

concrete is conveyed and placed by pneumatic means, the equipment shall be suitable in kind and adequate in capacity for the work. The machine shall be located as close as practicable to the work. The discharge lines shall be horizontal or inclined upwards from the machine. The discharge end of the line shall not be more than 3 m from the point of deposit. At the conclusion of placing the concrete, the entire equipment shall be thoroughly cleaned.

2. Placing of Concrete by Pumping

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

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

3. Placing Concrete in Water

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

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

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

k. Consolidation of Concrete

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

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

The consolidation shall be done by mechanical vibration. The concrete shall be vibrated internally unless special authorization of other methods is given or is provided herein. The intensity of vibration shall be such as to visibly affect a mass of concrete with a 3 cm slump over a radius of at least 50 cm. A sufficient number of vibrator shall be provided to properly consolidate each batch immediately after it is placed in the forms. Vibrators shall be manipulated so 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.

I. Concrete Surface Finishing: General

1. Float Finish

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

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

2. Trowel Finish

After applying float finish, trowel shall be applied first then concrete shall be consolidated by hand or power-driven trowel. Continue troweling passes and 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 shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay, in the application of the curing compound, which results in any drying or cracking of the surface, application of water with an atomizing nozzle as specified under "Water Method", shall be started immediately and shall be continued until the application of the compound is resumed or started, however, the compound shall not be applied over any

resulting free-standing water. Should the film of compound be damaged from any cause before the expiration of 7 days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

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

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

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

iii. Waterproof Membrane Method

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

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

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

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

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

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

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

iv. Forms-in-Place Method

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

v. Steam Curing Method

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

- (a) After placement of the concrete, members shall be held for a minimum 4 h pre-steaming period.
- (b) To prevent moisture loss on exposed surfaces during the pre-steaming period, members shall be covered immediately after casting or the exposed surface shall be kept wet by fog spray or wet blankets.
- (c) Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good condition and secured in such a manner to prevent the loss of steam and moisture.
- (d) Steam at jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure shall not exceed 20°C per hour. The curing temperature throughout the enclosure shall not exceed 65°C and shall be maintained at a constant level for a sufficient time necessary to develop the required compressive strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature of the enclosure will be the same as that of the concrete.
- (e) Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one (1) temperature recording device per 50 m of continuous bed length will be required for checking temperature.

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

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

i. **Curing Cast-In-Situ Concrete**

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

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

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

n. **Acceptance of Concrete**

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

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

D. Method of Measurement

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

E. Basis of Payment

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

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
900 (1)a	Structural Concrete, Class A, 3000 psi, 7 days	Cubic Meter
900 (1)b	Structural Concrete, Class A, 3000 psi, 14 days	Cubic Meter
900 (1)c	Structural Concrete, Class A, 3000 psi, 28 days	Cubic Meter
900 (1)d	Structural Concrete, Class A, 4000 psi, 28 days	Cubic Meter
900 (1)e	Structural Concrete, Class A, 5000 psi, 28 days	Cubic Meter
900 (1)f	Structural Concrete, Class A, 6000 psi, 28 days	Cubic Meter
900 (1)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

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 Steel Wire for Concrete Reinforcement	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete)
Welded Steel Wire Fabric for Concrete Reinforcement	ASTM A1064M Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
Cold-Drawn Steel Wire for Concrete Reinforcement	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete)
Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	AASHTO M 54M, Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement (ASTM A184M, Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement)
Welded Deformed Steel Wire	AASHTO M 336M, Standard Specification for Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement (ASTM 1064M, Standard Specification for
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

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

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.

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

b. Coating Application

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

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

c. Curing

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

d. Requirements for Epoxy-Coated Reinforcing Steel Bars

i. Coating Thickness

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

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

The coating thickness shall be measured on the body of a straight length of reinforcing steel bar between the deformations.

ii. Coating Continuity

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

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

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

iii. Coating Flexibility

- (a) The coating flexibility shall be evaluated by bending production coated reinforcing steel bars at a uniform rate around a mandrel of specified size within a maximum specified time as prescribed in the applicable requirements of bend test requirements of ASTM A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars. The two (2) longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius. The test specimen shall be between 20° C and 30° C.
- (b) No cracking or disbonding of the coating shall be visible to the unaided eye on the outside radius of the bent bar. Evidence of cracking or disbanding of the coating shall be considered cause for rejection of the coated reinforcing steel bars represented by the bend test sample.
- (c) Fracture or partial failure of the reinforcing steel bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test shall not be considered a flexibility failure of the coating, but shall require testing two (2) additional specimens. These two (2) specimens shall then meet the requirements of (b).
- (d) The requirements for coated reinforcing steel bars shall be met at the manufacturer's plant prior to shipment.

C. Construction Requirements

1. Order Lists

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

2. Protection of Material

a. Steel Reinforcement

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

b. Epoxy-Coated Reinforcing Steel Bars

- i. If rainy or exceptionally humid weather occurs or is anticipated, bars shall be stored under cover immediately upon delivery to site. Epoxy bars shall

- be covered with polyethylene or other materials to prevent exposure to direct sunlight.
- ii. Epoxy coated steel stored at the site shall be placed on timber sills suitably spaced so that no steel shall be laid upon or come in contact with the ground and elevated sufficiently to prevent sags in the bundles and from workers walking on the steel.
- iii. Reinforcement steel bars shall be handled and stored in manner to prevent damage to bars or the epoxy coating.
- iv. Coated reinforcing steel bars, whether individual bars or bundles of bars or both, shall be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked bundles, the protective covering shall be draped around the perimeter of the stack. The covering shall be secured adequately, and allow for air circulation around the bars to minimize condensation under the covering.
- v. All systems for handling the epoxy coated bars shall have padded contact areas to eliminate damage.
- vi. All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All bundles of coated reinforcing steel bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar to bar abrasion from sags in the bundles of coated reinforcing steel bars.

3. Bending

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

Table 902.5 Pin Diameter for Bending Bars

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

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

4. Placing and Fastening

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

Distance from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports, so that it does not vary from the position indicated on the Plans by more than 6 mm. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shapes and dimensions. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. Unless otherwise shown on the Plans or as required by the Engineer, the minimum distance between bars shall be 40 mm. Reinforcement in any member shall be placed and then inspected and approved

by the Engineer before the placing of concrete begins. Concrete reinforcement placed in violation of this provision shall be rejected and removal shall be required unless otherwise structural integrity of the structure was proved adequate by the Contractor in writing and approved by the Engineer. If fabric reinforcement is shipped in rolls, it shall be straightened before being placed. Bundled bars shall be tied together at not more than 1.80 m intervals.

5. Splicing

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

Bars shall be lapped in accordance to Table 902.6

Table 902.6 Bars Minimum Lap Distance

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

In lapped splices, the bars shall be placed in contact and wired together. Lapped splices will not be permitted at locations where the concrete section is insufficient to provide minimum clear distance of $1 \frac{1}{3}$ 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 Ø.
- b. For contact lap splices, minimum clear spacing between the contact lap splice and adjacent splices or bars shall be in accordance with the requirements below.
 - i. For parallel non-prestressed reinforcement in a horizontal layer, clear spacing shall be at least the greatest of 50 mm, nominal diameter of bar(db) and $(4/3)$ nominal maximum size of coarse aggregates (dagg).
- c. For non-contact splices in flexural members, the transverse center-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.
 - 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

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 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 inspection prior to concrete placement. Unless otherwise shown on the drawings, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 25 mm x 25 mm chamfer formed by a wood or metal chamfer strip.

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

- a. Proper foundations on ground, such as mudsills, spread footings, or pile footings should be provided. If soil under mudsills is or may become incapable

of supporting superimposed loads without appreciable settlement, it should be stabilized or other means of support should be provided.

3. Safety

Forms must be strong and sound (made of good quality and durable materials) in order to carry the full load and side pressure from freshly placed concrete. To ensure that forms are safe, correctly designed and strong enough for the expected load, Occupational Safety and Health Administration (OSHA) regulations under Section 1926.703 Safety and Health Regulations for Construction, American Concrete Institute 347 (ACI 347) – Guide to Formwork recommendations under Section 3.1 Safety Precautions in Construction and Section 3.2 Construction Practices and Workmanship, and local code requirements for formwork should be followed.

4. Delivery, Storage, Maintenance and Handling

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

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

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

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

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 found suitable after necessary repairs. In case of timber forms, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits. Reuse of job-built forms shall be permitted only when specifically approved by the Engineer.

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

D. Method of Measurement

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

E. Basis of Payment

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

Payment shall be made under:

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

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.

b. Structural Steel Materials

i. General

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

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

ii. Hot-rolled Structural Shapes

Hot-rolled structural shapes shall conform to the following specifications or as indicated in the Plans:

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

iii. Structural Tubing

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

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

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

iv. Steel Pipe

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

v. Steel Plates

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

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

vi. Steel Bars

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

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

vii. Steel Sheets

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

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

c. Steel Casting and Forgings

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

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

d. Bolts, Washers and Nuts

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

Designation	Title
Bolts	
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM F3125M	Standard specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
ASTM A449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
Designation	Title
Nuts	
ASTM A194M	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service or Both
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
Washers	
ASTM F436M	Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F959M	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series

e. Anchor Rods and Threaded Rods

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

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

f. Consumables for Welding

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

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

g. Head Stud Anchors

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

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

h. Turnbuckle

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

i. Stainless Steel Flagpole Post

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

C. Construction Requirements

a. Shop and Erection Drawings

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

b. Fabrication

i. Cambering, Curving and Straightening

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

ii. Thermal Cutting

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

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

iii. Planing of Edges

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

iv. Welded Construction

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

v. Bolted Construction

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

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

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

vi. Dimensional Tolerances

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

vii. Finish of Column Bases

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

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

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

viii. Holes for Anchor Rods

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

ix. Drain in Holes

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

x. Requirements for Galvanized Members

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

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

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

c. Shop Painting

i. General Requirements

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

ii. Inaccessible Surfaces

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

iii. Contact Surfaces

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

iv. Finished Surfaces

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

v. Surfaces Adjacent to Field Welds

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

d. Erection

i. Alignment of Column Bases

Column bases shall be set level to the required elevation with full bearing on concrete or masonry.

ii. Bracing

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

iii. Alignment

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

iv. Fit of Column Compression Joints and Base Plate

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

v. Field Welding

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

vi. Field Painting

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

vii. Field Connections

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

e. Quality Control

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

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

i. Cooperation

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

ii. Rejection

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

iii. Inspection and Testing of Welding

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

iv. Inspection of Slip-Critical High Strength Bolted Connections

The inspection of slip-critical high strength bolted connections shall be in accordance with the provisions of the RCSC Specification for Structural Joints Using ASTM F3125.

v. Identification of Steel

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

D. Method Of Measurement

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

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

E. Basis Of Payment

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

Payment shall be made under:

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

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

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.

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	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)

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%

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.

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.

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

ii. Finish and Appearance

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

iii. Sampling and Testing of AAC Blocks

Method of Sampling for Quality Test shall be as follows:

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

D. Method Of Measurement

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

E. Basis Of Payment

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

Payment shall be made under:

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

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.

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

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

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

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

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

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

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

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

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

C. Installation

1. Frames shall be set plumb and square in concrete/masonry work or framework of walls or partitions. Frames set in concrete or masonry shall be provided with two (2) rows of common wire nails 100 mm long for anchorage. The nails shall be staggered and spaced at 300 mm on center along each row. Frame set in concrete shall be installed in place prior to concrete work. Frames set in masonry work may be installed after laying of hollow concrete blocks, bricks or adobe. Space between frames and masonry shall be fully filled with cement mortar proportioned 1:3.
2. Hinged Doors Hinged doors, whether panel or flush type with standard height of 2,100 mm and width of not more than 900 mm shall be hung with four (4) loosepin butt hinges, 100 mm x 100 mm. Swing out exterior doors shall be hung with four (4) fast-pin butt hinges. Two (2) hinges shall be fitted 150 mm from top and bottom edge of door. The other two (2) hinges shall be fitted at third points between top and bottom hinges. Care should be taken to ensure that the hinges are fitted such that their pins are aligned for ease of pin insertion and smoothness of operation. For added smoothness pins should be lightly greased. Hammering of hinges to attain proper alignment shall not be allowed. For wider and heavier doors, such as Narra panel doors, an additional hinge shall be fitted 100 mm below the top hinge to counteract the door tilting action. Mounting screws shall be screwed in place in their entire length, not forced into place by hammering. Hammering of screw into place shall not be permitted.

3. Sliding Doors Overhead tracks, standard, locally manufactured as per Plans shall be installed level and mounting bracket secured in place with lag screws 270 supplied with the set. Bracket shall be spaced 1,000 mm on centers. Hangers, two (2) each per door leaf, shall be perfitted and bolted to the door rail. For panel doors, the hangers shall be centered on the door stiles. For flush doors, the hangers shall be centered 100 mm from the edges of the door. If there is no adequate space for installing the door with its attached rollers, through either end of the track the perfitted hangers shall be disassembled for connection to the rollers. After installation on the track, set the door plumb and in alignment by means of the adjustment mechanism integrated with the roller assembly.
4. Lock Installation Locks of doors shall be fitted at the same height, centered 1000 mm above the finished floor level. Locks shall be installed in conformity with the templates and instructions supplied with locksets. Holes for mounting locks shall be properly formed to provide snug fit and rigid attachment of the locks to the doors. Strike plates shall be fitted on the door frame in true alignment with the lock latch.
5. Sliding Type Window Sashes Sashes shall be trimmed to fit height of opening. A clearance of 2 mm shall be provided between the tongue's base at the top rail and the bottom of the window head. The same clearance shall be provided between the sash tongue and the groove at the window head. Paraffin wax shall be applied to contacts of sliding surfaces. The bottom rails shall be fitted with standard brass guided spaced 75 mm from both ends of the rail, mounted flush with the inner face and secured with three (3) brass screws each guide.
6. Casement Type Window Sashes Sashes shall be trimmed to fit size of opening, with provision for half lapping of meeting stiles. Right side sash shall lap onto the left side sash. Sashes shall be fitted with two (2) brass-plated narrow hinges, 50 mm x 75 mm, spaced 150 mm from top and bottom of stiles. In lieu of hinges, sashes maybe hung with cadmium-plated steel casement adjusters 200 mm long, subject to prior approval of the Engineer. The top and bottom rails of casement type window sashes shall be milled to provide for the installation of adjusters.
7. Awning Type Window Sashes Installation of awning type sashes shall be by means of casement adjusters specified under Subsection 1010.3.2 (6), Casement Type Window Sashes. 1010.4 Method of Measurement Frames of doors and windows shall be measured on the basis of number of sets completely installed and accepted by the Engineer. 271 Doors and windows shall be measured based on the number of square meters or lump sum including its hardware involved in the completed and accepted installation. Payment per square meter or in lumpsum shall include cost of required hardware and all incidental expenses, but exclusive of locks for doors. Locks shall be paid for per set completely installed. 1010.5 Basis of Payment Payment for completely installed and accepted wooden doors and windows shall be based on actual measurement and the corresponding contract unit price thereof. Payment based on Contract Unit Price shall constitute full compensation. Payment shall be made under:

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

XIV. ALUMINUM GLASS DOORS

A. Description

This Item shall consist of furnishing all aluminum glass door materials, labor, tools and equipment required in undertaking the proper installation in accordance with the Plans and this Specification.

B. Material Requirements

Frame and panel members shall be fabricated from extruded aluminum sections true to details with clean, straight, sharply defined profiles and free from defects impairing strength or durability. Extruded aluminum sections shall conform to the Specification requirements as defined in ASTM B 211, Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

Screws, nuts, washers, bolts, rivets and other miscellaneous fastening devices shall be made of non-corrosive materials such as aluminum, stainless steel, or other material equivalent.

Hardware for fixing and locking devices shall be closely matched to the extruded aluminum section and adaptable to the type and method of opening.

Vinyl weatherstrip shall be first class quality flexible vinyl forming an effective seal and without adverse deformation when installed.

Pile weather strip shall be silicon treated and free from residual wetting agents and made of soft fine hair as on wool, fur, among others.

Glazing shall conform to the requirement specified in Item 1012, Glass and Glazing.

C. Construction Requirements

For all assembly and fabrication works, the cut ends shall be true and accurately jointed, free of burrs and rough edges. Cut-out recesses, mortising, grinding operation for hardwares shall be accurately made and properly reinforced when necessary.

a. Installation Procedure

The width for door stiles and top, bottom and center rails shall be as shown on the Plans.

Main frame shall consist of head sill and jamb stiles specifically designed and machined to interfit and be joined at corners with self-threading screws

Frame sill shall be stepped and sloped with offset weep holes for efficient drainage to the exterior.

Door panel shall be accurately joined at corners, assembled and fixed rigidly to ensure weather tightness.

Aluminum glass door and main frame shall be installed in a prepared opening to be set plumb, square, level and true to details.

All joints between metal surface and masonry shall be fully caulked to ensure weather tightness.

Sliding type door panel shall be equipped with concealed roller overhead tracks with bottom guide.

Double action type door panel shall be equipped with heavy duty hinges that will control the door leaf in a close or open position.

Weatherstrip shall be furnished on edges at the meeting stiles of doors. Where aluminum is to be in contact with steel concrete cinder, block, tile, plaster or other similar masonry construction the aluminum surface shall be back painted before erection with a bituminous paint.

b. Shop Finish

Exposed aluminum surfaces shall be electro type hard coats.

c. Protection

All aluminum parts shall be protected adequately to ensure against damage during transit and construction operations.

Aluminum parts in contact with steel members shall be properly insulated by a coat of zinc chromate primer applied to the steel or by application of bituminous paint.

d. Cleaning

The Contractor is responsible for protecting all entrance units during construction, as well as the removal of protective materials and cleaning of aluminum surfaces.

Pay Item Aluminum shall be thoroughly cleaned with plain water mixed with kerosene or gasoline and then wipe surfaces using clean cotton fabric. No abrasive cleaning agents shall be permitted.

D. Method Of Measurement

Aluminum glass door, fully equipped with fixing accessories and locking devices shall be measured by square meter or by lump sum based on what is actually installed as shown on the Plans and approved by the Engineer.

E. Basis Of Payment

The area in square meter or in lump sum of aluminum glass doors installed including main frame and ready for service as provided in Section 1007.4, Method of Measurement shall be the basis of payment based on the unit bid or Contract Unit Price.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1007(1)a	Aluminum Framed Glass Door, Sliding Type	Square Meter
1007(1)b	Aluminum Framed Glass Door, Swing Type	Square Meter
1007(2)	Aluminum Framed Glass Door	Lump Sum

XV. ALUMINUM GLASS WINDOWS

A. Description

This Item shall consist of furnishing all aluminum glass window materials, labor, tools and equipment required in undertaking the proper installation in accordance with the Plans and this Specification.

B. Material Requirements

Frame and panel members shall be fabricated from extruded aluminum section true to details with clean, straight, sharply defined profiles and free from defects impairing strength or durability. Extruded aluminum section shall conform to the specification requirements defined in ASTM B211, Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire. Screws, nuts, washers, bolts, rivets and other miscellaneous fastening devices shall be made of non-corrosive materials such as aluminum, stainless steel, etc. Hardware for fixing and locking device shall be closely matched to the extruded aluminum section and adaptable to the type and method of opening. Weather strip shall be first class quality flexible vinyl forming an effective seal and without adverse deformation when installed. Glazing shall conform to the requirements specified in Item 1012, Glass and Glazing.

C. Construction Requirements

For all assembly and fabrication works the cut end shall be true and accurate, free of burrs and rough edges. Cut-outs recesses, mortising and grinding operation for hardware shall be accurately made and properly reinforced. Main frame shall consist of head, silt and jamb. All joints between metal surface and masonry shall be fully caulked. Aluminum parts in contact with steel members shall be properly insulated by a coat of zinc chromate, primer/bituminous paint applied to the steel surface. Weather strip shall be furnished on edges at the meeting stiles. Shop drawings which include window schedules, sections and multiple window assembly details shall be submitted to the Engineer for approval before installation.

a. Window Sash

Window panel shall be jointed at corners with miter and fixed rigidly to ensure weather tightness. Corners should be fastened with corrosion resistant screws and aluminum corner angles sealed with an acrylic sealant. All fixed glass is exterior glazed and all sashes are marine glazed with flexible PVC glazing. The fixed glazing shall be removed without disassembly of a sash. The vents will need to be disassembled to replace the glazing.

b. Sliding Window

Sliding windows shall be provided with nylon sheave. Sliding panels shall be suspended with concealed roller overhead tracks with bottom guide pitch outward and slotted for complete drainage. The sliding panels shall be provided with interior handles. The locking device shall be a spring loaded extruded latch that automatically engages special frame hips.

c. Casement Window

Casement window type shall be provided with two (2) hinges fabricated from extruded aluminum alloy. They shall open on stay arms having adjustable sliding friction shoes to control window panel operations. Locking device shall be one arm action handle for manual operations complete with strike plate.

d. Awning Window

The perimeter frame of the awning window type can be supplied with nailing fins. Awning window units to be installed in prepared openings in accordance with the manufacturer's recommendations and installation drawings. Frames must be securely fastened, set plumb and level without twisting, bowing or distortion

e. Fixed Type

Fixed type window members including any mullions, shall be made of aluminum. Secondary members such as friction tabs, shoes, and weather stripping guides, shall also be made of aluminum or a compatible material. The tilt housing and latch units shall be mechanically anchored to the sash rails. The latches shall be spring loaded and afford positive lock into the jamb profile. In a tilted position, the sash shall be removable to the interior.

f. Shop Finish

Exposed aluminum surfaces shall be electrolyte hand coats such as anodize, satin, powder coated, among others.

g. Protection

All aluminum parts shall be protected adequately to ensure against damage during transit and construction phase.

h. Cleaning

The Contractor does not only protect all entrance units during the construction phase but shall also be responsible for removal of protective materials and clearing the aluminum surface including glazing before work is accepted by the Engineer. Aluminum shall be thoroughly cleaned with aluminum and glass cleaning solution and then wipes surface using clean cloth rags. No abrasive cleaning materials shall be permitted in cleaning surface.

D. Method Of Measurement

Aluminum glass window fully equipped with fixing accessories and locking devices shall be measured in lump sum or square meters actually installed in place and accepted to the satisfaction of the Engineer.

E. Basis Of Payment

The area of aluminum glass windows in square meters ready for service as provided in the Bill of Quantities shall be the basis of payment based on the unit bid or Contract Unit Price which price and payment constitute all materials, labor including incidentals.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1008 (1)a	Aluminum Glass Windows, Sliding Type	Square Meter
1008 (1)b	Aluminum Glass Windows, Casement Type	Square Meter
1008 (1)c	Aluminum Glass Windows, Awning Type	Square Meter
1008 (1)d	Aluminum Glass Windows, Fixed Type	Square Meter
1008 (2)	Aluminum Glass Windows	Lump Sum

XVI. PRE-PAINTED METAL SHEETS

A. Description

This Item shall consist of furnishing all pre-painted metal sheet materials, tools and equipment, plant including labor required in undertaking the proper installation complete in accordance with the Plans and this Specification.

B. Material Requirements

All pre-painted metal sheet and roofing accessories shall be oven baked painted true to profiles indicated on the Plans as per approval of the Engineer.

1. Pre-painted Roofing Sheets Pre-painted roofing sheets shall be fabricated from cold rolled galvanized iron sheets specially tempered steel for extra strength and durability. It shall conform to the material requirements defined in PNS 67 Hot-dip Metallic Coated Steel Sheets for Roofing - Specification. Profile section in identifying the architectural moulded rib to be used is as follows: Regular corrugated, Quadrib, Tri-wave, Rib-wide, Twin-rib, and others. Desired color shall be subject to the approval of the Engineer. Gutters, Valleys, Flashings Hip and Ridge roll shall be fabricated from gauge 24 (0.60 mm thick) cold-rolled plain galvanized iron sheets specially tempered steel. Profile section shall be as indicated on the Plans. Fastening hardware shall be of galvanized iron straps, rivets or J-bolts. G.I. straps are of 0.50 mm thick x 16 mm wide x 267 mm long (gauge 26 x 5/8" x 10-1/2") and standard rivets. Base metal thickness shall correspond to the following gauge designation available locally as follows:

1. Coating thickness

Protective Coatings	Thickness (Coating Mass)
Zinc	14 microns (100 g/m ²)
55% Aluminum Zinc	14 microns (50 g/m ²)
Zinc-5% Aluminum	14 microns (95 g/m ²)
Paint coatings	
Top coat	15.20 microns
Bottom coat	6.8 microns

2. Overall thickness with protective coats

Nominal thickness (mm)	Thickness Range
0.20	0.16 – 0.25
0.30	0.26 – 0.35
0.40	0.36 – 0.44
0.50	0.45 – 0.54