PROJECT SPECIFICATIONS

I. GENERAL CONDITIONS

The work to be undertaken shall include the furnishing of labor, materials, tools and equipment for the following:

Project : **DEVELOPMENT OF NATURE PARK**
Location : **Borongan Eastern, Samar**

A. Scope of Work

1. General Requirements
2. Welcome Arc
3. Elevated Water Tank
4. Signage
5. 3-Level View Deck
6. Comfort Room
7. Electrical Works

The construction work must be executed strictly in accordance with the plans and specifications. The following principal items of work shall include but not limited to the following:

The construction procedures shall be done in accordance with the DPWH Standard Specifications, and in full compliance with the approved plans and specifications.

All items not specifically mentioned in the specifications or noted on the plans but which are obviously necessary for the completion of the work shall be included.

II. FIELD OFFICE FOR THE ENGINEER

The Contractor shall construct field offices, laboratories and living quarters, including all the necessary air conditioning, electricity, water, and drainage and security services for the use of the Engineer and his staff for 24 h a day or provide the same on a rental basis until end of Contract. All offices, laboratories and living quarters shall be ready for occupancy and use by the Engineer immediately for rental basis; or if to be constructed within 3 months upon the commencement of the Works. Their location and final plan shall require the approval of the Engineer prior to the start of construction. It is the intent of this Specification to locate the field offices, laboratories and living quarters in Government owned lots so that the use by the Government of these facilities can be maximized even after the completion of the project. In the selection of construction site of the Engineer's Building/s and Recreational Facilities, first priority shall be on DPWH property lots, second is public school lots, third is public health lots, fourth is Local

Government Unit (LGU) lots, and then other government property lots. The proximity, access road and cost of development of the proposed site shall be properly evaluated. The construction of building/s and recreational facilities on property other than DPWH-owned shall be covered by an approved Memorandum of Agreement (MOA) between the concerned parties. The Implementing Office shall be allowed to use the other government lots for the construction of the field offices, laboratories and living quarters free of charge until the completion of the project and shall be turned over without cost, effective after completion or acceptance of the project from the Contractor. The transfer/turnover shall be supported by applicable document and shall be a requirement to support the issuance of project Completion Certificate of the Contractor. If no Government lot is available, and these structures are to be erected on private property, it is the responsibility of the Contractor to make the necessary arrangements for the negotiation with the property owner for the lease/rental of the lot. The field office shall display an appropriate sign that identifies the DPWH facility to the public in locating it. The field offices, laboratories, and living quarters, the improvements thereon, including appurtenances shall be removed or transferred if so required in the Contract upon completion of the project. All facilities provided by the Contractor shall be within the 5 km radius or preferably near the job site, where necessary and shall conform to the best standard for the required types. On completion of the Contract, the facilities provided by the Contractor including utilities shall revert to the Government including office equipment, apparatus, pieces of furniture, laboratory equipment, etc. unless otherwise specified in the Contract documents. The Contractor shall be responsible for raising the ground (if necessary), grading and drainage in the vicinity of each facility with suitable access 2 walkways, seeding and sodding of the ground around as directed and approved by the Engineer. Also, the Contractor shall construct a parking area for the compound near the buildings and a satisfactory access road to the parking areas. The whole area of the Engineer's compound shall be fenced with barbed wire (or equivalent) with necessary gates as directed by the Engineer.

III. PERMITS AND CLEARANCES

A. General Requirements

The concerned DPWH Implementing Office (central, regional, district, project management office) shall be responsible for securing all necessary permits and clearances related to the project, which shall include but not limited to building permits, occupancy permit, excavation permit, locational clearances and environmental compliance certificate, etc. Contractors All Risk Insurance & Third Party Liability and Workman's Compensation Insurance (CARI), and other insurances required by the Local Government Unit (LGU) among others, including payment of assessed fees as may be required by the LGU and/or Regulating Agencies before the implementation of the project. However, for projects implemented by DPWH but owned by other agencies, the owner shall secure all the necessary permits and clearances. All heads of Regional/District/Project Management Offices of the DPWH are enjoined to review, and fully familiarize themselves with, the requirements of and procedures for application for Building Permits pursuant to Rules I and II of the Implementing Rules and Regulations of the National Building Code, such as conformity to local land use plan and zoning and ownership of the building site. Public buildings and traditional indigenous family dwelling shall be exempt from payment of building permit fees.

B. Method of Measurement

Permits and Clearances shall be measured by lump sum.

C. Basis of Payment

The accepted quantities, measured as provided in Section B.3.2, Method of Measurement shall be paid for at the Contract Unit Price of the Pay Item listed below that is included in the Bill of Quantities. The unit price shall cover full compensation for all related services necessary to complete the Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
B.3	Permits and Clearances	Lump Sum

IV. PROJECT BILLBOARD / SIGNBOARD

A. General Requirements

The Contractor shall install two (2) Project Information Signs at/or near the beginning and the end of the project or upon the discretion of the Engineer.

The signs are prescribed separately by the Department of Public Works and Highways (DPWH) for government Infrastructure projects to inform the public of the implementation of the project and to advise the road users of the ongoing construction.

The new billboard design layout, dimension and letter sizes on white background, shall be depicted on a standard billboard measuring 1,220 mm x 2,440 mm using 12.50 mm thick marine plywood or tarpaulin of the same size posted on 5 mm marine plywood. For each building project, the billboard shall be installed in front of the project site. For each road/bridge/flood control project, two billboards shall be installed, one (1) at the beginning and one (1) at the end of the project.

For road projects with a length of 10 km or more, additional billboard shall also be installed at every five (5) km interval. Name(s) and/or picture(s) of any personages should not appear in the billboard.

No other billboards shall be allowed to be installed 100 m before and 100 m after all DPWH projects and in-between the project limits or within the road right-of-way. DPWH contractors shall not be allowed to place names of politicians or carry political billboard on their equipment.

The Contractor shall also install one (1) Billboard as per COA Circular No. 2013-004, Information and Publicity on Programs/Projects/Activities of Government Agencies.

Upon completion of the work, all signs installed shall be removed from the site.

B. Method of Measurement

All expenses incurred in the furnishing/installation/illumination of the signs shall be paid for each billboard installed.

C. Basis of Payment

The accepted quantities, measured as provided in Section B.5.2, Method of Measurement shall be paid for at the Contract Unit Price of the Pay Item listed below that is included in the Bill of Quantities. The unit price shall cover full compensation for all related services necessary to complete the Item.
Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
B.5	Project Billboard / Signboard	Each

V. OCCUPATIONAL SAFETY AND HEALTH

A. Description

This Item covers the implementation of construction safety in all stages of project procurement (design, estimate, construction and maintenance), requirements, provisions, and instructions for the guidance of the Engineer.

B. Construction Safety and Health Program (CSHP)

Every construction project shall have a suitable and approved Construction Safety and Health Program (CSHP) as required in all projects regardless of amount, funding source and mode of implementation which shall comply with the minimum safety and health requirements as specified in the Occupational Safety and Health Standards.

The required CSHP shall include but not limited to the following:

1. Composition of the Safety and Health personnel responsible for the proper implementation of CSHP.

2. Specific safety policies which shall be undertaken in the construction site, including frequency of and persons responsible for conducting toolbox and gang meetings.

3. Penalties and sanctions for violations of the CSHP.

4. Frequency, content and persons responsible for orienting, instructing and training all workers at the site with regard to the CSHP which they operate.

5. The manner of disposing waste arising from the construction.

C. Construction Safety and Health Personnel

At the start of the project, the Contractor shall establish construction safety and health committee composed of the following personnel:

1. Project Manager/Project Engineer

The Contractor must provide for a full time Project Manager/Project Engineer, who is tasked to observe, monitor and supervise if the enforcement of CSHP was being followed strictly and correctly.

2. General Safety Engineer/Officer

The General Contractor (under which are a number of subcontractors) must provide for a full time Officer, who shall be assigned as the CSHP to oversee and enforce full time the overall management of the CSHP. Furthermore, deployment of part-time or full-time safety man depending on the number of workers shall be complied in accordance with Rule 1033 of the Occupational Safety and Health Standards (OSHS) and applicable provisions under 26 Section 7.0, Safety Personnel of Department of Labor and Employment (DOLE) Department Order (D.O.) 13 Series of 1998.

3. Health Personnel

The Contractor's health personnel may be full time or part time certified first-aider, registered nurse, physician and dentist depending on the total number of workers conforms to Section 8.0, Emergency Occupational Health Personnel and Facilities or DOLE D.O. 13, Series of 1998.

4. Safety Practitioner

The Contractor must provide a full time or part time Safety Practitioner, who shall initiate and supervise safety and health training for employees.

D. Supervision, Control and Monitoring

Overall supervision, control and monitoring of the implementation of CSHP for projects undertaken by administration/contracts shall be under the Implementing Office.

E. Construction Safety and Health Training

The Construction Safety and Health Seminar (COSH) shall be a 40 h training course as prescribed by the DOLE-Bureau of Working Conditions (BWC). All safety personnel involved in a construction project shall be required to complete such basic training course. The Contractor shall provide continuing construction safety and health training to all technical personnel under his organization. Continuing training shall be a minimum of 16 h per year for every full-time safety personnel.

F. Construction Safety and Health Reports

The Contractor shall be required to submit a monthly construction safety and health report to the DOLE Regional Office concerned. The report shall include a

monthly summary of all safety and health committee meeting agreements, a summary of all accident investigations/reports and periodic hazards assessment with the corresponding remedial measures/action for each hazard. In case of any dangerous occurrence or major accident resulting in death or permanent total disability, the concerned employer shall initially notify the DOLE Regional Office within 24 h from occurrence. After the conduct of investigation by the concerned construction safety and health officer, the employer shall report all permanent total disabilities to DOLE Regional Office on or before the 20th of the month following the date of occurrence of accident using the DOLE Employer's Work Accident Illness Report.

G. Personal Protective Equipment (PPE) and Devices

The Contractor shall furnish his workers with protective equipment for eyes, face, hands and feet, lifeline, safety belt/harness, protective shields and 27 barriers whenever necessary by reason of the hazardous work process or environment, chemical or radiological or other mechanical irritants of hazards capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical agent. All PPE and Devices shall be in accordance with the requirements of the OSHS and should pass the test conducted and/or standards set by the Occupational Safety and Health Center (OSHC). For General Construction Work, the required basic PPEs for all workers shall be safety helmet, safety gloves and safety shoes. Specialty PPEs shall be provided to workers in addition to or in lieu of the corresponding basic PPE as the work or activity requires. Workers within the construction project site shall be required to wear the necessary PPE at all times. Moreover, all other persons who are either authorized or allowed to be at a construction site shall also wear appropriate PPEs. Construction workers who are working from unguarded surfaces 6 m or more above water or ground, temporary or permanent floor platform, scaffold or where they are exposed to the possibility of falls hazardous to life or limb, must be provided with safety harnesses and life lines.

H. Signages and Barricades

Construction Safety Signages and Barricades shall be provided as a precaution and to advice the workers and the general public of the hazards existing in the worksite. Signages shall be posted in prominent positions at strategic location and as far as practicable, be in the language understandable to most of the workers employed. For road projects, it shall be in accordance with the DPWH Road Works Safety Manual.

I. Facilities

The Contractor shall provide the following welfare facilities in order to ensure humane working conditions:

1. Adequate supply of safe drinking water.
2. Adequate sanitary and washing facilities.
3. Suitable living accommodation for workers and as may be applicable for their families.
4. Separate sanitary, washing and sleeping facilities for men and women workers.

The services of a full time registered nurse, a full time physician, a dentist and an infirmary or emergency hospital with one (1) bed capacity when the number of employees exceed 300. In addition, there should be one (1) bed capacity for every 100 employees in excess of three hundred (300).

J. Costing

The cost for the implementation of construction safety and health shall be integrated to the overall project cost under the prescribed pay item. In consideration of the cost involved of providing the necessary safety equipment and manpower for an effective implementation of safety in the workplace, the following shall be used as a guide:

1. Personal Protective Equipment (PPE) The PPEs shall be provided by the Contractor, and its cost shall be duly quantified and made part of the overall cost of Item B.7, Occupational Safety and Health. The use of PPEs shall conform to Section B.7.7 Personal Protective Equipment and Devices.

2. Clinical Materials and Equipment Clinical materials and equipment such as medicines, beds and linens, other related accessories shall be to the account of the Contractor implementing the project and shall be in accordance with the Occupational Health Services of OSHS.

3. Signages and Barricades The quantities and cost of signages and barricades necessary for a specific item of work shall be quantified and made part of that particular pay item of work. For general signages and barricades not included in specific pay item of work but necessary for promoting safety in and around the construction site, the quantities and cost shall be a separate pay item and included in the overall cost of Item B.7, Occupational Safety and Health.

4. Facilities Facilities such as portable toilets, waste disposal, sanitary and washing facilities, convenient dwellings and office, adequate lighting, and other facilities related to construction safety and health shall be in accordance with OSHS and previously approved guidelines of the Department and shall be quantified and the cost thereof be made a separate pay item under "Facilities for the Engineers" and "Other General Requirements" as required in the DPWH Standard Specifications.
5. Salaries Labor cost for the medical and safety personnel actually assigned in the field shall be included in the overall cost of Item B.7, Occupational Safety and Health. Manpower cost shall be established based on the cost of labor in the area. Duration of employment shall be based on project duration of the particular project. 29

6. Safety and Health Training Cost associated for the provision of basic and continuing construction safety and health training to all safety and technical personnel shall be made part of the indirect/overhead cost of the project.

K. Safety on Construction during Heavy Equipment Operation

In relation to heavy equipment operation in all construction sites, the following are required in the different phases of the project.

1. Pre-Construction

The Contractor must ensure that appropriate certification is obtained from DOLE duly accredited organizations for the following:

a. All heavy equipment operators assigned at the project site must be tested and certified in accordance with a standard trade test prescribed by Technical Education and Skills Development Authority (TESDA) in coordination with its accredited organization.

b. All heavy equipment must be tested and certified in accordance with the standards prepared by DOLE or its recognized organization prior to commissioning of said equipment.

2. During Construction

The Contractor must ensure that the following conditions are met or complied with:

a. For mobilization or transport of heavy equipment, load restrictions, height and width clearances as imposed by Department for all roads and bridges to be utilized during transport. Moreover, only duly certified operators are allowed to load and unload heavy equipment to low-bed trailer.

b. During erection and set-up of heavy equipment, existing hazards must be avoided. Standard checklist of steps and procedures must be observed. List of necessary equipment, tools and materials must be available and properly utilized.

c. In the interest of accident prevention, duly certified mechanics and operators shall conduct daily routine inspection of all heavy equipment deployed at the site in accordance with standards set by TESDA in coordination with the Association of Construction Equipment Lessors (ASCEL, Inc.). During routine inspection all equipment which do not comply with the minimum safety standards for equipment certification shall be immediately removed from the work site for restoration or repair until they meet said standards or requirements. The Contractor and the equipment owner shall maintain a separate logbook for data on maintenance, repair, tests and inspections for each heavy 30 equipment. Such logbook shall be used as a necessary reference during the conduct of equipment inspection.

3. Post Operation and Post Construction

The procedures for dismantling and demobilization of heavy equipment shall follow the same requirements as listed under provisions of mobilization or transport of heavy equipment and erection and set-up of heavy equipment.

L. Violations and Penalties

The Contractor if found violating safety rules and regulations shall be meted sanctions depending on the gravity of offense. The amount corresponding to non-compliance shall be deducted from the Contractor's billing.

M. Method of Measurement

Occupational safety and health program shall be measured by lump sum.

N. Basis of Payment

The accepted quantities, measured as prescribed in Section B.7.13, Method of Measurement shall be paid for at the Contract Unit Price or for the pay item listed below that is included in the Bill of Quantities. Such payment shall be full compensation for furnishing, maintaining and ensuring against loss of the equipment/tools.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
B.7	Occupational Safety and Health	Lump Sum

VI. STRUCTURE EXCAVATION

A. Description

This Item shall consist of the necessary excavation for foundation of buildings, culverts, underdrains, and other structures not otherwise provided for in the Specifications. Except as otherwise provided for pipe culverts, the backfilling of completed structures and the disposal of all excavated surplus materials, shall be in accordance with the Plans and this Specification.

This Item shall include necessary diversion of live streams, dewatering, pumping, draining, sheeting, bracing, and the necessary construction of cribs and cofferdams, and furnishing the materials therefore, and the subsequent removal of cribs and cofferdams and the placing of all necessary backfill.

It shall also include the furnishing and placing of approved foundation fill material to replace unsuitable material encountered below the foundation elevation of structures.

No allowance shall be made for classification of different types of material encountered.

B. Construction Requirements

a. Clearing and Grubbing

Prior to starting excavation operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Item 800, Clearing and Grubbing.

b. Excavation

i. General, All Structures

The Contractor shall notify the Engineer sufficiently in advance at the beginning of any excavation so that cross-sectional elevations and measurements may be taken on the undisturbed ground. The

natural ground adjacent to the structure shall not be disturbed without permission of the Engineer.

Trenches or foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the Plans or as staked by the Engineer. They shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown. The elevations of the bottoms of footings, as shown on the Plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary, to secure a satisfactory foundation. 101 Boulders, logs, and other objectionable materials encountered in excavation shall be removed.

After each excavation is completed, the Contractor shall notify the Engineer to that effect and no footing, bedding material or pipe culvert shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

ii. Structures Other than Pipe Culverts

All rock or other hard foundation materials shall be cleaned of all loose materials, and cut to a firm surface, either level, stepped, or serrated as directed by the Engineer. All seams or crevices shall be cleaned and grouted. All loose and disintegrated rocks and thin strata shall be removed. When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to be placed. When the foundation material is soft or mucky or otherwise unsuitable, as determined by the Engineer, the Contractor shall remove the unsuitable material and backfill with approved granular material. This foundation fill shall be placed and compacted in 150 mm layers up to the foundation elevation.

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven and any placing of foundation fill shall be done after the piles are driven. After the driving is completed, all loose and displaced materials shall be removed, leaving a smooth, solid bed to receive the footing.

iii. Pipe Culverts

The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 300 mm or 4 mm for each 100 mm of fill over the top of pipe, whichever is greater, but not to exceed three-quarters of the vertical inside diameter of the pipe. The width of the excavation shall be at least 300 mm greater than the

horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 150 mm in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed to the depth directed by the Engineer and replaced with approved granular foundation fill material properly compacted to provide adequate support for the pipe, unless other special construction methods are called for on the Plans. 102

The foundation surface shall provide a firm foundation of uniform density throughout the length of the culvert and, if directed by the Engineer, shall be cambered in the direction parallel to the pipe centerline.

Where pipe culverts are to be placed in trenches excavated in embankments, the excavation of each trench shall be performed after the embankment has been constructed to a plane parallel to the proposed profile grade and to such height above the bottom of the pipe as shown on the Plans or directed by the Engineer.

c. Utilization of Excavated Materials

All excavated materials, so far as suitable, shall be utilized as backfill or embankment. The surplus materials shall be disposed of in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure. No excavated materials shall be deposited at any time so as to endanger the partly finished structure.

d. Trimming Works

The excavation shall conform to the lines, grades, cross sections and dimensions shown on the Plans. The Engineer shall order the removal of any soft spots, debris or organic material exposed when excavated areas shall have been trimmed to finished formation levels. Subgrade in earth shall be trimmed cut to an even surface free of loose material and compact as specified by the Engineer to the density prescribed in in the Plans.

i. Trimming and Finishing of Surfaces

Unless otherwise specified, all areas within the limits of clearing and outside the limits of earthworks shall be graded to an even surface. Ridges shall be trimmed and depressions shall be filled as necessary to produce a surface which will drain freely and is suitable for the operation of tractor mounted mowers. Batters in cut and fill shall be trimmed to shapes shown on drawings. Cut and fill batters shall be trimmed as specified in the Plans.

C. **Method of Measurement**

a. **Structure Excavation**

The volume of excavation to be paid for shall be the number of cubic meters measured in original position of material acceptably excavated as shown on the Plans or as directed by the Engineer, but in no case, except as noted, shall any of the following volumes be included in the measurement for payment:

i. The volume outside of vertical planes 450 mm outside of and parallel to the neat lines of footings and the inside walls of pipe and pipe-arch culverts at their widest horizontal dimensions.

ii. The volume of excavation for culvert and sections outside the vertical plane for culverts stipulated in (1) above.

iii. The volume outside of neat lines of underdrains as shown on the Plans, and outside the limits of foundation fill as ordered by the Engineer.

iv. The volume included within the staked limits of the excavation, contiguous channel changes, ditches, and the like, for which payment is otherwise provided in the Specification.

v. Volume of water or other liquid resulting from construction operations and which can be pumped or drained away.

vi. The volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed ground.

vii. The volume of any material rehandled, except that where the Plans indicate or the Engineer directs the excavation after embankment has been placed and except that when installation of pipe culverts by the imperfect trench method specified in Subsection 1718.3.7, Imperfect Trench of Item 1718, Pipe Culverts and Storm Drains is required, the volume of material reexcavated as directed will be included.

viii. The volume of excavation for footings ordered at a depth more than 1.5 m below the lowest elevation for such footings shown on the original Contract Plans, unless the Bill of Quantities contains a pay item for excavation ordered below the elevations shown on the Plans for individual footings.

b. **Shoring, Cribbing and Related Work**

Shoring, cribbing and related work whenever included as a pay item in Bill of Quantities shall be paid for at the lump sum bid price. This work shall include furnishing, constructing, maintaining, and removing any and all shoring, cribbing, cofferdams, caissons, bracing, sheeting, water control, and other operations necessary for the acceptable completion of excavation included in the work of this Subsection, to a depth of 1.5 m below the lowest elevation shown on the Plans for each separable foundation structure.

c. **Trimming Works**

Trimming shall include all activities associated with the excavation of any material, the haulage of material, and trimming of batters that conform to the lines, grades, cross sections and dimensions shown on the Plans.

D. Basis Of Payment

The accepted quantities, measured as prescribed in Section 1702.3, Method of Measurement shall be paid for at the Contract Unit Price for each of the particular pay items listed below that is included in the Bill of Quantities. The payment shall constitute full compensation for the removal and disposal of excavated materials including all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this Item, except as follows:

A. Any excavation for footings ordered at a depth more than 1.5 m below the lowest elevation shown on the original Contract Plans shall be paid for as provided in the Part K of Volume I Requirements and Conditions of Contract, unless a pay item for excavation ordered below plan elevation appears in the Bill of Quantities.

B. Concrete will be measured and paid for as provided under Item 900, Structural Concrete. The quantity of structural concrete to be paid for shall be the final quantity placed and accepted in the completed structure. No deduction shall be made for the volume occupied by pipe less than 100 mm in diameter or by reinforcing steel, anchors, conduits, weep holes or expansion joint materials.

C. Any excavation or borrow excavation required in excess of the quantity excavated for structures shall be measured and paid for as provided under Item 1702, Excavation.

D. Shoring, cribbing, and related work required for excavation ordered more than 1.5 m below plan elevation shall be paid for in accordance with Part K.

Payment shall be made under:

Pay Item Number	Description	Unit Of Measurement
1702 (1)a	Structure Excavation (Common Soil)	Cubic Meter
1702 (1)b	Structure Excavation (Soft Rock)	Cubic Meter
1702 (1)c	Structure Excavation (Hard Rock)	Cubic Meter
1702 (2)a	Excavation (Common Soil)	Cubic Meter
1702 (2)b	Excavation (Soft Rock)	Cubic Meter
1702 (2)c	Excavation (Hard Rock)	Cubic Meter
1702 (3)	Excavation ordered below Plan elevation	Cubic Meter
1702 (4)a	Shoring, cribbing and drain excavation (Shoring)	Lump Sum
1702 (4)b	Shoring, cribbing and drain excavation, (Cribbing/ Cofferdamming)	Lump Sum
1702 (5)a	Pipe culverts and drain excavation (Common Soil)	Cubic Meter
1702 (5)b	Pipe culverts and drain excavation (Soft Rock)	Cubic Meter
1702 (5)c	Pipe culverts and drain excavation (Hard Rock)	Cubic Meter
1702 (6)	Trimming Works	Square Meter

VII. EMBANKMENT

A. Description

This Item shall consist of the construction of embankment using suitable materials of various composition and compacted in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

B. Material Requirements

a. Suitable Material

Embankments shall be constructed of suitable materials and materials meeting with the following requirements:

i. Selected Borrow – soil of such gradation that all particles will pass a sieve with 75 mm square openings and not more than 15 mass percent will pass the 0.075 mm (No. 200) sieve, as determined by AASHTO T 11, Standard Method of Test for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing. The material shall have a plasticity index of not more than six (6) as determined by AASHTO T 90, Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils and a liquid limit of not more than 30 as determined by AASHTO T 89, Standard Method of Test for Determining the Liquid Limit of Soils.

ii. Gravel fill shall consist of crushed, partially crushed, or naturally occurring granular material. The abrasion loss as determined by AASHTO T 96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine shall not exceed 40 mass percent.

The gravel fill material grading requirements shall conform to Table 804.1.

Table 804.1 Grading Requirements

Sieve Designation		Mass Percent Passing
Standard, mm	Alternate US Standard	Grading A
63.5	2 ½"	100
50	2"	65 - 100
25.0	1"	50 - 85
4.75	No. 4	26 - 44
0.425	No. 40	16 max
0.075	No. 200	9 max

iii. Rock fill material shall be hard, sound and durable material, free from seams, cracks, and other defects tending to destroy its resistance to weather. Specific gravity of rock fill materials shall be above 2.40.

b. Unsuitable Material

Materials that are not acceptable for use are the following:

i. Organic soils such as peat and muck.

ii. Soils with liquid limit exceeding 80 and/or plasticity index exceeding 55.
iii. Soils with a natural water content exceeding 100%.
iv. Soils with very low natural density, 800 kg/m3 or lower.
v. Materials containing detrimental quantities of organic materials, such as grass, roots, sewerage, and other materials that cannot be properly compacted as determined by the Engineer.

C. **Construction Requirements**

a. **General**

Prior to placing of embankment materials, all necessary clearing and grubbing in that area shall have been performed in conformity with Item 800, Clearing and Grubbing.

Embankment construction shall consist of constructing embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or adjacent to any structures; the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the area.

Embankments and backfills shall contain no muck, peat, sod, roots or other deleterious matter. Rocks, broken concrete or other solid, bulky materials shall not be placed in embankment areas where piling is to be placed or driven.
Where shown on the Plans or directed by the Engineer, the surface of the existing ground shall be compacted to a depth of 150 mm and to the specified requirements of this Item.

Where provided on the Plans and Bill of Quantities the top portions of the roadbed in both cuts and embankments, as indicated, shall consist of selected borrow for topping from excavations.

b. **Methods of Construction**

Where there is evidence of discrepancies on the actual elevations and that shown on the Plans, a preconstruction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the embankment materials. 109

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built ½ of the width at a time, the existing slopes that are steeper than 3:1 when measured at right angles to the roadway shall be continuously benched over those areas as the work is brought up in layers. Benching will be subject to the Engineer's approval and shall be of sufficient width to permit operation of placement and compaction equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus excavated shall be placed and compacted along with the embankment material in accordance with the procedure described in this Section.

Unless shown otherwise on the Plans or Special Provisions, where an embankment of less than 1.2 m below subgrade is to be made, all sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surfaced shall be completely broken up by plowing, scarifying, or steeping to a minimum depth of 150 mm except as provided in Subsection 802.2.2, Conservation of Topsoil. This area shall then be compacted as provided in Subsection 804.3.3, Compaction. Sod not required to be removed shall be thoroughly disc harrowed or scarified before construction of embankment. Wherever a compacted embankment containing granular materials lies within 900 mm of the subgrade, such old embankment shall be scarified to a depth of at least 150 mm whenever directed by the Engineer. This scarified material shall then be compacted as provided in Subsection 804.3.3, Compaction.

When shoulder excavation is specified, the shoulders shall be excavated to the depth and width shown on the Plans. The shoulder material shall be removed without disturbing the adjacent existing base course material, and all excess excavated materials shall be disposed of as provided in Subsection 802.2.3, Utilization of Excavated Materials. If necessary, the areas shall be compacted before being backfilled.

Embankment of earth material shall be placed in horizontal layers not exceeding 200 mm, loose measurement, and shall be compacted as specified before the next layer is placed. However, thicker layer maybe placed if vibratory roller with high compacting effort is used provided that density requirement is attained and as approved by the Engineer. Trial section to this effect must be conducted and approved by the Engineer. Effective spreading equipment shall be used on each lift to obtain uniform thickness as determined in the trial section prior to compaction. 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, discing, or other methods satisfactory to the Engineer.

Where embankment is to be constructed across low swampy ground that will not support the mass of trucks or other hauling equipment, the lower part of the fill may be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers. Fill material shall be placed 110 in a way it effectively displaces unsuitable material from within unstable area of the proposed embankment.

When excavated material contains more than 25 mass percent of rock larger than 150 mm in greatest diameter and cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces resulting from excavation methods, such materials may be placed on the embankment in layers not exceeding in thickness the

approximate average size of the larger rocks, but not greater than 600 mm.

Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 600 mm in diameter shall be permitted provided that when placed, they do not exceed 1,200 mm 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 150 mm in greatest dimensions shall not be constructed above an elevation 300 mm below the finished subgrade. The balance of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 200 mm 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 compaction complies with the requirements of Subsection 804.3.3, Compaction.

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.

c. **Compaction**

i. **Compaction Trials**

Before commencing the formation of embankments, the Contractor shall submit in writing to the Engineer for approval his proposals for the compaction of each type of fill material to be used in the works. The proposals shall include the relationship between the types of compaction equipment, the number of passes required and the method of adjusting moisture content. The Contractor shall carry out full scale compaction trials on areas not less than 10 m wide and 50 m long as required by the Engineer and using his proposed procedures or such amendments thereto as may be found necessary to satisfy the Engineer that all the specified requirements regarding compaction can be consistently achieved. The compaction equipment shall be equivalent or higher than the required capacity prescribed in the Contract. Compaction trials with the main types of fill material to be used in the works shall be completed before work with the corresponding materials shall be allowed to commence. When embankment dimension is less than 10 m wide and 50 m long, the Engineer may waive the construction of compaction trials. 111 Throughout the periods when compaction of earthwork is in progress, the Contractor shall adhere to the compaction procedures found from compaction trials for each type of material being compacted, each type of compaction equipment employed and each degree of compaction specified.

ii. **Earth**

The Contractor shall compact the material placed in all embankment layers and the material scarified to the designated depth below subgrade in cut sections, until a uniform density of not less than 95 mass percent of the maximum dry density determined by AASHTO T 99, Standard Method of Test for MoistureDensity Relations of Soils Using a 2.5 kg Rammer and a 305 mm Drop - Method C, is attained, at a moisture content determined by Engineer to be suitable for such density.

The Engineer shall, during progress of the Work, make density tests of compacted material in accordance with AASHTO T 191, Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method, AASHTO T 205, Soil - Field density test sets: Balloon density apparatus or other approved field density tests, including the use of properly calibrated nuclear testing devices. If, by such tests, the Engineer determines that the specified density and moisture conditions have not been attained, the Contractor shall perform additional work as may be necessary to attain the specified conditions.

At least one group of three (3) in-situ density tests shall be carried out for each 500 m2 of each layer of compacted fill.

iii. **Gravel Fill**

Gravel fill shall be constructed below the original ground elevation. The maximum compacted thickness of any layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner. Gravel fill shall be in accordance with the approved Plan and conform to the applicable requirements of earth embankment.

iv. **Broken Concrete**

Pieces of concrete not exceeding 20 cm in diameter can be mixed if approved by the Engineer. Any exposed rebar on broken concrete pieces shall be cut and disposed of properly.

v. **Rock**

Density requirements will not apply to portions of embankments constructed of materials which cannot be tested in accordance with approved methods. Embankment materials containing rocks shall be deposited, spread and leveled the full width of the fill with sufficient earth or other fine material so deposited to fill the interstices to produce a dense compact embankment. In addition, one of the rollers, vibrators, or compactors shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment.

d. **Protection of Embankment During Construction**

During the construction, the in-placed embankments shall be maintained in such condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments or otherwise shall be so constructed as to avoid damage to embankments by erosion.

e. Protection of Structure

If embankment can be deposited on one (1) side of adjoining structure, care shall be taken that the area adjacent to the structure shall not be compacted to the extent that it will cause damages against the structure.

When embankment is to be placed on both sides of a concrete structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure unless otherwise specified in the Plans.

Embankment shall not be placed in areas where the materials will be submerged in water. The area shall be pumped dry and any mud or loose material shall be removed.

f. Rounding and Warping Slopes

Rounding except in solid rock, the tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded as indicated on the Plans. A layer of earth overlaying rock shall be rounded above the rock as done in earth slopes.

Warping adjustments in slopes shall be made to avoid injury in standing trees or marring of weathered rock, or to harmonize with existing landscape features, and the transition to such adjusted slopes shall be gradual. At intersections of cuts and fills, slopes shall be adjusted and warped to flow into each other or into the natural ground surfaces without noticeable break.

g. Serrated Slopes

Cut slopes in rippable material (soft rock) having slope ratios between 0.75:1 and 2:1 shall be constructed so that the final slope line shall consist of a series of small horizontal steps. The step rise and tread dimensions shall be shown on the Plans. No scaling shall be performed on the stepped slopes except for removal of large rocks which will obviously be a safety hazard if they fall into the ditch line or roadway.

h. Earth Berms

When called for in the Contract, permanent earth berms shall be constructed of well graded materials with no rocks having a maximum diameter greater than 25% the height of the berm. When local material is not acceptable, acceptable material shall be imported, as directed by the Engineer.

i. Compacted Berm

Compacted berm construction shall consist of moistening or drying and placing material as necessary in locations shown on the drawings or as established by the Engineer. Material shall contain

no roots, sod, or other deleterious materials. Contractor shall take precaution to prevent material from escaping over the embankment slope. Shoulder surface beneath berm will be roughened to provide a bond between the berm and shoulder when completed. The Contractor shall compact the material placed until at least 95 mass percent of the maximum density is obtained as determined by AASHTO T 99, Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 kg Rammer and a 305 mm Drop - Method C. The cross-section of the finished compacted berm shall reasonably conform to the typical cross-section as shown on the Plans.

ii. Uncompacted Berm

Uncompacted berm construction shall consist of drying, if necessary and placing material in locations shown on the Plans or as established by the Engineer. Material shall contain no roots, sod or other deleterious materials. Contractor shall take precautions to prevent material from escaping over the embankment slope.

i. Visual Inspection

Prior to final acceptance, the inspector shall visually inspect the entire section of the compacted embankment. If visual inspection shows that the course is not uniform or that the test values may not be representative of the entire section, additional tests may be performed and deficiencies shall be corrected by the Contractor. Deficiencies identified by visual inspection, such as laminations, dimensional deficiencies, soft areas, etc. shall be corrected before the section will be accepted. The section must be accepted prior to the placement of the next lift.

j. Dust Control

Adequate dust control must be maintained by the Contractor at all times during the earth-moving operations. Dust shall be controlled exclusively through the use of water unless otherwise indicated in the Contract documents or authorized by the Engineer.

k. Stockpiling

The Contractor shall not place stockpiles at locations where they are subject to erosion. The Contractor shall maintain erosion and drainage control near all stockpiles to the satisfaction of the Engineer and shall ensure that surface drainage does not adversely affect adjacent lands, watercourses or future reclamation sites.

Stockpiles shall not be situated at locations or by methods that will interfere or cause damage to any utilities such as power lines, telephone lines, pipelines, and underground utilities, among others.

Sites shall be cleared to the required dimensions. Topsoil and subsoil shall be separately excavated to the full depth or 300 mm, whichever is greater, and stockpiled separately.

Stockpiles shall not be situated within 30 m of a watercourse or permanent structure or within 4 m of adjacent property boundary unless otherwise permitted in writing by the property owner.

D. Method of Measurement

The quantity of embankment to be paid for shall be the volume of material compacted in place, accepted by the Engineer and formed with material obtained from an approved source.

The volume of embankment materials can be calculated using cross-sectional end area method or by the prismoidal formula method with the assistance of computer aided design program.

Material from excavation per Item 802, Excavation which is used in embankment and accepted by the Engineer will be paid under Embankment and such payment will be deemed to include the cost of excavating, hauling, stockpiling and all other costs incidental to the work.

E. Basis Of Payment

The accepted quantities, measured as prescribed in Section 1704.4, Method of Measurement shall be paid for at the Contract Unit Price for each of the Pay 885 Items listed below that is included in the Bill of Quantities. The payment shall continue full compensation for placing and compacting all materials including all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1704 (1)a	Embankment (From roadway/structure excavation)	Cubic Meter
1704 (1)b	Embankment (From Borrow)	Cubic Meter
1704 (2)a	Selected Borrow for topping (Case 1)	Cubic Meter
1704 (2)b	Selected Borrow for topping (Case 2)	Cubic Meter
1704 (3)	Earth Berm	Cubic Meter
1704 (4)	Gravel Fill	Cubic Meter

VIII. STRUCTURAL CONCRETE

A. DESCRIPTION

a. Scope

This Item shall consist of furnishing, placing and finishing concrete in buildings and related structures, flood control and drainage, ports, and water supply structures in accordance with this Specification and conforming to the lines, grades, and dimension shown on the Plans.

b. Classes and Uses of Concrete

Five classes of concrete are provided for in this Item, namely: A, B, C, P and Seal. Each class shall be used in that part of the structure as called for on the Plans.
The classes of concrete will generally be used as follows:

Class A – All superstructures and substructures which include the important parts such as slabs, beams, girders, columns, arch ribs, box culverts, abutments, retaining walls, shearwalls, pedestal and footings.

Class B – Pier shafts, pipe bedding, slab on fill, gravity walls (unreinforced or with only a small amount of reinforcement), and other miscellaneous concrete structures.

Class C – Thin reinforced sections, railings, precast R.C. piles and cribbing and for filler in steel grid floors. Class P – Prestressed concrete structures and members.

Seal – Concrete deposited in water

B. Materials Requirements

a. Portland Cement
Cement shall conform to the requirements of the following cited Specifications for the type specified or permitted:

b. Concrete Aggregates
Concrete aggregates shall conform to ASTM C33M, Standard Specification for Concrete Aggregates, and lightweight concrete aggregates shall conform to ASTM C330M, Standard Specification for Lightweight Aggregates except that aggregates failing to meet these specifications, but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used under Method 2 of Subsection 900.3.2, Methods of Determining the Proportions of Concrete, when authorized by the Engineer in writing.

Except as permitted elsewhere in this Subsection, the maximum size of the aggregate shall be or not larger than 1/5 of the narrowest dimensions between sides of forms of the member for which the concrete is to be used nor larger than 3/4 of the minimum clear spacing between individual reinforcing bars or bundles of bars or pre-tensioning strands

1. Fine Aggregates
Fine aggregates shall consist of natural and crushed sand, stone screenings or other inert materials with similar characteristics, or combinations thereof, having hard, strong and durable particles. Fine aggregates from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of concrete without the written approval of the Engineer.

It shall not contain more than three (3) mass percent of material passing the 0.075 mm (No. 200 sieve) by washing nor more than one (1) mass percent each of clay lumps or shale. The use of beach sand will not be allowed without the written approval of the Engineer.

If the fine aggregate is subjected to five (5) cycles of the sodium sulfate soundness test in accordance with AASHTO T 104, Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate and ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate, the weighted loss shall not exceed ten (10) mass percent.

Fine aggregates shall be free from injurious amounts of organic impurities. If subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be rejected. However, when tested for the effect of organic impurities on strength of mortar by AASHTO T 71, Standard Method of Test for Organic Impurities in Fine Aggregate on Strength of Mortar (ASTM C87, Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar) the fine aggregate may be used if the relative strength at 7 and 28 days is not less than 95%.

The fine aggregate shall be well-graded and shall conform to Table Below:

Grading Requirements for Fine Aggregate

Sieve Designation (mm)	Mass Percent Passing
9.50	100
4.75	95 – 100
2.36	-
1.18	45 – 80
0.60	-
0.30	5 – 30
0.15	0 – 10

2. Coarse Aggregates

Coarse Aggregates shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.

It shall contain no more than one (1) mass percent of material passing the 0.075 mm comment sieve, not more than 0.25 mass percent of clay lumps, nor more than 3.5 mass percent of soft fragments.

If the coarse aggregate is subjected to five (5) cycles of the sodium sulfate soundness test in accordance with AASHTO T 104, Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate and ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate, the weighted loss shall not exceed 12 mass percent.

Coarse Aggregates shall have a mass percent of wear not exceeding 40 when tested by AASHTO T 96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine).

If the slag is used, its density shall not be less than 1,120 kg/m3.

Gradiation shall conform to next table.

Grading Requirements for Coarse Aggregate

Sieve Designation (mm)	Mass Percent Passing				
	Class A	Class B	Class C	Class P	Class Seal
63.00					
50.00	100	100			
37.50	95 – 100	-			100
25.00	-	35 – 70		100	95 – 100
19.00	35 – 70	-	100	-	-
12.50	-	10 – 30	90 – 100	-	25 – 60
9.50	10 – 30	-	40 – 70	20 - 55	-
4.75	0 – 5	0 – 5	0 – 15*	0 – 10*	0 – 10*

*Note: * The measured cement content shall be within plus (+) or minus (-) 2 mass percent of the design cement content.*

3. Aggregate Tests

Samples of the fine and coarse aggregates to be used shall be selected by the Engineer for tests at least 30 days before the actual concreting operations shall begin. It shall be the responsibility of the Contractor to designate the source or sources of aggregates to give the Engineer sufficient time to obtain the necessary samples and submit them for testing.

No aggregates shall be used unless official advice has been received that it has satisfactorily passed all tests, at

which time written authority by the Engineer shall be given for its use.

c. Water

Water used in mixing, curing or other designated application shall be reasonably clean and free of oil, salt, acid, alkali, grass or other substances injurious to the finished product. Water which is drinkable may be used without test. Where the source of water is shallow, the intake shall be so enclosed as to exclude silt, mud, grass or other foreign materials.

If it contains quantities of substance that discolor it or make it smell or taste unusual or objectionable, or cause suspicion, it shall not be used unless service records of concrete made with it (or other information) indicated that it is not deleterious to the quality, shall be subject to the acceptance criteria as shown in Table 900.4 and Table 900.5 or as designated by the Engineer.

Table 900.4 Acceptance Criteria for Water Supply

Physical Property	Limit
Compressive strength, min. % control at 7 days	90
Time of Setting deviation from control, h:min[A]	from 1:00 earlier to 1:30 later

Note: [A]Comparisons shall be based on fixed proportions for concrete or mortar mixtures. The control mixture shall be made with 100% potable or distilled water. The test mixture shall be made with the mixing water that is being evaluated.

Table 900.5 Chemical Limitation for Water

Chemical Property	Limits (parts per million, ppm), max.	Test Method
A. Chloride as $Cl^{(-1)}$		
1. Prestressed concrete	500	ASTM C114
2. Other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place	1000	ASTM C114
B. Sulfate as SO_4	3000	ASTM C114
C. Alkalies as (Na_2O + 0.658 K_2O)	600	ASTM C114
D. Total Solids by mass	50000	ASTM C1603

Note: ASTM C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C1603 - Standard Test Method for Measurement of Solids in Water

Non-potable water will be tested in accordance with, and shall meet the suggested requirements of ASTM C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

d. Metal Reinforcement

Reinforcing steel bars shall conform to the requirements of Subsection 902.2, Material Requirements of Item 902, Reinforcing Steel.

e. Admixtures

Air-entraining admixtures, if used, shall conform to ASTM C260M, Standard Specification for Air – Entraining Admixtures for Concrete. Air-entraining admixture shall conform to the requirements of AASHTO M 154, Standard Method of Test for Time of Setting of Hydraulic Cement Paste by Gillmore Needles. Chemical Admixtures, if used, shall conform to the requirements of ASTM C494M, Standard Specification for Chemical Admixtures for Concrete or AASHTO M 194, Standard Specification for Chemical Admixtures for Concrete. Fly Ash, if specified or permitted as a mineral admixture and not exceeding 20% partial replacement of Portland Cement in concrete mix shall conform to the requirements of ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete. Chemical Admixture/s maybe added to the concrete mix to produce some desired modifications to the properties of concrete if necessary, but not as partial replacement of cement. If specified, monofilament polypropylene synthetic fibrin fibers, which are used as admixture to prevent the formation of temperature/shrinkage cracks and increase impact resistance of concrete slabs shall be applied in the dosage rate recommended by its manufacturer.

f. Storage of Cement and Aggregates

All cement shall be stored immediately upon delivery at the site in a weatherproof building which will protect the cement from dampness. The floor shall be raised from the ground. The buildings shall be placed in locations approved by the Engineer. Provisions for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner as to allow the earliest deliveries to be used first and to provide easy access for identification and inspection of each shipment. Storage buildings shall have capacity for storage of a sufficient quantity of cement to allow sampling at least 12 days before the cement is to be used. For a storage period of less than 60 days, stack the bags no higher than 14 layers, and for longer periods, no higher than seven (7) layers. As an additional precaution the oldest cement shall be used first. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. Stored cement shall meet the test requirements at any time after storage when retest is ordered by the Engineer. At the time of use, all cement shall be free flowing and free of lumps. The handling and storing of concrete aggregates shall be such as to prevent segregation or the inclusion of foreign materials. The Engineer may require that aggregates be stored on separate platforms at satisfactory locations. In order to secure greater uniformity of concrete mix, the Engineer may require that the coarse aggregate be separated into two (2) or more sizes. Different sizes of aggregate shall be stored in separate bins or in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed.

g. Curing Materials

Curing materials shall conform to the following requirements as specified;

1. Burlap cloth - AASHTO M 182, Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

2. Liquid membrane forming compounds - ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

3. Sheeting (film) materials - AASHTO M 171, Standard Specification for Sheet Materials for Curing Concrete

h. Expansion Joint Materials

Expansion joint materials shall be:

1. Preformed Sponge Rubber and Cork, conforming to AASHTO M 153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction (ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled 151 PVC Expansion Joint Fillers for Concrete Paving and Structural Construction)

2. Hot-Poured Elastic Type, conforming to ASTM D6690, Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphalt Pavement.

3. Preformed Fillers, conforming to AASHTO M 213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types), ASTM D994M, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)

C. Construction Requirements

The notation used in these regulations is defined as follows:
fc' = compressive strength of concrete

a. Concrete Quality

All Plans submitted for approval or used for any project shall clearly show the specified strength, fc', of concrete of the specified age for which each part of the structure was designed.

Concrete that will be exposed to sulfate containing or other chemically aggressive solutions shall be proportioned in accordance with "Recommended Practice for Selecting Proportions for Concrete (ACI 613)" and Recommended Practice for Selecting Proportions for Structural Lightweight Concrete (ACI 613A)."

b. Methods of Determining the Proportions of Concrete

The determination of the proportions of cement, aggregate, and water to attain the required strengths shall be made by one of the following methods:

Method 1. Without preliminary test

Where preliminary test data on the materials to be used in the concrete have not been obtained, the water-cement ratio for a given strength of concrete shall not exceed the values shown in Table 900.6. When strengths in excess of 27.58 MPa are

required or when lightweight aggregates or admixtures (other than those exclusively for the purpose of air entraining) are used, the required water-cement ratio shall be determined in accordance with Method 2.
Method 2. For combination of materials previously evaluated or to be established by trial mixtures.

Water-cement ratios for strengths greater than that shown in Table 900.6 may be used provided that the relationship between strength and water-cement ratio for the materials to be used has been previously established by reliable 152 test data and the resulting concrete satisfies the requirements of concrete quality. Where previous data are not available. Concrete trial mixtures having proportions and consistency suitable for the work shall be made using at least three (3) different water cement ratios (or cement content in the case of lightweight aggregates) which will produce a range of strengths encompassing those required for the work. For each water-cement ratio (or cement content) at least three (3) specimens for each age to be tested shall be made, cured and tested for strength in accordance with ASTM C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimen and ASTM C192, Standard Practice for Making & Curing Concrete Test Specimens in the Laboratory. The strength test shall be made at 7, 14 and 28 days at which the concrete is to receive load, as indicated on the Plans. A graph shall be established showing the relationship between water-cement ratio (or cement content) and compressive strength. The maximum permissible water-cement ratio for the concrete to be used in the structure shall be that shown by the curve to produce an average strength to satisfy the requirements of the strength test of concrete. Where different materials are to be used for different portions of the work, each combination shall be evaluated separately.

Table 900.6 Maximum Permissible Water-Cement Ratios for Concrete (Method No. 1)

Specified compressive strength at 28 days, MPa	Maximum Permissible water-cement ratio			
	Non-air-entrained concrete		Air-entrained concrete	
	Liters per 40 kg bag of cement	Absolute ratio by weight	Liters per 40 kg bag of cement	Absolute ratio by weight
17.24	25.77	0.642	22.22	0.554
20.70	23.11	0.576	18.66	0.465
24.13	20.44	0.510	15.99	0.399
27.58	17.77	0.443	14.22	0.354

c. Concrete Proportions and Consistency

The proportions of aggregates to cement for any concrete shall be such as to produce a mixture which will work readily into the corners and angles of the form and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or excess free water to collect on the surface. The methods of measuring concrete materials shall be such that the

proportions can be accurately controlled and easily checked at any time during the work.

d. Sampling and Testing of Structural Concrete

As work progresses, at least one (1) sample consisting of three (3) concrete cylinder test specimens, 150 mm x 300 mm, shall be taken from each 75 m3 of each class of concrete or fraction thereof placed each day. Samples from which compression test specimens are molded shall be secured in accordance with ASTM C172M, Standard Practice for Sampling Freshly Mixed Concrete. Specimens made to check the adequacy of the proportions for strength of concrete or as a basis for acceptance of concrete shall be made and laboratory-cured in accordance with ASTM C31M, Standard Practice for Making and Curing Concrete Test Specimen in the Field. Additional test specimens cured entirely under field conditions may be required by the Engineer to check the adequacy of curing and protection of the concrete. Strength tests shall be made in accordance with ASTM C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimen. Compliance with the requirements of this Subsection shall be determined in accordance with the following standard methods of AASHTO:

Sampling of fresh concrete	:	AASHTO R 60, Standard Practice for Sampling Freshly Mixed Concrete
Weight per cubic meter and air content (gravi-metric) of concrete	:	AASHTO T 121M, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
Slump of Portland Cement Concrete	:	AASHTO T 119M, Standard Method of Test for Slump of Hydraulic Cement Concrete

Tests for strength shall be made in accordance with the following:

Making and curing of concrete compressive specimen in the field	:	AASHTO T 23, Standard Method of Test for Making and Curing Concrete Test Specimens in the Field (ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field)
Compressive strength of molded concrete Cylinders	:	AASHTO T 22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens (ASTM C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens)

e. Proportioning and Strength of Structural Concrete

The concrete materials shall be proportioned in accordance with the requirements for each class of concrete as specified in Table 900.7, using the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1, Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete. Other methods of proportioning may be employed in the mix design with prior approval of the Engineer. A change in the source of materials during the progress of work shall necessitate a new mix design. 154 The strength requirements for each class of concrete shall be as specified in Table 900.7.

Table 900.7 Composition and Strength of Concrete for Use in Structures

Class of Concrete	Minimum Cement Content Per m^3 40kg/ (bag**)	Maximum Water / Cement Ratio (kg/kg)	Consistency Range in Slump (mm)	Designated Size of Coarse Aggregate Square Opening Std. mm	Minimum Compressive Strength of 150 mm x 300 mm Concrete Cylinder Specimen at 28 days, MN/m^2
A	364 (9.1 bags)	0.53	50 – 100	37.50 – 4.75	20.7
B	320 (8 bags)	0.58	50 – 100	50.00 – 4.75	16.5
C	380 (9.5 bags)	0.55	50 – 100	12.50 – 4.75	20.7
P	440 (11 bags)	0.49	100 max.	19.00 – 4.75	37.7
Seal	380 (9.5 bags)	0.58	100 - 200	25.00 – 4.75	20.7

*Note: * The measured cement content shall be within plus or minus 2 mass percent of the design cement content.*
*** Based on 40 kg/bag*

f. Consistency

Concrete shall have a consistency such that it will be workable in the required position and will flow around the reinforcing steel but individual particles of the coarse aggregates, when isolated, shall show a coating of mortar containing its proportionate amount of sand. The consistency of concrete shall be gauged by the ability of the equipment to properly place it and not by the difficulty in mixing and transporting concrete mix. The quantity of mixing water, which shall be determined by the Engineer and shall not be varied without his consent. Concrete as dry as it is practical to place with the equipment specified shall be used.

g. Strength Test of Concrete

As basis of acceptance, strength test shall generally be made with the frequency of not less than one (1) test [three (3) specimens] for each 75 m3 . Each test shall be made from a separate batch. One each day concrete is delivered, at least one (1) strength test shall be made for each class of concrete. The age for strength tests shall be 28 days or, when specified in the Plan, the earlier age at which the concrete is to receive its full load or maximum stress. 155 Additional test may be made at earlier ages to obtain advance information on the adequacy of strength development where age-strength relationships have been established for the materials and proportions used. For structures designed in accordance with the ultimate strength design method, and for prestressed structures the average of any three (3) consecutive strength test of the laboratory cured specimens representing each class of concrete shall be equal to or greater than the specified compressive strength, fc' and not more than 10% of the strength tests shall have values less than

the specified strength. When the laboratory-cured specimens failed to conform to the requirements for strength, the Engineer shall have the right to order changes in the concrete sufficient to requirements. If the cured specimen had attained the intended minimum strength requirement, the removal of forms and falseworks may take place and shall conform to the requirements of Item 903, Formworks and Falseworks. When in the opinion of the Engineer, the strengths of the jobcured specimens may not likely be achieved, the Contractor may be required to improve the procedures for protecting and curing the concrete specimen, or when test of field-cured cylinders indicate deficiencies in protection and curing, the Engineer may require test in accordance with ASTM C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete or order load tests as outlined in the load tests of structures for that portion of the structure where the questionable concrete has been placed.

h. Batching
Measuring and batching of materials shall be done at a batching plant.

1. Portland Cement

Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed. All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting operation. The discharge chute shall not be suspended from the weighing hopper and shall be so arranged that cement will neither be lodged in it nor leak from it.

Accuracy of batching shall be within plus (+) or minus (-) one (1) mass percent.

2. Water

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not more than 1%.

3. Aggregates Stockpiling of aggregates shall be in accordance with Subsection 900.2.6, Storage of Cement and Aggregate. All aggregates whether produced or handled by hydraulic methods or washed, shall be stockpiled or binned for 156 draining for at least 12 hours prior to batching. Shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. If the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required by the Engineer.

Batching shall be conducted as to result in a two (2) mass percent maximum tolerance for the required materials.
4. Bins and Scales

The batching plant shall include separate bins for bulk cement, fine aggregate and for each size of coarse aggregate, a weighing hopper, and scales capable of determining accurately the mass of each component of the batch.

Scales shall be accurate to 0.5% throughout the range used.

5. Batching

When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or between the fine and coarse aggregate. When cement is placed in contact with moist aggregates, batches will be rejected unless mixed within one and 1.5 h of such contact. Sacked cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer without loss, and, when more than one (1) batch is carried on the truck, without spilling of material from one (1) batch compartment into another.

6. Admixtures

The Contractor shall follow an approved procedure for adding the specified amount of admixture to each batch and will be responsible for its uniform operation during the progress of the work. He shall provide separate scales for the admixtures which are to be proportioned by weight, and accurate mesures for those to be proportioned by volume. Admixtures shall be measured into the mixer with an accuracy of plus or minus 3%.

The use of Calcium Chloride (CaCl2) as an admixture will not be permitted.

i. Mixing and Delivery

Concrete may be mixed at the construction site, at a central point or by a combination of central point and truck mixing or by a combination of central point mixing and truck agitating. Mixing and delivery of concrete shall be in accordance with the appropriate requirements of AASHTO M 157, Standard Specification for Ready-Mixed Concrete except as modified in the following paragraphs of this Subsection, for truck mixing or a combination of central point and truck mixing or truck agitating. Delivery of concrete shall be regulated so that placing is at a continuous rate unless delayed by the placing 157 operations. The intervals between deliveries of batches shall not be so great as to allow the concrete in place to harden partially, and in no case, shall such an interval exceed 30 min.

Volumetric measurement shall be used only if by weight batching plant is located more than 1 h travel from the project site.

Concrete mixing, by chute is allowed provided that a weighing scales for determining the batch weight will be used.

For batch mixing at the construction site or at a central point, a batch mixer of an approved type shall be used. Mixer having a rated capacity of less than a one-bag batch shall not be used. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity as shown on the manufacturer's standard rating plate on the mixer except that an overload up to 10% above the mixer's nominal capacity may be permitted, provided concrete test data for strength, segregation, and uniform consistency are satisfactory and provided no spillage of concrete takes place. The batch shall be so charge into the drum that a portion of the water shall

enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 s of the mixing period. Mixing time shall be measured from the time all materials, except water, are in the drum. Mixing time shall not be less than 60 s for mixers having a capacity of 1.5 m3 or less. For mixers having a capacity greater than 1.5 m3 , the mixing time shall not be less than 90 s. If timing starts, the instant skip reaches its maximum raised position, 4 s shall be added to the specified mixing time. Mixing time ends when the discharge chute opens.

The mixer shall be operated at the drum speed as shown on the manufacturer's name plate on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his own expense.

The timing device on stationary mixers shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to continue operations while it is being repaired, provided he furnishes an approved timepiece equipped with minute and second hands. If the timing device is not placed in good working order within 24 h, further use of the mixer will be prohibited until repairs are made.

Retempering concrete will not be permitted. Admixtures for increasing the workability, for retarding the set, or for accelerating the set or improving the pumping characteristics of the concrete will be permitted only when specifically provided for in the Contract, or authorized in writing by the Engineer.

Mixing Concrete:

General All concrete batching plant prior to use shall be accredited by the DPWH-Bureau of Research and Standards.

1. Mixing Concrete at Site

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.

When bulk cement is used and volume of the batch is 0.5 m3 or more, the scale and weigh hopper for Portland cement shall be separated 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 also be interlocked against opening when the amount of cement in the hopper is underweight by more than one (1) mass percent or overweight by more than three (3) mass percent of the amount specified.

When the aggregate contains 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.

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

Cement shall be batched and charged into the mixer so that it will not result in loss of cement due to the effect of wind, or in accumulation of cement on surface of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

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

All concrete shall be mixed for a period of not less than 90 s 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.

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

The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand, and water to coat inside of the drum without reducing the required mortar content of the mix. When mixing is to cease for a period of 1 hour or more, the mixer shall be thoroughly cleaned.

2. Mixing Concrete at Central Plant

Mixing at central plant shall conform to the requirements for mixing concrete at site.

3. Mixing Concrete in Truck

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, water-tight, 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 of which the mixing time can be readily verified by the Engineer.

The maximum size of batch in truck mixers shall not exceed the minimum rated capacity of the mixer as stated by the manufacturer 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.

Mixing shall begin within 30 min 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 oC, this limit shall be reduced to 15 min. 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 judgement of the Engineer, the aggregate is sufficiently free from moisture, so that there will be no harmful effects on the cement.

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

4. Transporting and Delivery of Mixed Concrete

Mixed concrete may only be transported to the delivery point in truck agitators or truck mixers operating at the speed designated by the manufacturers of the equipment as agitating speed, or in non-agitating hauling equipment, provided the consistency and workability of the mixed concrete upon discharge at the delivery point is suitable point for adequate placement and consolidation in place.

Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling. 160 No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point.

The rate of discharge of mixed concrete from truck mixers or agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When a truck mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within 1 h, or before 250 revolutions of the drum or blades, whichever comes first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 30°C, or above, a time less than 1 h will be required.

The maximum temperature of concrete produced with heated aggregates, heated water, or both, shall at no time during its production or transportation exceed 32°C.

The Contractor shall have sufficient plant capacity and transportation apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The rate shall be such that the interval between batches shall not exceed 20 min. The methods of delivering and handling the concrete shall be such as that will facilitate placing of the minimum handling.

j. Handling and Placing Concrete: General

Concrete shall not be placed until forms and reinforcing steel have been checked and approved by the Engineer.

If lean concrete is required in the Plan or as directed by the Engineer prior to placing of reinforcing steel bar, the lean concrete should have a minimum compressive strength of 13.8 MPa.

In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from inside the formwork. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under "Time of Hauling and Placing Mixed Concrete".

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete to the forms shall be permitted only on written authorization of the Engineer. The Engineer shall reject the use of the equipment for concrete transportation that will allow segregation, loss of fine 161 materials, or in any other way will have a deteriorating effect on the concrete quality.

Open troughs and chutes shall be of metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement to avoid segregation.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than 1.5 m, concrete shall be conveyed through sheet metal or approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower end shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement bars.

The concrete shall be placed as nearly as possible to its final position and the use of vibrators for moving of the mass of fresh concrete shall not be permitted.

1. Placing Concrete by Pneumatic Means

The equipment shall be so arranged that vibration will not damage freshly placed concrete. The capacity of equipment shall be 0.30 to 1.00 m3 . Where concrete is conveyed and placed by pneumatic means, the equipment shall be suitable in kind and adequate in capacity for the work.

The machine shall be located as close as practicable to the work. The discharge lines shall be horizontal or inclined upwards from the machine. The discharge end of the line shall not be more than 3 m from the point of deposit. At the conclusion of placing the concrete, the entire equipment shall be thoroughly cleaned.

2. Placing of Concrete by Pumping

The equipment shall be so arranged that vibration will not damage freshly placed concrete. The discharge capacity of the equipment shall be 1.5 to 10.0 m3/h. The minimum pressure capacity of the equipment shall be 0.60 MPa.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

3. Placing Concrete in Water

Concrete deposited in water shall be Class Seal concrete with a minimum cement content of 380 kg/m3 of concrete. The slump of the concrete shall be maintained between 4 and 8 cm, whichever is called for in the Bill of Quantities. To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom-dump bucket, or other approved means, and shall not be disturbed after being placed.

A tremie shall consist of a tube having a diameter of not less than 250 mm constructed in sections having flanged couplings fitted with gaskets with a hopper at the top. The tremie shall be supported so as to permit free movement of the discharge and over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be completely submerged in concrete at all times. The tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by lightly raising the discharge end, but always keeping it in the placed concrete. The flow shall be continuous until the work is completed.

When the concrete is placed with a bottom-dump bucket, the top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The buckets shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

k. Consolidation of Concrete

The consolidation method should be compatible with the concrete mixture, placing conditions, and degree of air removal desired. When concrete comes down the chute and flows into forms it carries entrapped air. The entrapped air shall be removed to prevent voids in concrete. Poorly consolidated concrete will be weak, porous and poorly bonded to the reinforcement.

Poured concrete shall be immediately and thoroughly consolidated. The concrete in walls, beams, columns and the like shall be placed in horizontal layers not more than 30 cm thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and consolidated before the preceding layer has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the layers. Each layer shall be consolidated so as to avoid the formation of a construction joint with a preceding layer.

The consolidation shall be done by mechanical vibration. The concrete shall be vibrated internally unless special authorization of other methods is given or is provided herein. The intensity of vibration shall be such as to visibly affect a mass of concrete with a 3 cm slump over a radius of at least 50 cm. A sufficient number of vibrator shall be provided to properly consolidate each batch immediately after it is placed in the forms. Vibrators shall be manipulated so 163 as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms and shall be applied at the point of placing and in the area of freely placed concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The diameter of the steel tube called poker depends on the spacing between the reinforcing bars in the form-work. In no case shall the vibrator be operated longer than 15 s in any one location. The vibration shall be of sufficient duration and intensity to consolidate the concrete thoroughly but shall not be continued so as to cause segregation and at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced, and not farther apart than twice the radius over which the vibration is visibly effective. Vibration shall not be applied directly or thru the reinforcement to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms of troughs or chutes.

l. Concrete Surface Finishing: General

1. Float Finish

Surface shall be consolidated with power–driven floats or by hand floating. Surfaces shall be left uniform, smooth and granular texture.

Float finish shall be applied to the surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

2. Trowel Finish

After applying float finish, trowel shall be applied first then concrete shall be consolidated by hand or power –driven trowel. Continue troweling passes and restraigthen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coating or floor coverings.

3. Concrete Rubbed Finish

After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Allow the concrete to cure before the final rubbing with a fine carborundum stone and water. The concrete shall be kept damp while rubbing. This rubbing shall be continued until the entire surface is of smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it should be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks. Surface coating of cementitious material which adds thickness to the original surface is not acceptable.

m. Curing Concrete

1. All newly placed concrete shall be cured in accordance with this Specification, unless otherwise directed by the Engineer. The curing method shall be one or more of the following:

i. Water Method

The concrete shall be kept continuously wet by the application of water for a minimum period of 7 days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water with an atomizing nozzle. Cotton mats, rugs, carpets, or earth or sand blankets may be used to retain the moisture. At the expiration of the curing period the concrete surface shall be cleared of the curing medium.

ii. Curing Compound

Surfaces exposed to the air may be cured by the application of an impervious membrane if approved by the Engineer.

The membrane forming compound used shall be practically colorless liquid. The use of any membrane-forming compound that will alter the natural color of the concrete or impart a slippery surface to any wearing surface shall be prohibited. The compound shall be applied with a pressure spray in such a manner as to cover the entire concrete surface with a uniform film and shall be of such character that it will harden within 30 min after application. The amount of compound applied shall be ample to seal the surface of the concrete thoroughly. Power-operated spraying equipment

shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay, in the application of the curing compound, which results in any drying or cracking of the surface, application of water with an atomizing nozzle as specified under "Water Method", shall be started immediately and shall be continued until the application of the compound is resumed or started, however, the compound shall not be applied over any resulting free-standing water. Should the film of compound be damaged from any cause before the expiration of 7 days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

Curing compound shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition. If the compound has not been used within 120 days after the date of manufacture, the Engineer may require additional testing before the use to determine compliance to requirements. 165 An anti-setting agent or a combination of anti-setting agents shall be incorporated in the curing compound to prevent caking.

The curing compound shall be packaged in clean barrels or steel containers or shall be supplied from a suitable storage tank located on the site. Storage tank shall have a permanent system designed to completely redisperse any settled material without introducing air or any other foreign substance. Containers shall be well-sealed with ring seals and lug type crimp lids. The linings of the containers shall be of a character that will resist the solvent of the curing compound. Each container shall be labeled with a manufacturer's name, specification number, batch number, capacity and date of manufacture, and shall have label warning concerning flammability. The label shall also warn that the curing compound shall be well-stirred before use. When the curing compound is shipped in tanks or tank trunks, a shipping invoice and Material Safety Data Sheet (MSDS) shall accompany each load. The invoice and MSDS shall contain the same information as that required herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply and/or on the site.

iii. Waterproof Membrane Method

The exposed finished surfaces of concrete shall be sprayed with water, using a nozzle that so atomizes the flow that a mist and not a spray is formed until the concrete has set, after which a curing membrane of waterproof paper or plastic sheeting shall be placed. The curing membrane shall remain in place for a period of not less than 72 h.

Waterproof paper and plastic sheeting shall conform to the specification of AASHTO M 171, Standard Specification for Sheet Materials for Curing Concrete.

The waterproof paper or plastic sheeting shall be formed into sheets of such width as to cover completely the entire concrete surface.

All joints in the sheets shall be securely fastened together in such a manner as to provide a waterproof joint. The joint seams shall have a minimum lap of 100 mm.

The sheets shall be securely weighed down by placing a bank of earth materials on the edges of the sheets or by other means satisfactory to the Engineer.

Should any portion of the sheets be broken or damaged within 72 hours after being placed, the broken or damaged portions shall be immediately repaired with new sheets properly fastened in place.

Sections of membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing the concrete shall not be used.

iv. Forms-in-Place Method

Formed surfaces of concrete may be cured by retaining the form-in-place. The forms shall remain in place for a minimum period of 7 days after the concrete has been placed, except that for members over 50 cm in least dimensions, the forms shall remain in place for a minimum period of 5 days. Wooden forms shall be kept wet by watering during the curing period.

v. Steam Curing Method

Steam curing for pre-cast members shall conform to the following provisions:

(a) After placement of the concrete, members shall be held for a minimum 4 h pre-steaming period.

(b) To prevent moisture loss on exposed surfaces during the pre-steaming period, members shall be covered immediately after casting or the exposed surface shall be kept wet by fog spray or wet blankets.

(c) Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good condition and secured in such a manner to prevent the loss of steam and moisture.

(d) Steam at jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms.

During application of the steam, the temperature rise within the enclosure shall not exceed 20°C per hour. The curing temperature throughout the enclosure shall not exceed 65°C and shall be maintained at a constant level for a sufficient time necessary to develop the required compressive strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature of the enclosure will be the same as that of the concrete.

(e) Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one (1) temperature recording device per 50 m of continuous bed length will be required for checking temperature.

(f) Curing of pre-cast concrete will be considered completed after the termination of the steam curing cycle.

2. The application for curing method shall be one or more of the following:

i. Curing Cast-In-Situ Concrete
All newly placed concrete for cast-in-situ structures, shall either be cured by the water method, the forms-in-place method, or as permitted herein, by the 167 curing compound method, all in accordance with the requirements of Subsection 900.3.13, Curing Concrete.

The curing compound method may be used on concrete surfaces which are to be buried under ground and surfaces where only Ordinary Surface Finish is to be applied and on which a uniform color is not required, and which will not be visible from public view.

When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surface being cured by the curing compound method or by the forms-in-place method until the Engineer determine that a cooling effect is no longer required.

ii. Curing Pre-Cast Concrete (except piles)

Pre-cast concrete members shall be cured for not less than 7 days by the water method, Subsection 900.3.13 (1), Water Method or by steam curing, Subsection 900.3.13 (5), Steam Curing Method. 3. Curing Pre-cast Concrete Piles All newly placed concrete for pre-cast concrete piles, conventionally reinforced or prestressed shall be cured by the "Water Method" as described in Subsection 900.3.11, Curing Concrete, except that the concrete shall be kept under moisture for at least 14 days. At the option of the Contractor, steam curing may be used in which case the steam curing provisions of Subsection 900.3.13(5), Steam Curing Method shall apply except that the concrete shall be kept wet for at least 7 days including the holding and steaming period.

iii. Curing Pre-cast Concrete Piles

All newly placed concrete for pre-cast concrete piles, conventionally reinforced or prestressed shall be cured by the "Water Method" as described in Subsection 900.3.11, Curing Concrete, except that the concrete shall be kept under moisture for at least 14 days. At the option of the Contractor, steam curing may be used in which case the steam curing provisions of Subsection 900.3.13(5), Steam Curing Method shall apply except that the concrete shall be kept wet for at least 7 days including the holding and steaming period.

n. Acceptance of Concrete

The strength of concrete shall be deemed acceptable if the average of three (3) consecutive strength test results is equal to or exceed the specified strength and no individual test result falls below the specified strength by more than 15%.

Concrete deemed to be not acceptable using the above criteria may be rejected unless the Contractor can provide evidence, by means of core tests, that the quality of concrete represented by the failed test result is acceptable in place. Three (3) cores shall be obtained from the affected area and cured and tested in accordance with AASHTO T 24, Standard Method of Test for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete (ASTM C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. Concrete in the area represented by the cores will be deemed acceptable if the average of cores is equal to or at least 85% and no sample core is less than 75% of the specified strength otherwise it shall be rejected

D. Method of Measurement

The quantity of concrete to be paid shall be the number of cubic meters placed and accepted in the completed structure. No deduction will be made for the 168 volume occupied by the pipe less than 101 mm outside diameter nor for reinforcing steel, anchors, weephole(s) or expansion materials.

E. Basis of Payment

The accepted quantities, measured as prescribed in Section 900.4, Method of Measurement shall be paid for at the Contract Unit Price for each of pay item listed below that is included in the Bill of Quantities of structural concrete and/or reinforced concrete completed in place will be paid for at the contract unit price for cubic meter as indicated on the Bid Schedule.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
900 (1)a	Structural Concrete, Class A, 3000 psi, 7 days	Cubic Meter
900 (1)b	Structural Concrete, Class A, 3000 psi, 14 days	Cubic Meter
900 (1)c	Structural Concrete, Class A, 3000 psi, 28 days	Cubic Meter
900 (1)d	Structural Concrete, Class A, 4000 psi, 28 days	Cubic Meter
900 (1)e	Structural Concrete, Class A, 5000 psi, 28 days	Cubic Meter
900 (1)f	Structural Concrete, Class A, 6000 psi, 28 days	Cubic Meter
900 (1)g	Structural Concrete, Class A, 7 days	Cubic Meter
900 (1)h	Structural Concrete, Class A, 14 days	Cubic Meter
900 (1)i	Structural Concrete, Class A, 28 days	Cubic Meter
900 (2)a	Structural Concrete, Class B, 7 days	Cubic Meter
900 (2)b	Structural Concrete, Class B, 14 days	Cubic Meter
900 (2)c	Structural Concrete, Class B, 28 days	Cubic Meter
900 (3)a	Structural Concrete, Class C, 7 days	Cubic Meter
900 (3)b	Structural Concrete, Class C, 14 days	Cubic Meter
900 (3)c	Structural Concrete, Class C, 28 days	Cubic Meter
900 (4)a	Structural Concrete, Class P, 7 days	Cubic Meter
900 (4)b	Structural Concrete, Class P, 14 days	Cubic Meter
900 (4)c	Structural Concrete, Class P, 28 days	Cubic Meter
900 (5)	Seal Concrete	Cubic Meter
900 (6)	Reinforced Concrete	Cubic Meter

IX. REINFORCING STEEL

A. Description

This Item shall consist of furnishing, cutting, bending, fabricating, welding, and placing of steel reinforcement with or without epoxy coating of the type, size, shape and grade required in accordance with this Specification and in conformity with the requirements shown on the Plans.

B. Material Requirements

Reinforcing steel shall conform to the requirements of the following Specifications:

Table 902.1 Reinforcing Steel Bars Requirements

Type of Reinforcing Steel	Specification
Deformed Billet Steel Bars for Concrete Reinforcement	AASHTO M 31M, Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement
	ASTM A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
	PNS 49, Philippine National Standard, Steel Bars for Concrete Reinforcement - Specification
Deformed Steel Wire for Concrete Reinforcement	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete)
Welded Steel Wire Fabric for Concrete Reinforcement	ASTM A1064M Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
Cold-Drawn Steel Wire for Concrete Reinforcement	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete)
Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	AASHTO M 54M, Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement (ASTM A184M, Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement)
Welded Deformed Steel Wire	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM 1064M, Standard Specification for
Fabric of Concrete Reinforcement	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete)
Plastic Coated Dowel Bars	AASHTO M 254M, Standard Specification for Corrosion-Resistant Coated Dowel Bars Type A
Low Alloy Steel Deformed Bars for Concrete Reinforcement	ASTM A706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
Deformed Rail – Steel and Plain Bars for Concrete Reinforcement	ASTM A996M, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

If reinforcing bars are to be welded, these ASTM specifications shall be supplemented by requirements assuring satisfactory weldability.

Dowel and tie bars shall conform to the requirements of AASHTO M 31 (ASTM A615)/PNS 49 except that rail steel shall not be used for tie bars that are to be bent and restraightened during construction. Tie bars shall be deformed bars. Dowel bars shall be plain round bars. They shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the site of the work, a minimum of 1/2 the length of each dowel bar shall be painted with one coat of approved lead or tar paint.

The sleeves for dowel bars shall be metal of an approved design to cover 50 mm, plus or minus 6.3 mm of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 25 mm from the end of the dowel bar. Sleeves shall be of such design that they do not collapse during construction.

Plastic coated dowel bar conforming to AASHTO M 254M may be used.

1. Wire Rope or Wire Cable

The wire rope or wire cable shall conform to the requirements of AASHTO M 30, Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail for the specified diameter and strength class.

2. Prestressing Reinforcing Steel

Prestressing reinforcing steel shall conform to the requirements of the following Specifications:

High-tensile wire : AASHTO M 204M, Standard Specification for Uncoated Stress Relieved Steel Wire for Prestressed Concrete ASTM A421M, Standard Specification for Stress-Relieved Steel Wire for Prestressed Concrete

High-tensile wire strand or rope : AASHTO M 203 M, Standard Specification for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement ASTM A416M, Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete

High-tensile-strength alloy bars shall be cold stretched to a minimum of 895.7 MPa. The resultant physical properties shall be as follows:

Table 902.2 Resultant Physical Properties of High Tensile Strength Alloy Bars

Physical Property	Requirement
Minimum ultimate tensile strength	1,000 MPa followed by stress relieving
Minimum yield strength, measured by the 0.7% extension under load method	895.7 MPa
Minimum modulus of elasticity	25,000,000
Minimum elongation in 20 bar diameters after rupture	4%
Diameters tolerance	0.254 mm to 0.762 mm

If shown on the Plans, Type 270 k strand shall be used, conforming to AASHTO M 203M. Where strands are to be used for post-tensioning, the same shall be colddrawn and either stress-relieved in the case of uncoated strands, or hot-dip galvanized in the case of galvanized strands. High strength alloy steel bar for post-tensioning shall be proofstressed to 90% of the granted tensile strength. After proofstressing, the bars shall conform to the following minimum properties:

Table 902.3 Minimum Requirements for High Strength Alloy Steel Bar for Post-Tensioning

Property	Requirement
Tensile Strength, fs'	1000 MPa
Yield Strength (0.2 offset)	0.90 fs'
Elongation at Rupture in 20 diameter	4%
Reduction of Area at Rupture	25%

3. Epoxy Coated Reinforcing Steel Bars

Epoxy coated reinforcing steel bars shall be applied with protective epoxy coating by the electrostatic spray method to strengthen the concrete and protect against corrosive conditions that will be exposed to the aggressive elements.

Epoxy coated reinforcing steel bars shall conform to ASTM A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Steel Bars for steel bars coated in straight condition and then bent, and ASTM A934M, Standard Specification for Epoxy-Coated Prefabricated Steel Bars for steel bars that are bent prior to coating.

The powder coating shall be of organic composition except for the pigment which may be inorganic if used.

The following kinds of reinforcing steel bars are allowed to be applied with epoxy coating.

Table 902.4 Kinds of Reinforcing Steel Bars are allowed to be applied with epoxy coating

Reinforcing Steel	Standard Designation
Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement	ASTM A615/AASHTO M 31
Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement	ASTM A706
Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcements	ASTM A996/AASHTO M 322

a. Surface Preparation

The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive blast cleaning to a near white metal. It is recommended that reinforcing steel bars and blast media be checked for contamination by any foreign materials and oil impurities prior to use. Blast media found to be salt contaminated should be rejected. Reinforcing steel bars and blast media found to be contaminated shall be rejected or washed cleaned prior to heating thru the use of methods suitable to remove the contamination.

Manufacturers shall be permitted to use a chemical wash or blast-cleaned steel reinforcing bar surface, or both, to enhance coating adhesion. This pretreatment shall be applied after abrasive cleaning and before epoxy coating, in accordance with the written application instructions specified by the pretreatment manufacturer.

b. Coating Application

If pretreatment is used in the preparation of the surface, the powder coating shall be applied to the cleaned and pretreated steel reinforcing bar surface as soon as possible after surface treatments have been completed, and before visible oxidation of the surface occurs as discernible to a person with normal 178 or corrected vision. In no case shall application of the coating be delayed more than 3 hours after cleaning.

The fusion-bonded epoxy powder coating shall be applied in accordance with the written recommendations of the manufacturer of the powder coating for initial surface temperature range and post application curing requirements. During continuous operations, the temperature of the surface immediately prior to coating shall be measured using infrared guns or temperature indicating crayons, or both, at least once every 30 minutes. The powder coating shall be applied by electrostatic spray or other suitable method.

c. Curing

Following powder application, the coating is allowed to cure at approximately 30 seconds during which time it hardens to a solid. In some plants, the curing is often followed by an air or water quench that quickly reduces the bar temperature to facilitate handling.

d. Requirements for Epoxy-Coated Reinforcing Steel Bars

i. Coating Thickness

For acceptance purpose, at least 90% of all recorded thickness measurements of the coating after curing shall be 175 µm to 300 µm. Thickness measurements below 125 µm shall be considered cause for rejection. The upper thickness limit does not apply to repaired areas of damaged coating.

A single recorded coated reinforcing steel bar thickness measurement is the average of three (3) individual gauge readings obtained between four (4) consecutive deformations. A minimum of five (5) recorded measurements shall be obtained approximately evenly spaced along each side of the test bar (a minimum of ten (10) recorded measurements per bar).
The coating thickness shall be measured on the body of a straight length of reinforcing steel bar between the deformations.

ii. Coating Continuity

Holiday checks to determine the acceptability of the reinforcing steel bars prior to shipment shall be made at the manufacturer's plant with a 67.5 V, 80,000 Ω, wet-sponge type direct-current holiday detector or equivalent method.

On average, there shall not be more than three (3) holidays per meter on a coated steel reinforcing bar. The average applies to the full production length of a bar.

A wetting agent shall be used as per applicable requirements of Test Method of ASTM G62, Standard Test Methods for Holiday Detection in Pipeline Coatings in the inspection for holidays on the coated steel reinforcing bars.

iii. Coating Flexibility

(a) The coating flexibility shall be evaluated by bending production coated reinforcing steel bars at a uniform rate around a mandrel of specified size within a maximum specified time as prescribed in the applicable requirements of bend test requirements of ASTM A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars. The two (2) longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius. The test specimen shall be between 20° C and 30° C.

(b) No cracking or disbonding of the coating shall be visible to the unaided eye on the outside radius of the bent bar. Evidence of cracking or disbanding of the coating shall be considered cause for rejection of the coated reinforcing steel bars represented by the bend test sample.

(c) Fracture or partial failure of the reinforcing steel bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test shall not be considered a flexibility failure of the coating, but shall require testing two (2) additional specimens. These two (2) specimens shall then meet the requirements of (b).

(d) The requirements for coated reinforcing steel bars shall be met at the manufacturer's plant prior to shipment.

C. Construction Requirements

1. Order Lists

Before materials are ordered, all order lists and bending diagrams shall be furnished by the Contractor, for approval of the Engineer. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists and diagrams. Any expense incident to the revisions of materials furnished in

accordance with such lists and diagrams to make them comply with the Plans shall be borne by the Contractor.

2. Protection of Material

a. Steel Reinforcement

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, detrimental rust, loose scale, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

b. Epoxy-Coated Reinforcing Steel Bars

i. If rainy or exceptionally humid weather occurs or is anticipated, bars shall be stored under cover immediately upon delivery to site. Epoxy bars shall be covered with polyethylene or other materials to prevent exposure to direct sunlight.

ii. Epoxy coated steel stored at the site shall be placed on timber sills suitably spaced so that no steel shall be laid upon or come in contact with the ground and elevated sufficiently to prevent sags in the bundles and from workers walking on the steel.

iii. Reinforcement steel bars shall be handled and stored in manner to prevent damage to bars or the epoxy coating.

iv. Coated reinforcing steel bars, whether individual bars or bundles of bars or both, shall be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked bundles, the protective covering shall be draped around the perimeter of the stack. The covering shall be secured adequately, and allow for air circulation around the bars to minimize condensation under the covering.

v. All systems for handling the epoxy coated bars shall have padded contact areas to eliminate damage.

vi. All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All bundles of coated reinforcing steel bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar to bar abrasion from sags in the bundles of coated reinforcing steel bars.

3. Bending

All reinforcing bars requiring bending shall be cold-bent to the shapes shown on the Plans. Bars shall be bent around a circular pin having the following diameters (D) in relation to the nominal diameter of the bar (d) as shown in Table 902.5.

Table 902.5 Pin Diameter for Bending Bars

Nominal Diameter (d), mm	Pin diameter (D)
10 to 20	6d
25 to 28	8d
32 and greater	10d

Bends and hooks in stirrups or ties may be bent to the diameter of the principal bar enclosed therein.

4. Placing and Fastening

All steel reinforcement shall be accurately placed in the position shown on the Plans and firmly held there during the placing and setting of the concrete. Bars shall be tied at all intersections except where spacing is less than 300 mm in each direction, in which case, alternate intersections shall be tied. Ties shall be fastened on the inside.

Distance from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports, so that it does not vary from the position indicated on the Plans by more than 6 mm. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shapes and dimensions. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. Unless otherwise shown on the Plans or as required by the Engineer, the minimum distance between bars shall be 40 mm. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete reinforcement placed in violation of this provision shall be rejected and removal shall be required unless otherwise structural integrity of the structure was proved adequate by the Contractor in writing and approved by the Engineer. If fabric reinforcement is shipped in rolls, it shall be straightened before being placed. Bundled bars shall be tied together at not more than 1.80 m intervals.

5. Splicing

All reinforcement shall be furnished in the full lengths indicated on the Plans. Splicing of bars, except where shown on the Plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible and with a minimum separation of not less than 40 bar diameters.

Bars shall be lapped in accordance to Table 902.6

Table 902.6 Bars Minimum Lap Distance

Splice Type	Grade 280 (40)	Grade 420 (60)	But not less than
Tension	24 bar dia.	36 bar dia.	300 mm
Compression	20 bar dia.	24 bar dia.	300 mm

In lapped splices, the bars shall be placed in contact and wired together. Lapped splices will not be permitted at locations where the concrete section is insufficient to provide minimum clear distance of 1 1/3 the maximum size of coarse aggregate between the splice and the nearest adjacent bar. Welding of reinforcing steel shall be done only if detailed on the Plans. Spiral reinforcement shall be spliced by lapping at least 1 ½ turns or by butt welding unless otherwise shown on the Plans. Splicing shall conform to the following requirements unless otherwise shown on the Plans.

a. Lap splices shall not be permitted for bars larger than 36 mm Ø.

b. For contact lap splices, minimum clear spacing between the contact lap splice and adjacent splices or bars shall be in accordance with the requirements below.

i. For parallel non-prestresed reinforcement in a horizontal layer, clear spacing shall be at least the greatest of 50 mm, nominal diameter of bar(db) and (4/3) nominal maximum size of coarse aggregates (dagg).

c. For non-contact splices in flexural members, the transverse center-tocenter spacing of spliced bars shall not exceed the lesser of one-fifth the required lap splice length and 150 mm.

d. Lap splices of bundled bars shall be in accordance with the requirements below.

i. Lap splices of bars in the bundle shall be based on the lap splice length required for the individual bars within the bundle.

ii. Individual bar splices within a bundle shall not overlap.

iii. Entire bundles shall not be lap spliced.

6. Lapping of Bar Mat

Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The overlap shall not be less than one (1) mesh in width.

7. Welding

Welding of reinforcing steel bars shall conform to American Welding Society, AWS D1.4M, Structural Welding Code - Reinforcing Steel.

For steel bars conforming to ASTM A706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement the bars can be welded without preheating. Steel bars conforming to ASTM A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement shall be preheated to 260°C.

After completion of welding on epoxy-coated bars, the damaged areas shall be repaired using patch materials conforming to ASTM A47M, Standard Specification for Ferritic Malleable Iron Castings.

D. Method of Measurement

The quantity of reinforcing steel to be paid for will be the final quantity placed and accepted in the completed structure as shown on the Plans.

E. Basis of Payment

The accepted quantity, measured as prescribed in Section 902.4, Method of Measurement shall be paid for at the Contract Unit Price for reinforcing steel which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
902 (1) a1	Reinforcing Steel (Deformed) Grade 40	Kilogram
902 (1) a2	Reinforcing Steel (Deformed) Grade 60	Kilogram
902 (1) b	Reinforcing Steel (Plain/Round)	Kilogram
902 (2) a1	Epoxy-Coated Reinforcing Steel (Deformed) Grade 40	Kilogram
902 (2) a2	Epoxy-Coated Reinforcing Steel (Deformed) Grade 60	Kilogram
902 (2) b	Epoxy-Coated Reinforcing Steel (Plain/Round)	Kilogram

X. FORMS AND FALSEWORKS

A. Description

This Item covers the furnishing, fabrication, installation, erection, and removal of forms and falseworks for cast-in-place concrete.

B. Material Requirements

Forms shall be constructed with metal or timber. For timber forms, it is important that the moisture content of the timber that will be used to make the formwork in between 15% to 20%. Low moisture content means the timber is very dry thus it can absorb moisture from the wet concrete resulting to swelling and bulging of timber and weak hardened concrete. Use of tough resin as wood coating is the treatment used to overcome the moisture problem in timber formworks though painting the wood with varnish is an alternative cheaper treatment. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiber board.

For metal forms, it is important that the metal used as sheating should be free from rust and nonreactive to concrete or concrete containing calcium oxide. Plywood or lined forms will

not be required for surfaces which are normally submerged or not ordinarily exposed to view. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.

C. Construction Requirements

1. General

Forms shall be furnished, fabricated, installed, erected, and removed as specified herein and shall be of a type, size, shape, quality and strength to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. The forms shall be true to line and grade in accordance with the tolerances as specified for cast-in-place concrete and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces.

The minimum thickness used for metal forms shall be 2.5 mm or 3 mm thick or of such thickness that the forms remain true to shape. For timber formworks plywood is used for sheating with a minimum thickness of 18 mm to 25 mm though the thickness of the plywood to be used will depend on the pressure that the wet concrete will put on the formwork. The design of formwork will specify the thickness of the plywood that will be incorporated in the project. All tie bars with bolts used in fastening forms should be countersunk to a depth similar to the required concrete covering and patched with cement mortar. The 185 use of approved internal steel ties or steel or plastic spacers shall be permitted. The fabricated spacer blocks shall have an embedded No. 16 G.I. Tie Wire with sufficient length to be attached to the reinforcing steel bars to hold the spacers in place after closure of forms and during pouring. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm.

The design and construction of the formworks and falseworks shall be the responsibility of the Contractor and for approval of the Engineer. The Contractor shall employ competent professional engineering services to design forms to be approved by the Engineer and supervise the erection of all formworks needed for the completion of the project. All materials to be incorporated to the site shall be inspected and approved by the Engineer.

2. Fabrication and Erection

Formworks to be used shall conform to ACI 347 - Guide to Formwork for Concrete. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties shall be approved by the Engineer and shall be of the snap cone or she-bolt with cone type. The spacing of form ties shall be designed to withstand concrete pressures without bulging, spreading, or lifting of the forms. The

forms shall produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.

Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used. All form panels shall be placed in a neat, symmetrical pattern with level and continuous horizontal joints. The Contractor shall place special attention on mating forms to previously placed walls so as to minimize steps or rough transitions. Form panels shall be of the largest practical size to minimize joints and to improve rigidity which is to be designed by the formworks engineer of the Contractor. For engineered wood, available panels sizes of 1.20 m x 2.70 m and 3.00 m x 2.40 m can be ordered. Beams and slabs supported by concrete columns shall be formed in a way that the column forms can be removed without disturbing the supports of the beams or slabs.

Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls, the forms on one side shall not extend more than 7 m above the joints.

When necessary, temporary openings shall be provided at the bottom of column and wall forms and at other points in order to facilitate cleaning and 186 inspection prior to concrete placement. Unless otherwise shown on the drawings, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 25 mm x 25 mm chamfer formed by a wood or metal chamfer strip.

Forms for exposed surfaces and all steel forms shall be coated with non-staining form release agent which shall be applied just prior to placement of steel reinforcement. After coating with industrial lubricants such as form oil, any surplus form release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating with industrial lubricant immediately before concrete placement, except in freezing weather form release coating shall be used. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measure shall be taken to ensure acceptable lines and surface to required dimensions and cross sections. If any forms bulge or show excessive deflection, in the opinion of the Engineer, the concrete shall be removed and the forms shall be rebuilt and strengthened.

a. Proper foundations on ground, such as mudsills, spread footings, or pile footings should be provided. If soil under mudsills is or may become incapable of supporting superimposed loads without appreciable settlement, it should be stabilized or other means of support should be provided.

3. Safety

Forms must be strong and sound (made of good quality and durable materials) in order to carry the full load and side pressure from freshly placed concrete. To

ensure that forms are safe, correctly designed and strong enough for the expected load, Occupational Safety and Health Administration (OSHA) regulations under Section 1926.703 Safety and Health Regulations for Construction, American Concrete Institute 347 (ACI 347) – Guide to Formwork recommendations under Section 3.1 Safety Precautions in Construction and Section 3.2 Construction Practices and Workmanship, and local code requirements for formwork should be followed.

4. Delivery, Storage, Maintenance and Handling

   Any formwork with steel components should be stored in a dry place. Avoid direct sunlight on timber forms. Store form materials and accessories above ground with a minimum height of 100 mm on framework or blocking without twist or bend, and shall be covered with a suitable waterproof of covering providing adequate air circulation and free from dirt. Store and handle form coating to prevent contamination in accordance with manufacturer's recommendation. For maintenance of the forms, use stiff brush and clean water for the cleaning of forms. Use scrapers only as a last resort for maintenance purposes. Keep forms well-oiled to prevent delamination of plywood or rusting of steel and always oil the edges.

5. Forms, falseworks and centering shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads, or until the concrete has attained the minimum percentage of specified design strength listed in the Table below. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.

   No forms shall be removed without the approval of the Engineer. In general and under normal conditions, the Engineer will approve removal of forms after the following time has elapsed:

Description of Structural Member	Period of time (days)	Minimum % of Design Strength
Walls, column and vertical sides of beams	1 to 2	70%
Beam soffits (steel formwork props/shoring left under)	7	80%
Soffits of slabs (steel formwork props/shoring left under)	7	70%
Removal of steel formwork props/shoring to slabs: Soffits of slabs, for slabs spanning up to 4.5 m	7	70%
Removal of steel formwork props/shoring to slabs: Soffits of slabs, for slabs spanning over 4.5 m	14	70%
Removal of steel formwork props/shoring to beams and arches: Centering under girders, beam frames and arches spanning up to 6.0 m	14	80%
Removal of steel formwork props/shoring to beams and arches: Centering under girders, beam frames and arches spanning over 6.0 m	21	80%

Order and method of removing formwork:

a. Shuttering forming the vertical faces of walls, beams and columns sides shall be removed first as they bear no load but only retain the concrete.

b. Shuttering forming soffit of slabs shall be removed next. 188

c. Shuttering forming soffit of beams, girders or other heavily loaded shuttering shall be removed in the end.

Care shall be taken into consideration during form removal to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified by the Engineer.

Removal of Forms for Special Structures

In continuous structures, support should not be released in any span until the first and second adjoining spans on each side have reached the specified strength. For prestressed concrete construction, pre-tensioning and posttensioning of strands, cables or rods can be done with or without side forms of the member in place. Bottom forms and supporting shores or falsework should remain in place until the member is capable of supporting its dead load and anticipated construction loads, as well as any formwork carried by the member. Side forms that remain in place during the transfer of pre-stressing force should be designed to allow for vertical and horizontal movements of the cast member during the prestressing operation. In all cases, the deflections of members due to pre-stressing force and the elastic deformation of forms or falsework should be considered in the design and removal of the forms. For reasons of safety, when using post-tensioned, cast-in-place elevated slabs, the Contractor should be careful to ensure that supporting shores do not fall out due to lifting of the slab during tensioning. For large structures where the dead load of the member remains on the formwork during pre-stressing, displacement of the dead load toward end supports should be considered in the design of the forms and shoring, including sills or other foundation support.

For concrete structures with direct or indirect contact with sea water, sea water or brackish water shall not come in direct contact with concrete prior to the age in days indicated in the Table shown below.

Requirements for the Removal of Formwork for Concrete in Contact with Sea Water or Brackish Water	
Water Salinity (ppm dissolved salts) (parts per million or mg/L of dissolved salts)	**Days to Elapse prior to Salt Water Contact (days)**
0 to 10,000	Normal Curing
10,000 to 20,000	15
20,000 to 30,000	25
Over 30,000	30

6. Quality Control and Inspection

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Materials and components used for formworks shall be examined for damage or excessive deterioration before use. Reuse of forms shall be allowed only if 189 found suitable after necessary repairs. In case of timber forms, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits. Reuse of job-built forms shall be permitted only when specifically approved by the Engineer.

The Engineer shall inspect the completed formwork, before carrying out any work, including fixing of reinforcing support.

D. Method of Measurement

Forms installed for the cast-in-place concrete in accordance to shop drawings and design calculations shall be measured in square meters or when the contract stipulates that the payment for formworks and falseworks will be on lump sum basis, the Pay Item will include all materials and components used for furnishing, fabrication, installation, erection and removal of forms. The quantity to be paid for shall be the square meters of formwork used and accepted by the Engineer or the lump sum bid price in the Contract.

E. Basis of Payment

The quantity measured as prescribed above shall be paid for at the Contract Unit Price or lump sum price bid for the pay item listed below that is included in the Bill of Quantities. This unit price shall cover full compensation for all materials, labor, tools, equipment, and related services necessary for the design, construction and removal of formwork and falsework. Properly supported members as required until the concrete is cured, set and hardened is also part of the Contract Unit Price.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
903 (1)	Formworks and Falseworks	Lump Sum
903 (2)	Formworks and Falseworks	Square Meter

XI. METAL STRUCTURES

A. Description

This work shall consist of furnishing, fabricating, hauling, erecting, welding and painting of metal structure and accessories constructed in accordance with the Plans and this Specifications.

B. Material Requirements

a. Classes of Structural Steels

i. Built – Up Shapes

Built-up shapes are defined as structural steel sections made up of steel plates with thickness ranging from 5 mm to 45 mm, welded together to form structural shapes. It shall conform to the requirements of ASTM A36M, Standard Specification for Carbon Structural Steel.

Built-up cross sections consisting of plates with a thickness exceeding 50 mm, used as members subject to primary tensile forces due to tension or flexural and spliced or connected to other members using complete joint-penetration groove welds that fuse through thickness of plate, shall conform to ASTM A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling, Supplementary Requirement S5, Charpy V-Notch Impact Test and ASTM A673M, Standard Specification for Sampling Procedure for Impact Testing of Structural Steel.

ii. **Cold Formed Plate Shapes**
Cold formed plate shapes are made from steel plates with thickness ranging from 6 mm to 20 mm formed by cold rolling or by press brake bending into the desired shape. It shall conform to ASTM A36M.

iii. **Cold Formed Light Gage Shapes**
Structural steel shapes cold-formed from coils or sheets with thicknesses ranging from 2 mm to 6 mm.

iv. **Rolled Steel Plates**
Rolled Steel shapes are structural steel sections produced by passing red hot blooms (for larger sections) or billets (for smaller sections) through rolls until the desired shape is attained. Rolled steel shapes shall conform to the billet specifications for PNS 49, Steel Bars for Concrete Reinforcement – Specification, Grade 230.

v. **Metal Decks**
Metal decks or panels shall conform to Item 1033, Metal Decks.

b. **Structural Steel Materials**

i. **General**
For hot-rolled structural shapes, plates and bars, such tests shall be made in accordance in ASTM A6M; for sheets, such tests shall be made in accordance with ASTM A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements; for tubing and pipe, such tests shall be made in accordance with the requirements of the applicable ASTM standards listed for those product forms.

Structural steel shall be furnished according to the following applicable ASTM specifications:

ii. **Hot-rolled Structural Shapes**
Hot-rolled structural shapes shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTM A36M	Standard Specification for Carbon Structural Steel
ASTM A529M	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572M	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588M	Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50ksi (345Mpa) Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A709M	Standard Specification for Structural Steel for Bridges
ASTM A913M	Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST)
ASTM A992M	Standard Specification for Structural Steel Shapes

iii. **Structural Tubing**

Structural tubing shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTN A500M	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

Designation	Title
ASTM A501M	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A618M	Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A847M	Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance

iv. **Steel Pipe**

It shall conform to the requirements of ASTM A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless, Grade B.

v. **Steel Plates**

Steel plates shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTM A36M	Standard Specification for Carbon Structural Steel
ASTM A242M	Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A283M	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A514M	Standard Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A529M	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572M	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588M	Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50ksi (345Mpa) Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A709M	Standard Specification for Structural Steel for Bridges
ASTM A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

vi. **Steel Bars**

Steel bars shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTM A36M	Standard Specification for Carbon Structural Steel
ASTM A529M	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572M	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A709M	Standard Specification for Structural Steel for Bridges

vii. **Steel Sheets**

Steel sheets shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTM A606M	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A1011M	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

c. **Steel Casting and Forgings**

Cast steel shall conform to ASTM A216M, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding, for High Temperature Service.

Steel forging shall conform to ASTM A668M, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

d. Bolts, Washers and Nuts

Bolts, washers and nuts shall conform to the requirements of the following specifications or as indicated in the Plans:

Designation	Title
Bolts	
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM F3125M	Standard specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
ASTM A449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

Designation	Title
Nuts	
ASTM A194M	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service or Both
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
Washers	
ASTM F436M	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F959M	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series

e. Anchor Rods and Threaded Rods

Anchor rod and threaded rod material shall conform to the following specifications or as indicated in the Plans:

Designation	Title
ASTM A36M	Standard Specification for Carbon Structural Steel
ASTM A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A572M	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength

f. Consumables for Welding

Filler metals and fluxes shall conform to the following applicable specifications of American Welding Society or as indicated in the Plans:

Designation	Title
AWS A5.1M	Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.5M	Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
AWS A5.17 M	Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
AWS A5.18M	Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
AWS A5.23M	Specification for /Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
AWS A5.25M	Specification for Carbon and Low-Alloy Steel Electrodes and Fluxes for Electroslag Welding
AWS A5.26M	Specification for Carbon and Low-Alloy Steel Electrodes for Electrogas Welding
AWS A5.32M	Welding Consumables – Gases and Gas Mixtures for Fusion Welding and Allied Processes
AWS A5.36M	Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding

g. Head Stud Anchors

Steel stud shear connectors shall conform to the requirements of AWS D1.1M, Structural Welding Code – Steel.

Studs are made from cold drawn bar, either semi-killed or killed aluminum or silicon deoxidized, conforming to the requirements of ASTM A29M, Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, HotWrought.

h. Turnbuckle

Unless otherwise specified, turnbuckle shall conform to the applicable requirements of ASTM F1145, Standard Specification for Turnbuckles, Swaged, Welded, Forged and AASHTO M 269, Standard Specification for Turnbuckles and Shackles.

i. **Stainless Steel Flagpole Post**

Unless otherwise specified, stainless steel for flagpole shall conform to the applicable requirements of ASTM A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes and ASTM A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.

C. **Construction Requirements**

a. **Shop and Erection Drawings**

Shop and erection drawings are permitted to be prepared in stages. Shop drawings shall be prepared in advance of fabrication and give complete information necessary for the fabrication of the component parts of the 458 structure, including the location, type and size of welds and bolts. Erection drawings shall be prepared in advance of the erection and give information necessary for erection of the structure. Shop and erection drawings shall clearly distinguish between shop and field welds and bolts and shall clearly identify pretensioned and slip-critical high-strength bolted connections.

b. **Fabrication**

i. **Cambering,Curving and Straightening**

Local application of heat or mechanical means is permitted to be used to introduce or correct camber, curvature and straightness. The temperature of heated areas as measured by the approved methods, shall not exceed 593 °C for ASTM A514M or as indicated in the Plans.

ii. **Thermal Cutting**

Thermally cut edges shall meet the requirements of AWS D1.1M clauses 5.14.5.2, 5.14.8.3 and 5.14.8.4, with the exception that thermally cut free edges that will be subject to calculated static tensile stress shall be free of round-bottom gouges greater than 5 mm and sharp V-shaped notches. Gouges deeper than 5 mm and notches shall be removed by grinding or repaired by welding.

Reentrant corners, except reentrant corners of beam copes and weld access holes, shall meet the requirements of AWS D1.1, Section 5.16. If another specified contour is required, it shall be shown on the contract. Beam copes and weld access shall meet the geometrical requirements of Section 510.1.6, Beam Copes and Weld Access Holes of Chapter 5, Structural Steel of National Structural Code of the Philippines (NSCP), 2015 Edition. Beam copes and weld access holes in shapes that are to be galvanized shall be ground. For shapes with a flange thickness not exceeding 50 mm the roughness of thermally cut surfaces of copes shall be no greater a surface roughness value of 50 µm as defined in ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay). For beam copes and weld access holes in which the curved part of the access hole is thermally cut in ASTM A6M hot rolled shapes with a flange thickness exceeding 50 mm and welded built-up shapes with material thickness greater than 50 mm, a preheat temperature of not less than 66 °C shall be applied prior to thermal cutting. The thermally cut surface of access holes in ASTM A6M hot rolled shapes and built-up shapes with a thickness greater than 50 mm shall be ground and inspected for cracks using magnetic particle inspection in accordance with ASTM E709, Standard Guide for Magnetic Particle Testing. Any crack is unacceptable regardless of size and location.

iii. **Planing of Edges**

Planing or finishing of sheared or thermally cut edges of plates or shapes is not required unless specifically called for in the Contract documents or included in a stipulated edge preparation for welding.

iv. **Welded Construction**

The technique of welding, workmanship, appearance and quality of welds, and the methods used in correcting nonconforming work shall be in accordance with AWS D1.1M.

v. **Bolted Construction**

Parts of bolted members shall be pinned or bolted and rigidly held together during assembly. Use of a drift pin in bolt holes during assembly shall not distort the metal or enlarge the holes. Poor matching of holes shall be cause for rejection.

Bolts shall comply with the provisions of the Research Council on Structural Connections (RCSC) Specification for Structural Joints using ASTM F3125M except that thermally cut holes shall be permitted with a surface roughness profile not exceeding 25 µm as defined in ASME B46.1. Gouges shall not exceed a depth of 2 mm.

Fully inserted finger shims, with a total thickness of not more than 6 mm within a joint, are permitted in joints without changing the strength (based upon hole type) for the design connections. The orientation of such shims is independent of the direction of application of the load. The use of high-strength bolts shall conform to the requirements of the RCSC Specification for Structural Joints using ASTM F3125M.

vi. **Dimensional Tolerances**

Dimension tolerances shall be in accordance with the American Institute of Steel Construction (AISC) Code of Standard Practice for Steel Buildings and Bridges.

vii. **Finish of Column Bases**

Column bases and base plates shall be finished in accordance with the following requirements:

1. Steel bearing plates 50 mm or less in thickness are permitted without milling, provided a satisfactory contact bearing is obtained. Steel bearing plates over 50 mm but not over 100 mm in thickness are permitted to be straightened by pressing, or if presses are not available, by milling for bearing surfaces (except as noted in subparagraph 2 and 3 of this section), to obtain a satisfactory contact bearing. Steel bearing plates over 100 mm in thickness shall be milled for bearing surfaces (except as noted in subparagraph 2 and 3 of this section).
2. Bottom surfaces of bearing plates and column bases that are grouted to ensure full bearing contact on foundations need to be milled.

3. Top surfaces of bearing plates need not be milled when complete-joint penetration groove welds are provided between the column and bearing plate.

viii. Holes for Anchor Rods

Holes for anchor rods shall be permitted to be thermally cut in accordance with the provisions of Subsection 1047.3.2.2, Thermal Cutting.

ix. Drain in Holes

When water can collect inside Hollow Structural Sections (HSS) or box members, either during construction or during service, the member shall be sealed, provided with a drain hole at the base.

x. Requirements for Galvanized Members

Members and parts to be galvanized shall be designed, detailed and fabricated to provide for flow and drainage of pickling fluids and zinc and to prevent pressure built up in enclosed parts.

Design and detailing of galvanized members shall conform to the requirements of the following:

1. ASTM A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings and Iron and steel Products.
2. ASTM A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
4. ASTM A780M, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

c. Shop Painting

i. General Requirements

Shop painting and surface preparation shall be in accordance with the provision of the AISC Code of Standard Practice for Steel Building and Bridges. Shop paint is not required unless specified in the Contract Documents.

ii. Inaccessible Surfaces

Except for contact surfaces, surfaces inaccessible after shop assembly shall be cleaned and painted prior to assembly

iii. Contact Surfaces

Paint is permitted in bearing-type connections. For slip critical connections, the faying surface requirements shall be in accordance with the RCSC Specification for Structural Joints Using ASTM F3125M.

iv. Finished Surfaces

Machine-finished surfaces shall be protected against corrosion by a rust inhibitive coating that can be removed prior to erection, or which has characteristics that make removal prior to erection unnecessary.

v. **Surfaces Adjacent to Field Welds**
Unless otherwise specified, surface within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes during welding.

d. **Erection**

i. **Alignment of Column Bases**
Column bases shall be set level to the required elevation with full bearing on concrete or masonry.

ii. **Bracing**
The frame of steel skeleton buildings shall be carried up true and plumb within the limits defined in the AISC Code of Standard Practice for Steel Buildings and Bridges. Temporary bracing shall be provided, in accordance with the requirements of the Code of Standard Practice for Steel Buildings and Bridges, wherever necessary to support the loads to which the structure may be subjected, including equipment and the operation of same. Such bracing shall be left in place as long as required safety.

iii. **Alignment**
No permanent bolting or welding shall be performed until the adjacent affected portions of the structure have been properly aligned.

iv. **Fit of Column Compression Joints and Base Plate**
Lack of contact bearing not exceeding a gap of 2 mm, regardless of the type of splice used (partial-joint-penetrating groove welded or bolted), is permitted. If the gap exceeds 2 mm, but is less than 6 mm, and if an engineering investigation shows that sufficient contact area does not exist, the gap shall be packed out with non-tapered steel shims. Shims need not be other than mild steel, regardless of the grade of the main material.

v. **Field Welding**
Shop paint on surfaces adjacent to joints to be field welded shall be wire brushed to assure weld quality. Field welding of attachments to installed embedment in contact with concrete shall be done in such a manner as to avoid excessive thermal expansion of the embedment which could result in spalling or cracking of the concrete or excessive stress in the embedment anchors.

vi. **Field Painting**
Responsibility for touch-up painting, cleaning and field painting shall be allocated in accordance with accepted local practices, and this allocation, shall be set forth explicitly in the design documents.

vii. **Field Connections**
As erection progresses, the structure shall be securely bolted or welded to support the dead, wind and erection loads.

e. **Quality Control**
The fabricator shall provide quality control procedures to the extent that the fabricator deems necessary to assure that the work performed is in accordance with

this Specification. In addition to the fabricator's quality control procedures, material and workmanship at all times may be subject to inspection by the Engineer.

i. **Cooperation**
As much as possible, the inspection by the Engineer shall be made at the fabricator's plant. The fabricator shall cooperate with the Engineer, permitting access for inspection to all places where work is being done.

ii. **Rejection**
Material or workmanship not in conformance with the provision of this Specification shall be rejected by the Engineer at any time during the progress of work.

iii. **Inspection and Testing of Welding**
The inspection and testing of welding shall be performed in accordance with the provisions of AWS D1.1 except as modified in Section 510.2, Welds of National Structural Code of the Philippines, 2015. The process, extent and standards of acceptance shall be clearly defined in the Contract.

iv. **Inspection of Slip-Critical High Strength Bolted Connections**
The inspection of slip-critical high strength bolted connections shall be in accordance with the provisions of the RCSC Specification for Structural Joints Using ASTM F3125.

v. **Identification of Steel**
The fabricator shall be able to demonstrate by a written procedure and by actual practice a method of material identification, visible at least through the "fit-up" operation for the main structural elements of each shipping piece.

D. Method Of Measurement

The quantity of structural steel to be paid for shall be the number of kilograms or lump sum installed in place and accepted.

The quantity of metal structure accessories to be paid for shall be the number of kilograms, pieces or lump sum installed in place and accepted.

E. Basis Of Payment

The accepted quantity, measures as prescribed in Section 1047.4, Method of Measurement shall be paid for at the Contract Unit Price for Metal Structures which price and payment shall constitute full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.
Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1047 (1)	Structural Steel	Lump Sum
1047 (2)a	Structural Steel, Trusses	Kilogram
1047 (2)b	Structural Steel, Purlins	Kilogram
1047 (2)c	Structural Steel, Cladding	Kilogram
1047 (3)a	Metal Structure Accessories, Bolts	Each
1047 (3)b	Metal Structure Accessories, Sagrods	Each
1047 (3)c	Metal Structure Accessories, Turnbuckle	Each
1047 (3)d	Metal Structure Accessories, Cross Bracing	Each
1047 (4)	Metal Structure Accessories, Cross Bracing	Kilogram
1047 (5)	Metal Structure Accessories, Steel Plates	Each
1047 (6)	Metal Structure Accessories, Steel Plates	Kilogram
1047 (7)a	Metal Structure Accessories, Bolts	Kilogram
1047 (7)b	Metal Structure Accessories, Sagrods	Kilogram
1047 (7)c	Metal Structure Accessories, Turnbuckle	Kilogram
1047 (8)	Structural Steel, Roof Framing	Lump Sum
1047 (9)	Stainless Steel Pipe, Flagpole Post	Kilogram
1047 (10)	Metal Structure Accessories	Lump Sum

XII. MASONRY WORKS

A. Description

This Item shall consist of furnishing of all necessary materials, tools, equipment and labor necessary to complete the execution of the masonry works as shown on the Plans.

B. Material Requirements

a. Hydraulic Cement

Hydraulic Cement shall conform to the applicable requirements of Subsection 900.2.1, Portland Cement of Item 900, Structural Concrete.

b. Aggregates

i. Aggregates for Concrete Hollow Blocks and Louver Blocks

Aggregates shall conform to the applicable requirements of Subsection 900.2.2, Concrete Aggregates of Item 900, Structural Concrete.

ii. Aggregates/Pozzolan for Autoclaved Aerated Concrete (AAC) Blocks

Aggregates and pozzolan shall conform to the applicable requirements of ASTM C332, Standard Specification for Lightweight Aggregates for Insulating Concrete and ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan in Concrete, respectively.

iii. Water

Water shall conform to the applicable requirements of Subsection 900.2.3, Water of Item 900, Structural Concrete.

iv. **Reinforcing Steel**

1. **Reinforcing Steel for Concrete Hollow Blocks and Louver Blocks**
   Reinforcing steel shall conform to the applicable requirements of Item 902, Reinforcing Steel.

2. **Reinforcing Steel for Autoclaved Aerated Concrete (AAC) Blocks**
   Dowels and tie bars shall conform to the applicable requirements of AASHTO M322M or ASTM A996M, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

v. **Mortar for Concrete Hollow Blocks and Louver Blocks**
Mortar shall consist of sand, cement and water conforming to the requirements of Item 900, Structural Concrete, mixed in the proportion of one (1) part cement to three (3) parts sand by volume, and sufficient water to obtain the required consistency.

vi. **Quicklime for Autoclaved Aerated Concrete (AAC) Blocks**
Quicklime shall conform to the applicable requirements of ASTM C5, Standard Specification for Quicklime for Structural Purposes.

vii. **Gypsum for Autoclaved Aerated Concrete (AAC) Blocks**
Gypsum shall conform to the applicable requirements of ASTM C22M, Standard Specification for Gypsum.

viii. **Aearation Agent for Autoclovaed Aerated Concrete (AAC) Blocks**
Aeration agent shall conform to manufacturer's specifications.

ix. **Thin-bed Mortar for Autoclaved Aerated Concrete (AAC) Blocks**
Thin-bed mortar shall conform to the applicable requirements of ASTM C1660, Standard Specification for Thin-bed Mortar for Autoclaved Aerated Concrete (AAC) Masonry.

x. **Backer Rod for Autoclaved Aerated Concrete (AAC) Blocks**
Backer rod shall conform to the applicable requirements of ASTM D5249, Standard Specification for Backer Material Use with Cold- and Hot- Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.

xi. **Concrete Hollow Blocks and Louver Blocks**
Width, height and length of concrete hollow blocks and louver blocks shall be ±3.20 mm from the specified dimension as shown on the Plans

1. **Load-Bearing Concrete Hollow Blocks**
   Load-bearing concrete hollow blocks shall conform to the physical requirements of the Tables 1046.1 and 1046.2 as prescribed on ASTM C90, Standard Specifications for Load-bearing Concrete Masonry Units.

Table 1046.1 Thickness of Face Shells and Webs

Nominal Width (W) of Units, mm	Minimum Face Shell Thickness (t_{fs}), mm	Minimum Web Thickness (t_w)	
		Webs, mm	Equivalent Web Thickness, mm/linear m
76.2 and 102	19	19	136
152	25	25	188
203	32	25	188
254 and greater	32	29	209

Table 1046.2 Strength, Absorption, and Density Classification Requirements

Density Classification	Oven-Dry Density of Concrete, kg/m³	Maximum Water Absorption, kg/m³		Minimum Net Area Compressive Strength, MPa (Psi)	
	Average of 3 Units	Average of 3 Units	Individual Units	Average of 3 Units	Individual Units
Lightweight	Less than 1680	288	320	13.1 (1900)	11.7 (1700)
Medium Weight	1680 to less than 2000	240	272	13.1 (1900)	11.7 (1700)
Normal Weight	2000 or more	208	240	13.1 (1900)	11.7 (1700)

2. **Non-Load Bearing Concrete Hollow Blocs and Louver Blocks**
   Non-load bearing concrete hollow blocks shall be clearly marked to prevent their use as load bearing units.

   a. **Type I, Moisture-Controlled Units** – Units shall conform to the requirements of Tables 1046.3, 1046.4 and 1046.5.
   b. **Type II, Non-Moisture-Controlled Units** – Units designated as Type II shall conform to the requirements of Table 1046.4.

Table 1046.3 Weight Classification

Weight Classification	Oven-Dry Density of Concrete, kg/m³
Lightweight	Less than 1680
Medium Weight	1680 to less than 2000
Normal Weight	2000 or more

Table 1046.4 Strength Requirements

	Compressive Strength (Average Net Area, Min.) MPa (Psi)
Average of 3 Units	4.14 (600)
Individual Unit	3.45 (500)

Table 1046.5 Moisture-Content Requirements for Type I Units

Total Linear Drying Shrinkage, %	Moisture Content, max., % of Total Absorption (Average of 3 Units)		
	Humidity Conditions at Job Site of Point of Use		
	Humid[A]	Intermediate[B]	Arid[C]
Less than 0.03	45	40	35
0.03 to less than 0.045	40	35	30
0.045 to 0.065, max	35	30	25

Note:
[A] Mean annual relative humidity above 75%
[B] Mean annual relative humidity 50 to 75%
[C] Mean annual relative humidity less than 50%

xii. Autoclaved Aerated Concrete Blocks

Overall unit dimension (width, height or length) of autoclaved aerated concrete blocks shall not exceed 3 mm from the specified dimension shown on the Plans.

Non-load bearing Autoclaved Aerated Concrete Blocks shall conform to the physical requirements of the following tables as prescribed on ASTM C1693, Standard Specifications for Autoclaved Aerated Concrete (AAC).

Table 1046.6 Weight Classification

Strength Class	Nominal Dry Bulk Density, kg/m3	Density Limits, kg/m3	
		Lower Limit >	Upper Limit <
AAC-4	500	450	550
	600	550	650
AAC-5	600	550	650
	700	650	750
AAC-6	600	550	650
	700	650	750

Table 1046.7 Strength Requirements

Strength Class	Minimum Compressive Strength,MPa (Psi)
AAC-4	4.0 (580)
AAC-5	5.0 (725)
AAC-6	6.0 (870)

Table 1046.8 Average Drying Shrinkage Requirement

Strength Class	Average Drying Shrinkage
AAC-4	≤0.02%
AAC-5	≤0.02%
AAC-6	≤0.02%

xiii. **Other Constituents for Concrete Hollow Blocks and Louver Blocks**
Air-entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents that are previously established as suitable for use in concrete masonry shall conform to applicable ASTM standards.

xiv. **Adobe Blocks**
Adobe units shall have an average compressive strength of 2068 KPa when tested in accordance with ASTM C67, Standard Test Methods for Sampling and Testing Brick and Structural Clay. Five (5) samples shall be tested and individual units are not permitted to have a compressive strength of less than 1724 KPa.

xv. **Mortar for Adobe Blocks**
Mortar for adobe shall conform to ASTM C270, Standard Specification for Mortar for Unit Masonry.

C. Construction Requirements

a. Concrete Hollow Blocks and Louver Blocks

i. Installation

1. All masonry work shall be laid true to line, level, plumb and neat in accordance with the Plans.
2. Units shall be cut accurately to fit all plumbing ducts, opening for electrical works, and all holes shall be neatly patched.
3. No construction support shall be attached to the wall except where specifically permitted by the Engineer.
4. Masonry unit shall be sound, dry, clean and free from cracks when placed in the structure.
5. Proper masonry units shall be used to provide for all window, doors, bond beams, lintels, plasters etc., with a minimum of unit cutting.
6. Where masonry units cutting is necessary, all cuts shall be neat and true to line.
7. Units shall be placed while the mortar is soft and plastic. Any unit disturbed to the extent that the initial bond is broken after initial positioning shall be removed and re-laid in fresh mortar.
8. Mortar shall not be spread too far ahead of units, as it will stiffen and loose plasticity, especially in hot weather. Mortar that has stiffened shall not be used. ASTM C270, Standard Specification for Mortar for Unit Masonry requires that mortar be used within 2½ hours of initial mixing.

ii. **Reinforcement for Concrete Hollow Blocks**
Reinforcement shall be done in accordance with the structural Plans as to size, spacing and other requirements of Section 902.3, Construction Requirements of Item 902, Reinforcing Steel.

Reinforcement shall be clean and free from loose, rust, scales and any coatings that will reduce bond.

iii. **Sampling and Testing for Concrete Hollow Blocks and Louvers**
Method of Sampling for Quality Test shall be as follows:

1. One (1) Quality Test for every 10,000 units or fraction thereof.
2. Six (6) specimens shall be submitted for one (1) quality test in which three (3) specimens for Compression Test and the remaining three (3) for Moisture Content and Water Absorption. Units shall be tested in accordance with ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units and ASTM C426, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.

iv. **Storage and Handling of Masonry Works**
The blocks shall be stockpiled on planks or other supports free from contact with ground and covered. The blocks shall be handled with care and damaged units shall be rejected.

b. Autoclaved Aerated Concrete (AAC) Blocks

i. **Installation**

1. Reference lines shall be established based on the given Plan.
2. Layout adjustments or opening rectifications (plumbing ducts or opening for electrical works) shall be made before laying masonry units.
3. Masonry unit shall be clean and free from dust or loose particles on it.
4. Floor and wall area shall be moistened prior to laying first layer of masonry unit. Mortar setting with 2:1 sand: cement ratio shall be provided as starter blocks if slab is unleveled beyond 2 cm.
5. Adhesive shall be mixed using manufacturer's specified proportion of water using a power mixer and a non-absorptive pail or mixing container. Adhesive that has stiffened shall not be used. The pot life of the adhesive mix shall be referred to the manufacturer's instructions.
6. Thin bed adhesive shall be set and screed with notched trowel on the starter blocks to receive initial layer of masonry unit.
7. Laying of masonry unit shall be continued until the lateral layer is complete before moving on to the next layer. Adhesive shall be applied at 5 mm thick using a notched trowel on the required portions and maintaining 3 mm to 5 mm gap on the wall side surface to allow any wall movement. Alignment and levelness shall be regularly checked using rubber mallet and level bar.
8. Gaps and joints shall be filled with adhesive. Excess adhesive shall be spread on the surface or used to fill the gaps.
9. Rebar dowels, 10 mm in diameter, shall be installed spaced at 600 mm on the wall sides and along the affected beam and slab soffit. Dowels shall be embedded at least 50 mm into the side and top structures, exposing 100 mm to support lateral movement. No epoxy is needed.
10. Polyethylene backer rod, 20 mm in diameter, shall also be simultaneously installed at the slab or beam soffit.

11. When cutting of masonry unit is necessary, it shall be downsized first before applying the adhesive. Ice or wood saw can be used for this matter.
12. Corner interlocking setup is recommended.

ii. Finish and Appearance

1. All units shall be sound and free of cracks or other defects that interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction. Minor cracks, incidental to the usual method of manufacture or minor chipping resulting from customary methods of handling in shipment and delivery, are not grounds for rejection.
2. Where units are to be used in wall construction, the face or faces that are to be exposed shall not show chips or cracks, not otherwise permitted, or other imperfections when viewed from a distance of not less than 6.1 m under diffused lighting. 5% of a shipment containing chips and cracks not longer than 1/3 of the dimension where it is found and not wider than 5 mm shall be permitted.
3. The color and texture of units shall be specified by the Engineer. The finished surfaces that will be exposed in place shall conform to an approved sample, consisting of not less than four (4) units, representing the range of texture and color permitted.
4. A shipment shall not contain more than 5% of units, including broken unit that do not meet requirements of the above provisions.

iii. Sampling and Testing of AAC Blocks

Method of Sampling for Quality Test shall be as follows:

1. Two (2) Quality Tests for every 10,000 units or a fraction thereof
2. Three (3) specimens shall be submitted for every one (1) quality test namely, Compression Test and Moisture Content & Bulk Density Determination. Units shall be tested in accordance with ASTM C1693, Standard Specifications for Autoclaved Aerated Concrete (AAC).

D. Method Of Measurement

The work to be paid for under this Item shall be the number of square meters of masonry units that are satisfactorily completed and accepted.

E. Basis Of Payment

The accepted quantity, measured as prescribed in Section 1046.4, Method of Measurement shall be paid for at the Contract Unit Price for Masonry Works which price and payment shall include the cost of furnishing all labor, materials and equipment necessary to complete the work.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1046 (1)a1	CHB Load-Bearing (including Reinforcing Steel), 100 mm	Square Meter
1046 (1)a2	CHB Load Bearing (including Reinforcing Steel), 150 mm	Square Meter
1046 (2)a1	CHB Non-Load-Bearing (including Reinforcing Steel), 100 mm	Square Meter
1046 (2)a2	CHB Non-Load Bearing (including Reinforcing Steel), 150 mm	Square Meter
1046 (3)	Louver Block	Square Meter
1046 (4)a1	AAC Non-load Bearing, 100mm	Square Meter
1046 (4)a2	AAC Non-load Bearing, 150mm	Square Meter
1046 (5)	Adobe blocks	Square Meter

XIII. WOODEN DOORS AND WINDOWS

A. Description

This Item shall consist of furnishing all materials, hardware, plant, tools, labor and services necessary for complete fabrication and installation of wooden doors and windows of the type and size in accordance with the Plans and this Specification and applicable Specifications of Item 1003, Carpentry and Joinery Works.

B. Material Requirements: 1010.2.

1. Lumber Lumber of doors, windows and jambs, and panels when required, shall be kilndried with moisture content of not more than 14% and shall be of the species indicated on the Plans and/or specified under Item 1003, Carpentry and Joinery Works.
2. Plywood Plywood for veneer of solid core and hollow core flush doors shall be 3-ply, rotary cut, 6 mm thick ordinary plywood, Class B grade. Marine or waterproof plywood, rotary cut, 3-ply, 6 mm thick shall be used for flush doors at toilets and bathrooms or at places where these are exposed to moisture.
3. Adhesive Adhesive shall be water resistant resins and shall be non-staining.
4. Glass Glass for window panes shall be 3 mm thick and/or 6 mm thick, tinted, tempered, stained, clear, among others, unless otherwise shown on the Plans or indicated in the Schedule of Doors and Windows. The type of glass used shall conform to the applicable requirements of Item 1012, Glass and Glazing.
5. Capiz Shells Capiz shells, when required for window sashes, shall be of selected quality, free from dirt or blemishes and shall be large enough to obtain flat square piece.
6. Hardware Hardware shall be as specified under Item 1004, Hardware. 267 1010.3 Construction Requirements
7. Fabrication Wooden doors and windows, including frames, shall be fabricated in accordance with the designs and sizes shown on the Plans. The fabricated products shall be finished square, smoothly sanded and free from damage or warpage.

1. Flush Type Hollow Core Doors Flush type hollow core doors shall be adequately framed with stiles and top and bottom rails having a minimum thickness of 44 mm and width of 75 mm. Two (2) intermediate rails at least 44 mm wide shall be provided for stiffness. The stiles and the top and bottom rails shall be rabbeted at least 10 mm wide to receive the 6 mm thick plywood veneer. A lock block shall be provided at each stile, long enough to connect to the two (2) intermediate rails and at least 75 mm wide for mounting the lockset. The plywood veneer shall be glued and nailed to the framing with 25 mm long finishing nails space at not more than 150 mm on centers.

2. Flush Type Solid Core Doors Flush type solid core doors shall be fabricated in the same manner as the hollow core type except that spaces between stiles and rails shall be filled and fitted with wood blocks of the same species and of uniform thickness thinner by about the thickness of the plywood veneers. The filler blocks shall be secured to either stiles or rails by nails. Stiles and rails of flush type doors shall be joined by means of blind mortise and tenon joint, tightly fitted, glued and locked with bamboo pin 5 mm round.

3. Panel Doors Rails with a minimum thickness of 44 mm and width of 140 mm. Rails shall be framed to stiles by mortise and tenon joints. Rabbets or grooves of stiles and rails to receive panels shall be 6.5 mm wide and 20 mm deep. Integral mouldings formed on both faces of stiles and rails framing the panels shall be true to shape and well defined. Intersections of mouldings shall be mitered and closely fitted. Panels of the same species and having a minimum thickness of 20 mm shall be beveled around its edges up to a minimum width of 50 mm, both faces. The beveled edges shall closely fit into the grooves of stiles and rails, but free to move to prevent splitting when shrinkage occurs.

4. Window Sashes with Glass Panes or Wood Panels Window sashes shall be fabricated in conformity with the design, size and type of installation shown on the Plans. Unless otherwise shown on the 268 Plans, stiles and rails shall be Tanguile with minimum thickness of 30 mm and width of 70 mm. Jointing of stiles and rails shall be mortise and tenon secured with glue and bamboo pin. Stiles and rails shall be rabbeted at the exterior face for mounting glass panes or wood panels. Integral mouldings formed as frames for panes or panels shall be true to shape, sharply defined and mitered at joints. Separate mouldings of the same design shall be provided for fixing glass panes and wood panel from the outside.

5. Window Sashes with Capiz Shells Stiles and rails shall be of the same sizes specified under Subsection 1010.3.1(4), Window Sashes with Glass Panes or Wood Panels, and assembled with mortise and tenon joint. Unless otherwise indicated on the Plans, lattices for framing Capiz shall be tanguile, 8 mm thick and 15 mm wide, spaced at not more than 60 mm on centers bothways. Grooves 2 mm wide and 5 mm shall be made at sides of lattices to receive the preformed Capiz shells. The lattices shall be assembled with half lap joints at their intersections and the assembled lattices containing the Capiz shells shall be framed into the stiles and rails. Selected Capiz shells shall be washed to remove dirt and blemishes and dried under the sun for bleaching effect. Capiz shells shall be cut square to required sizes with sharp bench cutter to produce non-serrated and nonpeeling edges.

6. Sliding Type Window Sashes Stiles of sliding type window sashes shall be framed to the top and bottom rails with mortise and tenon joints. Tenons shall be formed on the stiles. Joints shall be tightly fitted, glued and locked with bamboo pins. Top and bottom rails shall be 10 mm wider than the stiles. Top rails shall be rabbeted to form a tongue flush with the outer face, with width of 8 mm and height of 10 mm. The stiles and rails shall be rabbeted as specified under Subsection 1010.3.1(4), Window Sashes with Glass Panes or Wood Panels to receive glass panes or wood panels.

7. Awning Type Window Sashes Tenons of rails shall be fitted into the mortises formed on the stiles and the joints glued and locked. The stiles and rails shall be rabbeted as specified under Subsection 1010.3.1(4), Window Sashes with Glass Panes or Wood Panels for mounting of glass panes. Series of sashes to be installed vertically shall have their meeting rails rabbeted for half lapping when in closed position.

8. Casement Type Window Sashes Rails of casement type window sashes shall be fitted to stiles with mortise and tenon joint. Tenons shall be formed in the rails. Meeting rails shall be rabbeted to provide for half lapping when in closed position. The stiles and 269 rails shall be rabbeted as specified under Subsection 1010.3.1(4), Window Sashes with Glass Panes or Wood Panels for mounting of glass panes or wood panels.

9. Door and Window Frames Framing of the species specified under Item 1003, Carpentry and Joinery Works, shall be fabricated in conformity with the profile and sizes as shown on the Plans. Frames shall be assembled with tightly fitted tongue and groove joint mitered at both sides, and nailed. The assembled frames shall be finished square and flat on the same plane. Assembled frames shall be braced temporarily to prevent their distortion during delivery to the site and installation.

C. Installation

1. Frames shall be set plumb and square in concrete/masonry work or framework of walls or partitions. Frames set in concrete or masonry shall be provided with two (2) rows of common wire nails 100 mm long for anchorage. The nails shall be staggered and spaced at 300 mm on center along each row. Frame set in concrete shall be installed in place prior to concrete work. Frames set in masonry work may be installed after laying of hollow concrete blocks, bricks or adobe. Space between frames and masonry shall be fully filled with cement mortar proportioned 1:3.

2. Hinged Doors Hinged doors, whether panel or flush type with standard height of 2,100 mm and width of not more than 900 mm shall be hung with four (4) loosepin butt hinges, 100 mm x 100 mm. Swing out exterior doors shall be hung with four (4) fast-pin butt hinges. Two (2) hinges shall be fitted 150 mm from top and bottom edge of door. The other two (2) hinges shall be fitted at third points between top and bottom hinges. Care should be taken to ensure that the hinges are fitted such that their pins are aligned for ease of pin insertion and smoothness of operation. For added smoothness pins should be lightly greased. Hammering of hinges to attain proper alignment shall not be allowed. For wider and heavier doors, such as Narra panel doors, an additional hinge shall be fitted 100 mm below the top hinge to counteract the door tilting action. Mounting screws shall be screwed in place in their

entire length, not forced into place by hammering. Hammering of screw into place shall not be permitted.

3. Sliding Doors Overhead tracks, standard, locally manufactured as per Plans shall be installed level and mounting bracket secured in place with lag screws 270 supplied with the set. Bracket shall be spaced 1,000 mm on centers. Hangers, two (2) each per door leaf, shall be perfitted and bolted to the door rail. For panel doors, the hangers shall be centered on the door stiles. For flush doors, the hangers shall be centered 100 mm from the edges of the door. If there is no adequate space for installing the door with its attached rollers, through either end of the track the perfitted hangers shall be disassembled for connection to the rollers. After installation on the track, set the door plumb and in alignment by means of the adjustment mechanism integrated with the roller assembly.

4. Lock Installation Locks of doors shall be fitted at the same height, centered 1000 mm above the finished floor level. Locks shall be installed in conformity with the templates and instructions supplied with locksets. Holes for mounting locks shall be properly formed to provide snug fit and rigid attachment of the locks to the doors. Strike plates shall be fitted on the door frame in true alignment with the lock latch.

5. Sliding Type Window Sashes Sashes shall be trimmed to fit height of opening. A clearance of 2 mm shall be provided between the tongue's base at the top rail and the bottom of the window head. The same clearance shall be provided between the sash tongue and the groove at the window head. Paraffin wax shall be applied to contacts of sliding surfaces. The bottom rails shall be fitted with standard brass guided spaced 75 mm from both ends of the rail, mounted flush with the inner face and secured with three (3) brass screws each guide.

6. Casement Type Window Sashes Sashes shall be trimmed to fit size of opening, with provision for half lapping of meeting stiles. Right side sash shall lap onto the left side sash. Sashes shall be fitted with two (2) brass-plated narrow hinges, 50 mm x 75 mm, spaced 150 mm from top and bottom of stiles. In lieu of hinges, sashes maybe hung with cadmium-plated steel casement adjusters 200 mm long, subject to prior approval of the Engineer. The top and bottom rails of casement type window sashes shall be milled to provide for the installation of adjusters.

7. Awning Type Window Sashes Installation of awning type sashes shall be by means of casement adjusters specified under Subsection 1010.3.2 (6), Casement Type Window Sashes. 1010.4 Method of Measurement Frames of doors and windows shall be measured on the basis of number of sets completely installed and accepted by the Engineer. 271 Doors and windows shall be measured based on the number of square meters or lump sum including its hardware involved in the completed and accepted installation. Payment per square meter or in lumpsum shall include cost of required hardware and all incidental expenses, but exclusive of locks for doors. Locks shall be paid for per set completely installed. 1010.5 Basis of Payment Payment for completely installed and accepted wooden doors and windows shall be based on actual measurement and the corresponding contract unit price thereof. Payment based on Contract Unit Price shall constitute full compensation. Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1010 (1)	Frames (Jambs, Sills, Head Transoms and Mullions)	Set
1010 (2)a	Doors (Flush)	Square Meter
1010 (2)b	Doors (Wood Panel)	Square Meter
1010 (2)c	Doors (Glass Panel)	Square Meter
1010 (3)	Window Sashes	Square Meter
1010 (4)	Wooden Doors and Windows	Lump sum

XIV. CARPENTRY AND JOINERY WORKS

A. Description

The work under this Item shall consist of furnishing all required materials, fabricated woodwork, tools, equipment and labor and performing all operations necessary for the satisfactory completion of all carpentry and joinery works in accordance with the Plans and this Specification.

B. Material Requirements

a. Lumber

Lumber of the different species herein specified for the various parts of the structure shall be well-seasoned, sawn straight, sundried or kiln dried and free from defects such as loose unsound knots, pitch pockets, sapwood, cracks and other imperfections impairing its strength, durability and appearance. Jambs, transoms, mullions, headers, sills, frames, and wood base shall be air dried and well-seasoned for at least 2 months before use.

i. Grades of Lumber and Usage

1. Stress grade is seasoned, close-grained and high quality lumber of the specified specie free from defects and suitable for sustaining heavy loads. Stress grade lumber shall be used for wooden structural member subject to heavy loads, and for sub-floor framing embedded or in contact with concrete or masonry.
2. Select grade lumber of the specified specie is generally of high quality, of good appearance, without imperfections, and suitable for use without waste due to defects and suitable also for natural finish.
3. Select grade lumber shall be used for flooring, sidings, facia and base boards, trims, mouldings, millwork, railings, stairs, cabinet work, shelvings, doors, windows and frames of openings.
4. Common grade lumber has minimum tight medium knot not larger than 25 mm in diameter, with minimal imperfections, without sapwood, without decay, insect holes, and suitable for use with some waste due to minor defects and suitable also for paint finish.
5. Common grade lumber shall be used for light framework for wall partitions, ceiling joist and nailers.

ii. Lumber Species and Usage

Unless otherwise specified on the Plans, the following lumber species shall be used as indicated:

1. Yacal (stress grade) for structural member such as post, girders, girts, sleepers door and window frames set or in contact with concrete or masonry.
2. Guijo (select grade) for door and window frames set in wooden framework, for stairs, for roof framing supporting ceramic or cement tiles, for floor joists and other wooden structural parts.
3. Apitong (common grade) for roof framing supporting light roofing materials such as galvanized iron, aluminum, for wall framing, ceiling joists, hangers and nailers.
4. Tanguile (select grade) for door and windows, facia and base boards, trims, mouldings, millwork, railings, stairs, cabinet work, shelvings, flooring siding, ceiling joist, studs, roof framing and nailers.
5. Narra (select grade) for stair railings, flooring boards, wall panels base boards, trims, mouldings, cabinet work, millwork, doors and windows when indicated as such in the Plans.
6. Dao (selected grade) for stair railings, flooring boards, wall panels base boards, trims, mouldings, cabinet work, millwork, doors and windows when indicated as such on the Plans.

iii. **Moisture Content**

Except otherwise specified, lumber shall be sun-dried, or kiln-dried. At time of installation, the maximum moisture content, expressed as a percentage of the oven-dry wood, shall be as follows:

Rough Carpentry and Framing
a. Framing lumber 50.80 mm and less in thickness: 19%
b. Framing lumber over 50.80 mm thick: 25%

Interior millwork, finish and trim: 17%

iv. **Substitution in Lumber Species**

Any lumber equally good for the purpose intended may be substituted for the specified kind subject to the prior approval of the Engineer, provided the substitution shall be of an equal or better specie acceptable to the Engineer. In case of substitution with a better specie, no additional cost therefore shall be allowed to the Contractor

b. **Plyboard**

Plyboard shall be good grade and made of laminated wood strips of uniform width and thickness bounded together with water resistant resin glue. The laminated core shall be finished both faces with select grade Tanguile or red Lauan veneers not less than 2 mm thick similarly bonded to the core. The 232 plyboard of not less than 19 mm thick shall be free from defect such as split in veneer, buckling or warping.

c. **Plywood**

Plywood shall conform to the requirements of PNS ISO 12465:2017 Plywood – Specifications. Thickness of single layer laminae shall not be less than 2 mm. The laminae shall be superimposed in layers with grains crossing at right angles in

successive layers to produce stiffness. The face veneers shall be rotary cut from selected grade timber. The laminae and face veneers shall be bonded with water resistant resin glue, hot pressed and pressure treated.

Two (2) types of plywood based on bonding quality:

1. Type I (Exterior/Marine Plywood)
   This is intended for ceiling exposed to moisture such as at toilets and eaves, partitions and doors (toilet and bath) and ceiling to be finished with acrytex.

2. Type II (Interior/Ordinary Plywood)
   This is intended for interior ceiling, doors and partitions shall be of 6 mm thick tanguile plywood, grade "A", three (3) – ply with high water resistant.

Sample for testing shall comply with the applicable requirements of PNS ISO

12466-1:2016 Plywood – Bonding Quality – Part 1: Test Methods and PNS ISO 12466-2:2016 Plywood – Bonding Quality – Part 2: Requirements.

d. Lawanit

Lawanit, when required per plans, shall be 6 mm thick, tempered or oil-impregnated for moisture/water resistance. Texture of lawanit shall be subject to the approval of the Engineer.

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e. Materials Other than Lumber

i. Plastic Sheet

When required for counter top, plastic sheet such as Formica shall not be less than 1.50 mm thick and shall have hard, durable and glossy surface resistant to stain, abrasion and heat. Color and design shall be as selected from the manufacturer's standard and approved by the Engineer.

ii. Glue

Glue shall be from water resistant resins which, upon hardening, shall not dissolve nor lose its bond or holding power even when soaked with water for extended period.

Glue in powder form be in sealed container and shall be without evidence of lumping or deterioration in quality.

iii. Fasteners

Nails, screw, bolts and straps shall be provided and used where suitable for fixing carpentry and joinery works. All fasteners shall be brand new and of adequate size to ensure rigidity of connections. 1. Nails of adequate size shall be steel wire, diamond-pointed, ribbed shank and bright finish. 2. Screws of adequate size shall be cadmium or brass plated steel with slotted head. 3. Lag screws of adequate size, for anchoring heavy timber framing in concrete or masonry, shall be galvanized steel. 4. Bolts and nuts shall be of steel having a yield point of not less than 245 MPa. Bolts shall have square heads and provided with standard flat steel washers and hexagonal nuts. Threads shall conform to American coarse thread series. The threaded portion shall be long enough such that the nut can be tightened against the bolted members without any need for blocking. The bolt's threaded end

shall be finished smooth for ease of engaging and turning of the nut. 5. Wrought iron straps or angles, when required in conjunction with bolts or lag screws to provide proper anchorage, shall be of the shape and size shown on the Plans.

iv. **Fiber Cement Board**
It shall comply with the applicable requirements of ASTM C1186, Standard Specification for Flat-Fiber Cement Sheets for exterior application and ASTM C1288, Standard Specification for Fiber-Cement Interior Substrate Sheets for interior application.

v. **Gypsum Board**
It shall comply with the applicable requirements of Item 1041, Gypsum Board.

vi. **Pre-Painter Metal Panel**
It shall comply with the applicable requirements of Item 1014, Prepainted Metal Sheets.

vii. **Aluminum Metal Cladding**
Aluminum for metal cladding shall comply with the applicable requirements of Item 1039, Aluminum Cladding.

viii. **Polyvinyl Chloride (PVC)**
Polyvinyl Chloride (PVC) shall be made from 100% virgin PVC and Class A fire rating in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

ix. **Moulding**
Mouldings may be made of steel, wood, PVC, concrete and precast concrete or as indicated on the Plans. It shall match the surface where it shall be built.

Sizes, dimensions, colors, finishes, locations and design details shall be specified on the approved Plans and in accordance with the manufacturer's recommendation.

x. **Modular Partition**
Mouldings may be made of steel, wood, PVC, concrete and precast concrete or as indicated on the Plans. It shall match the surface where it shall be built.

Sizes, dimensions, colors, finishes, locations and design details shall be specified on the approved Plans and in accordance with the manufacturer's recommendation.

C. **Construction Requirements**

a. **Quality Materials**
All materials to be incorporated in the carpentry and joinery works shall be of the quality specified under Section 1003.2, Material Requirements. Before incorporation in work, all materials shall have been inspected/accepted by the Engineer or his authorized representative.

b. Storage and Protection of Materials

Lumber and other materials shall be protected from dampness during and after delivery at the site. Materials shall be delivered well in advance of actual need and in adequate quantity to preclude delay in the work. Lumber shall be piled in orderly stack at least 150 mm above ground and sheltered place where it will be of least obstruction to the work.

c. Shop Drawings

Lumber and other materials shall be protected from dampness during and after delivery at the site. Materials shall be delivered well in advance of actual need and in adequate quantity to preclude delay in the work. Lumber shall be piled in orderly stack at least 150 mm above ground and sheltered place where it will be of least obstruction to the work.

d. Rough Carpentry

Rough carpentry covers timber structural framing for roof, flooring, siding, partition and ceiling.

i. Framing shall be stress grade or common grade lumber of the specie specified under Subsection 1003.2.1.2, Lumber Species and Usage.
ii. Rough carpentry shall be done true to lines, levels and dimensions. It shall be squared, aligned, plumbed and well fitted at joints.
iii. Trusses and other roof framing shall be assembled, fitted and set to exact location and slope indicated on the Plans.
iv. Fasteners, connectors and anchors of appropriate type and number shall be provided and fitted where necessary.
v. Structural members shall not be cut, bored or notched for the passage of conduits or pipes without prior approval of the Engineer. Members damaged by such cutting or boring shall be reinforced by means of specifically formed and approved steel plates or shapes, otherwise, damaged structural members shall be removed and replaced to the satisfaction of the Engineer.
vi. Timber framing in contact with concrete masonry shall be treated with termite-proofing solution and after drying coated with bituminous paint.

e. Finished Carpentry

Finished carpentry covers work on flooring, siding and ceiling boards, stairs, cabinets, fabricated woodwork, millwork and trims.

i. Framing lumber shall be select grade, free from defects and where exposed in finished work, shall be selected for color and grain.
ii. Joints of framing shall be tenoned, mortised or doweled where suitable, closely fitted and secured with water resistant resins and glue. Exterior joints shall be mitered and interior angles coped.
iii. Panels shall be fitted to allow for contraction or expansion and insure that the panels remain in place without warping, splitting and opening of joints.
iv. Plyboard shall be as specified under Subsection 1003.2.2 unless otherwise indicated on the Plans.
v. Plywood shall be specified under Subsection 1003.2.3.
vi. Exposed edges of plywood or plywood for cabinets shall be provided with select grade hardwood strips, rabbeted as necessary, glued in place and

secured with finishing nails. To prevent splitting, hardwood for trims shall be drilled before fastening with nails or screws.

vii. Fabricated woodwork shall be done preferably at the shop. It shall be done true to details and profiles indicated on the Plans. Where set against concrete or masonry, woodwork shall be installed when curing is completed.

viii. Exposed wood surfaces shall be free from disfiguring defects such as raised grains, stains, uneven planning, sanding, tool marks and scratches. Exposed surfaces shall be machine or hand sanded to an even smooth surface, ready to finish.

f. **Fiber Cement Board**

Examine, clean, and repair as necessary any substrate conditions that would be detrimental to proper installation. Do not begin installation until unacceptable conditions have been corrected.

Prior to commencing installation, verify governing dimensions of building and condition of substrate. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

Installation requirements shall be in accordance with the manufacturer's instructions and drawing details approved by the Engineer.

i. Use trim details indicated on drawings.
ii. Touch up all field cut edges before installing.
iii. Pre-drill nail holes if necessary to prevent breakage.

Over wood studs without sheathing. Install building paper over studs prior to installing siding.

Over wood and wood-composite sheathing. Fasten siding through sheathing into studs. For sheathing of 25 mm thickness or less, nail through sheathing into studs using correspondingly longer nails.

Over Masonry Walls. Install furring strips of adequate thickness to accept full length of nails and spaced at 406 mm on center.

Over steel studs. Minimum 20-gauge steel, 92 mm C-studs, size as indicated on drawings or as required by limiting span. Use 41 mm long, #8-18 x 9.50 mm HD self-tapping, corrosion-resistant ribbed bugle head screws. Attach panel at each stud insuring that at least three (3) screw threads penetrate the studs.

After installation, seal all joints. Seal around all penetrations.

For finish painting, follow manufacturer's recommendation timeline for painting primed and unprimed products. Paint all exposed cut edges.

g. **Gypsum Board**

Installation requirements shall conform to the applicable requirements of Item 1041, Gypsum Board.

h. **Aluminum Metal Cladding**

Installation requirements shall conform to the applicable requirements of Item 1039, Aluminum Cladding.

i. **Prepainted Metal Panel**
It shall comply with the applicable requirements of Item 1014, Prepainted Metal Sheets.

j. **Moulding**
Moulding color finishes shall match the wall or the surface where it will be installed. Cutting details of molding and its installation shall be in accordance with the manufacturer's instructions and detailed drawings approved by the Engineer.

k. **Modular Partition**
Installation requirements shall be in accordance with the manufacturer's instructions and detailed drawings approved by the Engineer.

D. Method Of Measurement

The quantity to be paid for will be measured as per individual item detailed in Section 1003.5, Basis of Payment for the complete Carpentry and Joinery as furnished on site and in accordance with these design standard, specifications and as accepted by the Engineer.

E. Basis Of Payment

The Items measured and determined as provided in Subsection 1003.4, Method of Measurement shall be paid for at the unit bid price which payment constitute full compensation of materials, labor, equipment, tools and incidentals necessary to complete the work.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1003 (1)a1	Ceiling, 4.5 mm, Metal Frame, Fiber Cement Board	Square Meter
1003 (1)a2	Ceiling, 4.5 mm, Wood Frame, Fiber Cement Board	Square Meter
1003 (1)b1	Ceiling, 4.5 mm, Metal Frame, Marine Plywood	Square Meter
1003 (1)b2	Ceiling, 4.5 mm, Wood Frame, Marine Plywood	Square Meter
1003 (1)c1	Ceiling, 6 mm, Metal Frame, Marine Plywood	Square Meter
1003 (1)c2	Ceiling, 6mm, Wood Frame, Marine Plywood	Square Meter
1003 (1)d1	Ceiling, 6 mm, Metal Frame, Ordinary Plywood	Square Meter

Pay Item Number	Description	Unit of Measurement
1003 (1)d2	Ceiling, 6 mm, Wood Frame, Ordinary Plywood	Square Meter
1003 (1)e1	Ceiling, Metal Frame, Gypsum Board	Square Meter
1003 (1)e2	Ceiling, Metal Frame, Prepainted Metal Panel	Square Meter
1003 (1)e3	Ceiling, Metal Frame, Aluminum Metal Cladding	Square Meter
1003 (1)f	Ceiling, Wood Frame, Wood	Square Meter
1003 (2)a1	Wall, 4.5 mm, Metal Frame, Fiber Cement Board	Square Meter
1003 (2)a2	Wall, 4.5 mm, Wood Frame, Fiber Cement Board	Square Meter
1003 (2)b1	Wall, 6 mm, Metal Frame, Fiber Cement Board	Square Meter
1003 (2)b2	Wall, 10 mm, Metal Frame, Fiber Cement Board	Square Meter
1003 (2)b3	Wall, 12 mm, Metal Frame, Fiber Cement Board	Square Meter
1003 (2)be4	Wall, 6 mm, Wood Frame, Fiber Cement Board	Square Meter
1003 (2)c1	Wall, 4.5 mm, Metal Frame, Marine Plywood	Square Meter
1003 (2)c2	Wall, 4.5 mm, Wood Frame, Marine Plywood	Square Meter
1003 (2)d1	Wall, 6 mm, Metal Frame, Marine Plywood	Square Meter
1003 (2)d2	Wall, 6mm, Wood Frame, Marine Plywood	Square Meter
1003 (2)e1	Wall, 6 mm, Metal Frame, Ordinary Plywood	Square Meter
1003 (2)e2	Wall, 6 mm, Wood Frame, Ordinary Plywood	Square Meter
1003 (2)f	Wall, Aluminum Metal Cladding	Square Meter
1003 (2)g	Wall	Lump Sum
1003 (3)	Cabinets	Square Meter
1003 (4)	Cabinets	Each
1003 (5)	Roof Frame, Wood	Board Foot
1003 (6)	Floor Frame, Wood	Board Foot
1003 (7)	Flooring, Wood	Square Meter
1003 (8)	Flooring, Wood	Board Foot
1003 (9)	Wall Frame, Wood	Each
1003 (10)	Wall Frame, Wood	Meter

Pay Item Number	Description	Unit of Measurement
1003 (11)a1	Fascia Board, 19 mm, Fiber Cement Board	Meter
1003 (11)a2	Fascia Board, 25 mm, Lumber	Meter
1003 (12)	Fascia Board, Metal	Kilogram
1003 (13)	Phenolic Board	Each
1003 (14)	Phenolic Board	Square Meter
1003 (15)a	Moulding, Wood	Meter
1003 (15)b	Moudling, Concrete	Meter
1003 (15)c	Moulding, Precast	Meter
1003 (15)d	Moulding, PVC	Meter
1003 (15)e	Moulding, Steel	Meter
1003 (16)	Pressurized Laminated Wood Particles	Square Meter
1003 (17)	Carpentry and Joinery Works	Lump Sum
1003 (18)	Lawanit	Square Meter
1003 (19)	Wooden Post, Good Lumber	Board Foot
1003 (20)	Coco Lumber	Board Foot
1003 (21)	Moulding	Lump Sum
1003 (22)	Modular Partition	Square Meter
1003 (23)	Modular Partition	Lump Sum

XV. RAILINGS

A. Description

This Item shall consist of furnishing, fabricating and installing the railings for buildings and other similar structures of the material or combination of materials in accordance with this Specification and in conformity with the Plans.

Railings shall be classified as concrete, wooden, masonry, stone, metal, stainless steel and glass, in accordance with the predominating material contained in each.

Railing shall not be considered a part of the structural system of the building unless it is stated in the design.

B. Material Requirements

a. Concrete

It shall conform to the applicable requirements prescribed in Section 900.2, Material Requirements of Item 900, Structural Concrete.

b. Forms and Falseworks

It shall conform to the applicable requirements prescribed in Subsection 903.2 Material Requirements of Item 903, Formworks and Falseworks.

c. Lumber, Plywood and Other Related Materials

It shall conform to the applicable requirements prescribed in Section 1003.2, Material Requirements of Item 1003, Carpentry and Joinery Works.

d. **Hardware**
This shall conform to the applicable requirements of prescribed in Section 1004.2, Material Requirements of Item 1004, Hardware.

e. **Masonry**
These shall conform to the requirements of Section 1046.2, Material Requirements of Item 1046, Masonry Works.

f. **Mortar**
Mortar shall consist of sand, cement and water conforming to the requirements of Item 900, Structural Concrete, mixed in the proportion of one (1) part cement to three (3) parts sand by volume, and sufficient water to obtain the required consistency.

g. **Reinforcing Steel**
It shall conform to the applicable requirements of Subsection 902.2.2, Material Requirements of Item 902, Reinforcing Steel.

h. **Stone**
Stones shall be clean, hard, and durable and shall be subjected for the Engineer's approval. Adobe stones shall not be used unless otherwise specified.

i. **Metal**
Steel base metal to be welded shall be open-hearth or electric furnace steel conforming to AASHTO M 183, Standard Specification for Structural Steel, unless otherwise shown on the Plans.

j. **Stainless Steel (Non-Ferrous Metal)**
It shall conform to the requirements of ASTM A276M, Standard Specification for Stainless Steel Bars and Shapes or as called for in the Plan

k. **Glass and Glazing**
It shall conform to the applicable requirements prescribed in Section 1012.2 Material Requirements of Item 1012, Glass and Glazing.

Glass shall be laminated, heat strengthened, and tempered unless otherwise indicated in the Plans. If laminated glass were called for in the Plans it shall conform to ASTM C1048, Standard Specification for Heat-Treated Flat GlassKind HS, Kind FT Coated and Uncoated Glass and ASTM C1172, Standard Specification for Laminated Architectural Flat Glass. The minimum thickness of glass shall be 6 mm unless otherwise indicated in the Plans. If glass is intended for exterior railing in-fill panels, it shall comply with the following:

i. Test shall be in accordance with ASTM E2353, Standard Test Methods for Performance of Glass in Permanent Glass Railing Systems, Guards and, Balustrades. The said standard evaluates static strength, impact resistance, and post-break retention.
ii. Railing systems shall be in accordance to ASME E 2358, Standard Specification for the Performance of Glass in Permanent Glass Railing Systems, Guards, and Balustrades. These systems include glazing in-fill, as well as structural glass railing types. The four (4) levels of performance are shown.

Table 1051.1 Levels of Performance

Performance Level	ASTM E935 (Structural [A]) (Minimum)	ANSI Z97.1 (Safety Impact [B]) (Minimum)
1	Concentrated load: 890 N Uniform Load: 290 N/m Infill Horizontal Load: 220N	Pass 230 J
2	Concentrated load: 890 N Uniform Load: 290 N/m Infill Horizontal Load: 220 N	Pass 542 J
3	Concentrated load: 1330 N Uniform Load: 730 N/m Infill Horizontal Load: 220N	Pass 542 J
4	Concentrated load: 1620 N Uniform Load: 880 N/m Infill Horizontal Load:220 N	Pass 542 J

Note: [A] Tests performed as outlined in ASTM E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
[B] Tests performed as described in ANSI Z97.1 2015, For safety glazing materials used in buildings – safety performance specifications and method test.

l. **Aluminum**
It shall conform to the requirements of ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

m. **Painting, Varnishing and Other Related Works**
These shall conform to the applicable requirements prescribed in Section 1032.2, Material Requirements of Item 1032, Painting, Varnishing and Other Related Works.

C. **Construction Requirements**

a. **General**
Railings shall be constructed in accordance with the Plans and shall not reflect any unevenness in the structure/building. All railing posts shall be set plumb unless otherwise indicated on the Plans.

b. **Concrete Railing**
Concrete railing shall be constructed in accordance with the requirements of Subsection 900.3 Construction Requirements of Item 900, Structural Concrete.

i. **Concrete Railing Cast in Place**
Forms shall be secured to be smooth and tight fitting which can be rigidly held in line and grade and removed without damage to the casted concrete structure.

Forms shall either be of single width boards or shall be lined with suitable material to have a smooth surface which shall meet the approval of the Engineer or as shown in the Plans.

All moldings, panel work and bevel strips shall be constructed according to the detailed Plans with mitered joints. All corners in the finished work shall be true, sharp and clean cut, and shall be free from cracks, spalls, honeycombs and other defects.

ii. **Precast Railings**
Moist tamped mortar precast members shall be removed from the molds as soon as it is practicable and shall be kept damp for a period of at least ten (10) days. Any member that shows cracking of soft corners of surfaces shall be rejected.

iii. **Wooden Railing**
The construction requirements shall be in conformance, whenever applicable, with Subsection 1003.3 Construction Requirements of Item 1003, Carpentry and Joinery Works.

iv. **Masonry Railing**
The construction requirements shall be in conformance, whenever applicable, with Subsection 1046.3 Construction Requirements of Item 1046, Masonry Works

v. **Stone Railing**
The maximum projection of stones beyond the pitch lines and shall not be more than 50 mm.

vi. **Metal Railing**
The metal railing shall be fabricated in accordance with the dimensions shown on the approved Plans. In case of welded railings, all exposed joints shall be finished by grinding or filing after welding to give a neat appearance. Welding may be substituted for rivets or bolts with the approval of the Engineer

vii. **Stainless Steel Railing**
The metal railing shall be fabricated in accordance with the dimensions shown on the Plans. During installation, stainless steel railing shall be free from rust and surface blemish. It shall be rust free until ten (10) years after completion.

viii. **Glass Railing**
The construction requirements shall be in conformance, whenever applicable, with Section 1012.3 Construction Requirements of Item 1012, Glass and Glazing.

D. **Method Of Measurement**
The quantity to be paid for shall be the number of meters of specified railing materials and sizes or by lump sum for actually completed and accepted measured from center to center of end posts as shown on the Plans or as directed by the Engineer.

E. **Basis Of Payment**
The accepted quality, measured as prescribed in Section 1051.4, Method of Measurement shall be paid for at the Contract Unit Price for Railing, which price and payment shall be full

compensation for furnishing and placing all materials including all labor, equipment, tools and incidentals necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1051 (1)a	Railing	Lump Sum
1051 (1)b	Railing	Meter
1051 (2)a	Concrete Railing, Standard	Meter
1051 (2)b	Concrete Railing, Baluster	Meter
1051 (2)c	Concrete Railing, Parapet	Meter
1051 (3)	Wooden Railing	Meter
1051 (4)	Stone and Brick Railing	Meter
1051 (5)	Metal Railing	Meter
1051 (6)	Stainless Steel Railing	Meter
1051 (7)	Glass Railing	Meter

XVI. PAINTING, VARNISHING AND OTHER RELATED WORK

A. Description

This Item shall consist of furnishing all paint materials, varnish and other related products, labor, tools, equipment required and undertaking the proper application of painting, varnishing and related works in accordance with the Plans and this Specification.

B. Material Requirements

a. Paint Materials

Paint material shall conform to the requirements of the following Specifications:

Table 1032.1 Paint Material Specification Requirements

Material	PNS Code	Description	Application
Flat Latex Paint	PNS 139	Specification for Flat Latex Paint (white and light tints for exterior and interior use)	Properly prepared plaster, masonry and primed wood and other architectural surfaces
Semi-gloss Latex Paint	PNS 463	Specification for Semi-Gloss Latex Paint (white and light tints for exterior and interior use)	Properly prepared plaster, masonry and primed wood and other architectural surfaces
Semi-gloss Enamel Paint	PNS 225	Specification for Alkyd-based Semi-Gloss Enamel Paint (white and light tints for exterior and interior use)	Properly prepared plaster, masonry and primed wood and other architectural surfaces
Enamel Paint	PNS 226	Specification for Alkyd-based Gloss Enamel Paint (white and coloured for exterior and interior use)	Wood, metal and other architectural surfaces
Alkyd-based Metal Primer	PNS 366	Specification for Alkyd-based Metal Primer	Ferrous metal
Epoxy Metal Primer	PNS 2113	Specification of Epoxy Metal Primer	Ferrous metal
Flatwall Enamel Paint	PNS 227	Specification for Alkyd-based Flat Enamel Paint (white and light tints for exterior and interior use)	Wood
Gloss Latex Paint	PNS 462	Specification for Gloss Latex Paint (white and light tints for exterior and interior use)	Masonry
Water Based	PNS 612	Specification for Water-Based Gloss	Concrete, metal, wood and other paintable
Epoxy Enamel	PNS 2118	Specification for Epoxy Enamel, white and coloured	Concrete, wood, metal and other architectural surfaces
Roof paint (water-based, flat)	PNS 464	Specification for Roof paint (water-based, flat)	Paintable roofing materials
Roof paint (Portland Cement)	PNS 465	Specification for Roof paint (Portland Cement)	Paintable roofing materials

b. **Tinting Colors**
Tinting colors shall be first grade quality, pigment ground in alkyd resin that disperses and mixes easily with paint to produce the color desired. Same brand of paint and tinting color shall be used to effect good paint body.

c. **Acry-Colors**
It shall be high strength tinting colors for water-based coatings that are specially formulated from the finest blend of pigments combined with pure acrylic latex vehicle that is easy to disperse, fast drying, odorless, and gives maximum color retention.

d. **Concrete Neutralizer**
Concrete neutralizer shall be first grade quality concentrate diluted with clean water and applied as surface conditioner of new interior and exterior walls thus improving paint adhesion and durability.

e. **Silicon Water Repellant**
Silicon water repellant shall be transparent water shield especially formulated to repel rain and moisture on exterior masonry surfaces.

f. **Patching Compound**
Patching compound shall be fine powder type material like calciumine that can be mixed into paint that will produce a putty consistency, with oil base primers and paints to fill minor surface dents and imperfections.

g. **Varnish**
Varnish shall be a homogeneous solution of resin, drying oil, drier and solvent. It shall be extremely durable clear coating, highly resistant to wear and tear without cracking, peeling, whitening, spotting, etc. with minimum loss of gloss for a maximum period of time.

h. **Lacquer**
Lacquer shall be any type of organic coating that dries rapidly and solely by evaporation of the solvent. Typical solvent are acetates, alcohols and ketones. Clear gloss lacquer shall be in accordance with the requirements of PNS 368, Specification for Clear Gloss Lacquer.

i. **Shellac**
Shellac shall be a solution of refined lac resin in denatured alcohol. It dries up by evaporation of the alcohol. The resin is generally furnished in orange and bleached grades.

j. **Sanding Sealer**

Sanding sealer shall be quick drying lacquer, formulated to provide quick dry, good holdout of succeeding coats, and containing sanding agents such as zinc stearate to allow dry sanding of sealer. It shall be in accordance with the requirements of PNS 367, Specification for Lacquer Sanding Sealer.

k. **Oil Wood Stain**

Oil-based stain shall be a penetrating stain for interior doors, windows, trim and furniture. It rejuvenates and transforms interior timber. Oil-based stain penetrates deeply and adds color without raising the grain. Oil-based stain is best used to rejuvenate old or used timber.

l. **Glazing Putty**

Glazing putty shall be alkyd-type product for filling minor surface unevenness.

m. **Natural Wood Paste Filler**

Wood paste filler shall be quality filler for filling and sealing open grain of interior wood. It shall produce a level finish for following coats of paint varnish/lacquer and other related products.

n. **Schedule**

Exterior

i. Plain cement plastered finish to be painted - Three (3) coats acrylic base masonry paint
ii. Concrete exposed aggregate and/or tool finish - One (1) coat water repellant
iii. Ferrous metal - One (1) coat primer and two (2) coats enamel paint
iv. Galvanized metal - One (1) coat zinc chromate primer and two (2) coats Portland cement paint
v. Wood paint finish - Three (3) coats oil based paint
vi. Wood varnished finish - Varnish water repellant

Interior

i. Plain cement plastered finish to be painted - Two (2) coats acrylic base masonry paint
ii. Concrete exposed aggregate and/ or tool finish - Clean surface
iii. Ferrous metal - One (1) coat primer and two (2) coats enamel paint
iv. Woodwork sea-mist - Three (3) coats of three (3) parts thinner and one (1) part lacquer
v. Woodwork varnish - - First coat of one (1) part sanding sealer to one (1) part solvent Second coat of two-third (2/3) sanding sealer to one-third (1/3) solvent
vi. Woodwork painted finish - Three (3) coats oil base paint
vii. Ceiling boards textured finish - One (1) coat oil based paint, allow to dry then patch surfaces unevenness and apply textured paint coat

o. **Containers and Markings**

It shall be in accordance with the requirements of PNS 140, General Requirements for Packaging, Packing and Marking of Paints and Other Protective Coatings.

All paints, varnishes, and other related products shall be shipped in strong, substantial containers marked in prints distinctive color of the label or in letters clearly visible to the naked eye with the following information:

i. Type of Paint
ii. Brand or Trademark
iii. Name and address of manufacturer
iv. Net Volume and/or mass in metric units

v. Directions for use
vi. Safety precautions
vii. Batch or lot number any package or container not so marked will not be accepted for use under this Specification.

C. Construction Requirements

Prior to commencement of the painting, varnishing and related work, the surfaces to be applied shall be examined in order not to jeopardize the quality and appearances of the painting, varnishing and related works.

a. Surface Preparation

All surfaces shall be in proper condition to receive the finish. Woodworks shall be hand-sanded smooth and dusted clean. All knot-holes pitch pockets or sappy portions shall be sealed with natural wood filler. Nail holes, cracks or defects shall be carefully puttied after the first coat, matching the color of paint.

Interior woodworks shall be sandpapered between coats. Cracks, holes of imperfections in plaster shall be filled with patching compound and smoothed off to match adjoining surfaces.

Concrete and masonry surfaces shall be coated with concrete neutralizer and allowed to dry before any painting primer coat is applied. When surface is dried, apply the first coating. Hairline cracks and unevenness shall be patched and sealed with approved putty or patching compound. After all defects are corrected apply the finish coats specified on the Plans (color scheme approved).

Metal shall be clean, dry and free from mill scale and rust. Remove all grease and oil from surfaces. Wash, unprimed galvanized metal with etching solution and allow it to dry. Where required to prime coat surface with Red Lead Primer same shall be approved by the Engineer.

In addition, the following shall be undertaken prior to painting, varnishing and other related works:

i. Voids, cracks, nick, and other wood imperfections will be repaired with proper patching material and finished flushed with surrounding surfaces.
ii. Marred or damaged shop coats on metal shall be spot primed with appropriate metal primer.
iii. Painting and varnishing works shall not be commenced when it is too hot or cold.
iv. Allow appropriate ventilation during application and drying period.
v. All hardware will be fitted and removed or protected prior to painting and varnishing works.

b. Application

Paints when applied by brush shall become non-fluid, thick enough to lay down as adequate film of wet paint. Brush marks shall flawed out after application of paint.

Paints made for application by roller must be similar to brushing paint. It must be non-sticky when thinned to spraying viscosity so that it will break up easily into droplets.

Paint is atomized by high pressure pumping rather than broken up by the large volume of ai

c. **Mixing and Thinning**

At the time of application paint shall show no sign of deterioration. Paint shall be thoroughly stirred, strained and kept at a uniform consistency during application. Paints of different manufacture shall not be mixed together. When thinning is necessary, this may be done immediately prior to application in accordance with the manufacturer's directions, but not in excess of one (1) pint of suitable thinner per gallon of the paint.

d. **Storage**

All materials to be used under this Item shall be stored in a single place to be designated by the Engineer and such place shall be kept neat and clean at all times. Necessary precaution to avoid fire must be observed by removing oily rags, waste, etc. at the end of daily work.

e. **Cleaning**

All cloths and cotton waste which constitute fire hazards shall be placed in metal containers or destroyed at the end of daily works. Upon completion of the work, all staging, scaffolding and paint containers shall be removed. Paint 374 drips, oil, or stains on adjacent surfaces shall be removed. Paint drips, oil, or stains on adjacent surfaces shall be removed and the entire job left clean and acceptable to the Engineer.

f. **Workmanship in General**

i. All paints shall be evenly applied. Coats shall be of proper consistency and well brushed out so as to show a minimum of brush marks.
ii. All coats shall be thoroughly dry before the succeeding coat is applied.
iii. Where surfaces are not fully covered or cannot be satisfactorily finished in the number of coats specified, such preparatory coats and subsequent coats as may be required shall be applied to attain the desired evenness of surface without extra cost to the Owner. 4. Where surface is not in proper condition to receive the coat the Engineer shall be notified immediately. Work on the questioned portion(s) shall not start until clearance be proceed is ordered by the Engineer. 5. Hardware, lighting fixture and other similar items shall be removed or protected during the painting varnishing and related work operations and re-installed after completion of the work.

g. **Procedure for Sea-Mist Finish**

i. Depress wood grain by steel brush and sand surface lightly.
ii. Apply sanding sealer.
iii. Apply two (2) coats of industrial lacquer paint.
iv. Spray last coat of industrial lacquer paint mixed with sanding sealer.
v. Apply wood paste filler thinned with turpentine or paint thinner into the wood surface.
vi. Wipe off wood paste filler immediately.
vii. Spray flat or gloss lacquer whichever is specified.

h. **Procedure for Varnish Finish**

i. Sand surface thoroughly.

ii. Apply putty on all cracks and other wood imperfections with wood paste filler.
iii. Apply oil stain.
iv. Apply lacquer sanding sealer. 375
v. Sand surface along the grain.
vi. Spray three (3) coats of clear dead flat lacquer.
vii. Polish surface coated using cloth pad.
viii. Spray gloss lacquer or flat lacquer whichever is desired or specified.

i. **Procedure for Ducco Finish**
   i. Sand surface thoroughly
   ii. Apply primer surface white or gray by brush or spray.
   iii. Apply lacquer spot putty in thin coat. Allow each coat to become thoroughly dry before applying next coat.
   iv. Apply primer surfaces and then allow to dry in 2 h before applying the next coat.
   v. Apply a coat of flat tone semi-gloss enamel as per color scheme submitted and approved by the Engineer

D. Method Of Measurement

The areas of concrete, wood and metal surfaces applied with varnish, paint and other related coating materials shall be measured in square meters as desired and accepted to the satisfaction of the Engineer.

E. Basis Of Payment

The accepted work shall be paid at the unit bid price, which price and payment constitute full compensation for furnishing and proper application of all materials, labor, equipment, tools and other incidental necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1032 (1)a	Painting Works, Masonry/Concrete	Square Meter
1032 (1)b	Painting Works, Wood	Square Meter
1032 (1)c	Painting Works, Steel	Square Meter
1032 (2)	Varnishing	Square Meter
1032 (3)	Sea-mist Finish	Square Meter
1032 (4)	Ducco Finish	Square Meter
1032 (5)	Texture Finish	Square Meter

XVII. PLUMBING

A. Description

This Item shall consist of furnishing all materials, tools, equipment and fixtures required as shown on the Plans for the satisfactory performance of the entire plumbing and fire protection system including installation in accordance with the latest edition of the Revised

National Plumbing Code, Uniform Plumbing Code of the Philippines, The Fire Code of the Philippines, The National Building Code, and this Specification.

B. Material Requirements

All piping materials, fixtures and appliances fitting accessories whether specifically mentioned or not but necessary to complete this Item shall be furnished and installed.

a. **Cast Iron Soil Pipes and Fittings**

i. Pipes and fitting materials shall comply with the Specification requirements, whenever applicable, defined in ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings. The material description and standards of manufacture are herein described.

1. Cast Iron – the casting shall be made of gray iron which shall be sound, free from cracks, sand holes and blow holes. They shall be uniformly low hardness that permits drilling and cutting by ordinary methods. Pipes and fittings shall be true to pattern and of compact closed grained structure.
2. Quality of Iron – the iron shall be made by the cupola, air furnace, electric furnace or other processes which shall be checked by regular chemical and physical control test. The resultant shall be gray iron of good quality.
3. Manufacture – the pipes shall be made with hub and spigot ends or hub ends only. All hubs for pipes and fittings shall be provided with held lead grooves and all spigot ends shall be made with beads or plain if machine cast centrifugally. Plugs shall be wrought or cast, machined to the dimensions required and shall be free from defects.
4. Freedom from Defects – pipes and fittings shall be true, smooth and cylindrical, their inner and outer surfaces being as nearly concentric as practicable. They shall be in all aspects, sound and good casting free from laps, pin holes or other imperfections and shall be neatly dressed and carefully fettled. The ends shall be finished reasonably square to their axes.

ii. Each cleanout shall be installed so that it opens to allow cleaning in the direction of flow of the soil or waste or at right angles thereto and, except in the case of wye branch and end-of-line cleanouts, shall be installed vertically above the flow line of the pipe. Clean-outs shall be made of heavy cast brass ferrule with counter sunk screw cover same diameter as the pipe except that they shall not be larger than 100 mm diameter. Cleanouts installed under concrete or asphalt paving shall be made accessible by yard boxes or by extending flush with paving with approved materials and shall be adequately protected.

iii. Caulking lead shall be of molten type peg lead conforming to specification requirements defined in ASTM B29, Standard Specification for Refined Lead.

iv. Oakum shall be twisted or braided hemp or abaca fibers slightly impregnated with oil.

b. **Water Supply Pipes and Fittings**

i. Pipes shall be galvanized iron pipe schedule 40 conforming to specification requirements defined in ASTM A53M, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless with threaded

connection. Under roads where necessary shall suitably protected as shown on the Plans.

Fittings shall be malleable iron Type II, galvanized iron conforming to specification requirements defined in ASTM A338, Standard Specification for Malleable Iron Flanges, Pipe Fittings, and Valve Parts for Railroad, Marine, and Other Heavy Duty Service at Temperatures up to 345°C.

Water pipe and fittings with a lead content which exceeds 8% shall be prohibited in piping systems used to convey potable water.

Where required for large diameter pipes (315 mm up to 800 mm) with elastomeric rubber sealed ring, the Oriented Polyvinyl Chloride (PVC-O) Class 500 shall be in accordance with the applicable requirements defined in ISO 16422:2014, Pipes and Joints Made of Oriented Unplasticized Polyvinyl Chloride (PVC-O) for the Conveyance of Water under Pressure or ISO 1452:2009, Plastics Piping Systems for Water Supply and for Buried and Above-Ground Drainage and Sewerage Under Pressure - Unplasticized Poly(Vinyl Chloride) (PVC-U).

ii. Valves

Valves for water supply shall be bronze body with threaded ends rated 21 kg/cm^2. All valves shall be gate valves unless otherwise specified. Gate valves shall have solid wedge body and discs conforming to specification requirements defined in ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings. Globe valves shall have plug type discs with ferrule threaded ends and bronze body.

Valves up to and including 51 mm in size shall be brass or other approved materials. Sizes exceeding 51 mm shall be permitted to have cast-iron or brass bodies.

iii. Water Meter

Water meter when required to be furnished by the Contractor shall be of the type tested and approved by Metropolitan Waterworks and Sewerage System (MWSS) or Local Water Utilities Authority (LWUA) or any agency/ (ies) accredited by both.

c. Approved Alternate Pipes and Fittings

Pipes and fittings for sanitary and potable water lines as approved alternate shall be Unplasticized Polyvinyl Chloride Pipes and Fittings (uPVC).

Pipes and fittings shall be made of materials in its natural state conforming to specification requirements defined in ASTM D2241, Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series) and PNS 65: 1993, Unplasticized Polyvinyl Chloride (uPVC) Pipes for Potable Water Supply. Fittings shall be molded type and designed for solvent cement joint connection for water lines and rubber O-ring seal joint for sanitary lines.

All materials shall bear Philippine Standards (PS) mark for locally manufactured and Import Commodity Clearance (ICC) marks duly issued by Bureau of Philippine Standards (BPS) for imported materials.

i. **Unplasticized Polyvinyl Chloride (uPVC) – Potable Water**
   1. Pipes and fittings for water lines and pressure lines shall conform to PNS 65: 1993: - Unplasticized Polyvinyl Chloride (uPVC) Pipes for Potable Water Supply.
   2. Pipes and fittings shall be made of materials in its natural state with a medium K-Value, K65 grade resin by mass conforming to specification requirements defined in ASTM D2241, Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
   3. Maximum levels of toxic substances shall conform to Table 3 of PNS 65: - Unplasticized Polyvinyl Chloride (uPVC) Pipes for Potable Water Supply.
   4. Pipes and fittings for water lines, sizes 20 mm to 63 mm shall be designed for solvent cement jointing connection conforming to specification requirements defined in ASTM D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
   5. Pipes and fittings for pressure lines, sizes 63 mm and larger shall be designed for manually-installed or machine-installed fixed seal gasket type jointing connection. Gaskets is to be made of Ethylene Propylene Diene Monomer (EPDM) rubber homogeneously bonded to stiff polypropylene (PP) ring or metal reinforced embedded in EPDM rubber gasket.

ii. **Unplasticized Polyvinyl Chloride – Non-Potable Water (Sanitary and Sewer Line)**
   1. Pipes and fittings for sanitary lines shall conform to PNS 1950, Plastic piping systems for soil and waste discharge (Low & High temp.) inside buildings – Unplasticized Polyvinyl Chloride (PVC-U), conforming to specification requirements defined in ASTM D2729, Standard Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings for pipes, and ASTM D3311, Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns for fittings.
   2. Pipes and fittings for sewer lines shall conform to Standard Dimension Ratio (SDR) 34 conforming to specification requirements defined in ISO 4435, Plastics Piping Systems for Non-Pressure Underground Drainage and Sewerage – Unplasticized Polyvinyl Chloride (uPVC).
   3. Pipes and fittings shall be made of materials in its natural state with a medium K-Value, K65 grade resin by mass.
   4. Pipes and fittings for sanitary and sewer lines, sizes 57 mm and larger shall be designed for solvent cement jointing connection conforming to specification requirements defined in ASTM D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems and/or machine-installed seal gasket type jointing connection. Gaskets is to be made of Engineered

Natural Rubber homogeneously bonded to stiff polypropylene (PP) ring or metal reinforced NBR (Nitrile Butadiene Rubber).

iii. **Chlorinated Polyvinyl Chloride (cPVC)**
Pipes and fittings for hot and cold water line shall be designed conforming to specification requirements defined in ASTM 2846 (CTS) SDR 11, Standard Specification for Chlorinated Polyvinyl Chloride (cPVC) Plastic Hot and ColdWater Distribution Systems, with the use of one-step cPVC solvent cement in jointing method.

Pipes and fittings shall be Heavy Metal-Free (HMF) as validated through Inductively Coupled Plasma Optical Emission Spectrometry (ICPOES) method.

iv. **High-Density Polyethylene (HDPE) Pipe**
Pipes and fittings shall be made of materials in its natural state conforming to specification requirements defined in PNS-ISO 4427, Polyethylene (PE) Pipes and Fittings for Water Supply.

v. **Polypropylene Random/ Copolymer (PPR/PPR-C)**
Pipes and fittings for hot and cold water line shall be designed conforming to specification requirements defined in DIN 8077- Polypropylene (PP) Pipes- PPH, PP-B, PP-R, PP-RCT- Dimensions and DIN 8078 - Polypropylene (PP) PipesPP-H, PP-B, PP-R, PP-RCT – General Quality Requirements and Testing for pipes and DIN 19560/16962 – Pipes and Fittings made of Polypropylene (PP) 216 for hot water resistant waste and soil discharge systems inside buildings/Pipe Joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes; tees and branches produced by segment inserts and necking for butt welding; dimensions for fittings or ISO 15874-Plastic Piping Systems for Hot and Cold Water Installations- Polypropylene (PP).

vi. Ductile Iron shall be designed conforming to specification requirements defined in ASTM A536:2014 Standard Specification for Ductile Iron Castings, ASTM A746, Standard Specification for Ductile Iron Gravity Sewer Pipe and ASTM A377, Standard Index of Specifications for Ductile-Iron Pressure Pipe.

d. **Septic Tank**
The septic tank shall be provided as shown on the Plans including all pipe vents and fittings. The various construction materials such as concrete or masonry work shall conform to the corresponding Items of this Specifications. Inlet and outlet pipes shall conform to the latest edition of the Revised National Plumbing Code and Uniform Plumbing Code of the Philippines.

e. **Plumbing Fixtures and Fittings**
All fittings and trimmings for fixtures shall be chromium-plated and polished brass unless otherwise approved. Exposed traps and supply pipes for fixtures shall be connected to the roughing in, piping system at the wall unless otherwise indicated on the Plans. Built-in fixtures shall be watertight with provision of water supply and drainage outlet, fittings and trap seal. Unless otherwise specified, all plumbing fixtures shall be made of vitreous china complete with fittings.

1. Water closet shall be vitreous china, free standing toilet combination, round front bottom outlet siphonic washdown bowl with extended rear self and closed coupled tank with cover complete with fittings and mounting accessories. Model make and color shall be submitted for approval prior to delivery at jobsite by the Engineer or unless otherwise specified on the Plans.
2. Plastic toilet bowl shall be a high quality polypropylene virgin material composition, complete with integrated parts and other accessories or unless otherwise specified on the Plans.
3. Lavatory shall be vitreous china, wall hung with rear overflow and cast-in soap dishes, pocket hanger with integral china brackets, complete with twin faucets, supply pipes, P-trap and mounting accessories. Where indicated on the Plans, to be counter top model make and color shall be approved by the Engineer.
4. Urinal shall be china vitreous, wall hung wash-out urinal with extended shields and integral flush spreader, concealed wall-hanger pockets, 19 mm top spud complete with fitting and mounting accessories. Model make and color shall be approved by the Engineer.

i. **Prohibited Fixtures**

Water closets having an invisible seal or an unventilated space or having walls which are not thoroughly washed at each discharge shall be prohibited. Any water closet that might permit siphonage of the contents of the bowl back into the tank shall be prohibited. Drinking fountains shall not be installed in public toilet rooms.

Trough urinals and urinals with an invisible seal shall be prohibited. Non-water urinals are exception.

f. **Bathroom and Toilet Accessories**

i. Shower head and fitting shall be movable, cone type with escutcheon arm complete with stainless steel shower valve and control lever, all exposed surface to be chromium finish.
ii. Grab bars shall be made of tubular stainless steel pipe provided with safety grip and mounting flange.
iii. Floor drains shall be made of stainless steel beehive type, measuring 100 mm by 100 mm, and provided with detachable stainless strainer, expanded metal lath type.
iv. Toilet paper holder shall be vitreous china wall mounted. Color shall reconcile with the adjacent fixture and facing tiles.
v. Soap holder shall be vitreous china wall mounted. Color shall reconcile with the adjacent tile works.
vi. Faucet(s) shall be made of stainless steel for interior use.
vii. Hose-bib(s) shall be made of bronze cast finish.

g. **Special Plumbing Fixtures**

i. Kitchen sink shall be made of stainless steel self-rimming, single compartment complete with supply fittings, strainer traps, dual control lever

and other accessories or plastic made of a high quality polypropylene virgin material composition, with stainless steel strainer, lock-nut, rubber gasket and flexible connector unless otherwise specified on the Plans.

ii. Laboratory sink shall be made of cast iron metal with white porcelain finish with single compartment, flat rim ledge, 762 mm x 533 mm complete with supply fittings, strainer, trap and other accessories.

iii. Scrub-up sink shall be made of cast iron metal with white porcelain finish measuring 610 mm x 610 mm complete with supply fittings, strainer, trap and wall mounting accessories.

iv. X-ray developing tank shall be made of cast iron white porcelain finish with three (3) compartment x-ray processing, drain plug, open standing drain, 19 mm IPS inlet spud complete with stand and mounting accessories.

v. Squat bowl(s) shall vitreous china, wash down squat bowl with integral foot treads, pail flush type or plastic made of a high quality polypropylene virgin material composition, complete with P-Trap fitting and its rubber gasket. Color, make and type to be approved by the Engineer.

vi. Grease traps shall be made of cast bronze with detachable cover and mounting accessories.

h. **Roof Drains, Downspout, Overflow Pipe and Steel Grating**

The Contractor shall provide, fir and/or install necessary drains with strainers, where shown on the Plans. Each drain with strainer shall fit the size of the corresponding downspout (or roof leader) over which it is to be installed and in conformity with the following schedule:

i. Scupper drains (for balconies, parapet) shall be made of bronze base with flashing. Flange threaded outlet and convex with integral flashing clamp bolted to flange.

ii. Roof drains shall be made of bronze base semi-dome with large free area, flashing clamp and integral gravel stopper. To be used at roof decks, canopies, gutters, and elsewhere indicated on the Plans.

iii. Downspouts when encased in concrete, unless otherwise shown on the Plans shall be polyvinyl chloride (PVC). Whether indicated or specified to be cast iron or galvanized iron the same shall meet the specification requirement as herein described.

iv. Overflow pipes shall be made of galvanized iron pipe measuring at least 13 mm diameter and spaced 200 mm on center.

v. Steel grating shall be made of wrought iron metals of design on shop drawings approved and surfaces to be located with shop finish.

i. **Fire Protection System**

Firestop materials shall be installed in accordance with Uniform Plumbing Code of the Philippines, the National Building Code of the Philippines, Fire Code of the Philippines and the manufacturer's instructions.

i. Fire hose cabinets shall be locally available consisting of 38 mm diameter valve hose rack with nipple 30 mm rubber lined hose cable with standing pressure of 4,268 kg/cm^2, nozzle 38 mm diameter brass, chromium plated. Wet standpipes shall be located so that all portions of the buildings are within 6 m of a nozzle attached to 22 m of hose.

ii. Fire standpipe system shall consist of risers and hose valves. Pipe shall be extra strong black iron. Valves to be high grade cast bronze mounted

withstanding pressure of 79.40 kg/cm², working pressure as indicated on the Plans.

iii. Fire extinguisher shall be portable, suitable for Class A, B, C fires, mounted inside cabinet. Cabinet shall be full flush mounting door with aluminum trim for glass plate, frame and box shall be made of gauge 14 galvanized iron sheet with white interior and red exterior baked enamel finish over primer. Cabinet to be wall mounted and size to be able to accommodate the defined components.

iv. Yard hydrant where shown on the Plans shall match the integrated Fire Department requirements. Outlet shall be single 63 mm diameter gate valves with chain connected caps.

v. Pipes and fittings for fire sprinkler piping system as approved alternate shall be made out of high grade Chlorinated Polyvinyl Chloride (cPVC) materials conforming to specification requirements defined in ASTM F442 for pipes and ASTM F437, F438, F439 or F1970 for fittings.

vi. For Steel pipe and fittings shall conforming to specification requirements defined in ASTM A53 – Standard Specification for Pipe, Steel, Black and HotDipped, Zinc-Coated, Welded and Seamless, ASTM A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe and ASTM A795 – Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

vii. Fire pumps where shown on the approved Plans shall conform to the Integrated Fire Department requirements, wherein the Fire Pump Motor shall be electric-driven and the overall system shall include an integrated Jockey Pump, Controller, and all the necessary accessories.

j. Built-in Appliances

Built-in appliances such as urinal trough, lavatory and slope sink shall be made as indicated on the Plans, exposed surfaces to be tile wainscoting complete with fitting accessories required as practiced in this specialty trade.

C. Construction Requirements

The Contractor before any installation work is started shall carefully examine the Plans and shall investigate actual structural and finishing work condition affecting all his work. Where actual condition necessitates a rearrangement of the approved pipe layout, the Contractor shall prepare Plan(s) of the proposed pipe layout for approval by the Engineer.

For approved alternate pipes and fittings, installation work shall conform to the approved Plans or manufacturer's recommendation.

a. Installation of Soil, Waste, Drain and Vent Pipes

i. All soil and drainage pipes shall be pitch 6 mm per 300 mm but in no case flatter than 3 mm per 300 mm.

ii. Horizontal lines shall be supported by well secured length heavy strap hangers. Vertical lines shall be secured strongly by hooks to the building frame and a suitable brackets or chairs shall be provided at the floor from which they start.

iii. All main vertical soil and waste stacks shall be extended full size to and above the roof line to act as vents, except otherwise indicated on the Plans.

iv. Vent pipes in roof spaces shall be run as close as possible to underside of roof with horizontal piping pitched down to stacks without forming traps.

Vertical vent pipes may be connected into one main vent riser above the highest vented fixtures.

v. Where an end or circuit vent pipe from any fixtures is connected to a vent line serving other fixtures, the connections shall be at least 1.20 m above the floor on which the fixtures are located.

vi. Horizontal waste line receiving the discharge from two or more fixtures shall be provided with end vents unless separate venting of fixtures is noted on the Plans.

vii. All changes in pipe sizes on soil and waste lines shall be made with reducing fittings or recessed reducers. All changes in directions shall be made by appropriate use of 45 degrees wyes, half wyes, long sweep quarter bends or elbows may be used in soil and waste lines where the change in direction of flow is from the horizontal to the vertical and on the discharge from waste closets. Where it becomes necessary to use short radius fittings in other locations the approval of the Engineer shall be obtained prior to installation of the same.

viii. Cleanouts at the bottom of each soil stack, waste stack, interior downspout and where else indicated shall be the same size as the pipe up to and including 102 mm, 152 mm, for larger pipes.

ix. Each fixtures and place of equipment requiring connection to the drainage system except fixtures with continuous waste shall be equipped with a trap. Each trap shall be placed as near to the fixture as possible. Traps installed on threaded pipe shall be recessed drainage pattern.

x. Overhead horizontal runs of pipes shall be hung with adjustable wrought it on pipe hanger spaced not over 3.04 m apart except hub and spigot soil pipe which shall have hanger spaced not over 1.50 m apart and located near a hub.

b. Water Pipes, Fittings and Connections.

All water piping inside the building and underground, 100 mm diameter and smaller shall be galvanized iron threaded pipe with malleable iron fittings, PVCU, HDPE, PPR and ductile iron.

i. The water piping shall be extended to all fixtures, outlets, and equipment from the gate valves installed in the branch near the riser.

ii. The cold water system shall be installed with a fall towards a main shutoff valve and drain. Ends of pipes and outlets shall be capped or plugged and left ready for future connections.

iii. Mains and Branches

1. All pipes shall be cut accurately to measurements and shall be worked into place without springing or forcing. Care shall be taken so as not to weaken the structural portions of the building.
2. All piping above the ground shall be run parallel with the lines of the building unless otherwise indicated on the Plans.
3. All service pipes, valves and fittings shall be kept at sufficient distance from other work to permit finished covering not less than 12.5 mm from such work or from finished covering on the different service.
4. No water piping shall be buried in floors, unless specifically indicated on the plans and approved by the Engineer.

5. Changes in pipes shall be made with reducing fittings.

iv. Drain Cocks Pipe drain indicated on the drawings shall consist of 12 mm globe valve with renewable disc and installed at low points on the cold water piping so that all piping shall slope 100 mm in 30.5 m.

v. Threaded Pipe Joints All pipes shall be reamed before threading. All screw joints shall be made with graphite and oil or with an approved graphite compound applied to make threads only. Threads shall be full cut and not more than three (3) threads on the pipe shall remain exposed.

vi. Expansion and Contraction Pipes Accessible contraction-expansion joints shall be made whenever necessary. Horizontal runs of pipe over 15 m in length shall be anchored to the wall to the supporting structure about midway on the run to force expansion and contraction equally toward the ends or as shown on the Plans.

vii. Pipe Standpipe System Fire standpipe system shall consist of risers and valve. Pipe shall be extra strong black iron. Valves to be underwriter's approval high grade cast bronze mounted.

viii. Valves and Hose Bibs

1. Valves shall be provided on all supplied fixture as herein specified.
2. The cold water connections to the domestic hot water heater shall be provided with gate valves and the return circulation connection shall have a gate and a check valve.
3. All connection to domestic hot water heaters shall be equipped with unions between valve and tanks.
4. Valve shall not be installed with its stem below the horizontal. All valves shall be gate valves unless otherwise indicated on the Plans.
5. Valves up to and including 50 mm diameter shall be threaded ends, rough bodies and finished trimmings, except those on chromium plated brass pipe.
6. Valves 63 mm in diameter and larger shall have iron bodies, brass mounted and shall have either screws or flange ends.
7. Hose bibs shall be made of brass with 12.5 inlet threads, hexagon shoulders and 19 mm male.

c. **Fixtures, Equipment and Fastenings**

All fixtures and equipment shall be supported and fastened in a safe and satisfactory workmanship as practiced.

All fixtures, where required to be wall mounted on concrete or concrete hollow block wall, fasten with brass expansion bolts. Expansion bolts shall be 6 mm diameter with 20 mm threads to 25 mm into solid concrete, fitted with loose tubing or sleeves of proper length to acquire extreme rigidity.

Inserts shall be securely anchored and properly flushed into the walls. Inserts shall be concealed and rigid.

Bolts and nuts shall be horizontal and exposed. It shall be provided with washers and chromium plate finish.

d. Pipe Hangers, Inserts and Supports

i. Pipe hangers shall be wrought iron or malleable iron pipe spaced not more than 3 mm apart for horizontal runs or pipe, except hub and spigot soil pipe which shall have hanger spaced not over 1.50 m apart located near the hub.

ii. Chains, straps perforated turn-bucklers or other approved means of adjustment except the turn-buckles may be omitted for hangers on soil or waste lines or individual toilet rooms to maintain stacks when spaced does not permit.

iii. Trapeze hangers may be used in lieu of separate hangers on pipe running parallel to and close to each other.

iv. Inserts shall be cast steel and shall be of type to receive a machine bolt or nut after installation. Insert may be permitted adjustment of the bolts in one horizontal direction and shall be installed before pouring of concrete.

v. Wrought iron clamps or collars to support vertical runs of pipe shall be spaced not more than 6 mm apart for as indicated on the Plans.

e. Plates and Flashing

i. Plates to cover exposed pipes passing through floor finished walls or ceiling shall be fitted with chromium plated cast brass plates or chromium plated cast iron or steel plates on ferrous pipes.

ii. Plates shall be large enough to cover and close the hole around the area where pipes pass. It shall be properly installed to insure permanence.

iii. Roof areas penetrated by vent pipes shall be rendered watertight by lead sheet flashing and counter flashing. It shall extend at least 150 mm above the pipe and 300 mm along the roof.

f. Protection and Cleaning

i. During installation of fixtures and accessories and until final acceptance, protect items with strippable plastic or other approved means to maintain fixtures in perfect conditions.

ii. All exposed metal surfaces shall be cleaned and polished upon completion.

iii. Upon completion, thoroughly clean all fixtures and accessories to leave the work in polished condition.

g. Inspection, Warranty Test and Disinfection

All pipes, fittings, traps, fixtures, appurtenances and equipment of the plumbing and drainage system shall be approved by the Engineer and inspected both by the Engineer and the Contractor's duly designated representative (Licensed Master Plumber or Sanitary Engineer) to insure 224 compliance with all requirements of all Codes and Regulations referred to in this Specification.

i. Drainage System Test

1. The entire drainage and venting system shall have all necessary openings which can be plugged to permit the entire system to be

filled with water to the level of the highest stack vent above the roof.

2. The system shall hold this water for a full 30 min during which time there shall be no drop greater than 102 mm.
3. Where only a portion of the system is to be tested, the test shall be conducted in the same manner as described to the entire system except that a vertical stack 3 m highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure or water pump may be used to supply the required pressure.
4. If and when the Engineer decides that an additional test is needed, such as an air to smoke test on the drainage system, the Contractor shall perform such test without any additional cost.

ii. Water Test on System

1. Upon completion of the rough-in and before connecting fixtures the entire cold water piping system shall be tested at a hydrostatic pressure 1 ½ times the expected working pressure in the system during operation and remained tight and leak-proofed.
2. Where piping system is to be concealed the piping system shall be separately in manner similar to that described for the entire system and in presence of the Engineer or his duly designated representative.
3. The water test shall be applied to the drainage and vent systems either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 3 m head of water. In testing successive sections at least the upper 3 m height of the preceding section previously tested shall be tested again so that no joint or pipe in the building (except the uppermost 3 m of the system) shall have been submitted to a test of not less than 3 m head of water. The water shall be kept in pipe system or in the portion under test, for at least 15 min before inspection starts. The system shall be tight at all joints.

iii. Defective Work

1. The entire water distribution system shall be thoroughly flushed and treated with chlorine before it is operated for public use.
2. Disinfection materials shall be liquid chlorine or hypochlorite and shall be introduced in a manner approved as practiced or approved by the Engineer into the water distribution system.
3. After a contact period of not less than 16 h, the heavenly chlorinated water shall be flushed from the system with potable water.
4. Valves for the water distribution system shall be opened and closed several times during the 16 h chlorination treatment is done.

h. As-Built Drawings

Upon completion of the work, the Contractor shall submit two (2) sets of prints with all as-built changes shown on the drawings in a neat workmanship manner. Such prints shall show changes or actual installation and conditions of the plumbing system in comparison with the original drawings.

D. Method of Measurement

The work done under this Item shall be quantified per length and/or number of units as provided in the Bill of Quantities, tested and accepted to the satisfaction of the Engineer. Plumbing Fixtures shall be measured by set, piece, square meter and/or lump sum

E. Basis of Payment

The quantified items, installed in place shall be the basis for payment, based from the unit bid price for which prices and payments shall constitute full compensation including labor, materials and incidentals necessary to complete this Item.

Payment shall be made:

Pay Item Number	Description	Unit of Measurement
1002 (1)a	Galvanized Iron Pipes with Fittings, 13 mm dia.	Meter
1002 (1)b	Galvanized Iron Pipes with Fittings, 25 mm dia.	Meter
1002 (1)c	Galvanized Iron Pipes with Fittings, 32 mm dia.	Meter
1002 (1)d	Galvanized Iron Pipes with Fittings, 40 mm dia.	Meter
1002 (1)e	Galvanized Iron Pipes with Fittings, 50 mm dia.	Meter

Pay Item Number	Description	Unit of Measurement
1002 (1)f	Galvanized Iron Pipes with Fittings, 65 mm dia.	Meter
1002 (1)g	Galvanized Iron Pipes with Fittings, 75 mm dia.	Meter
1002 (1)h	Galvanized Iron Pipes with Fittings, 100 mm dia.	Meter
1002 (1)i	Galvanized Iron Pipes with Fittings, 150 mm dia.	Meter
1002 (2)a1	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 20 mm dia., PN 10	Meter
1002 (2)a2	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 20 mm dia., PN 16	Meter
1002 (2)a3	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 20 mm dia., PN 20	Meter
1002 (2)b1	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 25 mm dia., PN 10	Meter
1002 (2)b2	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 25 mm dia., PN 16	Meter
1002 (2)b3	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 25 mm dia., PN 20	Meter
1002 (2)c1	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 32 mm dia., PN 10	Meter
1002 (2)c2	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 32 mm dia., PN 16	Meter
1002 (2)c3	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 32 mm dia., PN 20	Meter
1002 (2)d1	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 40 mm dia., PN 10	Meter
1002 (2)d2	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 40 mm dia., PN 16	Meter
1002 (2)d3	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 40 mm dia., PN 20	Meter
1002 (2)e1	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 50 mm dia., PN 10	Meter
1002 (2)e2	Polyprophylene Random Copolymer (PPR-C) Pipes with Fittings, 50 mm dia., PN 16	Meter

Pay Item Number	Description	Unit of Measurement
1002 (6)	Water Closet, Elongated, Automatic Flush Valve, Complete, Sensor Type	Set
1002 (7)a	Water Closet, Round Front, Complete, Tank Type	Set
1002 (7)b	Water Closet, Round Front, Complete, Flush Type	Set
1002 (8)	Water Closet, Round Front, Automatic Flush Valve, Complete, Sensor Type	Set
1002 (9)a	Urinal, Flush Valve, Complete, Push Button Type	Set
1002 (9)b	Urinal, Flush Valve, Complete, Lever Arm Type	Set
1002 (10)	Urinal, Automatic Flush Valve, Complete, Sensor Type	Set
1002 (11)a	Kitchen Sink, Complete, Stainless	Set
1002 (11)b	Kitchen Sink, Complete, Aluminum	Set
1002 (11)c	Kitchen Sink, Complete, Plastic	Set
1002 (12)	Scrub Up Sink, Complete	Set
1002 (13)	Slop Sink, Complete	Set
1002 (14)a	Lavatory, Wall Hung, Complete, Manually Operated	Set
1002 (14)b	Lavatory, Wall Hung, Complete, Sensor Type	Set
1002 (15)a	Lavatory, Counter Top/Under Counter, Complete, Manually Operated	Set
1002 (15)b	Lavatory, Counter Top/Under Counter, Complete, Sensor Type	Set
1002 (16)a1	Floor Drain Plates, 50 mm dia., Stainless	Set
1002 (16)a2	Floor Drain Plates, 75 mm dia., Stainless	Set
1002 (16)a3	Floor Drain Plates, 100 mm dia., Stainless	Set
1002 (16)b1	Floor Drain Plates, 50 mm dia., Brass	Set
1002 (16)b2	Floor Drain Plates, 75 mm dia., Brass	Set
1002 (16)b3	Floor Drain Plates, 100 mm dia., Brass	Set

Pay Item Number	Description	Unit of Measurement
1002 (17)	Bidet	Piece
1002 (18)	Stainless Steel Grab Bar, 40mm dia.	Linear Meter
1002 (19)	Shower Head/Shower Valve	Set
1002 (20)	Facial Mirror	Square Meter
1002 (21)	Faucet	Piece
1002 (22)	Hose Bibb	Piece
1002 (23)a	Water Meter, 20 mm dia.	Piece
1002 (23)b	Water Meter, 25 mm dia.	Piece
1002 (23)c	Water Meter, 32 mm dia.	Piece
1002 (24)	Cold Water Lines	Lump Sum
1002 (25)	Hot Water Lines	Lump Sum
1002 (26)	Cistern	Lump Sum
1002 (27)	Plumbing Works	Lump Sum
1002 (28)a	Squat Bowl, Complete, Ceramic Porcelain	Set
1002 (28)b	Squat Bowl, Complete, Plastic	Set
1002 (29)	Toilet Bowl, Complete, Plastic	Set

XVIII. STORM DRAINAGE AND SEWERAGE SYSTEM

A. Description

This Item shall consist of furnishing all materials, equipment and labor for the complete installation of the storm drainage system which include all pipings, gutters, canals, catch basins, junction boxes, handholes, manholes and other appurtenant structures, and sewerage system which include all sanitary sewer piping and septic vault/tank where no public sewer exist, from the building to the point of discharge.

B. Material Requirements

a. Storm Drainage System

Materials for storm drainage system shall meet the requirements specified in the following Standard Specifications:

Material	Standard
Portland Cement	ASTM C150M, Standard Specification for Portland Cement
Fine and Coarse Aggregate	ASTM C33M, Standard Specification for Concrete Aggregates
Reinforcing Steel	ASTM A615M, Standard Specification for Reinforcing Steel
Non-reinforcing Concrete Pipes	AASHTO M 86/ASTM C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
Reinforced Concrete Pipes	ASTM C76/AASHTO M 170M, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
Cast Iron Pipes (for conductors and downspouts)	ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings
Galvanized Iron Pipes Schedule 40 (for conductors and downspouts)	ASTM A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
Polyvinyl Chloride (PVC) (for conductors and downspouts)	ASTM D2729, Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
	AASHTO M 278, Standard Specification for Class PS46 Poly(Vinyl Chloride) (PVC) Pipe
	AASHTO M 304, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
	PNS 1950:2003, Plastic Piping Systems for Soil and waste Discharge (low and high temperature) inside buildings – Unplasticized Polyvinyl Chloride (PVC-U)
High Density Polyethylene Pipes (HDPE)	ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
	ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
	PNS ISO 4427, Polyethylene (PE) Pipes for Water Supply - Specifications

b. Sewerage System

Materials for sewerage system shall meet the requirements specified in the following Standard Specifications:

Material	Standard
Cast Iron Pipes and Fittings	ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings
Pig Lead (for securing and sealing joints)	ASTM B29, Standard Specification for Refined Lead
PVC Pipes and Fittings (where called in Plans)	ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
	PNS 1950:2003, Plastic Piping Systems for Soil and waste Discharge (low and high temperature) inside buildings -- Unplasticized Polyvinyl Chloride (PVC-U)
Solvent Cement (for Securing PVC joints)	ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
High Density Polyethylene Pipes (HDPE)	ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
	ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
	PNS ISO 4427, Polyethylene (PE) Pipes for Water Supply - Specifications

Where PVC pipes and fittings are used, joints shall be secured with rubber "O" ring or solvent cement, as the case may be. Oakum for joints in bell and spigot pipes shall be made from hemp fiber, braided or twisted and oil-impregnated, free from lumps, dirt and extraneous matter.

c. **Structure Materials**

All storm drainage structures such as manholes, inlets, junction boxes and catch basins shall be constructed of either brick, solid block or precast concrete.

i. Clay Brick shall be solid, rough, sound clay brick conforming to ASTM C32, Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale). The brick shall be laid with full shove joints, filling up the joints with mortar. The thickness of the joints shall not exceed 9.53 mm.

ii. Concrete Block or brick shall be solid and conforms to ASTM C139, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes as to design and manufacture. The block or brick shall be embedded in a mortar bed to form a 12.70 mm mortar joint.

iii. Precast concrete manhole shall conform to ASTM C478, Standard Specification for Circular Precast Reinforced Concrete Manhole Sections. Fabricate precast concrete manhole to the sizes indicated on the Plans. 4. Concrete for drainage structures shall meet the applicable requirements of Item 900, Structural Concrete.

d. **Frames, Covers and Gratings**

Metal units shall conform to the Plan dimensions and to the following specification requirements for the designated materials:

Material	Standard
Gray Iron Castings	ASTM A48M/AASHTO M 105, Standard Specification for Gray Iron Castings
Carbon Steel Castings for General Application that require up to 485 MPa minimum tensile strength.	ASTM A27M/AASHTO M 103M, Standard Specification for Steel Castings, Carbon, for General Application
Hot-Dip Galvanized Coatings on Iron and Steel Products	ASTM A123M/AASHTO M 111M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
Reinforcing Steel	ASTM A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
	AASHTO M 31M, Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement

Samples of the material in casting shall be taken during the casting of the units and shall be separate casting poured from the same material as the casting they represent.

Metal gratings and covers which are to rest on frames shall bear on them evenly. They shall be assembled before shipment and so marked that the same pieces may be reassembled readily in the same position when installed. Inaccuracy of bearings shall be corrected by machining, if necessary. A frame and grating or cover to be used with it shall constitute one (1) pair.

All castings shall be uniformly coated with asphalt-based emulsion meeting the requirements of ASTM D1187, Standard Specification for Asphalt – Base Emulsion for Use in Protective Coating for Metal.

e. **Trench Drains and Downspouts**

Trench drains and downspouts shall conform to the applicable requirements of ASTM A36M, Standard Specification for Carbon Structural Steel. Trench trough, overlap splice, anchors and downspout pipe shall be steel, galvanized after assembly of each trench section. Fabricate trench drain corners using mitered sections of trough, then weld. Trench drain trough and trench gate shall be as shown in the Plans.

Cast iron trench grates shall conform to ASTM A48M. Grates shall be cast iron unless indicated as cast aluminum in the Plans.

Cast aluminum trench gates shall conform to ASTM B26M, Standard Specification for Aluminum-Alloy Sand Castings.

f. **Concrete Gutters and Canals**

Concrete gutters and canals shall be constructed to the profile indicated on the Plans. Concrete materials and steel reinforcement shall comply with the applicable requirements of Item 900, Structural Concrete and Item 902, Reinforcing Steel.

Forms shall comply with the applicable requirements of Item 903, Formworks and Falseworks.

g. Septic Tank

i. Materials used in constructing a septic tank shall be in accordance with the latest Unified Plumbing Code of the Philippines.

ii. The minimum wall thickness of a steel septic tank shall be 2.77 mm and each such tank shall be protected from corrosion both externally and internally by an approved bituminous coating or by other acceptable means.

iii. Septic tanks constructed of alternate materials shall be permitted to be approved by the Engineer in accordance with approved application standards. Wooden septic tanks shall be prohibited. Sizes, dimensions, reinforcing, structural calculations and such other pertinent data as required for septic tank shall be indicated on the Plans.

C. Construction Requirements

a. Installation of Pipes

Under no circumstances shall pipes be laid under water and when the trench condition or the weather is unsuitable for such work.

i. Bedding

Materials such as sand, sandy soil or any approved material shall be used to provide a firm foundation of uniform density. The bedding shall have a minimum thickness equivalent to 1/4 of the pipe's diameter.

ii. Laying of Pipes

Proper facilities shall be provided for lowering and placing pipes into trenches in order to preclude damage. Laying of pipes shall start upgrade with the spigot end of bell-and-spigot pipe, or the tongue end of tongueand-groove pipe, positioned towards the direction of the flow. The pipes shall be laid in accordance with the grades and alignments shown in the Plans.

The spigots or tongues shall be adjusted in bells or grooves to provide uniform space around joints to receive mortar. Blocking or wedging between spigot and bell or between tongue and groove to attain proper spacing shall be allowed provided such blocking/wedging shall not interfere with the caulking and shall not affect the water tightness of the joint.

No building sewer or other drainage piping or part thereof, which is constructed of materials other than those approved for use under or within a building, shall be installed under or within 610 mm of any building or structure, or part thereof, not less than 305 mm below the surface of the ground. The provisions of this subsection include structures such as porches and steps, whether covered or uncovered; breezeways; roofed portecocheres; roofed patios; carports; covered walks; covered driveways; and similar structures or appurtenances.

Septic tanks shall have not less than two compartments or as shown on the Plans.

Warning tape shall be laid above main pipes. The tapes shall be flexible and subject to the Engineer's approval. Width of the tape should be at least 150

mm. The text on the tape shall be permanent ink bonded to resist prolonged chemical attack by corrosive acids and alkaline with message repeated at a maximum interval of 2 m. The tapes shall be laid 300 mm above the pipeline. The tape shall be continuous over pipelines and at joints there should be a minimum of 1 m over lapping.

iii. Bell and Spigot Joint for Drain Pipe

The first pipe shall be properly bedded at the required grade. Just below the spigot of the first unit, a sufficient space shall be provided for engaging the bell end of the second pipe.

The spigot shall be carefully cleaned with a wet brush and the upper exterior portion applied with mortar to such a thickness as to bring the inner surfaces of the abutting pipes flush and even. The bell end of the second pipe shall be cleaned with a wet brush and uniformly matched with the spigot of the first pipe so that the sections are closely fitted. After the second pipe is laid, the remainder of the joint shall be fitted with mortar, and a bead shall be formed around the outside of the joints with sufficient amount of additional mortar. The inside of the joints shall be wiped and finished smooth. The mortar bead on the outside shall immediately be protected with a cover of wet burlap or wet earth for at least 3 days for curing.

iv. Tongue and Groove Joint for Concrete Pipe

The first pipe shall be properly bedded. A shallow excavation shall be made underneath the joint and filled with mortar to provide a bed second pipe. The tongue end of the first pipe shall be carefully cleaned with wet brush and soft mortar applied around the upper half of the tongue. After cleaning and positioning the second pipe close to the first, mortar shall be applied around the lower half of the groove. With just sufficient thrust, the second pipe shall be brought in close contact with the first until mortar is squeezed out of the joint. Sufficient mortar shall be used to fill the joint and to form a bead on the outside.

v. Mortar for Joint

Mortar shall be a mixture of Portland cement, sand and water mixed in the proportion by volume of one (1) part cement to two (2) parts of clean sand with just sufficient amount of water for plasticity.

vi. Leaded Joints of Cast Iron Pipes

Joints of cast iron pipes shall be packed with braided or twisted oilimpregnated hemp or oakum, properly caulked around the joint. The packing shall be at least 20 mm below the rim of the hub or bell and this space be filled with molten pig lead in one (1) continuous pouring. The "ring" of pig lead formed around the joint shall be properly caulked by appropriate caulking tools to render the joints watertight.

b. **Concrete Structures**

Concrete structures such as catch basins, canal gutters, junction boxes and manholes for the drainage system, and septic vault for sewerage system shall be constructed in accordance with the Plans and Specifications on Concrete Work.

c. **Sewer Connections and Clean-Outs**

i. The outlet of the septic vault shall be connected to the street drain or to other discharge point where sanitary sewer exists. Connection with the sanitary sewer shall not be made without the permission of the proper authorities, but shall be made in such a manner that any and all the service water, as well as house and other liquid wastes, will flow to the sanitary sewer. Provided that isolated faucets used exclusively for garden purposes, may in the discretion of the proper authorities, be allowed not to flow into the sanitary sewer.

ii. Clean-outs or rodding holes consisting of cast iron extensions with long sweep elbow fittings shall be provided at the ends of the runs and at every change of directions. Clean-outs shall be capped with cast brass ferrules with threads and screwed on removable brass plugs. Clean-outs extended outside the building and raised to the level of finished grade shall be terminated with the same cast brass ferrule with brass plug set in to a concrete slab shall be 150 mm thick and 300 mm square, finish flush with grade.

iii. Additional building sewer cleanouts shall be installed at intervals not to exceed 30,480 mm in straight runs and for each aggregate horizontal change in direction exceeding 135 degrees. When a building sewer or a branch thereof does not exceed 3,048 mm in length and is a straight-line projection from a building drain that is provided with a clean out, no cleanout will be required at its point of connection to the building drain.

d. **Septic Tank Construction**

Septic tanks shall be constructed in accordance with the Plans and requirements of the latest Uniform Plumbing Code.

e. **Incidental Earthwork**

Incidental earthwork for the storm drainage and sewerage systems, such as excavation and backfilling shall be undertaken in accordance with applicable requirements of Item 803, Structure Excavation.

f. **Inspection and Quality Control**

1001.3.6 Inspection and Quality Control Materials shall be inspected and accepted as to quality before same are installed. Piping installed in trenches shall first be inspected, tested and approved by the Engineer before these are covered or backfilled. All defects/leaks disclosed by the water test shall be remedied to the satisfaction of the Engineer and any extra cost shall be at the expense of the Contractor.

i. **Building Sewer Test**

Building sewers shall be tested by plugging the end of the building sewer at its points of connection with the public sewer or private sewage disposal system and completely filling the building sewer with water from the lowest to the highest point thereof, or by approved equivalent low-pressure air

test. Plastic 208 drain, waste, and vent piping systems shall not be tested by the air test method. The building sewer shall be water-tight at all points.

ii. Testing for Storm Drainage Systems

Except for outside leaders and perforated or open-jointed drain tile, the piping of storm drain systems shall be tested upon completion of the rough piping installation by water or air, except that plastic pipe shall not be tested with air, and proved tight. The Engineer shall be permitted to require the removal of any cleanout plugs to ascertain whether the pressure has reached parts of the system. One of the following test methods shall be used:

1. **Water Test**

   After piping has been installed, the water test shall be applied to the drainage system, either to the entire system or to sections. If the test is applied to the entire system, all openings in the piping shall be tightly closed except for the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except for the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 3,000 mm head of water. In testing successive sections, not less than the upper 3,000 mm of the next preceding section shall be tested so that no joint of pipe in the building (except the uppermost 3,000 mm of a roof drainage system which shall be filled with water to the flood level of the uppermost roof drain) shall have been submitted to a test of less than a 3,000 mm head of water. The water shall be kept in the system or in the portion under test for not less than 15 min before inspection starts. The system shall then be tight at all points.

2. **Air Test**

   The air test shall be made by attaching an air compressor testing apparatus to any suitable opening after closing other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 34.5 kPa or sufficient pressure to balance a column of mercury 250 mm in height. This pressure shall be held without introduction of additional air for a period of not less than 15 min.

D. Method of Measurement

Pipes, culverts, gutters, canals and gratings installed in place and accepted by the Engineer, shall be measured by the meter along their axes.

Catch basins, junction boxes, manholes and septic vault/tank shall be measured by the number of units or lump sum, completed and accepted by the Engineer.

Sewer Line works, Storm drainage and downspout and Pipes w/ Fittings connection shall be measured by lump sum, completed and accepted by the Engineer.

E. Basis of Payment

The quantities as determined in Section 1001.4, Method of Measurement shall be paid at the Contract Unit Price for each of the Items which shall constitute full compensation for all

materials, labor, tools and equipment and all other incidentals necessary to complete the Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1001 (1)a1	Pipe and Fittings, 50 mm dia., PVC, Series 600	Meter
1001 (1)a2	Pipe and Fittings, 75 mm dia., PVC, Series 600	Meter
1001 (1)a3	Pipe and Fittings, 100 mm dia., PVC, Series 600	Meter
1001 (1)a4	Pipe and Fittings, 150 mm dia., PVC, Series 600	Meter
1001 (1)a5	Pipe and Fittings, 50 mm dia., PVC, Series 1000	Meter
1001 (1)a6	Pipe and Fittings, 75 mm dia., PVC, Series 1000	Meter
1001 (1)a7	Pipe and Fittings, 100 mm dia., PVC, Series 1000	Meter
1001 (1)a8	Pipe and Fittings, 150 mm dia., PVC, Series 1000	Meter
1001 (1)a9	Pipe and Fittings, 200 mm dia., PVC, Series 1000	Meter
1001 (1)a10	Pipe and Fittings, 250 mm dia., PVC, Series 1000	Meter
1001 (1)a11	Pipe and Fittings, 300 mm dia., PVC, Series 1000	Meter
1001 (1)b1	Pipe and Fittings, 150 mm dia., Concrete	Meter
1001 (1)b2	Pipe and Fittings, 200 mm dia., Concrete	Meter
1001 (1)b3	Pipe and Fittings, 250 mm dia., Concrete	Meter
1001 (1)b4	Pipe and Fittings, 300 mm dia., Concrete	Meter

Pay Item Number	Description	Unit of Measurement
1001 (1)b5	Pipe and Fittings, 350 mm dia., Concrete	Meter
1001 (1)c1	Pipe and Fittings, 50 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c2	Pipe and Fittings, 75 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c3	Pipe and Fittings, 100 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c4	Pipe and Fittings, 150 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c5	Pipe and Fittings, 200 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c6	Pipe and Fittings, 250 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (1)c7	Pipe and Fittings, 300 mm dia., High Density Polyethylene (HDPE)	Meter
1001 (2)	Concrete Gutter	Meter
1001 (3)	Concrete Canal	Meter
1001 (4)	Wrought Iron Grating	Square Meter
1001 (5)a	Catch Basin, Concrete	Each
1001 (5)b	Catch Basin, CHB	Each
1001 (6)	Catch Basin	Lump Sum
1001 (7)a	Junction Box, Concrete	Each
1001 (7)b	Junction Box, CHB	Each
1001 (8)	Sewer Line Works	Lump Sum
1001 (9)	Storm Drainage and Downspout	Lump Sum
1001 (10)	Pipes with Fittings Connection	Lump Sum
1001 (11)	Septic Vault/Tank, Concrete/CHB	Lump Sum
1001 (12)	Septic Vault/Tank, PVC	Lump Sum
1001 (13)	Septic Vault/Tank, PVC	Each
1001 (14)	Manhole, Concrete/CHB	Lump Sum
1001 (15)	Manhole, Concrete/CHB	Each

Pay Item Number	Description	Unit of Measurement
1001 (16)a1	Inlets, 150 mm dia., Concrete	Meter
1001 (16)a2	Inlets, 200 mm dia., Concrete	Meter
1001 (16)a3	Inlets, 250 mm dia., Concrete	Meter
1001 (16)a4	Inlets, 300 mm dia., Concrete	Meter
1001 (16)a5	Inlets, 350 mm dia., Concrete	Meter

XIX. ELECTRICAL WORKS

A. Scope of Work

a. The work of the contractor consists of furnishing of all tools, labor, equipment, and materials and performing all operations in connection with the electrical and fire alarm system shown on the drawing, their test and inspection, complete and in accordance with these specifications and drawings and subject to the terms and conditions of the contract, and all other labor and materials not specifically mentioned under sections, to bring the electrical system to operating conditions and be ready for use by the Owner.

B. Applicable Documents

a. The works covered by these specifications shall be governed by the requirements of the Philippine Electrical Code, US Federal Specifications, NEMA standards.

C. Materials

a. Rigid steel conduit shall be hot-dipped galvanized mild steel pipe and shall 3m lengths including coupling.
b. PVC electrical conduit shall be supplied in standard effective lengths of 3.0m.
c. Wires and cables shall be insulated for 600 volts. Feeder and branch circuit wires and cables shall be type TW or THHN as manufactured.
d. Conduits fittings shall be US Underwriters Laboratories (UL) listed or approved local equivalent.
e. Outlet boxes shall be hot-dipped galvanized or case metal as required. Thickness of pressed steep boxes shall be less than gauge #16.
f. Circuit breakers for panel boards shall be molded case circuit breaker with quick-made, quick-break, trip-free mechanisms. They shall meet US Federal Specifications and NEMA standard.
g. Panel board shall be as manufactured by bolt-on type NEMA or approved equal.
h. Wiring devices such as switches and convenience outlets shall have ratings of 15 amperes, 250V and 16 amperes, 250V, respectively.
i. Pole - Tapered Hot - Dipped Galvanized Single Arm Steel Post, 8.0m height pole (100mmØ Bottom & 170mmØ Top) w/ 12mm thk. 300mm x 300mm base plate with 700mm Outrigger length.
j. Solar Panel - 150Watts Integrated Solar Street light with 220 -230Lm/W (33,000 - 34,500 Lumens) luminous flux, Monocrystalline Solar Panel 150W/18V, 6000 - 6500k CCT with High-quality Aluminum alloy, 12V 576Wh LifeP04 Battery, Life Time: 10,000hours, 10 - 12 hours of working time; 2 - 3 days continuous raining back - up, charging time of 6 - 7 hours

i. Warranty

Lithium Battery :	Minimum of 3 years
Solar Panel :	Minimum of 2 - 3 years
Pole :	Minimum of 3 - 5 years

D. Installation

a. Grounding

The following shall be grounded in accordance with the drawings and the requirements of the Philippine Electrical Code with standards grouping practices:

Metallic conduit and raceway system including gutters, cabinets and boxes.

Non-current carrying metal parts of all electrical equipment including fixtures and motors.

b. Feeders

Distribution voltage shall be 230V, 1-phase, 3-wire feeder conductors and conduit shall be installed as shown on the drawing and no change in size shall be made without consent of the Owner. Feeder conductors shall be continuous and without splices between terminals.

c. Branch Circuit

The drawing indicates the general methods of installations of all circuit wiring and the outlet which are to be supplied from this circuit. Branch circuit conduits shall be run from outlets to panel boards as directed as the building conditions will allow. Circuit allocations shall be indicated on the drawings where it becomes necessary to correct any outlet to circuit other than shown on the drawings. This shall be done without extra charge and only upon written consent of the Owner. No wire smaller than 2.0mm^2 (#14AWG) and 3.5mm^2 (#12 AWG) shall be used for any lighting and power circuits, respectively.

d. Panel boards and cabinets

Panel boards shall be mounted with their centers at 1.40m above the floor unless otherwise indicated by field conditions.

e. Locations of outlets and switches

The approximate location of each fixture receptacle, special purpose outlet and switch is indicated on the drawings. The exact location is to be determined later at the site as the work progresses.

f. Wires and boxes

No wire shall be drawn into the raceway until works, which may cause injury to the wires, is completed and until permission is given by the Owner in writing. Only powdered lubricant not injurious to cable insulation and raceways shall be used only when lubrication is necessary.

g. Splices

Branch circuit splices shall be soldered or joined by used insulated splicing device (wire nuts). All soldered joints shall be made mechanically strong before soldering and shall

Prepared By:

ENGR. NIKKO S. QUITANEG
Estimator – Civil Works

ENGR. JUNRIEH B. PAPELIRAS
Electrical Estimator/Designer

ENGR. GABRIELLE B. LASAY
Sanitary Engineer

Checked By:

ENGR. NOEL F. YAMBAO
Manager
Project Management Division

Noted:

ENGR. JEOFFREY L. MACALALAD
Manager,
Project Evaluation and Planning Department

be carefully soldered without the use of acid, then taped with rubber tape to a thickness equal to that of the insulation and with a covering of friction tape of two layer. . Where solid conductors are to be connected directly to devices without the use of lugs, such as lighting switches and plug receptacles, the wires shall be formed into a clockwise loop fitted around the screws.

h. Outlets, switches and junction boxes

The contractor shall install standard boxes at all outlets for lights, appliances and switches and other point as required by the constructions.

i. Conduit System

Not more than four 90 degrees bond shall occur in any run. When it becomes necessary to have more than four 90 degrees bends in any run, an intermediate pull box shall be installed to facilitate pull-in wires. All conduits run shall as called for on the drawings. Conduits shall be installed in such manner as not to weaken or interfere with the structure or the building. No horizontal runs embedded conduit shall be permitted in solid wall and partitions. Conduits below grade line shall be encased in concrete enveloped with minimum thickness of 50mm (2") or embedded in floor slab. Exposed conduit shall run parallel or at right angles with lines of the buildings and shall be securely fastened in place by means of approved fastening. Conduits support shall be fastened to walls by means of screws or bolts with expansion sleeves. The use of wooden or lead plug is not permitted. Conduits shall be cut by hacksaw, the ends shall be reamed after being firmly attached to cabinets or boxes by means of locknuts.

j. Lighting Fixtures

The Contractor shall furnish and install all lighting fixture as indicated on the drawings, including mounting channels and supports.

k. Pole - The pole shall be install in accordance with the drawings and the requirements of the Philippine Electrical Code with standards grouping practices:

l. Solar Lighting Fixtures - The Contractor shall furnish and install all All-in-One Solar Integrated Street light as indicated on the drawings, including mounting channels and supports.

m. Testing

i. Ground test

The entire installation shall be free from improper ground and from short circuits. Each panel shall be tested with means connected. Lamps removed or omitted from the sockets and all switches closed. Each individual power equipment shall be connected for proper and intended operation. In no case shall the resistance be less than that allowed by the Regulations for electrical equipment of building. Failures shall be corrected in any manner satisfactory to the Architect and Engineer.

ii. Performance test

The electrical contractor shall test all system of entire electrical installation for proper operational conditions. These conditions shall apply to the power and lighting installation, voltage drop, grounding defects.