



Republic of the Philippines
Tourism Infrastructure & Enterprise Zone Authority

PROJECT SPECIFICATIONS

I. GENERAL CONDITIONS

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

Project : **TOURIST REST AREA**

Location : People's Park, Barangay Pangobilian, Brooke's Point, Palawan

A. Scope of Work

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:

1. General Requirements
2. Earthworks
3. Concrete Works
4. Roofing Works
5. Masonry Works
6. Doors and Windows
7. Finishing Works
8. Painting Works
9. Plumbing Works
10. Electrical Works
11. Landscaping

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. 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-aiders, 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 advise 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

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. TEMPORARY FENCE (TEMPORARY ENCLOSURE)

A. Description

This work shall consist of furnishing, erecting, moving and removing chain link fencing and metal gates of the size and type shown on top of the temporary concrete barriers, and in sidewalk and roadway areas at the locations, as shown on the Plans or as directed by the Engineer.

B. Material Requirements

a. Barbed Wire

Barbed wire shall conform to the requirements of ASTM A121, Class I, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire. The barbed wire shall consist of two (2) strands of 12.5 gauge wire, twisted with two (2) points, 14 gauge barbs spaced 100 mm apart.

b. Chain Link Fence Fabric

Chain link fence fabric shall be fabricated from ten (10) gauge-galvanized wire conforming to AASHTO M 181, Chain Link Fence, and shall be of the type shown on the Plans. Before ordering the chain link fence fabric, the Contractor shall submit a sample of the material to the Engineer for testing and for approval.

c. Concrete Post

Concrete posts shall be made of Class A concrete in accordance with Item 900, Structural Concrete. The posts shall be cast to a tapered section as shown on the Plans and shall have a smooth surface finish.

d. Steel Post

Steel posts shall be of the sections and length as specified or as shown on the Plans. The posts shall be copper bearing steel and shall conform to the requirements of ASTM A702, Standard Specification for Steel Fence Post, Hot Wrought, for the grade specified.

e. Steel Reinforcement

Steel reinforcement for concrete posts shall be deformed steel bars conforming to the provisions of Item 902, Reinforcing Steel.

f. Hardware

Nuts, bolts, washers and other associated hardware shall be galvanized after fabrication as specified in ASTM A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. Construction Requirements

The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. The Contractor shall install fence posts on the concrete barrier in 38 mm diameter, 300 mm deep drilled or formed holes near each end of each section of the barrier. In addition, if

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

XIV. 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.

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:

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 unlevelled 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.

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 lose 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.

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/m ³	Density Limits, kg/m ³	
		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%

Table 1046.1 Thickness of Face Shells and Webs

Nominal Width (W) of Units, mm	Minimum Face Shell Thickness (t_s), 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/m^3	Maximum Water Absorption, kg/m^3		Minimum Net Area Compressive Strength, MPa (Psi)	
		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/m^3
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)

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. Aeration Agent for Autoclaved 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.

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

XIII. 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

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:

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

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.

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.

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 Copies 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.

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.

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:

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:

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

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

XII. 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.

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

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:

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.
- 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

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:

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

XI. 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 is 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 sheathing 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 sheathing 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 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

- 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

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 $1 \frac{1}{3}$ 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 $1 \frac{1}{2}$ 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 \emptyset .
- 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-prestressed reinforcement in a horizontal layer, clear spacing shall be at least the greatest of 50 mm, nominal diameter of bar (db) and $(\frac{4}{3})$ nominal maximum size of coarse aggregates (dagg).
- c. For non-contact splices in flexural members, the transverse center-to-center 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.

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.

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

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.

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 cold-drawn 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, f_s'	1000 MPa
Yield Strength (0.2 offset)	0.90 f_s'
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.

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 straightened 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

X. 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 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
Type of Reinforcing Steel	Specification
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

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)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
Pay Item Number	Description	Unit of Measurement
900 (4)c	Structural Concrete, Class P, 28 days	Cubic Meter
900 (5)	Seal Concrete	Cubic Meter
900 (6)	Reinforced Concrete	Cubic Meter

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.

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

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

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.

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 restraighthen 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

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 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.

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.

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.

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.

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.

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.

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 measures 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

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, f_c' 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.

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 (gravimetric) 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

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.

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:

f_c' = compressive strength of concrete

a. Concrete Quality

All Plans submitted for approval or used for any project shall clearly show the specified strength, f_c' , 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

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 may be 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

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: ^AComparisons 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. 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 ₂ O + 0.658 K ₂ O)	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.

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.

Gradation 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

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:

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

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

g. Safety Requirements

Formulate, treat and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Engineer and fit the filling hose with backflow preventer meeting local plumbing codes or standards. The filling operation shall be under the direct and continuous observation of the Contractor to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure 200 that proper protective clothing and equipment are worn and used during all phases of termiticide operation.

Disposal of used pesticide containers off the project site shall comply with the latest requirements of DENR Administrative Order for Revised Procedures and Standards for Management of Hazardous Waste, Material Safety Data Sheet (MSDS) shall also be strictly followed.

h. Warranty

Upon completion and acceptance of the work, the Contractor shall furnish the Engineer a written guarantee stating that termite control is guaranteed for a minimum period of three (3) years and annual inspections or as requested by the Engineer shall be done by both the Contractor and Engineer to ensure the quality of their work.

D. Method Of Measurement

Liquid termite control chemicals or toxicants shall be measured by actual number of liters used in the cordoning and drenching of lot areas and soil poisoning of granular fill or actual number of liters used in drenching wood surfaces, while powder chemical/toxicant shall be measured by kilograms applied to suspected subterranean termite mounds and tunnels. The quantity to be paid for shall be determined and accepted by the Engineer.

E. BASIS OF PAYMENT

The accepted quantities, measured as prescribed in Section 1000.4, Method of Measurement shall be paid for at the Contractor Unit Price for Termite Control Work which price and payment shall be full compensation for furnishing and applying termite control chemicals including the use of equipment and tools, labor and incidentals necessary to complete the work prescribed in this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1000 (1)	Soil Poisoning	Liter
1000 (2)	Wood Preservative	Liter
1000 (3)	Powder Termiticide	Kilogram

IX. 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

working solution after it has been compacted and set to required elevation. Additional treatment shall be applied as follows:

1. In critical areas, such as utility openings for pipes, conduits and ducts, apply additional treatment at the rate of 6 L/l.m. in a strip 150 mm to 200 mm wide.
2. Along the exterior perimeter of the slab and under expansion joint, at the rate of 2.5 L/l.m. in a strip 150 mm to 200 mm wide in a shallow trench.

Apply an overall treatment under entire building slab, and moving strips adjacent to the building. Treat sidewalks or other such paved areas abutting the building for a distance not less than 1 m from the building. Apply along each side of foundation walls and at penetrations through slabs such as pipes, ducts, etc. apply at application rate of 5 L per linear meter around the perimeter of the building.

Post signs in areas of application to warn workers that soil termicide treatment has been applied. Remove signs when areas are covered by other construction.

d. Wood Protection

Where the application of wood preservative is necessary, the Contractor shall use Type II working solution as recommended by the manufacturer.

All wood materials not pressure treated as specified in Item 1003, Carpentry and Joinery shall be treated with Type II ready mixed solution as herein called for or as directed by the Engineer.

Wood treatment shall be applied after framing, sheathing, and exterior weather protection is completed but before the electrical and mechanical systems are installed.

e. Powder Termicide

When powder termicide is to be applied to eradicate subterranean termites, extreme caution and care shall be done at the time of application. It shall not be allowed to enter drains, waterways, streams or rivers. It shall not be used if rain is expected to occur within 48 h of application. All heating and air conditioning ducts, air vents, floor drains, and edible plants shall be covered prior to application of powder termicide.

f. Delivery, Storage and Handling

Deliver termicides to the project site in sealed and labeled containers in good condition as supplied by the manufacturer. Store, handle and use termicides in accordance with manufacturer's labels. Labels shall bear evidence of registration and Material Safety Data Sheet (MSDS) shall also be provided.