORT FACILITIES

3.19.1 GENERAL

VOLUME I, preceding these Technical Specifications and Section these Technical Specifications and Section I, - GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, Whether or not referred to herein.

3.19.1.1 SCOPE OF WORK

This Section covers the surface preparation, coating materials and application of coatings system required for the Works.

3.19.1.2 GENERAL PROVISIONS

1. All exposed metal surfaces, except metal surfaces embedded in concrete or galvanized shall be painted unless otherwise specified. All tools and equipment shall be suitable for the work and shall be maintained in good order.

2. Applicable Publications: The following publications listed below, but referred to thereafter by basic designation only, forms a part of this specification to the extent indicated by the reference thereto:

Steel Structures Painting Council (SSPC) U.S. Specification.

JIS K 5628 Red-lead Zinc Chromate Anti-Corrosive Paint.

3.19.1.3 STORAGE AND DELIVERY

1. The Contractor shall deliver all materials to the job site in the original labeled seated cans and containers, with labels intact and seal unbroken.

    a. Seals shall remain unbroken until after inspection and acceptance of materials by the Engineer.

    b. The Contractor shall deliver materials in ample quantities in advance of the need to avoid any delays or interruptions in the Work.

2. Storage: Paint and thinner shall be stored in accordance with the manufacturer's printed instructions.

    a. Observe all regulations required for storage of paint and post all necessary safety signs required by governing codes.

    b. Repair any damage caused by failing to exercise proper precautions in paint storage.

    c. All containers of paint shall remain unopened until required for use; containers which have been opened shall be used first, otherwise the oldest paint shall be used first.

    d. No paint material shall be used which has exceeded the manufacturer's recommended shelf life.

3.19.1.4 QUALITY ASSURANCE

1. Surface preparation and painting work shall be carried out in accordance with the requirements specified herein.

2. The paint manufacturer's instructions shall be observed at all times, with particular reference to storage, mixing, thinning, application and the time interval between paint coats.

3. The Contractor shall ensure that his shop and site personnel, have at all times, available for the Engineer copies of al above mentioned standard Specifications and the applicable manufacturer's instructions and data sheets.

3.19.2 MATERIALS

3.19.2.1 GENERAL

Paints for the protective coating system shall be the product of a manufacturer, approved by the Engineer.

3.19.2.2 GENERAL PAINT SCHEDULE

1. Protective shop coating for metal works shall be as follows:

    a. Primer: One (1) coat of red-based zinc chromate anti-corrosive paint 3 mils (76 microns) conforming to JIS K 5628 or approved equal.

    b. Coating: Two (2) coats of anti-corrosive paint 6 mils conforming to JIS K 5621 or approved equal.

2. Protective shop coating for exposed general metal structures.

    a. Primer: One (1) coat of red-lead zinc chromate anti-corrosive paint 3 mils (76 microns) conforming to JIS K 5628 or approved equal.

    b. Coating: Two (2) coats of anti-corrosive paint for general use 6 mils conforming to JIS K 5621 or approved equal.

    c. Color: As shown on the Drawings or as requested by the Engineer.

3. Cement Mortar Wall and Wood as shown on the Drawings or as directed by the Engineer shall be painted with one coat of linseed oil and two coats of oil paint of approved quality.

4. Equipment

    a. Paint Mixers: Mechanical mixers shall be employed for all paint mixing operations, except that the Engineer may allow hand mixing of small quantities at his discretion.

    b. Compressed air supply for blast cleaning and paint spraying shall be adequate in pressure and volume.

3.19.3 EXECUTION

1. Steel surface shall be cleaned in accordance with the approved method as described below:

a. All ground welds, burrs and sharp surface projection shall be ground smooth and all weld splatter shall be removed prior to blast cleaning.

b. The grit size shall be 20-40 mesh Ottawa Fint Silica or equivalent. Grit or shot blasting which obtain the desired profile and degree of cleaning are also acceptable.

c. Blast cleaning operations shall not be conducted on surfaces that will be wet after blasting and before coating, or when the surfaces are less than 10°C above degree points, or when the relative humidity of the air is greater than 95 percent.

d. Any oil grease, soil, dust or other foreign matter deposited on the cleaned surfaces shall be removed prior to painting. In the event that rusting occurs after completion of the surface preparation, the surfaces shall be cleaned again in accordance with the specified method.

e. Particular care shall be taken to prevent contamination of cleaned surfaces with the salt, acids, alkali or other corrosive chemicals before the application of the paint. Such contamination shall be removed from the cleaned surface by flash blasting and the paint applied immediately.

f, Care shall be taken to prevent contamination of cleaned and painted surfaces by cleaning operations in an adjacent area.

g. Surfaces not included to be painted shall be suitably protected from the effects of cleaning and painting operation.

2. All loose mill scaled and all loose or non-adherent rust and all loose paint, shall be removed by one or more of the following methods; but large areas of tight, well adhered paint, even though they may be removable, shall be removed only if specified. The methods for such removal are:

a. Power wire brushing using rotary radial or cup brushes of suitable size, entering all accessible openings, angles, joints, and corners. The steel wire of such brushes shall have sufficient rigidity to clean the surface. Brushes shall be kept free of excess foreign matter, and shall be discarded shall be cleaned but not burnished to a detrimental degree.

b. Power impact tool cleaning using power driven needle guns, chipping or scaling hammers, scalers, or other similar impact cleaning tools. Cutting edges of such tools shall be kept in effective condition.

c. Power grinding using abrasive wheels or power sanding using abrasive materials. Sanding or abrasive materials shall be discarded when they become in effective.

3. Mill scale, rust and paint are classified as “loose mill scale”, “loose and non-adherent rust,” and “loose” or “removable paint” if they can be removed from a steel surface by power wire brushing using a commercial air or electric wire brushing machine operated at a speed under load of 3450 RPM and equipped with a 150 mm diameter cup brush, of double row knotted construction made of No. 20 gauge music wire (Osborn Manufacturing Company), Cleveland, Ohio, Brush No. 4503 or equal. The brush shall be held against be held against the steel surface with a forced of 35.2 kgs And the rate of cleaning shall be 0.186 square meters of surface per minute. This test must be conducted on an area not previously brushed, scrapped, or sanded, but from which all detrimented stratified rust (rust-scale), oil and grease, if present, have been removed. This test establishes a standard for surface preparation and shall not be considered as establishing the production rate of cleaning.

4. Regardless of the method use for cleaning under this specification, the surface shall be cleaned at least as well as the surface resulting from the test as specified in this specification or to match the alternatively specified visual standard.

5. In preparing surfaces for repainting, all loose paint shall be removed. Thick edges of remaining old paint shall be feathered so that the repainted surface can have a smooth appearance. The remaining old paint shall have sufficient adhesion so that it cannot be lifted as a layer by inserting the blade of a dull putty knife under it.

6. All accessible weld flux and spatter shall be removed by blast cleaning or by power tools. Any remaining detrimental weld flux deposits shall be removed by blast cleaning, thorough power tool cleaning, or by washing with water or with phosphate solution as described in the approved standard specifications.

7. The accessible portions of all partially enclosed steel members shall be cleaned. On new work, areas which will be inaccessible after assembly shall be cleaned before assembly.

8. Rivet heads, cracks, crevices, gap joints, filler welds, and re-entrant angles shall be cleaned by the use of power wire brushes, needles, guns, sharp chisels used in chipping, scaling hammers, rotary grinders, or sanders, or by a combination of such tools.

9. All tools shall be operated in such a manner that no burns or sharp ridges are left on the surface and no sharp ridges are left on the surface and no sharp cuts are made into the steel.

10. Areas inaccessible for cleaning by power tools but accessible for hand cleaning shall be cleaned by the approved methods.

11. After the aforesaid operations are competed, dust and other loose matter shall be removed from the surface. If detrimental amounts of grease or oil are still present, these areas shall be spot cleaned with solvent.

12. The pretreatment (if any), or the prime coat of paint shall be applied as soon as possible after cleaning and before further deterioration of the surface occurs.

3.19.3.1 ALTERNATIVE SURFACE PREPARATION OF STEEL

1. The procedures required for the pickling process of steel surfaces prior to the application of Inorganic zinc coating shall consist of the following sequences of operations:

    a. Pretreatment: Remove soil, drawing compounds, salts or other foreign matter (other than grease or oil) by brushing with stiff fiber or wire brushes or by scraping.

        1. Deposits of oil grease shall be completely removed by solvent wiping the surface with rags or brushes soaked in solvent. The final cleaning shall be done using clean solvent and clean rags or brushes to provide an oil-free surface.

        2. An alternate method may be used where heavy deposits are removed by the above method, followed by vapor degreasing using stabilized chlorinated hydrocarbon solvents.

    b. Acid Baths: The steel shall then be dipped into a solution of 5 - 6 percent sulphuric acid that is maintained at a temperature of 71 - 82°C until all rust and scale is removed. The required time for removal of rust and scale can vary from 5 - 32 minutes, depending on thickness of the steel.

    c. Water Rinse: The steel is then rinsed in a fresh water tank maintained at a temperature of 38 - 60°C for a minimum time of two minutes to completely neutralize the steel surface.

d. Caution: Prolonged immersion in the acid bath will caused smut deposit on the surface. Steel surfaces shall be examined prior to coating and, if surface is contaminated with smut, the surface shall be cleaned with rags.

e. Requirements: The maximum allowable concentration of dissolved iron content shall not exceed 5 percent in the sulphuric acid bath. Water rinse tanks shall contain only fresh water. The rinse tank shall be continuously supplied with fresh water and the total sulphate shall not exceed 0.1 percent by weight.

3.19.3.2 SURFACE PREPARATION OF WOOD

1. Wood surfaces shall be sanded to a fresh surface. Surface mould where present, shall be removed by washing, rubbing down and burning off as necessary. Oily timbers shall be swabbed with white spirt. Resinous exudation and large knots shall be removed and replaced with filler or knotting.

2. Parts of timber to be enclosed in walls shall always be primed unless already impregnated. Priming shall be brushed on and a minimum of two coats applied to end grain. When the priming paint is hard, all cracks, holds, open joints, etc. Shall be made good hard stopping and rubbed down with fine abrasive paper. Priming of joinery shall be applied only on site after the Engineer has approved such joinery and before it is fixed. For internal surfaces primer coats shall be carefully flatted.

3.19.3.3 MIXING AND THINNING

1. Mixing and thinning of paint shall be done in accordance with the manufacturer's printed instructions. The pot life of each paint as stated by the manufacturer shall not be exceeded.

3.19.3.4 WEATHER CONDITION

1. The paint shall not be applied when the relative humidity is above 85 percent. The paint shall not be applied in rain, wind, fog, dust or mist.

3.19.3.5 APPLICATION

1. Paint shall be applied in accordance with the manufacturer's printed instructions.

2. The paint work crew shall be property trained in the use of the paint materials specified herein. Paint shall not be applied by personnel who are not familiar with the paint and its application.

3. Each coat of paint shall be applied as a continuous film of uniform thickness free of pores. Any thin spots or missed areas shall be repainted and permitted to dry before the following coat of paint is applied.

4. During the application of the paint care shall be taken to prevent all runs or sags. Should either occur, they shall be brushed out. Paint shall be worked into all crevices and corners.

5. If during the application of the paint, there appears faulty paint, i.e., in color, consistency, dry lime or quality of finish, then the work shall be stopped by the Contractor and the manufacturer consulted. The Contractor shall also notify the Engineer in writing. The responsibility for such action lies solely with the Contractor.

6. Areas where field welds are to be made shall not be painted within the 150 mm of the edges to be field welded.

7. After the application of each coat, the dry film thickness shall be checked by means of a micrometer or magnetic thickness gauge.

8. Paint that curls or lifts after application shall be removed and the area shall be cleaned and repaired in accordance with these Specifications.

3.19.3.6 TOUCH-UP PAINTING

1. Touch-up painting shall be done with the same paint as used for the original coat. The resulting minimum dry film thickness shall be the same as for the original coat.

2. Touch-up painting shall include cleaning and painting of field connections, welds and all damaged or defective paint and rusted areas.

3. During touch-up painting, only loose, cracked brittle of non-adherent paint shall be removed during cleaning. All exposed edges shall be feathered. Touch-up painting shall be performed in a manner which will minimize damage to sound paint. Rust spots shall be thoroughly cleaned and edges of the existing paint shall be scraped back to sound material.

3.19.3.7 DRYING

1. No primer or paint shall be forced dried under conditions which will cause cracking, wrinkling, blistering, formation of pores which would detrimentally affect the condition of the paint.

2. No drier shall be added to the paint unless specified in the manufacturer's printed instructions.

3. Painted surfaces shall be protected from dust, dirt, and the elements of the weather until dry to the fullest extent practicable.

4. After drying, any areas of paint damaged from any cause shall be removed, the surface again prepared and then repainted with the same paint and to the same thickness as the undamaged areas.

3.19.3.8 HANDLING

1. Paint which is damaged in handling shall be scraped off the touched-up with the same paint and in the same thickness as was previously applied to the damaged are at Contractor's expense.

2. Precautions shall be taken to minimize damage to paint films resulting from stacking for drying.

3.19.3.9 INSPECTION

1. All work and materials supplied under this specification shall be subject to inspection by the Engineer.

2. The Contractor shall correct such work or replace such material as is found defective under this Specification at his own expense.

3.19.3.10 MEASUREMENT AND PAYMENT

1. Measurement for painting of Port facilities is included in the individual work items of structural steel, navigation aids and fender system.

2. Painting of port facilities will not be measured for payment and all costs thereof shall be deemed to be included in other items of work.

3. Payment for painting of buildings shall be by the square meter at the contract unit price for the pay items as shown in the Bill of Quantities which includes all other related works as prescribed in this Section.

3.20 CERAMIC-FILLED LIQUID MEMBRANE

3.20.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.20.1.1 SCOPE

This work covers all the following requirements regarding the application of a ceramic-filled liquid membrane on the surface of concrete deck in accordance with the dimensions shown on the Drawings.

3.20.1.2 DELIVERY AND STORAGE

The ceramic-filled liquid membrane shall be delivered in pre-measured containers of 15 litter pails (net material volume). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements.

3.20.2 MATERIAL REQUIREMENTS

The ceramic-filled liquid membrane shall meet the following requirements in full. if required, a sample of the material in 3 pieces of 150 mm x 150 mm in shall be supplied to the Engineering for approval and retention for purposes of comparative testing.

3.20.2.1 PHYSICAL PROPERTIES

1. The ceramic-filled liquid membrane shall be a single component with a vehicle type of water based vinyl terpolymer matrix, 56% volume solids.

2. The material furnished under this specification shall be moisture resistant, UV resistant, non toxic and non flammable.

3. The material furnished under this specification when mixed and applied in accordance with the manufacture's instruction, shall produce a high quality, durable, seamless and flexible membrane.

4. The ceramic-filled liquid membrane shall have a flat finish.

5. The DFT of the applied ceramic-filled membrane shall be at least 12 mils applied in two coats at 6 mils per coat.

3.20.2.2 MECHANICAL AND CHEMICAL PROPERTIES

The ceramic-filled liquid membrane supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Drying Time	Typical 1 hour under normal ambient conditions
Elongation	230% (ASTM D 2370)
Fire Retardancy	Does not support combustion (ASTM D 1360)
Standing Water	Atlas Cell Test-No blistering, debonding or water penetration after 1 month submerged and at 100% humidity.

1. Installation of the ceramic-filled liquid membrane shall be in accordance with the manufacturer's instructions and recommendations. Suppliers shall be required to provide detailed descriptions of their proposed installation procedure for each unit of the material. mThese descriptions shall include the following:

    a. Surface preparation techniques to insure effective adhesion of the membrane to various substrates.

    b. Application procedures of the membrane.

    c. Time and temperature conditions to be obtained in order to completely solidify and cure the membrane.

2. To facilitate Quality Assurance, each unit of the material delivered to site shall be clearly labeled on the box with the manufacturer's name, product name, and production batch number.

3. The ceramic-filled liquid membrane shall be manufactured by a reputable manufacturer who shall confirm in writing that their material meets or exceeds the specification required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

4. To ensure proper handling and installation, each unit of the material shall have a Material Safety Data Sheet and installation Instructions Manual attached inside the carton/box

5. The Engineer reserves the right to sample and inspect the delivered materials for individual quality testing at the contractor's expense. Materials not meeting the manufacturer's certified values will be rejected.

3.20.2.3 WARRANTY

1. Manufacturer must submit a warranty for the ceramic-filled membrane against manufacturing defects for a period of one (1) year from the data of original purchase.

2. Approved bidders must submit a warranty for all applications for no less than a one (1) year period for the installation of the materials.

3.20.3 MEASUREMENT AND PAYMENT

The quantity of waterproofing works shall be measured by the area of waterproofing in square meters including cement or concrete leveling and topping (if required) , installed, completed and accepted by the Engineer.

The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the waterproofing work, accepted and certified for payment by the Engineer.

3.21 SLIP RESISTANT SYSTEM FOR ROLL-ON/ROLL-OFF CONCRETE RAMP

3.21.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.21.1.1 SCOPE

This work covers all the following requirements regarding the application of a slip/skid resistant system on the concrete RO-RO ramp in accordance with the dimensions shown in the drawings.

3.21.1.2 DELIVERY AND STORAGE

1. The polymer composite structural adhesive shall be delivered in pre-measured containers of 5 kg units (net material weight). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements. The Base component and activator component shall be packaged in separate and differently sized metal containers. The containers shall be packaged together in a cardboard carton.

2. The metallic oxide aggregates shall be delivered in pre-weighed 25 kg bags.

3.21.2 MATERIAL REQUIREMENTS

3.21.2.1 GENERAL

The slip/skid resistant system shall meet the following requirements in full. If required, a sample of the material on a concrete block 150 mm x 150 mm shall be supplied to the Engineer for approval and retention for purposes of comparative testing.

3.21.2.2 PHYSICAL PROPERTIES

1. The slip/skid resistant system shall be composed of a polymer composite structural adhesive and metallic oxide aggregates.

2. The polymer composite structural adhesive shall be a two-component, 100% solids material comprised of a Base component and an activator component.

3. The polymer composite structural adhesive material furnished under this specification shall be of high molecular weight polymer base.

4. The polymer composite structural adhesive shall consist of a DGEBA polymer Base and an amidoamine Activator.

5. The polymer composite structural adhesive material furnished under this specification when mixed and applied in accordance with the manufacturer's instructions, shall produce a corrosion resistant, highly durable, waterproof bonding agent between the cured concrete and aggregates.

6. The polymer composite structural adhesive must be free of harmful odors that could damage the environment as well as the personnel handling the application or installation.

7. The metallic oxide aggregates furnished under this specification shall be of grit size between # 16 to # 24.

8. The cured slip/skid resistant system shall be resistant to permanent immersion in sea water and shall be impervious to water. The manufacturer shall certify in writing that exposure of the cured material to such working environments will not affect its adhesive properties and corrosion resistance.

3.21.2.3 MECHANICAL AND CHEMICAL PROPERTIES

The polymer composite structural adhesive supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Shelf life	Indefinite
% Volatile	Not Volatile (zero evaporation rate)
Minimum Pot life @25^{o}C	45 minutes
Mixing Ratio (by volume)5(Base):	1 (Activator)

Direct Tensile Adhesion (ASTM D-4541):

Substrate	Bond Strength (psi)	Failure Mode
Unblasted Carbon Steel	1,500	Stud and panel adhesive failure
Unblasted Stainless Steel	1,400	Stud and panel adhesive failure
Dry Concrete	400	Concrete cohesive failure
Damp Concrete	400	Concrete cohesive failure

3.21.3 EXECUTION

1. Installation of the slip/skid resistant system shall be in accordance with the manufacturer's instructions and recommendations. Supplier shall be required to provide detailed descriptions of their proposed installation procedure. These descriptions shall include the following:

   a. Surface preparation techniques to insure effective adhesion of the system to the concrete

   b. Mixing and installation of the polymer composite structural adhesive and metallic oxide aggregates.

   c. Time and temperature conditions required to completely solidify and cure the system.

2. The polymer composite structural adhesive shall be manufactured by a reputable manufacturer who shall confirm in writing that their materials meets or exceeds the specifications required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

3. To ensure proper handling and installation, each unit of the material shall have a Material Data Sheet and an installation / instruction manual inside the carton/box.

3.21.4 WARRANTY

1. Approved bidder must submit a warranty for all applications for no less than a one (1) year period for the installation of the anti-skid system.

3.21.5 MEASUREMENT AND PAYMENT

The quantity of the application of a slip/skid resistant system on the concrete Ro-Ro ramp shall be measured by the area in square meters installed, completed and accepted by the Engineer.

The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the application of slip/skid resistant system on the concrete Ro-Ro ramp, accepted and certified for payment by the Engineer.

3.22 FORGED WELDED GRATINGS

3.22.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.22.1.1 SCOPE

This work covers all the following requirements regarding the manufacture and installation of steel gratings and steel angle frames in accordance with the lines, grades, and dimensions shown in the drawings.

3.22.1.2 DELIVERY AND STORAGE

1. The steel gratings and steel angle frames shall be delivered at site in matching sets with the manufacturer’s brand name, inspections tags, and production number to facilitate site quality assurance.

2. Upon delivery at site from the manufacturer, the hot dip galvanized steel gratings shall not be subjected to the following activities:

a. Re-fabrication
b. Cutting
c. Grinding
d. Welding
e. Drilling
f. Sawing
g. Any hot works or similar activities

3. The steel gratings and steel angle frames shall not be exposed to sea water and other corrosive chemicals or substances prior to installation.

3.22.2 MATERIAL REQUIREMENTS

3.22.2.1 GENERAL

The steel gratings and steel angle frames shall meet the following requirements in full. If required, a 1.0 linear meter x required load bar span dimension sample shall be supplied to the Engineer for approval and retention for purposes of comparative testing against materials randomly sampled from the site.

3.22.2.2 PHYSICAL PROPERTIES

1. The steel gratings shall be manufactured using the forge-welding process wherein the steel load bars and the twisted cross rods become homogenously unified through fusion.

2. Manually welded load bars to twisted cross rods shall be rejected.

3. The steel gratings and steel angle frames shall all be hot dip galvanized in accordance with international standards BS EN1460.

4. Painted steel gratings shall be rejected. Likewise, painted steel angle frames shall be rejected.

5. The end-banding of the steel gratings shall be attached using the Metal Inert Gas (MIG) Welding Process. Likewise, steel angle frames shall be manufactured using the Metal Inert Gas (MIG) Welding Process.

6. The allowable tolerances on dimensions on the steel load bars shall not exceed the following:

   a. Thickness - 0.2 mm
      (i.e. for 5mm required load bar thickness, the allowable thickness is from 4.8 mm to above 5.0 mm only)

b. Height - 0.5 mm
(i.e. for 65mm required load bar height, the allowable height is from 64.5 to above 65 mm only)

7. The allowable tolerances on dimensions on the twisted cross rods shall not exceed the following:

a. Thickness - 0.1 mm
(i.e. for 5.7mm required twisted cross rod, the allowable thickness is from 5.6 mm to above 5.7 mm only)

3.22.2.3 MECHANICAL PROPERTIES

The steel gratings supplier shall be required to submit test certificates for steel materials used in its manufacture; and for hot dip galvanizing which shall meet or exceed the following properties:

ASTM A36 Carbon Steel	
Yield Strength	Min 250 Mpa
Tensile Strength	Min 400 Mpa

BS EN1460 Hot Dip Galvanizing
Minimum Coating Mass of 610 grams/sqm; or
Minimum Coating Thickness of 85 microns using the 5-Point Elcometer Test

3.22.3 EXECUTION

Installation of the steel gratings and steel angle frames shall be in accordance with the manufacturer's instructions.

3.22.4 MEASUREMENT AND PAYMENT

1. Measurement of the total quantities of work completed under this section shall be per linear meter of steel gratings installed complete and accepted by the Engineer in compliance with the requirements as indicated on the Drawings and these Specifications.
2. The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary including tests to complete the installation of forged welded gratings accepted and certified for payment by the Engineer.

3.23 CORROSION PROTECTION CLADDING FOR STEEL POLE

3.23.1 GENERAL

Work under this Contract shall be in accordance with Division 1 "General Requirements" of these Specifications and shall be applicable to this Section, whether herein referred to or not.

3.23.1.1 SCOPE

This work covers all the following requirement regarding the application of a corrosion resistant cladding material on the outside surface of floodlight steel pole in accordance with the dimensions shown ion the drawings.

3.23.1.2 DELIVERY AND STORAGE

The cladding material shall be delivered in pre-measured containers of 5kg units (net material weight). The containers must be appropriately sealed and boxed to protect from spillage and exposure to the elements. The Base component and activator component shall be packaged in separate and differently sized metal containers. The containers shall be packaged together in a cardboard carton.

3.23.2 MATERIAL REQUIREMENTS

3.23.2.1 GENERAL

The corrosion resistant cladding material shall meet the following requirement in full. If required, a sample of the material in 3 pieces of steel plate 150 mm x 150 mm shall be supplied to the Engineer for approval and retention for purposes of comparative testing.

1. PHYSICAL PROPERTIES

   a. The corrosion resistant cladding material shall be made of a two-component, 100% solids reinforced polymer composite system comprising of a Base component and an Activator component.

   b. The material furnished under this specification shall be of high molecular weight polymer base reinforced with abrasion resistant non-metallic fillers.

   c. The material furnished under this specification when mixed and applied in accordance with the manufacturer’s instructions, shall produce a high quality metal resurfacing and protection application.

d. The cladding material shall be of Diglycidyl Ether Bisphenol A (DGEBA) Polymer Base.

e. The cladding material shall have a smooth, high gloss finish.

f. The cladding material must be highly resistant to damage against exposure to sea water/breeze. The manufacturer shall certify in writing that exposure of the material to such working environment will not affect its adhesive properties and corrosion resistance.

g. The cladding material must be free of harmful odors that could damage the environment as well as the personnel handling the application or installation.

h. The DFT of the applied cladding material shall be between 300 microns and 400 microns.

2. MECHANICAL AND CHEMICAL PROPERTIES

The corrosion resistant cladding material supplier is required to certify that materials delivered will have to meet or exceed the following properties:

Mixed Density	1.28 grams per cc
Shelf Life	Indefinite
% Volatile	Not Volatile (zero evaporation rate)
Minimum Working Life @30^{o}C	55 minutes
Mixing Ratio (by volume) 5 (Base):	2(Activator)
Tensile Shear Adhesion (ASTM D-1002):	
Steel	259kg/cm^2
Stainless Steel	245 kg/cm^2

3.23.3 EXECUTION

1. Installation of the corrosion resistant cladding material shall be in accordance with the manufacturer's instructions and recommendations. Suppliers shall be required to provide detailed descriptions of their proposed installation procedure for each unit of the cladding material.

These descriptions shall include the following:

a. Surface preparation techniques to insure effective adhesion of the cladding material to various substrates including: steel, aluminum, copper, brass, bronze, cast iron, pvc, fiberglass, plastics, glass, wood, etc.

b. Mixing and Application of the cladding material.

c. Time and temperature conditions to be obtained in order to completely solidity and cure the cladding material.

2. To facilitate Quality Assurance, each unit of the material delivered to site shall be clearly labeled on the box with the manufacturer's name, product name and production batch number.

3. The corrosion resistant cladding material shall be manufactured by a reputable manufacturer who shall confirm in writing that their material meets of exceeds the specifications required herein. Such written confirmation must be attached to the bid for the bid to receive consideration.

4. To ensure proper handling and installation, each unit of the material shall have a Material Safety Data Sheet and installation Instructions Manual attached inside the carton/box.

5. The Engineer reserves the right to sample and inspect the delivered materials for individual quality testing at the contractor's expense. Materials' not meeting the manufacturer's certified values will be rejected.

3.23.4 WARRANTY

1. Manufacturer mush submit a warranty for the corrosion resistant cladding material against manufacturing defects for a period of one (1) year from the date of original purchase.

2. Approved bidder must submit a warranty for all applications for no less than a one (1) year period for the installation of the material.

3.23.5 MEASUREMENT AND PAYMENT

1. Measurement of the total quantities of work completed under this section shall be per square meter of the application of a corrosion resistant cladding material on the outside surface of floodlight steel pole cladding, installed complete and accepted by the Engineer in compliance with the requirements as indicated on the Drawings and these Specifications.

2. The quantity determined above shall be the basis of payment of the unit price for the pay items shown in the Bill of Quantities which price and payment shall be the full compensation for furnishing all materials, labor, equipment, tools and other incidentals necessary to complete the installation of corrosion resistant cladding material on the outside surface of floodlight steel pole accepted and certified for payment by the Engineer.